INSTRUCTION MANUAL

VOLUME II

ENGINE TYPE
H21/32

Warranty Service

Tel. (82) 52-204-7852
Email. service@hyundai-gs.com / powerplant@hyundai-gs.com

Parts Sales

Tel. (82) 52-204-7824
Email. sales@hyundai-gs.com / powerplant@hyundai-gs.com

Hyundai Global Service

Centum Science Park, 79, Centum Jungang-ro,
Haeundae-gu, Busan, 48058, Korea
www.hyundai-gs.com

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1 Introduction

1.1 Essential information

Design variants

This document is valid for different design variants of turbochargers. There may be sections and descriptions of components that are not relevant for a specific turbocharger variant.

Please contact an ABB Turbocharging Service Station if you have any questions regarding a design variant (see Contact information at www.abb.com/turbocharging).

Accuracy of illustrations

The illustrations in this document are general in nature and intended for ease of understanding. Differences in detail are therefore possible.

1.2 Registered trademarks

The trademarks of outside companies are used in this document. These are marked with the ® symbol.

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1.3 Related documents

Chapter	Document number
Operation Manual / 1 Introduction	HZTL4005
Operation Manual / 2 Safety	HZTL4022
Operation Manual / 3 Safety data sheet *)	Serial number of the turbocharger

Table 1: Related documents

*) This chapter is only available in serialised operation manuals.

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1.4 Layout and function of the turbocharger

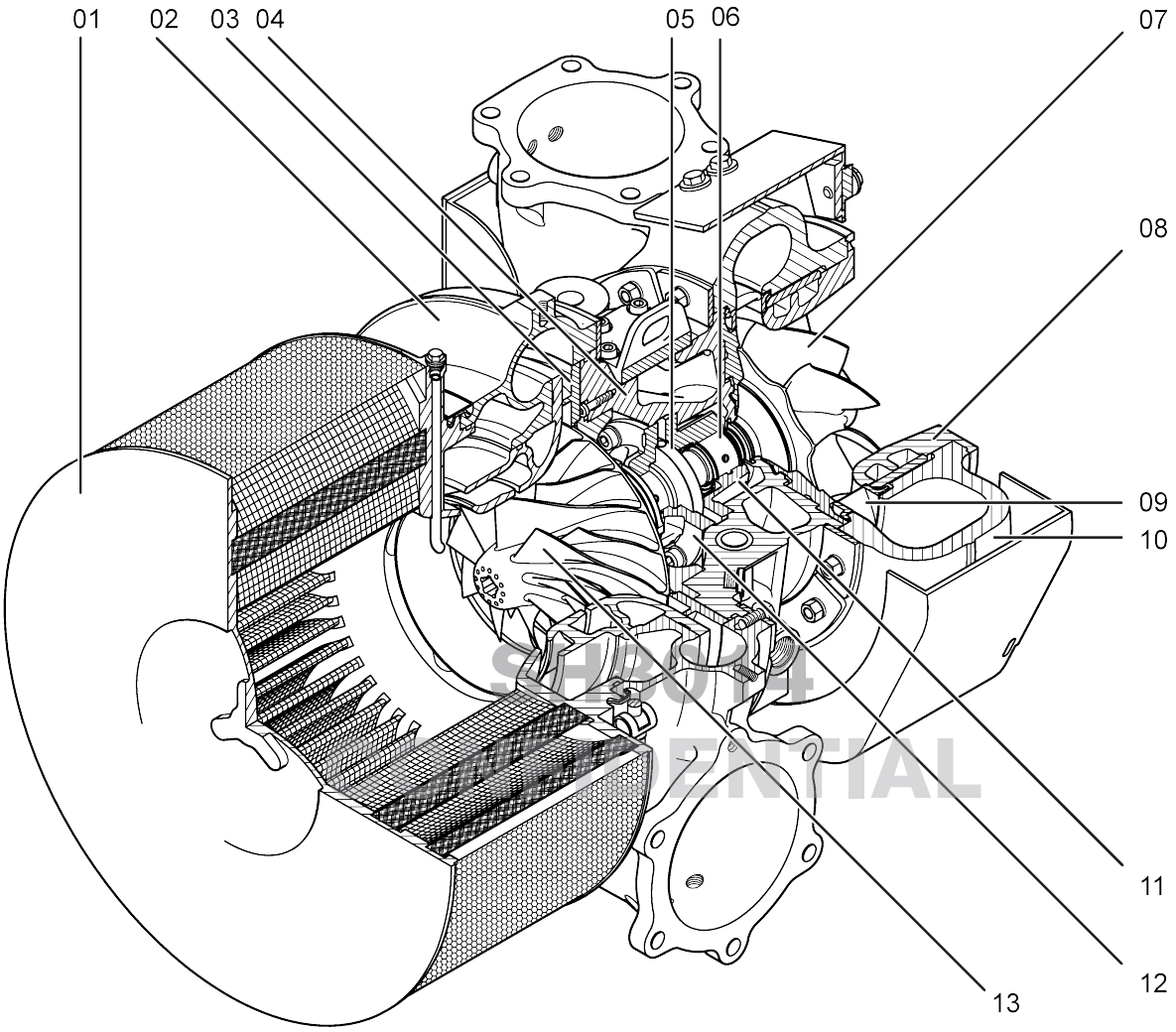


Fig. 1: Layout and function of the turbocharger

01	Filter silencer / air suction branch	08	Gas outlet flange
02	Compressor casing	09	Nozzle ring
03	Diffuser	10	Turbine casing
04	Bearing casing	11	Turbine-end bearing flange
05	Axial thrust bearing	12	Compressor-end bearing flange
06	Radial plain bearing	13	Compressor wheel
07	Turbine		

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Mode of operation

The turbocharger is a turbomachine and consists of the following main components:

- Turbine
- Compressor.

These components are installed on a common shaft and form the rotor.

The exhaust gases of the internal combustion engine flow through the turbine casing (10) and the nozzle ring (09) onto the turbine (07). The turbine (07) uses the energy contained in the exhaust gas to drive the rotor and, hence, the compressor wheel (13). The exhaust gases then reach the atmosphere through the exhaust gas pipe connected to the gas outlet flange (08).

The compressor wheel (13) sucks fresh air through the air suction branch or the filter silencer (01). In the compressor wheel (13), the energy required for building up the pressure is transferred to the air. By flowing through the diffuser (03) and the compressor casing (02), the air is compressed further and is then directed to the engine cylinders.

The rotor runs in two radial plain bearings (06) which are located in the bearing casing (04) between the compressor and turbine. The axial thrust bearing (05) is located between the two radial plain bearings.

The plain bearings are connected to a central lubricating oil duct which is normally supplied by the lubricating oil circuit of the engine. The oil outlet always lies at the deepest point of the bearing casing (04).

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1.4.1 Function of the compressor wheel cooling

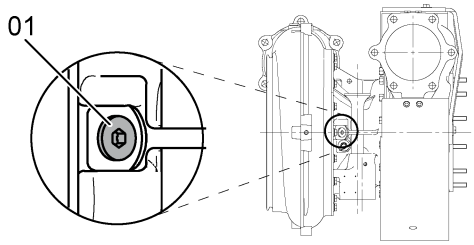


Fig. 2: Compressor wheel cooling

Depending on the application of an A100 radial turbocharger, the turbocharger is equipped with compressor wheel cooling. With compressor wheel cooling, after the compressor air has cooled down by passing through the charge air cooler on the engine side, it is supplied to the turbocharger for cooling the compressor wheel. Cooling of the compressor wheel is compulsory to ensure the reliability and replacement intervals for the relevant operating conditions. In the turbocharger version with compressor wheel cooling, the cooling air is supplied through a lateral connection in the bearing casing (01).

In addition, the turbocharger version with compressor wheel cooling is indicated by the turbocharger type (M6..) on the rating plate.

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1.5 Warning plates on the turbocharger

Warning plates are affixed at the following locations:

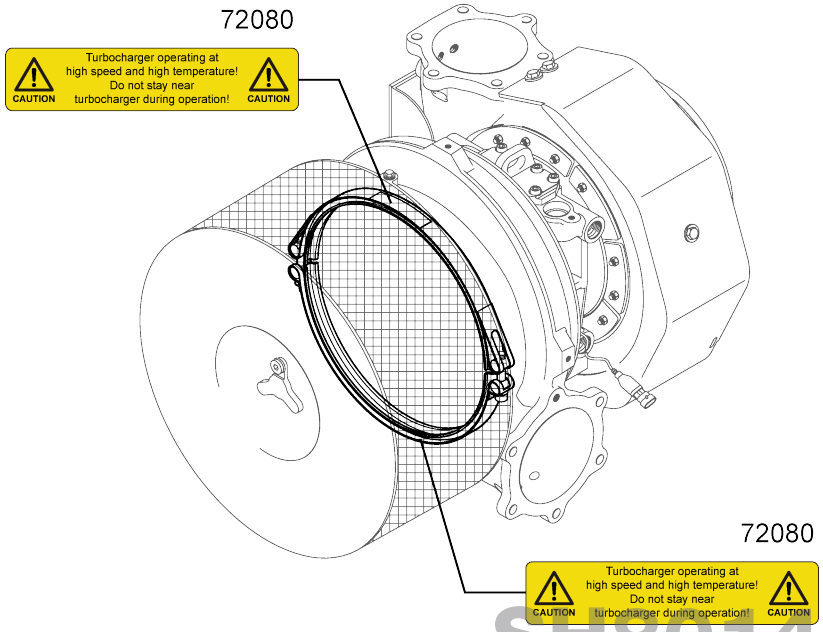


Fig. 3: Warning plate locations

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If warning plates are not present in the designated locations or not readable, proceed as follows:

- Order new warning plates from ABB Turbocharging Service Stations.
- Remove any warning plates that have become unreadable.
- Clean and degrease the areas designated for the warning plates.
- Fit new warning plates and remove protective sheets.

Turbochargers supplied to the enginebuilder without insulation must be equipped later with warning plates on the insulation. This is the responsibility of the enginebuilder.

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1.6 Locations of the rating plates

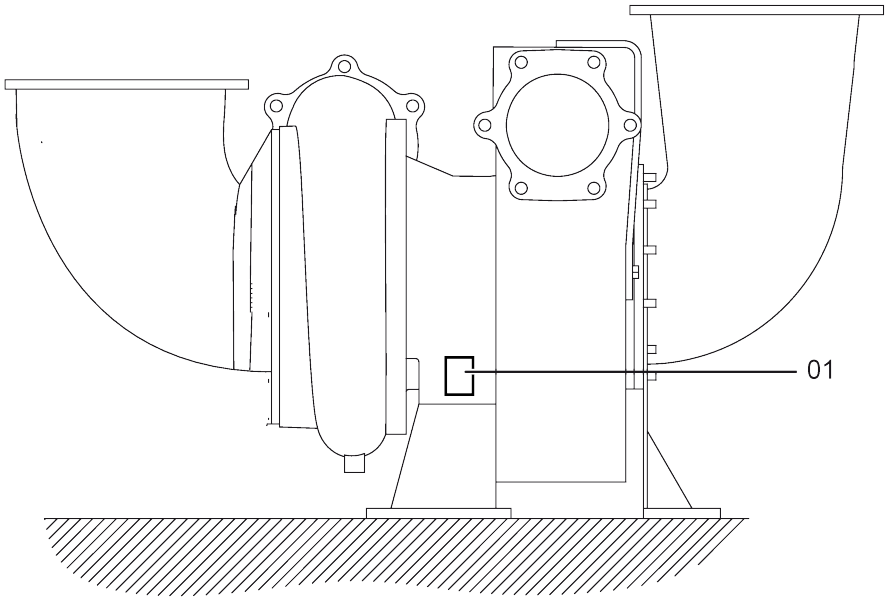


Fig. 4: Locations of the rating plates

One rating plate (01) each is attached on the left and the right side of the turbocharger bearing casing.

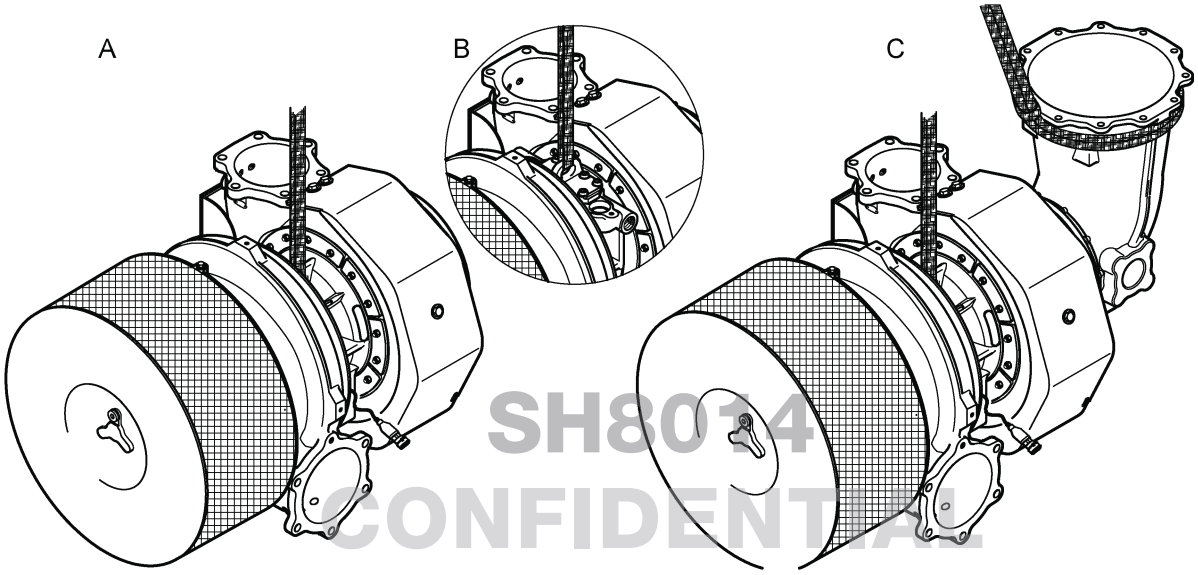
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2 Removing and Installing

2.1 Turbocharger weight and transportation

Lifting gear with a sufficient load limit must be used for transporting the turbocharger. The weight specified below applies to the heaviest variant possible. Depending on the specification, the weight specified on the rating plate may be lower than the standard value specified here.



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Fig. 5: Suspension of complete turbocharger unit

A Turbocharger with oil-cooled bearing casing
B Turbocharger with water-cooled bearing casing
C Complete turbocharger unit with gas outlet casing

Product	Weight of complete turbocharger unit [kg]
A130-M	210
A135-M	300
A140-M	500
A145-M	850

Table 2: Weight of complete turbocharger unit

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2.2 Removing the turbocharger

▶ Disconnect all pipes according to the instructions of the enginebuilder.

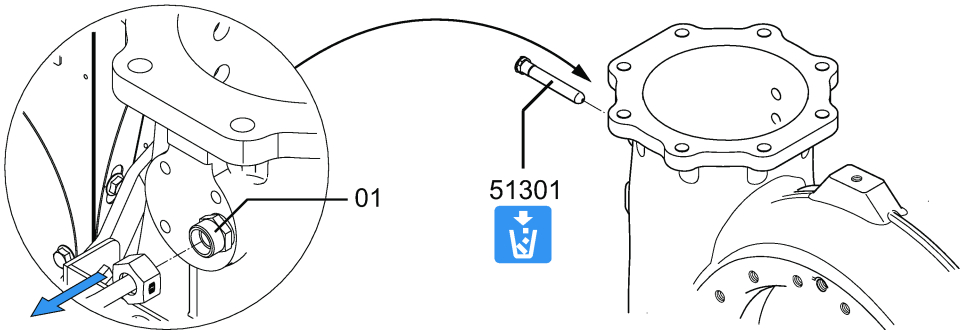


Fig. 6: Turbine cleaning nozzle

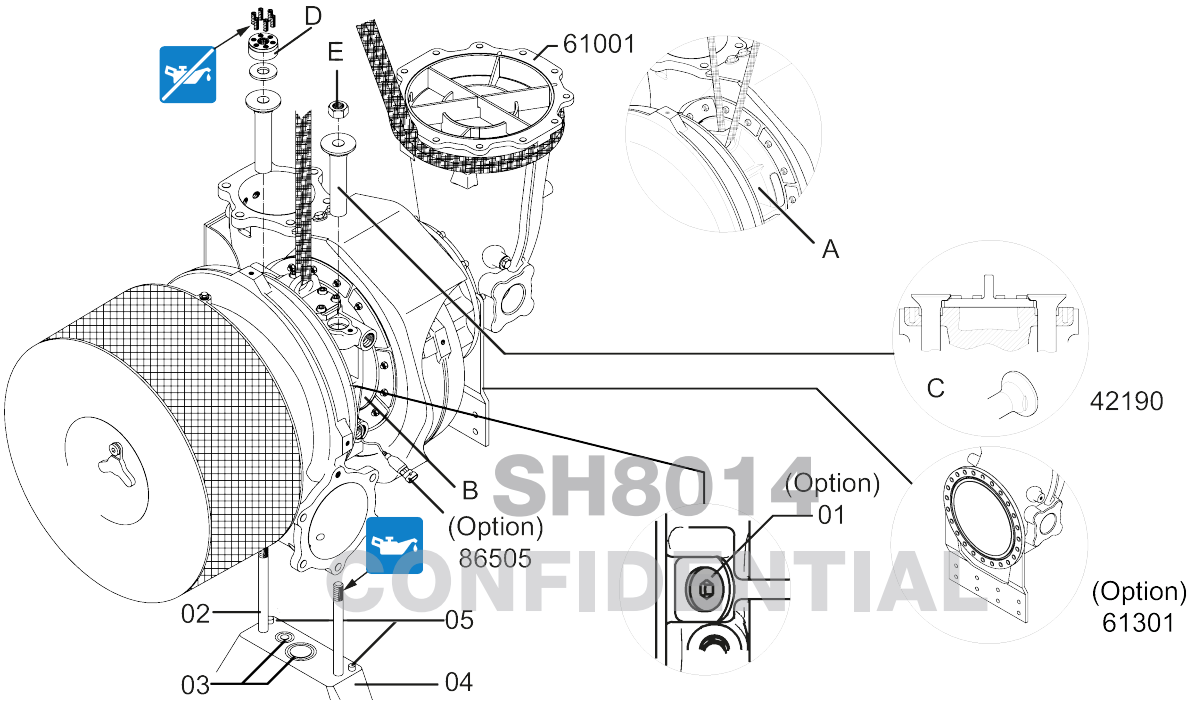
▶ If present: Loosen the turbine cleaning connection.
The cleaning nozzle (51301) must be replaced after each removal procedure. If the cleaning nozzle is not to be replaced, the screw connection (01) must not be loosened during disassembly.

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The gas outlet casing (61001) can remain fitted in the exhaust gas pipe if the locking nuts are accessible. Otherwise the complete turbocharger unit including gas outlet casing must be removed.

- ▶ If present: Loosen and remove the compressor wheel cooling connection. Close the compressor wheel cooling opening with a screw plug (01).
- ▶ If present: Disconnect the plug to the speed sensor (86505) and secure the rolled-up cable on the turbocharger. This protects the plug from being crushed.



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Fig. 7: Removing the turbocharger

A Oil-cooled bearing casing
B Water-cooled bearing casing
C Position of expansion sleeves
D Clamping nut
E Standard nut

- ▶ Apply penetrating oil to thread of stud (02) and nut and let it work in. Do not oil the pressure screws of the clamping nut (D).
- ▶ If present: Detach the support (61301) from the engine support.

Depending on the bracket version (04), two positioning pins (05) can be used for positioning and safeguarding against wrong fitting of the turbocharger. Therefore the turbocharger must always be removed from and installed on the bracket vertically.

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Version with water cooling



⚠ CAUTION

Freezing of the cooling water in the bearing casing

If cooling water freezes in the bearing casing, this can lead to severe damage.

- For transport and storage of the turbocharger, drain the cooling water from the bearing casing via one of the two bottom openings of the water connections.

2.2.1 Fastening of the turbocharger

Depending on the type and version, the turbocharger can be fastened in different ways. The appropriate procedure must be chosen to undo the connection.

Oil-cooled bearing casing (A)

- Attach lifting gear to the suspension eye.
- Loosen and remove nuts (E). If clamping nut (D) is present: Loosen in accordance with chapter Loosening the clamping nut →12.
- Positioning the turbocharger for storage →13.

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Water-cooled bearing casing (B)

- Loosen and remove water connections. Close the openings of the water connections with screw plugs.
- Attach lifting gear to the suspension eye.
- Loosen and remove nuts (E). If clamping nut (D) is present: Loosen in accordance with chapter Loosening the clamping nut →12.
- Positioning the turbocharger for storage →13.

Hydraulic loosening (round special nut)

- Attach lifting gear to the suspension eye.
- Loosen the round special nut with a hydraulic tool according to the instructions of the enginebuilder.
- Positioning the turbocharger for storage →13.

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2.2.2 Loosening the clamping nut

⚠ CAUTION

Incorrect procedure can make loosening impossible

If individual pressure screws are fully relieved, the pressure screws can become compressed, making it impossible to loosen them.

▶ Comply with the following steps for loosening the pressure screws.

⚠ CAUTION

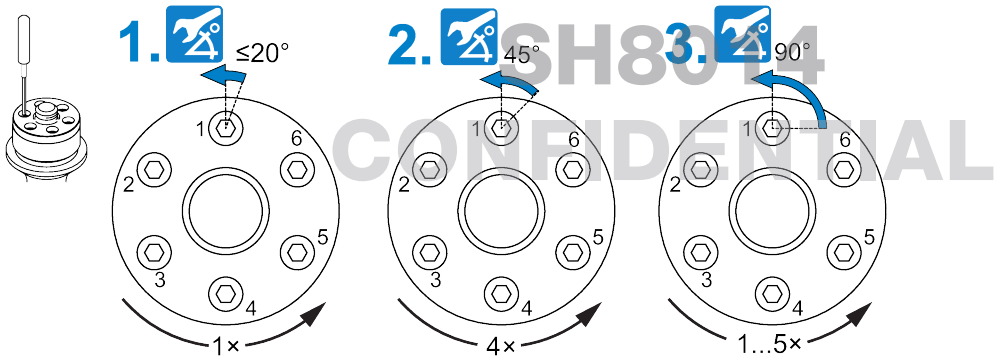
Do not clean pressure screws

The pressure screws are equipped with a permanent sliding layer that must not be removed. In case of non-compliance, it cannot be ensured that the necessary tension force is reached.

▶ Do not clean pressure screws.

▶ Do not lubricate pressure screws.

If a screw jams, the previously loosened screw must be tightened again a little.



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Fig. 8: Loosening the clamping nut

1. Working in a circle, break loose each pressure screw (≤ 20°).
2. Working in a circle, loosen each pressure screw by 45° in 4 rounds.
3. Working in a circle, loosen each pressure screw by 90° in 1...5 rounds until all of the pressure screws have been relieved.

▶ Loosen clamping nut by hand.

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2.2.3 Positioning the turbocharger for storage

⚠ WARNING

Risk of tipping

If the turbocharger is not positioned stably, it may tip over. This can result in serious personal injury.

- ▶ Place the turbocharger on a clean, level support.
- ▶ Secure the turbocharger to prevent it from tipping over by using wooden beams and wedges and by taking the centre of gravity into account.

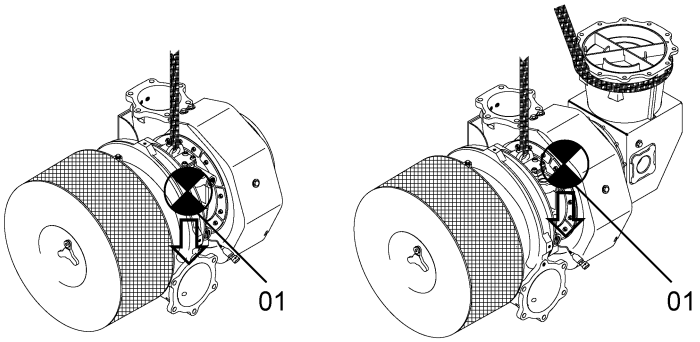


Fig. 9: Turbocharger centre of gravity

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01 Centre of gravity

- ▶ Remove turbocharger from engine support, set it down properly in an appropriate place and secure it.
- ▶ Close or cover the openings of the turbocharger and support.

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2.3 Installing the turbocharger

2.3.1 Inserting gaskets

⚠ CAUTION

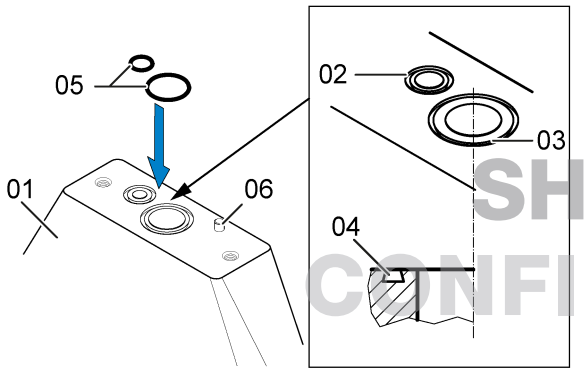
Inserting the gaskets

Gaskets that are forgotten, damaged or improperly inserted will lead to oil leaks.

- ▶ Always use new gaskets and insert them carefully into the slot.

The oil is supplied (02) and drained (03) through the bracket (01).

The necessary sealing is provided by O-rings. The O-rings are not included in the ABB Turbo Systems scope of delivery.



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Fig. 10: Inserting gaskets into the bracket

01	Bracket	04	Slot for O-ring
02	Oil supply	05	O-rings
03	Oil drain	06	Pin (optional)

Pin (06) as installation safety device

Turbochargers can have an oil inlet either on their right or left side; the oil inlet position can be different for the turbocharger fitted on the left and on the right engine bank.

A pin can be installed in every support as an installation safety device to prevent inadvertent incorrect fitting. This pin fits into the respective slot on the foot of the bearing casing. Instructions of the enginebuilder must be observed.

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2.3.2 Fitting threaded rods

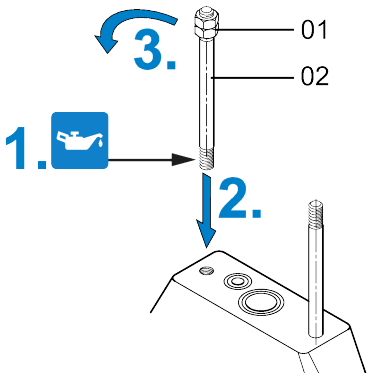


Fig. 11: Inserting the threaded rods

1. Lightly oil the surfaces of the threaded rods (02) to be screwed in.
2. Screw the threaded rods into the bracket with the aid of locknuts (01).
3. Remove nuts (01) again.

Requirements for the threaded rods

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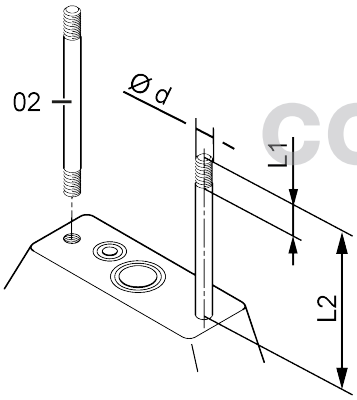


Fig. 12: Requirements for threaded rods

Product	Diameter Threaded rod [mm]	Material DIN / ISO 898 (Part 1)	Thread length L1 [mm]	Oil-cooled L2 [mm]	Water-cooled L2 [mm]
A130	Ø 16 / M16	10.9 / 12.9	≥ 30	250	250
A135	Ø 20 / M20	10.9 / 12.9	≥ 30	270	325
A140	Ø 24 / M24	10.9 / 12.9	≥ 70	350 … 360	410 … 420
A145	Ø 30 / M30	10.9 / 12.9	≥ 80	415 … 425	--

Table 3: Requirements for threaded rods

Fastening material, scope of delivery

The threaded rods and nuts for fastening the turbocharger on the bracket are not included in the ABB Turbo Systems scope of delivery.

The clamping nuts are included in the ABB Turbo Systems scope of delivery.

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2.3.3 Placing the turbocharger on the bracket

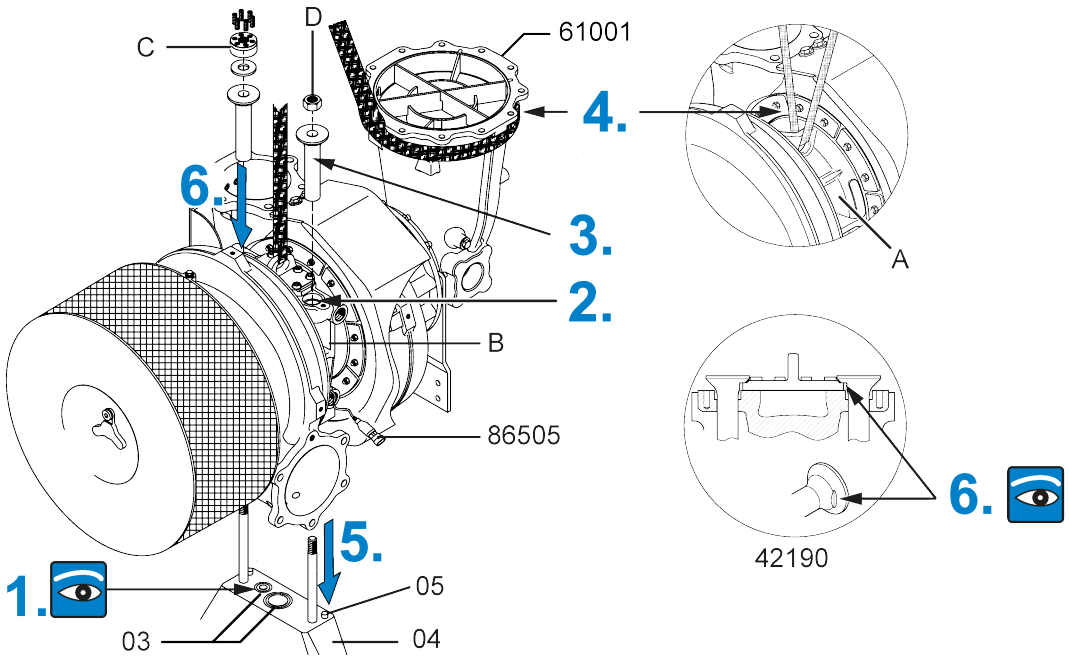


Fig. 13: Placing the turbocharger on the bracket

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A Oil-cooled bearing casing
B Water-cooled bearing casing
C Fixing with clamping nut
D Fixing with standard nut

▶ Make sure that covers of the oil and water connections are removed.

1. Make sure that the gaskets (03) are not damaged and are positioned correctly in the slots.
2. Clean the contact surfaces of the expansion bushes (42190) in the bearing casing.
3. Clean the expansion bushes (42190).
4. Attach the lifting gear to the suspension eye of the bearing casing (A/B) and loop around the gas outlet casing (61001). If the gas outlet casing is already fitted in the exhaust gas pipe, the attachment of the lifting gear on the bearing casing is sufficient.
5. Position the turbocharger on the bracket (04) and align it. Pay attention to the positioning pins (05) in the bracket.
6. When fixing with a standard nut (D), fit expansion bushes (42190) in the correct position in the slot (only relevant for older, water-cooled versions).

Safeguard against wrong fitting (only for water-cooled bearing casings)

Depending on the bracket version (04), two positioning pins (05) can be used for positioning and safeguarding against wrong fitting of the turbocharger. Therefore the turbocharger must always be removed from and installed on the bracket vertically.

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▶ Observe the instructions for the fastening variant at hand.

- Fastening the turbocharger with a standard nut →17 (A130 - A140)
- Fastening the turbocharger with a clamping nut →18 (A140 and A145)

2.3.4 Fastening the turbocharger with a standard nut

▶ Fit the nuts and tighten them according to variant 1 or 2 in the table below.

Product	Through hole in bearing casing [mm]	Fixing screws [mm]	Variant 1: Tightening torques [Nm] **)	Variant 2: Hydraulic pre-tensioning forces [kN]
A130	Ø 17	M16	280	110
A135	Ø 21	M20	560	175
A140	Ø 25	M24	960	250

Table 4: Tightening torque for standard nuts

**) When the turbocharger is mounted on the engine support, the bolt threads and screw heads must be lightly oiled (assumed friction coefficient μ = 0.12 for tightening torque)

▶ Remove the lifting gear.

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2.3.5 Fastening the turbocharger with a clamping nut

Preparations for tightening the clamping nut

⚠ CAUTION

Do not clean pressure screws (04)

The pressure screws are equipped with a permanent sliding layer that must not be removed.

Do neither clean nor lubricate the pressure screws. In case of non-compliance, it cannot be ensured that the necessary tension force is reached.

- ▶ Do not clean pressure screws.
- ▶ Do not lubricate pressure screws.

In order to correctly fit the clamping nuts, the pressure screws (04) must not protrude from the clamping nuts (03) in the direction of the thrust washer (02).

- ▶ Make sure the pressure screws do not protrude in the direction of the thrust washer.

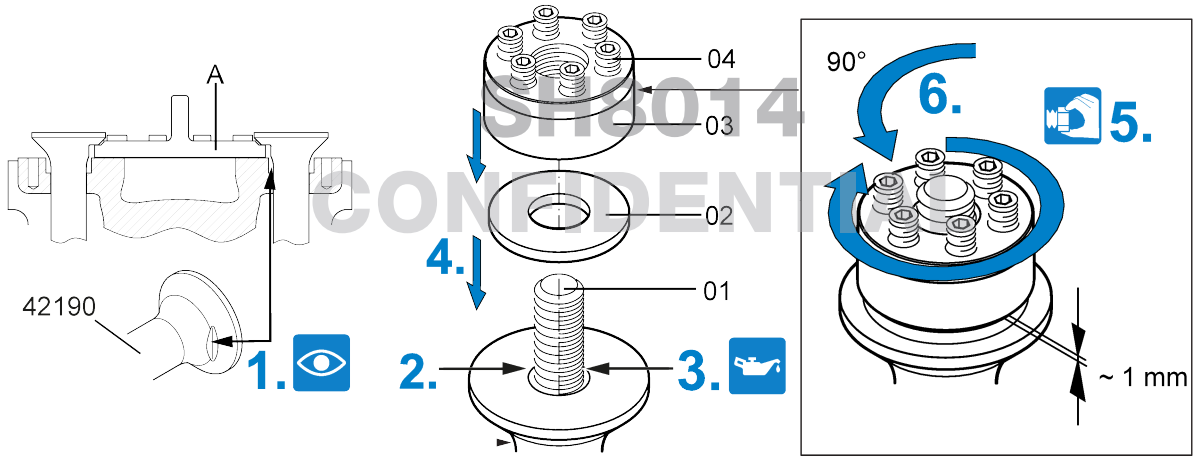


Fig. 14: Preparing the clamping nut for the tightening procedure

1. Check whether the expansion bushes (42190) with recess are correctly positioned and do not touch the flange of the core hole cover (A).
2. Clean the thread of the bolt (01) and the contact surface.
3. Lightly oil the bolt thread.
4. Position the thrust washer (02) in place.
5. Tighten clamping nut (03) by hand.
6. Unscrew clamping nut (03) by ¼ of a turn (90°).

The distance between the thrust washer and the clamping nut is now about 1 mm.

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Tightening pressure screws

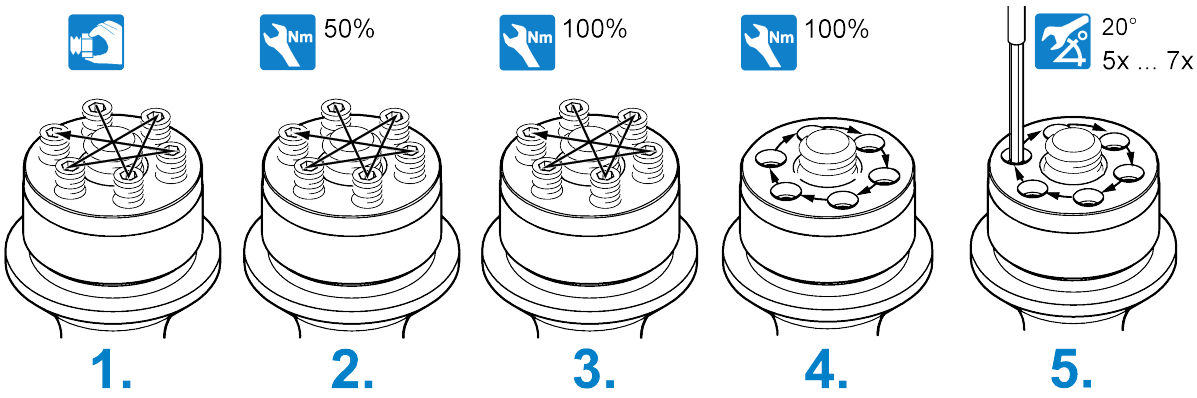


Fig. 15: Tightening pressure screws

Product	Fixing screw [mm]	Tightening torques [Nm]
A140	M24	35
A145	M30	45

Table 5: Torque-controlled tightening of the pressure screws

1. Screw in pressure screws crosswise by hand until reaching the stop.
2. Tighten pressure screws crosswise to 50 % of the tightening torque specified in the table.
3. Tighten pressure screws crosswise to 100 % of the tightening torque specified in the table.
4. Work in a circle to tighten all pressure screws to 100 % of the tightening torque specified in the table.
5. Tighten pressure screws to 100 % in 5 ... 7 rounds until the required residual tightening angle of < 20° is achieved.

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2.3.6 Connecting the turbocharger

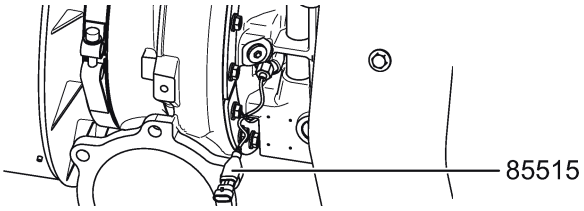


Fig. 16: Connecting the speed sensor

- ▶ Connect cable to speed sensor (86515).
- ▶ Connect all gas, water and air lines according to the instructions of the enginebuilder.

Version with water-cooled bearing casing

- ▶ Fit the water pipes according to the instructions of the enginebuilder.

Version with compressor wheel cooling



⚠ CAUTION

Failure of compressor wheel cooling

Any prolonged failure of the compressor wheel cooling will shorten the replacement interval of the compressor wheel.

- ▶ Make sure there is an uninterrupted supply of cooling air during operation.

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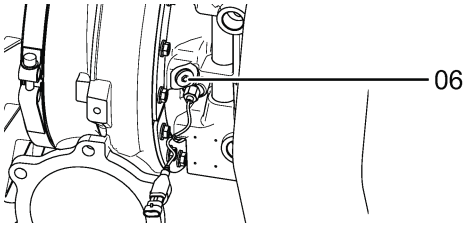


Fig. 17: Connecting the compressor cooling air intake

- ▶ Remove the screw plug on the connection for the compressor wheel cooling (06) and fit the cooling air line.

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2.3.7 Attaching the support

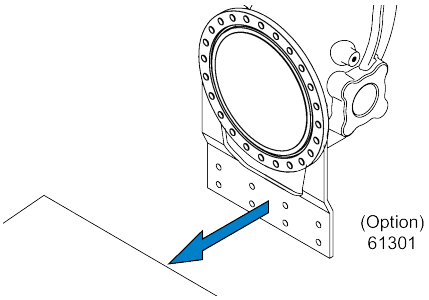


Fig. 18: Attaching the support

▶ If present: Attach support (61301) to engine support or to a connecting piece.

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3 Commissioning

3.1 Oil supply

3.1.1 Introduction

In all operating states, a functioning and carefully executed oil supply is an important prerequisite for trouble-free operation of the turbocharger.

The lubrication of the turbocharger is usually carried out with oil from the engine oil circulation.

- Comply with the enginebuilder's specifications regarding the selection of lubricating oil and the oil change intervals.

3.1.2 Pre-lubrication

Pre-lubrication must be carried out as follows:

- Switch on the oil pump.
- Build up oil pressure &.
- Do not exceed a pre-lubrication time of 2 minutes.
- Start the engine.
- Let the oil pump run until the pump driven by the engine generates sufficient pressure.

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3.1.3 Oil filtering

Filtering the lubricating oil with a filter mesh width of ≤ 0.034 mm is sufficient for this turbocharger.

3.1.4 Oil pressure

Comply precisely with the oil pressure before the turbocharger for trouble-free operation.

The admissible values are specified in chapter Monitoring operation →27.

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3.1.5 Oil orifice in the bearing casing

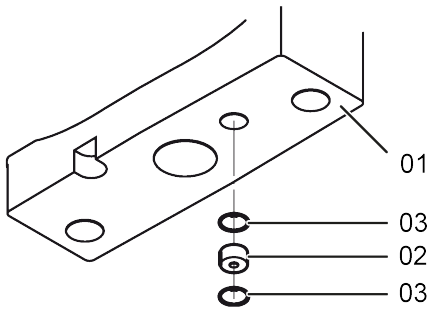


Fig. 19: Oil orifice

01 Bearing casing
02 Oil orifice
03 Circlip

With an oil inlet pressure of more than 3 bar of overpressure (with engine under load) upstream of the turbocharger, the bearing casings are equipped with an orifice at the oil inlet as standard.

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3.2 Inspection procedures

3.2.1 Introduction

Inspection procedures include preventative visual controls, monitoring and measuring work before and during commissioning. Inspection procedures enable changes to the turbocharger to be detected. Machine damage can be prevented.

3.2.2 Checks before commissioning

Filter mat (if available)

- ▶ Check for damage and contamination.

Lubricating system



⚠ CAUTION

Contaminated oil

Serious damage to engine or property can be caused by dirt and solid material particles in the oil.

- ▶ For the initial commissioning phase and after all service work, flush the complete lubricating system with warm oil.
- ▶ Use special running-in filters when running in the engine and after all service work on the lubricating system.

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- ▶ Check that the oil filter is clean before commissioning.
- ▶ Check the oil pressure in the oil supply pipes.

Warning plates

- ▶ Check whether warning plates are present and legible.
- ▶ Check whether the protective sheets have been removed from new warning plates.

Version with compressor wheel cooling:



⚠ CAUTION

Failure of compressor wheel cooling

Any prolonged failure of the compressor wheel cooling will shorten the replacement interval of the compressor wheel.

- ▶ Make sure there is an uninterrupted supply of cooling air during operation.

- ▶ Check whether the compressor wheel cooling is fitted on the bearing casing.

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Version with water-cooled bearing casing



⚠ CAUTION

Failure of bearing casing cooling

Any prolonged failure of the water cooling will shorten the lifetime of the turbocharger.

- ▶ Make sure that an uninterrupted supply of cooling water is provided during operation.

- ▶ Check whether the water pipes are fitted on the bearing casing.

3.2.3 Checks after commissioning (engine in idle mode)

Lubricating system

- ▶ Keep to the lubricating oil pressure at the inlet.
- ▶ Keep to the lubricating oil temperature at the inlet.
- ▶ Refer to chapter Monitoring operation →27 for admissible values.

Leaktightness of pipes

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⚠ WARNING

Risk of burning from hot gas

Escaping gases are hot and will lead to serious burns in the event of contact.

- ▶ Check all pipes for leaks in accordance with the enginebuilder's instructions.

3.2.4 Checks when starting up the engine

If present:

- ▶ Measure speed, oil pressure and charging pressure at various engine performances.
- ▶ Measure the exhaust gas temperature before and after the turbine.
- ▶ Measure the air temperature before and after the compressor.
- ▶ Compare the measured values with the values of the acceptance report. Different operating conditions indicate a malfunction (see chapter Eliminating malfunctions →60).

Lubricants and pastes used during assembly can liquefy or vaporise and escape as oily fluids during the initial hours of operation. Continual escape of an oily fluid indicates an oil leak. If there is a leak, contact an ABB Turbocharging Service Station.

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3.3 Commissioning after taking out of operation

If present

- ▶ Remove cover plates (blind flanges) from the compressor casing, the gas inlet and the gas outlet.
- ▶ Remove the screw plugs on the water connections and fit the water pipe.

Version with compressor wheel cooling:

- ▶ Remove the screw plug on the cooling air connection and fit the cooling air line.

General

- ▶ Check the exhaust gas pipe before and after the turbine for combustion residues or water residues and clean it. Remove any foreign objects that may be present.
- ▶ Check and clean filter silencer or air supply line, and remove any foreign objects that may be present.
- ▶ Put engine-side oil circulation to the turbocharger into operation.
- ▶ Prepare the turbocharger for operation (see Checks before commissioning →24).
- ▶ The turbocharger is now ready for operation.

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4 Monitoring operation

4.1 Oil pressure, oil temperature

Lubricating oil pressure, oil inlet

To limit the oil flow rate through the turbocharger to the admissible values with the engine at full load, an oil orifice is mandatory or already fitted at the turbocharger oil inlet if the oil inlet pressure is > 3 bar.

⚠ CAUTION

Assuring lubricating oil pressure

Serious damage to the engine or property can result from a missing or insufficient lubricating oil supply.

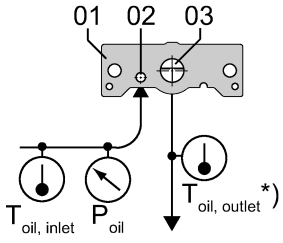
- ▶ The lubricating oil pressure must be monitored during operation and the necessary pressure assured at the oil inlet.

Status for operation	Pressure at oil inlet upstream of the turbocharger [bar] Overpressure
Normal operation	$2.0 < p_{oil} \leq 4.5$ *)
Engine start: Cold oil, admissible for a maximum of 15 minutes	< 8.0
Engine idling, admissible for a maximum of 1 hour	$0.5 < p_{oil} \leq 2.5$
Pre-lubrication and post-lubrication (engine stopped)	$0.5 < p_{oil} \leq 1.0$
Warning signal: ($n \geq 0.5 \times n_{Bmax}$)	< 1.25
Alarm signal: Not admissible. Stop the engine immediately.	< 0.6

Table 6: Lubricating oil pressure at oil inlet before turbocharger

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*) Depending on use of an oil orifice in accordance with the enginebuilder's specifications.



01 Turbocharger contact surface
02 Oil inlet
03 Oil outlet
P Oil pressure measuring point
T Oil temperature measuring point

For monitoring the lubricating oil pressure, ABB Turbo Systems recommends installing a "P" manometer immediately upstream of the turbocharger oil inlet before the orifice. If the pressure is controlled electronically, the relevant signals should be triggered at the warning and alarm values.

*) If the drain pipe is vented, the lubricating oil temperature measuring point can be installed at the outlet in the vent tank. Otherwise the measurement should be taken in the drain pipe as close to the turbocharger as possible.

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Lubricating oil temperature at the inlet

⚠ CAUTION

Machine damage

If the oil temperature at the oil inlet exceeds the admissible range, this may lead to engine damage.

▶ Observe oil temperature at the oil inlet according to the following table.

Status for operation	Oil temperature at the inlet $T_{oil,inlet}$
Admissible	30 … 105 °C
Temporarily admissible (< 1 h) → alarm	> 105 °C
Not admissible → stop engine	> 110 °C
Not admissible → do not start engine (before start: preheat oil)	< 30 °C

Table 7: Lubricating oil temperature at the inlet

Lubricating oil temperature at the outlet

The oil temperature at the outlet is mainly dependant on:

- Lubricating oil temperature and pressure at the oil inlet
- Engine load and turbocharger speed
- Exhaust gas temperature

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The maximum admissible oil temperature at the outlet is listed in the following table. The specified oil outlet temperature is to be considered as alarm value for the turbocharger operation and must be monitored according to the current regulations.

Status for operation	Oil temperature at the outlet $T_{oil,outlet}$
Admissible	≤ 160 °C
Temporarily admissible → alarm	> 160 °C
Not admissible → stop engine	> 180 °C
Admissible	≤ $T_{oil,inlet}$ + 55 K
Temporarily admissible → alarm	> $T_{oil,inlet}$ + 55 K

Table 8: Lubricating oil temperature at the outlet

If the turbocharger was operated for a longer period of time outside of the admissible range, ABB Turbo Systems recommends to have the turbocharger inspected by an ABB Turbocharging Service Station.

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4.2 Exhaust gas temperature before turbine



⚠ CAUTION

Factors influencing replacement intervals

Operation above the operating limits defined on the rating plate can shorten the recommended replacement intervals considerably.

- Measure exhaust gas temperature upstream of turbine.
- Comply with operating limits on rating plate.

- Definition and explanations concerning rating plate: refer to chapter 2 of Operation Manual / Safety.
- Operating limits: refer to chapter 3 of Operation Manual / Safety data sheet or examine rating plate.

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4.3 Turbocharger speed

4.3.1 Introduction

A speed measuring system enables the constant monitoring of the turbocharger speed.

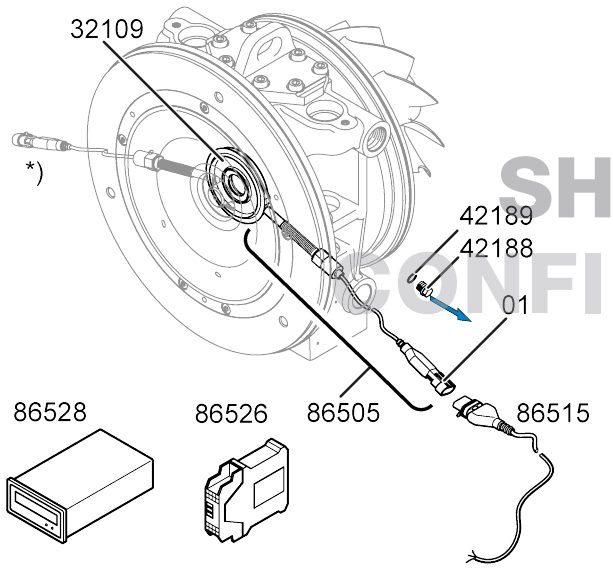
⚠ CAUTION

Do not strain cables

If you pull the speed measurement cables too hard, contacts can be pulled out.

▶ Do not strain the speed measurement cables by pulling.

4.3.2 Layout and overview



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Fig. 20: Layout and overview of speed measurement system

86505	Speed sensor	42188	Screw plug
86515	Cable connector	42189	Gasket
86526	F/I converter	01	Plug with integrated voltage limiter
86528	Tachometer	*)	Installation variant for speed sensor
32109	Sealing disc with cams		

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4.3.3 Speed differences with several turbochargers per engine

The speeds of all turbochargers on an engine vary only slightly from each other in standard operation.

The difference between the highest and the lowest turbocharger speed must not be more than 3 %, relative to the speed limit n_{Bmax}.

If this permissible range of difference is exceeded, the following steps must be carried out:

- Reduce the engine performance immediately to the point at which the maximum turbocharger speed does not exceed 70 % of n_{Bmax}.
- If the engine cannot be stopped, it can continue to be driven at this reduced engine load or turbocharger speed.
- If a turbocharger surges continuously, the engine performance must be reduced further.
- Measure the temperatures in the air lines and gas piping from and to the turbochargers and compare with normal values. If clear deviations of temperature are found, the nearest ABB Turbocharging Service Station has to be contacted.
- Check the pressure loss of the alternative air inlet and compare it with normal values.

If the engine can be stopped temporarily:

- Inspect air lines, gas piping and the turbochargers and remedy any malfunctions.
- In any case, contacting the nearest ABB Turbocharging Service Station is recommended.

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4.3.4 Malfunctions on the speed measurement system

In the case of malfunctions of the speed measurement system, refer to the chapter entitled Troubleshooting/Speed measurement system →66.

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4.3.5 Replacing the speed sensor



⚠ WARNING

Hot speed sensor

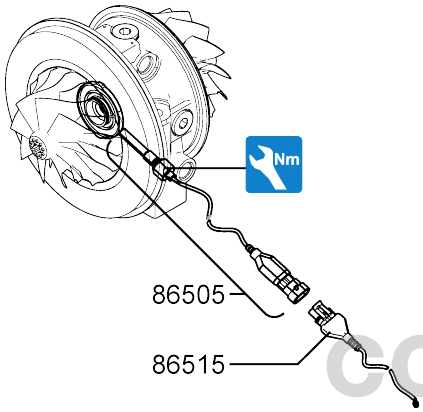
Danger of burns. The speed sensor can reach temperatures of more than 100 °C during operation.

- ▶ Wear safety gloves when disassembling the speed sensor.



Wear safety gloves to protect against thermal hazards.

The speed sensor supplied by ABB is equipped with a sealing lip and an O-ring. No additional gasket is required during assembly.



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Fig. 21: Replacing the speed sensor

Part number	A130	A135	A140	A145
86505	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm

Table 9: Tightening torque (86505)

- ▶ Reduce the engine performance to idling and then stop the engine. Pay attention to post-lubrication (Stopping the engine →41).
- ▶ Switch off the lubricating oil supply to the turbocharger.
- ▶ Disconnect cable connector (86515) from speed sensor (86505).
- ▶ Unscrew and remove defective speed sensor (86505).
- ▶ Screw in new speed sensor (86505) as far as it will go and tighten.
- ▶ Connect cable connector (86515) to speed sensor (86505).
- ▶ Switch on lubricating oil supply to the turbocharger.

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5 Operation and service

5.1 Noise emission



⚠ WARNING

Danger due to noise

Exposure to noise can harm the hearing system, impair health and the psychological state and may lead to lack of attention and irritation.

- ▶ When the engine is running, always wear ear protection.
- ▶ Always wear ear protection if the sound pressure level exceeds 85 dB(A).



Wear ear protection.

The emission sound pressure level (A-weighted) is measured at a distance of 1 meter from the turbocharger.

The highest value of the emission sound pressure level[1)] reaches a maximum of 105 dB(A) near the filter silencer. The following prerequisites must be fulfilled with regard to the turbocharger to observe this limit value:

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- Air-inlet system has been fitted
- All standard, noise-reducing measures[2)] have been fitted
- Bellows at the air outlet has been acoustically insulated by the enginebuilder (see Fig. 22: Noise insulation, bellows →34).

The enginebuilder is responsible for insulating the charge air/scavenging air line and the charge air cooler.

1) Directive 2006/42/EC, 1.7.4.2 / u / Paragraphs 5 + 7 :
A-weighted emission sound pressure level

2) The enginebuilder must provide acoustically equivalent measures in case of deviating insulation versions

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Suggestion for noise insulation, bellows

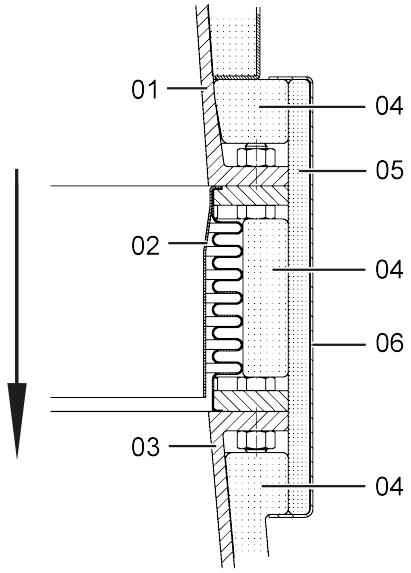


Fig. 22: Noise insulation, bellows

01 Compressor casing
02 Bellows
03 Charge air duct / scavenging air duct
04 Insulation cushion
05 Insulation mat (at least 15 mm)
06 Sheet metal cover

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5.2 Service work

Service work includes visual controls, monitoring, measuring and inspection as well as functional checks. Service work enables the detection and rectification of changes to the turbocharger and ensures full operability of the turbocharger.



⚠ CAUTION

Service intervals

Any service work on the turbocharger that is omitted or performed too late can cause excessive contamination, wear and operating failures.

▶ Carry out the service work at the specified time intervals.



⚠ CAUTION

Shortened service intervals

Exceptional stresses such as several starts/stops per day, harsh environmental conditions, poor fuel quality or high system vibrations can lead to untimely machine damage even if the prescribed service intervals are observed.

▶ Agree on a shortened service interval with ABB Turbo Systems.

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To prevent machine damage caused by ageing and downtime, we recommend having an inspection carried out by an ABB Turbocharging Service Station no later than 5 years after the last service.

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5.2.1 Service work every 25 … 50 hours



⚠ CAUTION

Unknown operational changes

Impairment to the degree of a possible operating failure can be the consequence.

- ▶ Have any unknown causes clarified by an ABB Turbocharging Service Station.

- ▶ Visual check for air, exhaust gas, water and oil leaks.
- ▶ Record operating data and enter in the engine logbook.
- ▶ In case of deviations, determine the cause.

5.2.2 Service work at 100 hours after commissioning

- ▶ Clean or replace the oil filter located in the supply pipe to the turbocharger while the engine is stopped.

5.2.3 Service work according to instructions of enginebuilder

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- ▶ Clean or replace the oil filter located in the supply pipe to the turbocharger while the engine is stopped.

5.2.4 Service work according to data on the rating plate

(Usually after 8000 … 12000 operating hours)

The rotor and bearing parts must be checked and assessed by an ABB Turbocharging Service Station. The following work can be carried out as preparation.

- ▶ Remove turbocharger from engine, dismantle and measure clearance (see Dismantling and fitting, general).
- ▶ Clean nozzle ring, turbine casing, compressor casing and diffuser, and check for cracks and erosion/corrosion.

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5.2.5 Other service work

If a protective grid is installed in the gas outlet casing (61001) by ABB Turbo Systems:

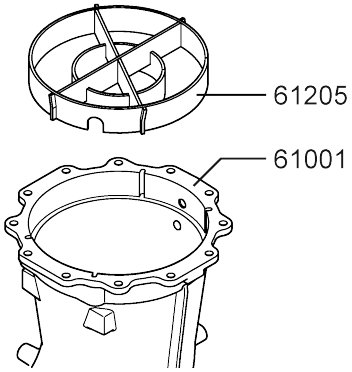


Fig. 23: Replacing the protective grid

- ▶ Remove the protective grid (61205) after 50000 hours and replace it with a new protective grid.

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5.2.6 Entries in the engine logbook

The monitoring of the engine system enables conclusions to be drawn on the behaviour of the turbocharger.

The following operating data and measured values must be entered regularly in the engine logbook of the enginebuilder:

- Rating and speed of the engine
- Air intake temperature
- Pressure of the charge air
- Pressure loss in the charge-air cooler
- Lubricating oil pressure and lubricating oil temperature

If present:

- Speed of the turbocharger
- Air temperature after the compressor and after the charge-air cooler
- Exhaust gas temperature before and after the turbine
- Pressure loss in the filter silencer.

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5.3 Expected replacement intervals

Rotating components

The recommended replacement intervals of the compressor and turbine wheels are specified with the aid of the safety concept for rotating parts (SIKO) and dependent on the operating conditions. These intervals are shown on the rating plate of the turbocharger.

Non-rotating components

Depending on the system-specific operating conditions, a differentiation must be made between the intervals to be expected for:

- replacing the bearing parts and
- replacing the non-rotating components exposed to hot gas.

A decisive role is played by various influencing parameters which, in extreme cases, can drastically reduce the replacement interval of these parts.

During the prescribed periodic service work, the individual parts are examined for wear and replaced if necessary.

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Expected replacement intervals [h]

	GAS / MDO	HFO
Turbine casing	25000 … 50000	25000 … 50000
Nozzle ring	25000 … 50000	10000 … 25000
Gas outlet flange	25000 … 50000	25000
Heat shield	25000 … 50000	25000
Rotor components	See rating plate data	
Bearing parts	12000 … 24000	12000 … 24000
Other casings	50000	50000

Table 10: Expected replacement intervals

GAS = Natural Gas
MDO = Marine Diesel Oil
HFO = Heavy Fuel Oil

The specified values are guideline values and not guaranteed values, see Influencing parameters.

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Influencing parameters

The specified values are guideline values and are not guaranteed. The actual values can deviate considerably from the guideline values, for example, due to the following influences:

- Fuel quality and fuel treatment
- Load profile (thermal cycling, also number of starts/stops, emergency shutdowns, operating point)
- Gas inlet temperature
- Frequency and execution of cleaning process during operation
- Turbocharger specification.
- System-specific operating conditions (combustion quality, exhaust gas composition)

For bearing parts

- Lubricating oil quality (oil filtering, oil condition, oil monitoring)
- Load profile (speed, pressure conditions, temperature)
- Number of starts/stops
- Unbalance of the rotor (degree of contamination).

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5.4 Stopping the engine



⚠ CAUTION

Residual heat in the turbocharger

If the residual heat in the turbocharger is not adequately dissipated, it may damage the engine.

- ▶ Adequate cooling of the turbocharger must be ensured after stopping the engine.

- ▶ Run the engine for 5 ... 10 minutes at idling speed before stopping it.
- ▶ Observe the oil pressure specified for engine idling (see Table 6: Lubricating oil pressure at oil inlet before turbocharger →27).
- ■ Post-lubricate water-cooled bearing casings until the rotors come to a standstill. Deactivate post-lubrication as soon as the rotor comes to a standstill. Deviating procedures must be coordinated with ABB Turbo Systems.
- ■ For oil-cooled bearing casings, post-lubricate for 20 minutes if the turbine inlet temperature (t_{TE}) exceeds the following values when the engine is stopped:
  - 550 °C with insulated casing
  - 600 °C with non-insulated casing

  At temperatures below the specified values, post-lubrication must be ensured until the rotors come to a standstill. ABB Turbo Systems recommends post-lubrication for 10 minutes.
- ▶ Observe the oil pressure specified for post-lubrication (see Table 6: Lubricating oil pressure at oil inlet before turbocharger →27).

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6 Periodic maintenance work

6.1 Foreword to maintenance

Maintenance work includes regular visual controls and cleaning operations which are intended to ensure the trouble-free functioning of the turbocharger.

To allow you to observe the standard service intervals and to maintain a high turbocharger efficiency, ABB Turbo Systems recommends that the cleaning procedure be carried out during operation. This allows the thermal load of the engine to be kept low while ensuring maximum fuel efficiency.

Maintenance interval	Maintenance work	Operating status
24 … 72 h [1)]	Cleaning the compressor during operation →43	Engine load 50 … 85 %
50 … 200 h [1)]	Cleaning the turbine during operation →46	Engine load 20 … 40% (guideline value)
Similar to the service interval (usually every 8000 … 12000 h) [2)]	Cleaning components mechanically →50	Engine stopped

Table 11: Maintenance table

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[h] = Hours of operation

[1)] If the maintenance intervals are incompatible with operation of the engine, contact ABB Turbo Systems.

[2)] ABB Turbo Systems recommends having mechanical cleaning carried out by an ABB Turbocharging Service Station during the service work. Otherwise, only carry out mechanical cleaning if cleaning during operation is not sufficient to achieve the thermal load and the rating of the engine.

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6.2 Cleaning the compressor during operation

6.2.1 Introduction

Approval by enginebuilder

The following instructions for wet cleaning only apply to cleaning with pure water and under the precondition that the enginebuilder approves the process.

Options and limits

Periodic cleaning during operation delays any major increase in contamination. The cleaning method is suitable as long as the contamination has not progressed far. Very heavily contaminated components can no longer be cleaned using this method. In this case, ABB Turbo Systems recommends having the contaminated components cleaned mechanically by an ABB Turbocharging Service Station.

Periodic cleaning during operation is not a substitute for the service work during which the turbocharger is completely dismantled and cleaned.

Cause and consequences of contamination

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The contamination of the compressor stage depends on the degree of purity of the air that is sucked in. Deposits can form in the flow channels if salt, oil mist, exhaust gas or dust are sucked in with the air.

Consequences of contamination:

- Impaired compressor efficiency
- Elevated exhaust gas temperatures
- Increased fuel consumption
- Increased rotor unbalance

6.2.2 Cleaning interval

The time period between the periodical cleaning cycles depends greatly on the operating conditions. Cleaning should normally be done every 24 ... 72 hours of operation.

If the specified cleaning intervals are incompatible with operation of the engine, contact ABB Turbo Systems.

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6.2.3 Cleaning method

Cleaning method and operating state

The compressor is cleaned during operation using the wet cleaning method. It is carried out at an engine load of 50 ... 85 %.

This cleaning method has been tested and approved by ABB Turbo Systems.

V-engines

On V-engines with several turbochargers per engine, parallel cleaning of both turbochargers is recommended. This cleaning process is faster and reduces the risk of surging of the turbocharger.

Sequential charging

With sequential charging, it must be made sure especially after operating periods in the lower range of performance that both turbocharger compressors are cleaned.

6.2.4 Function and safety of wet cleaning

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⚠ CAUTION

Volume of water

Uncontrolled volumes of water can damage the turbocharger and the engine.

- Never connect the water connection directly to a water pipe or a bigger metering container than the one specified by ABB Turbo Systems.

⚠ WARNING

Danger due to pressure vessels

Personal injury can occur if the locally applicable legal regulations on periodic inspections of the pressure vessels are not complied with.

- The locally applicable legal regulations regarding periodic checks of the pressure vessels must be observed.
- Do not use pressure vessels that are defective.

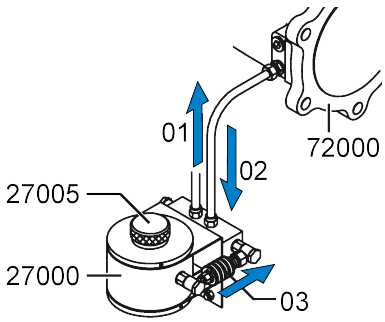
⚠ CAUTION

Corrosion and deposits when cleaning

Salt water and cooling water treatment substances damage and adversely affect turbocharger parts.

- Never use salt water, but only pure water for cleaning.

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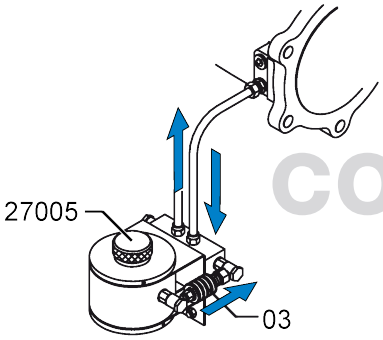


72000	Compressor casing
27000	External water pressure vessel
27005	Sealing plug
01	Water pipe to filter silencer or air suction branch
02	Pressurized air inlet pipe
03	Valve activator

Pressurized air from the compressor casing (72000) of the turbocharger passes through the pipe (02) to the water pressure vessel (27000). As soon as the valve activator (03) is activated, water is pressed into the pipe (01) and routed to the filter silencer or air suction branch.

The water does not act as a solvent. The coating is removed by the mechanical action of the impacting droplets.

6.2.5 Carrying out wet cleaning of the compressor



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Fig. 24: Carrying out wet cleaning of compressor

Engine load	Filling amount of water pressure vessel [dm³]	Water temperature [°C]	Water injection period [s]
50 … 85 %	0.4	5 … 30	10

Table 12: Parameters for wet cleaning of compressor

- ▶ Remove sealing plug (27005).
- ▶ Fill container with 0.4 dm^3 of pure water.
- ▶ Screw in sealing plug (27005) again.
- ▶ Push the valve activator (03) against the spring and hold for 10 … 15 seconds until the entire volume of water is injected.
- ▶ Continue to operate the engine for at least five minutes to ensure that all of the water is flushed out of the system.

Not more than three cleaning cycles should be conducted consecutively. Before repeating the process, continue to operate the engine for at least five minutes to ensure that all of the water is flushed out of the system.

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6.3 Cleaning the turbine during operation

6.3.1 Introduction

Approval by enginebuilder

The following instructions for wet cleaning only apply to cleaning with pure water and under the precondition that the enginebuilder approves the process.

Options and limits

Periodic cleaning during operation delays any major increase in contamination. The cleaning method is suitable as long as the contamination has not progressed far. Very heavily contaminated components can no longer be cleaned using this method. In this case, ABB Turbo Systems recommends having the contaminated components cleaned mechanically by an ABB Turbocharging Service Station.

Periodic cleaning during operation is not a substitute for the service work during which the turbocharger is completely dismantled and cleaned.

Cause and consequences of contamination

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ABB Turbo Systems recommends the use of fuels with low ash, sulphur, sodium and vanadium contents. Operating states with incomplete combustion also increase the tendency to form deposits and must be avoided.

The combustion of heavy fuel oil (HFO) in diesel engines causes contamination of the turbine stage. Poor quality fuel in conjunction with high exhaust gas temperatures can lead to extremely hard deposits on turbine components.

Consequences of contamination:

- Low turbine efficiency
- Elevated exhaust gas temperatures
- Increased charging and ignition pressures with increasing turbocharger speed
- Lower engine performance.

Possible damage to turbocharger:

- After the engine is stopped the rotor may become stuck in contamination deposits
- Damage to turbine heads with blade breaks.

6.3.2 Cleaning interval

The time period between the periodical cleaning cycles depends greatly on the operating conditions. Cleaning should normally be done every 50 to 200 hours of operation.

If the specified cleaning intervals are incompatible with operation of the engine, contact ABB Turbo Systems.

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6.3.3 Cleaning method

The turbine components are cleaned during operation using the wet cleaning method. This cleaning method is tested and approved by ABB Turbo Systems.

The precondition for wet cleaning is that the enginebuilder approves the process and these regulations are observed.

V-engines

On V-engines with several turbochargers per engine, parallel cleaning of both turbochargers is recommended. This cleaning process is faster and reduces the risk of surging of the turbocharger.

6.3.4 Function and safety of wet cleaning



⚠ CAUTION

Corrosion and deposits when cleaning

Salt water and cooling water treatment substances damage and adversely affect turbocharger parts.

- ▶ Never use salt water, but only pure water for cleaning.

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To clean the turbine stage during operation, water is injected before the nozzle ring. Based on an injection phase of 10 minutes, this cleaning procedure uses the principle of water solubility of dirt deposits.

To prevent corrosion of the inside surfaces of the casings, the engine must be continued to be operated for 10 minutes after a wet cleaning. The exhaust gas temperature downstream of the turbocharger can drop by up to 180 °C during cleaning.

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6.3.5 Prerequisites

Characteristic/component	Conditions
Engine load (guideline value)	20 … 40 %
*) Turbine inlet temperature T_{TE} before water injection	350 … 430 °C
Stabilisation phase after T_{TE} has been reached	10 minutes
Stabilisation phase after turbine cleaning	10 minutes
Water supply	ensured
Water pressure (overpressure compared to atmosphere) p_{WT}	1.5 bar
Water temperature	5 … 30 °C

Table 13: Turbine wet cleaning, recommended operating state

*) The temperature at the turbine inlet can be up to 100 °C higher than the exhaust gas temperature after the cylinder. This must be taken into account when setting the operating point before cleaning.

If necessary, the engine performance must be reduced to meet these conditions. The cleaning cycle can be started when the above conditions are fulfilled.

6.3.6 Carrying out wet cleaning of the turbine

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⚠ CAUTION

Inadmissible thermal stress and flooding of the turbine

Smaller amounts of water can lead to an inadequate cleaning result. Larger amounts of water lead to inadmissible thermal stress on the turbine components and can cause flooding of the turbine.

▶ It is imperative that turbine cleaning parameters are observed.

⚠ CAUTION

Maximum temperature at turbine inlet during cleaning

During cleaning, the temperature at the turbine inlet will rise and may strain the material significantly.

▶ Make sure the maximum temperature at the turbine inlet is not exceeded during cleaning.

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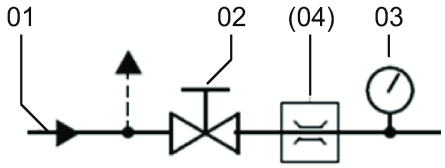


Fig. 25: Carrying out wet cleaning of turbine

- ▶ Fulfil prerequisites.
- ▶ Ensure that the water supply (01) is guaranteed.
- ▶ Open the stop valve (02) and set the required water pressure at the manometer (3) (see cleaning parameters in the table (see Table 13: Turbine wet cleaning, recommended operating state →48)).
  If an optional flowmeter (04) is present, set the water volume flow V_w on the basis of the cleaning parameters in the table (see Table 14: Wet cleaning of turbine, parameters →49).
- ▶ Close the stop valve (02) after 10 minutes.
- ▶ Wait for 10 minutes; do not change the load during this stabilisation phase.

If the cleaning result is unsatisfactory or there is water leakage, contact an ABB Turbocharging Service Station.

Product	Temperature before turbine before cleaning [°C]	Maximum temperature before turbine during cleaning [°C]	Water volume flow V_w [dm³/min] [1)]	Injection time [min]
A130	350 ... 430	530	4.0	10
A135	350 ... 430	530	5.5	10
A140	350 ... 430	530	8.5	10
A145	350 ... 430	530	12.0	10

Table 14: Wet cleaning of turbine, parameters

[1)] Corresponds to a water pressure p_{WT} of 1.5 bar (overpressure compared to atmosphere)

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6.4 Cleaning components mechanically

6.4.1 Preparation



⚠ CAUTION

Component damage and corrosion

If mechanical cleaning is carried out incorrectly, this can lead to damage and corrosion on the components.

- ▶ Pay attention to the specifications in this chapter pertaining to mechanical cleaning.



⚠ CAUTION

Selection of cleaning tools

Turbocharger components are sensitive and easily sustain mechanical damage. The use of needle descalers (for example) or other striking tools damages the components. Depending on the specification, nozzle rings or turbine casings may have protective coatings which can also be damaged.

- ▶ Use only soft tools such as rags, brushes or wire brushes.
- ▶ In case of heavy contamination, the cleaning methods described in this chapter (such as soaking, for example) can be repeated until a satisfactory result is achieved.

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The disassembly and assembly of the components is described in chapter Fitting and dismantling.

- ▶ Contaminated water and cleaning agents must be disposed of in an environmentally compatible, professional way and in compliance with locally applicable regulations.

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6.4.2 Cleaning the filter silencer

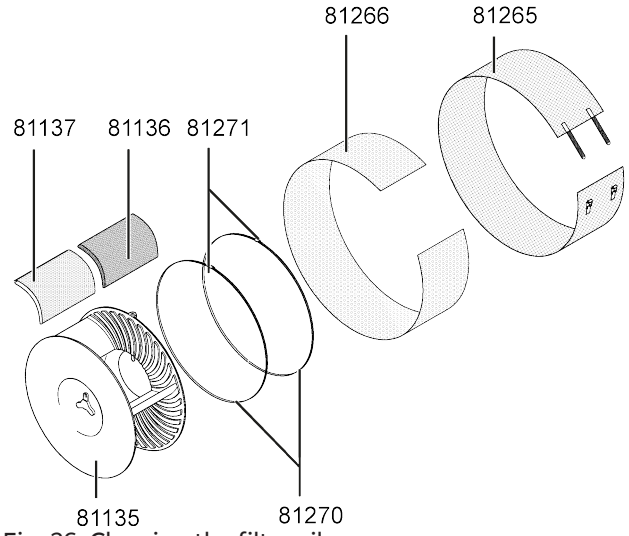


Fig. 26: Cleaning the filter silencer

81135	Filter silencer body	81266	Cover grid
81136	Absorption segment	81270	Tension band
81137	Sheet-metal covering	81271	Lock
81265	Filter ring		

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Cleaning the filter ring (if present)

- ▶ Remove filter ring (81265).
- ▶ Clean filter ring (81265) as required or every 500 hours of operation and replace after the fifth cleaning process at the latest.
  Contamination of the filter ring depends on the degree of purity of the sucked-in air.
- ▶ Rinse the filter ring (81265) with water and mild detergent or, in the case of heavy contamination, soak and carefully push through. Rinse in cold water. Avoid high mechanical loads (water jet).
- ▶ Let the filter ring dry completely before assembling.
- ▶ Dirty water and mild detergent must be disposed of in compliance with locally applicable regulations.

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Cleaning the absorption segments

(see Fig. 26: Cleaning the filter silencer →51)

- Loosen the tension bands (81270).
- Remove the cover grid (81266).
- Pull out and bend up the sheet-metal coverings (81137), and remove the absorption segments (81136).
- Clean the absorption segments (81136).
  When cleaning, note that the absorption segments (81136) must only be cleaned lightly with compressed air, a soft brush or a moist cleaning cloth.
- Have any heavily contaminated absorption segments replaced by an ABB Turbocharging Service Station.

Fitting the filter silencer

(see Fig. 26: Cleaning the filter silencer →51)

- Insert the absorption segments (81136) into the sheet-metal coverings (81137).
- Bend the sheet-metal coverings (81137) back to their original shape and insert into the slotted guides in the filter silencer body (81135).
- Fit the cover grid (81266).
- Fit the tension bands (81270) and tighten them at the locks (81271).
- Any tension bands that have become damaged must be replaced.
- Fit the filter ring (81265), if present.

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6.4.3 Compressor-end, non-rotating parts

⚠ WARNING

Handling operating materials and supplies

Swallowing or inhaling vapours of operating materials and supplies or contact with them may be harmful to health.

- ▶ Do not breathe in these substances and avoid contact with the skin.
- ▶ Ensure proper ventilation.
- ▶ Observe the information in the material safety data sheet for the operating materials and supplies.
- ▶ Wear personal protective equipment (PPE) according to the material safety data sheet.
- ▶ Comply with local legislation.

Wear safety goggles.

Wear safety gloves to protect against chemical hazards.

Wear a respiratory mask to protect against gases.

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The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.

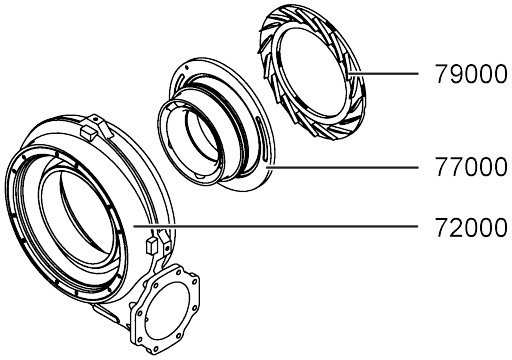


Fig. 27: Compressor-end, non-rotating parts

72000	Compressor casing
77000	Wall insert
79000	Diffuser

- ▶ Clean the above-mentioned components with steam or ultrasound. Alternatively, soak in diesel oil or water containing household cleaning agent. After soaking, remove contamination with a brush.
- ▶ Dry components completely.
- ▶ Spray cleaned surfaces with penetrating oil. Do not spray the outer surfaces of the turbocharger.
- ▶ Dispose of contaminated water and cleaning agents in accordance with the information in the material safety data sheet.

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6.4.4 Turbine-end, non-rotating parts



⚠ WARNING

Handling operating materials and supplies

Swallowing or inhaling vapours of operating materials and supplies or contact with them may be harmful to health.

- ▶ Do not breathe in these substances and avoid contact with the skin.
- ▶ Ensure proper ventilation.
- ▶ Observe the information in the material safety data sheet for the operating materials and supplies.
- ▶ Wear personal protective equipment (PPE) according to the material safety data sheet.
- ▶ Comply with local legislation.



Wear safety goggles.



Wear safety gloves to protect against chemical hazards.



Wear a respiratory mask to protect against gases.

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Baked layers of contamination, for example, from heavy fuel oil or coked oil occur at the turbine end. The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.

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Baked layers of contamination, for example, from heavy fuel oil or coked oil occur at the turbine end. The following parts, which are relevant in terms of performance, can be cleaned in accordance with the description below.

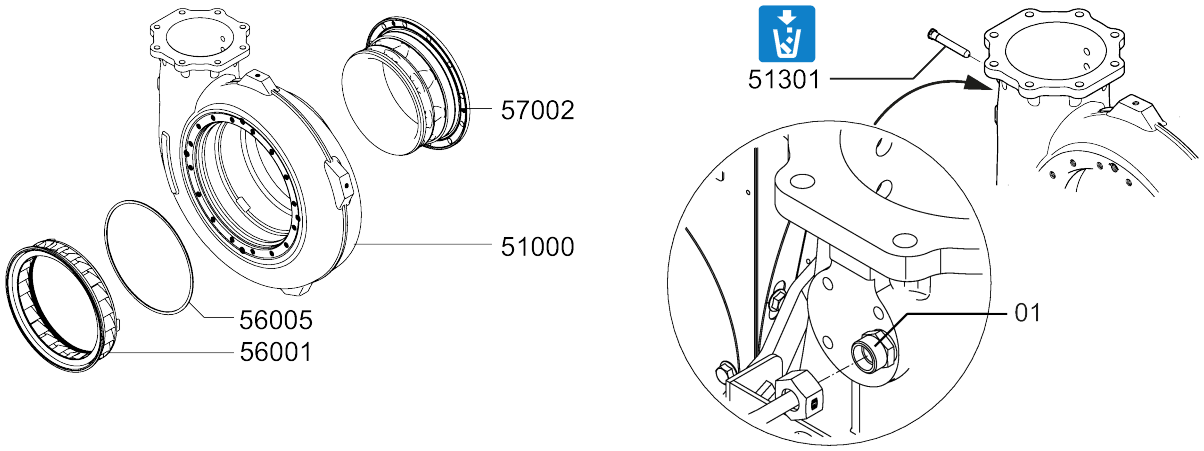


Fig. 28: Turbine end, non-rotating parts

51000	Turbine casing	51301	Cleaning nozzle (optional)
57002	Gas outlet flange	01	Screw connection (provided by the customer)
56001	Nozzle ring		
56005	Lamellar sealing ring		

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- ▶ Dismantle the lamellar sealing ring (56005) in the nozzle ring.
- ▶ Place contaminated parts in hot water or in a liquid such as brake cleaner to soften the contamination.
- ▶ Brush away the contamination or remove with a steam cleaner.
- ▶ Repeat the soaking and brushing process if necessary.
- ▶ Use clean water to remove all traces of solvent from parts.
- ▶ Dry components completely.
- ▶ Spray cleaned surfaces with penetrating oil. Do not spray exterior surfaces of the turbocharger.
- ▶ Dispose of dirty water and cleaning agents in accordance with the information in the material safety data sheet.

Option with cleaning nozzle

- ▶ The cleaning nozzle (51301) must be replaced after each removal procedure. If the cleaning nozzle is not to be replaced, the screw connection (01) must not be loosened during disassembly.

Water or air can be passed through the piping and into the cleaning nozzle to check whether it is blocked. When installed, the cleaning nozzle can be mechanically cleaned with a needle.

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6.4.5 Cartridge group, general



⚠ CAUTION

Corrosion

If the cartridge group is not put back into operation immediately after cleaning, parts may corrode.

- ▶ Immediately after cleaning, install the cartridge group and put it back into operation.

Compressor wheels can be heavily contaminated due to poorly filtered suction air; turbines can be heavily contaminated due to exhaust gas residues or coked oil. Cleaning during operation may not suffice to remove such contamination; instead, it may need to be cleaned mechanically during standard service intervals (see the Service work chapter).

- ▶ Remove the turbocharger from the engine (see chapter Removing and Installing →8).
- ▶ Remove the cartridge group (see chapter Dismantling and fitting →67).

First clean the compressor end and then the turbine end according to the following description.

6.4.6 Cleaning the cartridge group on compressor end

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⚠ CAUTION

Selection of the cleaning agent

Cleaning agents which contain chlorine attack metals.

- ▶ Use only pH-neutral cleaning agents which do not attack metals.
- ▶ Observe safety data sheet.



⚠ CAUTION

Water and contamination in the cartridge group

If water or contamination penetrates the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.

- ▶ Make sure that no water or contamination can enter into the cartridge group.

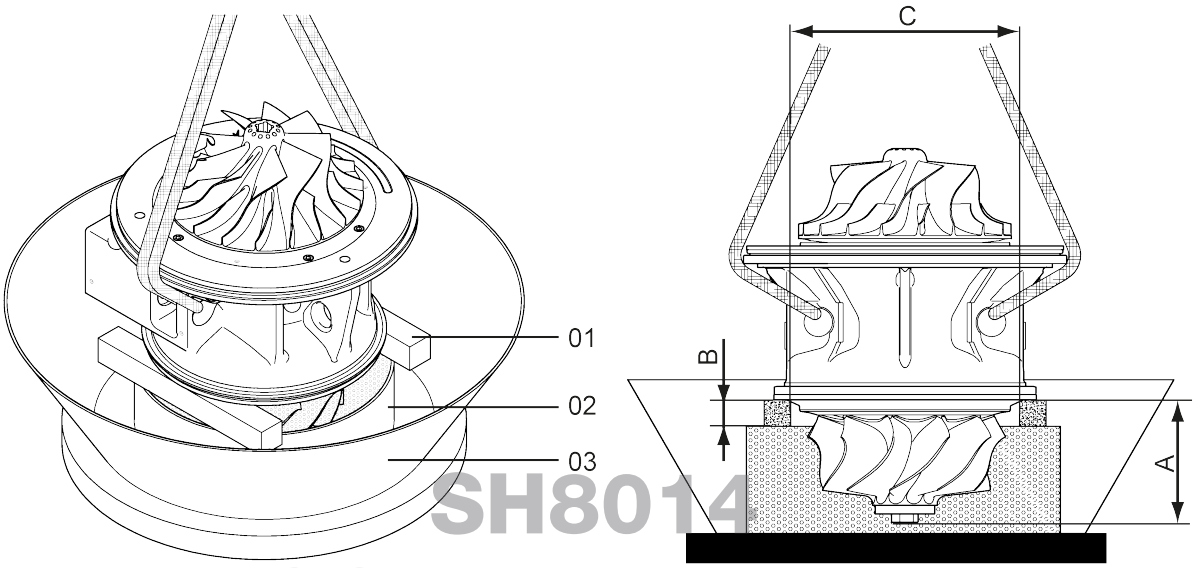
- ▶ Cleaning procedures should be selected that do not result in removal of the compressor wheel material or cause damage to its surfaces. Clean the compressor wheel with a rag or soft brush which has been soaked in water with a household cleaning agent. Do not use a wire brush!
- ▶ Dry the compressor wheel and the gap between the compressor and the bearing casing with low-pressure pressurized air.
- ▶ Lightly spray the compressor wheel and the gap between the compressor and the bearing casing with penetrating oil.
- ▶ Dispose of dirty water and cleaning agents in accordance with the material safety data sheet.

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6.4.7 Cleaning the cartridge group on turbine end

Soaking the contamination

Baked layers of contamination from heavy fuel oil or coked oil occur at the turbine end. The contamination can be removed by soaking and brushing. The procedure for soaking the layers of contamination as well as for cleaning the turbine are described in the following.



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Fig. 29: Soaking the turbine end

Product	A [mm]	B [mm]	C [mm]
A130	108	17	205
A135	128	20	245
A140	157	25	300
A145	187	30	357

Table 15: Value table for soaking

To soak the layers of contamination on the turbine, the cartridge group can be immersed vertically in a container (02) with fluid.

▶ Place the container (02) inside a larger container (03) so that the overflowing fluid can be collected.

⚠ CAUTION

Selection of the cleaning agent

Cleaning agents which contain chlorine attack metals.

▶ Use only pH-neutral cleaning agents which do not attack metals.

▶ Observe safety data sheet.

▶ Fill the container (02) with soaking fluid. To shorten the soaking time, the fluid can be heated up to a maximum of 60 ºC.

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⚠ WARNING

Heating up of cleaning agents and operating fluids

When cleaning agents or operating fluids are heated up, explosive vapours can be produced which are hazardous to health.

- ▶ Observe the information in the material safety data sheet.



Wear a respiratory mask according to material safety data sheet.



⚠ CAUTION

Water and contamination in the cartridge group

If water or contamination penetrates the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.

- ▶ Place the cartridge group on suitable supports (01) made of wood or metal.
- ▶ Observe dimension (B) for the supports (01) so that the cartridge group is not immersed too deeply.

- ▶ Let the layers of contamination on the turbine soak for four hours.

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Removing dirt



⚠ WARNING

Health hazard due to soot particles

If soot particles enter the eyes or respiratory tract, this can be harmful to health.

- ▶ Avoid the formation of dust.
- ▶ Vacuum up dust with a suitable vacuum cleaner.
- ▶ Wear a respiratory mask to protect against particles (P1 or P2 mask).
- ▶ Wear safety goggles.



Wear safety goggles.



Wear a respiratory mask to protect against dusts.



Wear safety gloves to protect against mechanical hazards.

- ▶ Lift up the cartridge group and align it horizontally.
- ▶ Remove dirt manually using a soft brush or a wire brush.

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⚠ CAUTION

Water and dirt in the cartridge group

If water or dirt enters the cartridge group, this can impair the function of the turbocharger and damage parts inside the cartridge group.

- ▶ Make sure that no water or dirt enters the gap between partition wall and turbine.



⚠ CAUTION

Non-permissible rotor unbalance after cleaning

Unevenly distributed residual contamination deposits lead to rotor unbalance. This can result in bearing or turbocharger damage.

- ▶ Remove all traces of contamination from the turbine.

- ▶ After brushing off the dirt, fill the container (02) with clean water and not with salt water .
- ▶ Immerse the turbine of the cartridge group in clean water so that any loose dirt comes off.
- ▶ Lift up the cartridge group and align it horizontally.
- ▶ Clamp the partition wall to the bearing casing.
- ▶ Dry the turbine and the gap between the turbine and the partition wall with low-pressure compressed air.
- ▶ Lightly spray the turbine and the gap between the turbine and the partition wall with penetrating oil.
- ▶ Dispose of dirty water and cleaning agents in accordance with the information in the material safety data sheet.

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7 Eliminating malfunctions

7.1 Malfunctions when starting

Delayed start-up

Possible causes		Remedy
Turbocharger	Turbocharger contaminated	Clean (see chapter Periodic maintenance work →42)
	Bearing damaged	Contact ABB Turbocharging Service Station
	Rotor rubbing	
	Foreign object in the turbocharger	

Table 16: Malfunctions when starting – Delayed start-up

Vibrations

Possible causes		Remedy
Turbocharger	Rotor unbalance	Contact ABB Turbocharging Service Station
	Turbine or compressor damaged	
	Bearing damaged	
Engine	Vibrations from engine	Contact enginebuilder

Table 17: Malfunctions when starting – Vibrations

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Rubbing of rotating parts

Normal behaviour, not a malfunction	
Turbocharger	A slight amount of uniform wear at the circumference of the rotor components caused by slight local rubbing against adjacent components is permitted. This causes the compressor or turbine blades to be somewhat shortened. To prevent significant loss of efficiency, specific tolerances must be fulfilled. ■ If there is any doubt about the extent of the rubbing, contact an ABB Turbocharging Service Station. ■ Have a dimension check carried out by an ABB Turbocharging Service Station.

Table 18: Malfunctions when starting – Rubbing of rotating parts

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7.2 Malfunctions during operation

Lubricating oil pressure too low



⚠ WARNING

Danger of fire and explosion due to lubricating oil leaks

Leaking oil may ignite on hot surfaces. This can result in serious injuries to personnel or fatal accidents.

- ▶ Cordon off danger area.
- ▶ Raise the alarm and, depending on the situation, stop the engine.
- ▶ Seal the oil leak.
- ▶ Soak up oil and dispose of in an environmentally compatible manner.



Wear safety gloves to protect against thermal hazards.

Possible causes		Remedy
Turbocharger	Axial clearance of the rotor excessive	Contact an ABB Turbocharging Service Station
Engine	Oil filter heavily contaminated	Clean
	Oil pump in lubricating system defective	Check/replace
	Manometer displays incorrectly	Replace manometer

Table 19: Malfunctions during operation – Lubricating oil pressure too low

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Speed reduces

Possible causes		Remedy
Turbocharger	Turbine and/or nozzle ring severely contaminated	Clean (see chapter Periodic maintenance work →42)
	Rotor components or bearing damaged	Contact ABB Turbocharging Service Station
Engine	Defects on the connected cylinders in pulse charging	Contact enginebuilder
Pipes	Defects, such as leaks, in the exhaust gas pipes or charge air ducts	Repair

Table 20: Malfunctions during operation – Speed reduces

Speed increases

Possible causes		Remedy
Turbocharger	Light to medium contamination of the turbine and/or nozzle ring (with 4-stroke application)	Clean (see chapter Periodic maintenance work →42) or contact an ABB Turbocharging Service Station

Table 21: Malfunctions during operation – Speed increases

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Exhaust gas temperature too high

Engine performance and engine speed unchanged

Possible causes		Remedy
Turbocharger	Insufficient air, for example, when filter silencer is blocked by contamination	Clean (see chapter Periodic maintenance work →42)
	Compressor/turbine contaminated	
	Exhaust gas back pressure too high	Clean or repair boiler or exhaust gas silencer
	Turbine damaged or eroded	Contact ABB Turbocharging Service Station
Engine	Malfunction in the injection system	Repair or contact manufacturer
Charge air cooler	Cooler contaminated	Clean
	Cooling water volume too low	Fill
	Inlet temperature of cooling water too high	Check/clean cooling system
	Insufficient ventilation	Improve ventilation

Table 22: Malfunctions during operation – Exhaust gas temperature too high

Charge air pressure too low

Engine performance and engine speed unchanged, suction condition normal

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Possible causes		Remedy
Turbocharger	Manometer display not correct	Replace manometer
	Supply pipe to manometer not sealed	Repair leak
	Filter silencer contaminated, therefore pressure drop too high	Clean (see chapter Periodic maintenance work →42)
	Compressor end and/or turbine end contaminated	
	Compressor/turbine damaged	Contact ABB Turbocharging Service Station
	Exhaust gas back pressure too high	Clean or repair boiler or exhaust gas silencer
Engine	Air receiver not sealed	Repair
	Gas piping between engine and turbine leaking	
	Injection mistimed	Set correctly
	Valve control misadjusted	
Pipes	Pipes downstream to the compressor outlet not sealed.	Repair.

Table 23: Malfunctions during operation – Charge air pressure too low

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Charge air pressure too high

Engine performance and engine speed unchanged, suction condition normal

Possible causes		Remedy
Turbocharger	Manometer display not correct	Replace manometer
	Increased speed due to contamination of nozzle ring	Clean (see chapter Periodic maintenance work →42) or contact an ABB Turbocharging Service Station
Engine	Malfunction in the injection system	Repair or contact manufacturer
	Injection mistimed	Set correctly
	Engine performance higher than indicated	Check engine performance

Table 24: Malfunctions during operation – Charge air pressure too high

Reduced compressor performance/efficiency and therefore engine performance losses



⚠ CAUTION

Compressor damage

A severely contaminated or corroded compressor wheel can reduce the compressor wheel's fatigue endurance limit and result in the turbocharger being damaged.

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▶ Rectify malfunction in accordance with the following table.

Possible causes		Remedy
Turbocharger	Compressor components severely contaminated by the ventilation gases that have been fed in	Clean (see chapter Periodic maintenance work →42)
		Optimize oil separation
	Increased blade vibration, compressor blade damage due to the ventilation gases that have been fed in	Correct the feed of ventilation gases according to instructions of enginebuilder.
	Material of the compressor wheel corroded due to the feeding in of ventilation gases containing corrosive components	Correct the feed of ventilation gases according to instructions of enginebuilder.
	Material of the compressor wheel corroded due to intake air containing exhaust gases or salt	Prevent exhaust gas leakages in the engine space
		Clean (see chapter Periodic maintenance work →42)

Table 25: Malfunctions during operation – Engine performance losses

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7.3 Turbocharger is surging



⚠ WARNING

Hot air escapes from the filter silencer

A surge blow is accompanied by a loud bang and escape of hot air from the filter silencer. This may result in injury to personnel.

- ▶ Keep a distance from the filter silencer while the turbocharger is surging.

Turbocharger surges continuously or periodically



⚠ CAUTION

Continuous or periodic surging

If the turbocharger surges continuously or periodically, parts of the turbocharger may be damaged.

- ▶ Gradually reduce the engine load.
- ▶ Have the cause clarified and remedied immediately by an ABB Turbocharging Service Station.
- ▶ Have parts assessed for damage and, if necessary, replaced by an ABB Turbocharging Service Station.

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Possible causes		Remedy
Turbocharger	Filter silencer or diffuser contaminated	Clean (see chapter Periodic maintenance work →42)
	Heavy contamination deposits in the turbine or in the nozzle ring	
Engine	Protective grating in front of the turbocharger contaminated or damaged	Clean/replace
Charge air cooler	Cooler contaminated	Clean
	Charge air duct blocked	

Table 26: Malfunction – Turbocharger pumping

Sporadic surge blows

Possible causes		Remedy
Engine	Engine load reduced quickly when manoeuvring. When this happens, the flow direction in the compressor is momentarily reversed. Such sporadic surge blows do not impair the safe operation of the turbocharger.	- -

Table 27: Malfunction – Sporadic surge blows

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7.4 Malfunctions when stopping

Runout noises

Possible causes		Remedy
Turbocharger	Turbocharger contaminated	Clean (see chapter Periodic maintenance work →42)
	Bearing damaged	Check clearances (see chapter Measuring clearance A and B →83). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.
	Rotor rubbing	Check clearances (see chapter Radial clearances N and R). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.
	Foreign object in the turbocharger	Dismantle turbocharger (see chapter Fitting and dismantling). In case of damage, replace the corresponding parts or contact an ABB Turbocharging Service Station.

Table 28: Malfunctions when stopping – Runout noises

Runout time too short

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The runout time must be noted down as a reference. Because the runout time depends on the oil viscosity, the runout time must always be measured at the same oil temperature.

If the runout time is significantly shorter in comparison to a previous measurement, the following table must be observed.

Possible causes		Remedy
Turbocharger	Turbocharger contaminated	Clean (see chapter Periodic maintenance work →42)
	Bearing damaged	Check clearances (see chapter Measuring clearance A and B →83). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.
	Rotor rubbing	Check clearances (see chapter Radial clearances N and R). If clearances are outside the tolerance or if in doubt, contact an ABB Turbocharging Service Station.
	Foreign object in the turbocharger	Dismantle turbocharger (see chapter Fitting and dismantling). In case of damage, replace the corresponding parts or contact an ABB Turbocharging Service Station.

Table 29: Malfunctions when stopping – Runout time too short

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7.5 Speed measurement system

No signal or poor signal amplitude of the speed measurement

Possible causes		Remedy
Turbocharger	The speed sensor was accidentally fitted with an additional gasket. An enlarged distance between the sensor tip and the signal-emitting sealing disc reduces the voltage amplitude of the speed signal.	The screw plug for the sensor is fitted with an additional gasket (copper ring). For information regarding the disassembly and assembly of the speed sensor, refer to chapter Replacing the speed sensor →32. Install the speed sensor without the additional gasket (copper ring).
	Sensor or cable defective	Contact an ABB Turbocharging Service Station. Order new speed sensor (86505) (refer to chapter Ordering spare parts →106). Replacing the speed sensor →32.

Table 30: Malfunction of the speed measurement system – No signal or poor signal amplitude

Measured speed too high

Possible causes		Remedy
Turbocharger	Sensor tip contaminated, since it is magnetic and can attract metallic particles. This reduces the distance to the signal-emitting sealing disc, which can lead to amplification of the noise component and, hence, to false triggering.	For information regarding the disassembly and assembly of the speed sensor, refer to chapter Replacing the speed sensor →32. Dismantle the sensor, clean the sensor tip, and fit the sensor back on with the specified tightening torque.

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Table 31: Malfunction of the speed measurement system – Measured speed too high

Measured speed too low

Possible causes		Remedy
Turbocharger	- -	Contact ABB Turbocharging Service Station

Table 32: Malfunction of the speed measurement system – Measured speed too low

If none of the measures described above remedy the malfunction, have the speed measurement system checked by an ABB Turbocharging Service Station.

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8 Dismantling and fitting

8.1 Introduction

The precondition for the work described in the following is a turbocharger removed from the engine (see chapter Removal and installation).



⚠ WARNING

Danger of burns

Touching hot surfaces or contact with hot operating fluids can cause burns.

- ▶ Do not touch hot surfaces. Observe the warning plate on the turbocharger.
- ▶ Wear heat-resistant safety gloves and protective clothing.
- ▶ Wait for the turbocharger to cool down before carrying out any work.



Wear safety gloves to protect against thermal hazards.



⚠ WARNING

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Cutting injuries when working on the turbocharger

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Some parts on the turbocharger may have sharp edges. There is a risk of a cutting injury.

- ▶ Wear safety gloves against mechanical risks when conducting assembly and disassembly work.



Wear safety gloves to protect against mechanical hazards.



⚠ CAUTION

Further operations

This Operation Manual may be used to carry out only those operations that are described in it. Further operations that are executed in an incorrect way can lead to serious damage to the machine.

- ▶ ABB Turbo Systems recommends having further operations carried out only by trained personnel from an ABB Turbocharging Service Station.

- ▶ Mark the casing position for assembly.

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Identification of the assembly devices

Not all assembly devices are marked with a part number. Identification is guaranteed by the tool list. This list is enclosed with the toolbox.



⚠ WARNING

Servicing the assembly devices

Assembly devices must be checked for damage before and after use.

- ▶ Visually inspect for corrosion, cracks, deformation and wear.
- ▶ Damaged assembly devices must no longer be used and must be replaced.

Customer spare part set

Before starting operations, make sure the required customer spare part set is available (see chapter Spare parts →106).

Oil orifice

- ▶ When disassembling the turbocharger, an oil orifice fitted in the oil inlet must not be removed (see also chapter Removing the cartridge group).

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Tightening torques for components of the turbocharger

The specified tightening torques of the screw fittings must be observed (Table of tightening torques →97).

Tightening torques for assembly devices

Unless described otherwise, the screws and nuts of the assembly devices supplied by ABB must be tightened so they rest firmly against the surface.



⚠ WARNING

Suspended loads

Loads that are not attached according to regulations can cause injury to personnel or fatal accidents.

- ▶ Only fasten the turbocharger, assemblies or individual parts on properly functional lifting gear with sufficient load limit.
- ▶ Pay attention to the correct attachment of loads on the crane hook.
- ▶ People must not stand beneath suspended loads.



Wear safety gloves to protect against mechanical hazards.



Wear safety helmet.

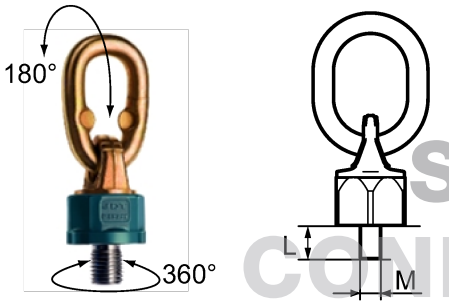
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Definition of terms

- **Suspension point**
  Defined loading point on a component or an assembly (blind hole thread, eyelet, lug).
- **Assembly device**
  Devices that are fitted on the turbocharger in order to obtain a suspension point. Assembly devices are specially constructed and designed for the defined use; they are not commercially available products. Use assembly devices only for the described applications.
- **Lifting gear**
  Equipment for the lifting and transporting of loads (ropes, chain block, crane). Lifting gear is not supplied by ABB.

Swivel lifting eyes to be used

Two swivel lifting eyes are required for the safe lifting of loads, these are not supplied by ABB Turbo Systems.



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Fig. 30: Swivel lifting eyes

Product	Thread M	Length L [mm]	Minimum load limit [kg]	Quantity
A130	M10	17 mm	100 kg	2
A135	M10	17 mm	150 kg	2
A140	M12	21 mm	250 kg	2
A145	M12	21 mm	300 kg	2

Table 33: Swivel lifting eyes

Ring nuts to be used

Two ring nuts (M16) are required for safer lifting of the cartridge group, which are not included in the ABB Turbo Systems scope of delivery.

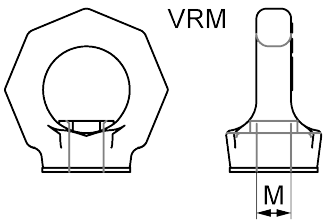


Fig. 31: Starpoint ring nut VRM

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8.2 Weights of individual parts

The specified weights of the individual parts or assemblies are rounded-up standard values.

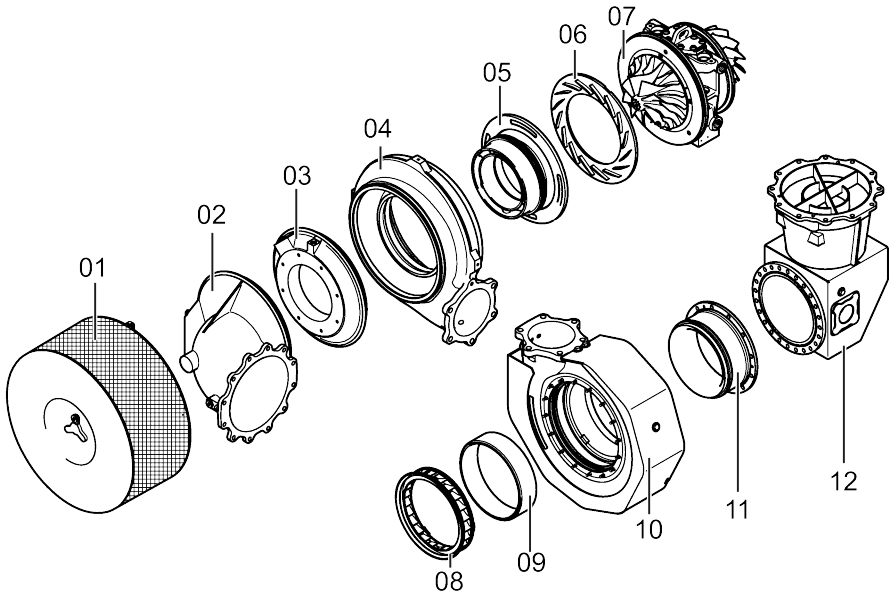


Fig. 32: Weights of assemblies

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	Designation		A130 [kg]	A135 [kg]	A140 [kg]	A145 [kg]
01	Filter silencer		19	30	40	65
02	Radial air suction branch		6	8	13	21
03	Axial air suction branch		4	5	6	9
04	Compressor casing		24	40	60	95
05	Wall insert		6	8	15	24
06	Diffuser		3	4	7	11
07	Cartridge group		40	60	110	180
08	Nozzle ring		2	2	4	6
09	Burst ring		2	3	5	12
10	Turbine casing *	1 inlet	50	75	135	210
	Turbine casing *	2 inlets	45	65	125	190
	Turbine casing *	3 inlets	- -	- -	125	190
11	Gas outlet flange		7	13	20	23
12	Gas outlet casing		30	35	65	120

Table 34: Weights of assemblies

* including burst protection

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8.3 Removing the air inlets

▶ Mark the casing position for assembly.

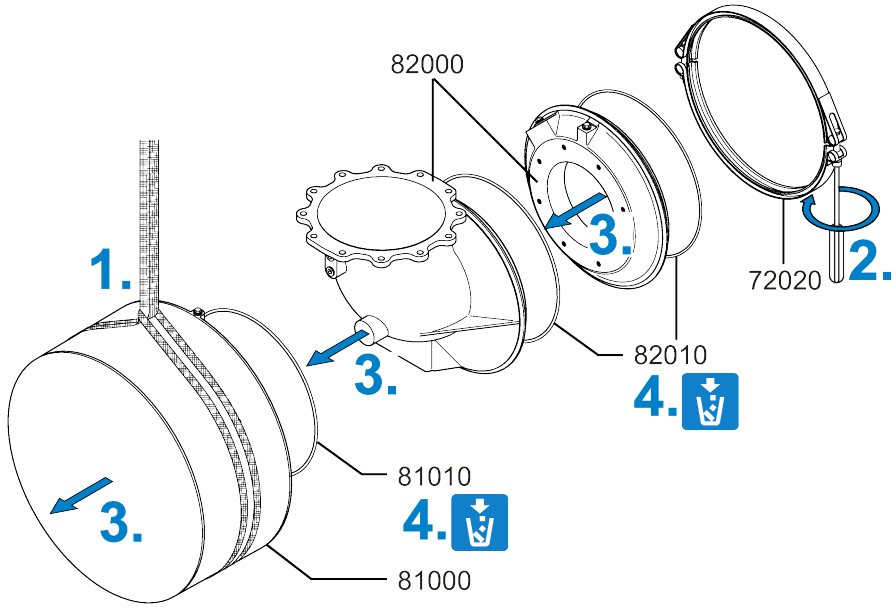


Fig. 33: Removing the air inlets

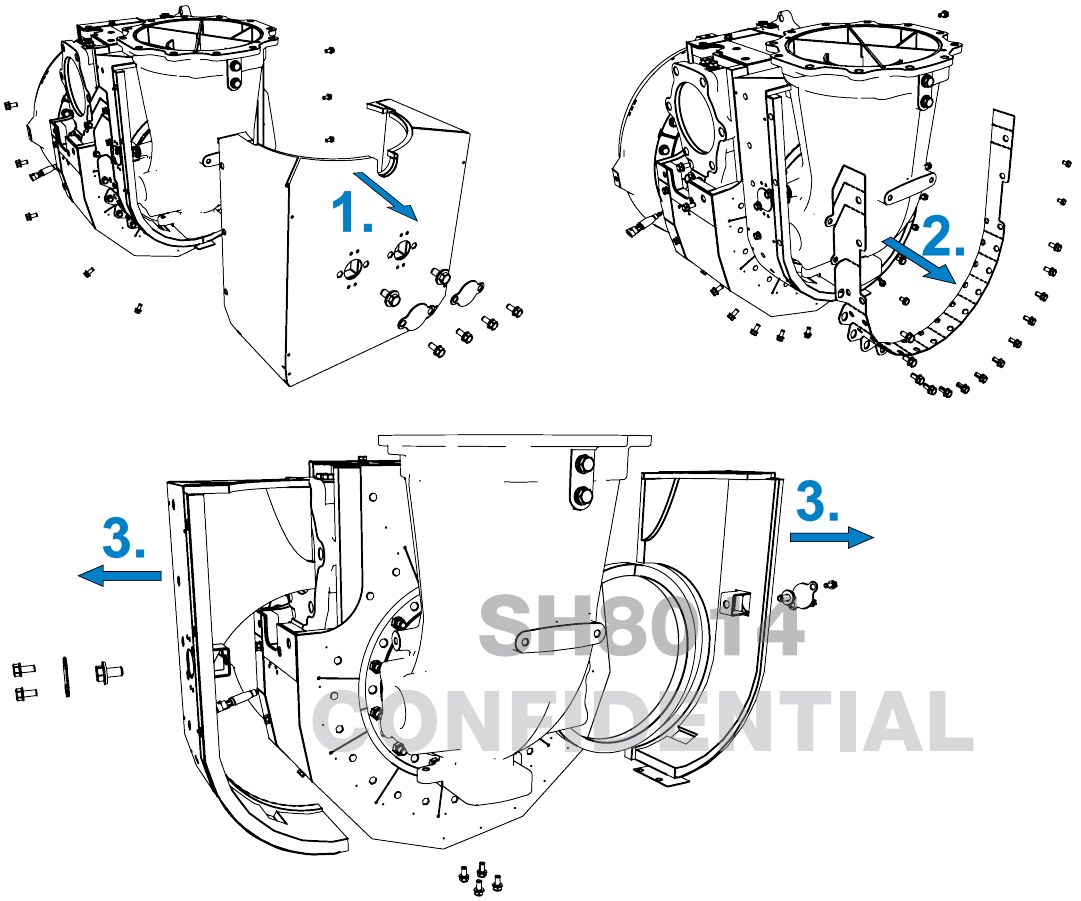
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1. Attach lifting gear to the filter silencer (81000) or air suction branch (82000).
2. Loosen and remove V-clamp (72020).
3. Remove filter silencer (81000) or air suction branch (82000), set it down properly in an appropriate place and secure it.
4. Remove and dispose of the O-ring (81010 / 82010).

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8.4 Removing the gas outlet casing

Removing the insulation



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Fig. 34: Removing the insulation

▶ Remove gas outlet casing insulation.

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▶ Mark the casing position for assembly.

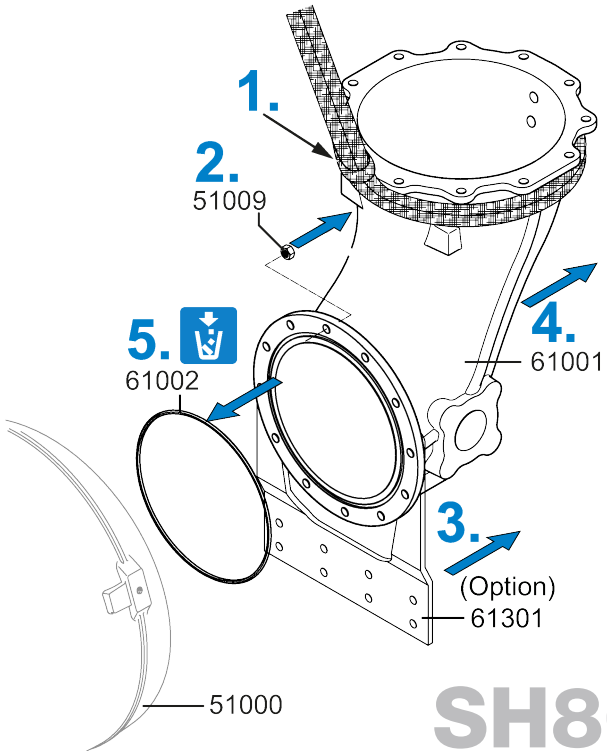


Fig. 35: Removing the gas outlet casing

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1. Attach lifting gear to the gas outlet casing (61001).
2. Loosen and remove nuts (51009).
3. If present: Detach support (61301) from bracket.
4. Remove the gas outlet casing (61001), set it down properly in an appropriate place and secure it.
5. Remove and dispose of the gasket (61002).

8.5 Removing the gas outlet flange

Depending on the way of fixing the gas outlet flange, the appropriate Working Instruction has to be consulted (pressing off using 3 or 6 press-off screws).

If the following Working Instructions are not observed, this can lead to cracks in the gas outlet casing.

The following variants are possible:

▶ Pressing off using 3 press-off screws.

▶ Pressing off using 6 press-off screws.

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Gas outlet flange with 3 press-off screws

⚠ CAUTION

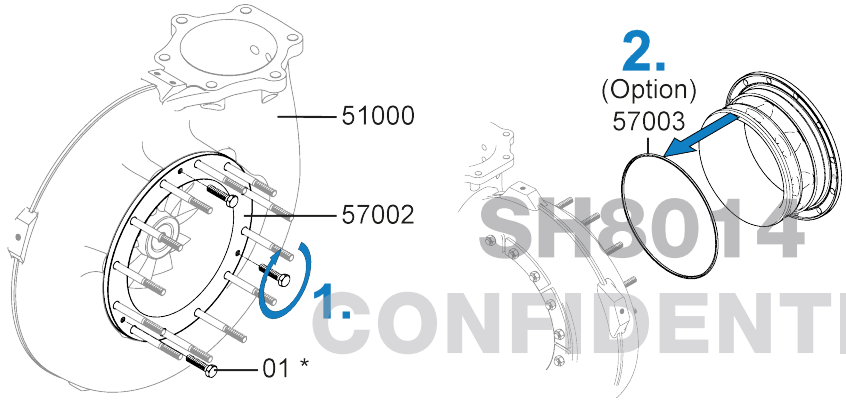
Cracks in the gas outlet casing

Non-observance of the action steps described can lead to inadmissible cracks on the gas outlet flange.

- ▶ Observe the maximum tightening torques when pressing off.
- ▶ Follow the action steps described.

Only dismantle the gas outlet flange if this is necessary for service work.

- ▶ If necessary: Treat the centering seat with rust remover through the press-off threads and the clearance holes.
- ▶ Mark the casing position for assembly.



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Fig. 36: Dismantling the gas outlet flange

Product	Press-off screws (strength 8.8) *	Tightening torque
A130	3 x M 8 x 20	≤ 20 Nm
A135	3 x M10 x 25	≤ 40 Nm
A140	3 x M12 x 30	≤ 65 Nm
A145	3 x M12 x 30	≤ 65 Nm

Table 35: 3 press-off screws

* not included in the ABB Turbo Systems scope of delivery

1. Press off and remove the gas outlet flange (57002) with screws (01) according to the table. If it is not possible to press off the gas outlet flange with the maximum tightening torque, contact an ABB Turbo Systems Service Station.
2. If present: Remove the C-ring (57003).

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Gas outlet flange with 6 press-off screws

⚠ CAUTION

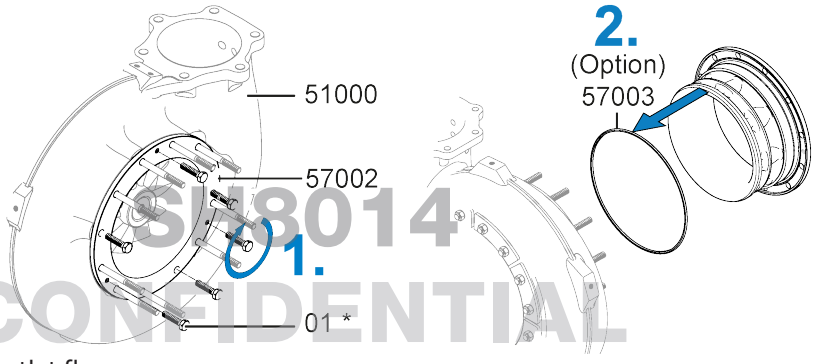
Cracks in the gas outlet casing

Non-observance of the action steps described can lead to inadmissible cracks on the gas outlet flange.

- ▶ Observe the maximum tightening torques when pressing off.
- ▶ Follow the action steps described.

Only dismantle the gas outlet flange if this is necessary for service work.

- ▶ If necessary: Treat the centering seat with rust remover through the press-off threads and the clearance holes.
- ▶ Mark the casing position for assembly.



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Fig. 37: Removing the gas outlet flange

Product	Press-off screws (strength 8.8) *	Tightening torque
A130	6x M6 x 20	≤ 10 Nm
A135	6x M8 x 25	≤ 20 Nm
A140	6x M10 x 30	≤ 40 Nm
A145	6x M12 x 30	≤ 65 Nm

Table 36: 6 press-off screws

* not included in the ABB Turbo Systems scope of delivery.

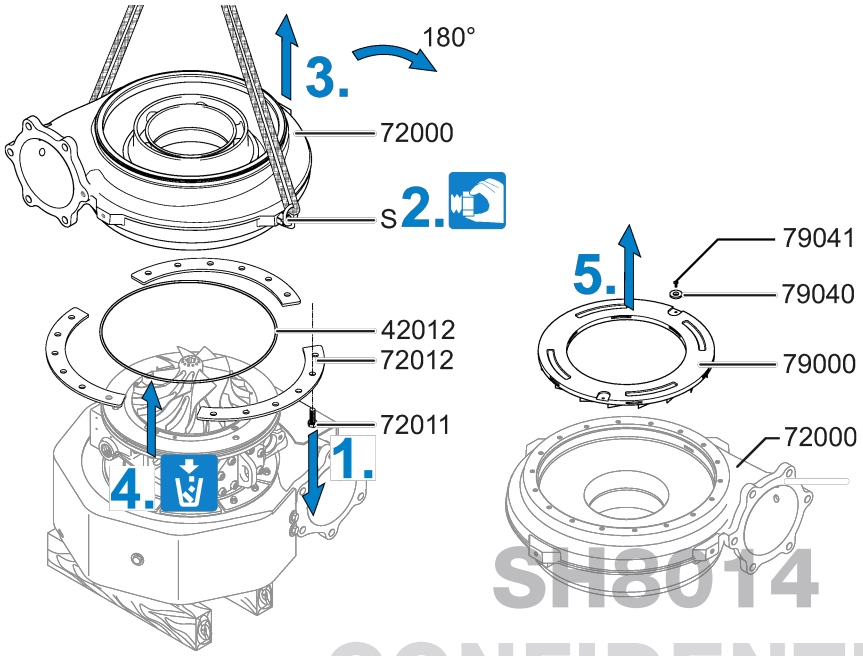
1. Evenly press off and remove the gas outlet flange (57002) with screws (01) according to the table. If it is not possible to press off the gas outlet flange with the maximum tightening torque, contact an ABB Turbo Systems Service Station.
2. If present: Remove the C-ring (57003).

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8.6 Removing the compressor casing

Removing the compressor casing

▶ Mark the casing position for assembly.



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Fig. 38: Removing the compressor casing

1. Loosen screws (72011) and remove together with fastening strips (72012).
2. Attach swivel lifting eye (S) to the compressor casing and the lifting gear.
3. Remove the compressor casing (72000) and turn it 180°.
4. Remove and dispose of the O-ring (42012).
5. Undo screws (79041) and remove from the compressor casing (72000) with fixing discs (79040) and diffuser (79000).

If the compressor casing cannot be loosened, it can be pressed off against the turbine casing using the press-off tool (90042) (see chapter Pressing off the casing →78).

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Dismantling the wall insert

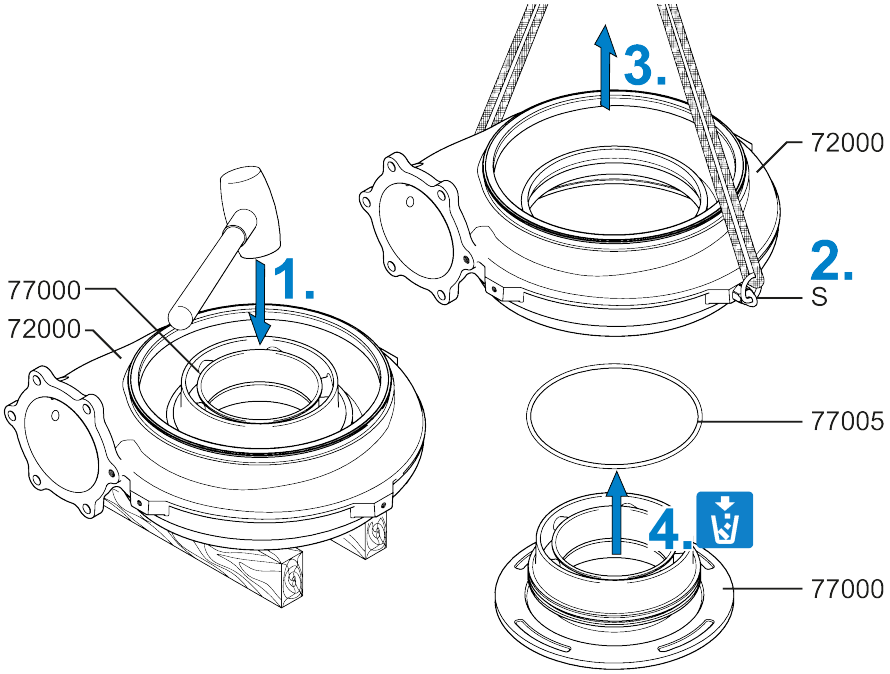


Fig. 39: Dismantling the wall insert

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1. Knock the wall insert (77000) out of the compressor casing (72000) with a plastic tip hammer.
2. Attach swivel lifting eye (S) to the compressor casing (72000) and the lifting gear.
3. Lift up the compressor casing (72000).
4. Remove and dispose of the O-ring (77005).

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8.7 Pressing off the casing

⚠ CAUTION

Axial force of the press-off tool

Using the press-off tool (90042), a high level of axial force can be generated. If the casing is pressed off with too much force on one side, the rotor can be damaged.

- ▶ Use the tool on both sides in alternation and make sure not to press off too hard on either side.

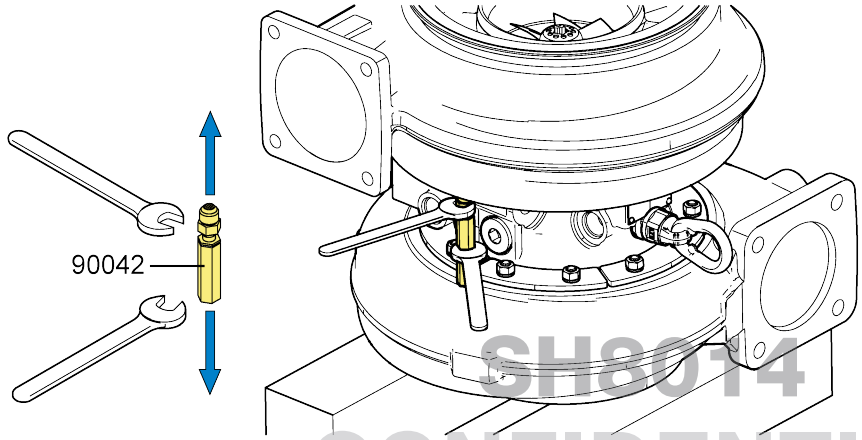


Fig. 40: Press off the casing

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8.8 Removing the cartridge group

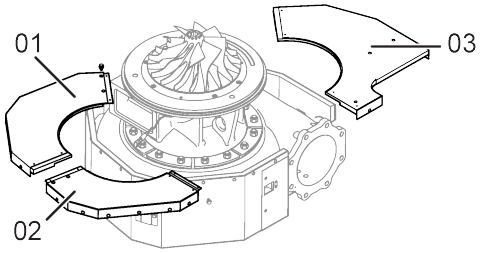


Fig. 41: Removing insulation sheets

- If present: Remove the insulation sheets (01, 02, 03).
- Mark the casing position for assembly.

Do not remove oil orifice (if present)

To limit the oil flow rate through the bearing casing during operation (engine under load) to the admissible values, an oil orifice is mandatory at the oil inlet of the bearing casing if the oil inlet pressure is > 3 bar (overpressure).

If an oil orifice is fitted in the oil inlet of the bearing casing, it must not be removed.

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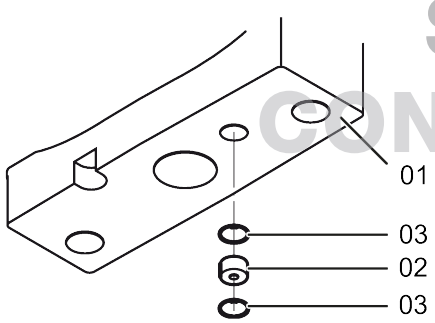


Fig. 42: Oil orifice

01 Bearing casing
02 Oil orifice
03 Circlip

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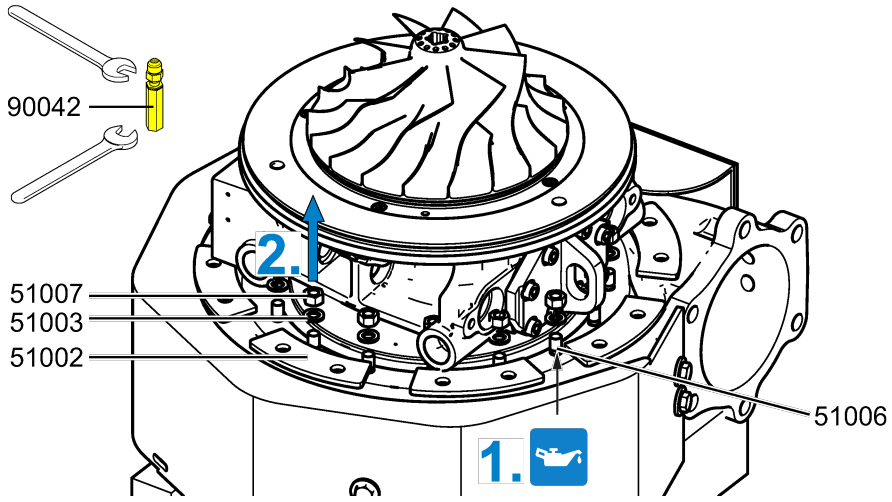


Fig. 43: Removing cartridge group 1

1. Treat threads of studs (51006) with penetrating oil and leave to take effect.
2. Undo nuts (51007) and remove Verbus Ripp® washers (51003) together with fastening strips (51002).

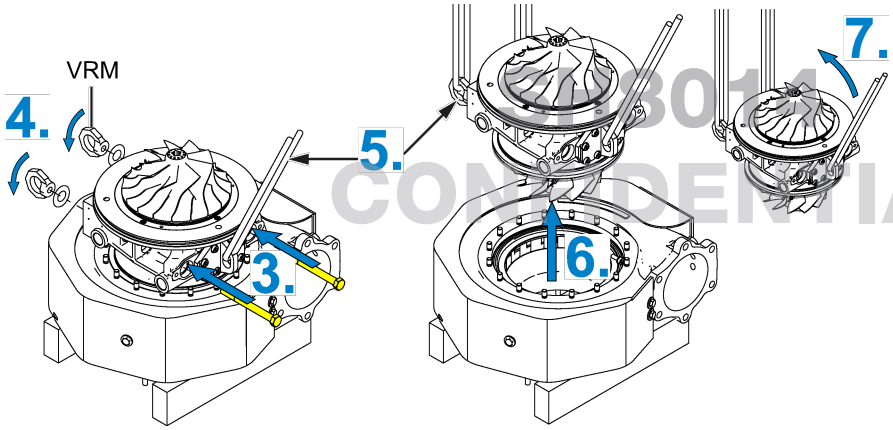


Fig. 44: Removing cartridge group 2

3. Insert screws from service support into cartridge group.
4. Secure ring nuts (VRM) onto the screws with washers.
5. Secure the lifting gear to the ring nuts and suspension eye as shown.
6. Remove the cartridge group vertically from the turbine casing.
7. Turn the cartridge group into the horizontal rotor axis.

If the cartridge group cannot be loosened, the press-off tool (90042) can be used (see chapter Pressing off the casing →78).

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8.9 Removing the nozzle ring

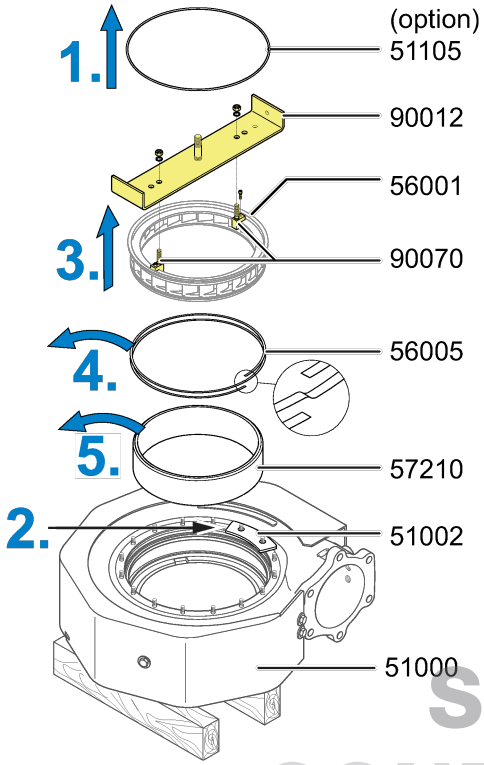


Fig. 45: Removing the nozzle ring

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1. If present: Remove the metal C-ring (51105).
2. Position the fastening strips (51002) in place.
3. Pull out the nozzle ring (56001) with the two extraction devices (90070) and the service support base (90012).
4. Remove the lamellar sealing ring (56005).
5. Remove the burst ring (57210).

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8.10 Installing the cartridge group on the service support

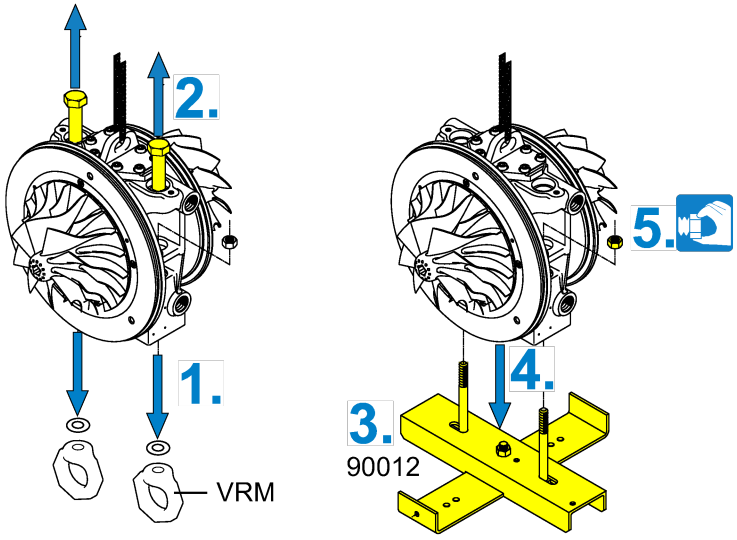


Fig. 46: Installing the cartridge group on the service support

1. Remove ring nuts (VRM).
2. Remove service support screws.
3. Fit service support (90012) according to the illustration.
4. Insert the cartridge group.
5. Fit the nuts.

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8.11 Measuring clearance A and B

- ▶ Measure and record clearances A and B after the removal and before the installation of the cartridge group.
- ▶ Attach the dial indicator and align it for the respective clearance as per the illustration.

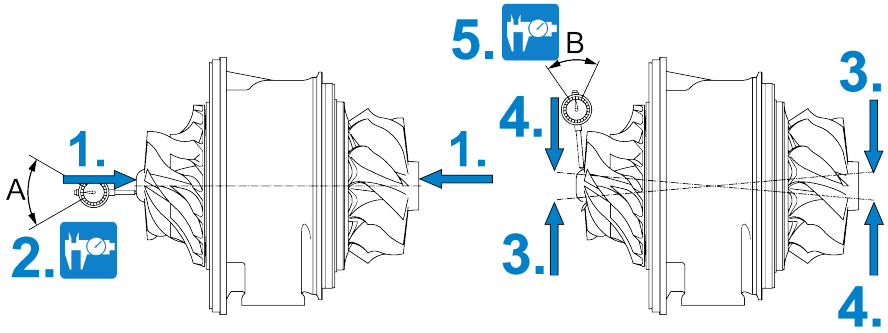


Fig. 47: Measuring clearance A and B

Product	A [mm]	B [mm]
A130-M	0.08 ... 0.16	0.47 ... 1.00
A135-M	0.10 ... 0.18	0.58 ... 1.16
A140-M	0.12 ... 0.21	0.70 ... 1.37
A145-M	0.15 ... 0.25	0.88 ... 1.56

Table 37: Permissible clearances A and B

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1. Move the rotor to and fro up to the stop. In order to obtain a correct measurement, elevate the turbine a little.
2. Measure clearance A and compare it with the permissible values in the table.
3. Raise the compressor and push the turbine down at the same time.
4. Raise the turbine and push the compressor down at the same time.
5. Measure clearance B and compare it with the permissible values in the table.

⚠ CAUTION

Clearances outside the tolerance

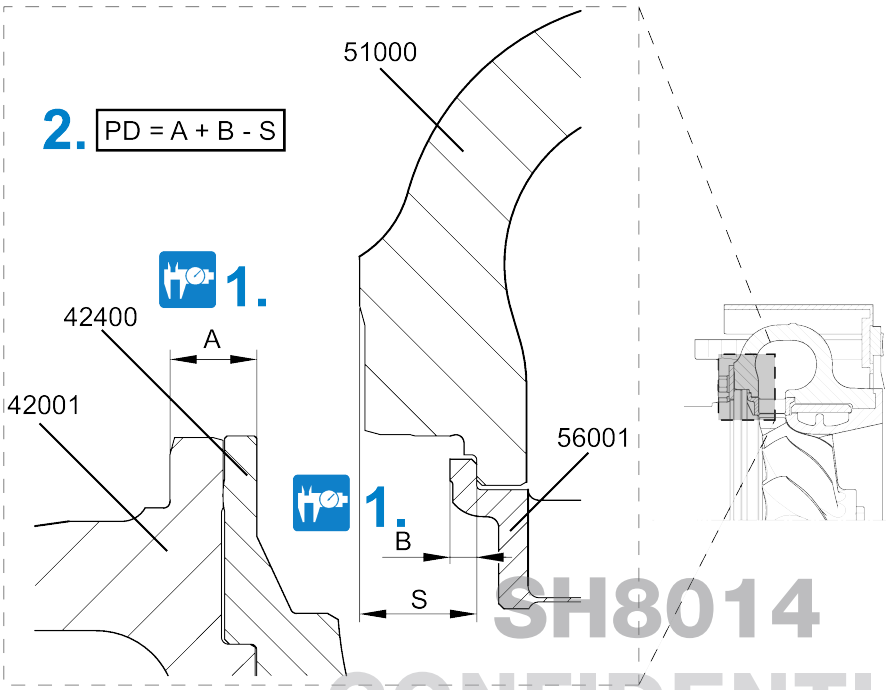
Serious damage to engines or property can be caused by clearances outside the tolerance and excessively worn parts.

- ▶ Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.

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8.12 Nozzle ring compression PD

In order for the nozzle ring (56001) to be fixed during operation, it must be clamped between the heat shield (42400) and the turbine casing (51000).



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Fig. 48: Nozzle ring compression PD

42001	Bearing casing	51000	Turbine casing
42400	Heat shield	56001	Nozzle ring

Product	Nozzle ring compression PD [mm]
A130-M	-0.15 ... 0.15
A135-M	-0.16 ... 0.16
A140-M	-0.16 ... 0.16
A145-M	-0.16 ... 0.16

Table 38: Nozzle ring compression PD

1. Measure dimensions A, B and S on cleaned surfaces.
2. Calculate compression (PD).

▶ If the calculated value (PD) lies outside the specified range, contact an ABB Turbocharging Service Station.

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8.13 Installing the nozzle ring

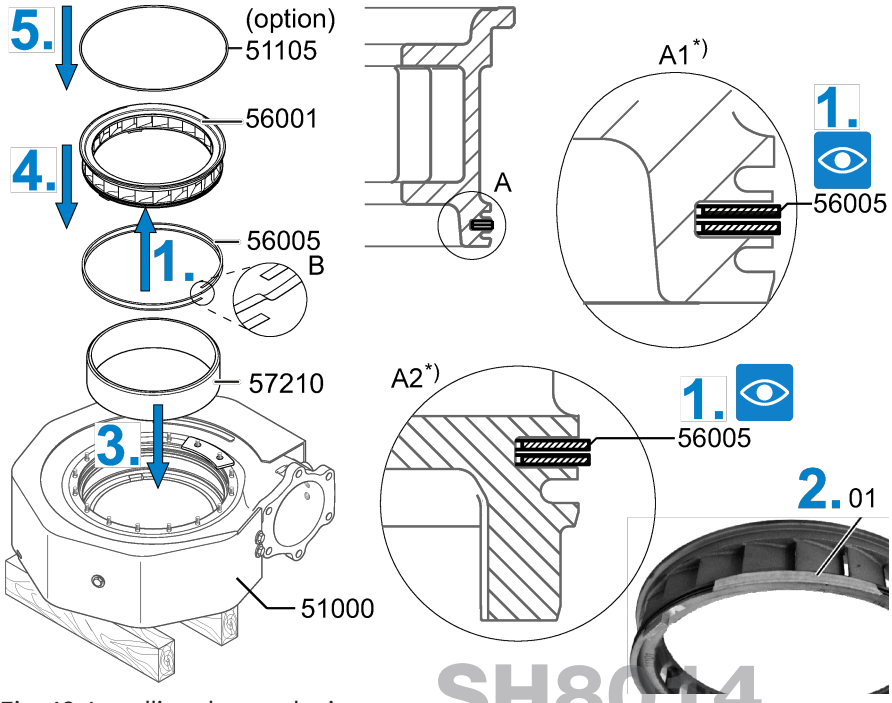


Fig. 49: Installing the nozzle ring

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*) Variant A1 or A2, depending on the nozzle ring version.

1. Fit the lamellar sealing ring (56005) in the correct slot (see detail A1/A2). When doing this, pay attention to correct winding of the lamellar sealing ring (see detail B).
2. Secure the lamellar sealing ring (56005) with adhesive tape (01).
3. Place the burst ring (57210) in the turbine casing.
4. Insert the nozzle ring (56001) (with the cams facing downwards) into the turbine casing as far as it will go. Align the cams on the nozzle ring with the recesses of the turbine casing (51000). Do not remove the adhesive tape (01).
5. If present: Fit the metal C-ring (51105).

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8.14 Installing the cartridge group

Lifting the cartridge group and rotating it by 90°

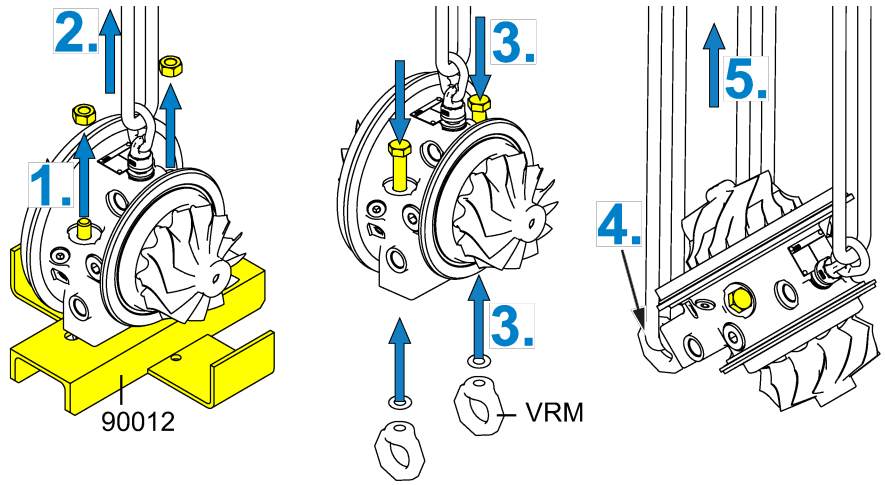


Fig. 50: Lifting the cartridge group and rotating it by 90°

1. Loosen and remove nuts.
2. Lift the cartridge group out of the service support (90012).
3. Insert the screws of the service support from above and fit ring nuts (VRM) with washers.
4. Attach lifting gear to the ring nuts (VRM).
5. Lift cartridge group at the side of the ring nuts (VRM) and turn it into a vertical position.

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Installing the cartridge group

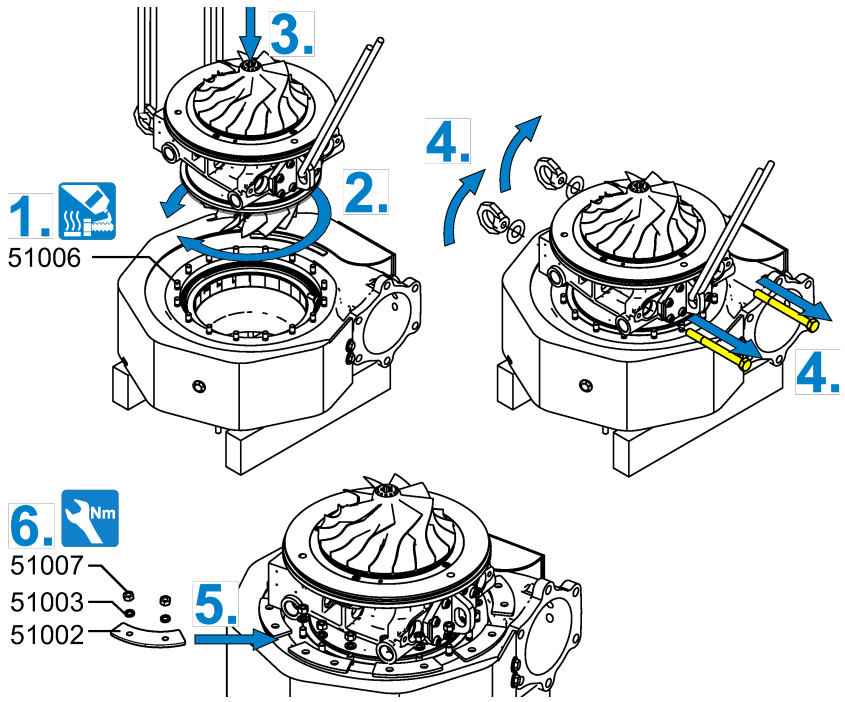


Fig. 51: Installing the cartridge group

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Product	Size	Tightening torque [Nm]
A130	M8	25
A135	M10	45
A140	M12	75
A145	M12	75

Table 39: Tightening torque (51007)

1. Coat thread of studs (51006) with high-temperature grease.
2. Align the casing position of the cartridge group to the marking.
3. Lower the cartridge group into the turbine casing.
4. Remove ring nuts and screws.
5. Fit fastening strips (51002) with Verbus Ripp® washers (51003) and hexagon nuts (51007).
6. Tighten the hexagon nuts (51007).

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⚠ WARNING

The turbine casing insulation supplied by ABB Turbo Systems also acts as burst protection

Serious injuries or accidents resulting in fatalities can occur if the turbine casing insulation (01) supplied by ABB Turbo Systems is removed. A burst protection is integrated into this turbine casing insulation supplied by ABB Turbo Systems.

For turbochargers which were ordered from ABB Turbo Systems without insulation or which are equipped with the insulation (02), separate burst protection (03) is fitted.

If the insulation from ABB Turbo Systems (01) is not installed, the separate burst protection (03) plus either the insulation (02) or an appropriate insulation supplied by the enginebuilder must be installed for operation.

▶ Never operate a turbocharger without burst protection and insulation.

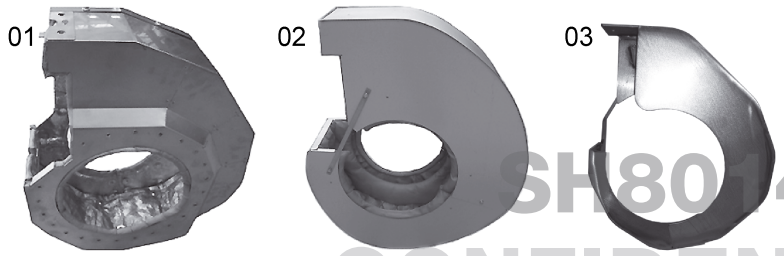


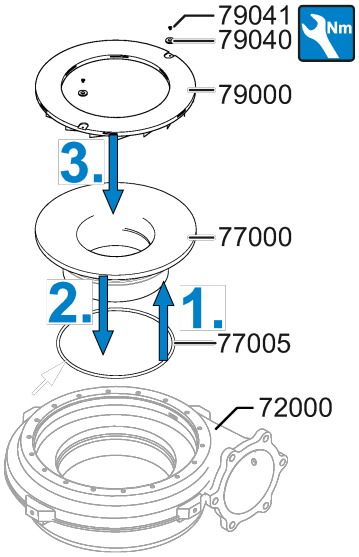
Fig. 52: Turbine casing insulation / Burst protection

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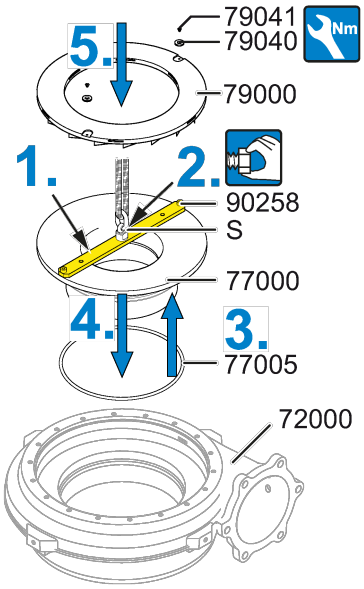
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8.15 Installing the compressor casing

Fitting the wall insert and the diffuser



A130 - A140



A145

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Product	Size	Tightening torque [Nm]
A130	M6	8
A135	M6	8
A140	M6	8
A145	M6	8

Table 40: Tightening torque (79041)

▶ Always replace the O-ring (77005) (see section Spare parts).

A130 - A140

1. Fit new O-ring (77005).
2. Install the wall insert (77000) in the compressor casing.
3. Fit diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

A145

1. Fit the lifting beam (90258) to the wall insert (77000).
2. Fit the swivel lifting eye (S) to the lifting beam. Secure lifting gear to the swivel lifting eye.
3. Fit new O-ring (77005).
4. Install the wall insert (77000) in the compressor casing.
5. Fit diffuser (79000) with fixing discs (79040) and screws (79041). Observe the tightening torque.

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Installing the compressor casing

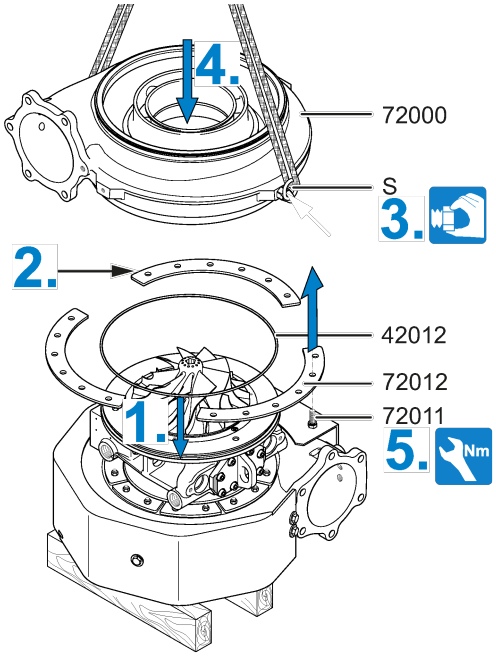


Fig. 53: Installing the compressor casing

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Product	Size	Tightening torque [Nm]
A130	M8	35
A135	M10	70
A140	M12	105
A145	M14	170

Table 41: Tightening torque (72011)

1. Fit new O-ring (42012).
2. Thoroughly clean the fastening strips (72012) before assembly.
3. Attach swivel lifting eyes (S) to compressor casing (72000). Secure lifting gear to the swivel lifting eyes.
4. Install the compressor casing (72000).
5. Install the fastening strips (72012) with screws (72011). Observe the tightening torque. If these screws do not have a Verbus Ripp® integrated, Verbus Ripp® washers (72010) must also be fitted.

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8.16 Measuring radial clearances N and R

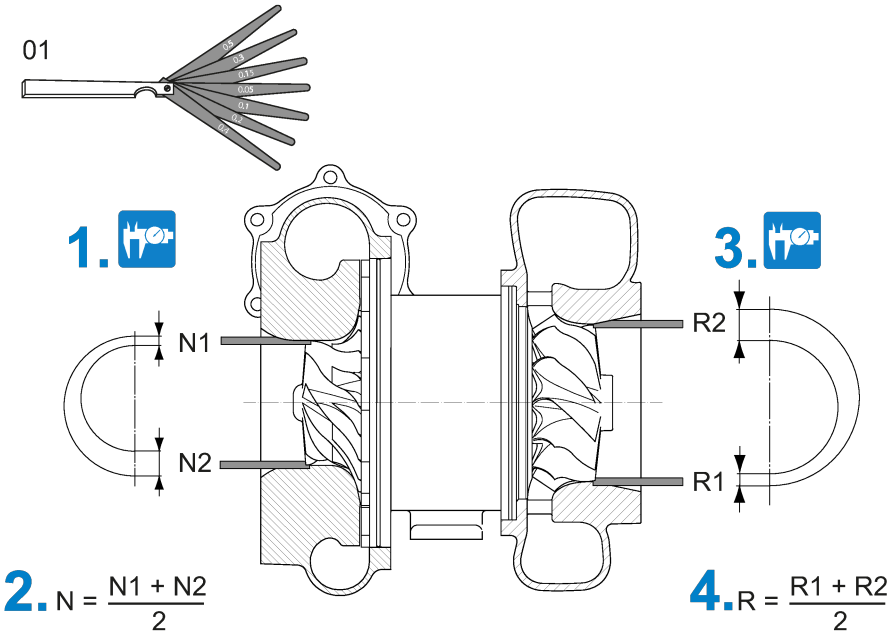


Fig. 54: Measuring clearances N and R

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Product	N [mm]	R [mm]
A130-M	0.26 ... 0.60	0.45 ... 0.70
A135-M	0.34 ... 0.70	0.51 ... 0.85
A140-M	0.45 ... 0.90	0.64 ... 1.00
A145-M	0.56 ... 0.95	0.76 ... 1.20

Table 42: Permissible clearances N and R

1. Push the feeler gauges (01) into the gap without clearance simultaneously at the top (N1) and the bottom (N2).
2. Calculate clearance N and compare it with the permissible values in the table.
3. Push the feeler gauges (01) into the gap without clearance simultaneously at the top (R2) and the bottom (R1).
4. Calculate clearance R and compare it with the permissible values in the table.

⚠ CAUTION

Clearances outside the tolerance

Serious damage to engines or property can be caused by clearances outside the tolerance and excessively worn parts.

▶ Have the components assessed and, if necessary, replaced by an ABB Turbocharging Service Station.

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8.17 Installing the air inlets

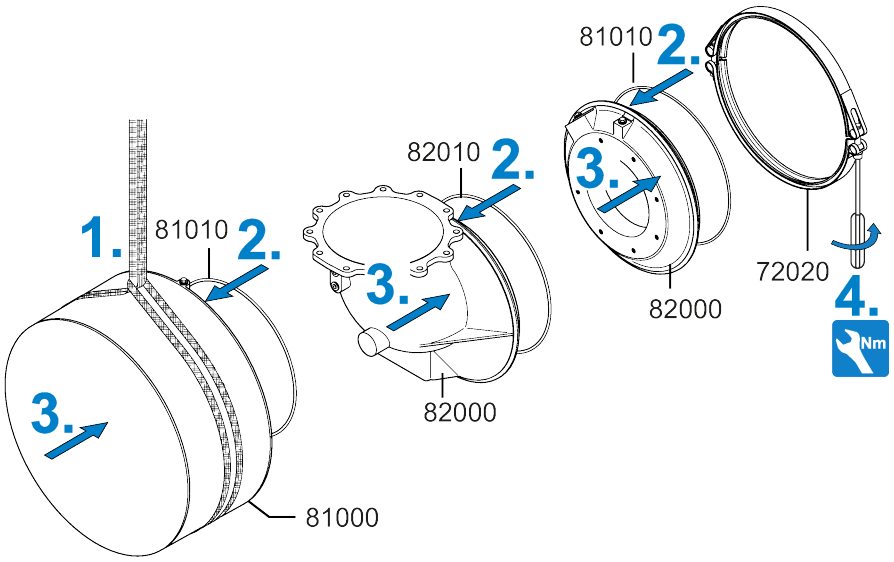


Fig. 55: Installing the air inlets

Product	Size	Tightening torque [Nm]
A130	M12	60
A135	M12	60
A140	M12	60
A145	M12	60

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Table 43: Tightening torque (72020)

1. Secure lifting gear to filter silencer (81000).
2. Fit a new O-ring (81010) to the filter silencer (81000) or a new O-ring (82010) to the air suction branch (82000).
3. Fit the filter silencer (81000) or air suction branch (82000) with the V-clamp (72020).
4. Observe the tightening torque.

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8.18 Installing the gas outlet flange

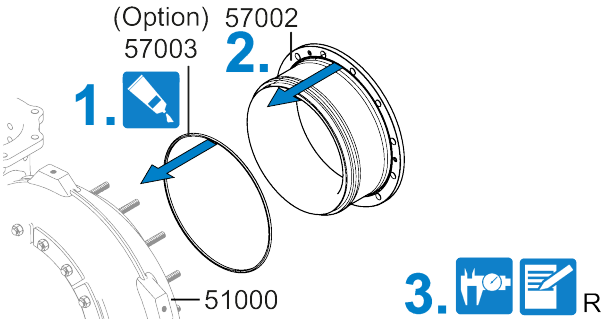


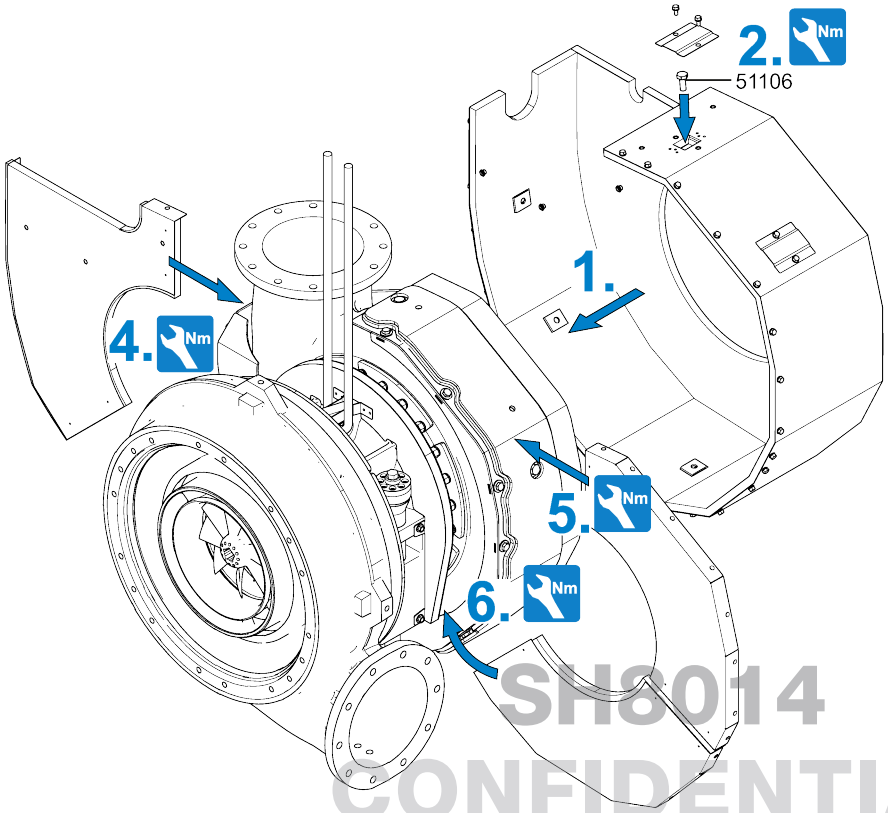
Fig. 56: Installing the gas outlet flange

1. If present: Insert the metal C-ring (57003) into the turbine casing (51000) and secure with high-vacuum grease.
2. Install the gas outlet flange (57002) in the turbine casing.
3. Measure radial clearance (R) (see chapter Radial clearances N and R).

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8.19 Fitting the insulation of the turbine casing



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Fig. 57: Fitting the insulation

▶ Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →97).

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8.20 Installing the gas outlet casing

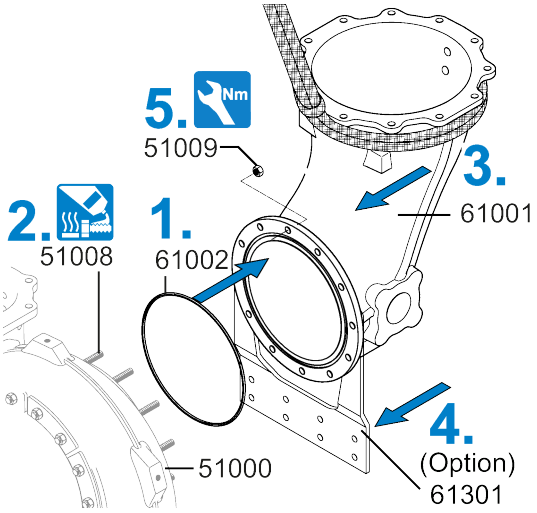


Fig. 58: Installing the gas outlet casing

Product	Size	Tightening torque [Nm]
A130	M8	20
A135	M10	40
A140	M12	65
A145	M12	65

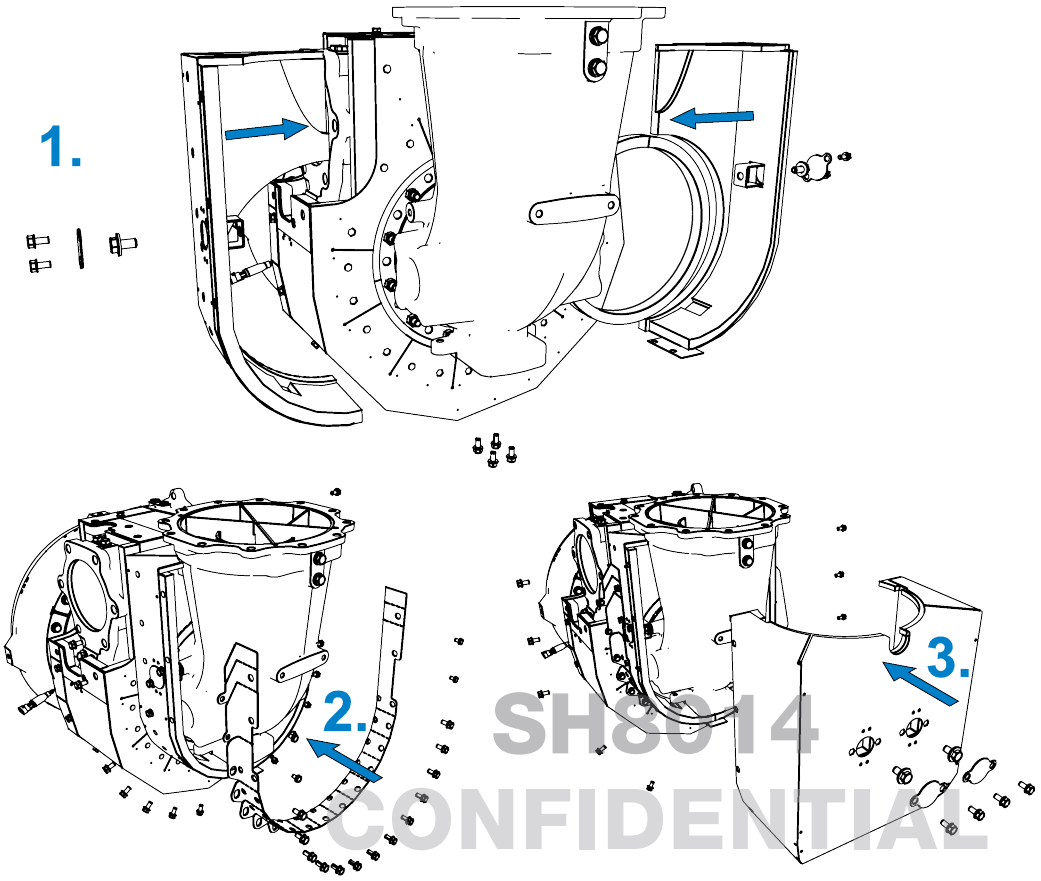
Table 44: Tightening torque (51009)

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1. Insert a new gasket (61002) into the gas outlet casing (61001).
2. Coat the threads of the studs (51008) with high-temperature grease.
3. Attach the lifting gear to the gas outlet casing (61001) and position the gas outlet casing in the correct position on the turbine casing (51000).
4. If present: Fit support (61301).
5. Fit hexagon nuts (51009). Observe the tightening torque.

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Fitting the insulation



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Fig. 59: Fitting the insulation

▶ Fit the insulation according to the illustration. Observe tightening torques (see Table of tightening torques →97).

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8.21 Table of tightening torques

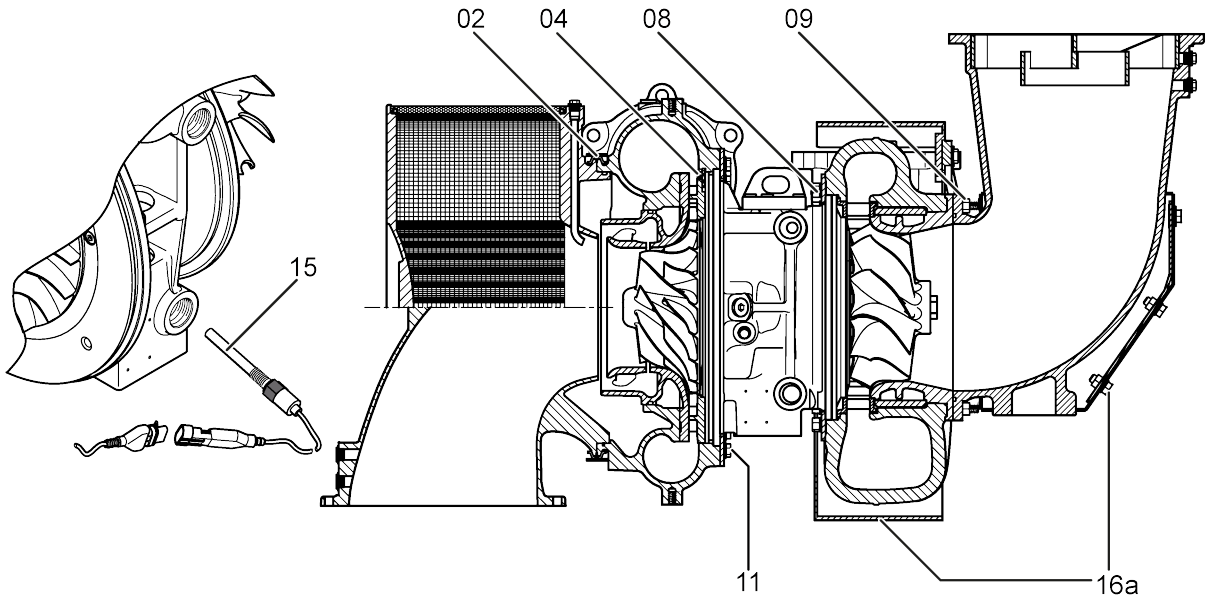


Fig. 60: Tightening torques

The following tightening torques must be observed for the specified screw connections:

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Position	Part number	A130	A135	A140	A145
02	72020	M12 60 Nm	M12 60 Nm	M12 60 Nm	M12 60 Nm
04	79041	M6 8 Nm	M6 8 Nm	M6 8 Nm	M6 8 Nm
08	51007	M8 25 Nm	M10 45 Nm	M12 75 Nm	M12 75 Nm
09	51009	M8 20 Nm	M10 40 Nm	M12 65 Nm	M12 65 Nm
11	72011	M8 35 Nm	M10 70 Nm	M12 105 Nm	M14 170 Nm
15	86505	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm	M12 x 1.5 15 Nm
16a *)	- -	M10 40 Nm	M10 40 Nm	M12 65 Nm	M12 65 Nm

Table 45: Tightening torques

*) With the variant "insulation with integrated burst protection", this position can be ignored.

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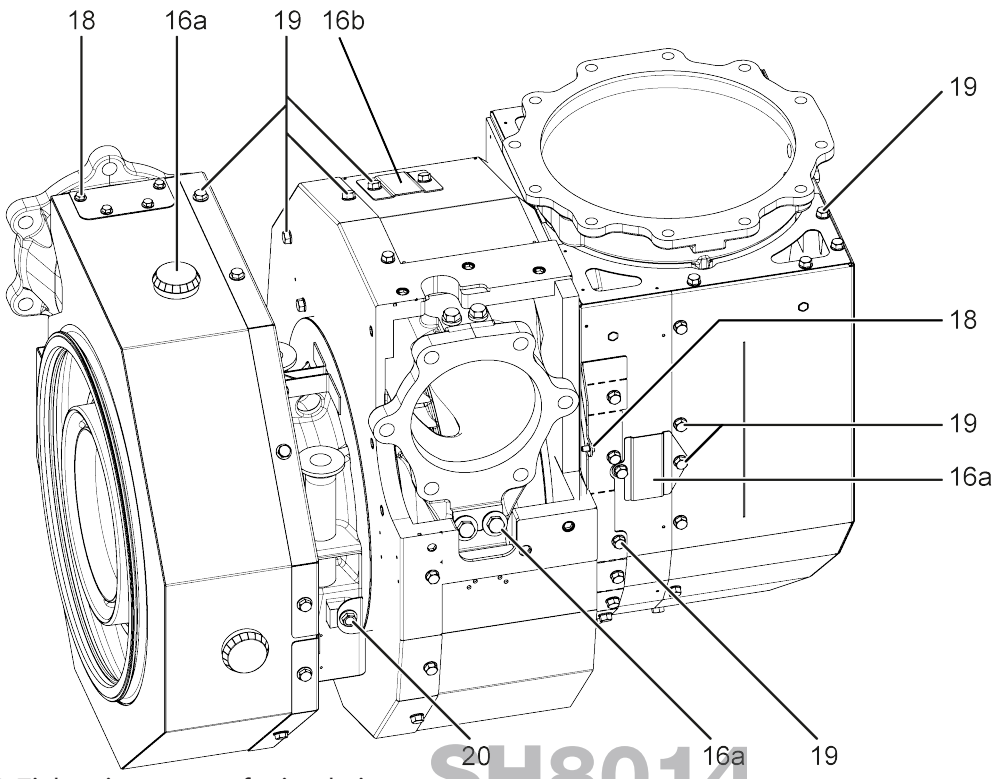


Fig. 61: Tightening torques for insulation

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The following tightening torques must be observed for the specified screw connections:

Position	Part number	A130	A135	A140	A145
16a / 16b [1)]	- -	M10 40 Nm	M10 40 Nm	M12 65 Nm	M12 65 Nm
16b [2)]	- -	M8 20 Nm	M8 20 Nm	M10 40 Nm	M10 40 Nm
18	- -	M6 10 Nm	M6 10 Nm	M6 10 Nm	M6 10 Nm
19	- -	M8 25 Nm	M8 25 Nm	M8 25 Nm	M8 25 Nm
20	- -	M10 45 Nm	M10 45 Nm	M10 45 Nm	M10 45 Nm

Table 46: Tightening torques for insulation

[1)] Tightening torque for attaching the insulation with integrated burst protection at the turbine casing

[2)] Tightening torque for attaching the insulation to the burst protection.

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9 Taking out of operation at short notice

9.1 Possible emergency repairs



⚠ WARNING

Danger of fire and explosion due to lubricating oil leaks

Leaking oil may ignite on hot surfaces. This can result in serious injuries to personnel or fatal accidents.

- ▶ Cordon off danger area.
- ▶ Raise the alarm and, depending on the situation, stop the engine.
- ▶ Seal the oil leak.
- ▶ Soak up oil and dispose of in an environmentally compatible manner.



Wear safety gloves to protect against thermal hazards.



⚠ CAUTION

Directives for taking out of operation

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Serious damage to engine or property can be caused by non-compliance with the directives for blanking the turbocharger off the engine.

- ▶ Follow the directives of the enginebuilder.

If the engine has to be operated again as quickly as possible following a turbocharger defect, then the following options are available for emergency repairs:

- If present: Installing the replacement turbocharger →100.
- If present: Installing the replacement cartridge group →100.
- If a replacement turbocharger or cartridge group is not available: Fit cover plate →101 and contact an ABB Turbocharging Service Station.

▶ Observe the following sections in connection with the emergency repairs mentioned.

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9.2 Installing the replacement turbocharger

To enable you to quickly put an engine back into operation after a turbocharger has sustained damage, ABB Turbo Systems recommends having a replacement turbocharger or appropriate spare parts available in storage. The defective turbocharger can be removed and the replacement turbocharger installed within a short period of time.

- ▶ Remove defective turbocharger (see chapter Removing and Installing →8).
- ▶ Install replacement turbocharger (see chapter Removing and Installing →8).
- ▶ Send the defective turbocharger to an ABB Turbocharging Service Station for inspection and repair.

9.3 Installing the replacement cartridge group



⚠ WARNING

Incorrect handling of a cartridge group

Incorrect handling of a cartridge group can damage the turbocharger and cause injuries to persons.

- ▶ Have repairs to the cartridge group carried out by an ABB Turbocharging Service Station only.

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To enable you to quickly put an engine back into operation after a turbocharger has sustained damage, ABB Turbo Systems recommends having a replacement cartridge group available in storage. The defective cartridge group can be removed and the replacement cartridge group installed within a short period of time. A replacement cartridge group is ready for use immediately and includes the complete bearing casing with bearing and a balanced rotor.

The repair of a cartridge group requires special tools and the expertise of an ABB Turbocharging Service Station. The rotating parts rotate extremely fast, and are sensitive to unbalance.

- ▶ Remove defective cartridge group (see chapter Dismantling and fitting →67).
- ▶ Install replacement cartridge group (see chapter Dismantling and fitting →67).
- ▶ Send the defective cartridge group to an ABB Turbocharging Service Station for inspection and repair.

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9.4 Fitting the cover plate

▶ Remove turbocharger (see chapter Removing and Installing →8).

- **Gas outlet casing removed**

▶ Fit the turbine casing with the gas outlet casing into the gas pipe again.

▶ Attach the cover plate (see following section).

- **Gas outlet casing not removed**

▶ Fit the turbine casing into the gas pipe and on the gas outlet casing again.

▶ Attach the cover plate (see following section).

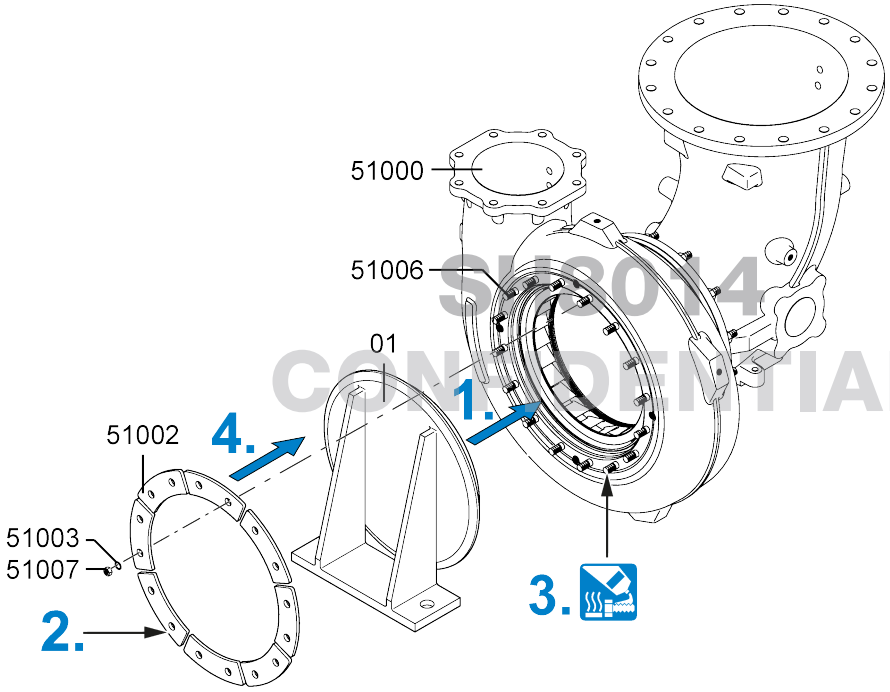


Fig. 62: Fitting the cover plate

▶ Make sure that the oil connections in the bracket are equipped with gaskets.

1. Close opening in turbine casing (51000) with cover plate (01).
2. Thoroughly clean the fastening strips (51002) before assembly.
3. Coat the threads of the studs (51006) with high-temperature grease.
4. Fasten cover plate (01) to turbine casing (51000) with fastening strips (51002), Verbus Ripp® washers (51003) and nuts (51007) and screw to bracket.

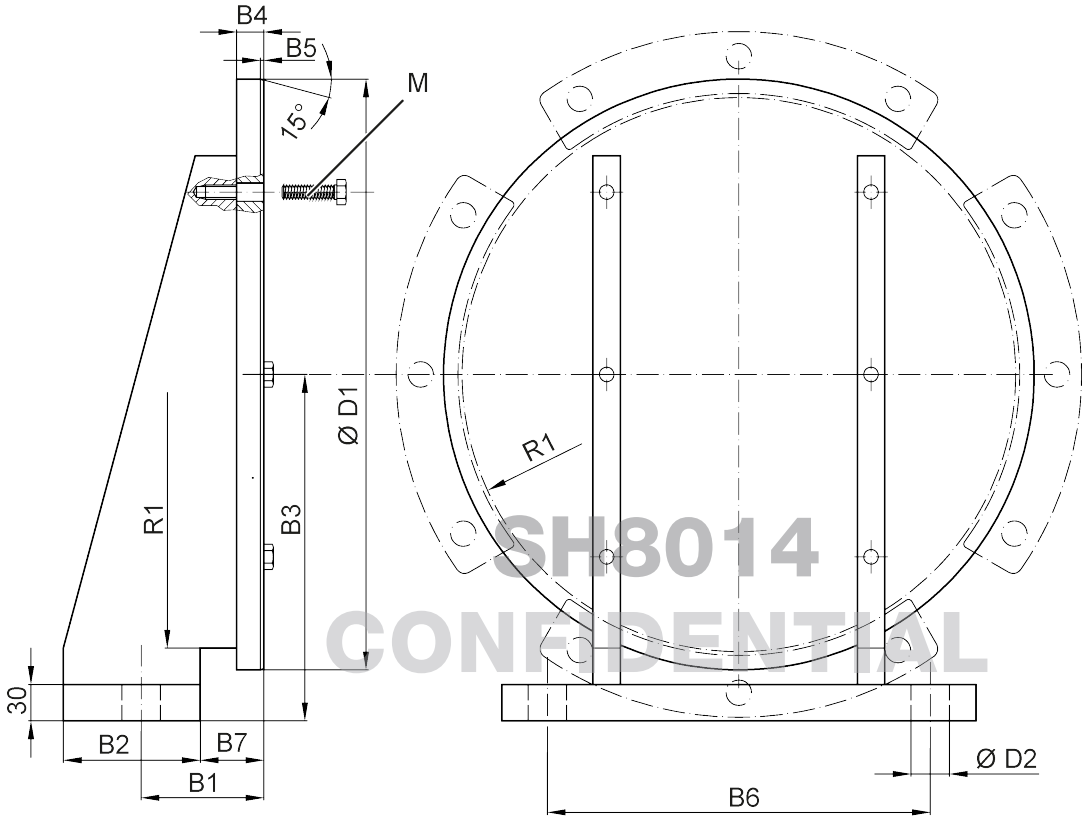
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9.5 Cover plate drawing

The cover plate is not included in the ABB Turbo Systems scope of delivery and must be manufactured by the operating company according to the following drawing.

Material: General structural steel, in compliance with DIN EN 10025-2.



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Fig. 63: Cover plate drawing

Product	B1 ± 0.5	B2	B3	B4 ± 0.2	B5	B6	B7	ØD1 ± 0.2	ØD2	R1	M
A130	65.7	60	130	11.7	1.4	150	35.7	227.7	17	≤ 105	M8
A135	79.6	80	155	14.2	1.6	180	39.6	271.7	21	≤ 125	M8
A140	98.2	102	190	17.2	2.0	220	48.2	332.5	25	≤ 153	M10
A145	116.8	120	226	20.5	2.4	260	56.8	395.9	31	≤ 182	M10

Table 47: Cover plate dimensions [mm]

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10 Mothballing the turbocharger

10.1 Taking the engine out of operation for up to 12 months

State of the engine lubricating oil

The turbocharger normally remains attached to the engine. The measures to be taken for mothballing the turbocharger depend on the state of the lubricating oil. No measures are required under the following conditions:

- Acid number (TAN) < 2 mg KOH/g
- The engine lubricating oil is replaced by a preservative oil and circulated with the pre-lubrication pump before the engine is taken out of operation. Residues of old engine oil are flushed away in this way and the bearing parts are largely protected against corrosion.

Preparations for mothballing



⚠ WARNING

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Handling operating materials and supplies

Swallowing or inhaling vapours of operating materials and supplies or contact with them may be harmful to health.

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- ▶ Do not breathe in these substances and avoid contact with the skin.
- ▶ Ensure proper ventilation.
- ▶ Observe the information in the material safety data sheet for the operating materials and supplies.
- ▶ Wear personal protective equipment (PPE) according to the material safety data sheet.
- ▶ Comply with local legislation.



Wear safety goggles.



Wear safety gloves to protect against chemical hazards.



Wear a respiratory mask to protect against gases.

If the acid number (TAN) is greater than 2 mg KOH/g, the following mothballing measures are necessary after taking the engine out of operation:

- ▶ Dismantle the turbocharger.
- ▶ The rotor and bearing parts must be dismantled and subsequently refitted by an ABB Turbocharging Service Station.
- ▶ Clean all parts.

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- ▶ Coat plain surfaces of steel and cast parts with anticorrosive oil.
- ▶ Fit turbocharger completely.

Rotation of the rotor in the stack draught

If the rotor turns as a result of the stack draught:

- ▶ Install a blind flange between the outlet flange of the compressor casing and the charge air duct.

10.2 Taking the engine out of operation for more than 12 months

If the engine is taken out of operation, the following variants are possible with regard to the turbocharger:

- Turbocharger remains attached to the engine
- The casings of the turbocharger remain attached to the engine, the rotor and bearing parts are dismantled by an ABB Turbocharging Service Station and stored separately
- The turbocharger is completely removed, either as a whole unit or in individual parts

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For the measures always necessary for preparing the turbocharger parts for mothballing, see section Taking the engine out of operation for up to 12 months, subsection Preparations for mothballing.

If the turbocharger remains attached to the engine, see section Taking the engine out of operation for up to 12 months →103, subsection Rotor turning in stack draught.

If the complete turbocharger is removed or the turbocharger is assembled again from the individual parts:

- ▶ Seal all openings of the turbocharger with paraffin paper and wooden lids.

Only dry rooms with 40 ... 70 % atmospheric humidity, in which no water condensation can form, are suitable as storage locations.

State of the mothballed turbocharger

- ▶ Check the turbocharger parts annually for corrosion.
- ▶ If there are signs of rust: Thoroughly clean parts and renew corrosion protection.

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11 Disposing of turbocharger components



⚠ WARNING

Handling damaged thermal insulation

Damaged thermal insulation can lead to dust exposure. The glass fibres can cause mechanical irritation of the eyes, skin, and respiratory tracts.

- ▶ Avoid the formation of dust.
- ▶ Vacuum up dust with a suitable vacuum cleaner.
- ▶ Wear a respiratory mask to protect against dusts (P1 or P2 mask).
- ▶ Wear work gloves made of leather.



Wear safety goggles.



Wear a respiratory mask to protect against dusts.



Wear safety gloves to protect against mechanical hazards.

Disposal must be environmentally compatible, professional, and in compliance with locally applicable regulations.

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The turbocharger consists largely of metal (cast iron materials, steel, nickel-steel alloys, aluminium and bearing brass).

Further components are: Non-metallic materials (filter components of felt and polyethylene), lubricants (engine oil), electronic parts (speed sensor and associated components), and thermal insulation.

- ▶ Dispose of metals as scrap metal for recycling.
- ▶ Dispose of non-metallic materials as waste.
- ▶ Dispose of residues of lubricants as waste oil.
- ▶ Dispose of electronic components as electronic waste.
- ▶ Dispose of thermal insulation as hazardous waste.

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12 Spare parts

12.1 Ordering spare parts

⚠ CAUTION

Spare part storage

All spare parts that were ordered together with the turbocharger must be kept intact and ready for use.

▶ Carefully clean any rusted parts and grease them.

Please quote the following data when making queries and ordering spare parts:

- Turbocharger type
- Serial number of the turbocharger
- Designation and part number

Spare parts can be ordered from any ABB Turbocharging Service Station.

▶ If different model variants are not taken into account in this document, contact an ABB Turbocharging Service Station.

▶ Dispose of placed and unusable parts in an environmentally-friendly and professional manner in accordance with the local regulations.

▶ Dispose of the packaging of new parts in an environmentally-friendly and professional manner in accordance with the local regulations.

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12.2 Required customer spare part set (97070)

For the operations described in the Operation Manual, the customer spare part set (97070) is required. These parts are only available in the complete set.

Part number	Designation	Quantity
42012	O-ring	1
61002 *	Gasket	1
77005	O-ring	1
79041	Counter-sunk screw	2
81010/ 82010	O-ring	1

Table 48: Customer spare part set 97070

* This gasket can only be installed when a gas outlet casing from ABB Turbo Systems is used.

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12.3 View of turbocharger with part numbers

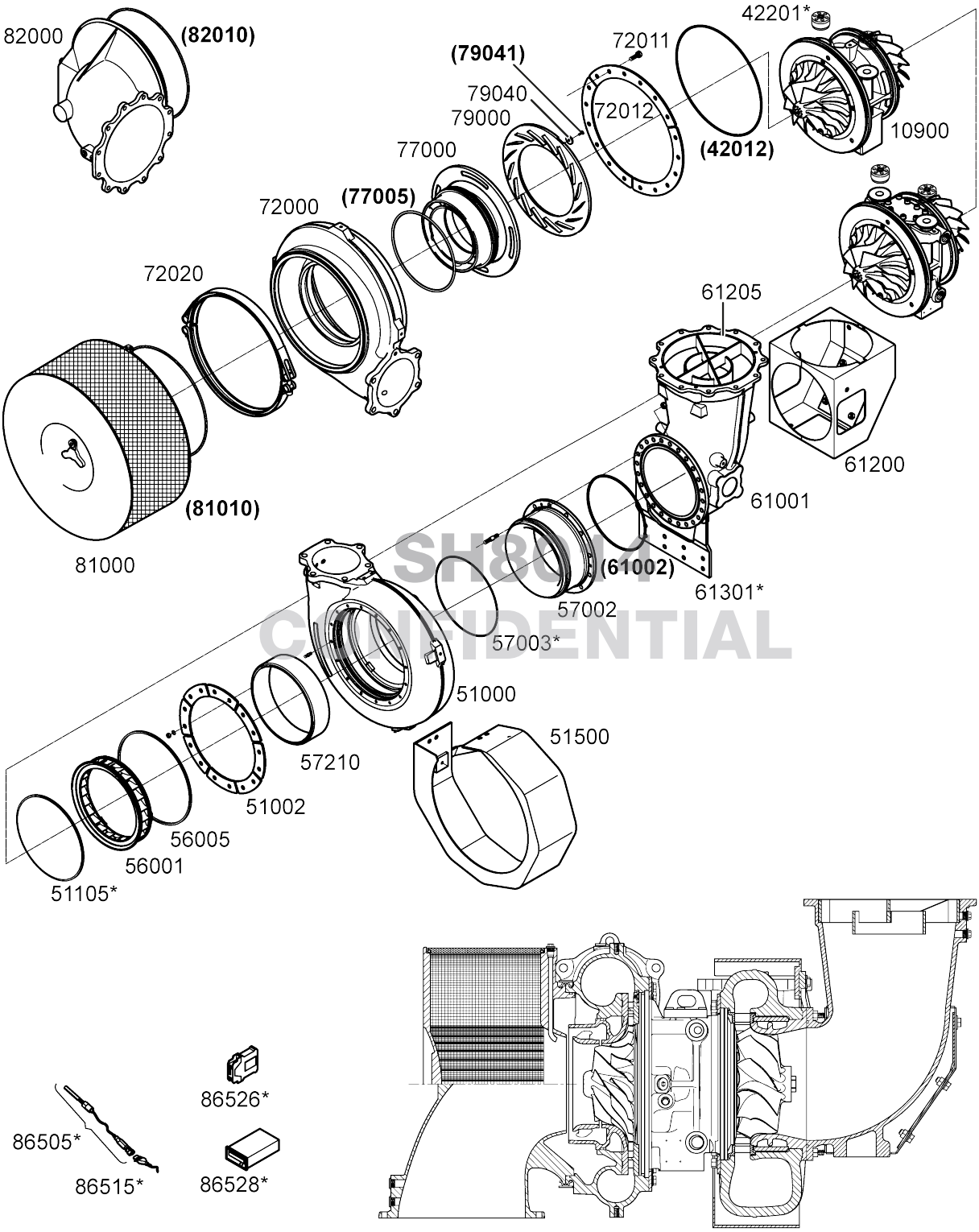


Fig. 64: Overview of part numbers

(.....) only available in customer spare part set (97070).

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Part number	Designation
10900	Cartridge group
42008	Socket screw
42012 (in the customer spare part set)	O-ring
42201*	Clamping nut
51000	Turbine casing
51002	Fastening strip
51105*	Metal C-ring
51500	Burst protection
56001	Nozzle ring
56005	Lamellar sealing ring
57002	Gas outlet flange
57003*	Metal C-ring
57210	Burst ring
61001	Gas outlet casing
61002 (in the customer spare part set)	Gasket
61200	Burst protection
61205	Protective grid
61301*	Support
72000	Compressor casing
72011	Hexagon-head screw
72012	Fastening strip
72020	V-clamp
77000	Wall insert
77005 (in the customer spare part set)	O-ring
79000	Diffuser
79041 (in the customer spare part set)	Counter-sunk screw
81000	Filter silencer
81010 (in the customer spare part set)	O-ring
82000	Air suction branch
82010 (in the customer spare part set)	O-ring
86505*	Speed sensor
86515*	Cable connector
86526*	F/I converter
86528*	Tachometer

Table 49: Spare parts list

* Depending on the specification of the turbocharger

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12.4 View of turbine cleaning device

12.4.1 One cleaning nozzle per turbine inlet

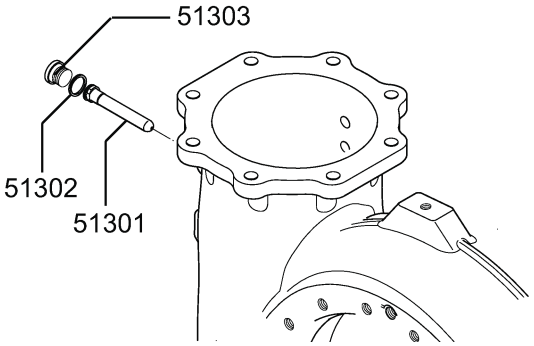


Fig. 65: Overview of part numbers

Part number	Designation
51301	1 inlet = 1 cleaning nozzle
	2 inlets = 2 cleaning nozzles
	3 inlets = 3 cleaning nozzles
51302	Gasket
51303	Screw plug

Table 50: Spare parts list

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WOODWARD

Product Manual 26579
Original Instructions



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UG-25+ Governor (P3 version)

Installation and Operation Manual

IMPORTANT

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DEFINITIONS

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the *publications page* on the Woodward website:

www.woodward.com/searchpublications.aspx

The current revision of all publications is shown in file "*current.pdf*".

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Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

NOTICE

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

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Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking.

EMC Directive: Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 Dec 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and all applicable amendments.

Other European Compliance:

Machinery Directive: Compliant as a component with 98/37/EC COUNCIL DIRECTIVE of 23 July 1998 on the approximation of the laws of the Member States relating to machinery.

Pressure Equipment Directive: Compliant as "SEP" per Article 3.3 to Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States relating to machinery.

Marine Compliance (APPROVALS PENDING):

Special Conditions for Safe Use:
Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field wiring must be suitable for at least 105 °C.

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WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

    - Do not touch any part of the PCB except the edges.
    - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
    - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

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NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Chapter 1.
General Information

How to Use This Manual

The following summarizes how to install a UG-25+ into a new or existing system:

- Unpack and inspect the hardware.
- Mount and wire the hardware following the procedures and recommendations in Chapters 2–3.
- Configure application-specific settings (Chapter 6).
- Speed control tuning information is found in Chapter 7.
- Specifications and Troubleshooting information are provided in the Appendixes.

General Description

The Woodward UG-25+ governor is a microprocessor controlled mechanical hydraulic governor for controlling diesel, gas, or dual fuel engines, or steam turbines. The UG-25+ includes enhanced control capabilities, such as start fuel and boost limiting schemes. The additional transient fuel limiting (jump-rate) improves the engine load acceptance and reduces transient emissions significantly.

The UG-25+ provides a fast-acting and high-work-output governor, without the need for any auxiliary devices such as a start booster.

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The UG-25+ offers speed control with software-selectable speed setpoints, dynamics, fuel limiting, and start behavior.

Front panel and external speed settings make synchronization easy for generator applications. A 4–20 mA speed setting is available for variable speed applications or for remote synchronization or remote setting of speed/load.

Adjustable droop permits load division and balancing among paralleled prime movers. Droop can be set with a knob on the front panel between 0–10%. The load limiter knob allows you to limit the governor output stroke manually.

The UG-25+ uses an internal, self-contained oil system operating at 1034 kPa (150 psi) internal pressure with an internal oil pump driven from the governor's drive shaft. Oil pressure is maintained by a relief valve system with a drain to an internal oil sump.

The UG-25+ combines all the advantages of a traditional mechanical governor with the state-of-the-art control algorithms for optimal engine operation.

Controller Features

The governor features include:

- State-of-the-art speed sensing and control algorithms
- Built-in user interface which provides speed raise/lower and local shutdown functions
- Speed Control with Droop and Dynamics features
- Configurable speed settings and adjustment rates
- Multiple Fuel Limiting algorithms, such as jump-rate, boost pressure, and start fuel limiting
- Temperature monitoring
- Run / Stop
- Status discrete output
- Speed setpoint adjustments using a 4–20 mA analog input or raise/lower discrete inputs or front panel raise/lower commands
- Front panel Droop, Stability, and Load Limit adjustments are also available
- Comprehensive diagnostics for easy troubleshooting

Inputs / Outputs

The following optional inputs and outputs are available, only input power is required.

- Input Power (single or dual)
- Run/Stop discrete input
- Unit Healthy Status discrete output
- Speed Setpoint Raise discrete input
- Speed Setpoint Lower discrete input
- Analog Speed Setpoint 4–20 mA input
- Analog Speed Setpoint Enable discrete input
- Boost Pressure 4–20 mA input
- Boost Pressure Input Enable discrete input

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Available Terminal Shafts and Drive Shafts

The following output terminal shafts and drive shafts are available:

Standard—
0.625–36 serrated terminal shaft
0.625–36 serrated drive shaft
0.625 keyed drive shaft with 0.625-18 thread

Available (for special applications at additional cost)—
0.562 / 0.625 D-shaped terminal shaft
Extended 0.625 keyed drive shaft

UG Governor Similarities

The base is designed to fit any drive designed for a UG governor. The terminal shaft location relative to the mounting base is similar to a UG governor.

Hydraulic Pump

The UG-25+ is equipped with a Gerotor fixed displacement pump (3161 governor type) with a relief valve. The pump/relief valve uses oil from its self-contained sump to provide 1035 kPa (150 psi) internal operating pressure.

Two displacements are offered to cover the speed range up to 1700 grpm. The large displacement pump (0.875 inch/22.22 mm thick) is intended to be used with governor drive speeds from 350 to 1200 rpm. Running the large displacement pump continuously above 1200 grpm could result in excessive oil temperatures. The small displacement pump (0.625 inch/15.88 mm thick) is designed to be used with governor drive speeds between 500 and 1700 rpm maximum continuous operation. The description of governors (naming in the extended description) refers to the thickness (equals flow) of the pump segment in inches.

The direction of rotation is selected by pump housing alignment. Once this selection is made, the pump operates in one direction only. The drive uses a maximum of 335 W (0.45 hp).

References

The following publications provide additional information about installation, operation, and storage of Woodward products. All are available on the Woodward website (www.woodward.com).

Publication	
25071	Oils for Hydraulic Controls
25075	Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls
50516	Governor Linkage for Butterfly Control Valve
03339	UG-25+ Governor Product Specification
36684	Booster Servomotor

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Contact your nearest Woodward Distributor or Authorized Independent Service Facility about repairs.

Serviceability

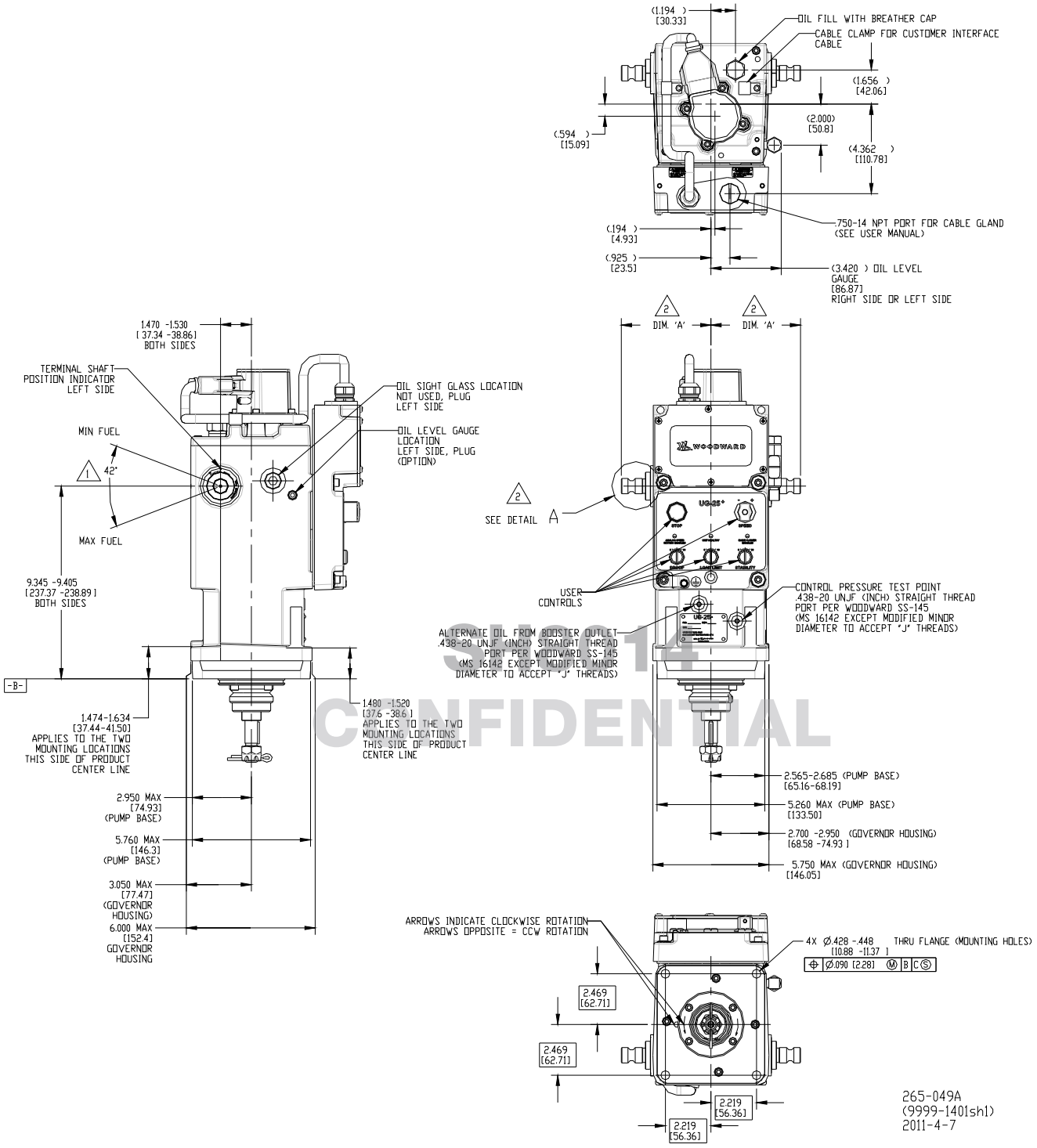
The UG-25+ has no field-replaceable parts.

Recommended service interval is 20 000 hours of normal operation. Units may need to be re-manufactured/overhauled before that time if there is oil leakage, parts become loose, or if the unit experiences severe operating conditions of heat or vibration.

⚠WARNING

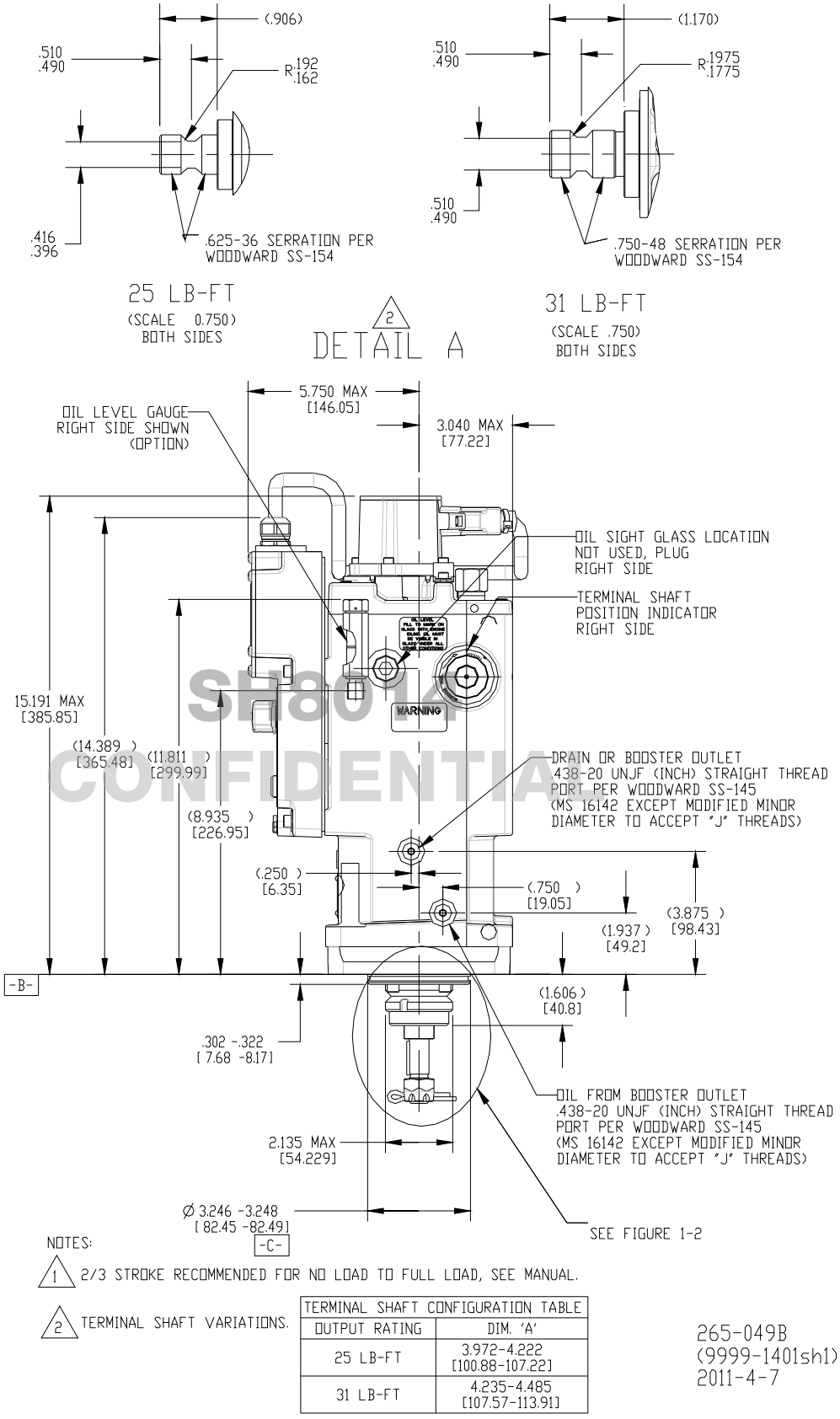
The UG-25+ is not equipped with an overspeed trip function. The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.



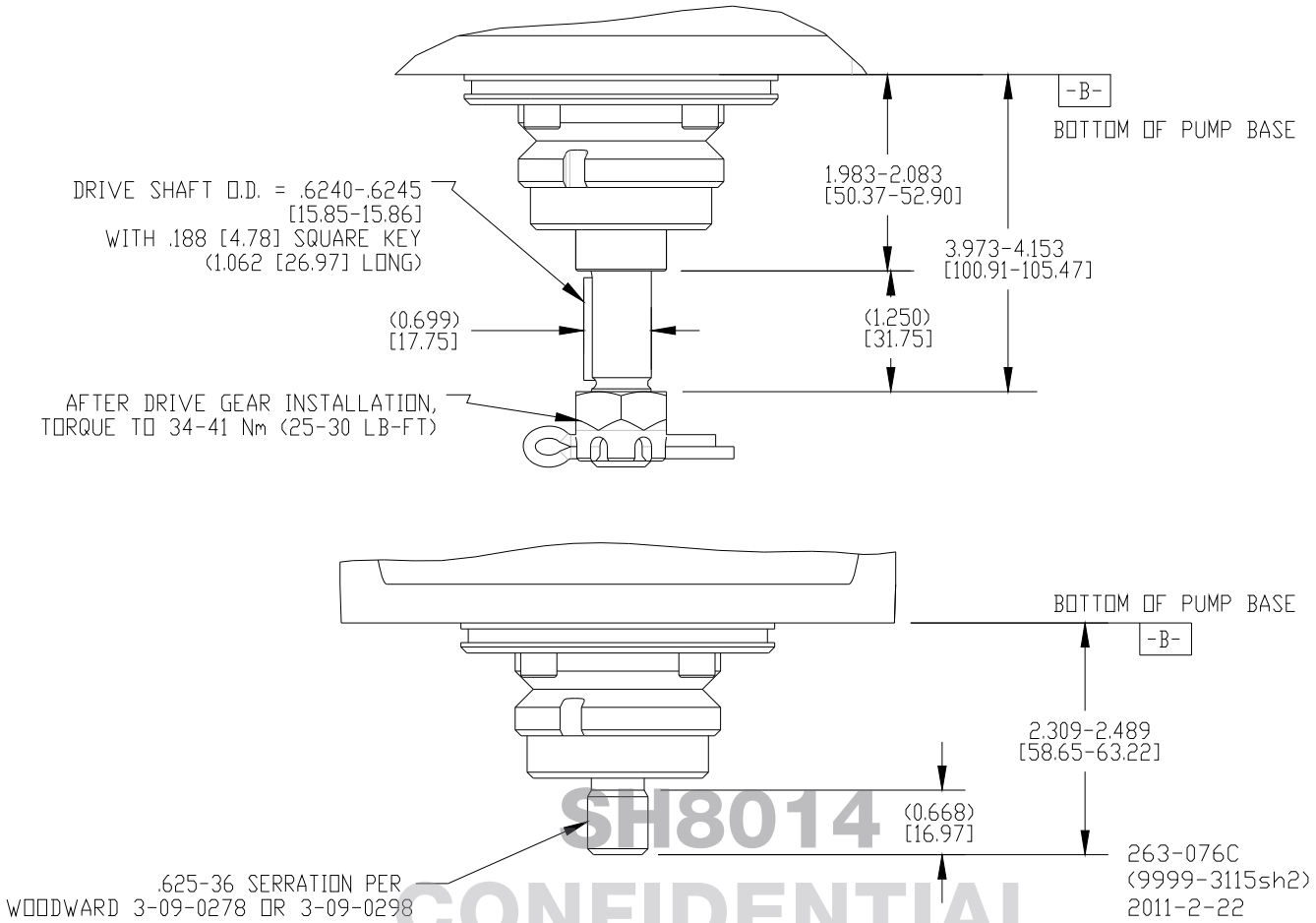
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Figure 1-1a. UG-25+ Outline Drawing (31 lb-ft version shown)



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Figure 1-1b. UG-25+ Outline Drawing (31 lb-ft version shown)



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Figure 1-2. UG-25+ Drive Shaft Configurations

Chapter 2.
Mechanical Installation

Introduction

This chapter describes receiving, storage, and installation requirements for the UG-25+.

WARNING

Due to typical noise levels in turbine or engine environments, hearing protection should be worn when working on or around the UG-25+.

WARNING

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

WARNING

Use of an independent device for positive shutdown, such as a fuel shut-off valve, is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

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WARNING

Use of an external spring to return to minimum fuel is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

WARNING

Use of a predicted minimum fuel shutdown procedure is highly recommended. Failure to comply with this recommendation can cause personal injury and/or property damage.

NOTICE

Use care while handling and installing the UG-25+. Be particularly careful to avoid striking the drive shaft, terminal shaft, or the electrical connector. Abuse can damage seals, internal parts, and factory adjustments. Do not set the governor on its drive shaft.

Initial Operation

WARNING

Before initial operation of the engine equipped with a UG-25+, read all of Chapters 2 and 3, Installation Procedures and Electrical Installation. Make sure that all installation steps have been correctly accomplished and all linkages are secured and properly attached. Carefully review the direction of rotation for the actuator oil pump. Configure the software settings following the instructions in Chapter 6.

Follow this procedure when putting a new or repaired UG into service.

1. Check that the actuator is full of the proper type and grade of clean oil.

2. Properly adjust the linkage.

⚠WARNING

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the actuator can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the actuator from shutting down the engine.

3. Select a low speed setting to give low engine speed at initial start-up.

⚠WARNING

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

4. Follow the engine manufacturer's instructions, and start the engine.

5. Adjust the selected speed setting to bring the engine to rated speed.

6. Obtain system stability as outlined in Chapter 7 (Speed PID Tuning). (If less than the recommended actuator output stroke is used, it may cause for less than optimum engine stability or response.)

All operating adjustments of the UG-25+ are made during factory calibration. Additional adjustment should not be needed.

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Unpacking

Be careful when unpacking the unit. Check the unit for signs of damage, such as bent or dented panels, scratches, and loose or broken parts. Notify the shipper and Woodward if damage is found.

Receiving

After factory testing and calibration, the UG-25+ is drained of oil. This leaves a light film of oil on internal parts to prevent rust. External parts are painted or coated with a spray lubricant/rust inhibitor.

No internal cleaning or flushing is necessary before installation and operation. The little oil left in the governor is clean, multi-viscosity engine oil, which will not contaminate the oil selected to operate the governor.

Fill the governor with 2.1 liters (2.2 quarts) of oil selected to match the expected operating conditions. (If the governor is a direct replacement for a UG governor, you may use the same grade and weight of oil that was being used in the governor.) Use only new, clean oil in the governor. Do not allow dirt or contamination to enter the governor while filling with operating oil. Do not use oil drained from the UG governor.



Figure 2-1. UG-25+ Governor Overview

Storage

The UG-25+ may be stored for short periods of time (less than a year) as received from the factory. For long-term storage (more than a year), storage in an environment with large temperature changes, humid or corrosive atmosphere, etc., or if the governor is installed on the engine for storage, fill the governor with oil and follow preservation packaging instructions in Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.

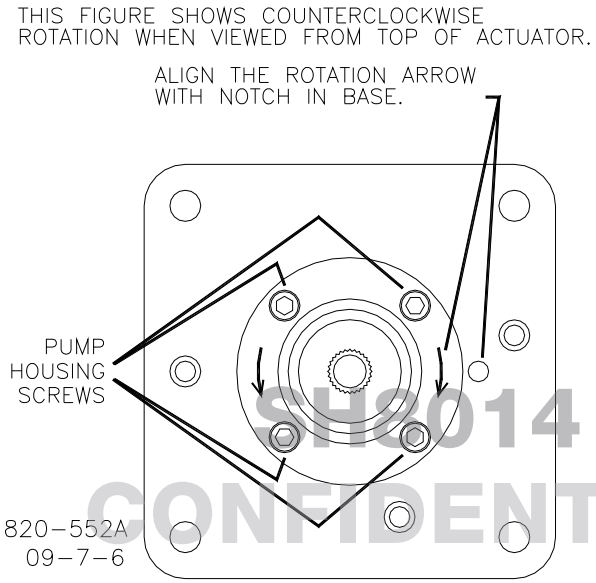
Drive Shaft Rotation

The governor drive-shaft rotation is one direction only. Rotation, as viewed from the top of the governor, must be the same as that of the engine drive when looking down on the mounting pad.

If the governor oil pump is rotated in the wrong direction, oil pressure will not be generated in the governor.

NOTICE

Be sure engine mounting-pad drive and governor-drive rotation are the same. Incorrect drive rotation will cause the governor to become inoperative, and may cause governor damage.



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Use the following procedure to change the direction of rotation:

1. Remove the four pump-housing screws located on the bottom of the UG-25+.
2. Index the pump plate 180 degrees to align the arrow corresponding to the direction of rotation selected with the reference notch in the base.
3. Replace the four screws, and torque the screws to 10.2 N·m (90 lb-in).
4. Make sure that the governor drive shaft rotates freely.

Mounting Location

Locate the UG-25+ a distance from sources of extreme radiant heat, such as exhaust manifolds, turbochargers, or live steam lines. The ambient operating temperature range of the control is 0 to 55 °C (32 to +131 °F) [maximum allowable governor case temperature is 100 °C (212 °F max)]. In spark-ignited applications, make sure the UG-25+ is located away from the ignition coil, and that harness wires are not routed next to the spark plug wires.

As shown in the specifications, the UG-25+ has been designed for and verified to a given accelerated life vibration test level at the mounting surface of the governor. The user should be aware that in any application, bracket design could significantly change the vibration levels at the module. Therefore, every effort should be made to make the bracket as stiff as possible so that engine vibrations are not amplified, creating an even more severe environment at the module.

Attitude

The UG-25+ can be installed in a vertical or near vertical position without affecting its calibration. Do not install more than 45 degrees from vertical. See the outline drawing for installation instructions and dimensions.

Mounting Dimension

When using the O-ring supplied with the governor to seal between the governor and governor mounting pad on the engine, the mounting hole should have dimensions of 82.7–83.2 mm (3.255–3.275 inches) in order to provide the correct amount of squeeze on the o-ring. The mounting hole must be concentric with the drive in order to avoid side-loading the governor drive shaft.

Drive Connection

Make sure the governor drive shaft turns freely before installing the governor. The drive gear or coupling must slip freely into the governor drive of the engine. Torque the nut that secures the drive gear to 34–41 N·m (25–30 lb-ft) maximum.

Do not apply external force. The drive must be free of binding, side load, or excess end-play. Improper alignment or fit between the parts can result in excessive wear or governor-drive seizure.

Mount the governor squarely on the mounting pad. Torque the mounting bolts evenly. There can be no movement or rocking of the governor on the engine-mounting pad.

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Control Linkage

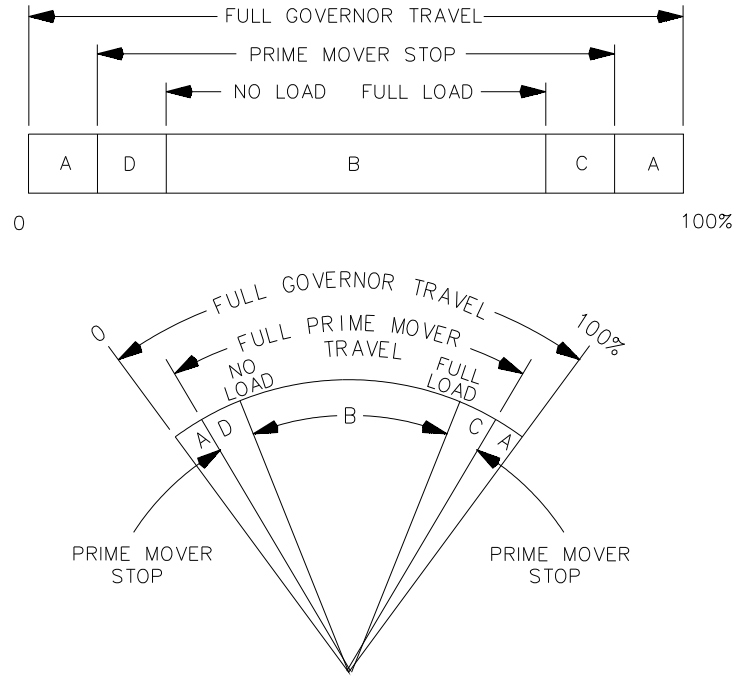
The terminal shaft rotates 42 degrees. Use 2/3 of the total rotation between no load and full load. The additional “overtravel” should be split and used at both ends to provide maximum fuel when required and to assure shutdown at minimum-fuel governor position (see Figure 2-2).

⚠WARNING

To prevent possible serious injury or loss of life, or damage to the engine, be sure to allow sufficient overtravel at each end of the terminal shaft so the governor can shut down the engine, and also give maximum fuel when required. Misadjusted linkage could prevent the governor from shutting down the engine.

Many control problems are related to the linkage between the governor and the engine. Use only high-quality rod ends for the linkage, rod ends that will last under the nearly constant motion associated with precise speed control. The linkage must be stiff, not subject to engine-caused vibration. The linkage must be as light as possible and still maintain the attributes of stiffness. Linkage which is too heavy can damage the governor as well as make it difficult to achieve steady control.

Installed linkages must operate smoothly, be free of binding, and free of lost motion due to worn parts. If there is a collapsible member in the linkage, be sure it does not yield each time the governor moves the linkage rapidly.



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Figure 2-2. Terminal Shaft Travel

Use a linear linkage for most diesel applications. Most gas-fueled engines will require a non-linear linkage. See Figures 2-3 and 2-4 for information on the arrangements of linear and nonlinear connections. Linear linkage moves the fuel setting shaft in direct proportion to the movement of the governor output.

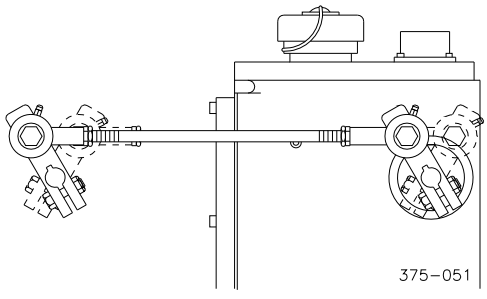


Figure 2-3. Linear Linkage

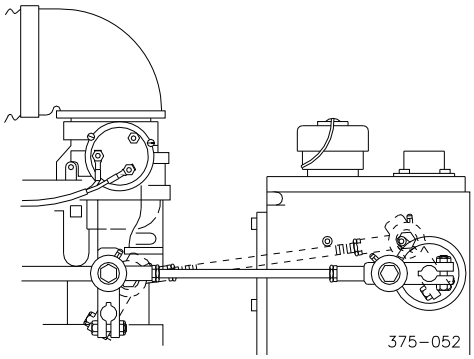


Figure 2-4. Non-linear Linkage

A non-linear fuel arrangement lets the governor move the fuel setting more at maximum settings than it does at minimum settings. Woodward application note 50516, *Governor Linkage for Butterfly Throttle Valves*, provides more information about non-linear linkage.

Design the linkage so the power output of the engine is proportional to the position of the governor output shaft.

Follow the engine manufacturer's instructions on linkage selection, installation, and adjustment. In almost all cases, the linkage designed for a UG-8 governor will work with the UG-25+, with the exception that the standard terminal shaft size is 0.625-36 serrated versus the UG-8 standard size of 0.50-36 serrated. In the case of a direct exchange, make sure that the linkage is in good condition and the installation of the lever on the governor is in the same position as it was on the old governor.

Oil Supply

See Woodward manual 25071, *Oils for Hydraulic Controls*, for more details on oil supply.

Use the information given in Figures 2-5 and 2-6 as a guide in the selection of a suitable oil. Oil grade selection is based on the operating temperature range of the governor. Also use this information to aid in recognizing and correcting common problems associated with oil used in the governor. Many operation and maintenance problems associated with UG-25+s are directly related to the selection and condition of the oil in the governor. Use care in the selection and make sure that the oil in the governor is not contaminated.

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The oil in the UG-25+ is both a lubricating and hydraulic oil. It must have a viscosity index that allows it to perform over the operating temperature range and it must have the proper blending of additives that cause it to remain stable and predictable over this range.

The UG-25+ is designed to give stable operation with most oils, if the fluid viscosity at the operating temperature is within a 50 to 3000 SUS (Saybolt Universal Seconds) range (see Figure 2-6). Poor governor response or instability is an indication that the oil is too thick or too thin.

Governor oil must be compatible with seal material, that is, nitrile, polyacrylic, and fluorocarbon. Many automotive and gas engine oils, industrial lubricating oils, and other oils of mineral or synthetic origin meet these requirements.

Fill the governor with about 2.1 liters (2.2 quarts) of oil, to a level visible in the oil sight glass. After the engine is started and the governor is at operating temperature, add oil if necessary. Oil must be visible in the glass under all operating conditions.

Excessive component wear or seizure in the governor indicates the possibility of:

1. Insufficient lubrication caused by:
- an oil that flows slowly when it is cold, especially during start-up;
- no oil in the governor.

2. Contaminated oil caused by:
- dirty oil containers;
- an governor exposed to heating and cooling cycles, which created condensation of water in the oil.

3. Oil not suitable for the operating conditions caused by:
- changes in ambient temperature;
- an improper oil level which creates foamy, aerated oil.

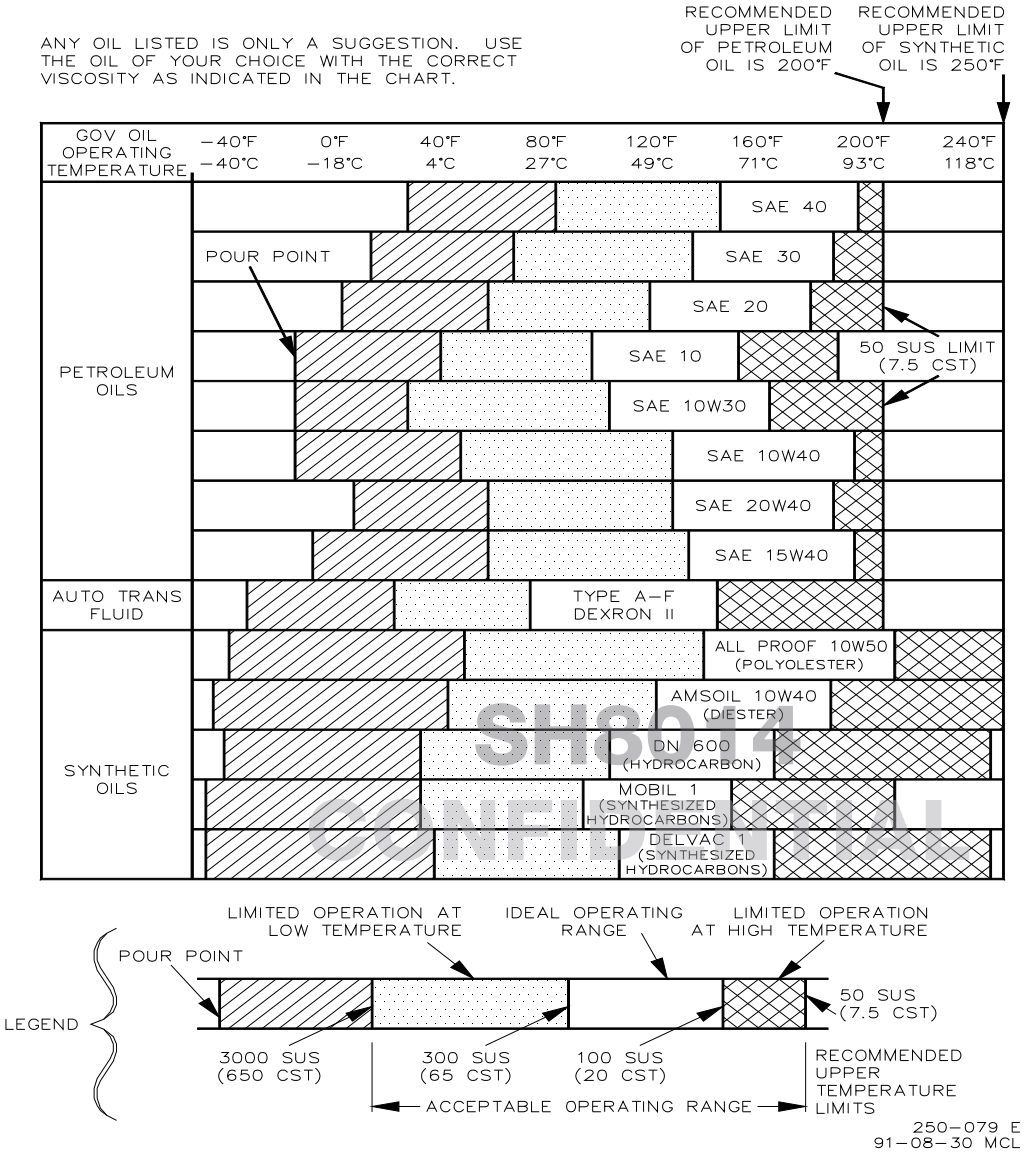


Figure 2-5. Oil Chart

Operating a governor continuously beyond the high limit temperature of the oil will result in oil oxidation. This is identified by varnish or sludge deposits on the governor parts. To reduce oil oxidation, lower the governor operating temperature with a heat exchanger or other means, or change to an oil more oxidation-resistant at the operating temperature.

⚠WARNING

To prevent possible serious injury or loss of life, or damage to the engine, resulting from engine overspeed or a runaway engine, be sure to use only oil that falls within the 50 to 3000 SUS range. Using oils outside this range could cause the governor to be unable to prevent a runaway engine.

VISCOSITY COMPARISONS				
CENTISTOKES (CST, CS, OR CTS)	SAYBOLT UNIVERSAL SECONDS (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROXIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

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Figure 2-6. Viscosity Comparisons

Oil Maintenance

Replace the governor oil if it is contaminated, and change it if it is suspected of contributing to instability. Drain the oil while it is still hot. Flush the governor with a clean solvent having some lubricating quality (fuel oil or kerosene) before refilling with new oil. If drain time is insufficient for the solvent to completely drain or evaporate, flush the governor with the same oil it is being refilled with to avoid dilution and possible contamination of the new oil.

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Oil that has been carefully selected to match the operating conditions and is compatible with governor components should give long service between oil changes. Check oil conditions regularly and change oil if any deterioration or contamination is suspected.

Regularly scheduled oil changes will extend the life of the governor and improve governor operation. Properly selected oil should permit annual oil changes, but more frequent changes are recommended. Too long an interval between oil changes can result in sticking of components and plugged oil passages.

⚠WARNING **Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.**

⚠AVERTISSEMENT **Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous vous situez bien dans une zone non explosive.**

Heat Exchanger

A heat exchanger for the UG-25+ is not available from Woodward.

Recommended Service Intervals

Change the oil and flush the governor twice a year if possible.

To change oil, remove the drain plug and drain out the old oil. Flush the governor by filling it with fuel oil, and with the prime mover running at low speed, cycle the governor by increasing the Stability knob setting on the user interface until the governor hunts. Let the governor hunt for a minute or two, then stop the engine and drain the governor. Flush the governor once again. Refill the governor with oil (see Chapter 2, Oil Supply).

Restart the engine and reset the Stability knob.

Woodward recommends the UG-25+ be overhauled after 20 000 hours of operation to inspect for wear and to replace seals, bearings, etc.

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Chapter 3.
Electrical Installation

Introduction

This chapter provides instructions for making the proper electrical connections to the UG-25+. Detailed wiring diagrams and recommended wiring practices are given to make the electrical installation as straightforward as possible. There are several functional wiring options for UG-25+, and these are outlined in this chapter. The only input that is absolutely required is a power connection; all others are optional features. All wiring and accessories (connectors, pins, plugs, etc) are provided by the customer, but are shown in this chapter for ease of assembly.

The UG-25+ has an operating voltage range of 18 to 32 Vdc. It is reverse input polarity protected, and consumes approximately 27 W maximum power at a peak current of 1.5 A (18 V) at 25 °C. Maximum power at the UG-25+ is only realized if an internal fault occurs. Nominal operating current will be less than 500 mA at 24 V nominal.

The control system should be protected with a 6 A fuse in the voltage supply lines. The application should be configured to apply power to the UG-25+ when the engine is first cranked, or slightly before.

Unit Grounding

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The governor housing must be electrically bonded to earth ground through the mechanical mounting interface in order to ensure proper EMC and Safety compliance. Do this using a 1" wide braided grounding strap with as short a length as possible. The ground strap can be tied to the ground post on the front of the governor, directly below the user interface panel.



NOTICE

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 3-2 and 3-3).

Shielded Wiring

The use of cable with individually shielded-twisted pairs is required where indicated by the control-wiring diagram (Figure 3-2). Cable shields must be terminated as indicated in the control-wiring diagram using the installation notes described below. DO NOT attempt to directly ground the shield at both ends or an undesired ground loop condition may occur. It is best to terminate the shield at the UG-25+, leaving the other end of the shield unterminated or electrically floating.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2 inches).
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2 inches), and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Failure to provide shielding can produce abnormal conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the product.

⚠WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division or Zone applications.

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⚠WARNING

External independent safety devices are always recommended by Woodward. Fuse the Power Input +(Terminal 19) with a 6 A fuse. Fuse Boost Pressure Sensor Power Output+ (Terminal 5) with a 500 mA fuse. See Figure 3-2.

⚠WARNING

This UG-25+ does NOT provide for power-loss annunciation. Woodward recommends that the device that is powered by this UG-25+ have an independent power-loss annunciation.

Electrical Connections

Prior to installation, refer to the wiring diagrams and the representative I/O interfaces schematic in this chapter. Also, review the hardware I/O specifications in Appendix B.

Use 1.3 mm² (16 AWG) stranded copper wire with insulation that meets temperature requirements in the harness design. A wiring harness stress relief within 400 mm (16”) of the UG-25+ is recommended.

Contain the harness with wire loom or sheath to make it into a single bundle or a cable with an overall jacket containing the signal wires. Use grommets when passing the harness through metal panels.

Recommended Signal Wire Specifications

1.3 mm² (16 AWG), Minimum Insulation O.D. 1.96 mm (0.077”), –65 to +200 °C, 1000 Vrms, 19/29 Stranded Conductor, Teflon Insulation (TFE).

All field communications and commands enter the UG-25+ through a threaded port in the top of the UG-25+ User Interface panel assembly. These signal wires should be contained in a cable with an overall jacket or bundled together with an overall sheath. To maintain the IP-56 ingress protection rating, the field cable must be installed through a cable gland nut, which is threaded into the cable entry port in the top of the User Interface panel. Several suggested gland nut sizes are listed in table below, depending on the overall diameter of the field cabling used in the installation.

Remove the wiring access cover plate located on the front of the User Interface panel by removing the six M4 x 0.7, 10 mm long locking screws (Woodward part number 1031-1806) to access all customer field connection terminal blocks. Securely replace the wiring cover plate after completing the wiring connections to ensure the integrity of electromagnetic noise interference capabilities of the UG-25+ governor.

⚠WARNING **The UG-25+ will not meet ingress protection requirements unless the cover is in place. See Figure 3-1 for warning label found on the inside of the cover.**

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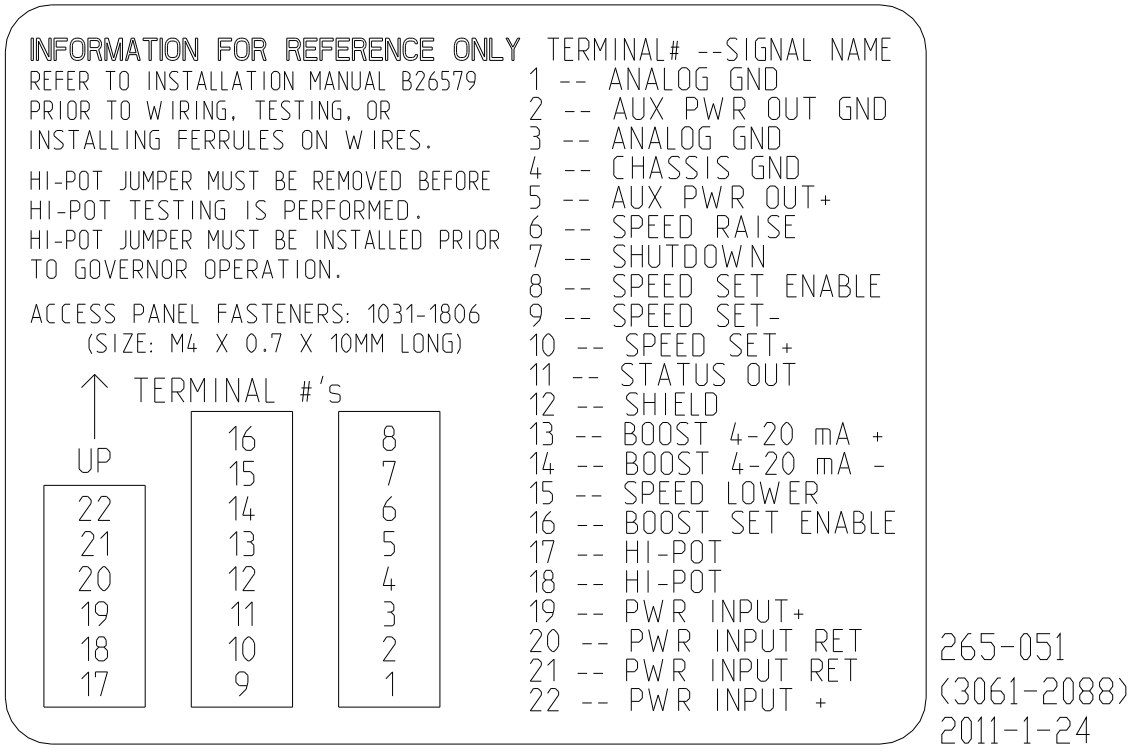


Figure 3-1. Access Cover Instruction Label

Slide the cable gland over the end of the cable with the cable gland threads toward the cable end. Select the appropriate cable gland from the chart below, depending upon the cable size.

Woodward Part Number	Heyco Part Number	Cable Diameter in mm	Mounting Hole Size
1325-4007	4572	9.5 - 12.5	0.750-14 (3/4" NPT)
1325-4008	4573	12.5 - 16	0.750-14 (3/4" NPT)
1325-4009	4574	16 - 20.5	0.750-14 (3/4" NPT)

Remove approximately 100 mm (4 inches) of the overall cable jacket to provide a sufficient service loop inside the User Interface panel to land the individual signal wires on the proper internal terminal.

Strip approximately 10 mm (0.4 inch) of insulation from each individual signal wire and crimp on a wire ferrule, Woodward part number 1606-667 (Phoenix part number 320043) for 16 AWG wire, to the end of each signal wire. Use the proper crimp tool, “CRIMPFOX 6H” Woodward part number 8996-2197 (Phoenix part number 12 12 046) to crimp the ferrules onto the signal wires with a hexagonal crimp. The wire should extend to the end of the ferrule, but not beyond it. If the wire extends beyond the end of the ferrule, cut the excess wire off with wire cutters. The ferrule assures the signal wire does not slip out of the terminal block in high vibration environments. Tinning (soldering) the ends is not an acceptable option since the spring terminals will not grip the wires as well.

Remove the threaded plug from the customer wiring port located on the top of the User Interface panel. Insert the ferrules and wires through the threaded port far enough to hook up the wiring. Use the small terminal release tool (Woodward part number ST-15011, WAGO part number 236-332), located inside the wiring cavity of the UG-25+, to assist in the insertion of the ferrule on the end of each signal wire into its associated terminal location. The terminal release tool is the best way to release the spring-loaded connection clamp located in the wiring terminal block, but a thin, flat-bladed screw driver can also be used if the terminal release tool is not available.

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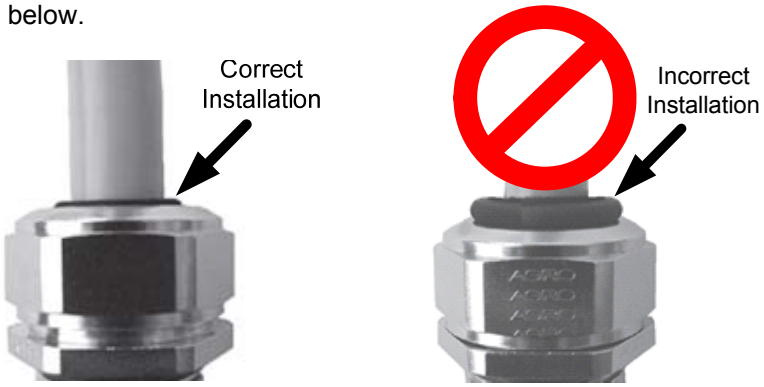
To provide better access to the terminal blocks, install wires going into Terminals 8 through 1 first, followed by the wires going into Terminals 16 through 9 next, and then wires going to Terminals 22 through 17 next.

After installing the wires, apply thread sealant (Woodward part number 2001-4002, Loctite 572 or equivalent) to the NPT threads and screw into the customer wiring port in the top of the UG-25+ User Interface panel assembly. Make sure that the cable’s overall jacket extends slightly past the cable gland so that the rubber seal completely and tightly grips the cable jacket.



Tighten the NPT thread to 10 N·m (88 lb-in).

Then tighten the cable gland top dome nut securely against the rubber gland as shown below.

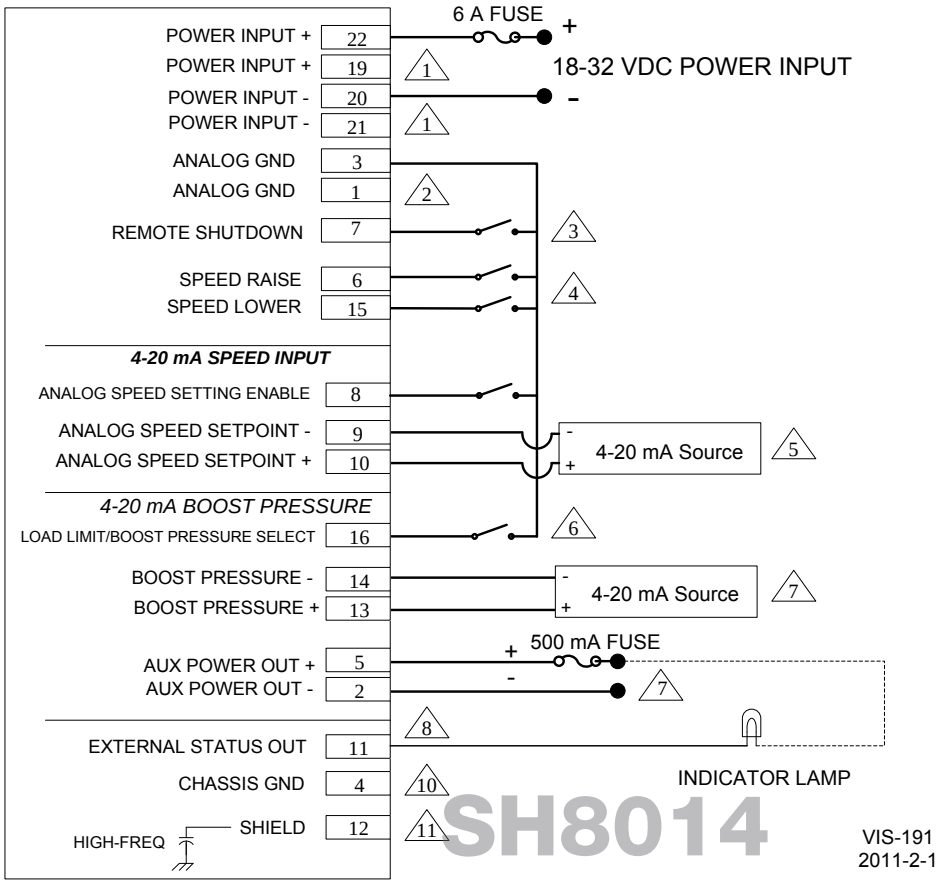


Do not over-tighten the top dome nut. Over-tightening the top dome nut causes the rubber gland to “bulge” out the top of the dome nut, as shown below, and compromises the IP-56 ingress protection seal.

Replace the wiring access cover plate and the six M4 screws holding it to the User Interface panel. Torque all six screws to 3.4 ±0.2 N·m (30 ±2 lb-in).

When routing cables, allow a sufficient service loop when routing the cable around corners. Two customer cable clamp mounting holes are located on the top, front corners of the User Interface panel and accept M5 x 0.8, 10 mm long screws, Woodward part number 1029-972.

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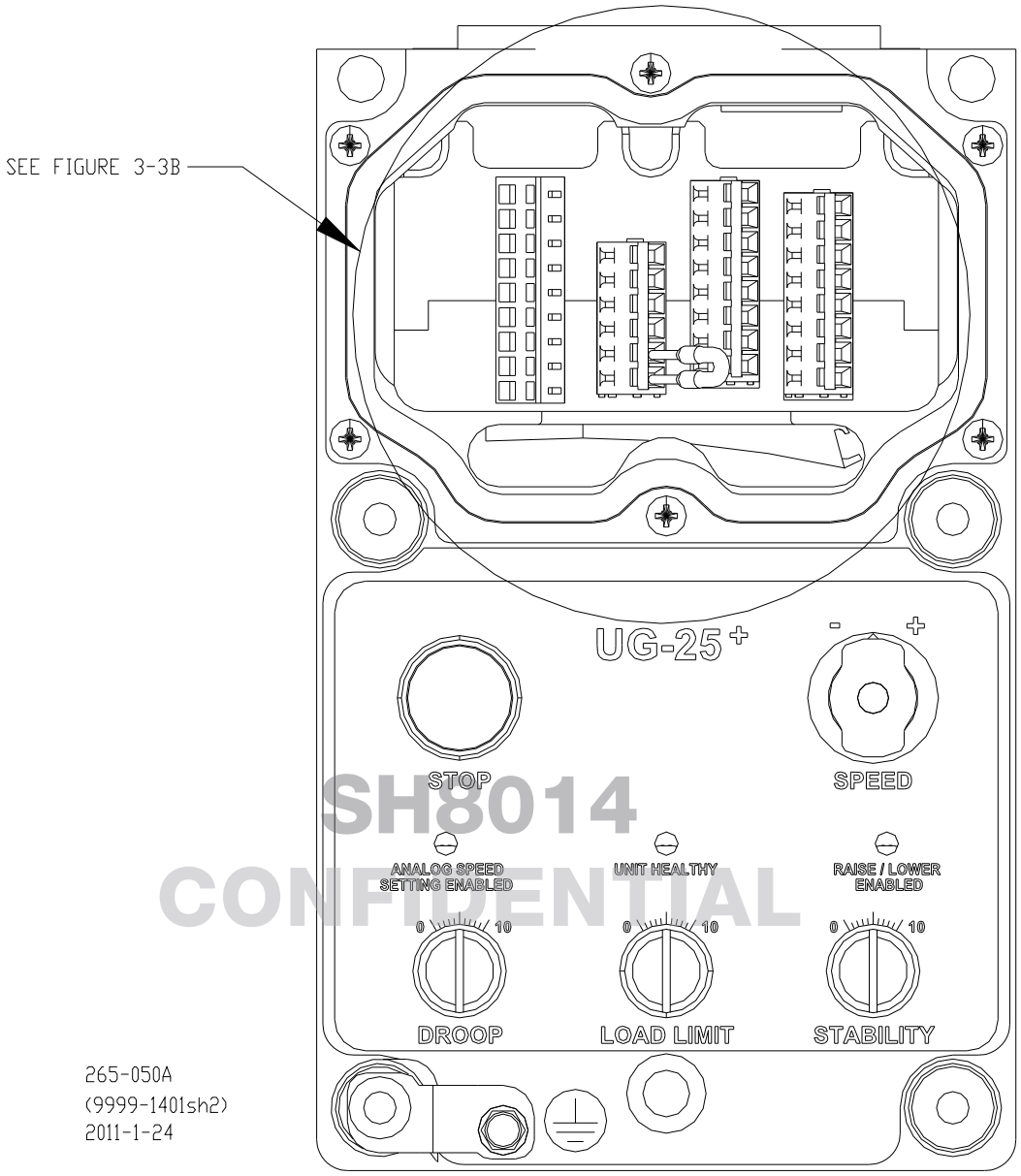


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1. WHEN USING REDUNDANT POWER, CONNECT TO TERMINALS 19 AND 21 IN THE SAME MANNER AS TERMINALS 22 AND 20 (USING A 6 A STANDARD FUSE). OTHERWISE LEAVE THESE TERMINALS UNTERMINATED.
2. A REDUNDANT ANALOG GROUND IS PROVIDED.
3. WHEN USING REMOTE SHUTDOWN, CONNECT AS SHOWN: OPEN TO RUN, CLOSE TO STOP (MOMENTARY CLOSED).
4. WHEN USING SPEED RAISE/LOWER, CONNECT AS SHOWN.
5. WHEN USING 4-20 mA SPEED INPUT. TERMINAL 8 MUST BE CONNECTED TO ANALOG GND.
6. WHEN USING 4-20 mA BOOST PRESSURE, TERMINAL 16 MUST BE CONNECTED TO ANALOG GND. IF PIN 16 IS LEFT FLOATING THEN LOAD LIMIT IS SELECTED.
7. A CONDITIONED 24V POWER SOURCE IS PROVIDED FOR POWERING EXTERNAL DEVICES (eg. BOOST PRESSURE SENSOR) AND THE STATUS OUTPUT. A FUSE SHOULD BE USED AS SHOWN.
8. THIS IS AN OPTIONAL HOOKUP. THIS PROVIDES FOR A REMOTE "UNIT HEALTHY" STATUS. IF AN EXTERNAL INDICATOR LAMP IS DESIRED, WIRE AS SHOWN.
9. CHASSIS GROUND IS PROVIDED, IF NEEDED.
10. SHIELDING IS NOT REQUIRED FOR EMC COMPLIANCE, HOWEVER A SHIELD TERMINATION POINT IS PROVIDED IN THE EVENT SHIELDING IS DESIRED BY THE CUSTOMER.
NOTE: THE SHIELD TERMINATION POINT CONSISTS OF A HIGH-FREQUENCY CAPACITOR WHICH ALLOWS THE CUSTOMER TO 'HARD GROUND' THE SHIELD ON THE OPPOSITE END OF THEIR CABLE, IF DESIRED.

GENERAL NOTE: FLOATING INPUTS ON TERMINALS 6, 7, 8, 15, AND 16 IS ACCEPTABLE BECAUSE THEY ARE INTERNALLY PULLED-UP TO +7 VDC. EXTERNAL PULL-UPS ARE *NOT* REQUIRED *NOR* RECOMMENDED.

Figure 3-2. UG-25+ Application Wiring



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Figure 3-3a. Connector Wiring

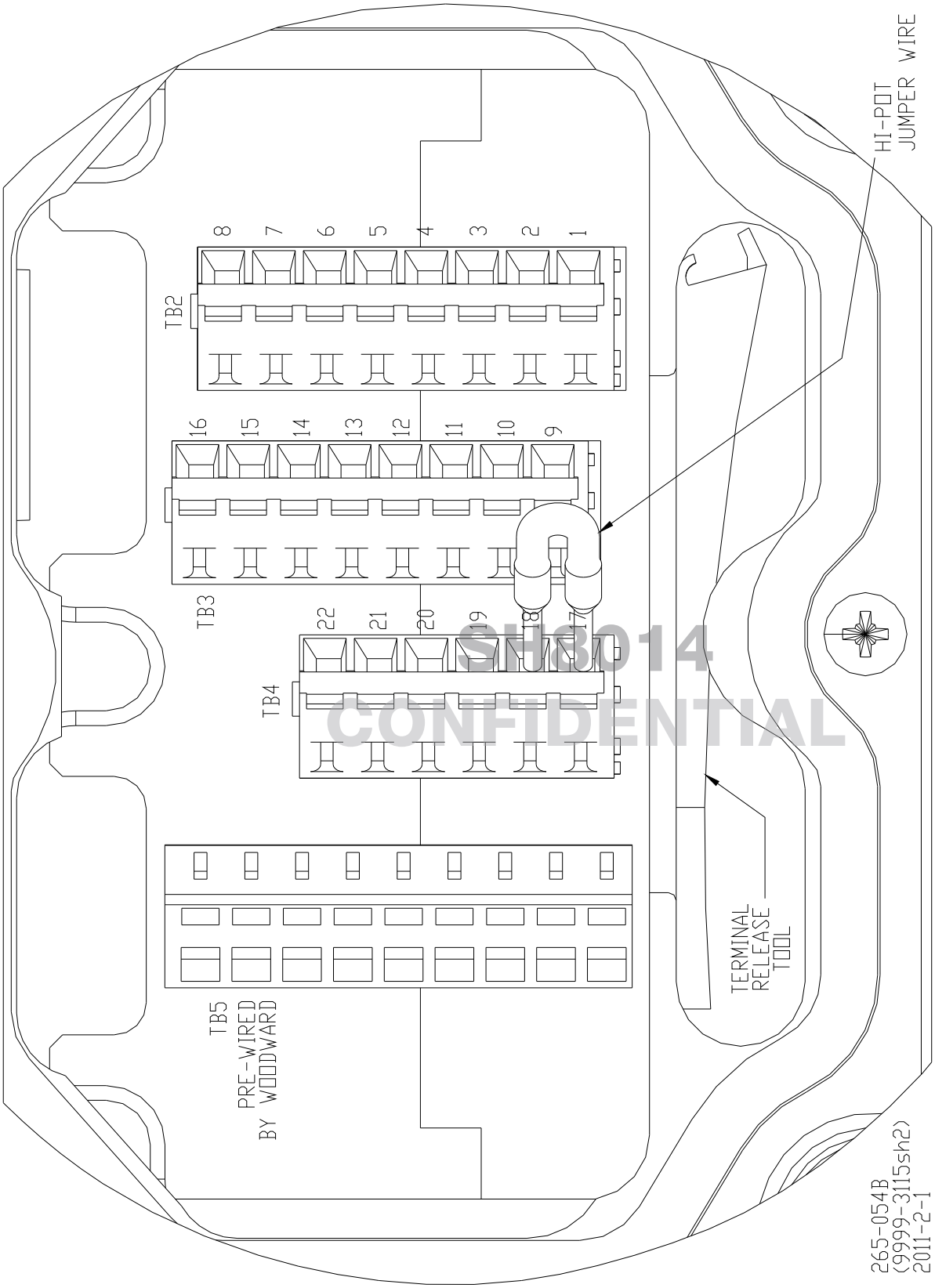
NOTICE

Due to the hazardous location listings associated with this product, proper wire type and wiring practices are critical to operation.

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 3-2 and 3-3).

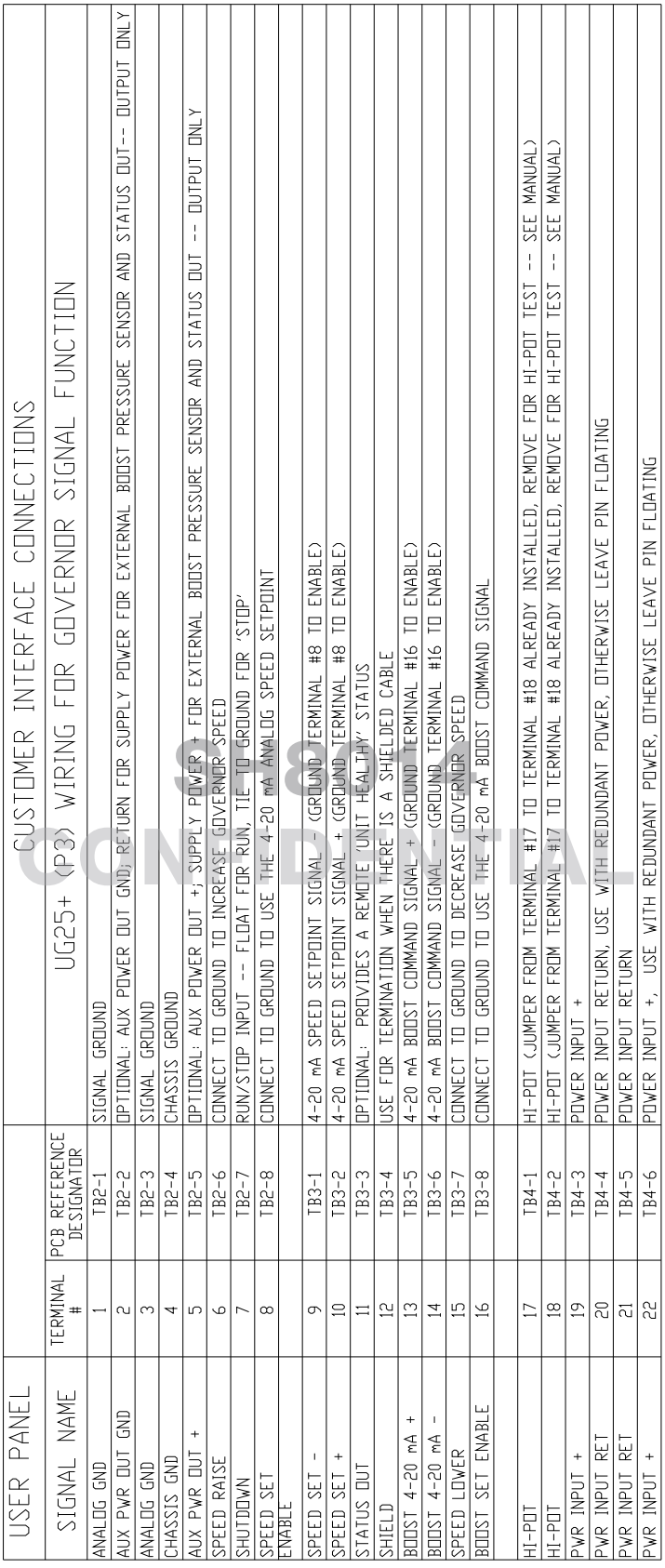
NOTICE

The Hi-Pot jumper must be installed for normal operation, and must be removed only during a Hi-Pot test.



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Figure 3-3b. Connector Wiring



USER PANEL			CUSTOMER INTERFACE CONNECTIONS
SIGNAL NAME	TERMINAL #	PCB REFERENCE DESIGNATOR	UG25+ (P3) WIRING FOR GOVERNOR SIGNAL FUNCTION
ANALOG GND	1	TB2-1	SIGNAL GROUND
AUX PWR OUT GND	2	TB2-2	OPTIONAL: AUX POWER OUT GND, RETURN FOR SUPPLY POWER FOR EXTERNAL BOOST PRESSURE SENSOR AND STATUS OUT-- OUTPUT ONLY
ANALOG GND	3	TB2-3	SIGNAL GROUND
CHASSIS GND	4	TB2-4	CHASSIS GROUND
AUX PWR OUT +	5	TB2-5	OPTIONAL: AUX POWER OUT +; SUPPLY POWER + FOR EXTERNAL BOOST PRESSURE SENSOR AND STATUS OUT -- OUTPUT ONLY
SPEED RAISE	6	TB2-6	CONNECT TO GROUND TO INCREASE GOVERNOR SPEED
SHUTDOWN	7	TB2-7	RUN/STOP INPUT -- FLOAT FOR RUN, TIE TO GROUND FOR 'STOP'
SPEED SET ENABLE	8	TB2-8	CONNECT TO GROUND TO USE THE 4-20 mA ANALOG SPEED SETPOINT
SPEED SET -	9	TB3-1	4-20 mA SPEED SETPOINT SIGNAL - (GROUND TERMINAL #8 TO ENABLE)
SPEED SET +	10	TB3-2	4-20 mA SPEED SETPOINT SIGNAL + (GROUND TERMINAL #8 TO ENABLE)
STATUS OUT	11	TB3-3	OPTIONAL: PROVIDES A REMOTE 'UNIT HEALTHY' STATUS
SHIELD	12	TB3-4	USE FOR TERMINATION WHEN THERE IS A SHIELDED CABLE
BOOST 4-20 mA +	13	TB3-5	4-20 mA BOOST COMMAND SIGNAL + (GROUND TERMINAL #16 TO ENABLE)
BOOST 4-20 mA -	14	TB3-6	4-20 mA BOOST COMMAND SIGNAL - (GROUND TERMINAL #16 TO ENABLE)
SPEED LOWER	15	TB3-7	CONNECT TO GROUND TO DECREASE GOVERNOR SPEED
BOOST SET ENABLE	16	TB3-8	CONNECT TO GROUND TO USE THE 4-20 mA BOOST COMMAND SIGNAL
HI-POT	17	TB4-1	HI-POT (JUMPER FROM TERMINAL #17 TO TERMINAL #18 ALREADY INSTALLED, REMOVE FOR HI-POT TEST -- SEE MANUAL)
HI-POT	18	TB4-2	HI-POT (JUMPER FROM TERMINAL #17 TO TERMINAL #18 ALREADY INSTALLED, REMOVE FOR HI-POT TEST -- SEE MANUAL)
PWR INPUT +	19	TB4-3	POWER INPUT +
PWR INPUT RET	20	TB4-4	POWER INPUT RETURN, USE WITH REDUNDANT POWER, OTHERWISE LEAVE PIN FLOATING
PWR INPUT RET	21	TB4-5	POWER INPUT RETURN
PWR INPUT +	22	TB4-6	POWER INPUT +, USE WITH REDUNDANT POWER, OTHERWISE LEAVE PIN FLOATING

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Figure 3-3c. Connector Wiring

Customer I/O Terminal Position Assignment

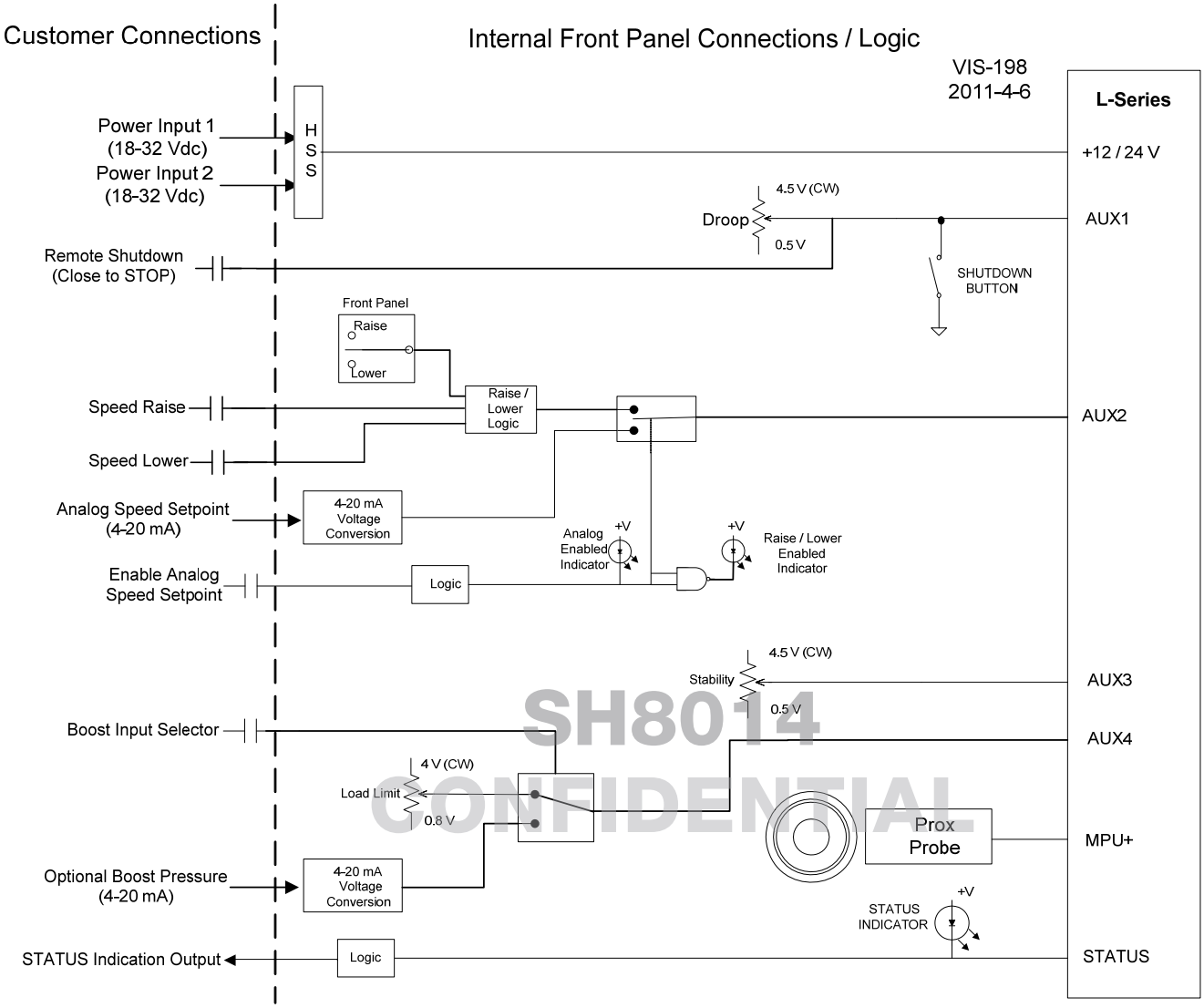
Terminal Position	Description	Comment	Type
1 (TB2-1)	Analog Ground	Circuit Ground for the following functions: Remote Run/Stop, Remote Speed Raise, Remote Speed Lower , Analog Speed Setting Enabled, Load Limit/Boost Pressure Select. *Do not connect Analog Ground to Input Power (–)*	N/A
2 (TB2-2)	Boost Pressure Sensor Power Out – (Return for 18-32 Vdc supply input)	Return for Supply Power for External Boost Pressure sensor. *Do not connect Analog Ground to this terminal.*	Output
3 (TB2-3)	Analog Ground	Circuit Ground for following functions: Remote Shutdown, Remote Speed Raise, Remote Speed Lower, Analog Speed Setting Enabled, Load Limit/Boost Pressure Select. *Do not connect Analog Ground to Input Power (–)*	N/A
4 (TB2-4)	Chassis Ground	This terminal connects to Chassis ground through the circuit board, and then to the UG-25+ metal housing.	N/A
5 (TB2-5)	Boost Pressure Sensor Power Out + (Supply Power, 18-32 Vdc, 1.5 A max.)	Supply Power for External Boost Pressure sensor. This is an *output* only! Do not connect external power to this power output. This output voltage follows the Power Input(+) minus a protection diode drop.	Output
6 (TB2-6)	Remote Speed Raise	Connecting this terminal to Analog Ground, 1, *increases* the UG-25+ governor speed. This terminal is internally pulled-up to 7 Vdc.	Input
7 (TB2-7)	Remote Shutdown	Connecting this terminal to Analog Ground, 1, turns OFF (stops) the UG-25+ governor. This terminal is internally pulled-up to 7 Vdc.	Input
8 (TB2-8)	Analog Speed Setting Enabled	This terminal *must* be connected to Analog Ground in order to use the 4–20 mA Analog Speed Setpoint. This terminal is internally pulled-up to 7 Vdc.	Input

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Terminal Position	Description	Comment	Type
9 (TB3-1)	Analog Spd Setpoint –	This is the negative input of 4–20 mA circuitry. Pin 8 *must* be connected to Analog Ground to use this function.	Input
10 (TB3-2)	Analog Spd Setpoint +	This is the positive input of 4–20 mA circuitry. Pin 8 *must* be connected to Analog Ground to use this function.	Input
11 (TB3-3)	External Status Output	This provides for a remote "Unit Healthy" status. See UG-25+ Application Wiring Figure 3-2.	Output, open drain, low-side switch.
12 (TB3-4)	Shield	This terminal is a conditioned shield tie point. (capacitively coupled to Chassis Ground)	N/A
13 (TB3-5)	Boost Pressure Input +	This is the positive input of the 4–20 mA circuitry. Pin 16 *must* be connected to Analog Ground to use this function.	Input
14 (TB3-6)	Boost Pressure Input –	This is the negative input of the 4–20 mA circuitry. Pin 16 *must* be connected to Analog Ground to use this function.	Input
15 (TB3-7)	Remote Speed Lower	Connecting this terminal to Analog Ground *decreases* the UG-25+ governor speed. This terminal is internally pulled-up to 7 Vdc.	Input
16 (TB3-8)	Load Limit/Boost Pressure Select	When Terminal 16 floats, Load Limit is selected. When Terminal 16 is connected to Analog Ground, Boost Pressure is selected. This terminal is internally pulled-up to 7 Vdc.	Input
17 (TB4-1)	Hi-Pot Test Jumper		Input
18 (TB4-2)	Hi-Pot Test Jumper		Input
19 (TB4-3)	Power Input +	Supply Power (18-32 Vdc, 1.5 A max.)	Input
20 (TB4-4)	Power Input –	Return for 18-32 Vdc Supply Input.	Input
21 (TB4-5)	Power Input –	Return for 18-32 Vdc Supply Input.	Input
22 (TB4-6)	Power Input +	Supply Power (18-32 Vdc, 1.5 A max.)	Input

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Detailed Description of UG-25+ Electrical I/O



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Figure 3-4. Internal Block Diagram

Power Supply Input 1 (18–32 V at Terminal 19, Power Input – at Terminal 21)
Power Supply Input 2 (18–32 V at Terminal 22, Power Input – at Terminal 20)

The UG-25+ will handle a voltage range of 18 to 32 Vdc, with an absolute maximum of 60 V.

The power supply terminals are reverse polarity protected, and in the case that a reverse polarity condition exists, the UG-25+ will not power-up and the output will remain at 0 Vdc.

Woodward recommends using a 6 A fuse on the power supply line feeding Terminals 19 and 22 of the UG-25+.

⚠WARNING

The input power must be fused. Failure to fuse the UG-25+ could, under exceptional circumstances, lead to personal injury, damage to the control valve, and/or explosion.

NOTICE

If circuit ground and chassis ground are shorted together at the UG-25+, there is an increased risk of EMI susceptibility.

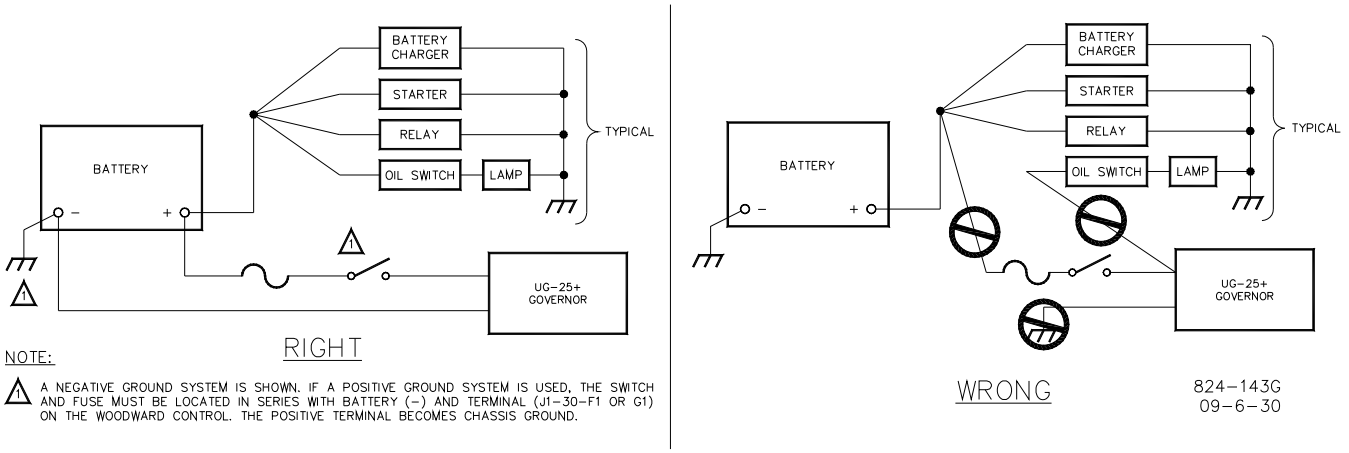


Figure 3-5. Correct and Incorrect Wiring to Power Supply

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Woodward recommends using a standard 6 A fuse on the 18–32 Vdc input as show in Figure 3-2. ***Do NOT use a slow-blow-type fuse in this application.***

Relay Driver Output (Status/Unit Healthy)

A discrete output is provided to serve as a status indicator, mimicking the front panel Unit Healthy LED. This switchable discrete output is a closure to ground capable of sinking 500 mA maximum with an output voltage rise of less than 1.5 V, and it is available to power external relays for devices such as alarms or fuel shutoff solenoids. The circuit is protected internally against over-current and inductive spikes, so external clamping is not necessary.

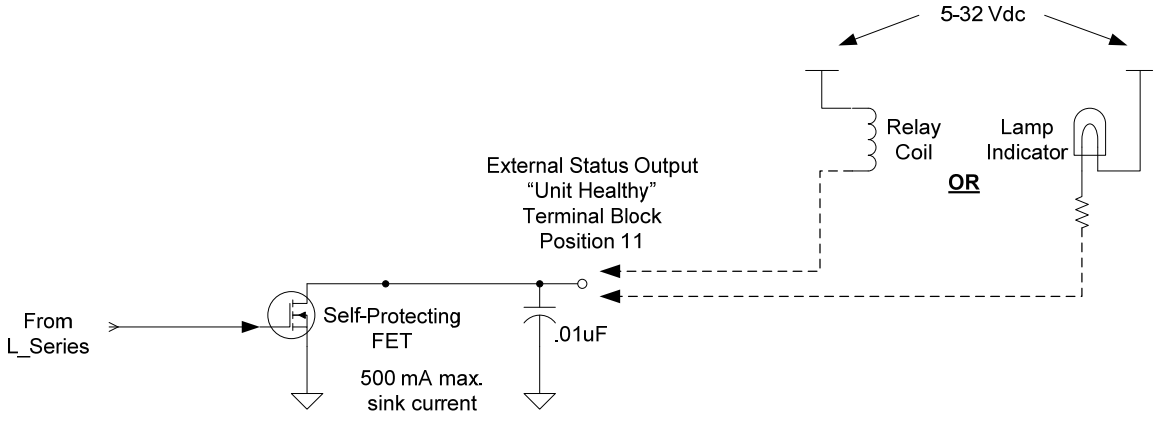


Figure 3-6. Relay Driver Output

Analog Speed Setpoint
This input accepts a 4–20 mA current input that is proportional to a desired speed setpoint. In order to use this input, the external Analog Speed Setpoint Enable signal must be connected to Analog Ground.

IMPORTANT

The user must provide an external means to clamp the speed bias input at 3 mA and 21 mA. An analog speed-bias input below 3 mA or above 21 mA is out of the normal 4 to 20 mA input range and may cause the analog speed bias function to become disabled even though the Analog indication LED remains on.

Analog Speed Setpoint Enable
The Analog Speed Setting Enable allows for remote speed settings. This input is enabled when the input is pulled to ground (0 Vdc). When this signal is not grounded, it can remain floating (no connection).

Boost Fuel Limit Input
This input accepts a 4–20 mA current input that is proportional to a desired boost signal. In order to use this input, the external Load Limit/Boost Pressure Select signal must be connected to Analog Ground.

Boost Input Selector
This external customer input allows the user to select either Load Limit or Boost Pressure. If the input floats and is not connected to analog ground, then Load Limit is selected. If the input is connected to Analog Ground, then Boost Pressure is selected.

Speed Raise/Lower command
The UG-25+ has both local and remote speed raise/lower capability. The local raise/lower is handled by using a magnetic proximity switch on the PCB that is actuated by a spring-loaded knob, mounted to the panel assembly. The knob can be set to either "+" or "–", but not both simultaneously.

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- The remote raise/lower adjustments are made by connecting their respective connector pins to analog ground.
- There is hardware arbitration that must take place for this scheme to work.

The rules are as follows:

1) The local raise and lower adjustments have priority over the remote raise and lower adjustments.
2) If remote raise and local lower are activated simultaneously, the control will default to "lower".
3) If remote raise and remote lower are activated simultaneously, the control will default to "lower".

Stop command
The shutdown feature of the UG-25+ interface panel allows the user to force the governor to min fuel by either pushing the big red button on the UG-25+ front panel, or by connecting Terminal 7 to analog ground (momentary closed) (in situations where the shutdown signal is to come from a control room).

NOTICE

To avoid EMI interference between the wire bundle and the interface panel, route the wires out of the connectors away from the panel controls. Do not allow the interface wiring to drape in front of the panel controls.

NOTICE



MAGNETIC FIELDS—During installation, avoid placing the interface panel in close proximity with any source of strong magnetic field (permanent magnet motor, magnetized tools, etc.). Strong magnetic fields can inject error into the adjustments available on the front of the interface panel.

High Potential Testing

Occasionally, marine certification requires that a high potential (HI-POT) test of the engine or prime mover be performed after the UG-25+ is installed. The UG-25+ is designed to accommodate this testing. Before performing any HI-POT testing, remove the small HI-POT jumper, Woodward part number 2008-1443, located between Terminals 17 and 18, which are found under the wiring access cover plate on the front of the User Interface panel.

The HI-POT test voltage is +755 Vdc. Repeat the test with the polarity reversed at –755 Vdc.

Apply the HI-POT voltage between all customer input and output terminals (located under the wiring access cover plate on the front of the User Interface panel) connected together and chassis ground (located on the front of the UG-25+ governor), except that Terminal 4 (chassis ground) and Terminal 12 (shield) must remain un-connected and not electrically tied to the other terminals during this test. The HI-POT test voltage ramp-up time is 5 seconds, and dwell is 60 seconds, or as specified by the certification authority.

Use the ground terminal located on the outside of the User Interface panel as the chassis ground tie point for the HI-POT test. Using Terminal 4 as the chassis ground tie point during the test does not properly check the internal chassis to circuit board connection.

NOTICE

Do not perform "AC" Hi-Pot testing on this assembly.

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Securely replace the jumper between Terminals 17 and 18 after completing the HI-POT test to ensure that the electrical power surge protection on the electrical circuit board is maintained during normal operation.

NOTICE

Install the jumper between Terminals 17 and 18 for normal operation. The UG-25+ may be damaged by power surges if this jumper is not properly installed.

Insulation Resistance Testing

Occasionally, marine certification requires that an insulation resistance test of the engine or prime mover be performed after the UG-25+ is installed. The UG-25+ is designed to accommodate this testing. Before performing any insulation resistance testing, remove the small HI-POT jumper, Woodward part number 2008-1443, located between Terminals 17 and 18, which is found under the wiring access cover plate on the front of the User Interface panel.

Connect the plus (+) probe of a multi-meter to each terminal block location in turn and the minus (–) probe to chassis ground.

NOTICE

Do not use test equipment that is powered from a power source that exceeds 64 Vdc to perform the insulation resistance testing. It may damage the governor electronics.

The resistance measured between each terminal block location (Terminals 1 through 3, 5 through 11, 13 through 16, and 19 through 22) and chassis ground must be greater than 830 kΩ.

Use the ground terminal located on the outside of the User Interface panel as the chassis ground tie point for the insulation resistance test. Using Terminal 4 as the chassis ground tie point during the test does not properly check the internal chassis to circuit board connection.

Securely replace the jumper between Terminals 17 and 18 after completing the insulation resistance test to ensure that the electrical power surge protection on the electrical circuit board is maintained during normal operation.

NOTICE

Install the jumper between Terminals 17 and 18 for normal operation. The UG-25+ may be damaged by power surges if this jumper is not properly installed.

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Chapter 4.
Description of Operation

General

The UG-25+ governor is a digital speed control with integral speed and position feedback. The governor output shaft provides a maximum rotation is 42 degrees for controlling diesel, gas, or dual fuel engines, or steam turbines. The speed setpoint can be adjusted with a 4–20 mA analog input or with raise/lower discrete inputs.

The UG-25+ front panel provides a convenient operating interface for the user. These functions and adjustments include:

SHUTDOWN—Pushing this red button forces the governor to immediately go to the minimum fuel position. The shutdown condition remains active until speed drops to zero.

SPEED—Selecting the (+) and (–) direction causes the speed setting to be raised or lowered. The speed setting will move toward the speed setting's upper or lower limit at the raise and lower speed setting rates for as long as the spring-loaded, return-to-center, selector switch is manually held in the (+) or (–) direction. Releasing this switch causes the speed setpoint to remain at that setting. Speed adjustment commands from this front panel switch have priority over external raise and lower commands. When raise and lower commands come from the front panel, remote raise and lower commands are ignored. This switch and external raise and lower commands are not active and will not change the speed setpoint when the external Analog (4 to 20 mA) speed setting signal is enabled.

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ANALOG SPEED SETTING ENABLED LED—This LED illuminates when the external Analog (4 to 20 mA) speed setting signal is enabled. The speed setpoint can be moved with the external Analog (4 to 20 mA) speed setting signal between Min Speed Limit (4 mA) and Max Speed Limit (20 mA). The manual front panel SPEED switch and the external raise and lower contact inputs are not active when this LED is on.

UNIT HEALTHY LED—This LED illuminates when there is electrical power supplied to the UG-25+ and the L-Series electronic governor internal to the UG-25+ is working properly. This LED goes off if supply power is removed or there is a fault in the L-Series electronics. See the "Shutdown Faults and Stop Details" section later in this chapter.

RAISE / LOWER ENABLED LED—This LED illuminates when either the manual front panel SPEED switch or the external raise and lower contact inputs are available to change the speed setpoint. This LED goes off if the external Analog (4 to 20 mA) speed setting signal is enabled.

DROOP Adjustment—This adjustment allows the amount of output position droop (as a function of terminal shaft position) to be set between zero and to about ten percent (assuming 30 degrees of terminal shaft travel). Setting the adjustment fully CCW (counterclockwise) sets zero droop into the governor for isochronous operation.

LOAD LIMIT Adjustment—This adjustment limits the rotational travel of the output terminal shaft, which in turn, limits the fuel going to the engine and, therefore, the amount of load the engine can carry. The position limit setting is linear from 0% at full CCW to 100% at full CW. The use of the LOAD LIMIT adjustment must be configured when the governor is configured and the external Boost Input Selector discrete input must be open (disabled).

STABILITY Adjustment—This adjustment allows quick access to the governor's dynamic performance adjustments: P (proportional) and I (Integral) gain terms. The adjustment ranges from 0.5 (fully CCW) and 2.0 (fully CW) times the nominal gain settings. A multiplication factor of one is applied to the gain settings when the adjustment is set to mid position (12 o'clock).

See Figure 4-1 the location of these adjustments and indicators.



Figure 4-1. UG-25+ Front Panel Overview

Control adjustments are made from a PC using the UG-25+ Service Tool. The Service Tool is a Windows-based software tool used to configure, monitor, adjust, and troubleshoot a UG-25+ governor. It runs on a personal computer and communicates with the UG-25+ governor through an RS-232 serial connection. The UG-25+ Service Tool includes optional password protection to provide security against tampering.

The internal speed sensor input contains a filter that minimizes the effects of firing torsionals that occur normally in reciprocating engines. This filter ensures the governor will not react to speed sensor input changes produced by firing torsionals. This provides exceptionally smooth steady-state speed control and allows matching the control dynamics solely to the engine rather than detuning dynamics to compensate for firing torsional frequencies.

The control has a switching power supply with excellent spike, ripple, and EMI (electromagnetic interference) rejection. Discrete inputs are capable of rejecting EMI and variable resistance in switch or relay contacts. Analog inputs are differential type with extra filtering for common-mode noise rejection.

The control provides one discrete output, which provides a Unit Healthy indication.

WARNING

The UG-25+ governor should not be used as the primary means of shutting down the engine.

Principal of Operation

The UG-25+ consists of the following 3 main components:

- **L-Series Governor**
  Controls prime mover speed/load with proportional rotary output by using speed reference/customer inputs.
- **Hydraulic Amplifier**
  Amplifies work output of L-Series governor.
- **User Interface**
  Provides local control of droop, load/fuel limiting, stability and shutdown functions. Also provides electrical connector for power and customer inputs.

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The hydraulic amplifier operation is depicted in Figure 4-2, which illustrates the working relationship of the various parts. The main elements of the hydraulic amplifier are listed below:

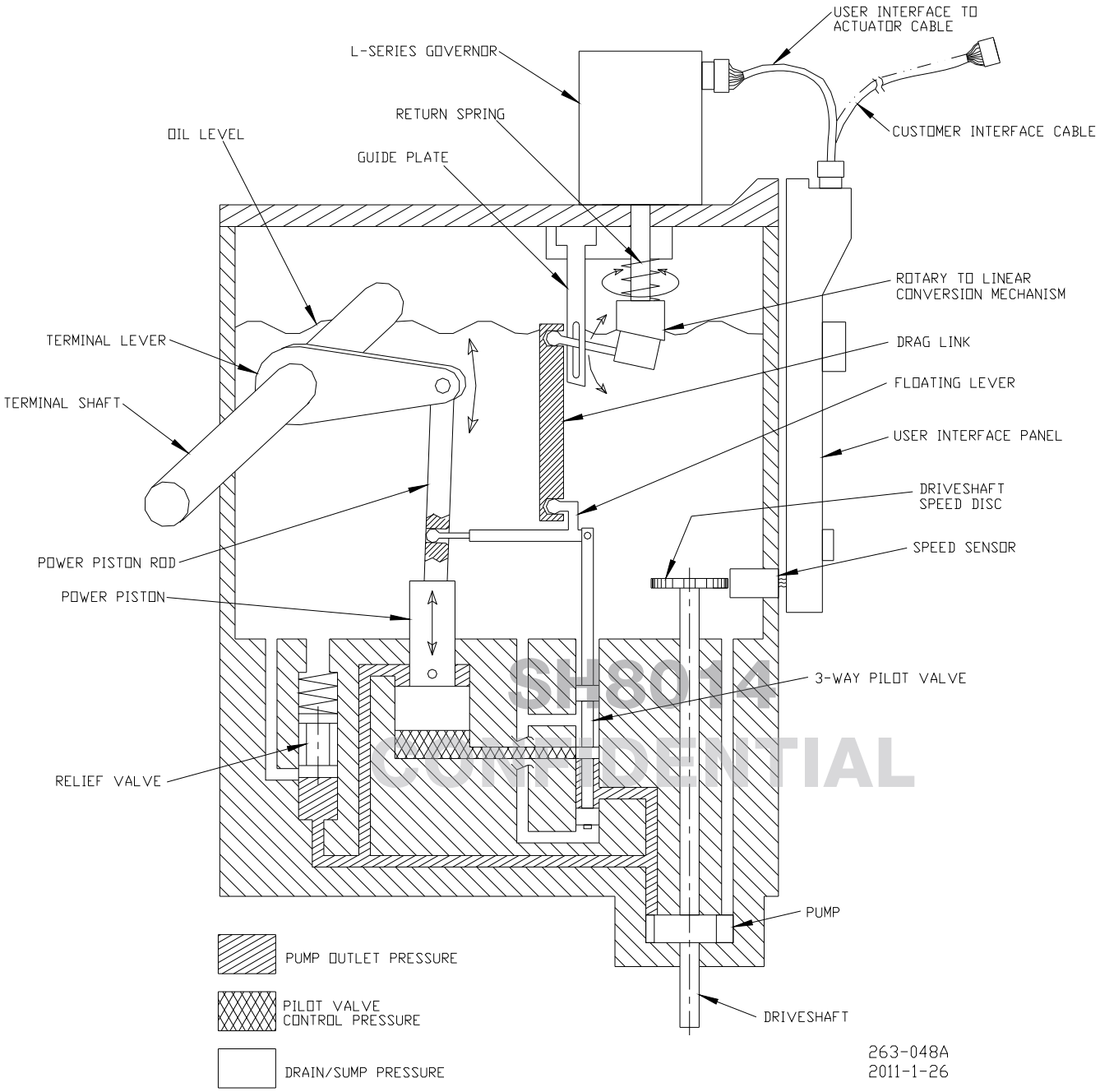
Oil Pump
Gerotor pump configuration. Pump is driven by the governor drive-shaft to provide oil pressure for the governor. The pump is fed oil from the self-contained sump.

Relief Valve
Set to maintain internal operating pressure at 1034 kPa (150 psi).

Rotary to Linear Conversion Mechanism
This mechanism converts rotary to linear motion to operate the pilot valve. It also provides enough linear motion to convert 50 degrees of L-Series travel to 42 degrees of terminal shaft rotation when coupled to the rest of the linkage in the hydraulic amplifier.

Return Spring
Used to provide shutdown to minimum fuel position upon loss of function of the L-Series.

Pilot Valve Plunger
The 3-way pilot valve directs flow to the control side of the differential area power piston or to governor drain.



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Figure 4-2. Governor Functional Overview

Power Piston, Terminal Lever, and Terminal Shaft
The terminal lever converts the linear motion of the differential-type servo piston to rotary motion of the terminal shaft, which in turn moves the fuel linkage. The terminal-shaft position is fed back to the torque-motor beam to provide the proportional control.

Speed Sensing Disk and Speed Sensor
Drive-shaft-driven 20-tooth gear with proximity probe speed sensor used to provide a speed signal to the L-Series governor.

Increase in Load or Speed Setting

An increase in load, or speed setting, causes the L-Series governor output shaft to rotate CCW when viewed from the top on the UG-25+. This, in turn, causes the pilot valve to lift allowing control pressure to act on the underside of the power piston. This pressure underneath the power piston opposes the pump outlet pressure acting on the topside and causes the piston to rise, since the piston bottom has twice the area of the topside.

As the power piston rises, the power piston rod moves with it and rotates the terminal shaft, converting the output motion back to rotary. One end of the floating lever is directly connected to the power piston rod and this end rises correspondingly.

When the desired terminal shaft position is reached due to the correct speed or load setting being achieved, the floating lever provides a mechanical feedback/restoring signal between the power piston rod and the pilot valve. During this condition, the pilot valve will be a its “null” position. Therefore, the L-Series governor and the hydraulic amplifier are proportional devices with their positions a direct function of the load or speed setting.

Decrease in Load or Speed Setting

A decrease in load, or speed setting, causes the L-Series governor output shaft to rotate CW. This, in turn, causes the pilot valve to lower allowing the control pressure acting on the underside of the power piston to flow to drain. The pump outlet pressure acting on the topside of the power piston will cause the piston to lower.

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As the power piston lowers, the power piston rod moves with it and rotates the terminal shaft towards the minimum fuel direction. The floating lever then lowers its end coupled to the power piston rod and provides its position feedback/restoring feedback to the power piston and pilot valve.

Loss of Control Voltage

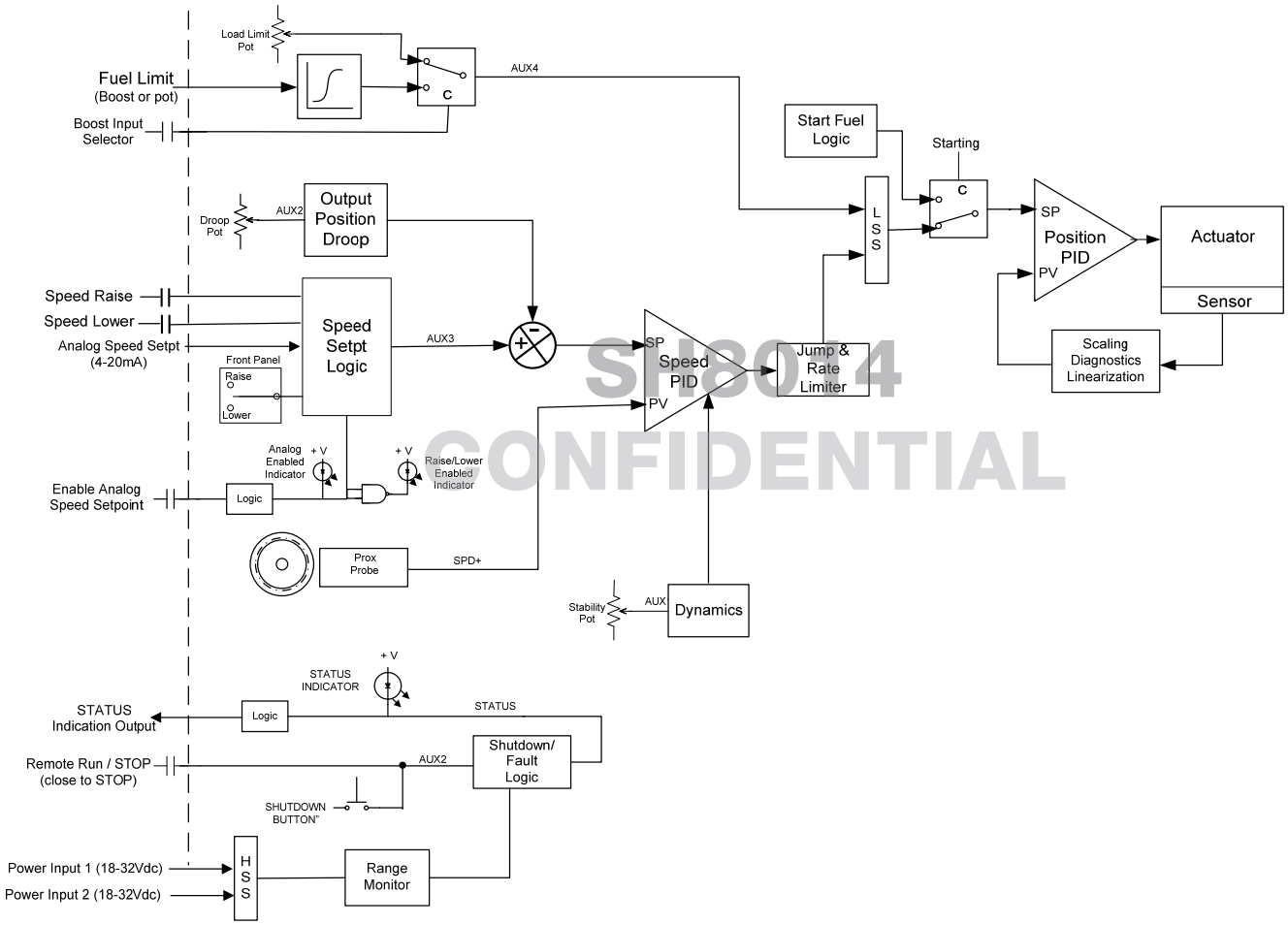
Upon loss of control voltage, the governor terminal shaft goes to minimum fuel, thus offering a safety feature. With loss of control voltage, the L-Series governor loses torque and the force of the loading or return spring causes the center adjustment to lower. The pilot valve follows, keeping the control port uncovered. Trapped oil escapes to drain, and the servo power piston moves down until it reaches minimum fuel position.

Speed Governor Features Description

The user must set up the speed input, speed setpoint/rates, start settings and fuel limit. The user can set multiple dynamics as necessary for stable operation. The user can choose all or none of the security functions depending on the application.

The governor features include:

- Speed Control with Droop and Dynamics features
- Fuel/Load Limiter (both startup and run time)
- Jump & Rate Limiter
- Temperature monitoring
- Run / Stop
- Status discrete output



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Figure 4-3. Governor Functional Overview

Starting the Engine

The following describes a typical engine starting sequence. The Run/Stop input must be open to permit a start.

When the starter is engaged and speed increases above the Start Speed 1 Threshold, the UG-25+ will position the governor output shaft to the Start Fuel position. If two Start Fuel positions are used, the UG-25+ will position the governor output shaft to the Start Fuel 2 position setting when the permissive is met. Depending on the configuration, this is either when the speed increases above the Start Speed 2 Threshold or after the delay time expires. Once the engine speed is above the Run Speed Threshold, the output will switch from start fuel demand to the fuel demand from the speed controller PID. At this point, the UG-25+ is in speed control and will control the engine to the speed setpoint. The PID output tracks the start fuel values, during a start, providing a bumpless transfer to speed control. Once in speed control, the speed setpoint increases to the configured start target speed setting - min speed or rated speed.

If a shutdown fault is detected, the control will drive the output to the minimum position.

Speed Control Functions

The speed controller consists of a speed input, speed setting logic, speed biasing logic, and speed dynamics options.

Speed Input

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Internally, the UG-25+ governor houses a proximity probe mounted next to a 20-tooth gear, which provides a speed signal to the control. Digital speed detection with firing torsional filtering is used for detecting engine speed. This digital detection method senses speed very quickly for rapid response to speed changes. The input frequency is converted to engine speed based on the number of gear teeth, gear ratio, number of cylinders, and engine stroke settings configured.

Speed Setting Options

The speed control's setpoint is adjustable with raise or lower commands through the user interface on the UG-25+ front panel or from remote contact inputs. In addition, a 4–20 mA analog input provides for remote speed setpoint control.

The speed setpoint can be in Analog or raise/lower mode. The front panel LEDs will display the active speed setpoint mode (Analog or raise/lower). When in the Analog mode, the setpoint signal comes from the UG-25+ analog speed setpoint input (derived externally by a customer supplied device). When in the raise/lower mode, the setpoint is adjusted using raise and lower commands available both on the front panel and through customer inputs.

Analog Speed Setpoint—The Analog Speed Setpoint input directly sets the internal speed setpoint. The maximum rate at which the analog input signal can change the speed setpoint is programmable and provides separate increase and decrease rate limits. The analog setpoint is enabled with the Enable Analog Speed Setpoint discrete input. The analog setpoint scaling is based on the Min Speed Limit and Max Speed Limit settings, a 4 mA input corresponds to Min and a 20 mA input corresponds to Max.

Analog Speed Setting mode is active only when the Analog Enable input is closed and the analog input signal is above 2.5 mA. All Setpoint Raise/Lower commands are ignored when the Analog Speed Setting mode is active.

The user must provide an external means to clamp the analog speed setpoint input between 3 and 21 mA. An analog speed setpoint command input below 3 mA or above 21 mA is out of the normal 4 to 20 mA input range and may cause the analog speed setpoint command function to become disabled even though the Analog indication LED remains on.

When the Analog Speed Setpoint mode is disabled, by loss of input signal or opening the Analog Enable input, the speed control's setpoint is held at the last setting and remains there until adjusted using the Raise or Lower commands.

Lower—The Lower Speed discrete input and front panel Lower command act directly on the internal speed setpoint and will progressively decrease the speed setpoint down to a programmable lower limit at the programmed lower rate for as long as the input is selected (closed). When this input is not selected (opened), the speed reference will remain fixed at the last setting.

Raise—The Raise Speed discrete input and front panel Raise command act directly upon the internal speed setpoint and will progressively increase the speed reference up to a programmable upper limit at the programmed raise rate for as long as the input is selected (closed). When this input is not selected (opened), the speed reference will remain at the last setting.

Front panel commands have priority over external commands – when Raise or Lower is selected locally, the remote raise/lower commands are ignored. In the event of a simultaneous external Raise and Lower command, the Lower has priority over a Raise command.

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⚠WARNING

It is recommended that the actual engine speed be used to externally verify that the speed command matches the command signal sent. Failure to comply with this recommendation can result in undetected system faults.

Speed Setting Functions

The control provides run speed, min speed, max speed, and rated speed setpoints with a lower and raise limit, plus raise and lower ramps and a starting ramp. All ramp rate settings are in rpm/sec and all speed setpoint changes are ramped for smooth setpoint transition. For emergency standby applications, a very high ramp rate effectively cancels the ramp function to provide rapid starting. Starting ramp determines how fast speed is increased from run to the start target speed (Min or Rated). Raise and lower rates determine how fast speed is increased or decreased by the raise and lower command inputs. A maximum adjustment rate limit is provided for the remote speed setpoint input. See Figure 4-4 for relative speed values. For additional details on these settings refer to the Overview tab and Setpoint tab configuration settings in Chapter 6.

The Run Speed setting must be above cranking speed, but below the speed attained at ignition speed by the start fuel limit setting. The speed control activates at Run speed by grabbing the current operating speed as the initial speed setpoint then ramping the setpoint up to the start target speed setting at the start target speed rate.

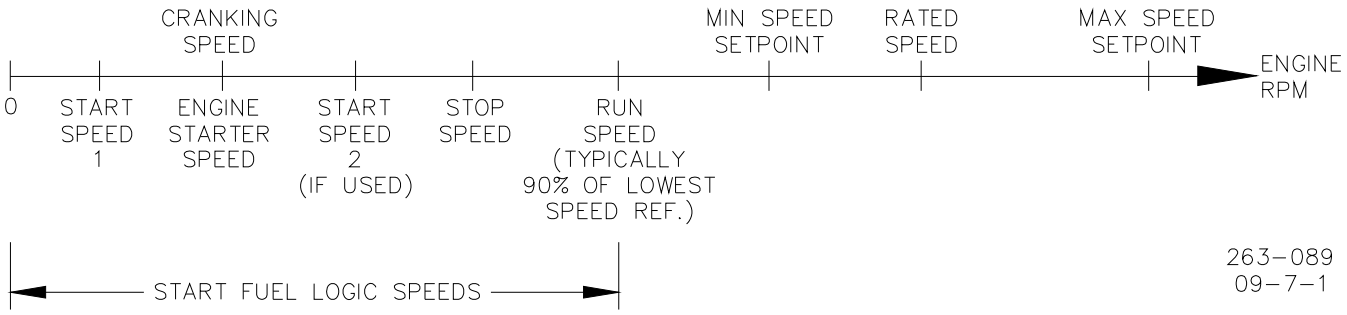


Figure 4-4. UG-25+ Relative Speed Values

If the target speed is Rated and a raise or lower command is selected during the ramp to target (Rated), the speed setpoint will halt and follow the raise/lower commands. If the halt is issued prior to reaching the Min Setpoint Limit, then the setpoint will continue up until Min prior to stopping.

Droop

This feature allows for a change in speed setpoint with a change in load. This feature is primarily used when the generator is connected to a utility bus or paralleled with another gen-set on an isolated bus. In this situation, the utility will determine the frequency of the generator and the speed of the engine. Should the governor speed reference be less than the utility frequency, power in the utility bus will flow to the generator and motor the unit. If the governor speed is even fractionally higher than the frequency of the utility, the governor will go to full load in an attempt to increase the bus speed. Since the definition of a utility is a frequency that is too strong to influence, the engine will remain at full fuel.

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Droop is one method of creating stability in a governor. Droop is also used to divide and balance load between units driving the same shaft or paralleled in the electrical system. Droop is the decrease in speed that occurs when the governor output shaft moves from the minimum to the maximum fuel position in response to a load increase, expressed as a percentage of rated speed.

Too little droop can cause instability in the form of hunting, surging, or difficulty in response to a load change. Too much droop can result in slow governor response in picking up or dropping off a load.

Reducing droop to zero allows the unit to change load without changing speed (isochronous operation). Normally, set zero droop on units running alone. On interconnected units, set the least amount of droop possible to provide satisfactory load division. For ac generating units tied in with other units, set droop sufficiently high to prevent interchange of load between units. If one unit in the system has enough capacity, set its governor on zero droop (isochronous operation), and it will regulate the frequency of the prime mover system. If its capacity is not exceeded, this unit will handle all load changes.

Marks on the droop adjustment scale on the front panel are reference numbers only and do not represent actual droop percentages. The governor droop percentage set by the droop pot is scaled 0 to 18% of the full 42 degrees of output shaft travel, but since the typical application uses 30 degrees travel, the pot roughly corresponds to 10% at full CW position. Shaft positions must be entered for no-load and full load to correlate the speed setting to load. Configuration settings are available on the Setpoint tab for the nominal droop percentage, no load, and full load positions.

The desired engine speed reduces with the following formula:

$$\frac{\text{Rated speed setpoint} * \text{droop percentage} * (\text{actual position} - \text{no load governor position})}{(\text{full load governor position} - \text{no load governor position})}$$

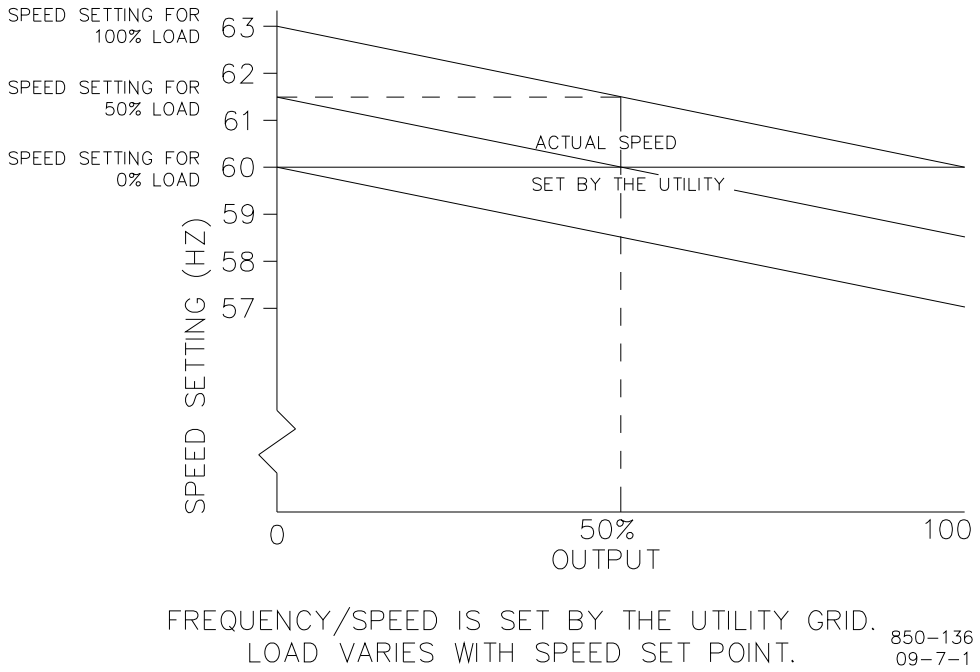


Figure 4-5. 5% Droop Example

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Speed Control Dynamics

The control algorithms used in the UG-25+ governor are designed specifically for reciprocating engine applications. The UG-25+ offers either a single set of dynamics or a position-based curve. In addition, cold start dynamics and dual gain settings can be configured for use in more demanding applications. These options are described below. A front-panel Stability potentiometer is provided to allow quick access to dynamic performance adjustments. Refer to the Dynamics tab in Chapter 6 for configuration details. Information on tuning of the speed control dynamics is provided in Chapter 7.

Cold Start Gain

In demanding gen-set applications that require ISO 8528-5, Class G3 performance but are also intolerant of cold start instability, the UG-25+ governor offers a cold start gain function that sets the gain of the controller to a lower-than-normal value until a programmable speed threshold is exceeded (see Start Gain and Start Gain Speed Threshold settings in Chapter 6). This gives an engine time to warm up slightly before switching to a normal gain value.

Single Gain

If configured for Single Gain, once the Start Gain Speed Threshold is exceeded, the proportional gain remains constant as entered and does not vary with engine speed or load. These are simplest dynamics and suit most constant speed applications. A single gain setting is typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Position Curve
A Position Curve varies the proportional gain value with fuel demand (governor position). Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. This gain curve is particularly useful for non-linear fuel systems (e.g., intake butterfly valves).

Integral and Derivative
The integral gain varies with engine speed. Idle Integral applies when running at the initial Run Speed. Rated Integral applies when operating at rated speed or higher. The gain varies linearly at intermediate speeds. For all dynamic configurations, the Derivative setting is constant and does not vary with either engine speed or load.

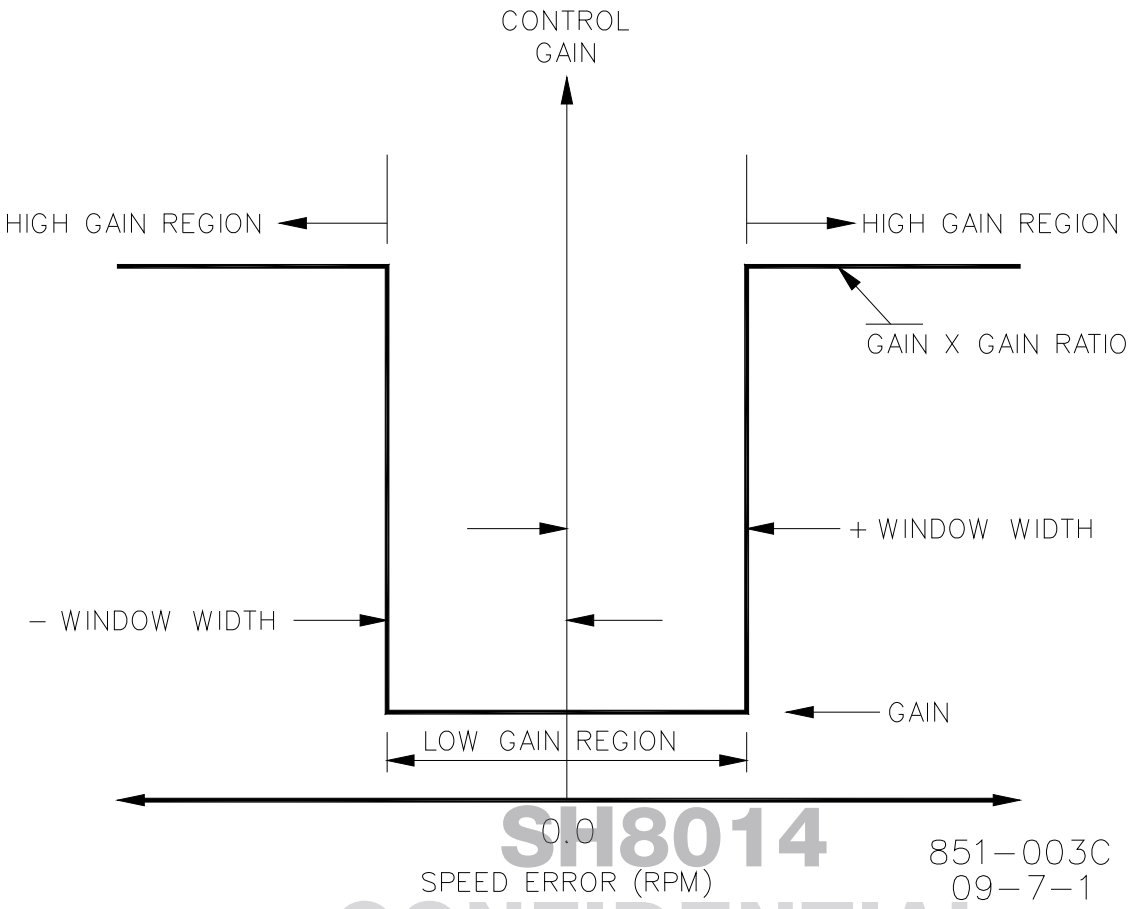
Stability Pot
The front panel stability pot provides a quick adjustment on the speed controller P (proportional) and I (integral) gain terms. This pot output, with a range of 0.5 to 2 X, is multiplied with the nominal gain settings to adjust the resultant performance. When the pot is at mid position, the multiplier is '1.0' and gains are at their nominal configured settings. At full clockwise position, P and I-term gains at multiplied by '2' providing increased response and at full counter-clockwise position the multiplier is at 0.5. The stability pot input and resultant gains can be monitored from the Overview tab on the Service Tool (see Chapters 5 and 7).

Dual Gain Settings
Gain Window and Gain Ratio settings further modify the applied gain. These Dual Gain Dynamic settings can improve both steady state and transient load performance by automatically switching between two gain settings. A low gain setting is applied during steady-state operation. A high gain setting is applied during load transients. Dual Gain Dynamics are available for all gain configurations.

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During steady-state loaded operation, the control uses the primary gain setting (rated gain, idle /rated gain, etc.). In this region, gain is set to prevent the control from responding to minor speed fluctuations inherent with reciprocating engines. This essentially eliminates harmful jiggle of the governor output and the fuel system linkage during steady-state loaded operation.

During load transients, should the speed error exceed the adjustable Gain Window width, the primary gain setting is multiplied by the gain ratio setting to temporarily increase the applied gain. This higher gain produces a faster fuel response to quickly restore engine speed to the speed setting. Speed error is the difference between actual engine speed and the engine speed setting. The primary gain setting is restored once the control senses a return to steady-state operation (see Figure 4-6). Setting the gain ratio to 1 disables the function.



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Figure 4-6. Dual Gain Settings

Fuel Limiting

Two modes of fuel limiting are provided, one during startup (start fuel) and one during normal operation (run time).

Start Fuel Limit Function

The Start Fuel Limit (SFL) is an adjustable limiter on the fuel demand that prevents over fueling during engine starting. Two configurable start fuel limiters are available:

- Single Start Fuel Limit
- Dual Start Fuel Limit
- Dual Limit with Time Delay

The simple Start Fuel Limit is suitable for most applications. With this configuration, the fuel demand immediately switches to the adjustable SFL1 Limit setting when the engine is cranking at the adjustable Start1 Speed setting. The SFL1 Limit is removed once the engine accelerates to the Run Speed. At the Run Speed the fuel is controlled by the speed control setpoint and ramping functions. The Run Speed setting must be set below the speed reached with the SFL1 Limit setting. See Figure 4-7.

The Dual Start Fuel Limit is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, black smoke or to prevent an overspeed shutdown. The start sequence will work the same as with only one start fuel setting, but once engine speed is above the Start2 Speed setting, the fuel demand starts ramping to the SFL2 limit at the configured actuator ramp rate.

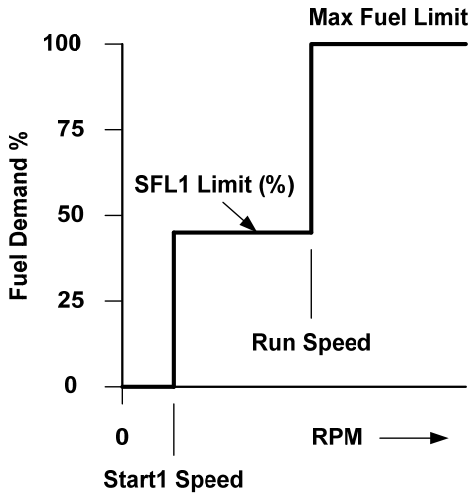


Figure 4-7. Single Start Fuel Limit

A Dual Limit with Time Delay start fuel limit option is available. Using this option, if the start 2 speed threshold is not exceeded, the fuel demand starts to ramp to the start fuel 2 (SFL2) limit after the configured time delay expires.

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If the ramp rate is set to its maximum value, the change to the second start fuel is nearly instantaneous. This will essentially eliminate the ramp feature. Start2 Speed must be set higher than the Start1 Speed setting. The SFL2 Limit can be set lower or higher than the SFL1 Limit setting. Otherwise, function is the same as the Start Fuel Limit described above. See Figure 4-8.

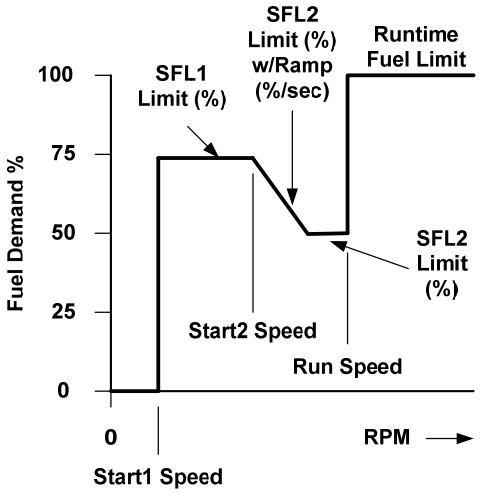


Figure 4-8. Dual Start Fuel Limiters

Run Time Fuel Limiting

During normal operation, the fuel limit can be set by the front panel load limit pot as a function of the operating speed or through an external analog setting. The appropriate hardware jumper (see Boost Input Selector discrete input in Chapter 3) AND software configuration selection must be set for the desired input. An absolute Maximum Fuel Limit is also available. Refer to Fuel Limiting tab in Chapter 6 for configuration details.

Maximum Fuel Limit
The Maximum Fuel Limit software setting places a fixed absolute maximum limit on the fuel demand (governor position), independent of the front panel fuel limit pot or analog input. It is generally adjusted to prevent engine overloading at rated speed or to merely limit fuel delivery to the engine for other situations (e.g., to prevent detonation). Configuring the Max Fuel Limit setting to 100% disables the function.

Boost (Analog Input) Fuel Limit Function
The Boost fuel limit is a software adjustable five-breakpoint curve based on an external transmitter analog input signal. Manifold Air pressure (MAP) is typically used for the external fuel limiter signal. The purpose of the manifold air pressure fuel limiter is to prevent over fueling during loading to significantly reduce black smoke in diesel engine exhaust and unburned hydrocarbons in spark gas engine exhaust. A fuel demand (governor position) limit is set for each specific air manifold pressure breakpoint.

The limiting value is linear between breakpoints as shown in Figure 4-9. The engineering units for each breakpoint are in percent and user set input units. The limiter must be carefully set since excessive fuel limiting can degrade the loading response. On occasion, exhaust temperature or other engine parameters are used for the external fuel limiting function. The external fuel limiter is disabled whenever the input signal is failed. The external fuel limiter is not active below the run speed setting.

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To select this input, the Boost Analog Input must be configured and the Boost Input Selector discrete input must be closed.

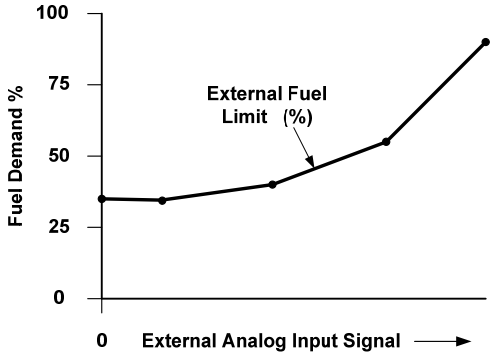


Figure 4-9. Boost (External) Fuel Limit Curve

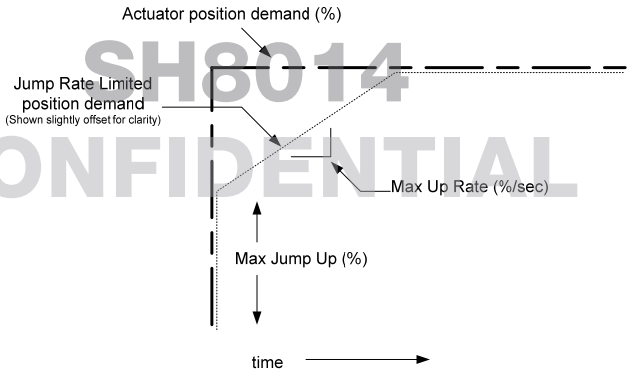
Fuel Limit Pot
The front panel fuel limit pot is a run time fuel limit that is set based on the position of the potentiometer. The position limit settings for this function is linear from 0%, pot full counter-clockwise, to 100% with the pot fully clockwise.

To select this input, the Front Panel Pot must be configured and the Boost Input Selector discrete input must be open.

Speed-based Fuel Limit Function
The Speed-based fuel limit is a software-adjustable, five-breakpoint curve with the input as actual engine speed and the output as the fuel limit in percentage of full 42 degrees of travel. The limiting value is linearly interpolated between breakpoints. To use this limiter function, the speed-based curve must be configured, and the Boost Input Selector discrete input must be open.

Jump and Rate Limiter

A jump and rate limiter is available to limit the governor output position command in the fuel increasing direction. This function provides a limit on instantaneous increases (Max Jump Up) and a limit on the rate of increasing shaft position output (Max Up Rate). Settings of 100% and 200%/sec for Max Jump Up and Max Up Rate, will disable this function. The jump rate limiter is not active below the run speed setting. Refer to Fuel Limiting tab in Chapter 6 for configuration details.



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Figure 4-10. Jump Rate Limiter

Discrete Output – Unit Healthy Indication

A discrete output is provided to mimic the front panel ‘Unit Healthy’ LED. When OFF, indicates a shutdown condition in the unit. The Service Tool can be used to display all faults, current and historical (logged).

Run / Stop (Shutdown) Functionality

The UG-25+ can be shut down from the front panel or through the external Shutdown discrete input (Open to Run, Close to Stop). When a ‘stop’ is commanded, the output shaft position will be commanded to minimum (0%).

Temperature Sensing

The UG-25+ has an on-board temperature sensor to monitor board temperatures and protect the unit from over-temperature. This temperature is monitored and a fault is annunciated if the setpoint is exceeded.

Current Limiting based on Temperature

The controller provides governor current limiting based on the electronics temperature. Dependent on board and governor thermal models, the software reduces current as necessary to avoid conditions that would damage the device due to extreme temperatures.

Current limiting based on temperature begins when the combined current and temperature environment causes board temperatures greater than 117 °C. The limit curve is a linear derate from full current at 117 °C down to zero current at 125 °C. At 125 °C, an OverTemp fault is annunciated. Depending on the current (governor torque) and ambient operating temperatures, the unit may never reach a reduced level.

Control Modes

The Service Tool displays the state of the UG-25+ governor, the present mode of the unit. Options include:

- Stopping
- Engine Stopped
- Power-down
- Start Fuel 1
- Start Fuel 2
- Ramping
- Running Rated

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Stopping
The stopping state indicates the control has a shutdown fault and is driving the output shaft position to the closed position. Once speed has reached zero rpm, the control transfers to the stopped state.

Engine Stopped
In this state the engine is stopped and the control is ready to begin the startup cycle if there are no shutdown's active. After the Stopped State Delay, the holding current is applied to the governor to limit the current draw and prevent battery drain.

Power down
In this state the governor position controller is turned off and the holding current is applied to the governor to limit the current. This state is only used if the engine is stopped and the run enable discrete input is not active.

Start Fuel 1
The Start Fuel 1 state is selected if the engine speed is higher then the Start Speed 1 threshold. In this state the governor position is set to the Start Fuel 1 value.

Start Fuel 2
The Start Fuel 2 state is selected if the engine speed is higher then the Start Speed 2 threshold. In this state the governor position is set to the Start Fuel 2 value. This state is only used if two start fuels are selected.

Ramping
The ramping state is used to ramp from one setpoint to another setpoint.

Running Rated
Indicates the unit is running at the rated speed setpoint or the changed rated setpoint if raise, lower, or analog control is used.

Fault Detection and Annunciation

The UG-25+ provides complete shutdown fault monitoring. A detected shutdown condition forces the governor to a go to the min fuel (0%) position. When the shutdown condition no longer exists, the UG-25+ is returned to a non-shutdown state. Faults are globally set as non-latching. When the condition no longer exists, the fault is automatically cleared without any reset.

Current (Active) Faults and Logged Faults

Faults are separated into two categories: Logged Faults and Current (Active) Faults. All faults are logged. Status of both current and logged faults is provided on the Service Tool. A Current Fault indicates a fault that is presently active/detected and causes the Unit Healthy LED to turn off. A Logged Fault is a fault that occurred since the last time the fault log was cleared. All logged faults are latched and written to the EEPROM. They must be cleared through the Service Tool. Each possible fault is described below.

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Shutdown Faults and Stop Details

Shutdown - Voltage Sense Fail
Indicates an out-of-range signal on the input power. Could indicate input power out of range or a fault in the supply voltage sense circuitry.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >33 V and <6.25 V
Persistence: 650 ms

Shutdown - Temp Sense Fail
Indicates a failure of the internal on-board Temperature Sensor.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >150 °C and <–45 °C
Persistence: 650 ms
Hysteresis: 5 °C (<145 °C or >–40 °C to clear)

Shutdown - OverTemp
If the on-board temperature sensor reads above 125 °C, this error will be set. The Current Limiting based on temperature will effectively make the output "limp" by reducing the drive current to zero (see Current Limiting Based on Temperature section for details).

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >125 °C
Persistence: 650 ms
Hysteresis: 5 °C (<120 °C to clear)

Stop - Zero Speed Detected
Loss of speed input signal.

Dedicated shutdown. The control must return to a safe condition, determined as the power-down or stopped state, prior to resuming operation.

Failure levels: < (Start Speed / 2)
Persistence: 13.0 ms

Stop - Stop Input Command
The Stop discrete input is opened or STOP is selected from the front-panel user interface. This is a hard-coded shutdown. This shutdown remains active until the speed has dropped to zero.

Persistence: 650 ms

Shutdown - EEPROM Fail (internal fault)
EEPROM Fail indicates failure or corruption of the internal non-volatile memory. This is a hard-coded internal shutdown. If detected, the control output will go limp. A power cycle is required to clear this fault.

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This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Shutdown - Position Sense Fail (internal fault)
This indicates a failure of the internal Position Sensor. This is a hard-coded internal shutdown. If detected, the control output will drive to the Fail Direction using current control. This fault latches and requires a reset or power cycle to clear.

This shutdown causes the Unit Healthy LED to turn off and the External Status output (Terminal 11) to open-circuit, turning off any External Status device that is connected.

Failure levels: >4.75 V and < 0.25 V
Persistence: 650 ms

Chapter 5.
Service Tool

Introduction

This chapter covers the process of installing and servicing the control via the UG-25+ Service Tool. It is assumed that the control has already been installed on the engine.

IMPORTANT **Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.**

Description

The Service Tool software is used to configure, tune, and troubleshoot the UG-25+ controller. This chapter describes installation and use of the Service Tool. It identifies the parameters available that can be viewed. It also provides detailed information on configuring and setting up the UG-25+ to the customer-specific field application.

The Service Tool software resides on a PC (personal computer) and communicates to the UG-25+ through terminal block TB5 Terminals 4 and 6. An external RS-232 transceiver is necessary to make communications possible with the Woodward UG-25+ service tool. A connectivity kit can be purchased from Woodward to accomplish this (Woodward part number 8923-1061).

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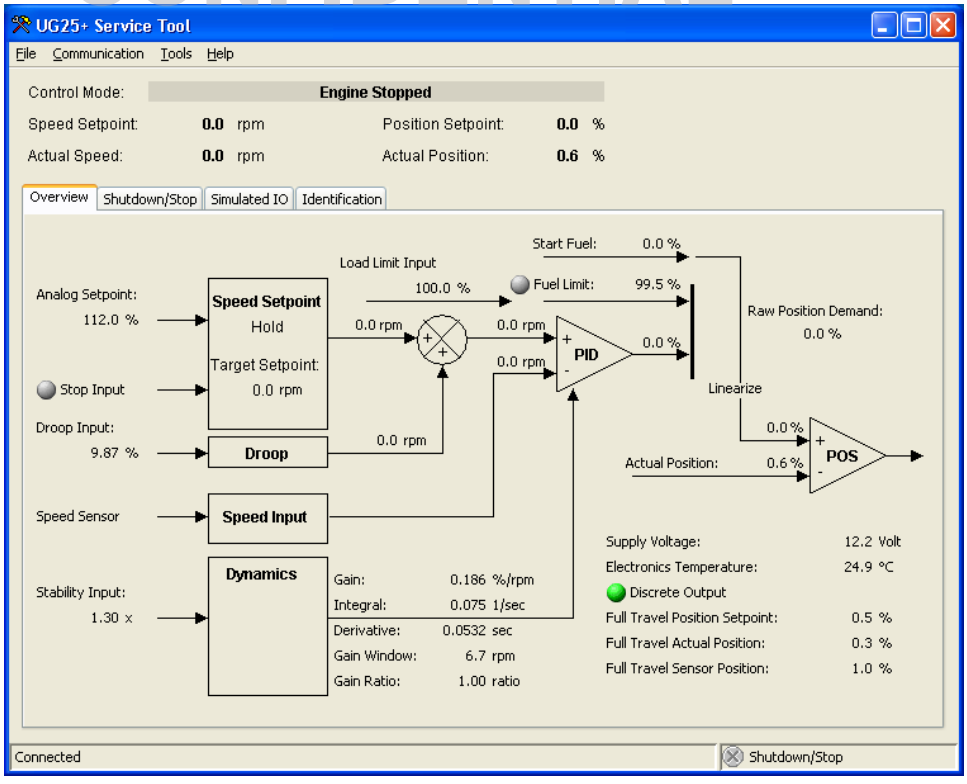


Figure 5-1. Example Service Tool Screen

The following hardware is required to work with the UG-25+ control:

- PC-compatible laptop or desktop computer* with at least one available serial communications port, and Windows 95/98/00/NT/Me/XP as the operating system.
- Programming/datalink harness as shown in Figure 5-2.

In addition to the hardware, the following are the distributions of tool software needed to communicate with the control:

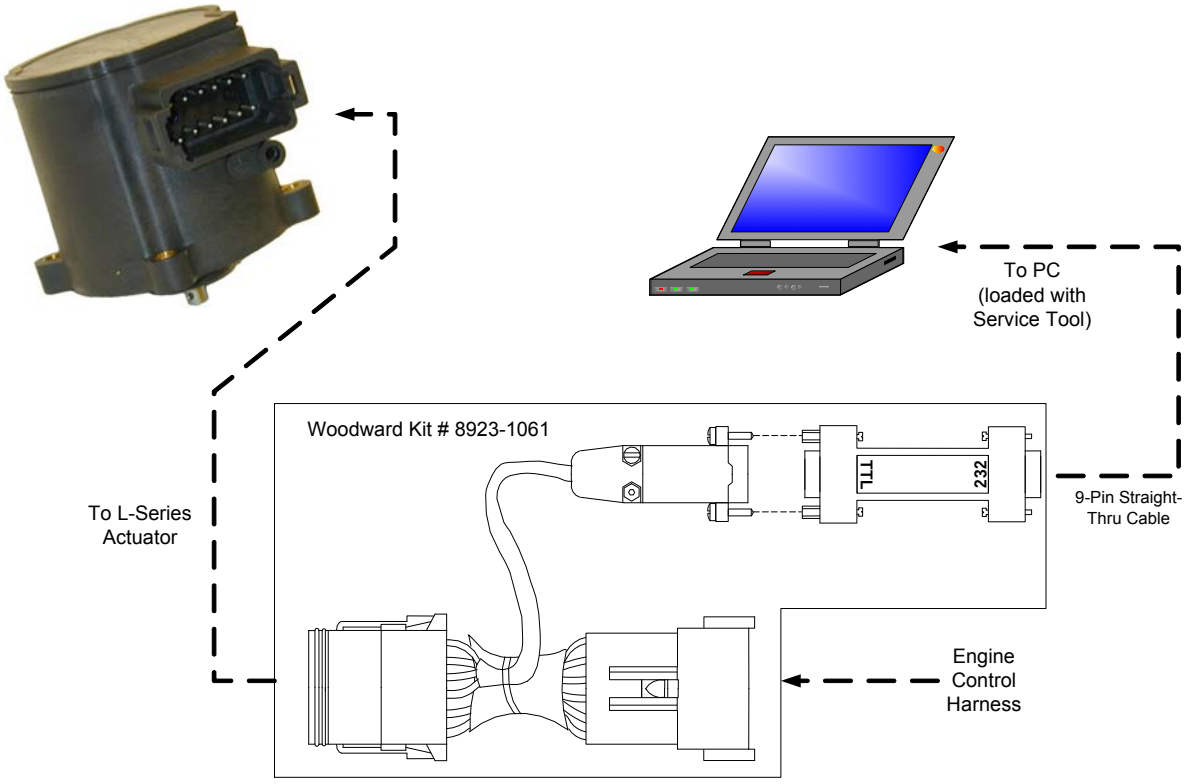
- Woodward part number 9927-1366, UG-25+ Service Tool

NOTICE

There is a potential for serial port damage when communicating with the UG-25+ control. This is caused by a difference in ac voltage between neutral and earth ground. If the PC RS-232 port ground is referenced to ac neutral, and the UG-25+ control is referenced to battery ground (ac earth ground), a large amount of current can be experienced. To avoid this situation, we strongly recommend placing an isolation transformer between the ac outlet and the PC or using a battery-powered PC such as a laptop.


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Figure 5-2a. Programming Harness Connection



Pinouts Viewed Looking into Control Connector and Computer Connector

Figure 5-2b. Typical Programming Datalink Harness Wiring

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Getting Started

Harness Connection

The programming harness is required to communicate with the Service Tool. To install the harness, remove the connector from the L-Series and insert the harness between this connector and the L-Series (see Figure 5-2a).

IMPORTANT

Connecting the programming harness causes some hardware inputs to cease operating. These include the following commands:

- **front panel stability**
- **front panel load limit**
- **external boost pressure (4–20 mA)**

Although these hardware inputs are not available when the programming harness is connected, these input commands can be simulated in software using the simulated I/O screen.

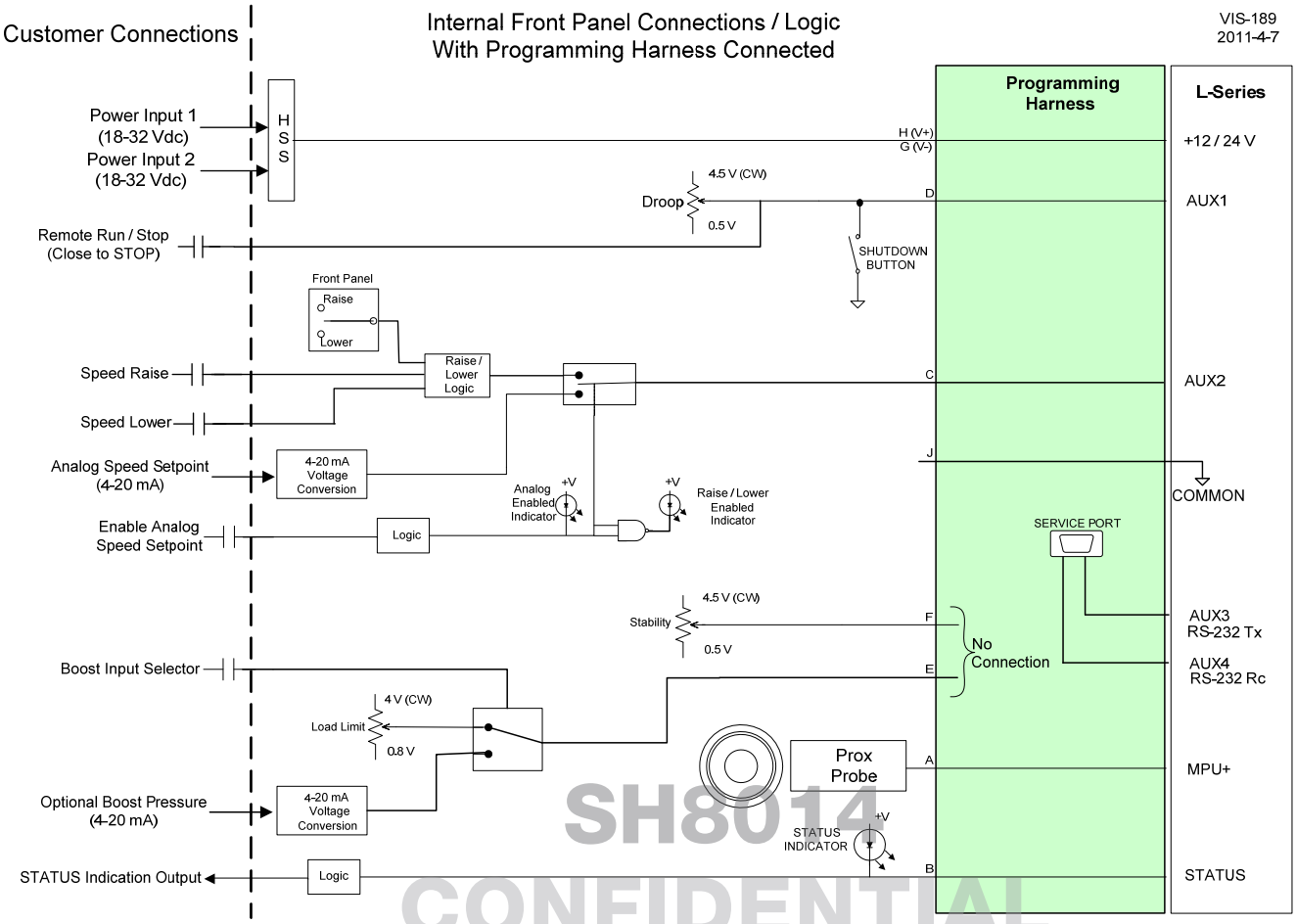


Figure 5-2c. Internal Block Diagram with Programming Harness Connected

Software Installation Procedure

The Service Tool software (entitled UG-25+ Service Tool) can be downloaded and installed from the Woodward internet site (www.woodward.com).

What to do next

After the software is installed, connect a serial communications cable between the RS-232 connections on the UG-25+ control and an unused serial port on your computer. Run the Service Tool program and select the appropriate comm port. Once connected to the control, the status bar will display 'connected' and the Service Tool screen will populate with monitor parameters.

WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

Service Tool Help

More help on using Service Tool is available and included with the installation of the Service Tool product. Service Tool Help can be accessed from the Service Tool 'Contents' drop-down window selection under the Help menu located on the Main Window (see Figure 5-1).

Software Version Identification

The Service Tool software version can found by selecting 'About' under the Help menu. The software version is identified as the 'Software Part Number' on the Service Tool screen. The Service Tool and Control must be connected to view this information. Refer to this version information in any correspondence with Woodward.

Service Tool Security

Various levels of security are available to protect application settings. One password is available that provides the ability to inhibit tampering of control settings. The individual protection settings include a general password protection on configuration reading (from the control), configuration loading (to the control), and speed PID tuning.

Monitoring the Governor

The Service Tool has 4 different tab sheets (seen in Figure 5-1) to monitor governor parameters while the engine or steam turbine is running or shut down. The tab sheet screens include:

- Overview (see Figure 5-3)
- Shutdown/Stop (see Figure 5-4)
- Simulated I/O (see Figure 5-5)
- Identification (see Figure 5-6)

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Each screen will display the UG-25+ control mode, actual speed, speed setpoint, position setpoint, and actual position values.

Control Mode
Displays the state of the UG-25+ control, the present mode of the unit. Options include:

- Power-down
- Engine Stopped
- Stopping
- Start Fuel 1
- Start Fuel 2
- Ramping
- Running Rated

Speed Setpoint
Displayed value of the speed setpoint (after droop is subtracted) - in engine rpm.

Actual Speed
Displayed value of the actual speed – in engine rpm.

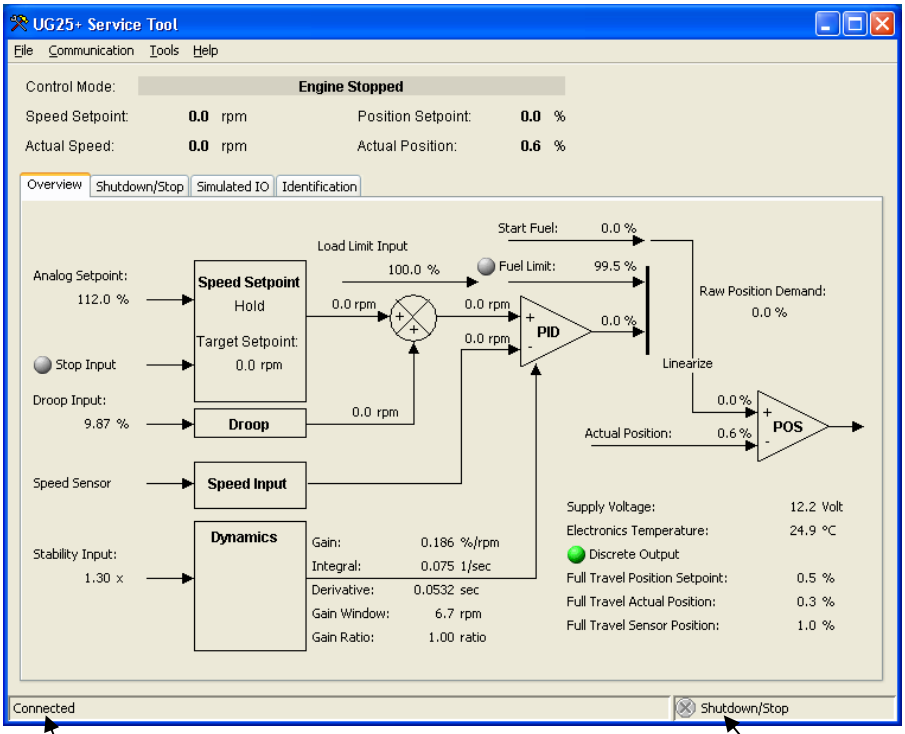


Figure 5-3. Service Tool – Overview Tab

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Communication status **Shutdown/Stop status**

Position Setpoint
Displayed value of the position demand—in percent of full travel (42 degrees).

Actual Position
Displayed value of the actual position—in percent of full travel (42 degrees).

Status Bar Indications
At the bottom of the Service Tool window is a status bar. The status bar has two sections. The bottom left section displays the communication status and bottom right section displays the shutdown status.

Communication Status
This section of the status bar shows the status of communication between the service tool and the device. For more information, see Establishing Communication.

- **Connected**—The Service Tool is connected to and communicating with the driver.
- **Not Connected**—The Service Tool is not connected to the driver.
- **Connecting**—The Service Tool is attempting to connect to the driver. This message is displayed when Connect is selected from the Communications menu or when attempting to re-establish communication to the driver. If the connection is lost it will continuously attempt to re-connect.

Shutdown/Stop Status
One or more faults on the Shutdowns/Stop screen is active.

Overview Parameters Screen

To monitor the overview parameters, go to the Overview page on the main window. This screen dynamically populates based on the unit's configuration. If a function is not programmed, then it will not appear.

Supply Voltage

Displayed value of the input power, in volts, as read by the processor.

Electronics Temperature

Displayed value of the electronics temperature sensor, in degrees Celsius, as read by the processor. The temperature sensor is physically located between the electronics module and the LAT motor.

Discrete Output

On/Off status of the discrete output command. The indicator is illuminated when the channel is commanded to ON and grayed-out when the command signal is OFF.

Full Travel Position Setpoint

Indication of the position setpoint in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Actual Position

Indication of the actual position in terms of total overall unit travel. Useful if a less than full-travel user-calibrated range is used.

Full Travel Sensor Position

Indication of the position in terms of total overall unit travel before linearization. This value will match the internal Travel Position Sensor (TPS) output.

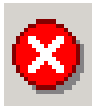
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The actual real-time values of the various parameters are shown on the functional block diagram. When the engine or turbine is shut down, some of these parameters are zero.

Shutdown and Stop Indications

The Shutdown / Stop screen displays the status of both active and logged fault conditions. The logged indications provide a history of events even after the unit has been powered down and power is reapplied again.

 Indicates a logged shutdown condition.

 Indicates an active shutdown condition.

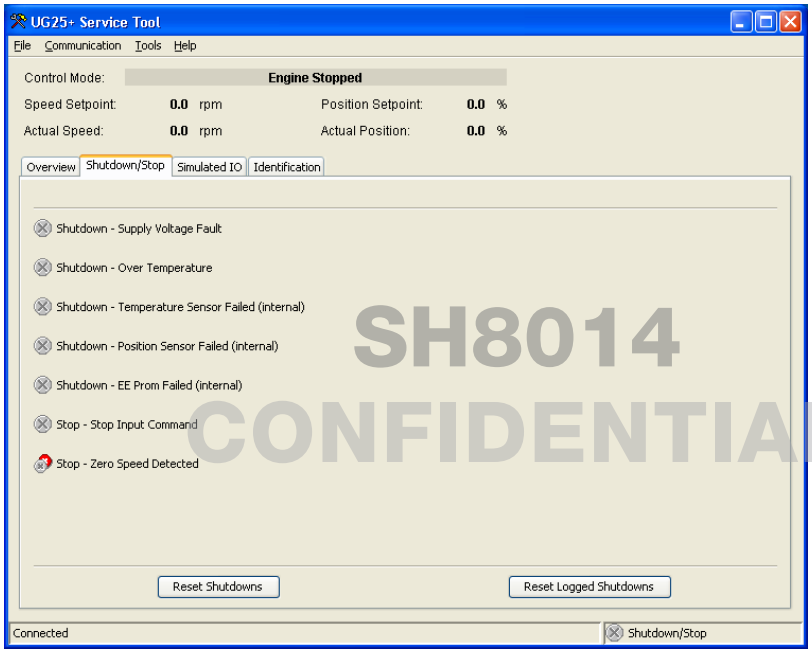
An active fault is one that is currently active or latched in the control. The latching/non-latching faults configuration setting factors into this indication. If the fault is latching, then an active fault could either be one that is still present or one that occurred but has not been reset. Latched faults can be cleared by cycling power on the UG-25+ control or by selecting the 'Reset Shutdowns' button on the Shutdown/Stop screen.

A logged fault is one that occurred but is no longer currently active or latched in the control. Logged faults are permanently cleared by selecting the 'Reset Logged Shutdowns' button on of the Shutdown/Stop screen.

Shutdown/Stop Screen

To monitor the shutdown conditions, go to the Shutdown/Stop pages (Figure 5-4) on the main window. The values displayed on the Shutdowns screen dynamically change with the fault configuration. Refer to Chapter 4 for a complete listing and details of all the faults.

A reset command is available on this screen to clear any current faults, if they are latched on. If a fault condition occurred but is no longer present, it will remain as a logged fault until cleared. The 'Reset Logged Shutdowns' command will clear all logged faults.



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Figure 5-4. Service Tool – Shutdown/Stop Tab

Simulated I/O Screen

While communicating to the service tool, Stability and Load Limit inputs (Aux 3 and Aux 4) are not functional since these input pins are used for both Input and for serial communications. The Simulated I/O screen (Figure 5-5) is provided to facilitate operational testing while connected to the Service Tool.

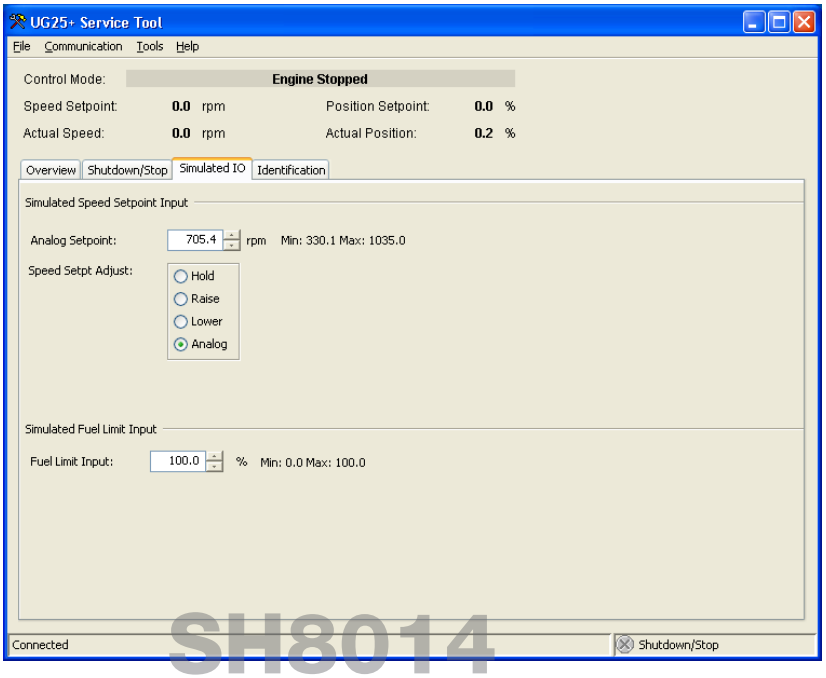


Figure 5-5. Service Tool – Simulated I/O Tab

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Identification Screen

To monitor the UG-25+ product identification, go to the Identification page on the main window. Information displayed includes the part number of the embedded UG-25+ software and the serial number of the unit.

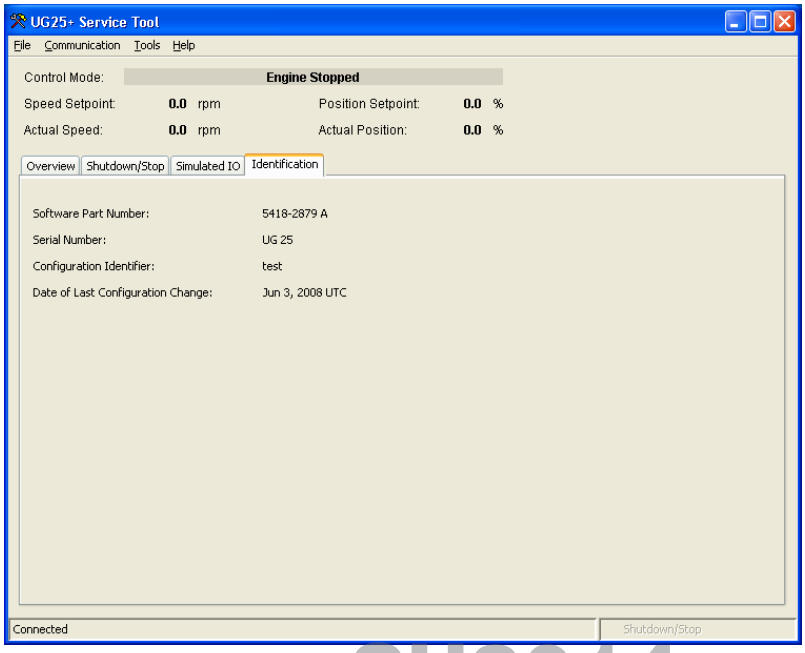


Figure 5-6. Service Tool – Identification Tab

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Chapter 6.
Configuration

Overview

The UG-25+ is configured using the Service Tool, refer to Chapter 5 for Service Tool installation and connection instructions.

The UG-25+ can be configured either on-line or off-line. On-line configuration can only be performed when the Service Tool is connected to and communicating with the UG-25+ control. Off-line configuration can be done at any time, however, settings will not take effect until they are loaded into the control.

IMPORTANT

Many applications are delivered pre-configured, calibrated, and tuned. These units do not require the use of the Service Tool.

Configuration reading and loading can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.

If using dynamics curves or fuel limiting curves, control power must be cycled after loading a new configuration before the new settings will take effect.

⚠WARNING

An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.

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The current UG-25+ control configuration settings can be viewed at any time when connected to the control by opening the Configuration Editor (File/Open Control Configuration), assuming password protection is not active. See Figure 6-1.

Configuring the Unit—On-Line

Unit configuration is summarized as follows:

1. Connect to the UG-25+ using the Programming Harness (see Chapter 5 for details).
2. Open the Configuration Editor Dialog by selecting ‘File/Open Control Configuration’.
3. Edit the configuration settings.
4. Optionally, save the configuration to a file on your PC. Saving the configuration prior to loading it will provide an identifier in the control. Only the first 8 characters are saved in the control, so it is best to ensure these identify the application.
5. Load the configuration to the UG-25+ control by selecting “Load Configuration File to Control”.

IMPORTANT

As changes are made to Configuration parameters, they are not used by the driver until a ‘load’ command is issued. Selecting the ‘Cancel’ button closes the Configuration Editor and does not make any changes to the driver.

Configuring the Unit—Off-Line

Unit configuration is summarized as follows:

1. Open the Configuration Editor Dialog using the File/New or File/Open options.
2. Edit the configuration settings.
3. Save the configuration to a file. At a later date simply open the configuration and load it into the control. Only the first 8 characters are saved in the control, so it is best to ensure these identify the application.

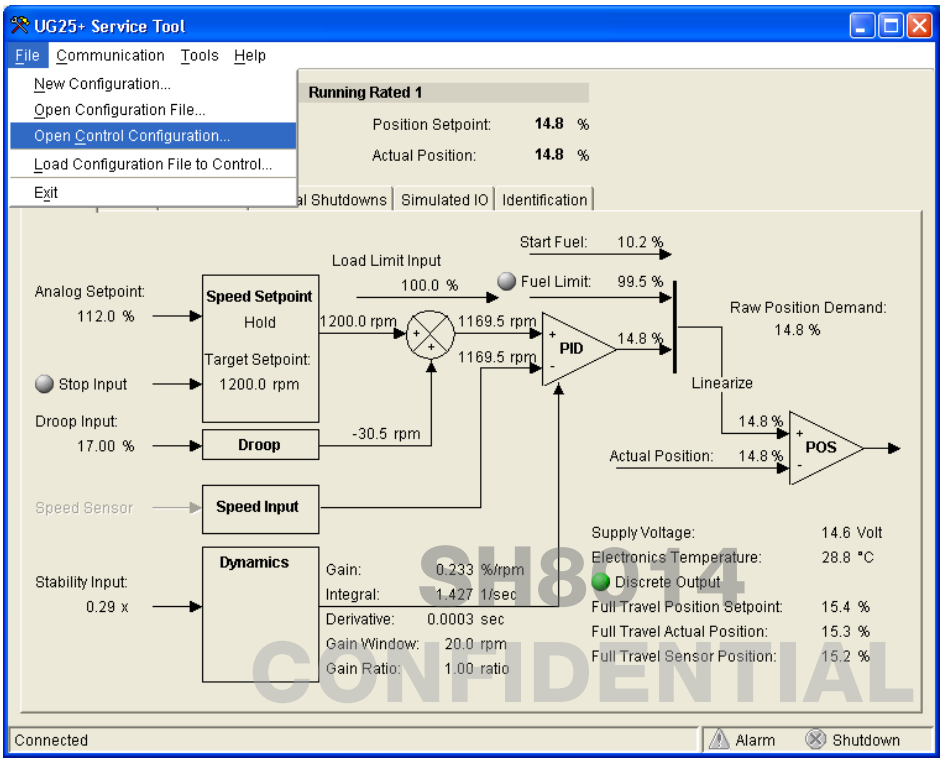
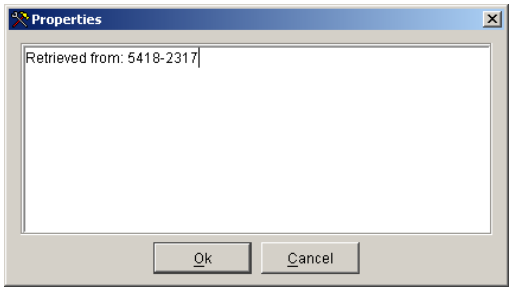


Figure 6-1. Configuration Selection Options

Application File Data

The OEM or customer can save configuration file specific data with the service tool by selecting Properties under the File menu pull down. This is a text field and can be used to store data such as:

- Customer
- Engine Type
- Application Type
- Notes



Configuration Parameters

There are 5 different screens that display/set the configuration settings in the UG-25+ Speed Controller: Overview, Setpoint, Fuel Limiting, Dynamics, and Security.

Overview Tab

The overview tab provides speed sensing and position controller configuration settings.

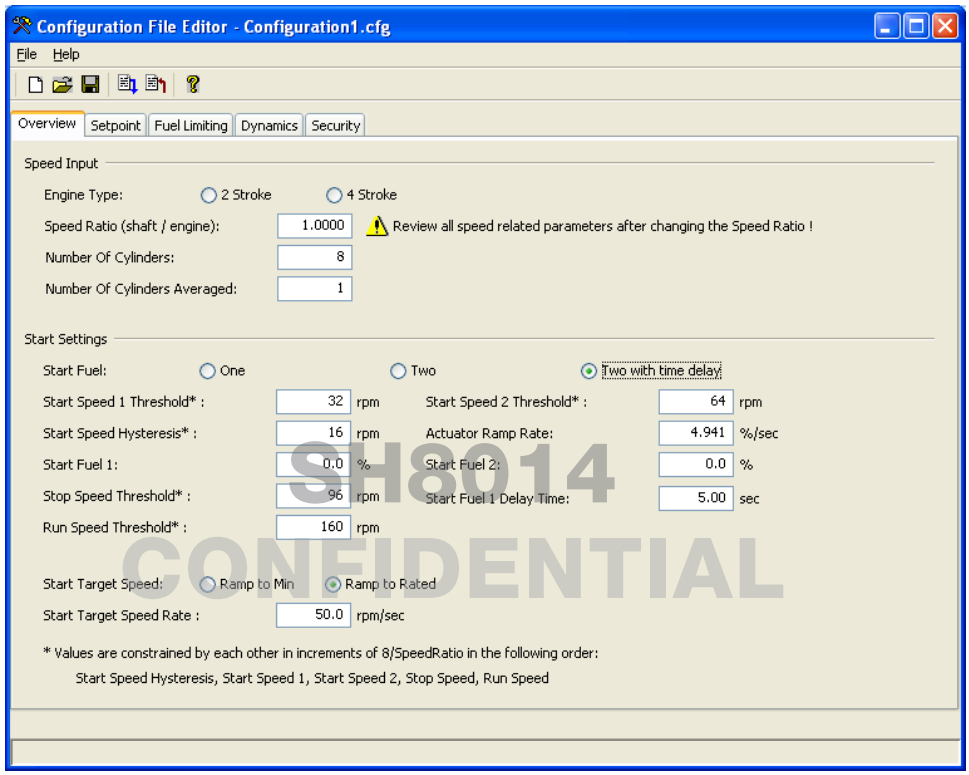


Figure 6-2. Configuration Editor – OVERVIEW TAB

Speed Input Configuration Settings

Engine Type
Set to either 2-stroke or 4-stroke.

Speed Ratio (shaft to engine speed)
Set the governor drive ratio between UG-25+ shaft speed (governor speed) and actual engine speed. This parameter sets the relationship between the speed of the governor (UG-25+ shaft speed) and actual engine speed (governor speed/engine speed). All speed values shown on the software service tool are engine speed values. When set to '1', all speed settings will be displayed in terms of governor shaft speed. Allowed values: 0.0625 – 50.

Number of Cylinders
Sets the number of cylinders.
Allowed values: 1 – 20.

IMPORTANT **Allowed adjustment ranges are displayed in the lower left corner of the window when an adjustable parameter is selected.**

Number of Cylinders Averaged
Sets the number of cylinders to be averaged by the speed sensing algorithm. This setting is used as a filter to minimize the effects of firing torsionals that occur normally in reciprocating engines. A lower value gives less filtering, producing higher steady-state speed variation but allowing a higher speed control gain setting for better transient response. A higher value produces less steady-state speed variation with correspondingly slower transient response. If unsure, set this to either '1' or half the 'Number of Cylinders' for a 4-stroke. On a 2-stroke engine, '1' or 'Number of Cylinders' are good choices.

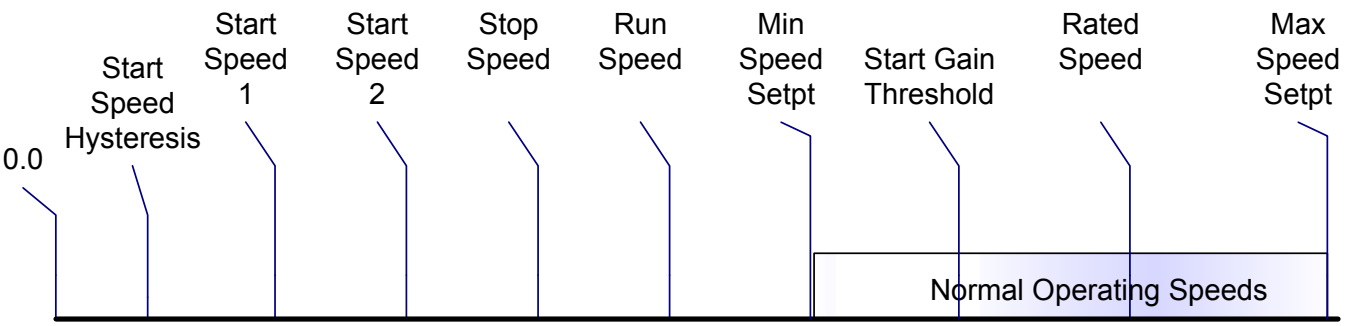
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For uneven firing patterns, 'Number of Cylinders Averaged' should be selected to eliminate repeating torsionals. If cylinder firings are paired, 'Number of Cylinders Averaged' should also be paired (2, 4, 6, …). If unsure, set to 'Number of Cylinders'.

Allowed values: 1 to 'Number of Cylinders'.

IMPORTANT **Steam Turbine applications settings should be 2-stroke, 1:1.0 Speed Ratio, 1 cylinder, and 1 cylinder averaged. For these applications all configured and displayed speed values will be in terms of governor (shaft) speed, not engine speed.**

The UG-25+ speed settings must follow the following general order.



Starting the Engine

The engine starting sequence will look like this, if no errors are detected:

While stopped, make sure the Run/Stop input is in the RUN position. Start (crank) the engine. When the engine speed increases above the Start Speed 1 Threshold, the governor will go to the Start Fuel 1 position demand. If two start fuel positions are used, as the engine speed increases above the Start Speed 2 Threshold, the governor will go to the Start Fuel 2 position demand. At this point the governor is still running open loop, the speed control PID is not controlling the governor position. Once the engine speed is above the run speed threshold, the governor will bumplessly switch from start fuel demand to the fuel demand from the speed PID. At this point the unit is in speed control, and the UG-25+ will control the engine as determined by the speed setpoint. The speed setpoint will ramp up to the configured control speed, rated or minimum speed setpoint. From this point the speed setpoint can be adjusted as needed using either raise/lower commands or the analog speed setpoint.

If an error is detected, the control will go to the stopping state. Once the engine speed decreases to zero rpm, the unit will be in the stopped state.

⚠WARNING

The UG-25+ is not equipped with an overspeed trip function. The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

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Engine Start Settings

IMPORTANT

All speed settings are in terms of engine speed and all position settings are in terms of percentage of full (42 degrees) shaft rotation. Speed values and adjustment increments are listed in terms of governor shaft speed with a Speed Ratio of 1.0, and will vary with the Speed Ratio setting.

Start Fuel Selection
Set to either one start fuel setting or 2 start fuel settings with a ramp between the settings. A single start fuel is suitable for most applications. With this configuration, the fuel demand immediately switches to the Start Fuel 1 setting when the engine speed has exceeded the Start1 Speed setting.

Dual start fuel configuration is appropriate for engines that need a rather high fuel setting to start the engine, but a much lower setting immediately thereafter to minimize speed overshoot, minimize black smoke, or to prevent an overspeed shutdown.

Start Speed 1 Threshold
Start Speed 1 Threshold is set below the starter speed. Once this threshold is exceeded, the control determines a start is in progress and opens the governor to the start fuel setting. At this point the governor state changes from ‘Stopped’ to ‘Start Fuel 1’. Typical value is 64 rpm (engine) to detect engine cranking. Allowed values: between 0 and ‘Stop Speed Threshold’ but must be less than ‘Start Speed 2 Threshold’ (if used). Adjustment Increment: 8 rpm (governor shaft).

Start Speed Hysteresis
Hysteresis is provided for the start speed threshold to ensure that a normal amount of variance in engine speed while in the Start Fuel State does not cause the control to enter the Stopping state. After the control has reached the Start Fuel state, it will go to the Stopping state if engine speed drops below the (Start Speed 1 Threshold – Start Speed Hysteresis) value.
Allowed values: 50% of 'Start Speed 1 Threshold' to 'Start Speed 1 Threshold'.
Adjustment Increment: 8 rpm (governor shaft).

Start Fuel 1
Specifies the maximum permitted shaft position when the governor state is 'Start Fuel 1'. Typical value is the same as the full load governor position.
Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Start Speed 2 Threshold
Specifies the speed at which the Governor State changes from 'Start1' to 'Start2.' Typical value is 50% of the lowest speed reference. Only displayed if two start fuel limits are configured.
Allowed values: Must be between 'Start Speed 1 Threshold' and the 'Stop Speed Threshold'. Adjustment Increment: 8 rpm (governor shaft).

Start Fuel 2
Specifies the maximum permitted shaft position when the governor state is 'Start Fuel 2'. Only displayed if two start fuel limits are configured.
Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Actuator Ramp Rate
Specifies the rate, in governor output shaft position %/second, the control will move the governor position from the Start Fuel 1 to the Start Fuel 2 position. If the ramp rate is set to its maximum value, the change to the second start fuel setting is nearly instantaneous, essentially eliminating the ramp feature. Only displayed if two start fuel limits are configured.
Allowed values: 0.235 – 200 %/second

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Stop Speed Threshold
Specifies the speed at which the Governor State changes from 'Stopping' to 'Stopped'. If the engine is stopped by a shutdown, the control will go to the Stopping state and the engine must stop before proceeding to any other state. If the engine is stopped by the Run Enable input, the control will again go to the Stopping state. In this case, however, if engine speed is still above the Stop Speed Threshold, making the Run Enable switch active again will allow the control to go directly back to the running state. Below the Stop Speed Threshold, the control will not allow a coast-down restart of the engine.
Allowed values: Must be greater the 'Start Speed Threshold' and less than 'Run Speed Threshold'. Adjustment Increment: 8 rpm (governor shaft).

Run Speed Threshold
Specifies the speed at which the Governor State changes from 'Start Fuel' to 'running.' Typical value is 90% of the lowest speed reference. If the engine speed is above the Run Speed Threshold, the control will switch to one of the running states and start using the speed control to drive the governor position demand up to the configured Start Target Speed setpoint.
Allowed values: Must be greater than 'Stop Speed Threshold' and less than 'Min Speed Setpoint'. Adjustment Increment: 8 rpm (governor shaft).

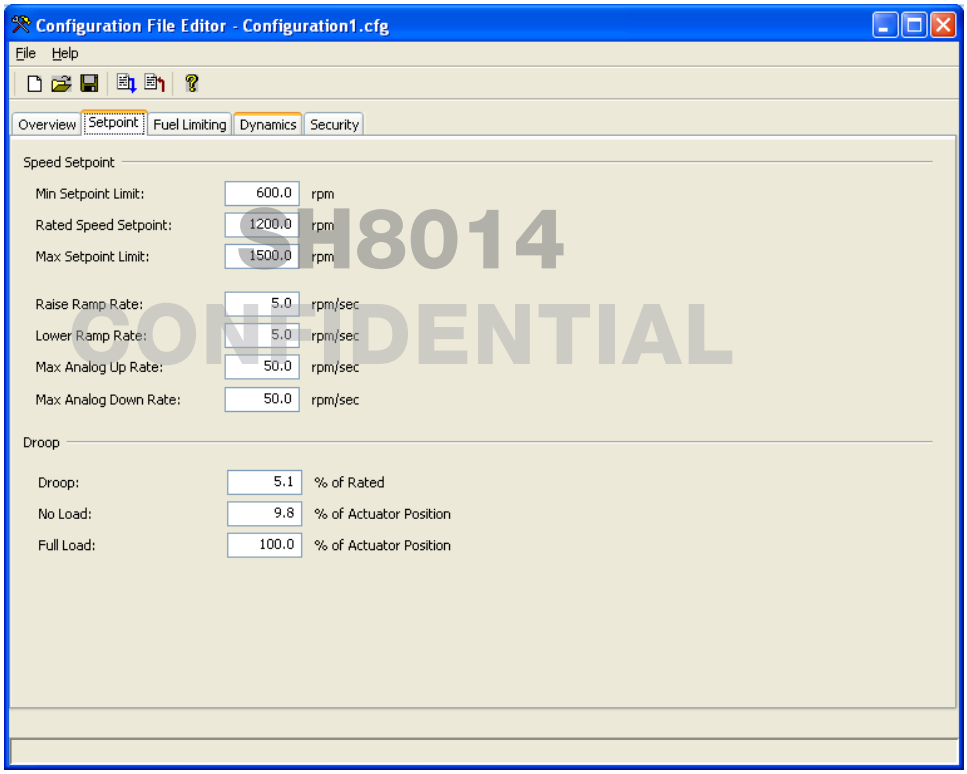
Start Target Speed Selection
Sets the desired speed setpoint at the conclusion of the start sequence. The 2 options are either Rated Speed or Min Speed Setpoint – both of these are set on the Setpoint tab.

Start Target Speed Rate
Specifies the ramping rate for the speed setpoint from Run Speed up to the specified Start Target Speed setpoint. Allowed values: 0.2 – 500 rpm/second (governor shaft).

Start Fuel 1 Delay Time
Sets the time delay at the start fuel 1 limit prior to ramping to the start fuel 2 limit. Only displayed if start fuel is configured as 'Two with time delay'. Allowed values: 0.1 – 429 seconds.

Setpoint Tab

The Setpoint tab provides the speed setpoint configuration settings.



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Figure 6-3. Configuration Editor—SETPOINT TAB

Min Setpoint Limit
Specifies the lowest desired speed setpoint possible that can be adjusted with the Raise/Lower Adjust or Analog functions. Allowed values: From 'Run Speed' to the 'Rated Speed Setpoint'.

Rated Speed Setpoint
Sets the Rated Speed Setpoint. Allowed values: From the 'Min Setpoint Limit' up to the 'Max Setpoint Limit'.

Max Setpoint Limit
Specifies the highest desired speed setpoint possible that can be adjusted with the Raise/Lower Adjust or Analog functions. Allowed values: From the 'Rated Speed Setpoint' up to 4080 rpm, but must be less than the factory set/installed pump speed limitation. Existing pump speed limits are 1700 and 1200 rpm (governor shaft), but are subject to change.

Raise Ramp Rate
Specifies the ramping rate for the speed setpoint Raise function. Allowed values: 0.2 – 500 rpm/second (governor shaft).

Lower Ramp Rate
Specifies the ramping rate for the speed setpoint Lower function. Allowed values: 0.2 – 500 rpm/second (governor shaft).

Max Analog Up Rate
Specifies the maximum rate allowed for the speed setpoint Analog adjust function in the increase direction. Allowed values: 0.2 – 500 rpm/second (governor shaft).

Max Analog Down Rate
Specifies the maximum rate allowed for the speed setpoint Analog adjust function in the decrease direction. Allowed values: 0.2 – 500 rpm/second (governor shaft).

IMPORTANT

It is recommended the Max Analog Rate settings be set to values that will prevent overshoot and possible overspeed on enabling of the Remote Input.

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Droop
Specifies the nominal droop as a percentage of the Rated Speed Setpoint value. Allowed values: 0 – 100 % of Rated.

No Load
Sets the no load shaft position for the droop function. Below this shaft position the droop is zero. Allowed values: 0 – 100 %.

Full Load
Sets the full load shaft position for the droop function. Allowed values: "No Load' setting to 100%.

⚠WARNING

The UG-25+ is not equipped with an overspeed trip function. The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

Fuel Limiting Tab

The fuel limiting tab provides run time and boost fuel limiting configuration settings.

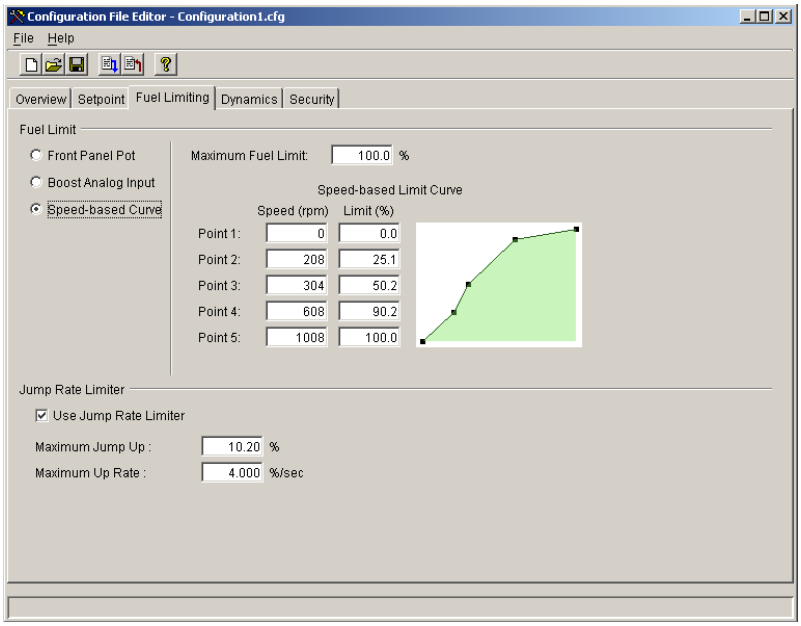


Figure 6-4. Configuration Editor– Fuel Limiting Tab

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Fuel Limiting Settings

Maximum Fuel Limit
Sets the maximum permitted shaft position. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Fuel Limit Input Selection
Selects between the Boost Input Curve (analog input) vs front panel Load Limit potentiometer. This selection must be done in conjunction with the wiring option to properly select the desired input (see Load Limit/Boost Pressure Select discrete input in the wiring section).

Boost Fuel Limiting Curve Settings
These settings are only displayed when the Fuel Limit Input selection is set to ‘Boost Analog Input’.

Boost (%)
Fuel limit curve inputs. Allowed values: 0 –100 % of full analog input range (4 mA is 0% and 20 mA is 100%). Each point [5] must be larger than the previous and less than the next value, in increments of 1.2%.

Limit (%)
Fuel Limit curve outputs. Sets the maximum governor positions [5] based on the boost analog input. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

Speed-based Curve Settings

These settings are displayed when the Fuel Limit selection is set to ‘Speed-based Curve’.

Speed (rpm)
Fuel Limit curve input breakpoints, in rpm. Allowed values: 0–4080 rpm. Each point [5] must be larger than the previous value and less than the next value, in increments of 16 rpm (governor shaft).

Limit (%)
Fuel Limit curve outputs, in percentage. Sets the maximum governor positions [5] based on engine speed. Allowed values: 0–100% of full 42 degree shaft rotation.

Jump Rate Limiter Settings

The Jump Rate Limiter can be used limit the increasing fuel position output to prevent excessive emissions.

Use Jump Rate Limiter
Enables or disables the jump rate limiter function. If used, “jump up” and “up rate” limit are available.

Max Jump Up
Specifies the ramping rate for the speed setpoint Raise function. These settings are only displayed when the ‘Use Jump Rate Limiter’ option is selected. Allowed values: 0 – 100 % of full 42 degree shaft rotation.

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Max Up Rate
Specifies the max governor output rate in the increasing direction. ramping rate for the speed setpoint Lower function. These settings are only displayed when the ‘Use Jump Rate Limiter’ option is selected. Allowed values: 0.235 – 200 %/second.

Dynamics Tab

The Dynamics tab provides speed controller dynamics settings. The dynamic settings can also be adjusted from the Edit Speed Dynamics screen during run-time.

See Chapter 7 (Speed PID Tuning) for a description of the terms used in the Dynamics tab.

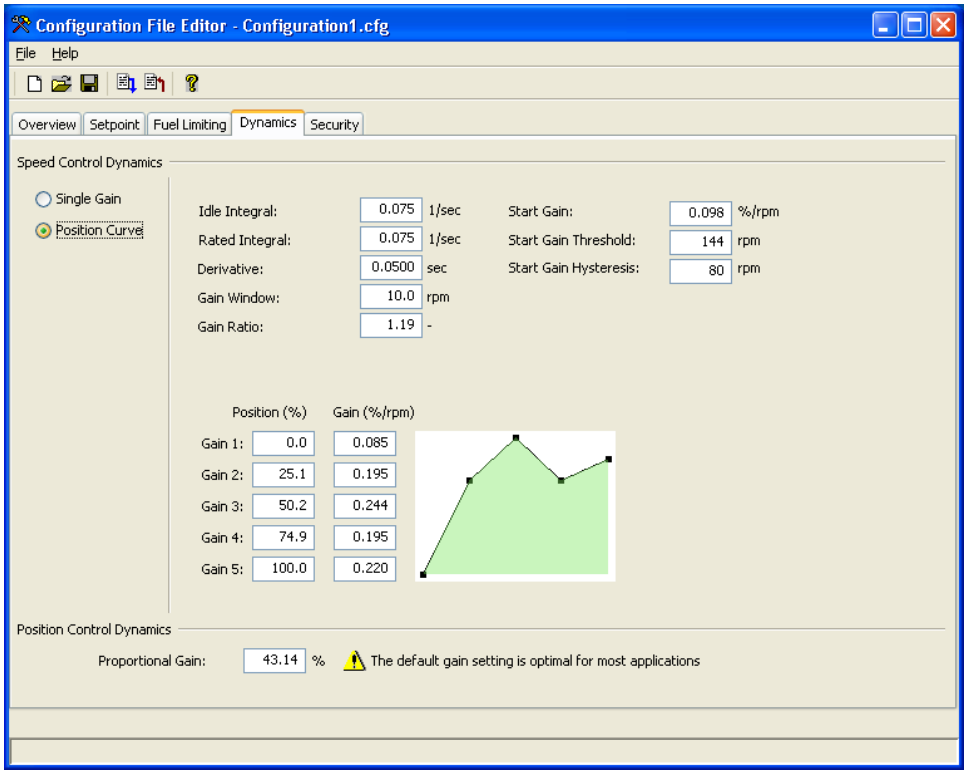


Figure 6-5. Configuration Editor–Dynamics Tab

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Speed Controller Dynamics Settings

Single Gain or Position Curve—selects the type of P-gain term used in the PID.

Single Gain is a single speed gain term which remains constant and does not vary with engine speed or load. These are simple dynamics that suit most constant speed applications. Rated dynamics are typically used on engines that operate continuously at rated speed or on variable speed engines that tend to be stable at all speeds with constant dynamic settings.

Position Curve adjusts the gain term based on governor output shaft position using a 5-pt curve. Fuel demand is roughly proportional to load but not necessarily in a linear manner. A 5-breakpoint gain curve is provided to map gain versus fuel demand. Gain is applied linearly between breakpoints. A common gain setting is also provided to shift all gain curve gains higher or lower. This gain curve is particularly useful for non-linear fuel systems (for example, intake butterfly valves).

Start Gain
Sets the gain to be used during a start. Typically this is set to a lower than normal gain value. The Start Gain Threshold and Hysteresis are used to select the Start Gain. Allowed values: 0 – 3.114 %/rpm.

Start Delay
Sets the number of seconds the Start Gain is used during a start. To disable the Start Gain, set the Timer to zero. Allowed values: 0 – 300 seconds.

Start Gain Threshold
Sets the speed threshold for the Start Gain, which is the speed controller gain used during a start. The Start Gain is active until the Start Gain Threshold is exceeded at which point it will use the configured gain (Rated or Rated Curve) based on the Single Gain or Position Curve selection. The Start Gain is re-activated if the speed drops below the Start Gain Threshold minus the Start Gain Hysteresis. Allowed values: 'Run Speed Threshold' (Overview tab) to 'Min Setpoint Limit' (Setpoint tab). Adjustment Increment: 8 rpm (governor shaft).

Start Gain Hysteresis
Sets the amount of hysteresis, in rpm below the Speed Threshold, before re-activating the Start Gain. Below this speed setting (Threshold – Hysteresis), the Start Gain is active. Allowed values: 0 to 'Start Gain Threshold'. Adjustment Increment: 8 rpm (governor shaft).

Idle Integral
Speed control nominal PID integral term at Idle (run speed threshold), in repeats per second. The integral gain value is interpolated between Idle and Rated based on the speed setpoint. In addition, the value is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. The actual 'used integral gain' can be viewed on the Overview tab of the Service Tool. Allowed values: 0 – 19.15 repeats/second.

Rated Integral
Speed control PID integral term at or above the configured Rated speed setpoint, in repeats per second. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 19.15 repeats/second.

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Derivative
Speed control PID derivative term in seconds. Allowed values: 0 – 0.1036 seconds.

Gain Window
Speed control PID gain window, in rpm. When the speed error is greater than the window, the proportional Gain is multiplied by the Gain Ratio. Allowed values: 0 – 255 rpm.

Gain Ratio
Speed control PID gain ratio. When the speed error is greater than the window, the proportional Gain is multiplied by the Gain Ratio. Allowed values: 1 – 15.

Proportional Gain
Speed control nominal PID proportional gain term. This setting is only displayed when 'Rated' dynamics mode is selected. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 3.114 %/rpm.

Position (%)
Position breakpoints for the gain curve. These settings are only displayed when 'Rated Curve' is selected. Allowed values: Each point [5] must be larger than the previous and less than the next value, in increments of 0.4%.

Gain (%/rpm)
Sets the nominal PID proportional gain value [5] based on the position. These settings are only displayed when 'Rated Curve' is selected. The actual 'used gain' is manipulated by the front panel Stability pot, and will be equal to the nominal setting when the pot is in mid position. Allowed values: 0 – 3.114 %/rpm.

Position Controller Dynamics – Proportional Gain (%)
Sets the Position Controller PID proportional gain value. Note that the default gain setting is optimal for must applications. Increased gain corresponds to increased PID output (higher proportional = faster response). This setting is not affected by the front panel Stability pot. Allowed values: 25.88 – 60 %.

Security Tab

The security tab provides the security configuration settings. To use any security, the Read Configuration security must be configured for use. Once selected, the Security Password must be set (Figure 6-7). One common password is used for all security selections (password is case-sensitive). The password entry is prompted (Figure 6-8) whenever a secured function is selected by the user.

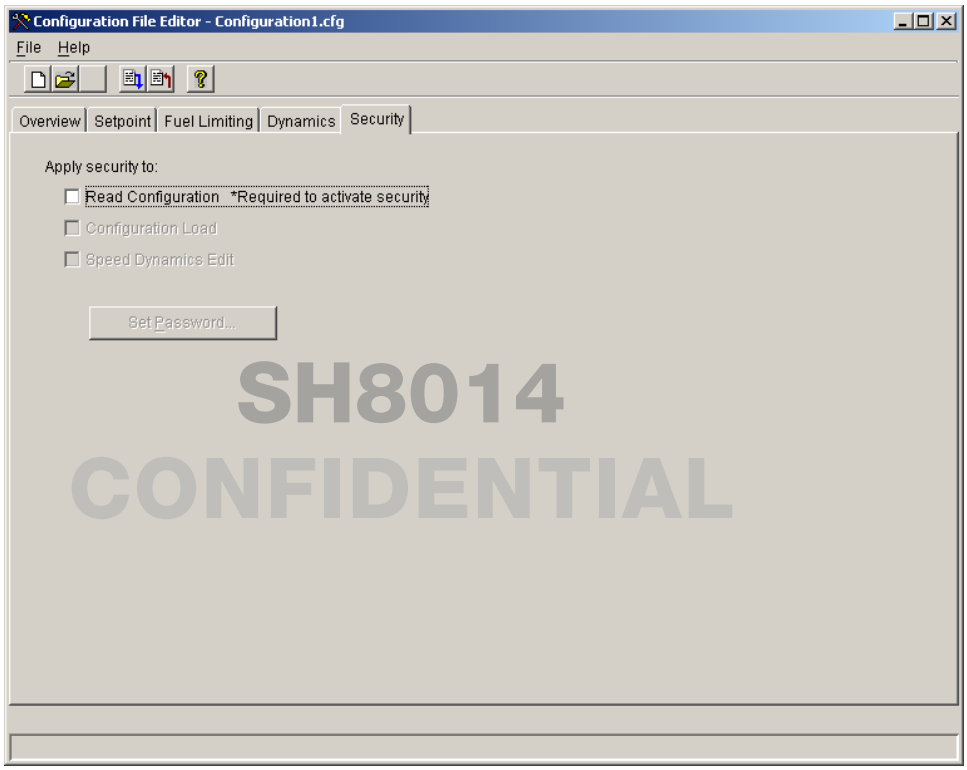


Figure 6-6. Configuration Editor– Security Tab

Security Configurations

All checked features will have the security password enforced prior to allowing the function. Unchecked features will not be prompted with a password.

Read Configuration
When checked, requires a password before the configuration can be read from the UG-25+ control (protects Open From Control execution).

Configuration Load
When checked, requires a password before a configuration can be loaded into the UG-25+ control (protects Load to Control execution).

Speed Dynamics Edit
When checked, requires a password before allowing tuning to the speed PID (protects Edit Speed Dynamics screen).

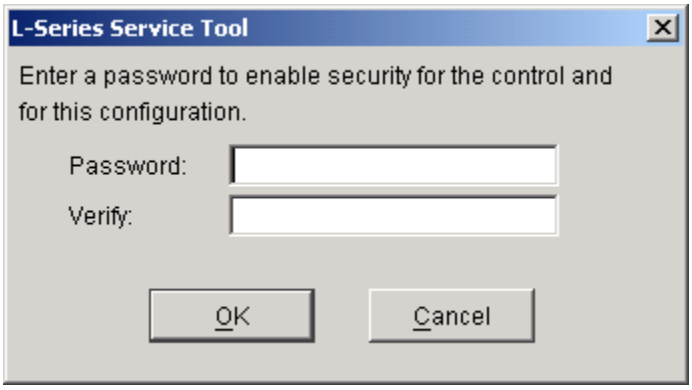
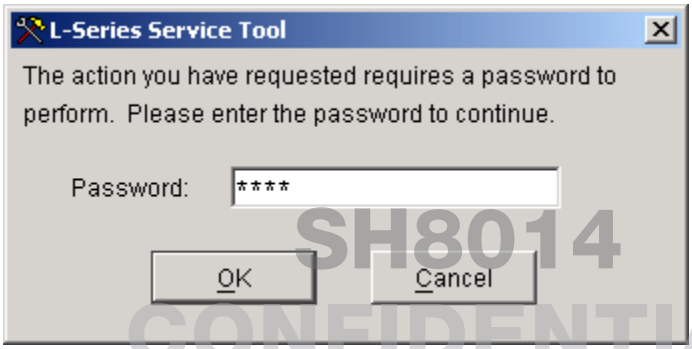


Figure 6-7. Security tab Set Password Pop-up

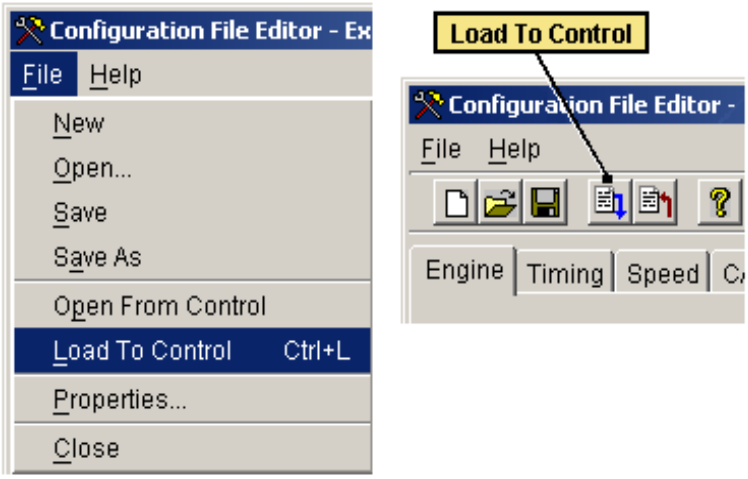


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Figure 6-8. Password Entry Prompt

Loading the Configuration (Save)

Select the File/'Load to Control' option from the menu or Blue Arrow icon on the Configuration Editor to load the changes into the control. The UG-25+ speed must be zero prior to allowing a 'Load' command. This feature can be optionally password protected.



Load Configuration File to Control

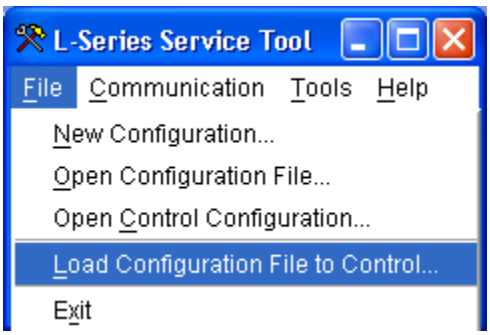


Figure 6-9. Direct Load of Configuration File

The 'Load Configuration File to Control' option under the Run screen File menu allows loading a configuration file to a control without opening it. Thus, a password protected configuration file can be downloaded without entering the password while preserving the configuration's security.

If you are downloading a configuration to a control that already contains a configuration with password protection enabled for configuration loads, you will need to use that password.

Configuration Checks

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Whenever a configuration is saved or loaded to the control, some basic checks are performed. This check cannot determine if the values are realistic, but it makes sure that values are loaded into the required parameters. If an error is found, the Service Tool will not allow the load or save function to be performed until the error is corrected.

1. **Speed range exceeds governor limits (Max Setpoint Limit setting)**. The setting for Max Setpoint Limit (on the Setpoint tab) must be less than the Max Pump Speed Limit or this Configuration Error message is displayed. Since the Pump Size is based on the installed UG-25+ pump size, this check is only done when a Load to Control is selected.
2. **Run Speed > Min Speed Setpt**. The setting for Run Speed Threshold (Overview tab) must be less than the Min Setpoint Limit (Setpoint tab) or this configuration error message is displayed.
3. **Speed sensing/filtering limits exceeded**. Try reducing the Number of Cylinders Averaged . This error message is displayed when the settings exceed control limits. The limit is determined by Service Tool calculations and based on the speed input settings of stroke, gear ratio, number of cylinders and number of cylinders averaged.
4. **Start Gain Threshold exceeds Rated Speed Setpt**. The setting for the Start Gain Threshold (Dynamics tab) must be less than the Rated Speed Setpoint (Setpoint tab) or this configuration error message is displayed.

Chapter 7.
Speed PID Tuning

Introduction

The UG-25+ is configured using the Service Tool, refer to Chapter 5 for Service Tool installation and connection instructions. This chapter covers the process of tuning and servicing the control via the UG-25+ Service Tool. It is assumed that the control has already been installed on the engine.

An application requires the following setup steps. In many applications these steps have already been performed by the OEM.

Configure the UG-25+ control (configuration is covered in Chapter 6).
Tune the Speed controller loop PID for each application.

In addition, jump and rate limit settings and the position controller proportional gain term can be adjusted to meet application requirements.

IMPORTANT **Setup and tuning features can be individually password protected for security purposes. If security is applied, these features will not be accessible without the password.**

IMPORTANT **Many applications are delivered pre-configured, calibrated, and tuned. For most applications, the default gains do not need to be changed.**

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⚠WARNING **An unsafe condition could occur with improper use of these software tools. Only trained personnel should have access to these tools.**

NOTICE **When the Service Tool programming harness is connected, the speed setpoint (raise/lower/analog) and load limit functions are no longer available. However, simulation of these functions is provided in the Service Tool software.**

The Service Tool can be used to tune the Speed PID or to just trend/monitor the speed PID output. The Speed PID Dynamics screen (Figure 7-1a & b) is opened by selecting ‘Edit Speed Dynamics’ under the ‘Tools’ menu (Figure 5-1).

Pressing the Properties button pops open the Properties Window. From this window the user can adjust the trending window properties including the speed range, update rate and display range.

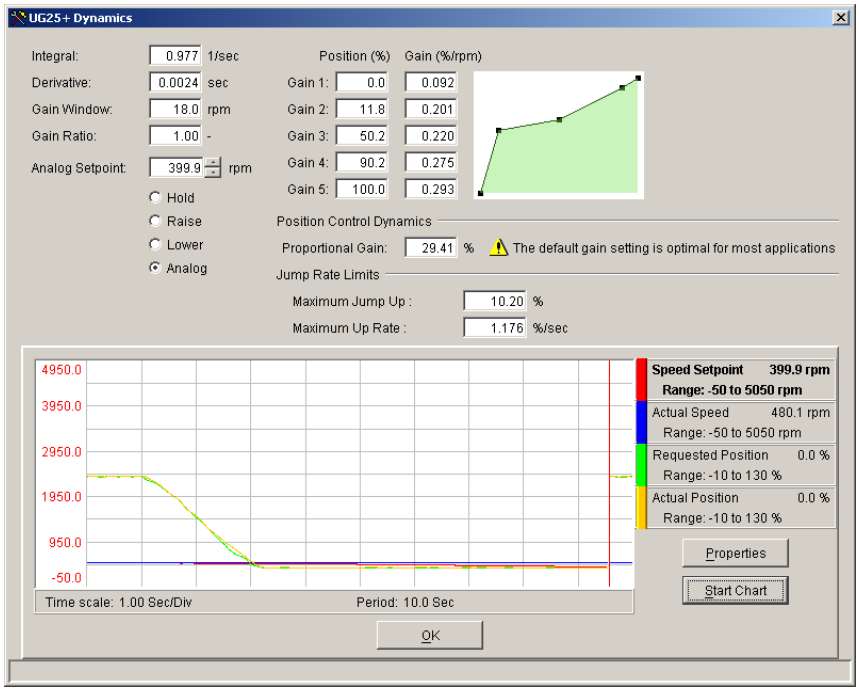


Figure 7-1a. Service Tool – Speed Dynamics Position Curve

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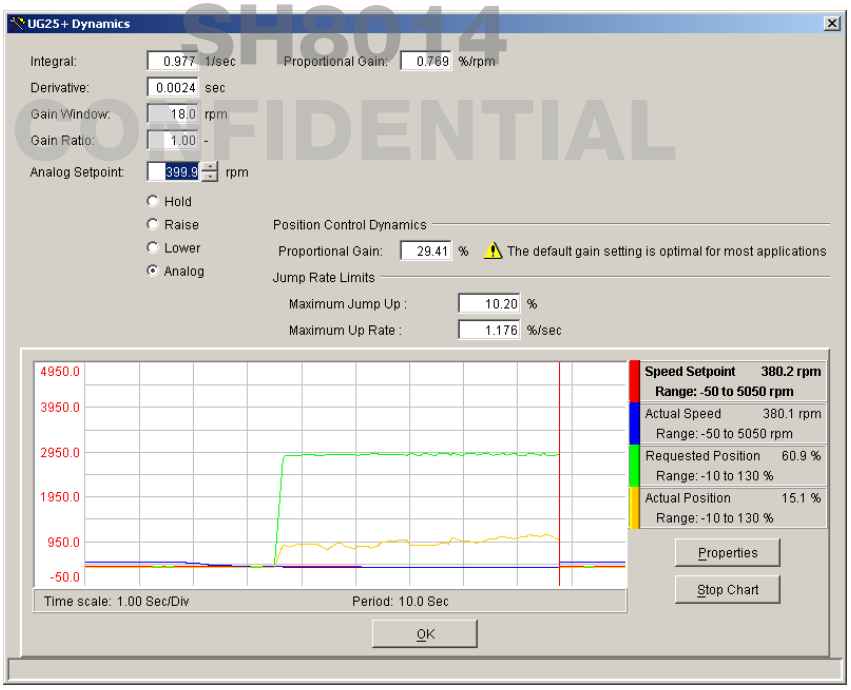


Figure 7-1b. Service Tool – Speed Dynamics Single Gain

IMPORTANT **If the dynamics curve inputs (position values) are changed, the values are not applied until the OK button is selected.**

Adjusting Trend Settings

Pressing the Properties button pops open the Properties Window (Figure 7-2). From this window the user can adjust the trending window properties including the update rate and display range.

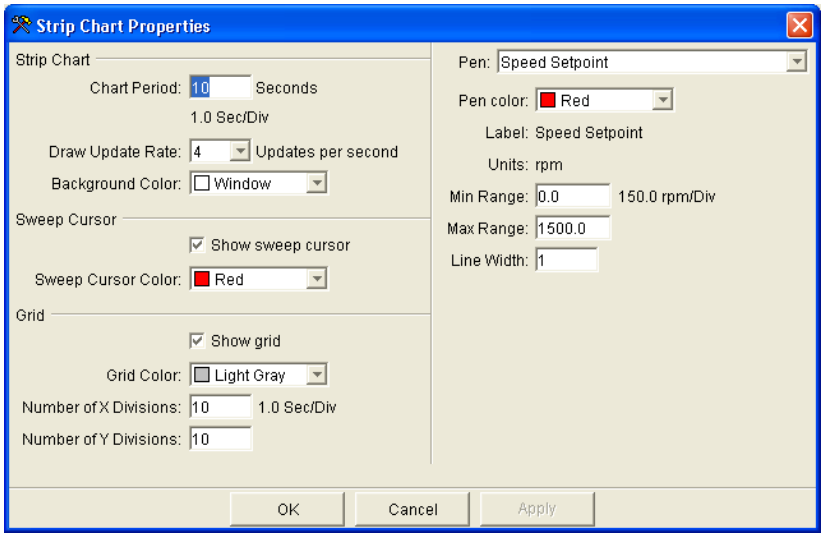


Figure 7-2. Service Tool – PID Tuning Properties Window

Each trend line, called pens, can be individually modified from the Properties window. To change the properties of a trend, select the pen from the drop-down window. The color, range, and line width of each pen can be modified.

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Speed PID Dynamic Settings

The Speed loop utilizes a PID controller. The response of this control loop can be adjusted for optimum response, however it is important to understand what a PID controller is and the effect each controller adjustment has on the controller response. Proportional gain (P), integral gain (I), and derivative (D) are the adjustable and interacting parameters used to match the response of the control loop with the response of the system.

Proportional Control

Proportional response is directly proportional to a process change.
Analogy: Setting the throttle on an automobile to keep constant speed on a straight and level road.
Proportional control (using the same analogy) results in a certain speed as long as the automobile is not subjected to any load change such as a hill. If a throttle is set to any particular setting, the speed of the automobile will remain constant as long as the automobile remains on a straight and level road. If the automobile goes up a hill, it will slow down. Of course, going down a hill the automobile would gain speed.

Integral Control

Integral compensates for process and setpoint load changes.
Analogy: An automobile's cruise control maintains the automobile's constant speed regardless of hills.
Integral, sometimes called reset, provides additional action to the original proportional response as long as the process variable remains away from the setpoint. Integral is a function of the magnitude and duration of the deviation. In this analogy the reset response would keep the automobile's speed constant regardless of the terrain.

Derivative

Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).
Analogy: Accelerating an automobile into the high speed lane with merging traffic.
Derivative, sometimes called "preact" or "rate", is very difficult to draw an accurate analogy to, because the action takes place only when the process changes and is directly related to the speed at which the process changes. Merging into high speed traffic on a highway from an "on" ramp is no easy task and requires accelerated correction (temporary overcorrection) in both increasing and decreasing directions. The application of brakes to fall behind the automobile in the first continuous lane or passing gear to get ahead of the automobile in the first continuous lane is derivative action.

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Proportional Response

The amount of controller change is directly related to the process change and the Proportional gain setting on the controller; Controller output change is Proportional to the process change. If there is no process change, there is no change in output from the controller (or valve change) regardless of the deviation. This results in an undesired offset between the original desired Setpoint and the resulting drop in the Control Point.

Figure 7-3 shows the effect of Proportional gain settings on control. Starting at the top of the graph a load change is introduced. With a small Proportional gain (meaning a large process change is required to produce full valve travel), stability is good but offset is very high. With a moderate gain setting (higher number setting) stability is still good - offset is still fairly high. With a high setting, offset is considerably smaller but the stability is poor. The 0.25 ratio effects a minimum area whereby the offset is reduced to a minimum while stability is in a decaying manner at 0.25% ratio. The decay ratio used (0.25%) means that if the second cycle is 1/4 of the first cycle, then each succeeding cycle will be 1/4 of the preceding cycle until the cycle is not visible.

Since Proportional gain is adjusted to produce (only) the proper stability of a process, do not continue increasing its effect to correct offset conditions. The amount of stability and offset is directly related to the setting of the Proportional setting. Stability is of course also affected by the stability of the process. In essence, the amount of output from the controller due to the Proportional setting is from the error. If there is no error, then there is no Proportional effect.

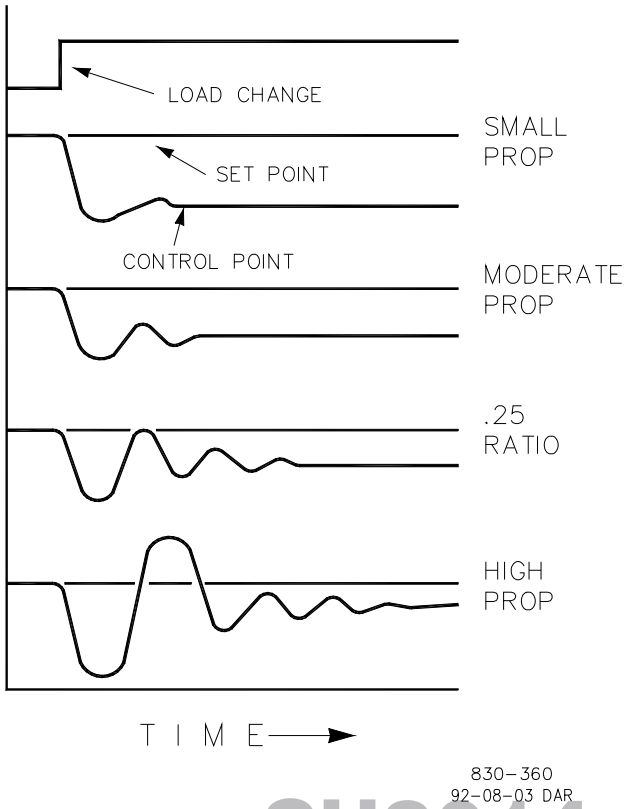


Figure 7-3. Proportional Gain Setting Effects

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Integral Response

In the UG-25+, integral gain is in units of repeats per second (or Reset Rate). Therefore, a high amount of Integral gain (high number) would result in a large amount of Reset action. Conversely, a low Integral gain (low number) would result in a slower reset action.

Integral response is provided to eliminate the offset that resulted from straight Proportional control. Figure 7-4 shows how the controller action is Proportional to the measurement change, but this results in offset. The Integral (or Reset) action is a function of both time and magnitude of the deviation. As long as an offset condition (due to load changes) exists, Integral action is taking place.

The amount of Integral action is a function of four things:
1. The magnitude of the deviation.
2. The duration of the deviation.
3. The Proportional gain setting.
4. The Integral setting.

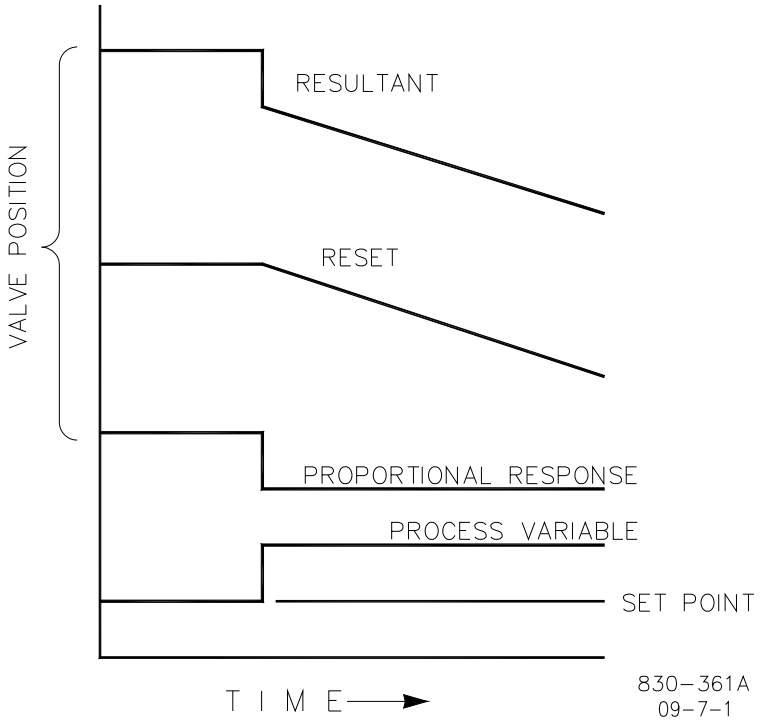


Figure 7-4. Open Loop Proportional and Integral Response

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In this Open Loop figure (Figure 7-4), the Integral response is shown increasing due to the offset condition existing between the process variable (like speed) and the setpoint. The resultant action is the top curve showing the step Proportional response that ends as soon as the measurement stops changing. Then the Integral (or reset) action is added to the Proportional action in an amount equal to the Integral of the deviation. In other words, Reset action continues (in either or both directions) as long as there is a difference (deviation) between the setpoint and the process measurement. In this case, the deviation will never be eliminated (or even reduced) because the system is in Open Loop.

Figure 7-5 shows the closed loop effects of integral action. The bottom curve displays the load change. The next curve up shows the setpoint and the measured process variable. With the load change, the process variable (like speed) droops or deviates from the setpoint. The next highest curve is the Proportional action and follows the measured variable proportionately. The Integral curve adds to the Proportional curve resulting in a different output position, thereby returning the process to the Setpoint.

In Closed Loop, however (as opposed to Open Loop), as the measurement decays toward the Setpoint the Proportional action is taking place Proportionally to the measurement change, and the Integral action is decaying proportionately to the magnitude and duration of the deviation until the measurement reaches the setpoint at which time the Integral action is zero.

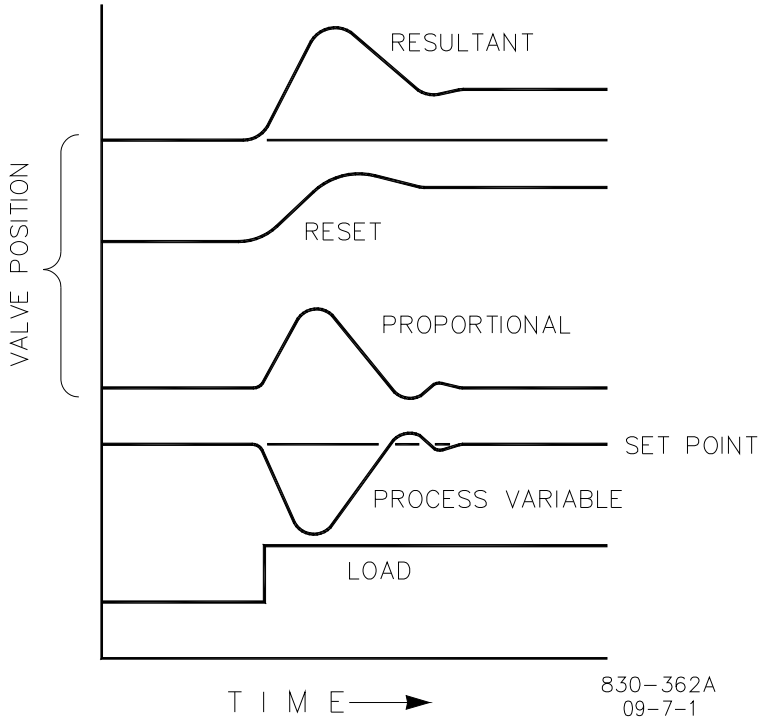


Figure 7-5. Closed Loop Proportional and Integral Response

Figure 7-6 shows the effect of fast or slow Integral action. For a given load change an offset results with Proportional response only. Since recovery time (for a given load change) is important, the Integral setting should remove the offset in a minimum time without adding additional cycling. Ideally, the process should not continue to cycle after the setpoint has been reached as in the second curve from the bottom.

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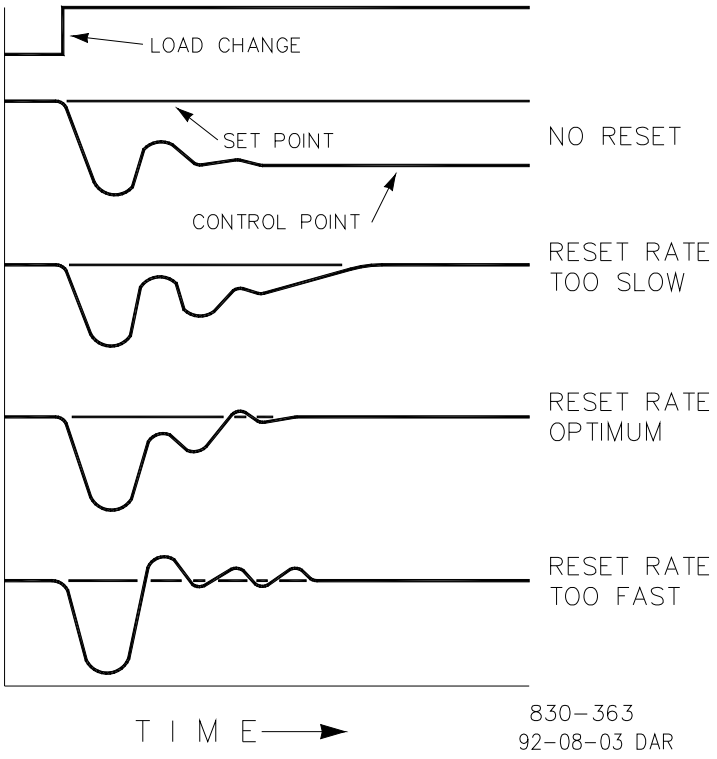


Figure 7-6. Integral Gain (Reset) Setting Responses

Derivative Response

In a process control loop the Derivative action is directly related to how fast the process changes (rate of change). If the process change is slow then the Derivative action is proportional to that rate of change. Derivative acts by advancing the Proportional action. Derivative acts at the start of the process change, when the process changes its rate and when the process stops its change.

Derivative action takes place at only three times:

1. When the process starts to change.
2. When the rate of change takes place in the process.
3. When the process stops changing.

The net result of Derivative action is to oppose any process change and combined with Proportional action to reduce stabilization time in returning the process to the setpoint after an upset. Derivative will not remove offset.

Figure 7-7 shows how Derivative acts to oppose a change in process in either direction. The dashed line shows the Derivative action going through zero to oppose the process deviation traveling toward zero. Notice offset still exists between the desired setpoint and the drooped control point that resulted from the load change. The top curve is the resultant controller output, Proportional plus Derivative. If an upset (momentary) had occurred rather than a load change, there would be no offset.

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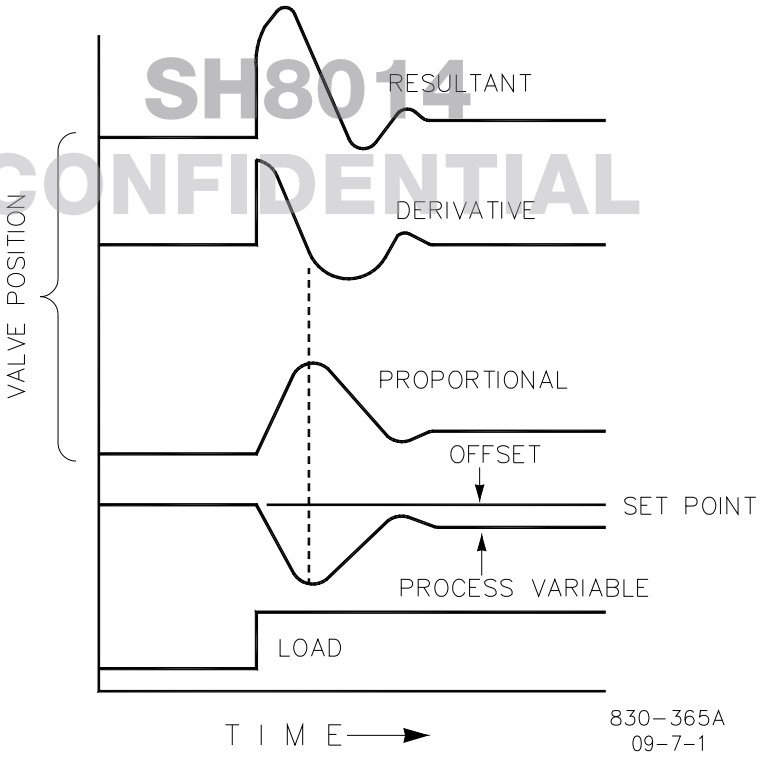


Figure 7-7. Closed Loop Proportional and Derivative Action

Figure 7-8 shows the effect of different Derivative settings. The curves are relative since it depends on what type of control is desired in order to properly adjust Derivative time. In all the above curves, the offset still exists since offset can only be eliminated by the addition of Integral (or Reset).

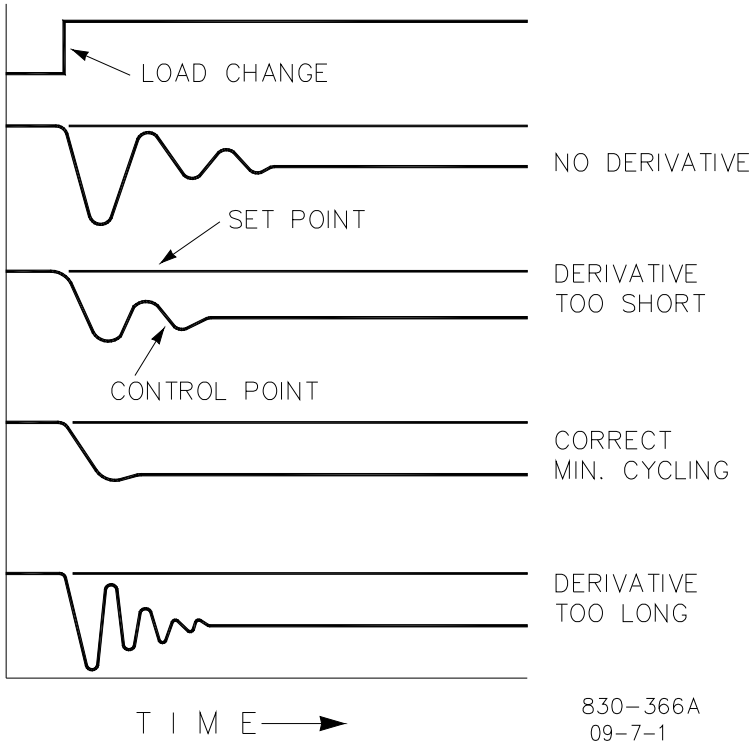


Figure 7-8. Derivative Setting Effects

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Figure 7-9 shows the relationship of output position to the interaction of the PID modes of control whenever a load change takes place in closed loop. As the process variable drops due to the load change, the proportional action moves the control valve proportionately to the measurement (process variable) change. The integral gain/reset adds to the proportional action as a result of the magnitude and time (duration) of the deviation. And the derivative temporarily over-corrects based on the speed at which the measurement moves in any direction. The resultant curve (at the top) shows a similar over-correction (in this case), but in addition the valve will stay at the new position required to keep the measurement at the setpoint.

Derivative provides a temporary over-correction to compensate for long transfer lags and reduce stabilization time on process upsets (momentary disturbances).

Another possible use of the derivative adjustment is to reconfigure the controller from a PID to a PI controller. This is done by adjusting the derivative term to zero.

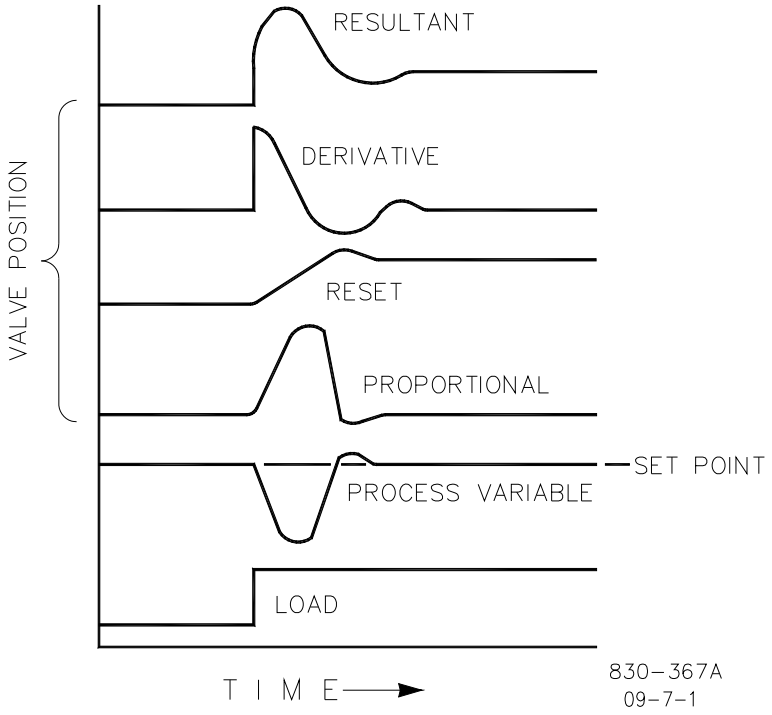


Figure 7-9. Closed Loop Proportional, Integral and Derivative Action

General Field Tuning Guidelines

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Best results are obtained when the adjustment (tuning) is done systematically. Prior training and experience in controller tuning are desirable for effective application of this procedure. The settings made for one operating set of conditions may result in excessive cycling or highly damped response at some other operating condition. The tuning procedure should be applied under the most difficult operating conditions to assure conservative settings over the normal operating range. The UG-25+ can be configured for a 5-point position curve, providing greater flexibility in dynamics settings over this range.

It is good practice to keep the average of the setpoint changes near the normal setpoint of the process to avoid excessive departure from normal operating level. After each setpoint change, allow sufficient time to observe the effect of the last adjustment. It is wise to wait until approximately 90% of the change has been completed.

Speed Setpoint Adjustments

While the Service Tool is connected, all normal means of adjusting the Speed Setpoint (raise/lower, analog) are still enabled. The Speed Setpoint can also be adjusted from the Speed PID tuning screen (Figure 7-1) or from the Simulated IO tab (Figure 7-10).

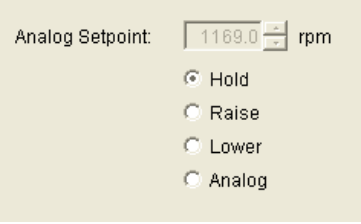


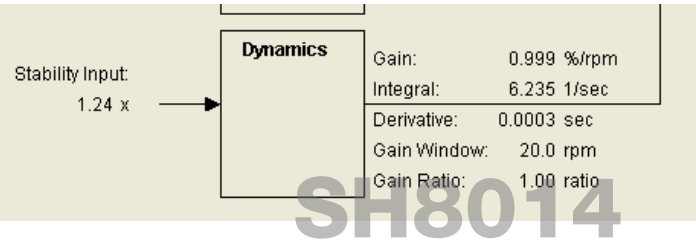
Figure 7-10. Speed Setpoint Adjustment

The default setpoint mode is 'Hold', which maintains a constant setpoint. When 'Raise' or "Lower' is selected, the speed setpoint will increase at the Raise Ramp Rate or Lower Ramp Rate, respectively. When 'Analog' is selected, the setpoint moves to the selected Analog Setpoint at the Max Analog Rate. The analog setpoint tracks the speed setpoint to ensure bumpless mode transfers. All adjustments are limited between the normal operating range (Min Setpoint Limit to Max Setpoint Limit). Refer to the Speed Setpoint settings in Chapter 6- Configuration.

Front-panel Stability Pot

The front panel stability pot is active at all times and provides a multiplier on the Gain (P) and Integral (I) settings. When the pot is a mid-position, the multiplier is '1' and the gains will be at their nominal configured values (see Dynamics in Chapter 6).

The Overview tab of the Service Tool provides a display of the actual "used" values of the controller (see Figure 7-11). The displayed values take into account the Stability pot input and provides an indication of the gain curve value, when configured.



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Figure 7-11. Actual PID Dynamics on Overview Tab

If System is Unstable

If the system is unstable, make sure the speed PID dynamics is the cause. This can be checked by reducing the load limiter until it has control of the governor output. If the governor is causing the oscillation, time the oscillation cycle time. A rule-of-thumb is, if the system's oscillation cycle time is less than 1 second reduce the Proportional gain term. A rule-of-thumb is, if the system's oscillation cycle time is greater the 1 second reduce the Integral gain term (proportional gain may need to be increased also).

On an initial startup with the UG-25+, all PID dynamic gain terms will require adjustment to match the PID response to that of the control loop.

The proportional gain setting of the position controller is also available for adjustment on the dynamics tuning window. Reducing this gain will lower the overall control bandwidth. Lowering this gain term in some systems can reduce the nervousness of the output shaft. The nominal gains settings are optimal for most applications but if the speed controller dynamic adjustments do not achieve the desired results, modifying this setting may help.

Chapter 8. Troubleshooting

Introduction

This chapter presents several broad categories of application failures typically experienced in the field, possible causes, and some tests used to verify the causes. The exact failure experienced in the field is the product of the mechanical/electrical failure combined with the configuration file resident in the control. Ideally, the troubleshooting chart contains information about mechanical, electrical, engine, and load failures in addition to the possible governor failures.

The troubleshooting scenarios listed below assume that the user has a digital multimeter for testing voltages and checking continuity, and assume that the application has been engineered and tested thoroughly.

There are four parts to the troubleshooting section:

- General Troubleshooting
- Engine/Generator Troubleshooting
- Troubleshooting Shutdown Diagnostic Flags
- Input/Output (I/O)Troubleshooting

⚠WARNING

The actions described in this troubleshooting section are not always appropriate in every situation. Always make sure that any action taken will not result in loss of equipment, personal injury, or loss of life.

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⚠WARNING

The UG-25+ is not equipped with an overspeed trip function. The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

The UG-25+ is used on prime movers that typically have a high noise level. Always use appropriate hearing protection while working around the UG-25+.

⚠WARNING

The UG-25+ wiring must be in accordance with North American Class I, Division 2 or Zone 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

General System Troubleshooting Guide

The following is a general troubleshooting guide for areas to check which may present potential difficulties. Make these checks before contacting Woodward for technical assistance.

- Valves
- Is the wiring correct?
- Is the shaft direction correct?
- Is the direction of the stroke correct?
- Is the direction of the failsafe shutdown correct?
- Does the output shaft move through its proper stroke smoothly?
- Does the output travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the output fully seat (close)?
- Does the output fully open?

Oil

Keep the governor oil level to the mark on the oil sight glass with the unit operating. Dirty oil causes governor problems. Use clean, new, or filtered oil. Oil containers used must be perfectly clean. Oil contaminated with water breaks down rapidly, causing foaming, and corrodes internal governor parts.

Preliminary Inspection

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Governor problems are usually revealed in speed variations of the prime mover, but it does not necessarily follow that such variations are caused by the governor. When improper speed variations appear, the following procedure should be performed:

1. Check the load to be sure the speed changes are not the result of load changes beyond the capacity of the prime mover.

2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.

3. Check the linkage between the governor and fuel racks or valve. There must be no binding or lost motion.

4. Check that the oil is clean and oil level is correct at operating temperature. The source of most problems in any hydraulic governor stems from dirty oil. Grit and other impurities can be introduced into the governor with the oil, or form when the oil begins to break down (oxidize) or becomes sludgy.

   The internal moving parts are continually lubricated by the oil within the unit. Valves, pistons, and plungers will stick and even “freeze” in their bores, due to grit and impurities in the oil.

   If this is the case, erratic operation and poor response can be corrected (if wear is not excessive) by flushing the unit with fuel oil or kerosene.

   The use of commercial solvents is not recommended as they may damage seals or gaskets.

Change the oil and flush the governor twice a year if possible.

To change oil, remove the drain plug and drain out the old oil. Flush the governor by filling it with fuel oil, and with the prime mover running at low speed, cycle the governor by increasing the Stability knob setting on the user interface until the governor hunts. Let the governor hunt for a minute or two, then stop the engine and drain the governor. Flush the governor once again. Refill the governor with oil (see Chapter 2, Oil Supply).

Restart the engine and reset the Stability knob.

5. Check that the drive to the governor is correctly aligned and free of roughness, side loading, and excessive backlash.

Engine/Generator Troubleshooting

Problem	Possible Cause	Suggested Test/Correction
Engine hunts or surges	The problem may be originating in the governor or prime mover.	Block the throttle, fuel racks, or steam valve in the direction of increase fuel. (Never block the governor output shaft in the direction that would prevent a complete shutdown.) The same blocking action can be performed by using the load limit knob on the governor panel. **⚠WARNING** **The UG-25+ is not equipped with an overspeed trip function. The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.** **The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.** If hunting and/or surging continues while the governor output shaft is blocked, the problem is in the prime mover. If, after removing the block, hunting and/or surging starts again, the problem can be in the governor or in the prime mover. Go through the dynamics adjustment procedure for the governor (see Chapter 7). If the problem is still there, replace the governor with a replacement governor. Go through the dynamics adjustment procedure for the replacement governor. If the hunting and/or surging continues, the problem is in the prime mover.
	Controller gain adjustments incorrect.	Adjust the gain settings using the Service Tool (see Chapter 7).
	Oil varnish, which causes sticking of parts.	Add oil to the mark on oil sight glass. If oil level decreases and no external oil leaks can be seen on the governor, check the drive shaft for oil leak. If foaming continues, drain oil and refill using a non-detergent type oil. See Woodward manual 25071, Oils for Hydraulic Controls.

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Problem	Possible Cause	Suggested Test/Correction
Engine hunts or surges (continued)	Dirty oil (sludge) in governor.	Drain oil, clean governor, and refill.
	Lost motion in engine linkage or fuel pumps.	Repair linkage and/or pumps.
	Binding in engine-to-governor linkage or fuel pumps.	Repair and realign linkage and/or pumps.
	Governor output shaft travel too short to provide full fuel.	Adjust travel until proper travel is obtained.
	Low oil pressure.	Return governor for repair.
	Fuel linkage incorrectly set. This might occur if the governor has been changed or removed and replaced. Relationship of governor travel to power output of engine should be linear.	Rework or reset the linkage from governor to unit to obtain the linear relationship.
	Faulty linkage.	Linkage should be free of binding and lost motion throughout service life of unit. Check yield links, shutdown arrangements, etc, to be sure that prime mover power changes for very small increments of governor output shaft travel. Stability and good steady-state performance will suffer unless this condition is met.
	Incorrect non-linear relationship between governor travel and power output of the prime mover. Engine may hunt with light loads and be stable with a heavy load.	Adjust linkage from governor to gas valve to obtain linear relationship between governor travel and engine output. See Figures 2-3 and 2-4. Also, see application note 50516.
	Gas or steam pressure too high.	Adjust gas or steam pressure.
	Engine misfiring (bad fuel injector or low pilot fuel on dual fuel engine).	Check pyrometer readings of each cylinder and make necessary repairs or adjustments.
	Governor dynamics/stability issue.	See Engine Unstable section below.
	Governor worn.	Return governor for repair.
Jiggle at governor output shaft	Rough engine drive or governor drive.	Inspect drive mechanism. a. Check alignment of gears. b. Inspect for rough gear teeth, eccentric gears, or excessive backlash in gear train. c. Check gear keys and nuts or set screws holding drive gears to shafts. d. Check for bent drive shaft. e. Check serrated or spline coupling for wear and alignment. f. Tighten chain between crankshaft and camshaft (if used). g. Check engine vibration damper (if used).
	Governor is not aligned properly.	Loosen governor mounting screws and move the governor slightly on its mounting pad to align the drive shaft with its coupling.
	Governor dynamics/stability issue.	See Engine Unstable section below.
Engine does not start	Stuck throttle/frozen shaft	Move throttle by hand. Assess smoothness, friction, and return spring force.
	Power not applied to control	Test for +18 to 32 Vdc between input power pin and ground pin.
	No configuration or incorrect configuration in controller.	Using Service Tool, read configuration from controller and evaluate parameters for correction.
	Fault detected in controller.	Using Service Tool, read faults from controller. Verify/correct any shutdown conditions (see fault troubleshooting below).

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Problem	Possible Cause	Suggested Test/Correction
The governor is not opening the fuel control valve during engine cranking.	The control has detected a shutdown situation and has not been reset.	Reset the control by cycling power to the control or hitting reset on the Service Tool, (see fault troubleshooting below). Verify Remote Stop input is open.
	There is no power supplied to the control.	Check fuse, wiring, and battery voltage.
	The control does not read any speed. Speed sensor defect or wiring defect.	Read speed on the Service Tool to verify the governor detected speed. If incorrect, check speed input configuration settings.
	The control reads an actual engine speed below the start speed threshold.	Start speed is set too high. Lower start speed threshold.
	The Start Fuel 1 and or 2 setup is incorrectly set to zero position or set to a value too low.	Set up the Start Fuel to the correct value for this engine.
	Load limit pot not working.	Attempt to start with the Service Tool / harness connected, this bypasses the Load Limit pot. Check voltage at L-Series pin 6 and verify voltage changes with pot position.
	Load limit analog input fault.	Verify that boost input selector wire is connected to ground. Check voltage at L-Series pin 6 and verify voltage changes with analog input. Verify Load Limit configuration settings.
The engine will not go to rated speed.	The Control is not configured for Ramp To Rated operation.	Configure the Control for Ramp To Rated (operation if that is the correct operation mode.
	Droop pot not working.	Check voltage at L-Series pin 10 and verify voltage changes with pot position.
	Wiring fault in analog speed setpoint.	Verify analog speed setting input is selected and wired correctly.
The engine will not raise the speed setpoint.	Analog setpoint mode is active.	Check Raise/Lower Enabled LED on Front Panel. Raise and lower commands are not functional when Analog mode is active.
	The Raise input wiring is defective.	See Service Tool overview screen for input open/closed status. Check wiring.
The engine will not lower the speed setpoint.	Analog setpoint mode is active.	Check Raise/Lower Enabled LED on Front Panel. Raise and lower commands are not functional when Analog mode is active.
	The Lower input wiring is defective.	See Service Tool overview screen for input open/closed status. Check wiring.

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Problem	Possible Cause	Suggested Test/Correction
Engine unstable	Improperly tuned dynamics.	Using Service Tool, tune the speed dynamics. Turn the front panel Stability pot in the CCW direction to reduce the gains.
	If analog mode is active, device sending analog command is sending oscillating signal.	Measure input signals.
	Stability pot fault.	Check voltage at L-Series pin 8 and verify voltage changes with pot position.
	If analog mode is active, device sending analog command is sending oscillating signal.	Measure input signal. Verify signal using Service Tool.
Poor frequency control	Improperly tuned dynamics.	Using Service Tool, tune the dynamics. Turn the front panel Stability pot in the CW direction to increase the gains.
	Output speed not at setpoint.	Verify that linkage is free. Verify that load limit is not active.
Unable to develop full power	Non-indexed linkage slipped on shaft.	Manually verify full travel of throttle plate.
	Fault detected in controller.	Using Service Tool, view status of fault codes. Take appropriate action for active faults.
Unit Healthy LED is off	No power. Controller fault. Overtemperature or internal temperature sensor failure.	Verify supply voltage. Using Service Tool, verify detected faults. Using Service Tool, verify internal temperature. Verify faults.
Discrete output not working	Wiring fault. Internal governor fault.	Check the wiring leading to Terminal 11 for open connections or misconnections. Verify that Terminal 11 is not connected directly to input power or ground. Verify Unit Healthy Status LED functionality. Both Discrete out and LED are driven from the same controller terminal and should activate together (L-Series Terminal B on TB5-2). Verify on/off command signal to discrete out using Service Tool (overview tab).
Service Tool not communicating–'Not Connected' status indicated	Wiring fault. The Service tool is disconnected. The wrong communication port has been selected.	Check programming harness and serial cable for loose or mis-connected connections. Check fuse, wiring, and battery voltage. Verify harness setup and connections (see Chapter 4). Check that Service Tool is running. Verify the port setting is correct. Connect the service tool by using the connect menu.
Service Tool not communicating–'Error message displayed on PC when trying to connect	Old version of Service Tool or file corruption or bad install.	Re-install Service Tool, get the latest version from the Woodward web site (www.woodward.com).

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Problem	Possible Cause	Suggested Test/Correction
Service Tool will not accept password	Caps Lock is on.	Password is case sensitive, make sure you enter the password correctly using upper and lower case. If password is lost contact the OEM for retrieval.

Troubleshooting Shutdown Faults

Error Flag	Description	Possible Source	Possible Action
Stop- Zero Speed Detected	Indicates speed sensor input pulses have not been detected.	Engine stopped.	Verify engine was stopped by some external source or command.
		Damaged, loss of speed probe or wiring. Damaged or loss connector.	Fix wiring. Return to replace connector or speed probe.
		Speed input incorrectly configured.	Check speed input and speed ratio configuration settings using the service tool.
Stop - Stop Input Command	A shutdown (stop) command is issued.	Stop command is still active.	Verify Stop input status using Service Tool. Check wiring for bad or loss connection.
		Defective Front Panel interface or stuck Stop button.	Check Stop button. Check wiring for bad or loss connection.
		Speed did not go to zero.	A Stop command is latched-in until speed reaches zero.
Internal Shutdown	All internal shutdowns will set this flag.	The Control is defective.	Return unit for repair.
Shutdown - Temperature Sensor Failed	This error is set if the temperature inside the control is higher or lower than allowed by the specifications.	Control has been placed in an environment that is too hot or too cold.	Lower temperature by adding cooling, heat shielding, moving the unit, etc.
		The internal temperature sensor is defective. This can be determined by checking the temperature of the unit and comparing this to the service tool value of the electronics temperature.	Increase temperature, if low, by adding heat. Verify Control detected temperature reading using Service Tool. Return unit for repair.
Shutdown – Over Temperature	High internal temperature.	Detection of high temperature.	Check ambient temperature around control. Verify Control detected temperature reading using Service Tool. If the temperatures seem normal, could indicate a problem with the internal temperature sensor.

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Error Flag	Description	Possible Source	Possible Action
Shutdown - Voltage Sense Failure	The power supply voltage is higher than the diagnostic limits. The Power supply voltage is lower than the diagnostic limits.	Bad or damaged battery. Defective battery charging system. Incorrect setting of power supply voltage level. Power supply wiring to long or to thin. Control will flag low voltage during higher power uses.	Replace battery. Fix battery charging system. Set correct voltage levels on power supply. Make sure wiring is of the correct thickness and length according to manual.
Shutdown - Position Sensor Failure (internal fault)	If the internal position sensor is outside the diagnostic limits.	Internal failure of position sensor.	Cycle power on the unit. Return unit for repair.
Shutdown - EEPROM Failure (internal fault)	The software can't write to the EEPROM. The software can't read from the EEPROM.	The control is experiencing problems with internal EEPROM.	Cycle power on the unit. Return unit for repair.

Electrical Troubleshooting Guide

Speed Input

If the speed input is not functioning properly, verify the following:

- Check the values seen by the UG-25+ using the Service Tool and verify that is matches the input signal.
- Check the wiring. Look for loose connections and disconnected / misconnected cables/connections.
- Check the software configuration to ensure that the input is configured properly as the demand source.
- Measure the input voltage and frequency (internal 20 tooth gear is driven off governor shaft). Terminal Block TB5-11 (+) to Terminal Block TB5-3 (–).

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Analog Input

(Faulty Speed Setting or Faulty Stability Input or Faulty Fuel Limit Input)

If an Analog Input is not functioning properly, verify the following:

- Measure the input. Refer to Analog Input in Specifications section for input impedances.
- Check the values seen by the UG-25+ using the Service Tool and verify that it matches the input signal. Note that when using the Service Tool, the Load Limit and Speed Setpoint inputs are disconnected and thus the values displayed are actually set using the simulated I/O.
- Verify that there are no or minimal ac components to the Analog Input signal. AC components can be caused by improper shielding.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 V, look for loose connections and disconnected / misconnected cables/connections.

Discrete Input

If a discrete input is not functioning properly, verify the following:

- Measure the input voltage on the terminal block. Refer to Discrete Input in Specifications section for expected ON/OFF voltage levels.
- Check the status of the input from the Overview screen of the Service Tool.
- Check the wiring, looking for loose connections or misconnected cables.
- Verify the input is properly configured.

Shutdown Conditions

If the UG-25+ control has any shutdown conditions, refer to Chapter 4 for fault details. The Service Tool must be used to determine the cause of any shutdown condition. Refer to the Troubleshooting of Shutdown Faults earlier in this chapter.

Discrete Output

If the discrete output is not functioning properly, verify the following:

- Measure the output voltage on the terminal block. It should be in the range of 10–28 Vdc when the output is off/false. The voltage will be in this range only if all shutdowns are false. This can be verified through the Service Tool.
- Check the wiring, looking for loose connections or disconnected / misconnected cables.

Service Tool

If the service tool is not functioning properly, review the installation information in Chapter 4. Verify the following:

- Check the wiring, looking for loose connections or disconnected / misconnected cables (Programming harness or equivalent must be used).
- Check that Service Tool is running. Verify the Port setting is correct.
- Follow on-screen error messages. Re-install software as needed. The latest version of software is available for download from the Woodward web site (**www.woodward.com**).

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Chapter 9.
Service Options

Product Service Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM and Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

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- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available by searching on "***25225***" or "***worldwide directory***" at:

www.woodward.com/searchpublications.aspx

Woodward Factory Servicing Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

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Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return authorization number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

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Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com**.

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-0
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

You can also contact the Woodward Customer Service Department or consult our worldwide directory (search on "***25225***" or "***worldwide directory***" at: **www.woodward.com/searchpublications.aspx**) for the name of your nearest Woodward distributor or service facility.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

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Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.
Acronyms / Abbreviations

CCW	counterclockwise
CW	clockwise
CMRR	common-mode rejection ratio
CRC	cyclic redundancy count
EMC	electro-magnetic compatibility
I/O	inputs/outputs
L-Series	Woodward electronic engine governor that contains both a rotary governor and a controller circuit board
O.D.	outside diameter
OEM	original equipment manufacturer
PID	proportional/integral/derivative
ppm	parts per million
TPS	travel position sensor
UG-25+	Universal Governor 25+

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Appendix B.
UG-25+ Control Specifications

Governor

Power Supply	18 to 32 Vdc, dual inputs at 2.5 A max. each
Power Consumption	Reverse polarity protection, 32 W max
Torque/Work Output (minimum)	45.4 N·m (33.5 lb-ft) torque; 32.9 J (24.3 ft-lb) of work over 42 degrees (standard version, which has a 0.625 inch diameter terminal shaft) 55.5 N·m (40.9 lb-ft) torque; 40.2 J (29.6 ft-lb) of work over 42 degrees (increased output version, which has a 0.75 inch diameter terminal shaft)
Continuous Speed	500 rpm to 1700 rpm (governor shaft speed) max (small pump); 350 rpm to 1200 rpm (governor shaft speed) max (large pump)
Hysteresis	1.0 % or less (measured over full terminal shaft travel)
Temperature Drift	1.0 % of full terminal shaft travel between 27 °C and 77 °C (80 °F and 170 °F)
Linearity	2.5 % or less (measured over full terminal shaft travel)
Ramp-up Rate	configurable from 0.2 to 200 rpm/s (governor shaft)
Steady State Speed Band	±0.25% of rated speed (under normal operating conditions)
Weight	28 kg (62 lb), dry weight

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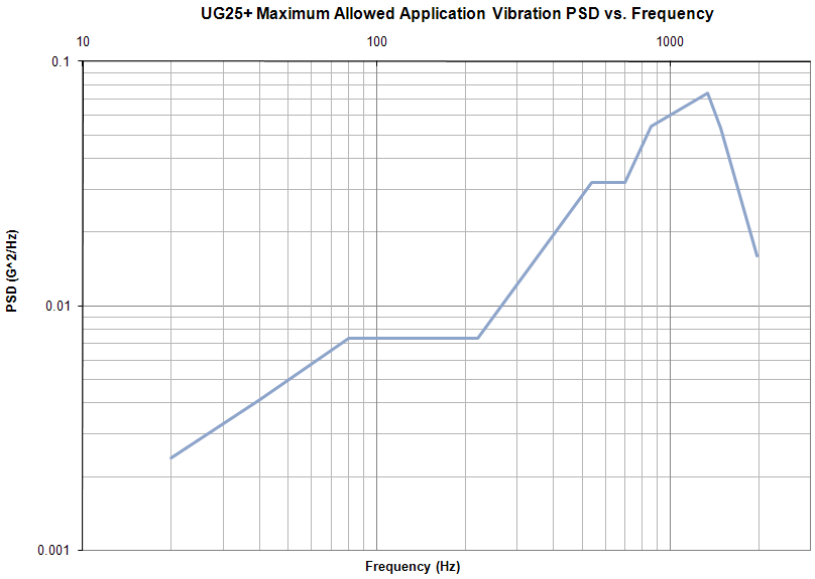
Governor Drive / Hydraulic System

Input Shaft Options	0.625 keyed drive shaft with 0.625-18 threads or 0.625-36 serrated (standard version); 0.750-36 serrated (increased output version)
Output	42.2 ± 0.6 degrees rotary
Terminal Shaft Options	0.625-36 serration
Drive Power Requirement	335 W (0.45 hp) max.
Internal Hydraulic Pressure	1034 kPa (150 psi)
Oil	Self-contained sump (2.2 qt/2.1 L capacity). See Woodward Manual 25071, Oils for Hydraulic Controls, for oil recommendations.
Drive Rotation	Pump can be configured to operate in CW or CCW direction

Environment

Ambient Operating Temperature	0 to +55 °C (32 to +131 °F)
Governor Case Temperature	100 °C (212 °F) maximum
Storage Temperature	–40 to +85 °C (–40 to +185 °F), limited by electronics
EMC	EN61000-6-4, 2007: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
Humidity	US MIL-STD 810E, Method 507.3, Procedure III
Shock	MS1-40G 11 ms sawtooth

Vibration Validation — Power Spectral Density (PSD) must not exceed the level or frequency as shown in the curve while the governor is running on a loaded engine, as measured at governor base.



Frequency (Hz)	Allowed PSD Level (G^2/Hz)
20	0.00240
40	0.00414
80	0.00736
220	0.00736
540	0.03197
700	0.03197
860	0.05453
1340	0.07452
1480	0.05339
1960	0.01595

Thermal Shock — SAE J1455, Paragraph 4.1.3.2

Ingress Protection — IP45 for Entire Unit, IP56 for User Interface per EN60529 and only if proper cable glands are used as described in this manual.

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Functions

Function Options — Start Fuel Limiter; Adjustable Max Fuel Stop; Jump and Rate Limiter; Position-based Gain curve; Manifold Air Pressure Biased Fuel Limiter, Analog set-point rate limit; separate Raise and Lower Rates; Start Gain

Programming Port — Programmable with Windows GUI (Graphical User Interface) software (9927-1366) and harness

I/O — 4–20 mA analog speed setting; Analog Speed Set-point selector
Raise, Lower, and Stop discrete inputs
Analog Speed Set Enable discrete input
4–20 mA boost fuel limiter input; Boost Input selector
Unit Healthy discrete out

Front Panel Functions — Raise and Lower speed set-point commands
Stop command; Droop adjustment; Stability adjustment, Fuel-Limit adjustment

Front Panel Indications — Unit Healthy status indication, Speed Set-point mode indications (Raise/Lower or Analog)

I/O Specifications

Power Input (1 and 2)

Parameter	Value
Range	18–32 Vdc
Power Consumption	Nominal consumption is less than 500 mA. If internal failures occur, the device can draw 32 W maximum. (18 V @ 1.8 A)
Protection	Reverse-polarity protected
Isolation	None

Status (Unit Health) Output

Parameter	Value
Output Type	Low-side output driver
Max Contact Voltage (Open)	32 V
Max Current	0.5 A
Max Contact Voltage at 0.5 A (Closed)	1.5 V
Max Delay Time for Opening Contact	6.5 ms
Default at Power Up	On (conducting), if there are no faults
During Error Condition	Off
Driving Inductive Loads	Yes, internally protected low-side switch
Protection	Utilizes circuitry that will open the contact when output contacts are short-circuited. Self-resetting when fault is removed

Boost Input

Parameter	Value
Input Type	4–20 mA
Input Scaling	4 mA is minimum boost signal 20 mA is maximum boost signal
Max Input (Full Scale)	0 mA to 25 mA
Input type	Differential
3 db Circuit Bandwidth	30 Hz
Input Impedance	200 Ω
Anti-Aliasing Filter	1 anti-aliasing pole at 0.47 ms (338 Hz)
Resolution	10 bits
Accuracy	±0.8% of full scale at 25 °C
Drift	80 ppm/°C
I/O Latency	6.5 ms
CMRR	60 dB
Common-Mode Range	45 Vdc

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Boost Input Selector

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to UG-25+ analog ground to allow for 4–20 mA boost signal to be used.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Analog Speed Setpoint

Parameter	Value
Input Type	4–20 mA
Input Scaling	4 mA is minimum speed setpoint 20 mA is maximum speed setpoint
Max Input (Full Scale)	0 mA to 25 mA
Input type	Differential
3 db Circuit Bandwidth	30 Hz
Input Impedance	200 Ω
Anti-Aliasing Filter	1 anti-aliasing pole at 0.47 ms (338 Hz)
Resolution	10 bits
Accuracy	±0.8% of full scale at 25 °C
Drift	80 ppm/°C
I/O Latency	6.5 ms
CMRR	60 dB
Common-Mode Range	45 Vdc
Fault Detection	< 2.5 mA, analog mode is disabled, raise/lower mode is enabled and last speed setpoint is held

Analog Speed Setpoint Enable

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to UG-25+ analog ground to allow for 4–20 mA remote speed signal to be used.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

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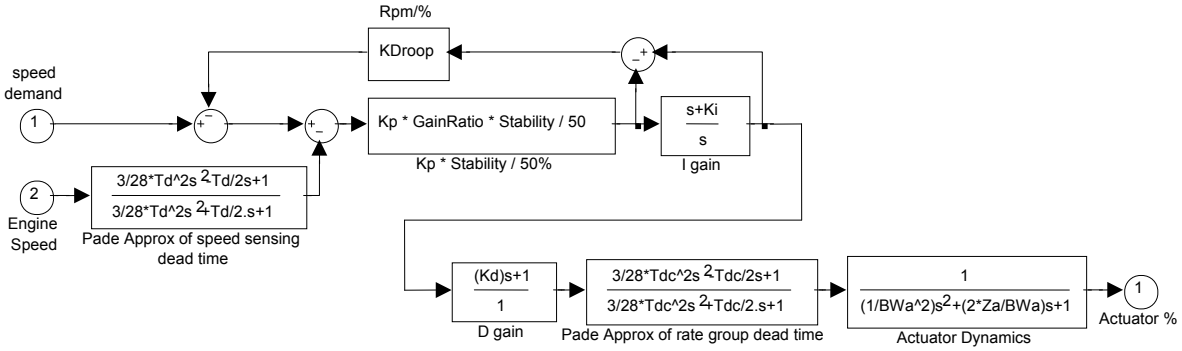
Remote Run/Stop Input

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull this input to UG-25+ analog ground to shut down the governor.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

Remote Speed Raise/Lower Discrete Inputs

Parameter	Value
Input Type	Active-Low, discrete input
Activation	Pull these inputs to UG-25+ analog ground (individually) to remotely apply speed raise or speed lower commands.
If unused	Floating allowed and recommended (internally pulled-up to 7 V)
Isolation	None

UG-25+ Transfer Function



Td = Speed Sensor delay. Depends on Speed Sensor settings and speed.
Td = 15 / rpm * Nstroke * CylindersAveraged/CylinderCount

Nstroke = 2 or 4 (2 stroke or 4 stroke)

CylindersAveraged = 1 to CylinderCount (speed input setting)

CylinderCount = total number of cylinders (speed input setting)

KDroop = Droop [% speed droop/100% load] * Rated Speed [rpm]/100%

Kp = Proportional Gain [%/rpm]

GainRatio = 1 within the GainWindow, as set in speed loop setup outside the GainWindow

Stability = Proportional Gain modifier. 50% = Gain of 1.

Ki = Integral Gain [repeats/sec]

Kd = Derivative Gain [sec]

Tdc = calc time delays, including 1.5 multiplier = 0.011 [sec]

BWa = actuator Bandwidth Depends on position loop gain.
@ P=44, BWa=30. @ P=36, BWa=25. @ P=26, BWa=15

Za = actuator damping ratio. Depends on position loop gain.
@P=44, Za=0.8 @ P=36, Za=0.7 @ P=26, Za=0.7

Pade = a type of approximation for a time delay (dead time); exp(–Td·s)

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UG-25+ Configuration Summary

APPLICATION _____

ACTUATOR SERIAL NUMBER _____
For details on individual settings refer to Chapter 6.

Properties _____

Speed Input
Engine Type (stroke) 2 ____ 4-Stroke ____
Speed Ratio (engine to shaft) = _____
Number of Cylinders = _____
Number of Cylinders Averaged = _____

Start Settings
Start Fuel One ____ Two ____
Two w/delay ____
Start 1 Speed Threshold = _____
Start Speed Hysteresis = _____
Start Fuel 1 = _____
Stop Speed Threshold = _____
Run Speed Threshold = _____

Start 2 Speed Threshold = _____
Actuator Ramp Rate = _____
Start Fuel 2 = _____
Start Fuel 1 Time Delay = _____

Start Target Speed Min ____ Rated ____
Start Target Rate = _____

Speed Setpoint
Min Setpoint Limit = _____
Rated Speed Setpoint = _____
Max Setpoint Limit = _____
Raise Ramp Rate = _____
Lower Ramp Rate = _____
Max Analog Up Rate = _____
Max Analog Down Rate = _____

Droop
Droop (% of Rated) = _____
No Load (% of position) = _____
Full Load (% of position) = _____

Fuel Limit
Mode Pot ____ Analog ____ Speed____
Maximum Fuel Limit = _____

Input % (pt 1) = _____
Input % (pt 2) = _____
Input % (pt 3) = _____
Input % (pt 4) = _____
Input % (pt 5) = _____
Limit % (pt 1) = _____
Limit % (pt 2) = _____
Limit % (pt 3) = _____
Limit % (pt 4) = _____
Limit % (pt 5) = _____

Jump Rate Limiter
Use Jump Rate Limiter? Yes ____ No ____
Maximum Jump Up % = _____
Maximum Up Rate %/sec = _____

Dynamics
Mode Single ____ Curve____
Start Gain (%/rpm) = _____
Start Gain Spd Threshold (rpm) = _____
Start Gain Spd Hysteresis (rpm) = _____

Idle Integral Gain (1/sec) = _____
Rated Integral Gain (1/sec) = _____
Derivative Gain (sec) = _____
Gain Window (rpm) = _____
Gain Ratio = _____

Proportional Gain (%/rpm) = _____

Position % (pt 1) = _____
Position % (pt 2) = _____
Position % (pt 3) = _____
Position % (pt 4) = _____
Position % (pt 5) = _____
Gain %/rpm (pt 1) = _____
Gain %/rpm (pt 2) = _____
Gain %/rpm (pt 3) = _____
Gain %/rpm (pt 4) = _____
Gain %/rpm (pt 5) = _____

Security
Read Configuration security? Yes ____ No ____
Configuration Load security? Yes ____ No ____
Speed Dynamics Edit security? Yes ____ No ____
Password = _____

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We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26579.

B26579:NEW

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PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.

2011/4/Colorado

MULTI CHANNEL

KTC CO.,LTD.

Plate Heat exchanger
Installation & Operation Manual



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Good to Great KTC.

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09. Maintenance and repair (정비)
(Disassemble, Clean-up, Precaution of disassemble, Assembly of Heat Plate)
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10. Defect Inspection (결함 점검 방법)
(Leakage Between Frame and Heat plate, Leakage Between Frame and Flange)
(프레임과 열판 사이의 누설, 프레임과 프랜지 사이의 누설)
(Leakage of Heat plate, Mixing Oil, Loss of pressure, Reduction of Heat Transfer Capacity)
(전열판 사이 누설, 유체 섞임, 압력손실이 커질 경우, 열전도 용량 저하)

11. Cleaning of Heat transfer plate (전열판 청소 방법)
(contamination, Biological Growth and mucilage, Scale, precipitation, Oil, Asphalt, Fats)
(오염, 미생물 번식 및 점액, 스케일, 침전, 유류/아스팔트/지방)

12. Purchase of parts (필요 부품 구매)

13. Summary of Maintenance (유지보수 요약)

14. PHE Exploded View (분해도)

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Plate
Heat
Exchang



1 Preface (머리말)

Thanks for considering our Multichannel products of KTC Co. ltd.
(저희 케이티씨 주식회사의 Multichannel 제품을 사용해 주셔서 대단히 감사합니다.)

We do our best to provide high quality of products and services based on our rich history of world-class technologies and know-how in heat exchanger industry.
(Multichannel 열교환기는 전 열교환기 분야에 걸쳐 세계적인 기술력과 노하우를 바탕으로 고객 여러분께 최선의 제품과 서비스를 제공하고자 노력하고 있습니다.)

This Manual contains overall information about structure of heat exchanger, function, installation, maintenance, repair, and problem solution.
(저희 제품에 관하여 최대한 간편하고 안전한 유지 보수를 위하여 제작된 매뉴얼로서 누구나 쉽고 명확하게 열교환기의 구조, 기능, 설치, 유지보수, 수리, 문제점 파악을 할 수 있는 전반적인 정보를 담고 있습니다.)

All managers of heat exchanger should read this manual carefully before operating heat exchanger to minimize impair of heat exchanger.
(안전과 위험요소 및 손상을 최소화하기 위하여 열교환기를 관리하는 모든 담당자들은 이 자료를 충분히 숙지한 후에 작업에 임하시기 바랍니다.)

Users will find information by using contents. If you have any questions and more detailed information, please feel free to ask KTC Co., Ltd.
(사용자 여러분들은 목록을 확인하시어 보다 빠르게 필요한 정보를 찾으실 수 있으며, 혹시 미흡하거나 더욱 자세한 내용이 궁금하신 고객께서는 케이티씨 주식회사에 문의 하시면 됩니다.)

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With this manual, we hope you will operate KTC Multichannel products successfully and efficiently.
(저희 매뉴얼과 함께 저희 케이티씨 주식회사, Multichannel 제품의 성공적이고 효율적인 운영이 되시길 바랍니다.)

Thank you.
(감사합니다.)

Heat exchanger safety (열교환기 안전관리)

2.1 General Safety (일반안전)

This chapter advises you on general precautions for the proper handling before operation. If you are not follow this manual, you might be in danger. Please read this manual carefully and follow the instructions. Next signs represent Caution and Danger.

(이 장에서는 작업 전에 지켜야 할 안전관련 사항에 대하여 안내할 것이며 본 매뉴얼에 따르지 않은 잘못된 취급은 위험성을 내포하기에 항상 각 분야에 대한 내용을 꼼꼼히 살펴서 처리해야 합니다. 다음의 기호는 주의와 위험을 표시합니다.)

 NOTE

 CAUTION

All workers need to follow the obligation of safety operation. Please notice next instructions.

(모든 작업자는 안전한 작업에 대한 의무를 이행하여야 하며 다음사항을 주지 하시기 바랍니다.)

- Please adhere to the operational safety regulations, for example, wearing protective glasses, close-fitting protective clothing, and safety shoes.
  (안전관리지침에 의거 보안경, 올바른 작업복과 안전화, 기타 안전장비를 착용 바랍니다.)
- Please adhere to the specified instructions in this manual.
  (본 매뉴얼에 명시된 사항을 준수 하십시오.)
- The heat exchanger may not only be operated in perfect condition. Each change on the heat exchanger must be immediately reported to the available responsible supervisor.
  (열교환기는 항상 완벽한 상황에서만 운전되고 있지 않을 수 있으므로 열교환기의 주변사항에 변동이 있을 시 즉각 책임자에게 보고 하도록 하십시오.)
- Before beginning of work with heat exchanger, operators must familiarize themselves with the possible dangers.
  (열교환기 작업에 들어가기 전에 작업자는 잠재 위험에 대한 인식을 정확히 숙지 하십시오.)
- Before starting each operation of the heat exchanger, ensure that all conditions are in perfect condition and function correctly.
  (열교환기 기동 전에는 모든 조건들이 올바른 운전조건과 완벽한 기능에 대해 확인 하십시오.)

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2.2 Incorrect operating conditions (2.2 부적절한 운전조건)

Operation of the heat exchangers is not permitted, whenever.

(다음사항에서는 절대로 열교환기를 운전하지 마십시오.)

- substantial faults or damages are presents.
  (기초적인 문제점이나 현 상태 손상이 있는 상황)
- the maintenance is not regularly performed.
  (장기간의 유지, 보수 관리의 부재)
- Standard operating conditions such as inner pressure, temperature, media, external influences are exceeded.
  (다음 운전조건들(예: 내압, 온도, 유체, 외부영향) 등의 기준 초과 상태)

 NOTE

KTC Co., Ltd. accepts no liability for damages caused by incorrect operation conditions.
(부적절한 운전조건으로 발생하는 열교환기 손상에 대해 케이티씨는 책임지지 않습니다.)

2.3 Correct operating conditions (올바른 운전 조건)

- Each operator must be appropriately trained for the task to be performed.
(운전에 대한 적합한 교육을 받아야 한다.)
- Each operator must be familiar with the work safety and accident prevention regulations.
(안전지침과 위험요소 대비에 대한 사전 지식을 습득해야 한다.)
- Each operator must have the information of operating conditions and background knowledge of heat exchanger.
(열교환기에 대한 사전 지식과 운전조건에 대한 지식을 갖추고 있어야 한다.)
- Each operator who in chare of the set-up, assembly, start-up, maintenance of Disassembly of the heat exchanger must have command of the necessary knowledge, and follow the instruction in this manual.
(열교환기의 설치, 시동, 유지, 보수, 정비를 담당하는 담당자는 열교환기에 대한 충분한 지식을 가져야 하며 매뉴얼이 지식하는 사항에 따라야 한다.)

2.4 Residual dangers (기타위험요소)

Residual dangers can never be fully excluded. You can only prevent these dangers through appropriate behavior.
(기타 위험요소는 언제나 존재함으로 항상 이에 대한 적절한 행동지침으로 예방하여야 한다.)



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Heat exchanger (HE) Plates (전열판)
The HE Plates are sharp edged. Please wear protective gloves when handling the HE plates.
(전열판의 모서리는 날카롭습니다. 이에 열판을 취급 시에는 적절한 장갑을 사용하십시오.)

Outside of the PHE (열교환기 외부)
Outside of HE plates are also sharp edged. Please wear suitable protective clothing and gloves.
(열교환기 외부도 열판 모서리 부분이 날카로우므로 항상 작업복과 장갑을 착용 하십시오.)

Hazardous flow-through media (유체에 의한 손상)
Hazardous flow-though media preset dangers of chemical burns. Please wear suitable protective clothing when working on the Heat Exchanger with hazardous flow-though media.
(유독물이나 인체에 해가 되는 유체에 의한 위험이 있습니다. 위험유체 취급 시에는 적절한 작업복과 신체 보호 장구를 사용하십시오.)

Opening the PHE (열교환기의 운전)
When dissembling of the heat exchanger, you should ensure that it is unpressurised and empty.
Always ensure that the HE plates do not unintended loosen from the frame and unintended slippage.
(열교환기를 분해할 시 열교환기에 어떤 압력이나 유체가 남지 않은 상태에서 실시하여야 하며 프레임 개봉 시 재 조립시의 누수 방지를 위해 열판의 느슨해짐이나 쓰러짐을 주의 하십시오.)

Operating instructions (운전 지침)

3.1 Operating instructions (운전 지침)

These operating instructions are the instructions of the manufacturer for the PHE managers and for all persons who are responsible for the set-up, operation, maintenance and repair of the PHE.
These operating instructions are generally applicable to all gasket type of PHEs manufactured and supplied by Multichannel.
(열교환기 운전지침은 열교환기 생산과 관련된 작업자 혹은 운전, 시동, 유지, 보수, 정비 등의 관련 작업자를 위한 자료입니다. 열교환기 매뉴얼은 Multichannel 에서 공급한 모든 가스켓 타입 열교환기에 적용됩니다.)

3.2 User Notes of Drawings and Figures (도면과 형상에 대한 참고사항)

For reasons of clarity, some drawings have been greatly simplified. The detailed drawings are provided when we individually.
deliver PHE with technical documentation. We do not refer about tools and equipments for assembling PHE in this manual.
(본 열교환기 사용설명서의 도면들은 실제보다 크게 단순화된 샘플입니다. 상세 도면들은 각 열교환기 배송 시 첨부하게 되며 기술자료와 함께 제출되어 집니다. 열교환기의 운전, 시동, 유지, 보수등의 매뉴얼을 습득한 책임자에 의해서 실시 되어야 합니다. 본 매뉴얼에는 열교환기 분해 조립 시 필요한 공구, 장비에 대하여는 자세히 언급하지 않습니다.)

3.3 Safety Signs (안전표시)

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Caution
This symbol means dangers to factors and precaution to dealing.
(위험성을 갖고 있는 요소에 대하여 취급에 주의하라는 표식)



Attention
This symbol means danger to the PHE or its parts and the surroundings.
(열교환기의 위험이나 주변의 잠재적 위험요소를 경고하는 마크)



Note
This symbol appears above paragraphs that give you useful or important notes for the correct handling of the PHE. This information helps you to avoid problems and makes it easier to handle the PHE.
(열교환기 분해, 조립 등의 작업 시 중요하거나 도움이 되는 정보에 대한 표시로 이 표식은 문제 발생의 소지가 있는 경우나 보다 원활한 작업이 필요한 부분에 사용)

User Guides (책임자 지침사항)



In the case of hazardous media(acids or similar media), high pressure and high/ low temperatures in the PHE, there is a danger of injury during maintenance or leakages. In this situation, PHE operator must wear protective gear.
(위험요소를 갖고 있는 유체의 경우에는 (강산 혹은 유사 유체) 높은 압력 또는 극고온, 극저온 상태의 열교환기는 유지보수나 누수의 위험성이 항상 존재합니다. 이 경우에는 열교환기 취급자는 보호장구를 반드시 갖추어야 합니다.)

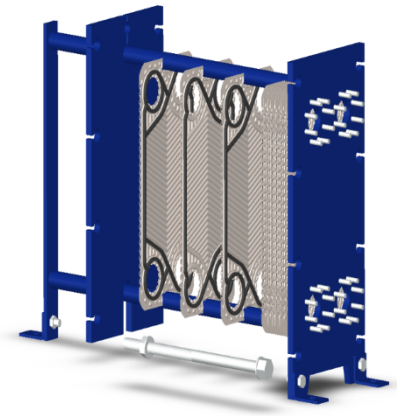
As a manager of PHE, you must ensure that each operator who is responsible for set-up, operation, maintenance or repair must read this manual. Damages to the PHE can arise if you do not adhere to the following instructions.
These operating instructions must always be accessible to the operators entrusted to work on the PHE.
(열교환기 담당자는 현장 작업자에게 열교환기 운전, 시동, 유지, 보수 등의 제반 사항을 정확히 숙지 시킨 후 작업에 임하도록 하시기 바랍니다. 본 사용 메뉴얼을 따르지 않을 경우 심각한 위험이 발생할 수도 있으므로, 현장에 비치하여 항상 숙지할 수 있도록 하시기 바랍니다.)

5 Plate Type of Heat Exchanger (판형 열교환기 설명)

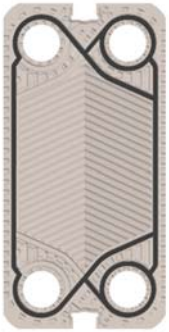
5.1 Basic Structure (기본 구조)

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The following figure represents the basic structure of plate heat exchanger.
(아래의 그림은 열교환기 일반 구조에 대한 사항입니다.)
The actual design may change depends on the actual application.
(실제 열교환기 도면은 각 사용처에 따라서 달라질 수 있습니다.)



No.	Component (부품명칭)
1	Carrying beam (상부 지지대)
2	Pipe connections (접속구)
3	Base plate (고정 프레임)
4	Support column (지지대)
5	Loose plate (이동프레임)
6	HE Plate (전열판)
7	Gasket (가스켓)
8	Guiding bar (가이드바)
9	Tightening bolt (조임볼트)



The plate pack consists of heat transfer plate and gasket becomes the pack heat plate.
(전열판과 가스켓의 조합으로 이루어진 plate pack은 서로 조합하여 전체 열판 팩을 형성합니다.)

5.2 Identification (Name plate) (명판)

All delivered PHE of Multichannel have each name plate which is attached in front side of fixed frame.

(모든 출고되는 Multichannel의 열교환기는 각각의 Name plate 를 가지고 있으며, 이는 열교환기 전면의 고정프레임에 부착되어 있습니다.)

Name plate includes (Some countries might differ)

(명판에는 다음의 사항들이 기록되어 있습니다.) (국가별 약간의 차이는 있습니다.)

- PHE type (열교환기 타입 plate heat exchanger type)
- serial no. (일련번호)
- admissible working pressure) [bar g] (허용 운전 압력)
- (admissible working temperature) [°C] (허용 운전 온도)
- (test pressure) [bar g] (테스트 압력)
- Volume [L] (체적)
- Net weight, Year of construction (무게, 제작년도)
- Compression dimensions: "a max." / "a min." [mm] (조임치수)
- Additional details [project specific] (추가사항)

* Drawings include the size of frame, the detailed type, the size, the detailed applied pipe.

(도면은 외형사이즈, 세부 타입, 사이즈, 파이프 접속 상세 사항들이 나타나 있습니다.)

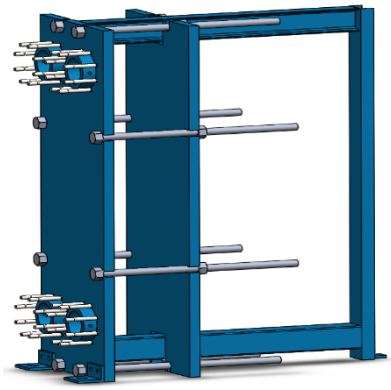
5.3 Frames (프레임)

Multichannel have various and special frames of HE. It have basically FR type and FP type.

(Multichannel 열교환기는 여러 분야에 대한 다양하고 특별한 프레임들을 보유하고 있습니다. 기본적으로 FR type 디자인과 FP type 이 있습니다.)

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FR type



FP type



In case of food industry and pharmaceutical industry, specialized stainless parts are used.

(식품 산업이나 제약산업 분야일 경우 특수 설계된 스테인레스 부속품들이 사용되기도 합니다.)

Surface of frame is coated by Epoxy, and tightening bolt/ nut is high strength quality(B7, 2H).

(프레임 표면은 Epoxy 코팅 되었으며, 타이트닝 볼트/너트는 고장력 재질(B7,2H)을 사용합니다.)

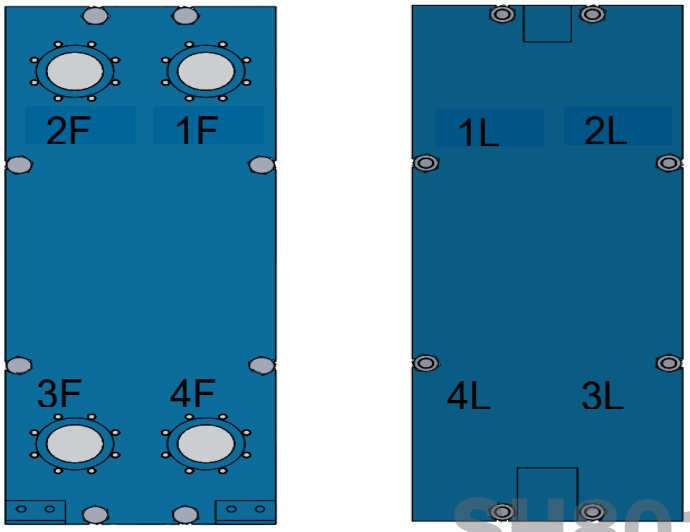
Connection method of pipe (배관 접속 방법)

Following figure represents the method of assembly pipe and connectible hole.

(열교환기의 접속구경과 배관과의 접속 방법은 우측의 그림과 같습니다.)

Fixed frame has counter clockwise of 1F, 2F, 3F, 4F indicators, and indicators of connectible pipe which access to unfixed frame has clockwise of 1L, 2L, 3L, 4L.

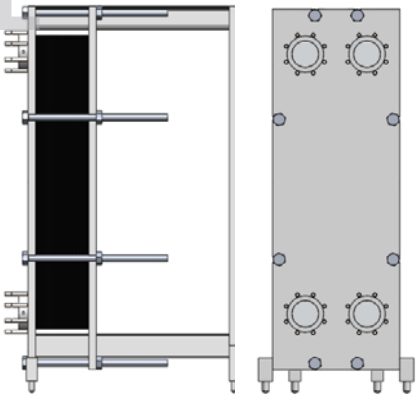
(고정 프레임의 경우에는 시계 반대방향의 1F, 2F, 3F, 4F의 표식이 되어 있으며, 이동식 프레임에 접속되는 배관 접속 표식은 시계방향의 1L, 2L, 3L, 4L 이 됩니다.)



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Stainless Frame

- In some cases, we can do stainless process over original frame, we call the frame as FRS type or FPS type.
  (경우에 따라서는 일반 프레임 위에 스테인레스 가공을 할 수 있는데 이때 프레임의 명칭은 FRS type 또는 FPS type 으로 칭합니다.)
- In particular cases, we provides manufactured legs made of stainless steel.
  (제작된 다리(stainless steel)가 부착되어 제공됩니다.)



5.4 Heat Transfer Plate (전열판)

NOTE

Quality, Type and pattern of heat transfer plate can be determined by customer-specific operating.

(전열판의 재질이나 타입, 패턴 등은 고객의 기본 설계사항에 따라서 달라 질 수 있습니다.)

5.4.1 Heat plate pattern (열판 패턴)

Heat plate consists of horizontal pattern and vertical pattern, and it used alone or in combination.

(열판은 수평무늬와 수직무늬로 구성되며, 단독으로 사용되거나 혼용되어 사용되기도 합니다.)

5.5 Gasket (가스켓)

CAUTION

Damages to Human Body and Property Loss
(인체 상해 및 재산 손실 위험)

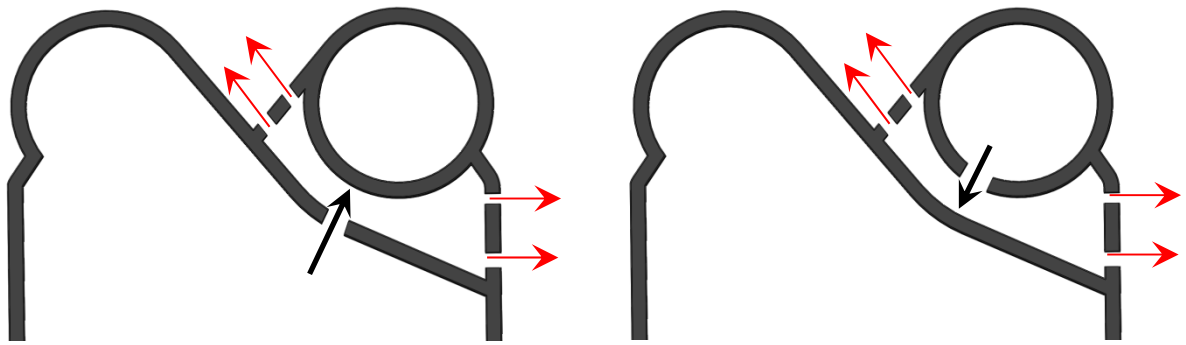
In case of changing conditions such as proper pressure, temperature, media, may cause serious damages in gasket.
It will cause serious damages of human body and environment. Therefore, never exceed the admissible operating parameters
(기초 설계 시에 명시되어 있는 정격압력, 설계온도, 유체의 성분이 달라질 경우에는 가스켓에 심각한 영향을 미칠 수 있으며 이는 인체나 주변 환경에 심각한 위험을 초래 할 수 있습니다. 따라서 기준 설계 조건을 절대로 넘지 않도록 합니다.)

ATTENTION
water leak (누수)

Inadmissible usage of gasket may cause a reduction of the service life.
The gaskets are wearing parts and sensitive to chemical, thermal and mechanical damages.
The selection of the gasket is determined by customer-specific operating conditions (pressure, temperature, media).
(가스켓은 화학적, 온도변화, 외부적인 손상에 영향을 받습니다. 따라서 가스켓의 선정은 사용자의 온도, 압력, 유체, 기타 조건들을 종합적으로 점검한 후 선택하셔야 하며, 비정상적인 사용은 가스켓 수명에 큰 영향을 미칠 수 있습니다.)

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All gaskets from Multichannel are designed to enable separating both media from each other.
It has a dual safety device, and the gasket has a basic air-band hole, which you can see directly from the outside Air bent hole in gaskets is an architecture that can be visible.
(Multichannel의 모든 가스켓은 두 유체 사이를 분리하는 역할을 하며 이는 기본적으로 이중 안전장치를 갖고 있으며 가스켓에는 기본적인 에어밴트 홀이 있어서 밖에서도 바로 육안으로 확인 할 수 있는 구조입니다.)



The materials of the gaskets are clearly marked by painted marks.
(가스켓 재질은 각각의 가스켓 한쪽에 페인트 표시로 구분합니다.)
Customers may consider proper storage of gaskets because of its sensitivity.
(가스켓은 햇빛과 온도, 습도에 민감하므로 적절한 보관이 중요합니다.)
Never exceed the admissible parameters.
(항상 허용한계를 넘지 않아야 합니다.)

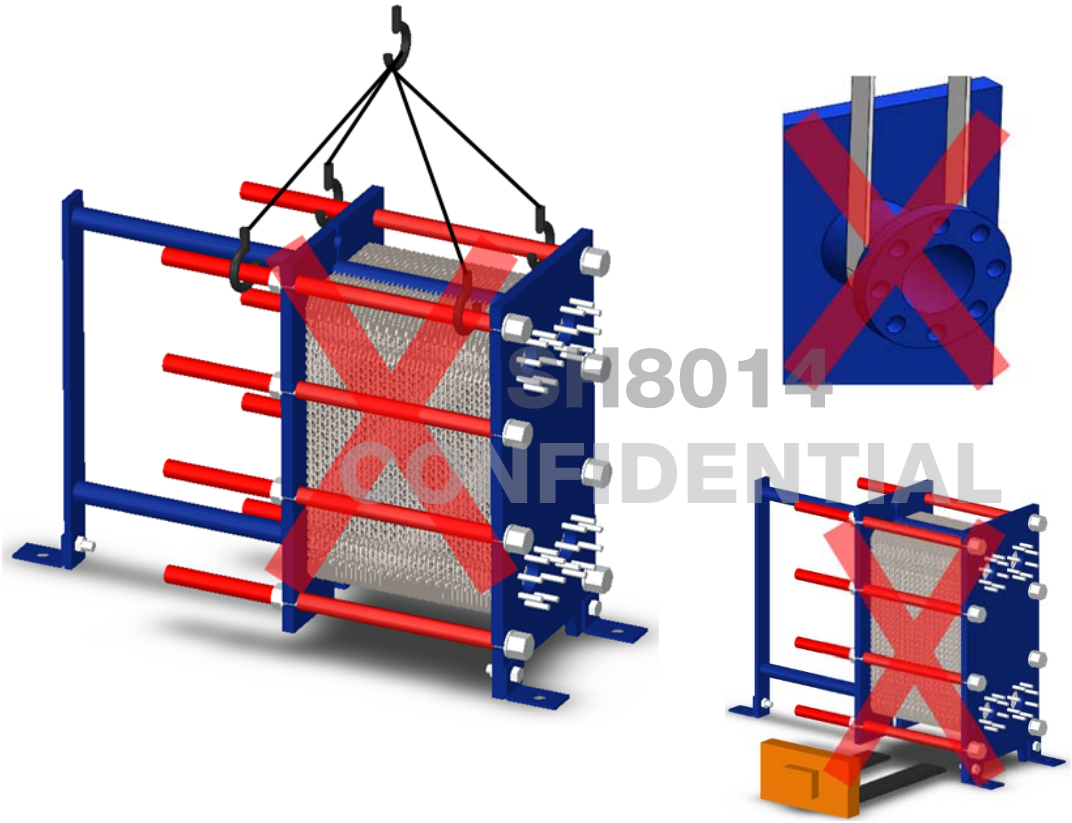
Delivery and Precaution (운송방법 및 주의사항)



CAUTION

Danger of injury and PHE
(인체나 열교환기 손상 주의)

Improper and careless handling of the PHE can lead to danger to persons and property. The PHE may never be lifted underneath the plate pack, at the connections or at the tightening bolts.
(적절하지 못한 방식의 이동은 열교환기 파손의 원인이 되며 열교환기 운송 시 절대로 열판 팩 밑부분이나 접속부위, 조임 볼트에 힘을 가하면 안됩니다.)



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Damage of PH (열교환기 손상)

Figure above represent badly effect on connection diameter welding part because the heat exchanger is not a very powerful structure.
Therefore, special attention is required. The PHE may never be lifted underneath the plate pack, at the connections or at the tightening bolts.
Connecting parts of Heat exchanger cannot be under physical pressure, so above figures explain that connecting part may cause damages.
(열교환기 접속 부위는 크게 힘을 받을 수 있는 구조가 아니므로 그림과 같은 운송 방법은 접속구경 용접부위에 심각한 영향을 미치므로 각별한 주의가 필요합니다.)

6.1 Precautions of Transferring the Hoist
(호이스트 이송 시 주의점)

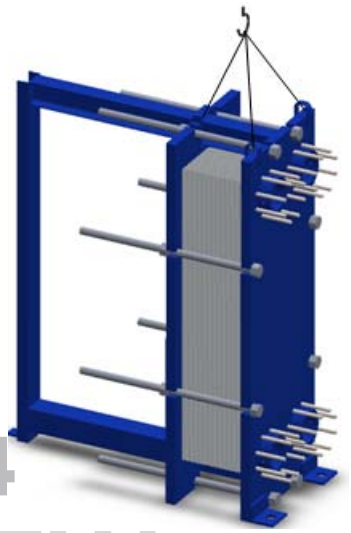


CAUTION

Damages to Heat Exchanger
(열교환기 손상 주의)

Before transferring heat exchanger, customers always ensure that.
(열교환기를 이동하시기 전에 아래의 사항을 꼭 준수하십시오)

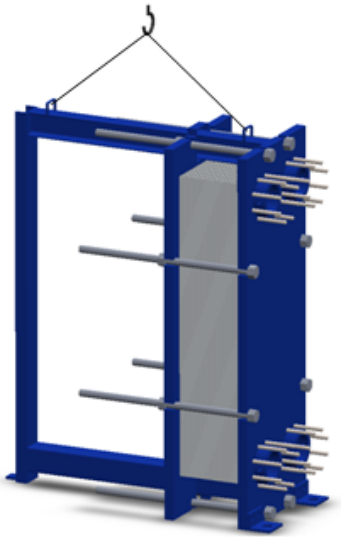
- the hoisting gear are of sufficient dimensions.
  (호이스팅 기어는 충분한 공간을 확보하여야 합니다.)
- the hoisting gear cannot come loose or slide off.
  (호이스팅 기어는 느슨하거나 움직이지 않아야 합니다.)
- no swing movements to the side result when lifting the heat exchanger.
  (열교환기를 들어 올렸을 경우에 좌우로 움직이지 않도록 한다.)
- the installation site is sufficiently large, level and able to support the load.
  (설치공간은 충분한 여유 공간이 필요하며 적절한 높이와 열교환기를 고정 시킬 수 있어야 합니다)



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Follow the next conditions when delivering heat exchanger with eyebolt.
(아이볼트로 이송 시에는 다음 사항을 지켜주시기 바랍니다.)

- Attach a hoisting gear to the both upper guide bar.
  (호이스팅 기어를 상부 가이드바 양쪽에 부착합니다.)
- Lift the heat exchanger slowly.
  (천천히 열교환기를 들어 올려 줍니다.)



7 Installation of Heat Exchanger (열교환기의 설치)

CAUTION

Damages to Human Body
(인체 손상 주의)

There is always a danger that the Heat Exchanger may cause. Always ensure that.
(열교환기 설치에는 항상 위험이 있으므로 주의하시기 바랍니다.)

- The hoisting gear are of sufficient dimensions.
(호이스팅 기어는 충분한 공간을 마련하여야 합니다.)

- The hoisting gear cannot come loose or slide off.
(호이스팅 기어는 느슨하거나 움직이지 않아야 합니다.)

- No swing movements to the side result when lifting the PHE.
(열교환기를 들어 올렸을 경우에 좌우로 움직이지 않도록 한다.)

- The floor at the installation space is sufficiently large, level and able to support the load.
(설치 공간은 충분한 공간이 확보 되어야 하며 고정 볼트로 고정 시킬 수 있어야 한다.)

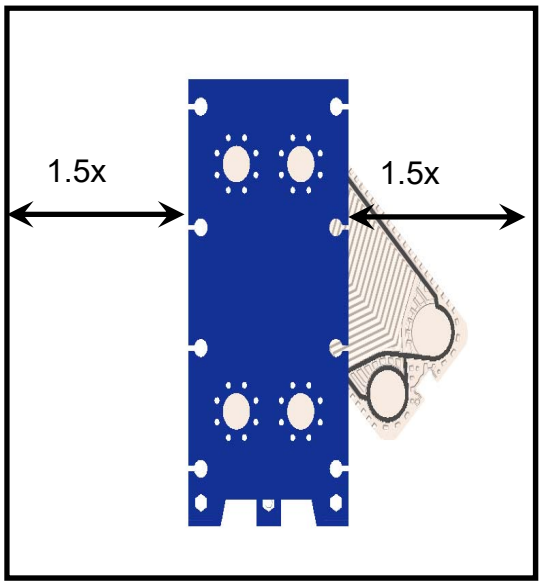
* 만약, 열교환기가 외부에 설치될 경우에는 유체 동결에 대한 사전 주의를 하여야 합니다.

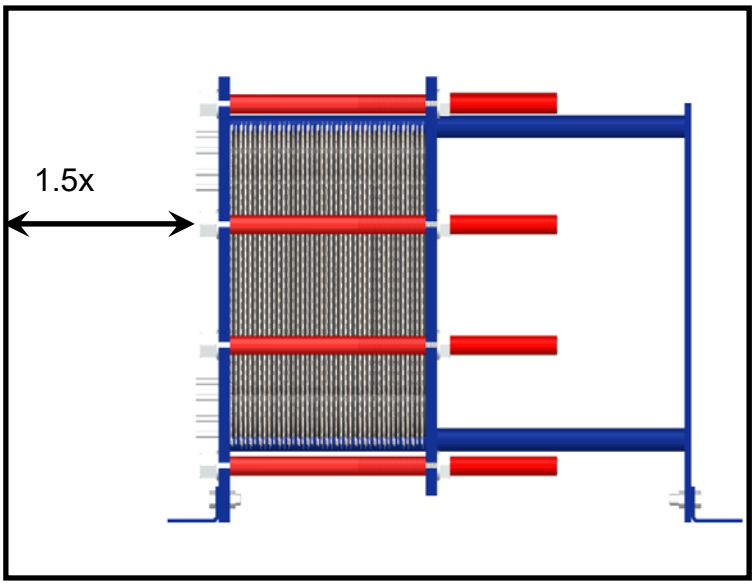
7.1 Installation Space (설치 공간)

Provide enough space around the PHE. This facilitates access to the PHE and necessary service tasks. (e.g. replacing individual plates, compressing the plate pack).
(유지, 보수를 위하여 충분한 작업공간을 확보하여야 합니다.) (예: 열판교체, 열판조임 등)

The values for the necessary space given are guide and recommended by Multichannel. Consider below figures.
(Multichannel은 적절한 여유 공간에 대하여 안내를 하고 있습니다. 아래 그림을 참고 바랍니다.)

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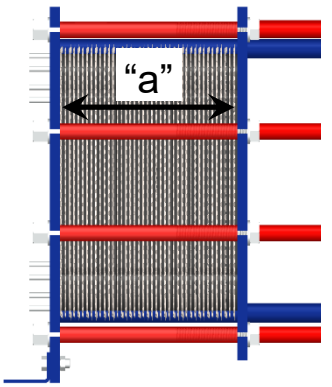
8 Operation, Start-up, and Shutdown (운전, 시동, 정지)

CAUTION

Hazardous flow-through media present dangers of human body.
Inform yourself and make sure that a protective covering is on hand.
(위험한 화학적 유체의 경우, 안전을 위해 열판 팩 주변에 적절한 보호 장치를 갖추어야 합니다.)

ATTENTION

Environmental Damages (Damages of Heat Exchanger)
(환경적인 손상 (열교환기 손상))



- Make sure that all media is drained during operating;
  Leaking media inside of Heat Exchanger causes environmental damages.
  (열교환기 내부 유체의 누수는 환경적 영향을 미치므로 일단 모든 유체를 드레인 시킨 후 작업하여야 합니다.)
- Make sure that dimensions of the tightening "a“("a min." < "a" < "a max“).
  (열판을 재조립할 때에는 열판 조임치수 "a"값에 대한 최대, 최소치를 확인하여 주시기 바랍니다.)

ATTENTION

Damages to Heat Exchanger
(열교환기 손상 주의)

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- Avoid sudden startup or sudden operation related to valve operation, as it may cause serious effect on the heat exchanger due to instantaneous pressure.
- When assembling Heat Exchanger, customer considers the dimensions of the tightening "a“.
- Make sure that no forces, moments, or vibrations that are too high via the valve onto the connections of the PHE.
- Customers should assemble the heat exchanger according to value "a“, dimensions of the tightening.
  (순간적인 기동 또는 밸브조작과 관련된 급격한 기동은 순간 압력으로 인하여 열교환기에 심각한 영향을 미칠 수 있으므로 될 수 있으면 피해주시기 바랍니다. 열교환기 조립 시에는 "a" 치수에 따라서 작업을 하여 주시기 바랍니다.)

8.1 Start upd (시동)

Before start-up, make sure that.
(시동 전 다음 사항을 점검 합니다.)
- the Heat Exchanger is not operated with inadmissible conditions.
  (열교환기는 절대 설계조건 이외로 운전하지 마시기 바랍니다.)
- all pipe connections are firmly connected to the Heat Exchanger.
  (모든 접속배관은 열교환기와 잘 연결이 되었는지 확인 바랍니다.)
- all necessary heat Exchanger components are completely installed.
  (모든 열교환기 관련 부속품들이 잘 조립되어 있는지 확인 바랍니다.)
- all plates are not compressed below to value "a“ , dimensions of the tightening.
  (열판은 조임치수 "a"값 이상으로 조이지 마시기 바랍니다.)

8.2 Operation (운전)

Make sure all operating conditions which located on name plate are followed.
the minimum and maximum parameters given on the name plate are not exceeded.
If the parameters are exceeded, the operating approval dissolves and GEA Ecoflex accepts no liability for resulting damages.
(열교환기에 부착되어 있는 명판(name plate)에 명시되어 있는 운전조건 데이터를 초과하지 않도록 체크를 합니다.)

8.3 Pumps (펌프)

Supplying flow-through media by pump manages by regulating valve.
If the pump with a capacity greater than the prescribed pressure allowed by the heat exchanger should equipped with safety valve.
(펌프에 의한 열교환기로의 유체의 공급은 조절밸브(Regulating valve)에 의해서 조절 되어야 하며, 만약 열교환기에서 허용하는 규정된 압력 이상의 용량을 가진 펌프의 경우라면 안전밸브(Safety valve)를 장착 하여야 합니다.)

8.4 Start-up (시동)

The pumps should start with locked valve to prevent momentary pressure shock.
Customers should open valves at the same time, and slowly increase flow-through media up to operating temperature.
If you do not follow instruction, you will experience hammering phenomenon which can cause leaking water and breakaway of gaskets.
(순간적인 압력쇼크를 방지하기 위해 펌프는 밸브를 잠근 상태에서 시동 바랍니다. 가능하면 입구쪽 밸브와 출구쪽 밸브는 동시에 열며, 운전 온도에 이를 때까지 유량은 서서히 높여 주시기 바랍니다. 그렇지 않으면 해머링(Hammering) 현상을 가져 올 수 있으며 이는 가스켓의 이탈 및 누수 현상을 일으킬 수 있습니다.)

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8.5 Venting (배출)

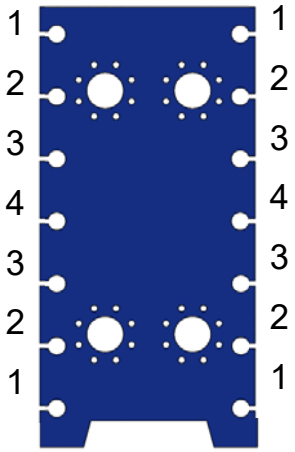
All air is removed from the Heat Exchanger after operating.
Air in Heat Exchanger may cause Air-lock phenomenon or impairment in heat plate, and reducing ability to transfer heat which can be rust.
(열교환기가 작동된 이후 바로 공기배출(venting) 하여 주시기 바랍니다. 기기 내부에 남아있는 공기들은 에어락(Air-lock)현상 또는 열판에 손상을 줄 수 있으며 이는 열 전달 능력을 떨어뜨리며 열판 부식의 원인이 될 수 있습니다.)

8.6 Shutdown (정지)

The shutdown should be made gradually over time.
Make sure that no flow-through media can escape during the shutdown period.
In case of outdoor installation, take precautions (e.g. emptying, heating) against freezing the flow-through media in the Heat Exchanger.
In case of long-term shutdown, Heat Exchanger must be protected by loosening tightening - bolt and basic leaning.
운전정지는 시간을 두고 서서히 이루어져야 합니다. 특히 결빙의 위험이 있거나 위험한 유체의 경우에는 열교환기에서 깨끗이 제거하여야 합니다. 오랫동안 열교환기를 사용하지 않을 시에는 조임볼트를 약간 느슨하게 하여 열판을 보호 할 수 있습니다.
그러나 이때 열판 사이에 먼지 등의 이물질이 들어가지 않도록 하여야 합니다.

9 Maintenance (정비)

9.1 Disassemble Heat Exchanger (열교환기 분해)



- Make sure that remove all pressure and flow-through media.
  (열교환기는 압력 유/무 및 내부의 유체가 모두 비워졌는지 확인합니다.)
- Check if the heat exchanger has cooled down.
  (열교환기가 식었는지 확인 및 가능하다면 밤새 식혀 둡니다.)
- Make sure that all connecting parts are removing.
  (프레임에 붙어 있는 모든 연결부위가 해체 되었는지 확인합니다.)
- Record value “a”.
  ("a" 값을 기록하여 둡니다.)
- Loosen bolt 1.
  (볼트 1을 풉니다.)
- Loosen nuts 2, 3, 4, move the movable frame.
  (2, 3, 4의 너트를 풀어서 이동식 프레임을 이동 할 수 있도록 합니다.)
- Remove 3, 4 bolt.
  (3, 4 볼트를 제거 합니다.)
- Loosen 2 nuts take turn.
  (2번 너트를 번갈아 풉니다.)

9.2 Attention: Please wear gloves.

(주의: 열판의 가상자리 부분은 날카로우니 반드시 장갑을 착용 바랍니다.)

- More than two heat plates are stuck and difficult to fall apart, remove the heat plate with care not to damage the gasket.
  (두 개 이상의 열판이 붙어서 떨어지기 힘든 경우에는 가스켓에 손상이 가지 않도록 주의하여 열판을 분리해야 합니다.)
- If a single heat plate is damaged and cannot be used, and a new heat plate cannot be replaced, even the adjacent heat plate must be removed from the heat exchanger.
  (만약에 한 개의 열판이 손상을 입어서 사용이 불가할 경우가 발생하고 새로운 열판으로 교체하지 못할 경우 인접한 열판까지도 함께 열교환기에서 분리해야 합니다.)
- If the number of heat plates changes, then the A-dimension value in plate pack should be changed.
  (만약에 열판의 숫자가 변경 될 경우에는 조여지는 열판팩 (Plate pack), A-dimension 값이 변경되어야 합니다.)
- If the changing heat plate is a multi-pass heat exchanger, it must be replaced with the same type of heat plate.
  (만약 변경 되는 열판이 첫 장이나 맨 끝장 혹은 다방향유로의 multi-pass heat exchanger인 경우에는 반드시 같은 종류의 열판으로 갈아 주어야 합니다.)

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9.3 Cleaning heat plate (열판청소)

Too low a flow rate inside the heat plate can cause heat plate contamination.
(열판 안에서의 너무 낮은 유속은 열판 오염의 원인이 될 수 있습니다.)
Customers can solve this problem by lowering the capacity or increasing the value of pressure loss. If the heat plate is badly charred, disassemble the heat exchanger to clean up.
(이는 용량을 낮추거나 압력 손실의 수치를 높이는 방식으로 유량을 높여서 해결하실 수도 있으나, 결정체가 형성되거나 심한 오염, 혹은 전열판이 심하게 그을렸을 경우에는 열교환기를 분해하여 청소하여야 합니다.)

9.3 Cleaning Heat Plate (continue) (열판 청소) (계속)

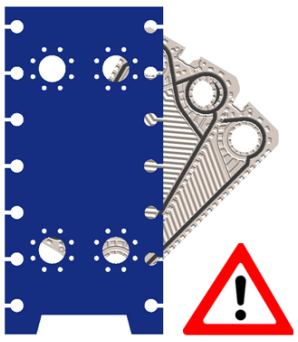
- Disassemble the heat exchanger in the manner of 9.1.
  (열교환기를 9.1의 방식으로 분해 합니다.)
- Cleaning with steel wool brush is prohibited.
  (강모 혹은 쇠 브러쉬를 절대 사용하지 마십시오.)
- Do not damage the heat plate and gasket which are the core of the heat transfer.
  (열 전달의 핵심인 열판 및 가스켓을 손상시키지 마십시오.)
- Cleaning the plate with high level of hydrochloric acid or sulfuric acid is prohibited.
  (고농도의 염산 또는 황산으로 세척하는 것은 금지 되어 있습니다.)
- Use clearly defined detergent.
  (명확히 정의된 세제만 사용 하십시오.)
- Nylon or soft brush should be used for cleaning debris on the surface.
  (표면을 청소할 때는 나일론이나 부드러운 솔을 사용하십시오.)
- Heat plate oxide,Remove any contaminant from the calcite or oxide on heat plate by using 2 to 5 percent nitrates and a soft brush.
  (열판의 산화물, 석회성분의 오염물은 2~5%의 질산염과 부드러운 솔을 이용하여 제거합니다.)
- Do not use hydrochloric acid and sulfuric acid.
  (염산 및 황산은 사용하지 마십시오.)
- Remove organic deposits such as protein with 50°C and 2% caustic soda and soft soles.
  (단백질을 포함한 유기 퇴적물은 50℃, 2%의 가성소다와 부드러운 솔로써 제거하십시오.)
- Oily contamination is cleaned using kerosene and soft brush. Wash with clean water.
  (기름기에 의한 오염은 등유와 부드러운 솔을 이용하여 청소하고, 깨끗한 물로 헹구어 주십시오.)

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important : hydroxide or concentrated nitrates can seriously damage the surface and mucous of the heat plate.
Therefore, use the prescribed amount of detergent and wear safety glasses and waterproof gloves when cleaning the top.
With our CIP (Clean In Place), the equipment can be cleaned without dismantling.
It is environmentally friendly and can remove multiple contaminants with a single detergent.
(중요- 수산화물이나 농축된 질산염 등은 심각하게 열판의 표면이나 점막을 손상 시킬 수 있습니다. 따라서 규정된 세액을 사용하시고위의 청소 작업 시에는 안전 안경과 방수 장갑을 필히 착용하시고 작업 하시기 바랍니다. 저희의 CIP (Cleaning-in-Place)를 사용하실 경우에는 장비의 해체 없이 청소를 하실 수 있으며, 이 경우 환경 친화적이며 하나의 세제로 여러 오염물을 제거 하실 수있습니다.)

9.4 Precautions for Heat Exchanger Disassembly (열교환기 분해 조립시 주의 사항)

- Wearing protective devices.
  (항상 보호장구를 갖춘다.)
- Work after the drain of the fluid in the heat exchanger is completed.
  (열교환기내 유체의 드레인이 완료된 후에 작업한다.)
- Precautions for temperature.
  (유체의 온도에 따라서 데이거나 동상의 위험이 있으니 주의 바랍니다.)
- Dangerous fluid will cause serious damages to human body.
  (위험한 유체의 경우 인체에 영향을 미칠 수 있습니다.)
- Beware of breakaway of heat transfer plate.
  (전열판의 이탈에 대해 주의 바랍니다.)



Be careful when removing the heat transfer plate as it may be dangerous to remove it from the guide bar.
(전열판이 가이드바를 이탈하여 위험 할 수 있으므로 전열판의 탈 부착 시에 주의 하십시오.)

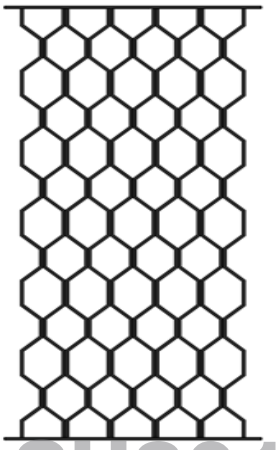
9.5 Assembly of Heat Plate (열판 조립)

All Heat Exchanger have inspection of heat transfer plate.
(모든 열교환기는 전열판 조립 명세서가 있습니다.)

Each heat plate must be assembled in Heat Exchanger by inspection of heat transfer plate.
(개별 열판 들은 이 전열판 조립명세서에 따라 열교환기 안에 조립되어야 합니다.)

When all the heat plates are correctly installed, the outside of the plate pack must show a continuous honeycomb pattern.
(정확히 조립된 열판은 외부 형체는 일반적으로 벌집모양 패턴을 갖습니다.)





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10 defect inspection (결함 점검 방법)

10.1 Leakage Between Frame and Heat plate (프레임과 열판 사이의 누설)

Inspection (점검 방법)	**Remedy (조치 방법)**
Record the dimension, mark for leaking area, and disassemble the Heat Exchanger. (치수를 기록하고 누설 부위를 표시한 후 열교환기를 분해합니다.)	-
Ensure that start-plate, end-plate, and gasket are on right position. (스타트 플레이트 또는 엔드 플레이트(양 끝단 전열판)와 연결구간의 가스켓 손상상태, 이완, 이탈을 점검합니다.)	Replace impaired gasket. (손상된 가스켓을 교체합니다.) Place gasket on right location. (가스켓을 제 위치에 끼웁니다.) Remove contaminant. (이물질을 제거합니다.)
Check contaminant between gasket and frame. (고정식 또는 이동식 프레임의 표면 상태와 이물질이 끼어 가스켓 접촉 상태가 이상 없는지를 점검 합니다.)	Remove contaminant. (가스켓과 프레임 접촉에 지장을 주는 요인을 제거합니다.)
Check if there any impaired heat plate. (열판 자체에 균열이 생기거나 구멍이 있는가 점검 합니다.)	Replace impaired heat plate. (균열이 생기거나 구멍이 있는 열판을 교체합니다.)

10.2 Leakage Between Frame and Flange (프레임과 플랜지 사이의 누설)

Inspection (점검 방법)	**Remedy (조치 방법)**
Disassemble flange from frame. (플랜지를 프레임으로부터 풀어 줍니다.)	-
Check if there is a possibility that the crooked connection between the flange and the gasket, and the contaminant of gasket and flange. (플랜지와 연결구간의 비뚤어진 연결, 가스켓의 이탈이나 손상, 가스켓이나 플랜지 표면상에 이물질 등이 있는가를 점검합니다.)	Rearrange the pipe. (파이프가 무리하게 설치되어 있으면 재조정 합니다.) Replace the impaired gasket. (가스켓을 다시 취부합니다. 손상된 가스켓은 교체합니다.) Replace the lining of connecting parts. (연결구의 라이닝에 이상이 있으면 교체합니다.) Remove contaminant of gasket and flange. (플랜지와 가스켓의 이물질을 제거합니다.)

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10.3 Leakage to outside of heat transfer plate (전열판 사이에서 밖으로의 누설)

Inspection (점검 방법)	**Remedy (조치 방법)**
Record A-Dimension, mark leakage area, and disassemble the Heat Exchanger. (A-Dimension 을 기록하고 누설 부위를 표시한 후 열교환기를 분해합니다.)	-
Check gasket is relaxed, breakage, or impaired. (가스켓의 이완, 이탈 또는 손상이 있는지 점검합니다.)	Adhere relaxed gasket. (이완된 가스켓을 재 접착합니다.) Repositioning breakage gasket. (이탈된 가스켓을 다시 끼웁니다.) Replace impaired gasket. (손상된 가스켓은 교체합니다)
Check if there is transformation in guide bar. It may cause misalignment of heat plates. (열판의 상.하부 가이드바에 걸리는 부분의 변형을 점검합니다. 이는 열판의 정렬 불량 원인이 됩니다.)	Repair or replace the impaired part. (손상된 부분은 수리하거나 열판을 교체합니다.) Rearrange temporary. (열판의 수를 줄인 임시 배열을 합니다.)
Check that the heat plate is correctly arranged ccording to the pre-heat assembly specification. (열판이 전열판 조립명세서 대로 올바르게 배열되어 있는지 확인 합니다.)	Rearrange the heat plate. (잘못된 열판을 바르게 배열 합니다.)
Check whether impaired heat plates are existed. (열판 자체에 균열이 생기거나 구멍이 있는가를 점검합니다.)	Replace the heat plate. (균열이 생기거나 구멍이 있는 열판을 교체합니다.)
Replacing the heat transfer plate for repair or replacement. (전열판의 교체, 수리를 위해 떼었다 붙이는 경우)	If the damaged heat transfer plate is replaced and attached from the heat exchanger for repair, the heat plate in front or back must also be removed. Calculate A-Dimension again and tighten the tightening bolt. (손상된 전열판 교체, 수리를 위해 열교환기로부터 떼었다 붙이는 경우 반드시 앞 혹은 뒤의 열판도 같이 떼어내야 하고 A-Dimension 을 다시 계산하여 조임볼트를 조여 줍니다.)

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10.4 Mixing Oil (유체의 섞임)

Inspection (점검 방법)	**Remedy (조치 방법)**
Check the connected pipes are in the right position. (연결된 배관이 바른 위치로 되었는지 확인하십시오.)	Reconnecting pipes. (바른 위치로 배관 연결을 다시 합니다.)
Unplug one pipe under the heat exchanger and raise the other pressure to check for leakage and check the location of the leak preheating plate. (열교환기 아래 한쪽 배관 연결을 풀고 다른쪽 압력을 올려 누설이 생기는가 점검하여 누설 전열판 위치를 확인합니다.)	-
If leakage is found, record the number of positions on the heat transfer plate and disassemble the heat exchanger. (누설이 발견되었을 때에는 전열판의 몇번째 위치인가를 기록 후 열교환기를 분해합니다.)	-
Check ring gasket in heat plate and the drain passage does not interfere with leakage outside the heat exchanger. (열판의 링 가스켓 부위의 누설을 점검하며 배출용 통로가 교환기 밖으로의 누설에 지장이 없는가 확인 합니다.) Due to faulty water-tightness of one fluid, no pressure should be created to apply pressure to another fluid. (한 유체의 수밀 불량으로 압력이 형성되어 다른 유체에 압력을 주어서는 안됩니다.)	If there is leakage or impairment in gasket, inspect or replace gasket. (누설이 있거나 가스켓의 이 부위가 손상되었다면 적합한 공구로 다시 분해 점검하거나 가스켓을 교체해야 합니다.)
If there is no leakage as mentioned above, check that there is a hole in each heat plate. (만약 위에서 언급한 바와 같은 누설이 없었다면 매 전열판 마다 구멍이 있는지 확인 합니다.) Light the light on the back of the heat shield to check that light is leaking out of a small hole or crack. (전열판 뒷면에 불빛을 대어 조그만 구멍이나 균열부위에서 빛이 새어 나오는지 확인합니다.) Check suspicious areas such as magnifying glasses. (확대경 등으로 의심스러운 부위를 점검합니다.) Clean up the heat transfer plate and chemical penetration test. (전열판을 깨끗이 소제 후 약품 침투 시험을 합니다.)	Dispose or replace the perforated heat transfer plate. (구멍난 전열판은 폐기하거나 교체되어야 합니다.) For temporary operation by reducing the number of heating plates, the front or back heat plates are also taken out and A-Dimension is recalculated to tighten the tightening bolts. (전열판의 수를 줄여 임시적인 운전을 할 경우는 앞 혹은 뒤의 열판도 같이 취외 후 A-Dimension 을 다시 계산하여 조임볼트를 조여 줍니다.)

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10.5 Loss of pressure (압력 손실이 커질 경우)

Inspection (점검 방법)	**Remedy (조치 방법)**
Check all pipes. (모든 밸브들을 점검합니다)	-
Measure the pressure and flow rate of the inlet and outlet of the Heat Exchanger. (열교환기의 입.출구 측의 압력과 유량을 측정합니다.) Compare losses of pressure at actual flow and pressure in data printer. (실제 유량에서의 압력 손실과 데이터 프린트의 압력손실을 비교합니다.)	-
Check temperature if the loss of pressure is greater than data print. (압력 손실이 데이터 프린트의 압력손실 보다 크다면 온도 설정치도 함께 점검합니다.)	-
If the thermometer matches the data print, the heat transfer plate is considered clean and only the inlet side of the heat exchanger may have been blocked by some debris. (온도계의 계측치가 데이터 프린트와 일치한다면 전열판은 깨끗하다고 보며 단지 열교환기의 입구쪽이 어떤 이물질에 의해 막혔을 것으로 봅니다.)	Disassemble the heat exchanger and remove any foreign substance that block the flow path. If there is back-flushing system may help to remove foreign substance. (열교환기를 분해 후 유로를 막고 있는 이물질을 제거하거나 백플러싱(Back-flushing)시스템이 있다면 이를 사용하여 이물질을 제거합니다.)
If the measurement of the thermometer differs from the data print, the thermal conductivity will be lower than the specification, which is due to the deposition of the heating surface and at the same time increases the pressure loss as the flow path narrows. (온도계의 계측치가 데이터 프린트와 다르다면 열전도는 사양서보다 떨어질 것이고 이것은 전열면의 퇴적물 때문이며 이와 동시에 유로가 좁아지면서 압력 손실이 커지게 됩니다.)	Cleaning In Place If you have a chemical cleaning device, clean the deposit according to the instructions. If you do not have one, remove the heat exchanger and clean the heating plate. (Cleaning In Place (화학세정장치)가 있다면 설명서에 따라 퇴적물을 닦아 내고 이 장치가 없다면 열교환기를 분해 후 전열판을 깨끗이 청소하여 주십시오.)
No other action is required if the pressure loss matches the data print. (압력 손실이 데이터 프린트와 일치할 경우에는 어떤 다른 조치를 할 필요가 없습니다.)	Other devices in the piping system must be checked. (배관 계통내 다른장치를 점검해야 합니다.)
If the pressure loss is lower than the data print, the pump capacity is low or measurement is incorrect. (압력 손실이 데이터 프린트보다 낮다면 펌프 용량이 너무 작거나 측정이 잘못된 것입니다.)	Remeasure the pressure or refer to pump manual. (펌프 설명서를 참고하거나 압력을 다시 측정합니다.)

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10.6 Reduction of Heat Transfer Capacity (열 전도 용량 저하)

Inspection (점검 방법)	**Remedy (조치 방법)**
Check the inlet temperature and flow rate of both fluids and measure the temperature and flow rate of at least one fluid. Ensure that the amount of heat energy transferred matches with the data print. Use an experimental thermometer with a precision of 0.1°C and suitable equipment for flow measurement. (가능하다면 양 유체의 입.출구 온도 및 유량을 점검하며 적어도 한쪽 유체의 온도와 유량은 측정되어야 합니다. 전도되는 열에너지의 양이 데이터 프린트와 일치하는지 확인합니다. 정밀 계측이 중요하므로 정밀도 0.1℃ 눈금의 실험 실용 온도계와 유량 계측을 위하여 적절한 장비를 사용합니다.)	If the capacity of heat conduction is lower than data print, heating surface needs to clean up. (열교환기의 열전도 용량이 데이터 프린트보다 낮다면 전열면의 세정이 필요합니다.) Cleaning In Place may be used or clean up the heat transfer plate. (Cleaning In Place (화학세정장치)를 이용하거나 열교환기를 분해하여 육안 점검 후 전열판을 청소하여 줍니다.)

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11 Cleaning Heat Transfer Plate (전열판 청소 방법)

Too low a flow rate inside the heat plate can cause heat plate contamination.
(열판 안에서의 너무 낮은 유속은 열판 오염의 원인이 될 수 있습니다.)
This can be solved by lowering the capacity or increasing the pressure loss level.
(이는 용량을 낮추거나 압력손실의 수치를 높이는 방식으로 유량을 높여서 해결하실 수 있습니다.)
If the heat transfer plate is badly charred or contaminated, the heat exchanger must be dismantled and cleaned.
(그러나 결정체가 형성 되거나 심한 오염, 혹은 전열판이 심하게 그을렸을 경우에는 열교환기를 분해하여 청소하여야 합니다.)

Attention (주의)
- Make sure you are wearing protective glasses and waterproof gloves.
  (청소 작업 시에는 안전 안경과 방수 장갑을 필히 착용하시고 작업하십시오.)
- Steel wool brush is prohibited.
  (강모 혹은 쇠 브러쉬를 절대 사용하지 마십시오.)
- Do not damage the heat plate and gasket which are the core of the heat transfer.
  (열전달의 핵심인 열판 및 가스켓이 손상되지 않도록 작업 하십시오.)
- Cleaning the plate with high level of hydrochloric acid or sulfuric acid is prohibited.
  (고농도의 염산이나 황산 등으로 전열판을 닦지 마십시오.)
- Use clearly defined detergent.
  (규정된 세척액을 사용하여 주십시오.)

With our CIP (Clean In Place), equipment can be cleaned without dismantling.
It is environmentally friendly and can remove multiple contaminants with a single detergent.
(저희의 CIP (Cleaning-in-Place)를 사용하실 경우에는 장비의 해체 없이 청소를 하실 수 있으며 이 경우 환경 친화적이며 하나의 세제로 여러 오염물을 제거 하실 수 있습니다.)

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11.1 Contaminant (Gross Fouling) (오염) (Gross Fouling)

Chemicals (종류 및 세척제)	**Cleaning Method (청소 방법)**
Ascidians (해초류) A piece of wood (나무조각 등) Fiber (섬유질) Shellfish, Cirripedia (조개류, 만각류)	Use a soft brush to clean the contaminants by spraying them with water. (물을 뿌려주면서 부드러운 솔을 이용하여 오염물을 청소하여 주십시오.) Clean the debris with a high-pressure hose. (고압호스로 찌꺼기를 깨끗이 닦아 주십시오.) Back-flushing without disassembly is also effective if conditions are available. (여건이 된다면 분해 없는 백플러싱 (Back-flushing)도 효과적 입니다.)

11.2. Biological Growth, Slime (미생물 번식, 점액)

Chemicals (종류 및 세척제)	**Cleaning Method** (청소 방법)
Bacteria (박테리아) Nematode (선충류) Protozoan (원생동물)	Use a soft brush to clean the contaminants by spraying them with water. (물을 뿌려주면서 부드러운 솔을 이용하여 오염물을 청소하여 주십시오.) Clean the debris with a high-pressure hose. (고압호스로 찌꺼기를 깨끗이 닦아 주십시오.)
Chemical Cleanser (세척제)	Use the following chemicals as cleaning agents: 4% and maximum temperature: 80°C. (농도: 4%, 최고온도: 80℃의 아래 화학약품을 세척제로 사용합니다.) Add sodium carbonate and a small amount of chlorine to improve cleaning efficiency. (가성소다 탄산 나트륨과 소량의 염소를 첨가하여 세척의 효율을 높일 수 있습니다.)

11.3 Incrustation Scaling (스케일)

Chemicals (종류 및 세척제)	**Cleaning Method** (청소 방법)
Calcium carbonate (탄산칼슘) Calcium sulfate (황산칼슘) Silicate (규산염)	For coarse contamination, use a high-pressure cleaner jet to loosen the particles. Wash each plate with flowing, warm water and a soft brush. (물을 뿌려주면서 부드러운 솔을 이용하여 오염물을 청소하여 주십시오.) (고압호스로 찌꺼기를 깨끗이 닦아 주십시오.)
Chemical Cleanser (세척제)	concentration : 2~5% (농도 : 2~5%) temperature: under 50℃ chemicals will be used for detergent. (최고온도: 50℃의 아래 화학약품을 세척제로 사용합니다.) nitric acid (질산) sulfamate (설파민산) citric acid (구연산) phosphoric acid (인산) synthetic detergent (EPDA, NTA) (합성세제) sodium polyphosphate (폴리인산 나트륨)

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11.4 Sediment (침전)

Chemicals (종류 및 세척제)	**Cleaning Method** (청소 방법)
Corrosion product (부식성 제품) Metallic oxide (금속 산화물) Mud (진흙) Alumina (반토(알루미나)) Organisms and organic waste. (유기체 및 유기체의 배설물)	For coarse contamination, use a high-pressure cleaner jet to loosen the particles. Wash each plate with flowing, warm water and a soft brush. (물을 뿌려주면서 부드러운 솔을 이용하여 오염물을 청소하여 주십시오.) (고압호스로 찌꺼기를 깨끗이 닦아 주십시오.)
Chemical Cleanser (세척제)	concentration : 2~5%, (농도 : 2~5%) temperature: under 50℃ chemicals will be used for detergent. (최고온도: 50℃의 아래 화학약품을 세척제로 사용합니다.) nitric acid (질산) sulfamate (설파민산) citric acid (구연산) phosphoric acid (인산) synthetic detergent (EPDA, NTA) (합성세제) sodium polyphosphate (폴리인산 나트륨)

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11.5 Oil, Asphalt, Fats (유류, 아스팔트, 지방)

Chemicals **(종류 및 세척제)**	**Cleaning Method (청소 방법)**
Oil (유류) Asphalt (아스팔트) Fat (지방)	Contamination by greasy is clean up by paraffin or solvent (ex: Kerosene) Wash each plate with a soft brush. (기름기 등에 의한 오염은 파라핀이나 나프타계의 솔벤트(예: 등유)와 부드러운 솔을 이용하여 표면의 오염물을 청소 하여 주십시오.) Attention: Gasket may not contact to chemicals over 30 minute. Wash with flowing water or clean up with mop. (주의: 가스켓은 30 분 이상 약품에 닿지 않도록 하십시오. 걸레로 닦거나 물로 깨끗이 씻어내 주십시오.)
Chemical Cleanser (세척제)	Do not use detergent for following chemicals. (다음의 약품은 세척제로 사용하지 말아 주십시오.) ketone (ex: methylethylketone(MEK), acetone) (케톤) (예: 메틸에틸케톤(MEK), 아세톤) ester (ex: ethyl acetate , butyl acetate) (에스터) (예: 에틸 아세테이트, 부틸 아세테이트) halogenated hydrocarbon(ex: chlorotin, carbon chloride, freon) (할로겐화 탄화수소) (예: 클로로틴, 염화탄소, 프레온) air freshener (ex: benzene, toluene) (방향제) (예: 벤젠, 톨루엔)

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12 Purchasing necessary components (필요 부품 구매)

You always welcome to contact KTC Co., Ltd.. when you want buy components of heat transfer plate and gasket.
We, KTC Co., Ltd. is responsible for implementation of sale and provide its genuine components.
(열교환기 전열판 및 가스켓의 경우 사용에 따른 노후나 고장 수리를 위하여 부품만을 구매하실 때에는 저희 케이티씨로 연락 주시면 전국 어디서나 빠르게 구매 가능합니다.
저희 케이티씨는 Multichannel 제품의 판매총괄을 맡고 있으며 항상 고객이 사용하시는 제품의 정품 부품만을 공급하고 있습니다.
부품구매 및 A/S 를 위한 연락처는 다음과 같습니다.)

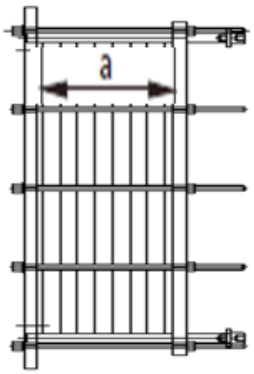
Contact information (연락처 정보)
Seoul, Headquarter: 1009 Munjeong-Daemyung Valeon 127 Beobwon-ro, Songpa-gu, Seoul 05836, Korea
(서울 본사 : 서울시 송파구 법원로 127, 대명벨리온지식산업센터 1009 호 KTC)
Phone) 02-3781-0550
Fax) 02-3781-0555
E-mail) ktc@ktc.com
Homepage) www.ktc.com

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13 Summary of Maintenance (유지보수 요약)

1. Measuring the tensioning dimension between fixed and loose plate.

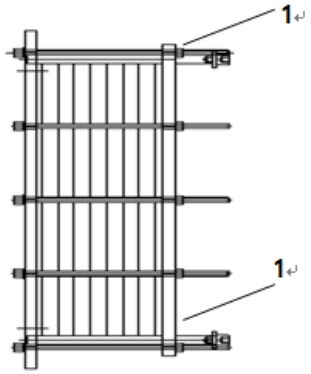
(고정용 플레이트와 이동용 플레이트의 사이를 측정한다)



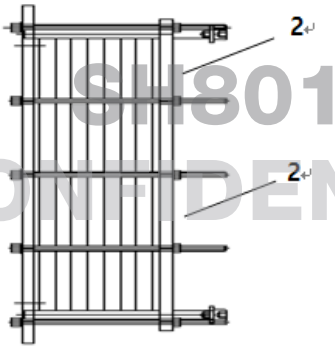
Be sure to write down the current tensioning dimension "a" of the HE plate pack.

2. Removing the tensioning bolts

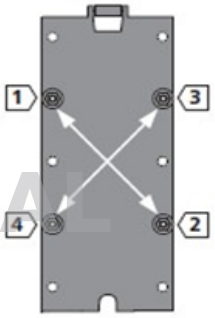
(인장 볼트를 분리한다)



2.1 Remove the tensioning bolts[1]



2.2 Remove the tensioning bolts[2]

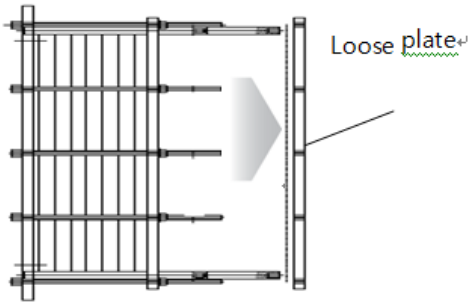


2.3 Slackening off tensioning bolts(diagram)

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3. Pushing the loose plate backward

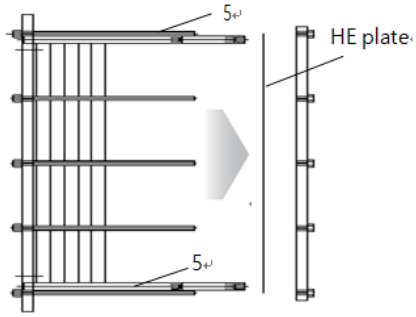
(이동용 플레이트를 뒤로 이동한다)



The HE plates must not fall out. If required, have the open HE plate pack secured by a **second person**.

4. Removing HE plates one by one.

(HE Plate 하나씩 분해한다)



Remove HE plate one by one from the top/bottom beam guide rail [5].

5. Stacking HE plates horizontally.

(HE Plate는 수평으로 쌓아 놓는다)

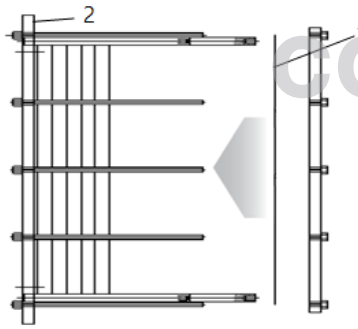


WARNING! Do not exceed the permitted stacking height
Stack the HE plates [**1**] on a clean and level surface.
Never stack HE plates any higher than:
60 HE plates

6. Installing the HE plate into the frame.

(HE Plate 를 Frame 에 넣는다.)

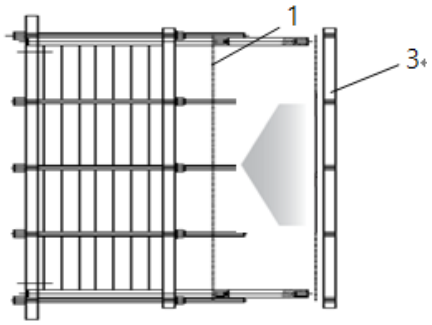
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Install the HE plates [1] in the PHE frame in the correct order.
HE plates towards the fixed plate[2] one by one.

7. Pushing the loose plate next to the complete HE plate pack.

(HE Plate pack 을 모두다 넣으면 Loose plate 를 밀어 넣는다)



Push loose plate [**3**] next to the HE plate pack [**1**] and insert all tensioning bolts.

➥ Do **not yet** tighten the HE plate pack.

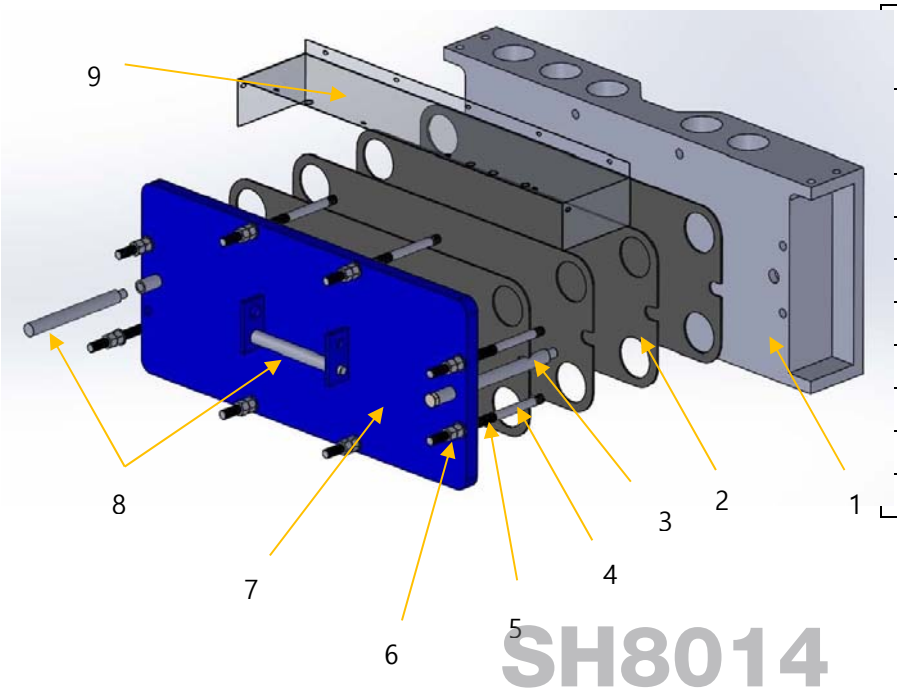
➥ Continue in the next chapter

Note : You shall have to look at the standard manual(No 9 Maintenance) about more information in detail and shall follow it.

(자세한 내용은 표준매뉴얼(No9번-정비)을 자세하게 살펴보고 따라야 합니다.)

14 PHE Exploded View (분해도)

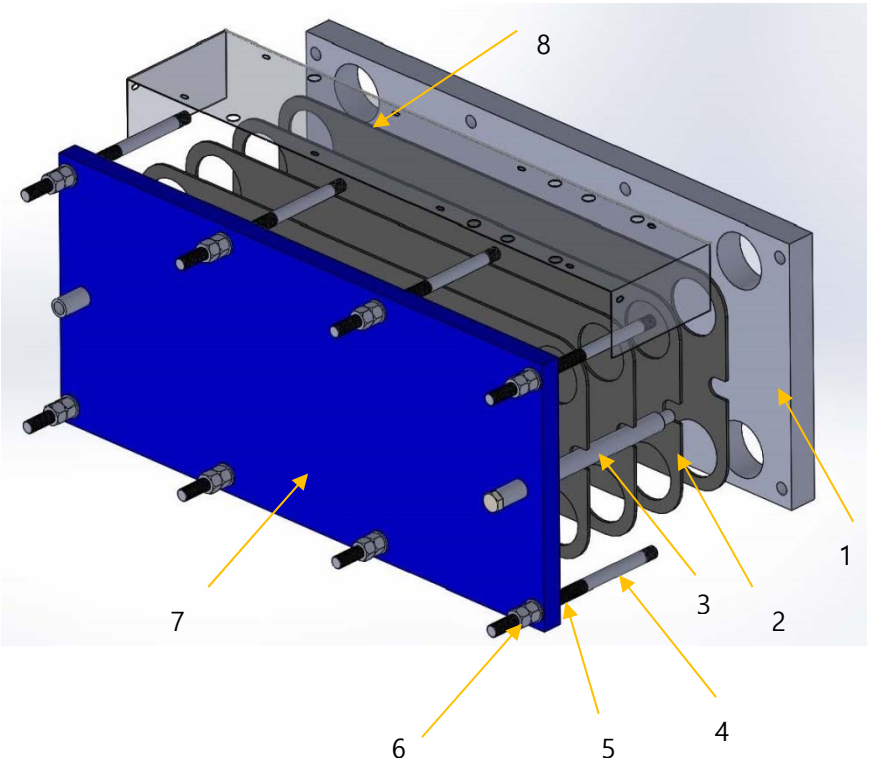
-Type 21/32



No.	Component (부품명칭)
1	HOUSING **(Supplied item)**
2	PLATE
3	CARRYING BEAM
4	DISTANCE PIECE
5	TIGHTENING BOLT
6	TIGHTENING NUT
7	LOOSE PLATE
8	EXTENSION BOLT
9	GUARD

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-Type 32/40



No.	Component (부품명칭)
1	BASE PLATE
2	PLATE
3	CARRYING BEAM
4	DISTANCE PIECE
5	TIGHTENING BOLT
6	TIGHTENING NUT
7	LOOSE PLATE
8	GUARD

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INSTRUCTION MANUAL

AIR COOLER

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DongHwa Entec

1575-6, SONG JUNG DONG, KANGSEA-KU, BUSAN, KOREA

TEL : + 82 51 970-1114 FAX : + 82 51 970 - 1131

Web Site : www.dh.co.kr

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I. DESCRIPTION

The DONGHWA ENTEC air cooler is a heat exchanger cooling the air supplied diesel engine to the specified temperature for improvement the performance of engine. It is called fin & tube type heat exchanger and used for MAN B&W and SULZER MAIN DIESEL ENGINE.

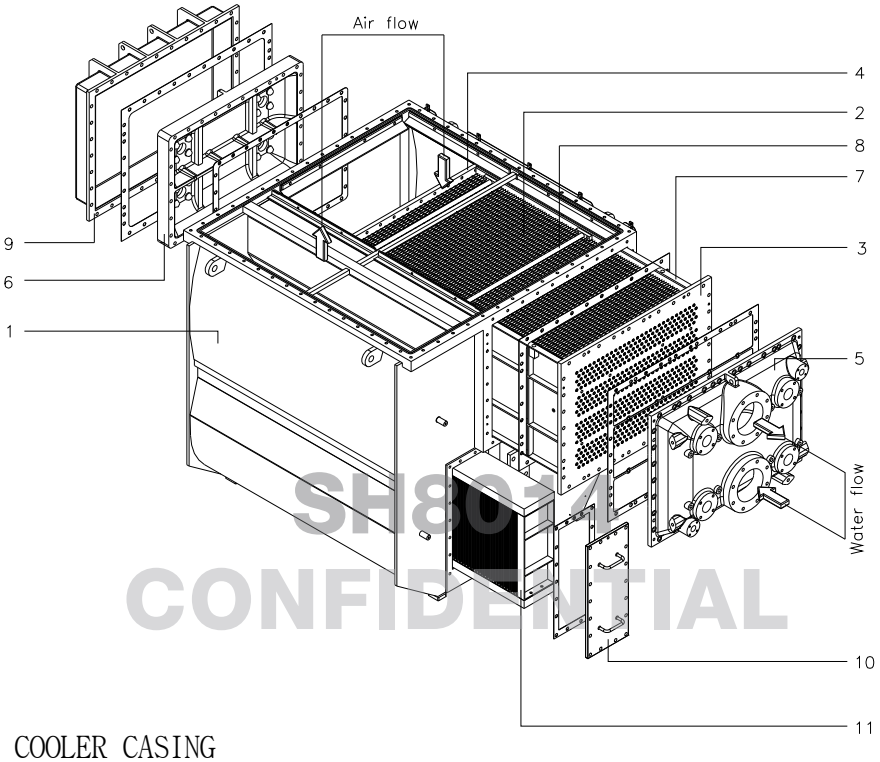
The heat removed from air is carried away by the cooling water (sea water or fresh water). The cooling water flows on the inside of the fin-tube, while air flows along the outside of the fin-tube.

We call a cooling water side as Water Side and fin-tube side as Air Side. The cooling methods of water side are differential into F.W(Fresh Water) cooling & S.W (Sea Water) cooling, and Central cooling system.

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II. STRUCTURES

Air cooler mainly consists of cooler insert and casing. Cooler insert is made up of tube bundle and water cover.



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1. AIR COOLER CASING
2. FIN TUBE BUNDLE
3. FIXED TUBE SHEET
4. FLOATING TUBE SHEET
5. CHANNEL COVER
6. REVERSING COVER
7. SIDE PLATE
8. SUPPORTING BAR
9. END COVER
10. MIST CATCHER COVER
11. MIST CATCHER

AIR COOLER WITH CASING

II-1. TUBE BUNDLE

The bundle has several multi-finned tube block arranged in the direction of the air flow. According the cooler capacity, the number of block and size of each tube block are decided.

Both ends of the finned tubes are installed in the tube sheets by tube expansion with mechanical tube expander. And special hydraulic ball expander is used for the preference adherence of fin and tube. Fin-tube block is immortally fixed at tube sheet so that is unable to take apart each other.

The two side plates serve for protecting the finned-tube and for reinforcing the cooler performance by preventing air by-pass.

The channel cover is securely bolted to tube sheet, while the reversing cover is only supported by stud bolt with clearance for absorbing thermal expansion of tubes and stud bolt is fixed with wire.

At side plate, lifting bosses are welded on for eye bolt and these make easier handling of unit. The supporting bars bolted on side plate serve for supporting tube bundle and for preventing the damage from a abnormal vibration. And also all bolts are tag-welded to prevent unlocking.

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Ⅱ-2 WATER COVER

Water cover has water inlet & outlet nozzle, partition plate for controlling water pass, air vent & water drain connection and chemical cleaning. And there is two jack bolt to easily detach cover from bundle for cleaning. Two water covers, the channel and reversing cover, are tightly bolted to corresponding tube sheet with gasket. Here water inlet & outlet nozzle detached cover is called channel cover and the opposite cover is called reversing cover. When the cooling medium is sea water, there is zinc anode or soft iron on water cover inside to protect cover from corrosion. The corrosion protecting medium, zinc anode or soft iron, is connected as flange type to exchange it when it was wear away and is bolted with gasket to water cover.

Ⅲ OPERATION

Ⅲ-1 COOLING WATER SIDE

The bundle is to be filled with water and at the same time the air vent valve is to be opened so that the air in the bundle can escape through it. There is no more air bubbles in the escaping cooling water (it means air vented completely and the bundle has been filled with water), close the air vent valve tightly. If air remains in the tubes, which will not only deteriorate the performance, but also may cause accidents during operation, so that special care is required. After the cooler is filled with water completely, it may be O.K to operate the air cooler. When the pressure and temperature reach the normal operating condition, confirm that there are no abnormalities in regard to bolts, nuts, and gaskets. If water should be leaking from the gaskets, retighten the bolts and nuts. Continuously water leak even after retightening, the gasket should be exchanged for a spare gasket.

During operation, do not exceed the permitted condition. If do exceed, contact us and consider the operation condition. If you don't, we don't take the responsibility of resulting problem.

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Ⅲ-2 AIR SIDE

Make sure that the operation on the cooling water side is normal, and then the cooler is fed with air. When the operating temperature has been reached, check on the air leakage. The charged air temperature inlet and outlet of the cooler is checked up and the cooling water quantity is to be corrected, if required. After operation start for the air side, once more confirm that the connections of the cooling water side and the air side are secure.

Ⅲ-3 OPERATION STOP

When stop the operation, first stop the air side and then the cooling water side. When stop period will continue several days, during winter season without worming open the drain valve in the cover and drain all water from the cooler to prevent freezing. In case of sea water cooling, even when staying at port for short time, if the port sea water is polluted, it is recommended to replenish with fresh water to prevent corrosion from the polluted sea water.

Ⅲ-4 COOLING WATER VELOCITY

Cooling water velocity is limited in view of erosion, corrosion, and fouling so that do operate over the minimum velocity. *And the best tube inside velocity is staying the recommended velocity range.*

Tube Material	Recommended velocity (m/sec)		Minimum velocity (m/sec)
	Fresh Water	Sea Water	
Copper-Nickel (9:1)	1.8 ~ 2.5	1.5 ~ 2.0	1.0

※Note : Please never operate at the minimum velocity for the prolonged periods to prevent causing serious fouling.

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Ⅳ MAINTENANCE AND INSPECTION DURING OPERATION

Ⅳ-1 COOLING MANAGMENT

(1) With use for a long time, various contaminations are deposited inside of tubes and fins. It cause to deteriorate the performance of the air cooler, so following items should be checked during operation

· *Temperature difference between inlet and outlet side of air and water*

· *Pressure loss for air and water*

When a pressure loss has been doubled of initial condition, execute washing and cleaning.

(2) When running the engine at part loads as well as during maneuvering or running in winter season, the temperature or the amount of cooling water passing through the air coolers should be regulated so that the air temperature at the outlet of the cooler does not drop too low. If the air is cooled down to a dew point temperature, considerable amount of condensed water will collect in the air receiver. If the charged air temperature is above the dew point, condensates will form only where the air comes in contact with surface whose temperature is below the dew point. At this time, it is advisable to control the cooling water source temperature by adjusting circulation valve but inevitably if the cooling water quantity for the air cooler is controlled, the outlet valve should be throttled.

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Ⅳ-2 ELECTROCHEMICAL CORROSION PROTECTING METAL

When the cooling water is sea water, a protection metal is installed inside the cover of the air cooler to protect the cooler from corrosion.

In order to protect the electrochemical corrosion of the cooler, the anode plates are installed in the cover. When operation is continued after the protection metal has been used up, notable corrosion will occur for the cover in case of standard equipment or for the tubes and tube sheets when the cover is equipped with anticorrosion rubber lining etc., so that this metal should be periodically and should be replenished as required. The anode plate has to be exchanged for new one regularly. Generally the consumption of the anode plate in new cooler is very fast. *So, generally the first exchanging should be done within 2*

months after delivering ship. After that time the exchanging intervals are decided in accordance with the degree of the consumption on the last inspection.

Care should be taken that the surface of the protection metal and the threaded part are free of oil, paint, etc.

Ⅳ-3. COVER COATING MANAGEMENT

At the inside of the cover is coated with tar-free epoxy resin, neoprene lining, etc to protect the cover from corrosion by the cooling water, the inside coating should be inspected when the cover detached for inspection, cleaning, etc. *If there is any damage, it should be repaired immediately.* If you don't, local corrosion will occur at the damaged part, and finally the cover will be destroyed.

And also when you detach the cover, careful handling is required so that the surface will not be damaged.

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Ⅳ-4. USE OF THE PLUG

When the tubes are broken because of corrosion or for some other reasons, use the accessory plugs to plug both ends of the tube. The plug should be installed according to the followings

(1) Drain the water completely from the cover.

(2) Detach the cover installation bolts and nuts, and detach the cover. When it is difficult to detach the cover from the casing, the jack bolts should be used.

(3) Drive the plug into both ends of the broken tube.

Ⅳ-5 INSPECTION

Normal hydro test pressure of water side is 6kg/cm². And air side test is done during operation whether leak or not. and general test pressure is 3kg/cm².

The holding time of air side and water side pressure test is 30 minutes. *Only clean fresh water is used for the water pressure test of the cooler.* Add soluble ferrous sulphate(FeS40, 7H2O) to stimulate generating the protective film at new cooler. The quantity of soluble ferrous sulphate is 1ppm per hour.

It takes a time to be generating the protective film at new cooler tubes. So it is very harmful directly to contact tube with dirty harbor water. If dirty harbor water contact, the dirt film immediately generate on tube and will hinder the build-up of a protective layer.

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Ⅴ. CLEANING

Use the cooler for a long times, various contaminations are deposited inside of tubes and fins. It causes to deteriorate the performance of the cooler. Check the cooler outlet air temperature and if it is increased considerably, and water side pressure loss is doubled when compared initial condition, you must execute cleaning.

Water side cleaning of the bundle should be carried out, if a considerable increase in air temperature measured at the outlet of the cooler. Keep in mind that a slight fouling at the water side is too much influencing to air cooler performance. Air side cleaning of the bundle should be carried out if the pressure loss of the cooler has been about double of the initial condition.

Ⅴ-1. WATER SIDE CLEANING

(1) USE BRUSHING TOOLS

① Turn off the blower

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② Close the cooling water supplying valves and discharge pipe valves

③ Open the drain valve so that the bundle is to be empty.

④ Disconnect pipelines, and take off the both water covers using the jack bolts, if necessary.

⑤ If the unit comprises zinc protection plates or soft iron, these should be examined for their condition when water covers are detached. Damaged or wore down zinc plates or soft iron have to be exchanged new ones. The cover has to be sandblasted and given a new coat of tar-free epoxy, if the damaged cover area is large. Covers made of bronze or gunmetal don't need protective coats of paint and zinc protection plates but at that case soft iron is usually used for generating protective film on the tube surface.

⑥ Using the provided nylon brush tool, clean all tubes while they are still wet.

⑦ Rinse each tube with water to remove the brushed off dirt.

⑧ And then it is make sure that the tube inside is clean, and replace the covers and gasket after checking up the water side connections again.

⑨ After completely reassembled, operate water pump and do hydro test to check leaking.

⑩ All work is done, open valves and operate the cooler.

(2) CHEMICAL CLEANING

When it is impossible to remove the fouling with tube brush, it is effective to circulate chemical cleaning solution. But, it take a considerable cautions, because if chemical cleaning fails, the tubes and others will be damaged, resulting in shortening the life of apparatuses remarkably. After finishing chemical cleaning, circulate fresh water so that cleaning solution is not remain in the cooling water. *If you have no experience in chemical cleaning, consult the manufacturer.*

Chemical cleaning should be carried out by circulating method as built-in or by dipping the bundle into some cleaning solution after pull out it from the casing or between the air ducts. Working methods are following

① Turn off the blower

② Close the cooling water supplying valves and discharge pipe valves

③ Open the drain valve so that the bundle is to be empty.

④ Mix the chemical solution with water to specific concentrate, and sufficient amount as calculated water side volume.

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⑤ Connect circulation pump and chemical tank at chemical connection on water cover. And then run pump and circulate solution.

⑥ When chemical cleaning has been done, stop pump and drain the solution through drain valve.

⑦ *After solution draining, add neutralizer at chemical tank and neutralizing the remained solution.*

⑧ Finish all of above steps, check again and run the cooler.

Ⅴ- 2. THE AIR SIDE CLEANING

(1) At moderation condition, it is possible to clean out by washing with hot water and compressed air.

(2) But there are some deposits such as oil, grease, carbon, etc., it is preferable to clean it with steam blasts(3 ~ 7 kgf/cm2, 150℃ of less) or hot water and compressed air.

(3) It is impossible to clean by above, chemical cleaning must be carried out. Detach the bundle from the casing and dip it in cleaning solution. Chemical cleaning method is available as built-in by circulation of solution, when the cleaning system is equipped on

board. *After the bundle has been cleaned, it should be thoroughly flushed, dried, and properly reassembled.*

Consideration should be taken to choose the chemical solution and cleaning process and must follow the guidance of chemical supplier not to attack tube or fin material.

(4) *When all work is done, you should add neutralizer and dissolve the remaining solution*

Ⅴ-3. RECOMMENDED CHEMICAL AGENT AND SUPPLIER

	Chemical	Supplier
FOR WATER SIDE	SAF-ACID	= Drew Ameroid Japan Co., Ltd. Minato Ise Bldg. 12-1, 3-Chome, Kaigan-Dori, Naka-ku,Yokohama-si, Xanagwa-Ken, 231, Japan Phone : 045 - 212 -4741 Faxsimile : 045 - 212 - 4754 = Drew-Chemical
FOR AIR SIDE	ACC9	= Drew Ameroid Japan Co., Ltd. = Drew Chemical Co. New York, USA

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※ *Please consult chemical supplier's description.*

Ⅵ. PURCHASE SPARE PARTS FOR MAINTENANCE

During operation period, exchanging from old parts into new ones is necessary for maintenance. For purchase, you know the detail structures and if necessary, refer to section Ⅱ Structures and attached drawing.

The air cooler's parts names are tube bundle, water cover, gasket or packing, bolt, nut, anode, anode cover.

The ordering methods are following

1) See the nameplate and write down followings

SHIP NO., MANUFACTURE NO.

MANUFACTURING DATE, CLASS

If there is not name plate or hard to see, you can also find at left or right side of tube sheet.

2) Check 1) and numbers and names that you need parts.

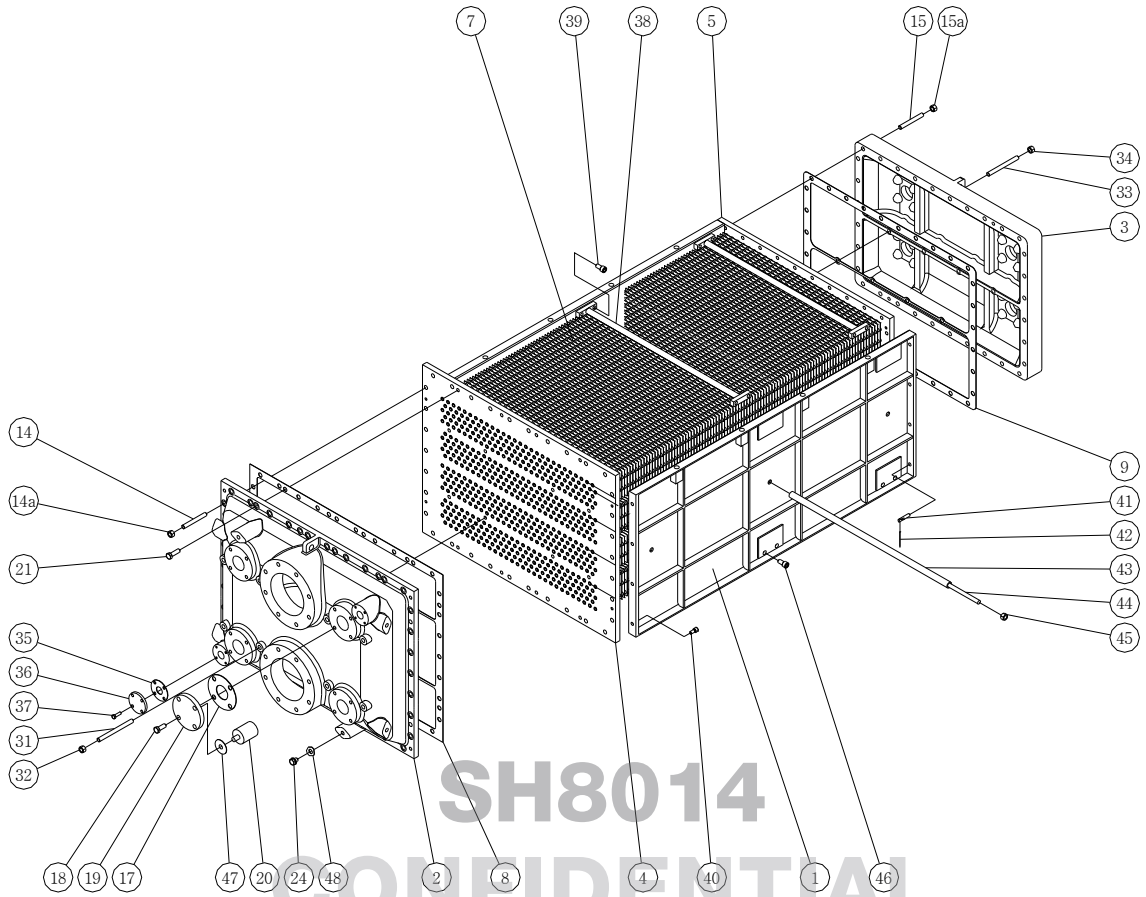
3) Contact us by in person, mail, telephone, or fax and inform us.

4) Reconfirm your ordering list.

Tel. +82 - 051 - 970 - 1115, +82 - 051 - 970 - 1116

Fax. +82 - 051 - 970 - 1111

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PART NO.	NAME	PART NO.	NAME
1	Side plate	34	Hex. nut
2	Channel cover	35	Gasket
3	Reversing cover	36	Flange
4	Fixed tube sheet	37	Hex. bolt
5	Floating tube sheet	38	Supporting bar
7	Fin & tube	39	Wrench bolt
8	Channel cover gasket	40	Wrench bolt
9	Reversing cover gasket	41	Stud bolt
14	Stud bolt	42	Wire
14a	Hex. nut	43	Pipe
15	Stud bolt	44	Round bar
15a	Hex. nut	45	Hex. nut
17	Anode cover gasket	46	Wrench bolt
18	Anode cover	47	Gasket
19	Hex. bolt	48	Gasket
20	Protecting anode		
21	Hex. bolt		
24	Plug		
31	Stud bolt		
32	Hex. nut		
33	Stud bolt		
34	Hex. nut		

APPENDIX

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II. TREATMENT ---------- 18

III. CHECK-LIST OF COVER-SIDE AT OVERHAUL ---------- 19

IV. CHECK-LIST OF FIN-SIDE AT OVERHAUL ---------- 20

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CHECK SHEET

ITEM	WORKS	INTERVAL			
		D	W	M	O.H
Cooling Water Temp. (Inlet & Outlet)	Check by thermometer	●			
Vibration & Noise	Observe from appearance	●			
Appearance	Leakage from gasket-face		●		
	Looseness of tightening bolt			●	
Inspection For Internal	Corrosion on gasket-face of the interior of cover				●
	Check tube inside by visual				●
	Check welds by pt				●
	Measurement tube I.D & Spot check insert-tube				●
	Check corrosion and damage for fin surface				●
	Check corrosion and damage for cover internal				●
	Corrosion on tube				●
	Deformation and corrosion for support-plates				●
	Check gasket face				●
Leak And Proof-Test	Leakage from tube to tube-sheet joints				●
	Pressure proof test				●

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NOTE : D = DAILY W = WEEKLY

M = MONTHLY O.H = OVERHAUL

TREATMENT

ITEM	WORKING	TREATMENT
Gasket-Seat-Face	Check Leaking	Re-Tighten Bolt/Nut and Renew Gasket
Vibration and noise	Observe from Appearance	Clarify the Cause & Treat
Tube Inside	Check Inlet-Attack	Plugging for Tube
Outside of Tube	Check Leaking	Plugging for Tube

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CHECK-LIST OF COVER-SIDE AT OVERHAUL (✓)

	Check Internal Pressure and Temperature
	Open Air Vent Valves and Drain Valves
	Remove Instrument
	Dismount Cover
	Dip-out Drain Remained in the Inside of Cover
	Clean Cover Inside and Parts
	Check Gasket-Face of Cover
	Measure & Record Inside Diameter of Tubes for Total-Number
	Set Gasket with Gasket-Paste on Pass Partition
	Mount Cover and Carry Pressure-Test
	Set Instrument, Valve and the other Attachments
	Record Necessary Parts Next Overhaul

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DATE : EXECUTIONER : ASSUROR :

CHECK-LIST OF FIN-SIDE AT OVERHAUL (✓)

	Check Internal Pressure and Temperature
	Remove Instrument
	Consider Support-Plates or Side-Plates for Deformation and Corrosion
	Check Support-Plates or Side-Plates for Deformation and Corrosion
	Inspect Surface of Fins for Damage and Corrosion
	Clean Surface of Fins
	Check Bolts And Nuts for Damage and Deformation of Support-Plates or Side-Plates
	Set Instrument
	Record Necessary Parts for Next Overhaul

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DATE : EXECUTIONER : ASSUROR :

Service Manual



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Air Starter

Model : SM10

SHIN HEUNG PRECISION CO., LTD.

Publication No. : SHP-SM07-V2

Rev-1

We've changed model No.from ASM10 to SM10 but all specification / function are not changed

Rev-2

We've added this sentence "Exceptively, SHP has no liabilities to the malfunction of solenoid valve and air valve piston caused by even foreign substances which inflow with clean air into solenoid valve and air valve piston" **in the page 1**

Rev-3

We've added ILLUSTRATED PARTS LISTS

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3.0	Installation of a starter(시동기의 설치)	3
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List of drawing(도면리스트)

Section(구분)	Subject(제목)	Page
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2.	Installation diagram(설치도)	14
3.	Performance Curve(성능곡선)	15

1.0 General Information

This manual explains how to install and operate the SM10 air starter.
Contact SHIN HEUNG PRECISION CO., LTD.'s agencies or distributors if you have further questions that can not be answered through the manual.

SM10 is a turbine engine air starter equipped with a pre-engaged device.
It is suitable for from 1800CID(30Liters) of a diesel engine to 18000CID(300Liters) of a gasoline engine.
SM10 starter can be operated in various ranges of temperature surrounded and under a different air pressure in a gate.
The actual minimum pressure to start is determined by the size and/or loads of the engine.

SM10 starter is designed to use compressed air to operate a starter.
Even tiny foreign substances or oils in the air will not have an impact on operating SM10 starter. None of the SM series require lubrication in the air supplied.
(Exceptively, SHP has no liabilities to the malfunction of solenoid valve and air valve piston caused by even foreign substances which inflow with clean air into solenoid valve and air valve piston)
Read this manual carefully before installing the SM10 air starter.

1.0 일반적 정보

이 설명서는 SM10 Air Starting Motor 의 설치와 작동방법을 설명한다. 만약 이 설명서로써 이해가 불충분하다면 신흥정공(주)대리점이나 판매처에 연락하여 도움을 받아라.

SM10 starter는 pre-engaged 장치를 가진 turbine시동 모타이다.
SM10은 1800CID(30Lters) 디젤엔진부터 18000CID(300Liters) 가스엔진의 범위까지 적합하도록 되어있다.

SM10모델은 광범위한 주위온도와 입구공기압력에 작동될 수 있도록 되어 있다.
엔진크기와 부하에 의해 시동을 할 수 있는 실질적인 최저압력이 결정될 것이다.

SM10은 압축공기나 가스에 의해 작동되도록 설계되었다.
공급공기 중에 있는 극소량의 이물질이나 어떠한 액체는 SM10시동기에 영향을 미치지 않는다. 모든 SM시동기는 공기공급에 어떠한 윤활도 필요로 하지 않는다.
(단, Solenoid valve 및 Air valve piston 내부로 이물질이 혼입되는 경우

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에는 오작동이 발생할 수 있음. 신흥정공(주)는이에 대해서는 책임을 지지 않는다.)

SM10 시동모터를 설치하기 위해서는 이 매뉴얼을 반드시 읽어본 후 설치해야 한다

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Warning, Caution, and Note

There are 3 types of user's attention in the manual.

Warning – when it is possible to harm a human and/or to damage the equipment.

Caution – when it is possible to damage the equipment.

Note – when there is a particular comment for specific cases.

Note

"AIR" in this manual represents a transmission object for operating a starter.

Thus, "AIR" means compressed air or gas unless otherwise stated.

경고, 주의, 그리고 NOTE

경고-사람에게 상해를 입히거나 설비에 손상을 줄만한 사항.

주의-설비에 손상을 줄 가능성이 있는 사항

NOTE-특별한 주의를 지적할 때 표시 사항

NOTE

이 설명서에서 "AIR"란 표현은 시동기를 구동하기 위한 매개체로 사용되는 것을 의미한다. 다른 언급이 없다면 "AIR"는 압축된 공기나 가스를 의미한다.

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1.1 Description

SM10 starter is composed of 3 basic components, which include unique 2 steps of turbine motor parts such as an offset/spur gear part and a pre-engaged drive part.

A 2nd step motor part that has a greater stall torque characters than a 1st step turbine is helpful to control the aerodynamic speed.

Such aerodynamic speed control is effective to prevent an SM10 starter from being damaged due to the over speed of a motor. In addition, a motor housing module and low-mass rotors that have been uniquely designed are offered for safe operating of a starter.

1.1 서술

SM10은 3가지의 기본적인 조합품으로 구성된다. 독특한 2단계의 터빈모터 part 즉, offset/spur 기어 part와 pre-engaged drive part 이다.

1단계의 터빈보다 훨씬 더 큰 stall torque특성을 갖는 2단계 모타 부분은 공기역학적인 속도제어에 도움이 된다.

이 공기역학적 속도 조절은 SM10시동기가 시동기 모타의 과속으로 인한 손상을 막아주는데 효과가 있다. 또한 특별히 고안된 motor housing module과 low-mass rotors는 안전한 가동을 제공한다.

A spur gear box with the ratio of 9.25:1 is used for ASM10, of which a lower ratio of turbine motor spins for a longer period in a lower speed so as to keep a bearing life longer. A turbine spins in 27750rpm at a typical pinion speed of 3000rpm.

A pre-engaged operation transmits torque to pinion.

Pinion is delivered to a piston of a starter through an engine ring gear.

Compressed air or gas is sent through inlet ports and used as a power source of SM10. Those compressed air or gas will be expanded through a first nozzle or a stator. High speed gas collides with a 1st step rotor, causing energy conversion, and creates torque in a gear box. More gas will be induced by a 2nd stator that transmits additional torque.

SM10은 9.25:1 비율의 SPUR기어박스를 사용하였다. 이 낮은 기어 비율은 터빈모터가 낮은 속도에서 장시간동안 회전하므로 베어링 수명을 길게 한다. 전형적인 3000rpm의 pinion 속도에서 터빈은 27750rpm으로 회전한다.

pre-engaged 구동은 토르크를 pinion에 전달한다.

pinion은 엔진 링 기어를 거쳐 시동기의 피스톤으로 전달된다.

압축된 공기나 가스는 inlet포트를 거쳐 SM10의 동력원으로 사용된다. 공기 또는 가스는 첫 번째 노즐이나 고정자를 통해 팽창한다. 고속의 가스는 1단계의 회전자에 충돌하여 에너지 변환을 일으켜 기어박스에서 torque를 생성한다. 가스는 추가적인 torque를 전달해주는 2차 고정자를 통해서 보다 더 유도된다.

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1.2 Product

There will be the following descriptions on a starter tag attached to turbine housing: model number, serial number, maximum operating pressure, and contact information.

Rotation can be either to the right or to the left direction.

1.2 제품

터빈하우징에 부착된 시동기 명판에는 다음과 같은 사항이 표시되어 있다.

모델넘버,시리얼넘버,최대작동압력,연락처 이다.

회전방향은 오른쪽 또는 왼쪽이다.

A rotation to the right is defined by moving clockwise from the end of pinion on a starter. A rotation to the left is a counterclockwise movement from the end of pinion on a starter.
A maximum operating pressure on a tag is measured from an entrance of a starter inlet while being operated.

오른쪽 회전은 스타터의 피니언 끝에서부터 보았을 때 시계방향으로 정의한다. 왼쪽 회전은 스타터의 피니언 끝에서 보았을 때 반시계방향이다.
명판에 표시된 최대 작동 압력은 운전중 stater의 inlet 점검구에서 측정된 것이다.

Caution
Higher maximum pressure than the one on a tag can cause damages on a starter or failure to engine which can damage the engine.

Housing proof pressure is 600psig. That is, turbine housing will not be destroyed when a constant pressure is 600psig.

주 의
명판에 표시된 최고압력을 초과하면 시동기에 손상을 주거나 엔진에 손상을 주는 구동실패를 초래한다.

Housing proof pressure는 600 psig이다. 이것은 터빈 하우징이 600psig의 정압력일 때 파열되지 않는다는 것을 의미한다.

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1.3 Physical characteristics

Figure 1 is a standard external form of SM10 with an exhaust screen. The model weights about 54lbs and 16.8inch in length. These features are the same on all SM10 starter models.

1.3 물리적 특징

그림1는 SM10의 배기 screen이 있는 표준 외형도이다. 이 모델의 무게는 대략 54lbs이고 길이는 16.8inch이다. 이것은 모든 SM10 시동기 모델에 공통적이다.

1.4 Performance

The performance curve of SM10 explains torque characteristics and horse power compared to pinion speed (rpm) in constant operating pressure.

1.4 성능

SM10의 성능곡선은 일정한 구동압력으로 피니언 속도(RPM)대비 TORQUE 특성 및 마력을 설명하고 있다.

Pinion speed is in the horizontal axis, and pinion torque is in the left hand side of the vertical axis. Air consumption ratio can be determined by each drive pressure. The operating gas used for a performance curve is air.

피니언 속도는 가로축에 표시하고 피니언 토크는 세로축선의 왼쪽에 표시된다. 공기소모비율은 각종 드라이브 압력에 따라 결정된다. 성능곡선에 사용된 구동용 가스는 공기이다.

2.0 Orientation of a starter

If the orientation of turbine housing on a starter is not appropriate for installing on an engine, elements may be relocated. Determine the orientation required for a pinion housing and gear box housing.

Turbine housing components can be rotated in 6 different positions with gearbox housing.

Operating components can be rotated in 24 different positions in accordance with inlet-port. Orientation of a starter must be determined before installing a starter on an engine.

2.0 시동기의 위치

만일 시동기 터빈 하우징이 엔진설치 조건에 적합하지 않을 경우 이 구성부품은 설치하기 위하여 재조정 할 수 있다. 터빈하우징 조립품 및 기어박스 하우징 조립품이 설치되기 위한 위치 조건을 결정하라.

터빈하우징 조립품은 기억박스 하우징과 6개의 다른 위치로 회전 할 수 있다.

구동조립부는 INLET-PORT와 관련된 24개의 다른 위치로 회전할 수 있다. 시동기의 오리엔테이션은 엔진에 시동기를 설치하기 이전에 결정되어져 있어야 한다.

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Caution
All screw mounts are treated with adhesive compounds in factory. Each screw and tap holes should be cleaned well. Use loctite271 for screw mounts before installation.

주 의
모든 나사산은 공장에서 체결용 컴파운드 처리되어있다. 각 나사 및 tap hole 은 청결하게 하고 설치되기 전에 나사산에 loctite271을 사용하여 체결한다.

3.0 Installation of a starter

A turbine engine starter can be operated without any lubrication in air supplied. Therefore, if a Vane-type starter motor is replaced, SHIN HEUNG PRECISION CO., LTD. recommends removing all facilities and lines of lubrication in order to minimize a flow resist.

Warning
If a fuel (pulse) lubrication device is already installed on a system, disconnect the engine and connect a line to plug in order to prevent the engine from being sprayed by diesel fuel.

3.0 시동기의 설치

터빈 공기 시동기는 공급되는 공기에 윤활을 필요로 하지 않는다. 그러므로 vane형식의 시동기 모터로 대체되었다면, 신흥정공(주)는 공기흐름 제한을 최소화하기 위하여 모든 윤활 장치 및 line이 제거 될 것을 권장한다.

경 고
만약 시스템에 연료 lubricator가 사전에 설치되어져 있다면 연결을 해제하고 엔진에 디젤 연료의 분사를 방지하기 위해 line에 plug 처리를 해라

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An inlet valve of a starter should be oriented a little bit lower than a horizontal line and inclined. There should be no condensed water in air lines or in a starter.

Warning
Do not operate a starter unless the starter connects to an engine properly

시동기의 inlet valve의 위치는 수평한 line에서 약간 밑으로 경사지게 설치되어져야 한다. 어떠한 응축수도 공기라인과 시동기에서 발생되어 있어서는 안된다.

경 고
시동기가 엔진과 적절히 연결되어 있지 않다면 작동을 하지마라.

3.1 Installation of supplying line

3.1 공급라인설치

Warning
All valves installed in a starter supplying line should be in off position and there are no pressure decreasing due to any leakage in an air tank in accordance with safety system.

The connection entrance of inlet of SM10 starter is standardized with 2" flange type. Supplying line consists of a pressure regulator (if applicable), relay valve, and lines of a starter inlet connector from an air source. When using solid pipes such as steel pipes that are not flexible, install flexible tubes in order to prevent damages while the engine is being vibrated. All inlet supplying line pipes should be at least 1.5" and all components of the line should be used to make air flow smoothly.

Caution
40CV(A) or higher valves are recommended.

If supplying line is longer than 20feet, use pipes with at least 2" in diameter for inlet supplying line for a suitable performance.

Turbine starters like SM10 are sensitive to air flow limits. Therefore, hose or fitting and connecting entrance for connecting supplying lines should be flat and constant. Minimize the length of tee, elbow

경 고
어떤 시동기 공급라인에 설치되어있는 모든밸브가 잠겨있는가 혹은 air tank에서 leak가 발생하여 압력저하가 없는지 등의 안전 시스템을 반드시 확인해라.

SM10시동기 inlet 접속구는 2″pt flange type으로 규격화 되어있다

공급 line은 air공급원으로부터,압력 regulartor(필요시설치),relay valve그리고 시동기 inlet 연결구의 line으로 구성되어있다. steel pipe와 같이 유연성이 없는 단단한 pipe를 사용할 경우 엔진진동으로부터 파손되는것을 방지하기 위해 중간에 flexible tube를 설치해야한다. 확실히 명심할 것은 모든 inlet 공급라인의 관이 적어도 1.5″가 되어야 하고 line 의 모든 구성부품들은 원활한 공기흐름이 가능하도록 사용되어져야 한다.

주 의
40CV(A) 또는 그보다 높은 밸브를 추천한다.

만약 공급라인이 20feet보다 길다면 ASM10의 적정한 성능을 위해 inlet 공급라인의 piping은 직경 2″정도 사용해야한다.

SM10과 같은 터빈 시동기는 공기흐름제한에 민감하기 때문에 공급라인의 연결을 위해 사용한 호스 또는 fitting 및 연결구를 평평하고 일정하게 유지하여 사용해야한다. 티, 엘보우

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and/or line lengths. SHIN HEUNG PRECISION Co., LTD recommends to install flex couplings and hose in order to remove any possibility of leakage due to strain of supplying lines.

및 line길이는 최소한으로 유지하라. 신흥정공(주)는 공급라인의 strain에 의해 야기되어지는 leakage가능성을 제거하기위해 호스와 플렉스 커플링 설치를 권장한다.

Generally air strainer is not required. 40mesh Y-strainer is recommended for a polluted environment. SM10 stands dusts of air lines, but using an air filter can extend the life of a starter.

일반적으로 공기 strainer 는 필요하지 않다. 오염된 환경에서는 40메쉬 Y-strainer 사용을 권장한다. SM10 은 에어라인의 먼지에 견뎌내지만 공기여과기 사용으로 시동기의 수명이 연장될 수 있다.

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A regulator will be used when an air supplying pressure is high enough to operate the maximum torque and/or a pressure for operating a starter. A manual ball valve will be used when supplying air/gas to a starter. A manual valve should be in a safe location far from an engine.
A pilot valve that operates automatically by an air pressure or electrically would be better.

Regulator는 에어 공급 압력이 시동기의 운전압력 그리고/또는 최대토크를 가동하는 충분할 만큼보다 더 높을 때 사용되어진다. 수동 볼 밸브는 시동기에 air/gas를 공급할 때 사용되어진다. 수동 밸브는 엔진에서 떨어진 안전한 곳에 위치하여야 한다.
보다 더 좋은 밸브는 공압이나 전기적으로 작동되는 pilot작동 밸브이다. 좋은 성능을 위해 밸브는 시동기 inlet 이나 그 부근에 가깝게 위치해야한다.

The valve should be located in or near a starter inlet for better performance.

Air pressure or electrical control lines may be appropriately determined in accordance with workspace situations. Such types of valve operate very quickly from a completely closed position to a completely open position. SHIN HEUNG PRECISION Co., LTD provides relay valves of 45 port which is operated by an air pressure. Supplying lines should be ready for an appropriate alignment and location before being completely assembled. All join area of drain screw mounts should be sealed with a loctite pipe thread sealant or equivalent to prevent leakage before finally being assembled.

공압 또는 전기적 control 라인은 사용자의 작업장의 작업 상황에 따라서 적합하게 결정되어진다. 이러한 타입의 밸브는 완전히 닫힌 상태에서 완전히 열린 상태의 위치가 될 때 까지 매우 빠르게 작동된다. 신흥정공(주)는 공압으로 작동하는 ∅45의 port의 relay 밸브를 제공한다. 공급라인은 최종으로 조립되기 이전에 적절한 alignment 와 location이 준비되어 있어야 한다. 모든 배관나사산의 조인트 부분은 최종 조립전에 loctite pipe thread sealant나 이에 상당하는 누수조임 이음매로 밀봉하여야 한다.

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Caution
Under the cold weather condition, condensed water which may affect on a starter system should be considered to be prevented in an installation stage. A regulator or relay valve will possibly be frozen.

주 의
추운날씨에서는 시동기 시스템에 영향을 주는 응축수를 방지하기 위한 구상을 설치단계에서 반영되어야만 한다. 레규레이터나 릴레이 밸브는 얼어붙을 가능성이 있다.

A tee connection which can be quickly disconnected is available for an inlet. It can be used for an

quick disconnect 할 수 있는 tee 연결은 inlet에 연결할 수 있다. 이것은 만약 시스템이 얼어버렸을 경우“blow start”를 하기위해 사용되는

external air source for "blow start" when a system is frozen.

Once an engine starts operating, other components of the system will defrost.

외부공기원에 이용 될 것이다.

엔진이 한번 가동되기 시작하면 다른 시스템의 부품들은 해빙되어진다.

Caution
For the first installation, removing dusts or welding slag by air blowing before connecting SM starter is strongly recommended. Make sure that the end of supplying line is not closed before blowing air through the line.

주 의
신규설치에 있어서 SM시동기를 마지막으로 연결하기 전 공급라인을 공기로 불어 먼지나 용접 슬래그를 제거하기를 강력하게 권장한다. 라인을 공기로 불기 이전에 공급라인의 끝이 막혀있지 않은지 반드시 확인한다.

3.2 Entrance of the inlet

There is ¼"pt port in an entrance of the inlet. This port is used to check supplying pressure in a starter while the starter is operating. Remove ¼"pt pipe plug and store this in order to use later.

Install a ¼"pipe to the port. Keep a drain pipe far from a starter for a safety reason. Install a pressure gage in a drain pipe. This pressure gage will be permanently installed for monitoring and measuring line. Use a loctite pipe thread sealant or equivalent materials. Install a pressure converter in an entrance of a pressure monitor and determine whether or not deploy an electric line to show a digital screen on a worker's position.

3.2 인입구

AIR 인입구에는 1/4″PT PORT가 있다. 이포트는 시동기가 작동되고 있을 때 시동기에서 공급압력을 체크하는데 사용된다. 1/4″PT PIPE플러그를 제거하고 다음에 사용을 위해 보관하라.

1/4″크기의 관을 포트에 설치하라. 엔진에서부터 시동기의 안전한 위치에 배관을 멀리 유도 한다.압력게이지를 배관에 설치하라. 이 압력 감시 라인/측량계는 영구적으로 설치되어있을 것이다. loctite pipe thread sealant 나 그에 상응하는 자재를 사용하라. 압력 점검구에 압력변환기가 설치되고 작업자의 위치에 디지털로 나타낼 수 있도록 전기 line을 포설할지를 선택하라.

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The pressure port is very important for installation as it examines an air starter.

이 압력포트는 공기시동기의 진단을 내리고 설치문제에 있어 매우 중요하다.

3.3 Exhaust pipe

A turbine starter may be measured far from local. All starters using gas should be exhausted in accordance with industrial codes and local regulations.

A back-pressure which results from a smaller exhaust pipe than a recommended pipe will decrease a turbine starter performance. The back-pressure interrupting a starter performance can be controlled by increasing air pressure. Ask SHIN HEUNG PRECISION Co., LTD for advice. An exhaust pipe should be directed to the bottom in order to prevent condensed water of a starter from being stacked. If a starter is not supported by other methods, SHIN HEUNG PRECISION Co., LTD recommends supporting exhaust pipes with proper brackets.

3.3 배기관

터빈배기는 시동기 지역에서부터 멀리 측정될지도 모른다. 가스를 사용하는 모든 시동기는 산업용코드와 지역규칙에 따라 배관되어져야 한다.

터빈시동기의 성능은 권장하는 관보다 설치된 배출관이 작을 때 발생하는 back-pressure로 인하여 성능이 저하된다. back-pressure가 시동기 성능을 방해하는 경우에, 공급압력을 증가해서 보상할 수 있다. 신흥정공(주)와 연락하여 조언을 구하라. 배기관은 시동기 모터의 응축수가 적체되는 것을 막기 위해 아래로 향해야한다. 만일 시동기가 다른 방법으로 지지되지 않는 경우에 신흥정공(주)는 배기관이 적절한 bracket로 지지되기를 권장한다.

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3.4 soft start valve & filter fitting

A soft start fitting opens and closes a relay valve of a starter smoothly so as to limit overloads of pinion gear of the starter. A soft start fitting can be

3.4 soft start valve & filter fitting

soft start fitting 은 시동기의 릴레이 밸브를 완만하게 개폐를 하게 함으로써, 시동기 피니언 기어의 과도한 하중을 제한한다. 소프트 스타트 피팅은

classified with soft start notes attached. The fitting should be installed as shown in Figure 4. It is screwed "in" or "app" on a relay valve of a starter. There are currently no other alternative materials approved for this fitting.

그것에 붙어있는 soft start 표시를 통해 구분할 수 있다. 이 피팅은 반드시 그림4에 나와있는 것처럼 설치되어야 한다. 그것은 시동기 릴레이 밸브 port에 “in" or "app"에 나사조임 되어 있다. 이 fitting에 대해서는 현재 승인된 어떠한 대체품도 없다.

A filter fitting is to be installed in the bottom area of a soft fitting in order to prevent pollution of pre-engagement mechanism of a starter. The fitter joint should be installed on "in"port as shown in Figure 4. It looks similar to a soft start fitting, but a filter fitting does not have any notes on a joint. When multiple starters are used, soft start fittings should be installed on each relay valve and filter fitting joints should be installed on each starter as shown in Figure 5.

filter fitting은 시동기의 pre-engagement 메카니즘의 오염방지를 위하여 soft fitting하류부분에 설치한다. 피터 이음새는 그림 4에서 보는 것과 같이 “in" port에 설치하여야 한다. 보기에는 소프트 스타트 피팅과 유사해 보이지만 필터 이음새에 어떠한 표시도 되어있지 않다. 여러개의 시동기를 사용할 때에는 그림5에서 보는 바와 같이 소프트 스타트 피팅은 각 릴레이 밸브에 설치되어야 하고 필터 이음새는 각 시동기에 설치한다.

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Caution
A soft start valve when being installed on app port of a relay valve guarantees a maximum pinion life.

주 의
최대의 피니언 수명과 전체보장을 위하여 소프트 스타트 밸브는 릴레이 밸브의 app port에 설치되어져야 한다.

3.5 Installation of natural gas starter

When installing a starter using natural gas, all steps except piping fittings,

3.5 천연가스 설치

천연가스를 사용하는 시동기를 설치할 시에는 천연가스에 호환 될 수 있는 모든 fitting류 배관,

valves, or regulators for natural gas are similar to installing a starter using air. The most important part of installing a gas starter is the proper dealing with gas. All starters using gas should be exhausted in accordance with industrial codes and local regulations. Gas vent port of turbine housing is plugged to use compressed air. This vent hole prevents the gas from being leaked after 1st turbine shaft sealing. Remove the 3/8"pt plug and install an exhaust line in order to exhaust gas far from a starter.

,밸브,레규레이타를 제외하고 air설치와 유사하다.
적절한 가스 조절은 시동기 시스템의 사용에 있어 가장 중요하게 여겨야 할 부분이다. 가스를 사용하는 모든 시동기는 산업용코드나 지역규정에 적합하게 배기가 되어야 한다. 터빈하우징의 가스 vent 포트는 압축된 공기사용을 위해 plug 되어있다. 이 vent구는 1차 터빈 샤프트 sealing을 지나서 가스가 샐 가능성이 있는 것을 방지하게 해준다. 이 3/8″PT 플러그를 제거하고 시동기 부분으로부터 가스를 멀리 배출할 수 있는 라인을 설치하라.

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Warning
Do not connect turbine exhaust line with turbine housing vent line. The exhausted gas may add pressures on turbine housing.

경 고
터빈배기라인에 터빈 하우징 vent 라인을 연결시키지 마라. 배기된 가스가 터빈하우징에 압력을 줄 수 있다.

3.6 drain pipe system

Approved metal types of hose assembles are to be used in a compressed air line where permanently add pressures in a starter. Non-metal hose assembles can be used when the drain system is empty after being operated. Only KS-approved products can be used

3.6 배관시스템

metal 호스조립품으로 승인된 타입은 시동기의 영구적으로 압력을 가하는 압축공기라인에 사용하도록 되어있다. 비금속 호스 조립품은 배관 시스템이 시동 절차를 거친 후에 비어있을 경우에 사용이 적용된다. 배관은 반드시 KS에서 승인 제품에 한해 이용한다.
레규레이터

for drain pipes. A relief valve in the bottom of a regulator is provided.

하단의 릴리프 밸브는 제공된다.

4.0 Operating a starter

Ensure all connects are tight and safe from any leakage before operating a starter. Examine 1/4"pt pipe plug connected to an inlet pressure port, or pressure gage/converter of a starter.

4.0 시동기 작동

작동하기 전에 모든 연결이 타이트하고 누설로부터 안전한지 점검하라. 시동기 인입압력 port에 연결된 1/4″ PT 배관 플러그나 압력 게이지/변환기를 점검하라.

Warning
Do not operate SM air starter series of SHIN HEUNG PRECISION CO., LTD. over the air pressure indicated on a tag. It is the pressure measured from an inlet of the starter while operating the starter.

경 고
명판에 표시된 범위보다 더 높은 압력으로 신흥정공(주)의 SM 시동기를 운전하지 마라. 이 압력은 시동기가 작동하고 있을 때 시동기 인렛에서 측정된 것이다.

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A maximum pressure limit for operating is measured from an inlet check port of a starter. A ¼"pt tap is processed to attach a pressure gage onto the inlet housing in order for checking a starter.

최대 작동 압력한계는 시동기 인렛 압력 체크포트에서 측정된 인렛 압력이다. 시동기를 점검하기 위해 inlet하우징에 압력게이지를 부착하기 위한 1/4″ PT tap이 가공되어있다.

Supplying pressure of constant pressure will be always over operating (dynamic) pressure. The maximum pressure (internal pressure) of SM10 starter housing is 600psig(42bar).

정압의 공급압력은 시동(동적인)압력보다 항상 높을 것이다. SM10 시동기 하우징의 최대 임계압력(내압력)은 600PSIG(42BAR)이다.

A pressure decreasing device should be used to guarantee a smooth operation of SM10 starter if the system pressure

최대 작동압력을 초월하는 시스템 압력은 SM10 시동기의 원활한 작동을 보장하기 위해 압력 감압장치를 사용해야한다.

Install a pressure decreasing device together with a relief valve of under 600psig in supplying line if a system constant pressure is over 600psig(42bar).

Note
In order to protect engine ring gear and for a maximum life of pinion of the starter, an operating pressure in the most difficult operation condition is required to be set.

All other parts of the system should comply with local pressure code and pressure limit, which are prior to standard in this manual. If an exhaust pipe causes a back-pressure and/or performance decreasing in a starter, discuss with SHIN HEUNG PRECISION Co., LTD.'s distributors. Supplying pressure can be increased once the decreased power is restored.

Follow the guideline from en engine manufacturers for operating engines.

600PSIG(42BAR)을 초과하는 시스템 정압력은 압력 감압 장치와 더불어 공급 AIR 라인에 600PSIG이하의 릴리프 밸브를 설치하라.

NOTE
시동기 피니언의 최대 수명과 엔진 링 기어의 보호를 위해 가장 어려운 시동 조건에서 엔진에 시동을 걸 때 필요한 운전압력의 설정이 필요하다.

모든 시스템에 있는 다른 부속품들은 지역 압력 코드와 압력한계를 반드시 준수되어야 하고 이설명서의 기준보다 우선한다. 만약 배출관이 후압력 및 시동기 성능 감소를 야기한다면 신흥정공(주)공급자와 상의하라. 감소된 동력을 회복한다면 공급 압력을 증가 시킬 수 있다.

엔진 시동을 위해 엔진 생산자의 지시사항을 따르라.

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4.1 Basic operation

The basic operation of a starter is as follows: Pressed air or gas will operate an engaged piston chamber of the starter through "in" port of open solenoid valve or by manual. Air changes to a piston movement of a starter so that piston can be

4.1 기본적인 운전

시동기의 기본적 운전은 다음과 같다. 가압된 공기나 가스는 수동이나 솔레노이드 밸브의 open된 “in"port를 통해 시동기의 인게이지 피스톤 챔버에 작동한다. air는 시동기의 피스톤 운동으로 전환하여 피스톤이

engaged in to a ring gear of the engine.

엔진의 링기어에 인게이지 될 수 있도록 작동한다.

The forward movement of the piston opens "out"control port of a starter. Air will be delivered to an automatic pilot port (app) of a relay valve to open the relay valve. Pressed air or gas operates to turbine assembly ofa starter through the opening of the relay valve. Air will be expanded in turbine which creates torque and rotates axis. A starter motor torque accelerates the engine. Fuels and igniting device starts the engine. Closing the relay valve will stop the starter.

피스톤의 전진 운동은 시동기의“out” 컨트롤 포트를 open한다. air는 릴레이 밸브의 자동pilot포트(app)에 전달되어 릴레이 밸브를 open하게한다. 가압된 공기나 가스는 릴레이 밸브의 open을 통해 시동기의 터빈 assembly에 작동한다. 공기는 축 회전과 토르크를 발생하는 터빈에서 팽창한다. 시동기 모터 토크는 엔진가속을 할 수 있게 한다. 연료와 점화장치가 바로 엔진을 점화시킨다. 릴레이 밸브를 잠금으로써 시동기를 멈추게 한다.

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Constant operating the starter after starting the engine may result in shorting life of the starter. Thus immediately turn off the air of the starter for successful operating the engine.

엔진이 가동되고 난 후의 지속적인 시동기의 운전은 시동기 수명을 단축시킬 수 있다. 성공적인 엔진 시동을 위해 시동기의 공기를 즉시 꺼라.

The minimization in operating the starter (while the engine is working) will maximize the life of the starter. If ignition is failed, do not restart it until the engine and the starter will settle down.

최소한의 시동기 운전으로써(엔진이 가동하고 있을 때) 시동기 수명을 최대화 시킨다. 만약 시동이 실패하면 엔진과 시동기가 안정 될 때까지 재시동을 하지마라.

Caution
Do not engage the starter (insert the pinion ring to the ring gear) while the engine is working.

The air pressure for the operation is the most important parameter of controlling the starter. In particular, in the first installation such pressure will be measured through several times of engine starting process. The speed will be measured in accordance with the usual engine starting speed and the starter crank ratio. The cranking ration can be divided into a number of pinion saw teeth and ring gear saw teeth. The speed of the starter pinion can be determined by the various engine speeds by crank ratio. The speed of pinion is normally about 2000~3500rpm for the typical engine staring speed.

4.2 Automatic starting panel

A starter drive pressure which is measured from an inlet of the starter will be required for setting. As stated in the above, operating pressure limit is required to be determined for the worst environment in order to protect engine ring gear and for the longest life of the starter pinion. Speed adjusting parameters

주 의
엔진이 가동되고 있을 때 시동기를 engage(피니언을 링기어에 인입)하지 말라.

구동 에어압력은 시동기 조정의 첫 번째로 중요한 파라미터이다. 이것은 중요한 것이며 특히 신규로 설치시에 몇 번에 걸친 엔진 시동과정에서 이 압력이 측정된다. 두 번째 파라미터는 시동기 피니언 속도이다. 이 속도는 보통 엔진 시동의 속도와 시동기 크랭크 비율에 따라서 측정되어진다. 크랭킹 비율은 수많은 개수의 피니언 톱니의 링 기어 톱니로 나누어진다. 시동기 피니언 속도는 크랭크 비율에 의한 여러 가지 엔진 속도에 의해 결정된다. 피니언 속도는 전형적인 엔진 시동 속도에 있어서 보통 2000-3500rpm 정도이다.

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4.2 자동 시동판넬

시동기 인렛에서 측정되어진 시동기 드라이브 압력은 셋팅하는데 필요할 것이다. 위에 언급된바와 같이,시동기 피니언의 최대수명과 엔진 링기어의 보호를 위해 가장 가혹한 조건에서 엔진 구동에 필요한 운전압력 한계를 정한다. 속도조절 파라미터는

will be required for setting. Engine starting speeds in accordance with the crank ratio will be used to determine the speed of the starter pinion. The speed of pinion is normally 2000~3500 for the typical engine starting speed. Once starting sequence starts, air is inserted to the starter. The starter accelerates the engine. The engine accelerates its own power. The speed of the starter can be lowered when an rpm is over the igniting speed, but will be smaller than the IDLE speed of the engine. The automatic starting panel should monitor the speed of engine in order to determine on/off the air. Do not simply use time as adjusting parameters. After the engine starts, avoiding excessive operating of the starter can maximize the life of the starter.

5.0 Warranty

SHIN HEUNG PRECISION CO., LTD. offers the 1 year free warranty after installing of SM10 air starter to ensure the materials and qualities of the equipment. The warranty period is for 1.5 years from when the equipment is manufactured. (If a unit is manufactured in Feb 2009, the

셋팅 하는데 필요한 것이다. 크랭크 비율 수에 따른 엔진시동속도는 시동기 피니언 속도를 결정하는데 이용된다. 피니언 속도는 전형적인 엔진 시동 속도에서 보통 2000-3500rpm 정도이다. 시동 sequence가 시작되면 공기가 시동기로 유입된다. 시동기는 엔진을 가속시키기 시작한다. 엔진은 자체 동력을 증속시키기 시작한다. 시동기는 점화속도보다 높은 rpm에서 속도가 떨어질 수 있지만 엔진의 IDLE 속도보다는 적을 것이다. 자동 시동판넬은 공기의 on/off를 결정하기위해 엔진 속도를 모니터 해야한다. 단순히 시간을 조정 파라미터로 사용하지마라. 엔진이 점화된 뒤 시동기의 과도한 운전을 하지 않음으로써 시동기의 수명을 최대화 할 수 있다.

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5.0 보증

신흥정공(주)는 SM10의 정품 공기 시동기의 사용자들에게 설치후 1년간 발생하는 재료나 결함에 대해 보상한다. 보증기간은 제품생산일로부터 1.5년이 넘은 제품에 대해서는 적용되지 않는다.(2009년 3월에 생산된 제품은

warranty is valid till Aug 2010)

The condition for the warranty is as follows:

the trouble with the starter should have been communicated to SHIN HEUNG PRECISION CO., LTD. within the warranty period installation should have been conducted upon explanations in the manual operating and maintaining a starter should have been appropriate by a user; a trouble should not be caused by common abrasion or by being torn a starter should have been maintained by a technician from SHIN HEUNG PRECISION CO., LTD. or a designated individual or agencies certified by SHIN HEUNG PRECISION CO., LTD and a starter should have been installed based upon the guideline of the manual offered by SHIN HEUNG PRECISION CO., LTD.

SHIN HEUNG PRECISION CO., LTD. will repair or exchange equipment for free within the warranty period and offer the service in the appropriate procedure.

SHIN HEUNG PRECISION CO., LTD. is not responsible for any warranty other than those set out above.

2010년 8월 이후로는 적용되지 않는다.)보증의 조건은 신흥정공(주)에 시동기의 고장이 보증기간 내에 통보되었을 시, 시동기가 신흥정공(주)의

설명대로 설치되었을 경우, 시동기가 잘못 사용되어지든지 남용되거나 또는 사용자에 의해 부적절하게 유지되지 않았을 경우, 마멸이나 손상에 의한 결함이 아니거나 시동기가 신흥정공(주)의 기술자 또는 허가된 단체나 개인에 의해 수리가 되어졌을 경우, 그리고 시동기가 신흥정공(주)의 설치 안내지침에 의하여 설치된 경우 보상된다.

신흥정공(주)는 보증기간동안 제품에 대해 무상으로 고객들에게 수리 또는 옵션에 따라 교환 등을 제공하고 적절한 반납절차에 따라 보상받을 수 있도록 제공할 것이다.

신흥정공(주)는 간접적인 보증이나 다른 특정한 목적의 일의 진행을 포함하는 보증에 대해서는 보증을 하지 않는다.

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SHIN HEUNG PRECISION CO., LTD. offers its complete obligation to guarantee the equipment based on the price at the time of purchasing the equipment. SHIN HEUNG PRECISION CO., LTD. is not responsible for any specific and consequential damage either directly or indirectly caused by nature or by accident while using its engine starter after sales.

이 보증은 판매와 제품의 사용에 관계되는 신흥정공(주)의 전반적인 책무에 대해서 구성되어 있으며 구매일을 기준으로 한 제품의 구입가격이내에 범위로 책임이 한정되어 있다. 부수적인, 간접적, 또는 우발적으로 발생하거나 시동기 제품의 판매나 사용에 있어 자연적인 재앙으로 발생하는 특별한 손상에 대해서는 책임이 없다.

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6.0 Troubleshooting

Description	Cause	Solution
1. Air keeps exhausted.	A. A relay valve was not appropriately installed.	A. Check a typical installation diagram and fix the problem.
	B. A relay valve was not appropriately sealed.	B. Check the damaged sealing and replace the damaged parts and a relay valve.
	C. A solenoid was not sealed and there is remaining pressure on APP port of relay valve.	C. Check the potential of solenoids lead from the ground and set it 0. If there is still a trouble, check the igniting switch.
2. An engaged starter is not working.	A. A relay valve is no good.	A. Replace the relay valve.
3. A starter is not working and there is a small amount of air leaking through a drive housing or a turbine exhaust pipe	A. Nozzles are blocked.	A. Remove the parts blocked or damaged in the nozzle.
4. A starter is not working and there is an average amount of air leaking through an exhaust pipe.	A. There is an excessive bending in supplying lines.	A. Have air supplying lines straight or shorter.
5. A pinion is not engaged.	A. Air pressure is too low.	A. Increase the air pressure to 7 BAR.
	B. A port in control lines of a starter is changed.	B. Check the installation diagram and fix the problem.
	C. A solenoid valve is not working or is plugged.	C. Check the status of solenoid and electric cables. Fix where electric cables are broken, remove parts blocked, and/or replace the solenoid valve, if needed.
	D. There is damage on pinion gear mounts.	D. Replace the pinion gear, if needed.

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6. A starter is working but an engine crankshaft is slowly rotating or fails to work.	A. Air pressure is too low.	A. Increase the air pressure to 7 BAR.
	B. An excessive back pressure occurred.	B. Check the exhaust pipe plate.
	C. Nozzles are blocked or damaged.	C. Remove the parts blocked or damaged in the nozzle.
7. A starter keeps operating even after releasing a start button.	A. A solenoid valve was not properly sealed.	A. Refer to the above 1C.
	B. A relay valve was not appropriately sealed.	B. Refer to the above 1B.
8. A pressure in an air tank is reduced after shutting down.	A. Air connection is not tight enough.	A. Tighten the loosen fitting area. Replace or repair the damaged fitting area.
	B. Air lines got damaged, broken, twisted, or worn off.	B. Replace the damaged lines.
	C. A relay valve was not appropriately sealed.	C. Refer to the above 1B.
	D. A solenoid valve is open.	D. Refer to the above 1C..

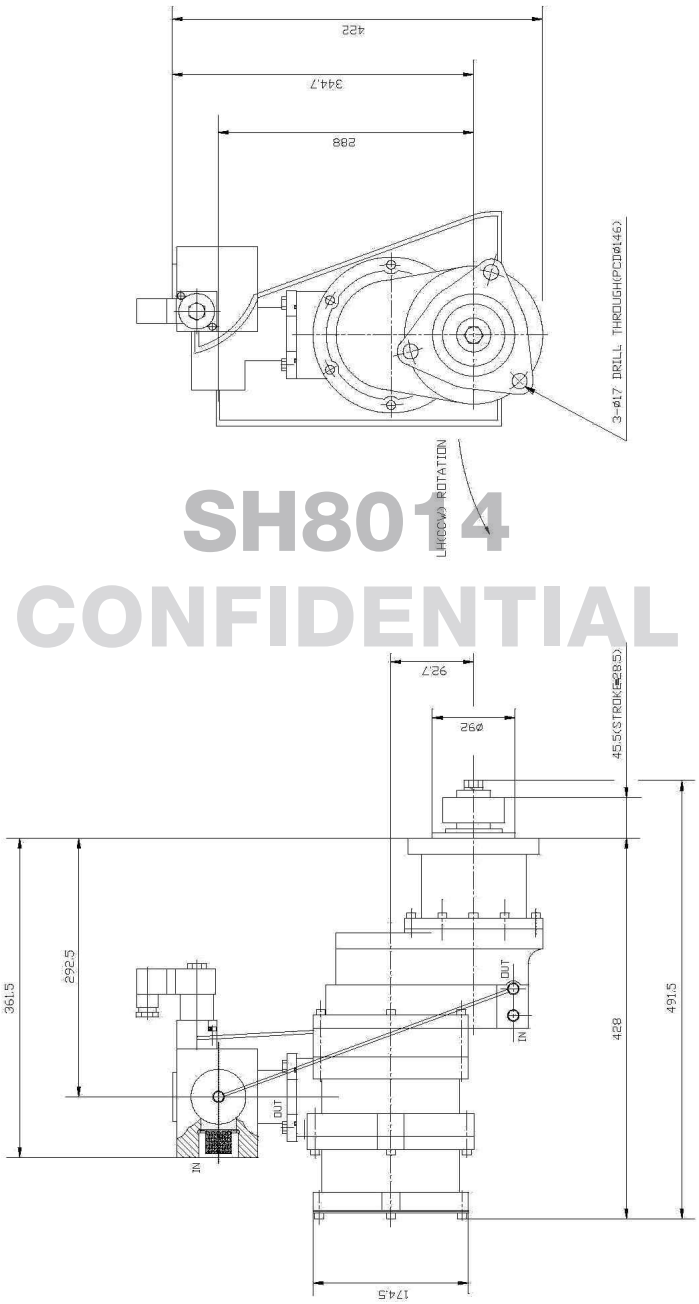
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6.0 작업자 고장조치 요령

고 장	원 인	수 리 방 안
1. AIR가 항상 배기(exhaust)된다.	A.릴레이밸브가 적절하게 설치되지 않았다.	A.전형적인 설치다이아그램을 점검하고 수정해라.
	B.릴레이밸브가 적절하게 sealing 되지 않았다.	B.손상된 sealing을 점검하고 릴레이밸브와 손상된 부분을 교체해라.
	C.솔레노이드가 sealing이 되지않고 릴레이밸브의 APP port에 압력이 남아있다.	C.그라운드로부터 lead된 솔레노이드의 potential을 점검하고 0이 되도록 한다. 만일 그렇지 않으면 점화스위치 문제를 고쳐라.
2. engage된 시동기가 동작하지 않는다.	A.릴레이밸브가 나쁘다.	A.릴레이밸브를 교체해라.
3. 시동기가 동작하지 않고 드라이브 하우징이나 터빈 배기로부터 작은 AIR 유출이 있다.	A.노즐이 막혔다.	A.노즐의 봉쇄된 부분이나 장애부분을 제거해라.
4. 시동기가 동작하지 않고 배기로부터 보통의 AIR 유출이 있다.	A.공급라인의 과도한 Bend.	A.AIR공급라인을 곧게 하거나 길이를 짧게 한다.
5. 피니언이 Engage되지 않는다.	A.에어압력이 너무 낮다.	A.AIR압력을 7BAR로 상승한다.
	B.시동기의 콘트롤라인Port가 바뀌었다.	B.설치다이아그램을 점검하고 수정해라.
	C.솔레노이드밸브가 작동되지 않거나 PLUG되어있다.	C.솔레노이드 작동상태와 전기결선을 점검해라. 전기결선을 수정하고 봉쇄된 곳을 제거하고 필요하다면 솔레노이드밸브를 교체해라.
	D.피니언 기어산이 손상되었다.	D.필요하면 피니언 기어를 교체해라.
6. 시동기가 가동되지만 엔진크랭크축이 천천히 회전하거나 동작되지 않는다.	A.에어압력이 너무 낮다.	A.에어압력은 7BAR까지 상승시킨다.
	B.과도한Back Pressure	B.배기PLATE를 점검한다.
	C.노즐이 막혔거나 손상되었다.	C.막힌 곳을 제거하거나 손상된 부분을 교체한다.
7. START BUTTON이 해제된 후에도 시동기가 계속 작동 한다	A.솔레노이드밸브가 올바르게 실링이 되지 않는다.	A.언급된 1C 참조.
	B.릴레이밸브가 올바르게 실링이 되지 않는다.	B.언급된 1B 참조.
8. SHUT-DOWN 시행 후 에어탱크압력이 저하된다.	A. AIR Connection이 타이트 하지 않다.	A.느슨한 Fitting부를 조여라. 손상된 Fitting부를 교체하거나 수리하여라.
	B.에어라인이 손상, 파손, 뒤틀림, 마모	B.손상된 라인을 교체해라.
	C.릴레이밸브가 올바르게 실링이 되지 않았다.	C.언급된 1B 참조.
	D.솔레노이드밸브가 열려있다.	D.언급된 1C 참조.

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Figure 1. SM10 Air starter Dimensional Data



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Figure 2. SM10 Installation Diagram

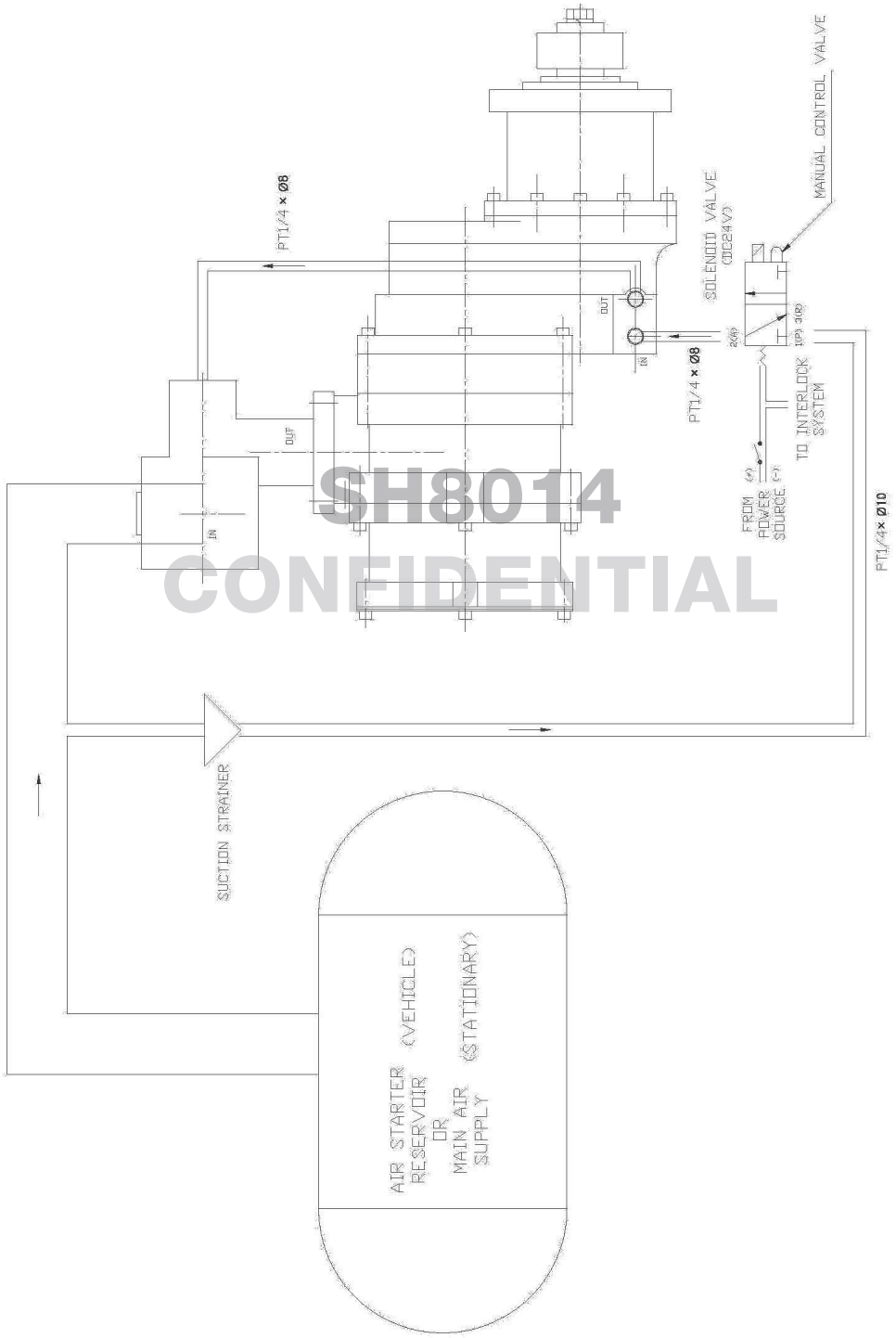
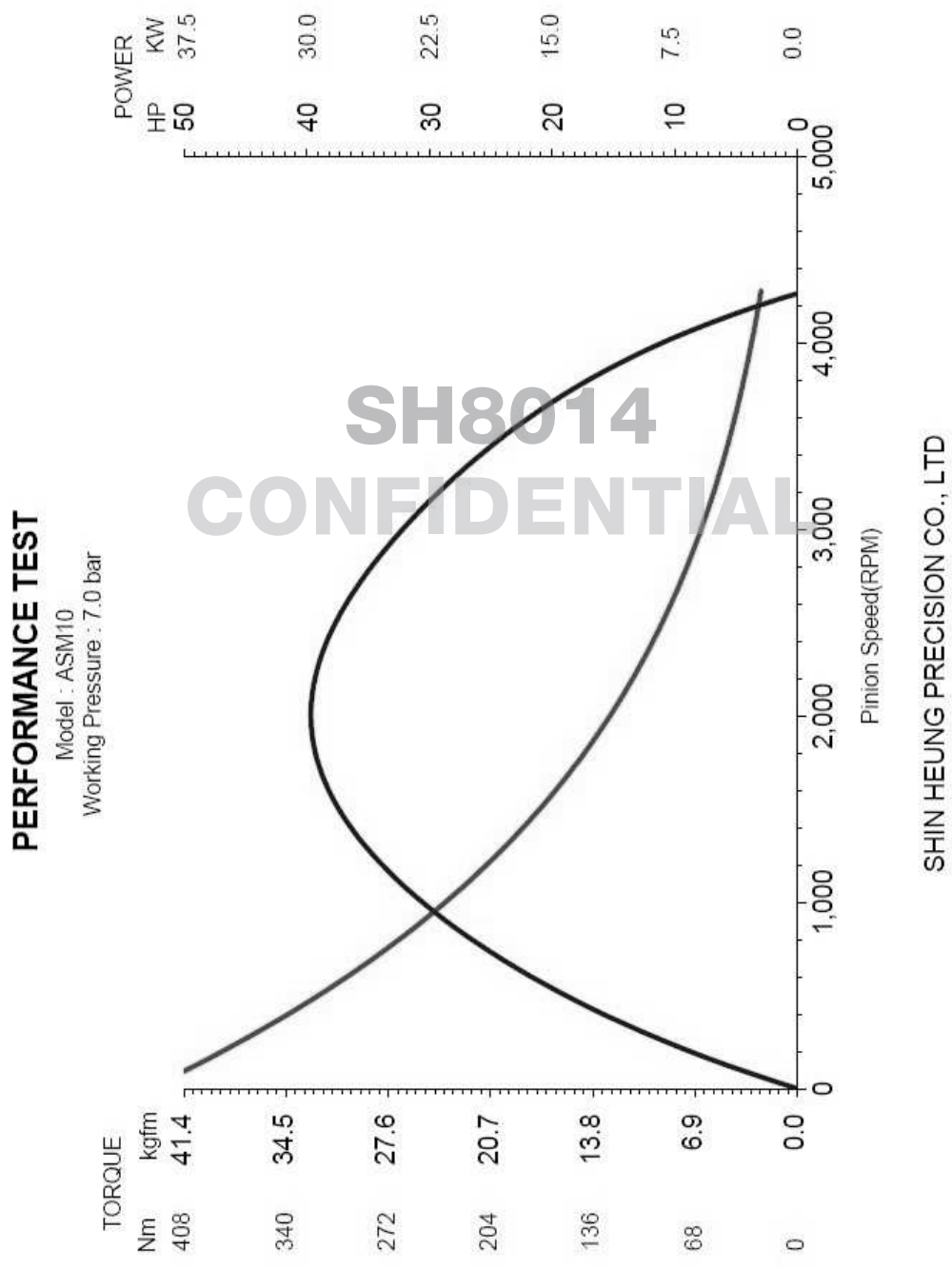
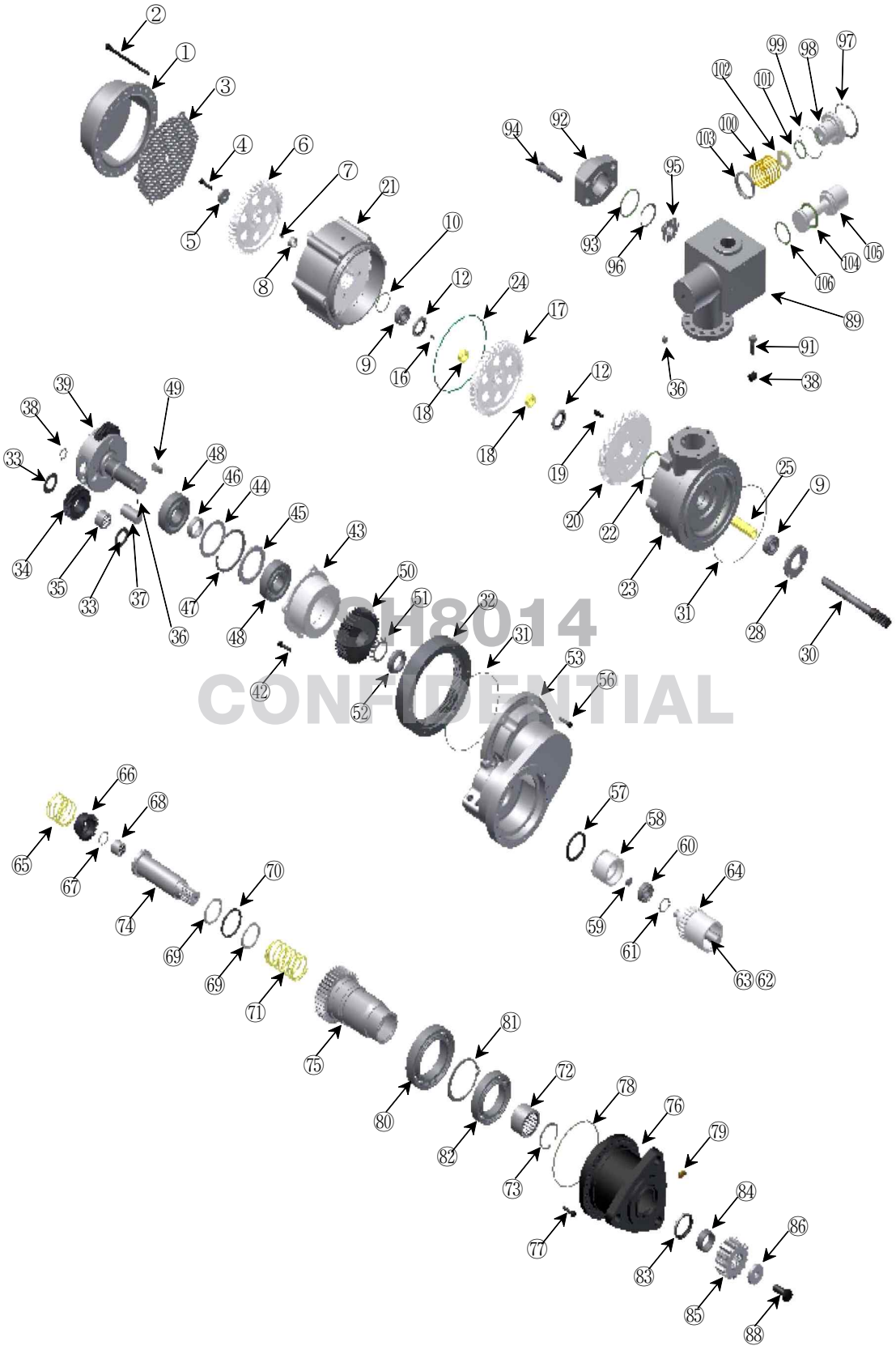


Figure 3. SM10 Performance Curves



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Position	Description	Part No.	Q'ty	OVERHAUL KIT
1	Exhaust Cover	1-14000	1	
2	Wrench Bolt	2-24000-6110	6	
3	Exhaust Safety Guard	1-14001	1	
4	Wrench Bolt	2-24001-625-1	1	
5	Blade Washer	1-14002	1	
6	2nd Stage Moving Blade	1-14003-41	1	
7	Woodruff Key	2-24002	1	
8	Spacer	1-14004	1	
9	Bearing	2-24003	2	
10	O-Ring	2-24004	1	
11	Wave Washer	2-24005	1	
12	Lip Seal	2-24006	2	
13	Pin	2-24007	1	
14	Wrench Bolt	2-24006-1012	4	
15	2nd Stage Fixed Blade	1-14005-19	1	
16	Woodruff Key	2-24009	1	
17	1st Stage Moving Blade	1-14006-37	1	
18	Spacer	1-14007	2	
19	Wrench Bolt	2-24010	4	
20	1st Stage Fixed Blade	1-14006-12	1	
21	Blade Casing	1-14009	1	
22	O-Ring	2-24011-034	1	
23	Turbine Casing	1-14010	1	
24	O-Ring	2-24012-140	1	

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Position	Description	Part No.	Q'ty	OVERHAUL KIT
25	Spacer	1-14011	1	
26	Wrench Plug	2-24013	1	
27	Wrench Plug	2-24014	1	
28	Bearing Cover	1-14012	1	
29	Wrench Bolt	2-24015-515	4	
30	Blade Shaft	1-14013	1	
31	O-Ring	2-24016-050	2	◎
32	Ring Gear	1-14014	1	
33	Planet Gear Spacer	2-24017	6	
34	Planet Gear	1-14015	3	
35	Roller Bearing	2-24018	3	
36	Spring Pin	2-24019	3	
37	Planet Gear Shaft	1-14016	3	
38	Snap Ring	2-24020	3	
39	Planet Gear Casing	1-14017	1	
40	Square Key	2-24021	1	
41	Carrier Shaft	1-14018	1	
42	Wrench Bolt	2-24022-620	4	
43	Bearing Housing	1-14019	1	
44	Wave Washer	2-24023	6	
45	Wave Washer Plate	1-14020	1	◎
46	Spacer	1-14021	1	◎

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Position	Description	Part No.	Q'ty	OVERHAUL KIT
47	Snap Ring	2-24024	1	
48	Carrier Shaft Bearing	2-24025	2	◎
49	Woodruff Key	2-24026	1	
50	Planet Transmission Gear	1-14022	1	
51	Lock Washer	2-24027	1	
52	Lock Nut	2-24028	1	
53	Gear Box Casing	1-14023	1	
54	Wrench Plug	2-24029	2	
55	Wrench Plug	2-24030	2	
56	Wrench Bolt	2-24031-660	6	
57	O-Ring	2-24032-327	1	
58	Pre-Engaged Piston	1-14024	1	
59	Snap Ring	2-24033	1	
60	Helical Shaft Bearing	2-24034	1	
61	Snap Ring	2-24035	1	
62	Square Key	2-24036	2	
63	Helical Shaft	1-14025	1	
64	Helical Shaft Spline	1-14026	1	
65	Drive Spring	2-24037	1	
66	Helical Clutch	1-14027	1	
67	Snap Ring	2-24038	1	
68	Roller Bearing	2-24039	1	
69	Thrust Washer	2-24040	2	
70	Snap Ring	2-24041	1	

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Position	Description	Part No.	Q'ty	OVERHAUL KIT
71	Return Spring	2-24042	1	
72	Roller Bearing	2-24043	1	
73	Snap Ring	2-24044	1	
74	Ratchet Shaft	1-14028	1	
75	Clutch Transmission Gear	1-14029	1	
76	Pinion Gear Casing	1-14030	1	
77	Wrench Bolt	2-24045-625	8	
78	O-Ring	2-24046-158	1	
79	Air Vent Plug	2-24047	1	
80	Ball Bearing	2-24048	1	
81	Snap Ring	2-24049	1	
82	Ball Bearing	2-24050	1	
83	Oil Seal	2-24051	1	
84	Collar	1-14031	1	
85	Pinion Gear	1-14032	1	
86	Pinion Gear Washer	1-14033	1	◎
87	Spring Washer	2-24052	1	
88	Hex. Bolt	2-24053	1	◎
89	Air Valve Casing	1-14034	1	
90	O-Ring	2-24054-60	1	
91	Hex. Bolt	2-24055-830	6	
92	Inlet Flange	1-14035	1	
93	O-Ring	2-24056-50	1	
94	Wrench Bolt	2-24057-1250	4	
95	Inlet Filter	2-24058	1	
96	Snap Ring	2-24059	1	

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Position	Description	Part No.	Q'ty	OVERHAUL KIT
97	Snap Ring	2-24060	1	◎
98	Air Valve Piston Cover	1-14036	1	
99	O-Ring	2-24061-035	1	◎
100	Return Spring	2-24062	1	
101	O-Ring	2-24063-31.5	1	◎
102	Cushion Ring	2-24064	1	
103	Spring Seat	2-24065	1	
104	O-Ring	2-24066	1	◎
105	Air Valve Piston	1-14037	1	
106	O-Ring	2-24067	1	
107	Wrench Bolt	2-24068-530	2	◎
108	Solenoid Valve	2-24069	1	
109	Protected Vent	2-24070	1	
110	Soft Starter	2-24071	1	
111	Filter	2-24072	1	
112	Male Elbow Connector	2-24073	1	
113	Male Elbow Hose Adapter	2-24074	2	
114	Male Hose Adapter	2-24075	2	
115	Swivel 45° joint	2-24076	2	
116	Hose	2-24077	2	

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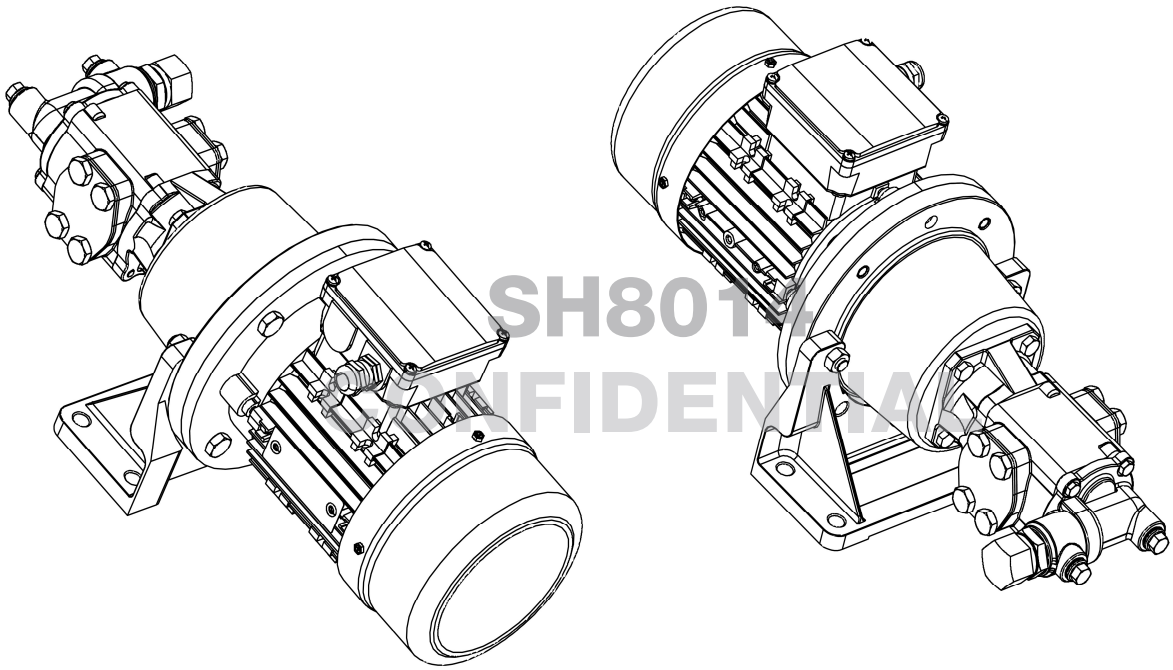
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YURIM

GEAR PUMP

YR080

Maintenance and Instruction manual

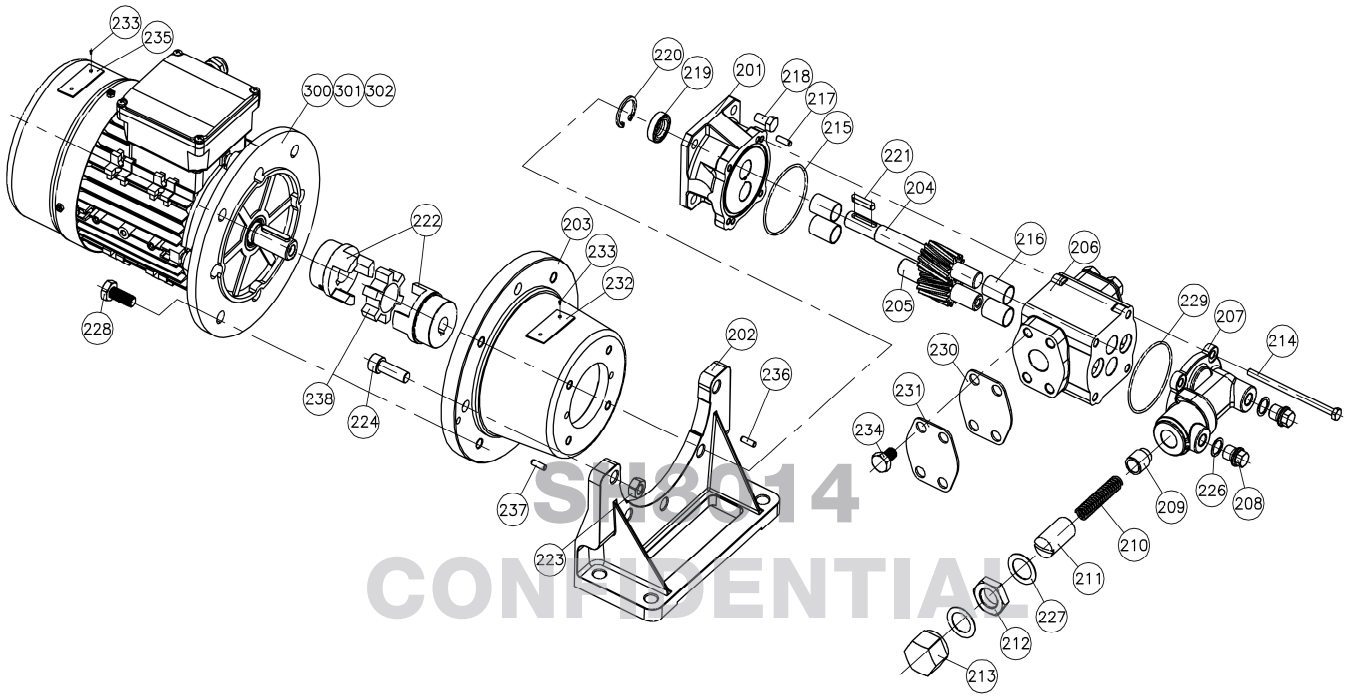


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YURIM INDUSTRIAL CO., LTD
#26-2,San gyuk 2-Dong ,Buk-Gu, Daegu, Korea
TEL:82-53-384-4894
FAX:82-53-384-0030
E-Mail:ldbeom@chol.com

Exploded view

Gear pump
YR080



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List of components

POS. NO	Denomination	Q'TY	PART.NO.			weight (kg)	POS. NO	Denomination	Q'TY	PART.NO.			weight (kg)
			YRB080	YRE080	YRH080					YRB080	YRE080	YRH080	
201	DRIVING COVER	1	YR0080-201			2.3	221	KEY	1	YR080-221			0.007
202	BRACKET	1	YR080-202			1.1	222	JAW COUPLING HUB	1	YR080-222			0.75
203	CONNECTION COVER	1	YR080-203			2.1	223	NUT	3	YR080-223			0.015
204	DRIVIING GEAR SHAFT	1	YR080-204			0.77	224	SOCKET HEAD BOLT	3	YR080-224			0.045
205	GEAR SHAFT	1	YR080-205			0.57	225	BLANK		YR080-225			
206	GEAR HOUSING	1	YR080-206			3.2	226	WASHER	2	YR080-226			0.001
207	VALVE HOUSING	1	YR080-207			1.0	227	WASHER	2	YR080-227			0.005
208	PLUG	2	YR080-208			0.03	228	HEX'S HEAD BOLT	4	YR080-228			0.04
209	PISTON	1	YR080-209			0.045	229	O-RING	1	YR080-229			0.004
210	COMPRESSION SPRING	1	YR080-210			0.015	230	RUBBER PLATE	2	YR080-230			0.02
211	SPRING HOUSING	1	YR080-211			0.045	231	COVER PLATE	2	YR080-231			0.095
212	STOP NUT	1	YR080-212			0.035	232	NAME PLATE	1	YR080-232			0.005
213	CAP NUT	1	YR080-213			0.12	233	RIVETS	4	YR080-233			0.002
214	HEX'S HEAD BOLT	4	YR080-214			0.07	234	HEX'S HEAD BOLT	8	YR080-234			0.03
215	O-RING	1	YR080-215			0.004	235	NAME PLATE	1	YR080-235			0.002
216	BUSH	4	YR080-216			0.025	236	SPRING PIN	2	YR080-236			0.002
217	PIN	2	YR080-217			0.005	237	SPRING PIN	2	YR080-237			0.002
218	HEX'S HEAD BOLT	4	YR080-218			0.025	238	JAW COUPLING SPIDER	1	YR080-238			0.02
219	OIL SEAL	1	YR080-219			0.01	300	MOTOR (Brook)	1		YRB080-300		29.0
220	SNAP RING	1	YR080-220			0.003	301	MOTOR (Hoyer)	1		YRE080-301		22.0
							302	MOTOR (Hyundai)	1			YRH080-302	43.0

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2. Gear pump 기능	2. Function of gear pump
3. 유지 및 보수	3. Maintenance
4. 작동 유체	4. Fluid
5. 분해 및 조립	5. Dismantling and assembling
6. 부품의 교환	6. Replacement of part
7. 설 치	7. Mounting
8. 조립도면	8. Assembly drawing

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1. 설계사양

1-1 전동기

TYPE	YR080	
rpm	3,450	2,880
Voltage (V)	440~480	380~415
Frquency(Hz)	60	50
Protection	IP55	

1-2 펌프

TYPE	YR080	
rpm	3,450	2,880
capacity (m^3/h)	8.2	6.6
Max.Work press(bar)	2.0	
Min.Work press(bar)	0.5	

2. 기어 펌프의 기능

예비 윤활 오일펌프는 모터에 의해
구동 되는 기어 타임 펌프로 엔진 시동
30분전에Pump를 구동시켜 엔진 내부 각 구동부
에 윤활오일를 공급 하는 장치로서 엔진
초기 시동시에만 사용되는 펌프임.

3. 유지 및 보수

3-1 기어 오일 펌프 의 최초기동시는 펌프 내부
에 오일이 충만한 상태로 운전 되어져야 하며.
+23℃ ~+90℃ 까지 사용가능 하나.
오일온도가 +40℃~ +60℃에서 정상 운전 된다.

3-2 오일 온도가 +15℃이하에서는 반드시
가열을 해서 구동시켜야 하며
과다한 열의 발생, 이상소음이나 진동이 일어날
경우는 즉시 작동을 중지하고 원인을 조사하여
제거한 후 사용한다.

3-3 릴리프 밸브는 임의 조정및 분해하지 마시오.

4. 작동 유체

기어 오일 펌프에 사용되는 오일은
SAE#30/40을 적용하며
오일을 교체. 보충시기는 주엔진
오일교체. 보충 시기에 따른다.

1. Design specification

1-1. Electric motor

TYPE	YR080	
rpm	3,450	2,880
Voltage (V)	440~480	380~415
Frquency(Hz)	60	50
Protection	IP55	

1-2 Pump

TYPE	YR080	
rpm	3,450	2,880
capacity (m^3/h)	8.2	6.6
Max.Work press(bar)	2.0	
Min.Work press(bar)	0.5	

2. Function of gear pump

Prelubricating oil pump is a kind of gear type pump
which is operated by electric motor. It supply, deliver
lubricating oil to each inside driving part of the engine
by operating pump 30 minutes before engine start-up
and used only for engine start-up.

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3. Maintenance and service

3-1 At the initial start-up stage of gear oil pump, inside of the pump should be fully filled with oil. It is applicable in the range of +23℃~+90℃, however, it is normally operated at +40~+60℃.

3-2 When oil temperature is under 15℃, it should be driven after heating. And if it generates excessive heat, noise and vibration, deenergize it immediately and investigate causes, then use it again after have removed causes.

3-3 Don't adjust and dismantle relief valve randomly

4. Fluid

Oil used in gear oil pump applies to SAE#30/40.
The time that change and replace oil is in accordance
with main engine's.

5. 분해 및 조립

5-1. 분해

5-1-1 취급설명서에 첨부된 도면을 완전히 이해한 후 분해 할 것.

5-1-2 분해의 목적을 정확히 하고, 분해할 부위를 최소로 한다.

5-1-3 분해시 필히 각 부품의 위치를 표시하고 분해하는 순서에 따라 정리한다.

5-1-4 어떤 경우에도 각 부위를 무리하게 두드리지 말고. 강제적인 힘을 가해서는안된다.

5-1-5 만약 분해작업이 어렵다면 도면을 재검토 하여 구조를 충분히 이해한 후 다시 한다.

5-2 조립

5-2-1 주위 환경을 먼지등이 없도록 청결히 한다.

5-2-2 각 부품은 세척유로 철저히 세척하고, 결합 분위에는 적당한 윤활유를 바른후 조립한다.

5-2-3 분해시에 표시한 위치를 준수한다.

5-2-4 펌프조립이 완료되면 커플링연결축 을 손으로 돌렸을때 부드럽게 돌아가야한다.

5-2-5 모터 와 펌프를 최종적으로 조립한다.

5. Dismantling and assembling

5-1. Dismantling

5-1-1 Dismantle after clearly understand about drawing which is attached in guideline.

5-1-2 Ensure the object of dismantling and minimize parts to dismantle.

5-1-3 When dismantling, certainly mark the position of every part and arrange it by dismantling order.

5-1-4 Do not hammer or load excessive pressure on each part in any cases.

5-1-5 If you find any difficulty on dismantling work, recheck drawing and try again after understand structure completely.

5-2 Assembling

5-2-1 Ensure that there is not any dust in surrounding environment.

5-2-2 Clean every parts thoroughly with cleaning fluid and assemble it after grease connecting coupling part.

5-2-3 Marked position at dismantling stage should be observed.

5-2-4 When pump assembling is completed, coupling connection axle should turning(rounding) softly by hand.

5-2-5 Assemble motor with pump in final.

6. 부품의 교환

6-1 드라이빙 기어 샤프트 는 유림공업㈜에서 설계된 특수제품임으로 필요시 제작구매 요청할 것.

6-2 모터용 베어링은 표준규격품을 사용하였으므로 시중구매가 가능하다.

6-3 오일실은 고무재질로서 사용환경에 따른 고무의 열화로 성능이 저하될수 있으므로 정기적인 교체가 필요하며, 어떤 이유로 분해했을 경우에도 새것으로 교체 해야한다. 교체시에는 내.외경에 손상을 입지 않도록 특별히 주의해야됨.

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6. Replacement of part

6-1 As driving gear shaft is a special product designed by Yurim industries, request purchase order if necessary.

6-2 Bearing for motor is standardized goods, therefore it is purchasable from market.

6-3 As oil seal is made of rubber material, its capacity might fall off by rubber deterioration that caused by working environment, so need to be replaced regularly. And it should be replaced with new one by any reasons when dismantled. When replace it, special care must be observed that inside and outside of parts are not damaged.

7. 설 치

예비오일 펌프는 수직, 수평 설치를 원칙으로 하며 설치 볼트는 완전히 죄어 진동이나 충격등 외력에 견딜 수 있도록 한다. 부적당한 설치는 펌프의 수명을 극단적으로 줄일수 있으며, 파손등 중대한 결함을 초래할 수 도 있다.

7. Mounting

Pre oil pump make vertical, horizontal mounting as a principle and set-up bolt should be tightened firmly to stand against vibration or impact and so on. Inappropriate installation might reduce pump's service life extremely and cause serious damage and injury.

8. 조립도면

별 첨

8. Assembling drawing

attached

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DATE	13.09.17
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INSTRUCTION MANUAL

MODEL
NAME THERMOSTATIC VALVE



CEC COREA ELECTRONICS Corp.

<FACTORY>

168-16 YONGTAN-DONG, CHUNGJU-CITY CHUNGCHEONGBUK-DO, KOREA

TEL : +81-43-853-2876 FAX : +81-43-853-2870

E-MAIL : cec@cecom.co.kr http://www.cecom.co.kr

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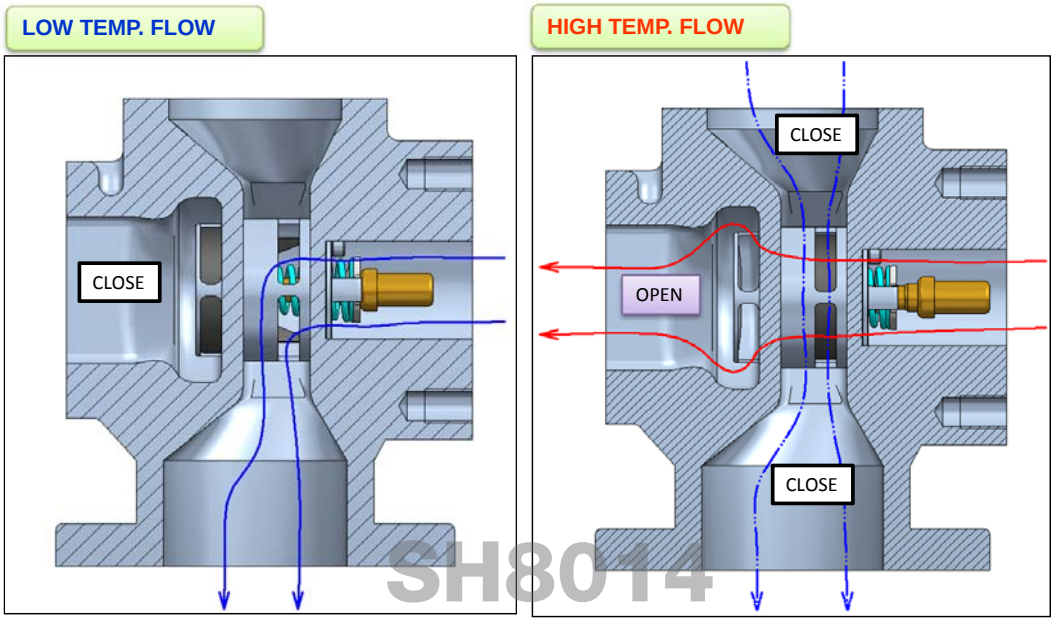
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▣ Features of item

It is installed in the interior of automobile, ship and industrial engine to detect coolant temperature.
The valve opens above the set temperature and is closed below.
It is a valve that automatically controls the engine at a constant temperature.

▣ Mode of operation

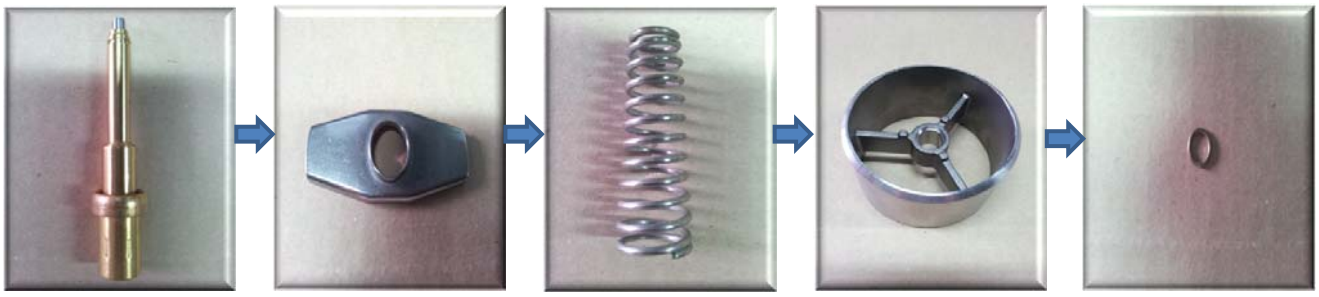


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▣ Regulation of fluid temperature in the system

Depending on the temperature of the cooling water flowing in the system, up and down.
the VALVE connected by the action of the ELEMENT will move
It keeps the temperature of the engine constant by sending cooling water to the channel opened by VALVE.

▣ Construction & Assembly





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▣ Construction & Assembly



PELLET



FREAM



SPRING



SHAFT



WIRE RING



VALVE ASS'Y



HOUGING



ORING



THERMOSTATIC VALVE

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▣ Thermostatic valve operation checking

Lift Test



Equipment to measure LIFT according to set temperature after putting thermostatic valve in constant temperature water tank.

Full Lift Test



Constant temperature chamber

Before the LIFT test

After LIFT test

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▣ Trouble-shooting and solution

If the product does not open

After boiling the water according to the full opening temp according to the product standard
If the valve does not open, replace the product.

If the product does not close

If the valve does not close after 1 to 2 minutes after putting the product into cold water,
replace the product.

The pressure transmitter measures the actual pressure and converts the pressure to an eletrical signal. This pressure transmitter is used for measuring the pressure of Compressed Air Inlet, Charge Air, HT & LT water, Fuel oil, Lub oil. See ***Fig 1.***

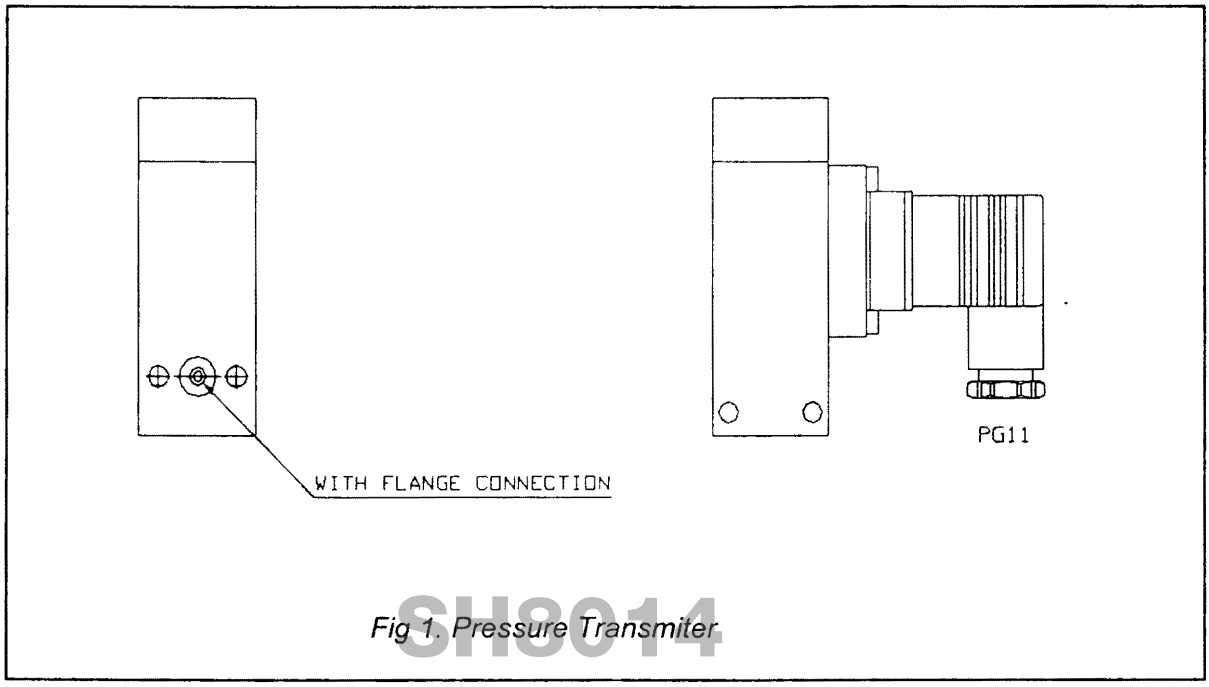


Fig 1. Pressure Transmiter

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Test

The functional test of the pressure transmitter is carried out according to the following procedure :

1) Shut of system pressure.
2) Take the sensor out of the engine.
3) Connect the testing apparatus to the pressure input part and input the pressure within the working area of the transmitter. ***Fig 2.***
4) Read the pressure at the Engine Control Panel. And, check it according to the pressure on the testing apparatus.
5) Remove the testing apparatus.
6) Connect the sensor to the Engine system.

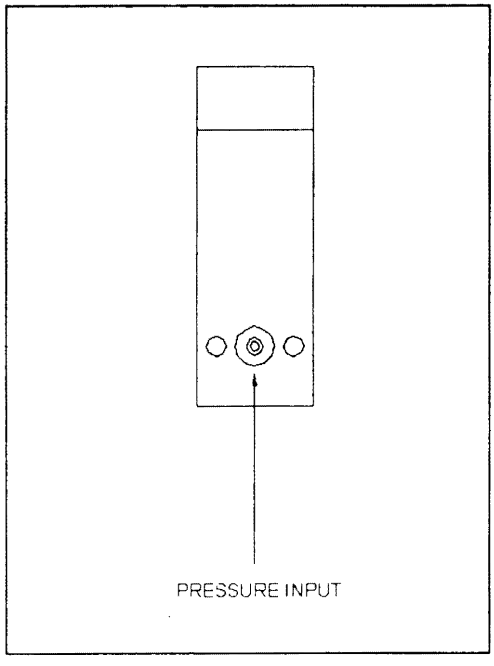


Fig 2. Test of Pressure Transmitter

ADJUSTMENT

The pressure transmitter has been factory calibrated, no further adjustment is normally required.

In case of adjustment, it is carried out according to the following procedure :

1) Remove the screw and the cap, see ***Fig 3***.

2) Adjust the "span" screw, see ***Fig 4***, to change the value of the electrical signal according to the pressure measurement area.

3) Be careful not to insert Driver before remove the screw and the cap, see ***Fig 5.***

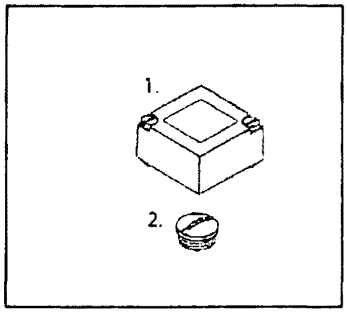


Fig 3. Remove screw and cap

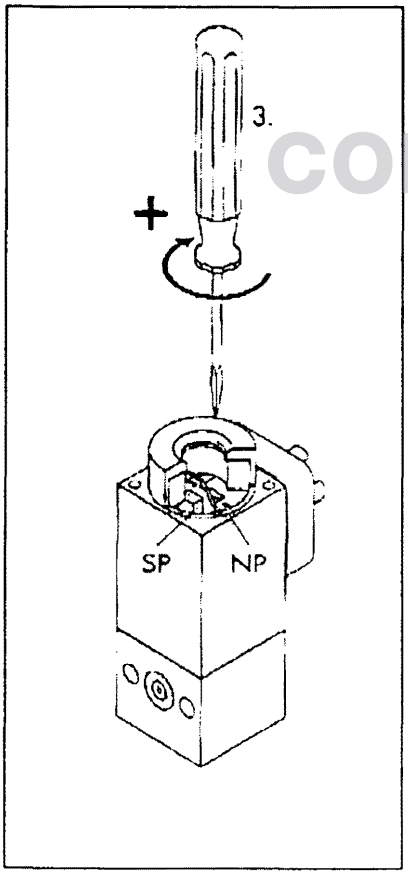


Fig 4. Adjustment of zero and span

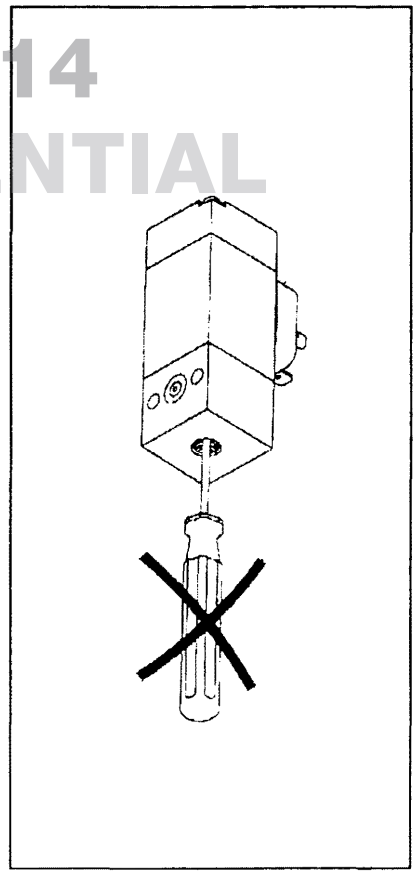


Fig 5. Attention

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Three types of Temperature Transmitter is applied for this project. NiCr/Ni Sensor, Combi-Type Sensor, PT 100 sensor.

NiCr/Ni type Temperature Transmitter

The Nickel-Chrome/Nickel-Aluminium(NiCr/NiAl) sensor, which is used for measurement of the exhaust gas temperature and generates the mV signal depending on the temperature. See ***Fig. 1***



Fig 1. Nickel-Chrome / Nickel-Aluminium Temperature Sensor

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Combi-Type Temperature Sensor

The Combi-Temp Type Thermometer is used for measureing the temperature of HT Water & Fuel Oil. This type of Thermometer measures the temperature and indicates the each level of temperature and generates the mV signal at the same time. See ***Fig 2.***

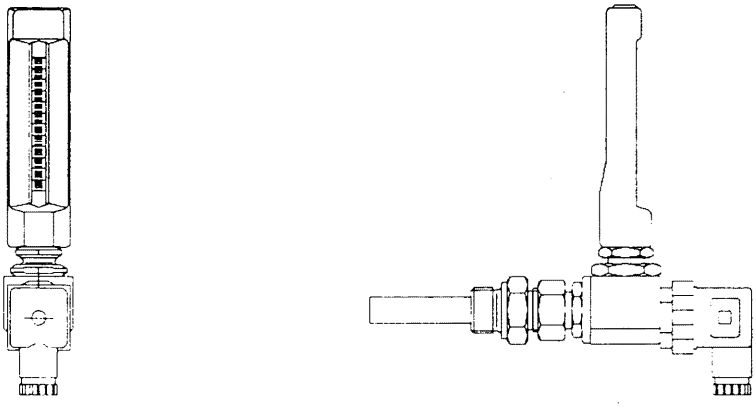


Fig 4. Combi-Type Temperature Sensor

PT100 Temperature Sensor

The PT 100 sensor consists of a resistance wire which changes resitance depending on the temperature.

The PT 100 sensor is used for measuring the temperature of Charge Air, LT water and Fuel Oil, Lub. Oil. See ***Fig 3.***

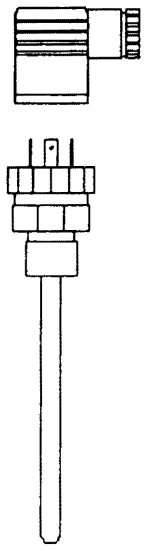


Fig 3. PT102 Temperature Sensor

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Test

Functional test of the NiCr/NiAl sensor, Combi-type Sensor, PT 100 sensor can be carried out according to the following procedure.

1) Take the sensor out of the engine.

2) Test the measuring value by submerging the sensor in the water bath, which is controlled by a special testing apparatus producing a constant temperature.

3) Check that the measuring value indicated on the Engine Control Panel is equal to the testing apparatus measuring value.

4) After the above test, the sensor is mounted again.

※ NOTE
The test can also be made by special simulation instruments for the temperature sensors.
The instruments can measure the sensor value and simulate a sensor signal for the Base Module and alarm system.

Adjustment

Since these types of sensor has been factory calibrated and factory adjusted, more adjustment does not need in site. In case of sensor adjustment, the special tool and equipment needs for adjustment.

YECS-1000

USER'S MANUAL (TYPE. A)

REV.15 (04-05-2018)

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YUMYUNG ENGINEERING CO., LTD.
307, Yeompo-Ro, Buk-gu, Ulsan, 683-420, Korea / TEL : 052.210.9900 / FAX : 052.210.9911

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* Revision history

Rev. No	PART	filet Correction contents
REV. 1	SETTING	(1) Soft group table (i)H17/28 U(E) ⇒ 900 RPM(soft 10) [page 35, 44] (ii) H17/28 U(E) ⇒ 1000 RPM(soft 11) (2) CON AIR ⇒ START AIR correction. (compressed air press . Alarm by starting air correction)[page 40,43] (3) CON DO "ON/OFF" selection addition. (continuous MOD select addition) [page 41, 44]
	GENERAL	"Engine exceeds start and 10 RPM" phrase addition in item named jet assistance system control among operation of MCU. [page10]
REV. 2	GENERAL	(1) All Picture filet correction. (2) Name correction : OPU ⇒ YECS-1000D, ETN ⇒ YECS-1000E, TPM ⇒ YECS-1000T, MCU ⇒ YECS-1000M, ACU ⇒ YECS-1000A, SCU ⇒ YECS1000S by correction.
REV. 3	SETTING	Password addition before proceed YECS-1000S, YECS-1000M setting.
	GENERAL	13 circle LED regard contents additions in YECS-1000T, YECS-1000E. [page 5, 6]
REV. 4	GENERAL	(1) YECS-1000M "GENERAL SPEC" ⇒ T/C 0 ~ 60000 by 0 ~ 80000 correction, 0 ~ 2kHz by 0 ~ 3kHz correction. [page 8] (2) YECS-1000M "START FAIR" ⇒ "In case of do Remote Start in Turning Gear Engaged state" addition. [page 10]
	FUNCTION	(1) YECS-1000A ⇒ ° C, bar unit to YECS-1000 addition. [page 20] (2) YECS-1000A ⇒ Correct 485 RX, 485 TX by MODBUS RX, MODBUS TX. [page 21]
	TROUBLE	(1) YECS-1000A ⇒ "RS485 TX" as "MODBUS TX" correction. [page 30] (2) YECS-1000D ⇒ "To 5678, Turbocharger FND to engine FND 1234 indications" delete. [page 30] (3) YECS-1000S ⇒ in CABLE SUPERVISION SAFETY signal correction (X2-29, 30 by X2-21, 22 correction), REMOTE EM'CY signal correction. (X2-21, 22- > by X2-29, 30 correction) [page 27] (4) page27 ⇒ BUTTON EM'CY signal correction.
	SETTING	(1) Soft group (soft.12, soft.13) ⇒ Engine Gear : 286 ⇒ 42 correction. [page 35,44]
REV. 5	GENERAL	(1) Revised to H17/28 from H17/28M. [page 1]
		(2) YECS-1000E, YECS-1000T-> Added the contents which YECS-1000T & YECS-1000E communicate with YECS-1000A by using CAN. [page 5,6]
		(2) YECS-1000A-> Added the contents which YECS-1000A communicates with Monitoring Box by using CAN. [page 12]
		(3) YECS-1000S-> Revised Delay time "OFF" of Overspeed from 5 sec to 3 sec. [page 17]
		(4) YECS-1000S-> Added the "From main Control" in Automatic Stop condition. [page 18]
		(5) YECS-1000SIF-> Added the "Engine Stop while the relay works. (To YECS-1000M)." [page 19]
	FUNTION	(1) "MCU ERR" -> Revised from normal to abnormal. [page 21]
		(2) YECS-1000M –> Deleted the function "O.M.D HIGH DENSITY, EM`CY STOP. " [page 21]
		(3) YECS-1000A-> Revised from "Sensor Open" to "Sensor ERROR". [page 21]
		(4) YECS-1000S-> Added the function "FROM MAIN CONTROL". [page 21]
		(5) YECS-1000S-> Revised the explanation in SYSTEM FAIL "If Oil Mist High Density Failure occurs LED will turn on. [page 22]
		(6) YECS-1000S-> Deleted the function "CABLE FAULT". [page 22]
		(7) YECS-1000D-> Added the function "OIL MIST HIGH DENSITY TRIP". [page 23]
	TROUBLE	(1) YECS-1000S-> Added the item "TO MAIN CONTROL "LED turn on. [page 25]
		(2) YECS-1000S-> Added the item "TO MAIN CONTROL" Cable Supervision LED Turn off. [page 28]
		(3) YECS-1000M-> Added the item "No display Temperature & Pressure on the FND." [page 31]
	SETTING	(1) Soft group (soft.8, soft.10) ⇒ Engine Gear : 256 ⇒ 286 correction. [page 37,46]
REV. 6	GENERAL	(1) YECS-1000S-> Added the contents -> "AVR(Automatic Voltage Regulator)START" [page 19]
		(2) YECS-1000SIF-> Added the contents which relay "AVR Start signal(To. AVR)" [page20]
REV. 7	SETTING	(1) Analog Input Channel Calibration => Modify setting method. [page 50]

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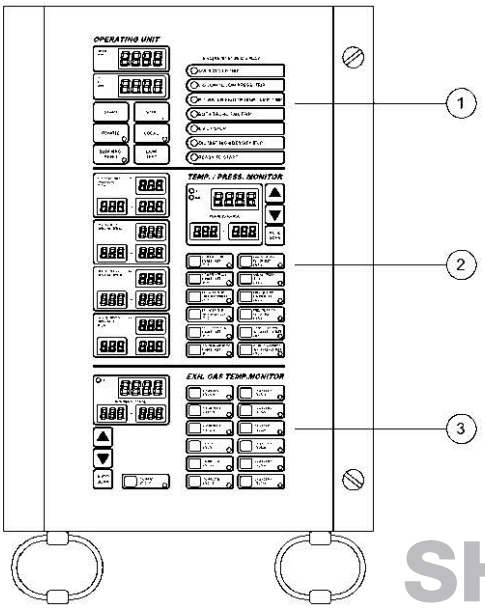
Rev. No	PART	filet Correction contents
REV. 8	GENERAL	(1) YECS-1000M-> "READY TO START CONDITION" : Revised from "Pick-up Failure " to "Main Pick-up Failure"[page 9] (2) YECS-1000M-> "START FAIL" : Safety System Error (Tacho fail, system fail) Deleted. [page 9]
	FUNTION	(1) YECS-1000D-> Revised from "Pick-up Sensor breakaway." to "Main Pick-up Sensor breakaway"[page 33]
REV. 9	FUNTION	(1) YECS-1000M-> Added the function "READY TO START CONDITION". [page 9]
REV. 10	GENERAL	(1) YECS-1000S-> Added the engines RUNNING relevant operating conditions. [page17,18,19]
	TROUBLE	(1) YECS-1000S->Added the checklist "2) SPEED MONITORING" [page26]
REV. 11	GENERAL	(1) YECS-1000MIF-> Added the contents -> OVERSPEED TEST SWITCH [page15]
REV. 12	GENERAL	(1) YECS-1000M-> Revised from 'JET ASSISTANCE SYSTEM CONTROL FUNCTION'[page 11]
	SETTING	(1) YECS-1000M-> Added the setting ⇒ JET SOL. VALVE_DELAY TIME [page 42, 45]
REV. 13	GENERAL	(1) YECS-1000M-> Revised from 'STOP FAIL DELAY TIME'(30sec->40sec)[page 11]
REV. 14	SETTING	(1) YECS-1000M-> -> Added the setting ⇒ "TURBOCHARGER TYPE SETTING" & "TIER SETTING" [page 40~47]
REV. 15	SETTING	(1) YECS-1000M-> -> Added the setting ⇒ JET SOL.. VALVE Operating condition [page 40~49]

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1. GENERAL

1-1. SYSTEM CONFIGURATION

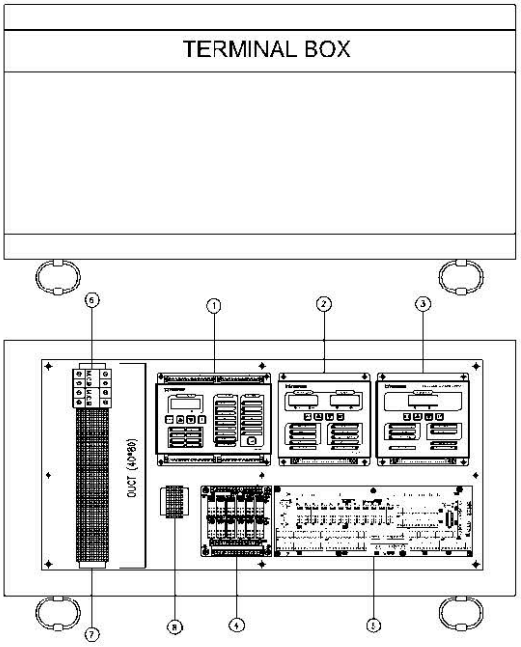
YECS-1000 consists of a monitoring box and a terminal box as below Figure1. It can control HYUNDAI HIMSEN Generator Engine(G/E) which is H17/28, H21/32, H25/33, H32/40 for controlling & monitoring & protecting engine system.



1. Operating Unit
   (YECS-1000D)
2. Temperature & Pressure Monitor Unit
   (YECS-1000T)
3. Exhaust Gas Temperature Monitor Unit
   (YECS-1000E)

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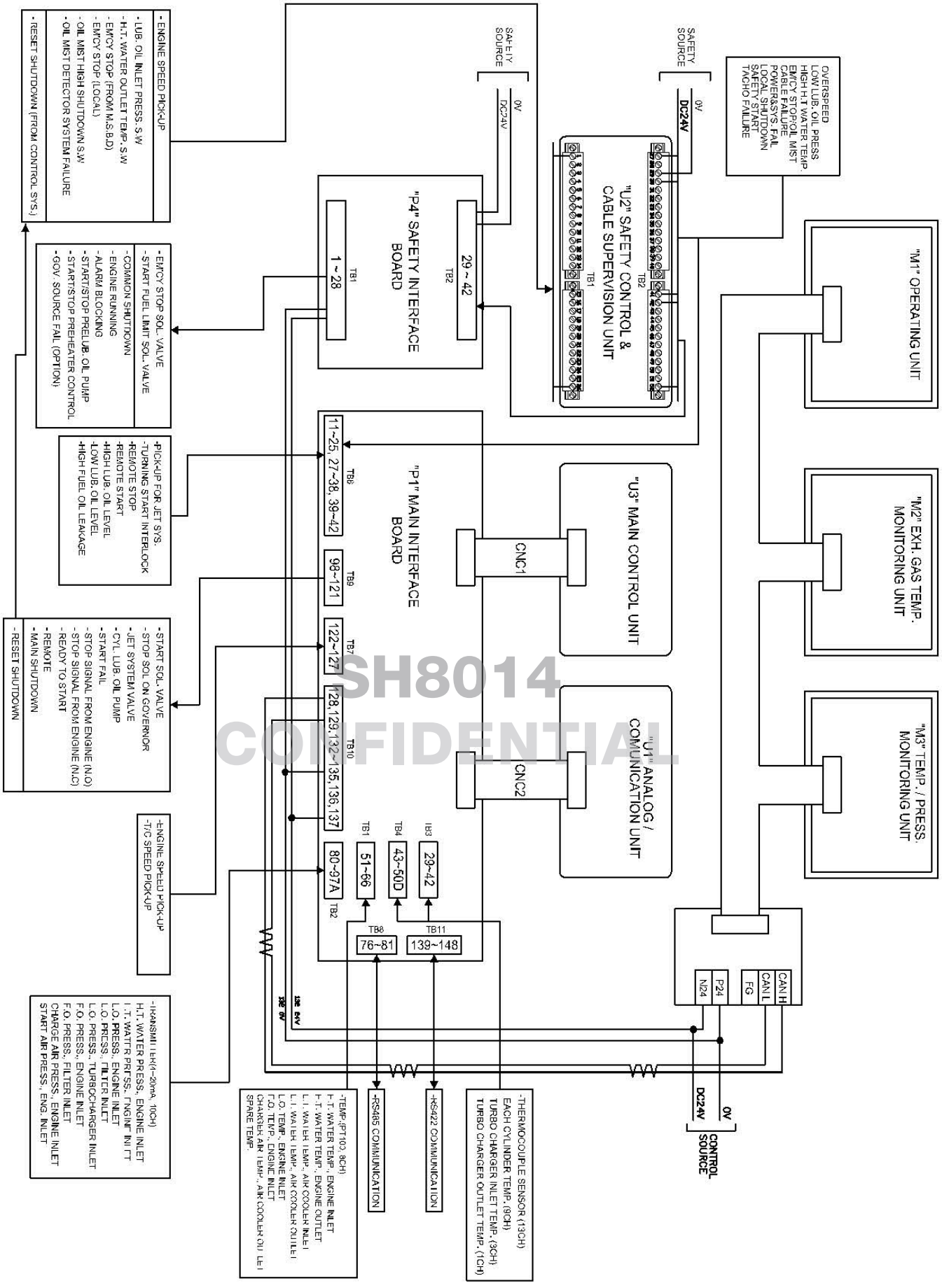
<Monitoring box>



1. Safety Control & Cable Supervision Unit
   (Symbol : U2, Remarks : YECS-1000S)
2. Main Control Unit
   (Symbol : U3, Remarks : YECS-1000M)
3. Analog / Communication Unit
   (Symbol : U1, Remarks : YECS-1000A)
4. Safety Interface Board
   (Symbol : P4, Remarks : YECS-1000SIF)
5. Main Interface Board
   (Symbol : P1, Remarks : YECS-1000MIF)
6. Main Circuit Breaker (MCB)
7. Terminal Block X1~X4 (WDK2.5-PA : 47EA, WEIDMULLER)
8. Terminal Block X5 (RKD2.5-PA : 5EA, CONTACLIP)
   Terminal Block COLOR : X5.1(RED : 1EA), X5.2(YELLOW : 1EA),
   OTHER(BEIGE : 3EA)

<Terminal box>

Figure 1. Monitoring & Terminal box



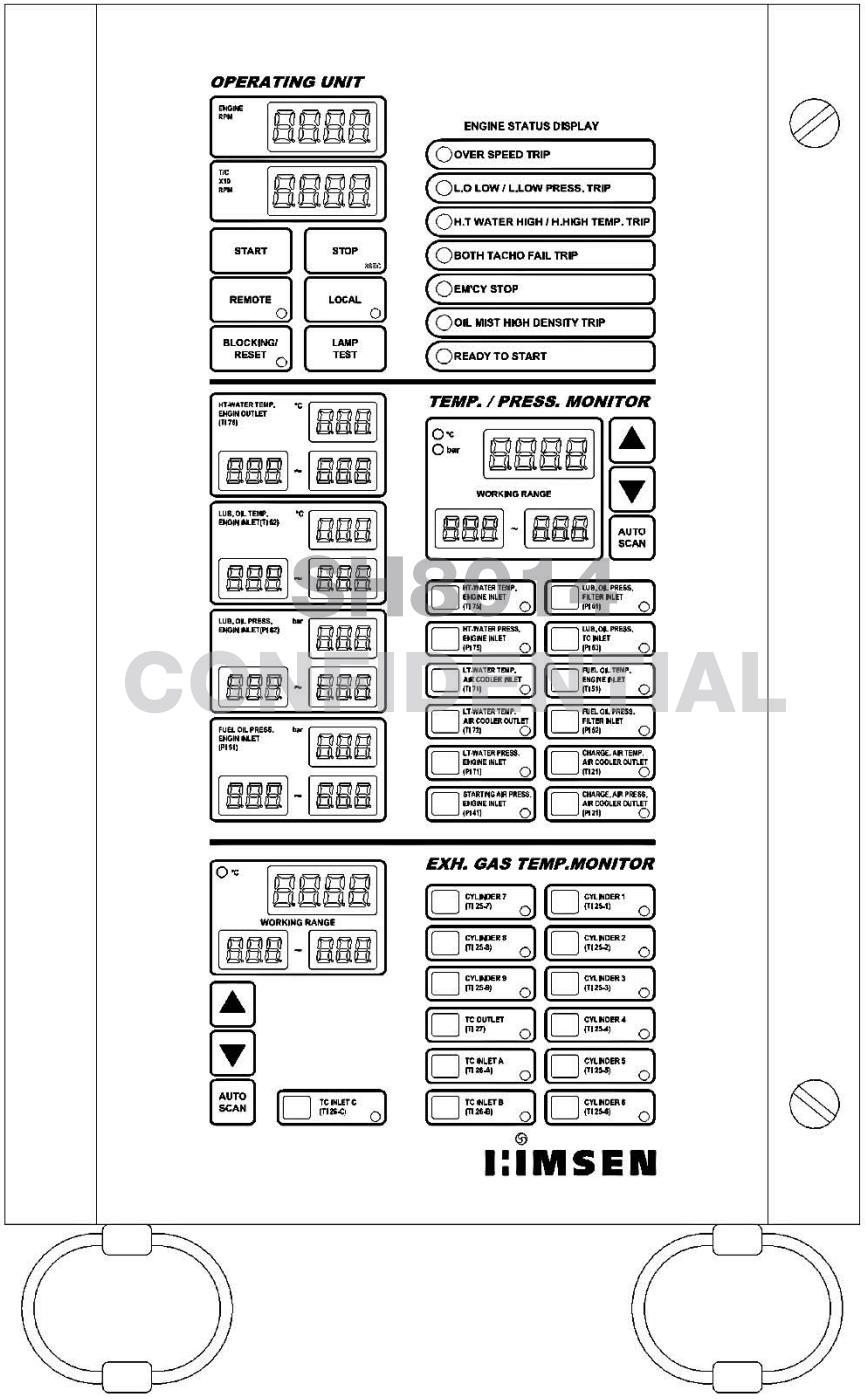
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Figure 2. System Interface Layout

1-2. Monitoring box

The monitoring box consists of the below modules.

- Operating Unit (YECS-1000D)
- Temperature & Pressure Monitor Unit (YECS-1000T)
- Exhaust Gas Temperature Monitor Unit (YECS-1000E)



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Figure 3. Monitoring box

1-2.1 Operating Unit (YECS-1000D)

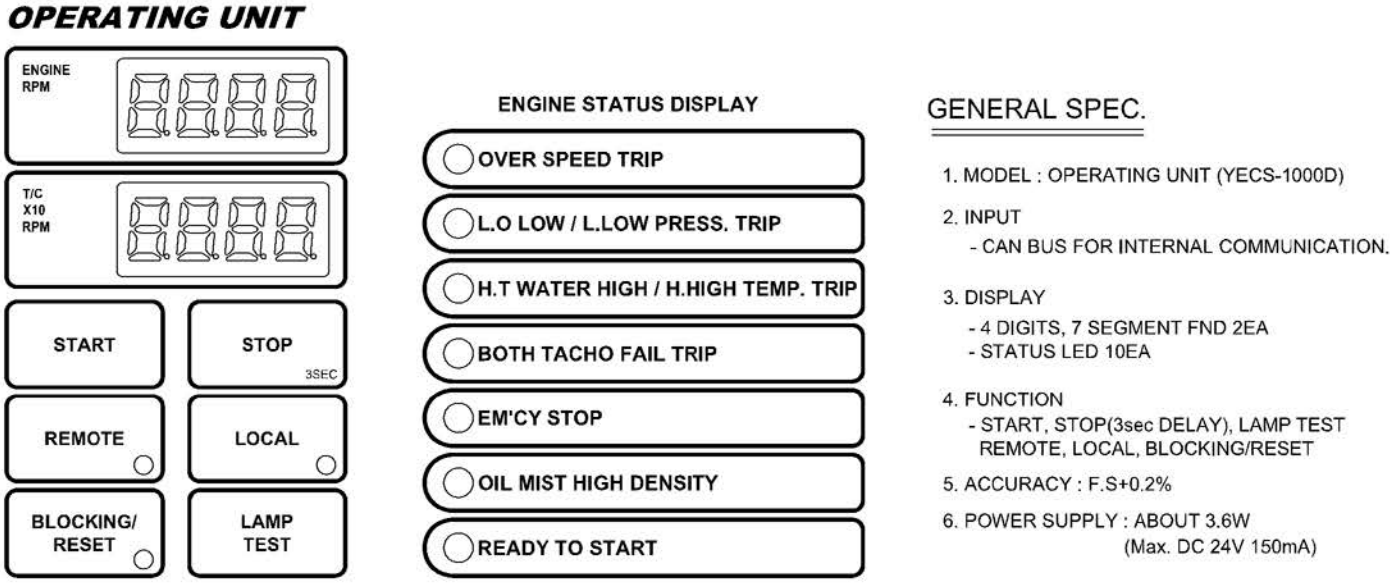


Figure 4. YECS-1000D

1) Description

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YECS-1000D consists of two FNDs which display engine RPM and turbocharger (T/C) RPM and 7 LEDs which display the current engine status.

This unit communicates with YECS-1000M by using CAN bus.

YECS-1000M transmits engine RPM, T/C RPM and 7 signals of engine status into YECS-1000D by CAN bus, and YECS-1000D displays the received data at 2 FNDs & 7 LEDs.

2) Function

- START : In Local condition, if you press the button "start" until starting, the engine will start.
- STOP : In Local condition, If you press the button "stop" for 3 seconds, the engine will stop.
- LAMP TEST : If "LAMP TEST" key is pushed for checking normal status of display, all FNDs & LEDs will turn on in Monitoring Box.
- ENGINE CONTROL KEY : If "REMOTE", "LOCAL", "BLOCKING/RESET" keys are pushed, the relevant LEDs will turn on.

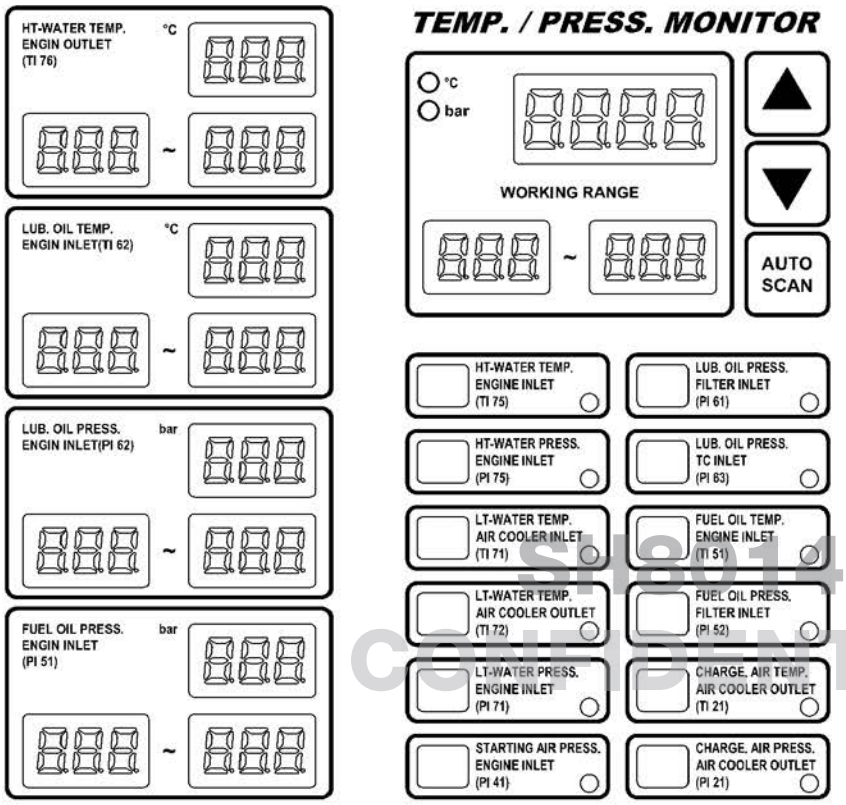
(NOTE 1 : Remote, local and blocking/reset has self-holding function. So if YECS-1000D is powered on, remote, local and blocking/reset will be returned to the status before power off.)

(NOTE 2 : In case of "BLOCKING/RESET" position, the engine should not be started from local or remote.)

(NOTE 3 : The engine stop function can use only "REMOTE" and "LOCAL" position.)

- FND : It displays ENGINE RPM and TURBOCHARGER RPM.
- LED : It displays Engine condition - "OVER SPEED TRIP", "L.O LOW PRESS. TRIP/L.LOW PRESS.TRIP", "H.T WATER HIGH/H.HIGH TEMP. TRIP", "BOTH TACHO FAIL TRIP", "EM'CY STOP", "OIL MIST DENSITY TRIP (OPTION)", "READY TO START".

1-2.2 Temperature & Pressure Monitor Unit (YECS-1000T)



GENERAL SPEC.

1. MODEL : TEMP. & PRESS. MONITOR UNIT (YECS-1000T)
2. INPUT
   - CAN BUS FOR INTERNAL COMMUNICATION.
3. DISPLAY
   - 4 DIGITS, 7 SEGMENT FND 1EA
   - 3 DIGITS, 7 SEGMENT FND 14EA
   - RECTANGLE LED 12EA
   - CIRCLE LED 12EA
5. ACCURACY : F.S+0.2%
6. POWER SUPPLY : ABOUT 13.2W (Max. DC 24V 550mA)

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Figure 5. YECS-1000T

1) Description

YECS-1000T consists of 12 circular LEDs and a FND. The LEDs display position of selected channel and the FND display temperature/pressure statues and operating range of selected channel. (12 rectangular LEDs display ALARM.)

This unit communicates with YECS-1000M (Main Control Unit) & YECS-1000A (Analog/Communication Unit) by using CAN bus and it receives temperature and pressure data of each channel.

2) Function

- UP KEY : You can check a wanted channel to upwards.

- DOWN KEY : You can check a wanted channel to downwards.

- AUTO SCAN KEY : It sequentially scans channels from top of right to bottom (You can use the "up" & "down" button during the working "AUTO SCAN")

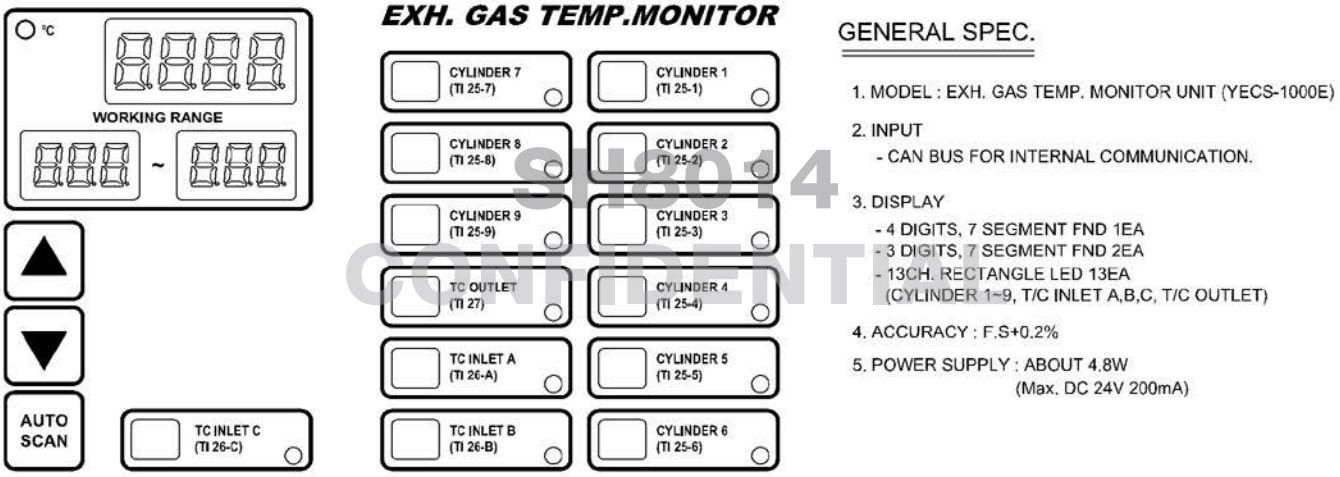
(NOTE 1 : The selected analog signal displays on the top of FND.)

(NOTE 2 : If you press the auto scan key, the signal of channel will be sequentially indicated from the right top rectangular LED.)

(NOTE 3 : The operating range & current status of "HT-WATER TEMP. ENGINE OUTLET(TI 76)", "LUB. OIL TEMP. ENGINE INLET(TI 62)", "LUB. OIL PRESS. ENGINE INLET (PI 62)", FUEL OIL PRESS. ENGINE INLET(PI 51)" is continuously displayed. (if the alarm occurs the relevant FND will flicker.))

(NOTE 4 : If the alarm occurs the rectangular LED of the relevant channel will flicker.)

1-2.3 Exhaust Gas Temperature Monitor Unit (YECS-1000E)



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Figure 6. YECS-1000E

1) Description

YECS-1000E consists of 13 circular LEDs, a FND. The LEDs indicate position of selected channel and the FND display temperature/pressure statues and operating range of selected channel.

This unit communicates with YECS-1000M(Main Control Unit), YECS-1000A(Analog/Communication Unit), by using CAN and it receives exhaust gas temperature data of each channel.

2) Function

- UP KEY : You can check a wanted channel to upwards.

- DOWN KEY : You can check a wanted channel to downwards.

- AUTO SCAN KEY : It automatically scans channels from top of right to bottom (You can use the "up" & "down" button during the working "AUTO SCAN")

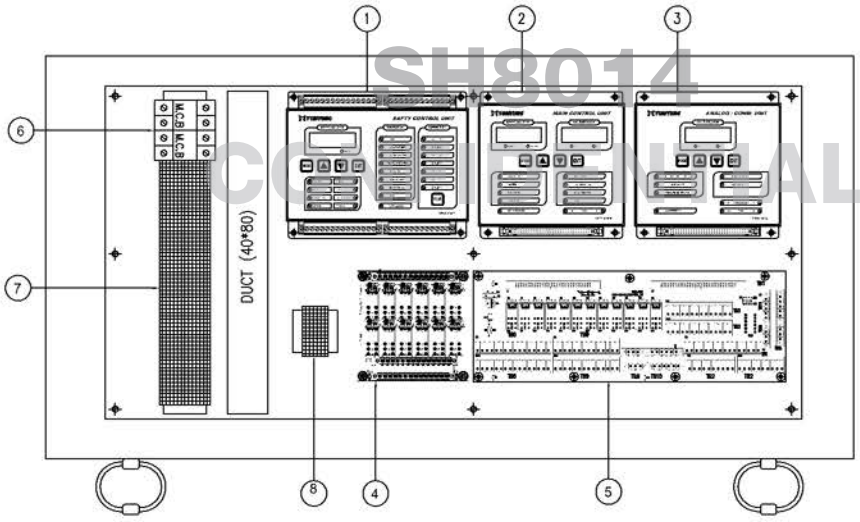
(NOTE 1 : The selected analog signal displays on the top of FND.)

(NOTE 2 : If you use the auto scan key, the signal of channel will be sequentially indicated from the right top rectangular LED.)

(NOTE 3 : If the alarm occurs the rectangular LED of the relevant channel will flicker.)

1-3. Terminal box

Terminal box consist of "Control System" and "Safety System". The "Control System" includes Main control unit (YECS-1000M), Analog/Communication unit (YECS-1000A) and Main interface board (YECS-1000M MIF). Also the Safety system includes Safety control & Cable supervision unit (YECS-1000S), Safety interface board (YECS-1000SIF).



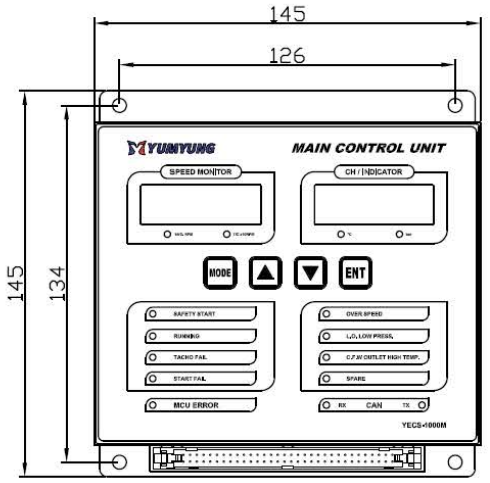
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1. Safety Control & Cable Supervision Unit (Symbol : U2, Remarks : YECS-1000S)
2. Main Control Unit (Symbol : U3, Remarks : YECS-1000M)
3. Analog / Communication Unit (Symbol : U1, Remarks : YECS-1000A)
4. Safety Interface Board (Symbol : P4, Remarks : YECS-1000SIF)
5. Main Interface Board (Symbol : P1, Remarks : YECS-1000MIF)
6. Main Circuit Breaker (MCB)
7. TERMINAL BLOCK X1~X4 (WDK2.5 : BEIGE 47EA) (WEIDMULLER)
8. TERMINAL BLOCK X5 (RKD2.5 : RED 1EA, YELLOW 1EA, BEIGE 3EA) (CONTA-CLIP)

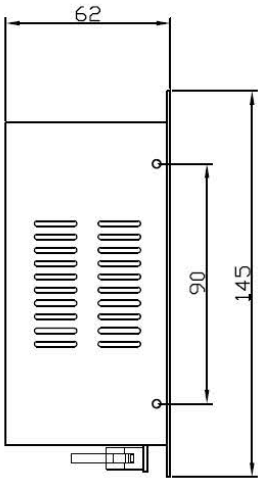
Figure 7. Terminal box

1-3-1. Control System

1-3-1.1 Main Control Unit : (YECS-1000M)



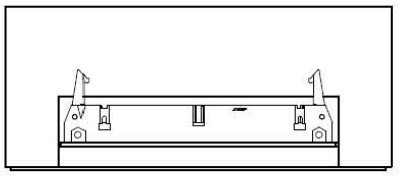
<FRONT VIEW>



<SIDE VIEW>

GENERAL SPEC.

1. MODEL : MAIN CONTROL UNIT(YECS-1000M)
2. INPUT : BINARY 20EA
   - ENG. : SQUARE WAVE, 0~1200 /0~10kHz(POWER: +15V)
   - T/C : SINE WAVE, 0~80000 / 0~3kHz(POWER: +15V)
3. OUTPUT
   - DRY CONTACT : 12EA PHOTO COUPLER, MAX. 20mA
4. COMMUNICATION
   - CAN-BUS FOR INTERNAL COMMUNICATION WITH THE YECS-1000A, MONITORING BOX
5. DISPLAY
   - 6 DIGITS, 7SEGMENT FND, 2EA
   - STATUS LED 15EA
6. ACCURACY : F.S+0.2%
7. POWER SUPPLY : ABOUT 24W (MAX.:1000mA, DC24V)



<BOTTOM VIEW>

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Figure 8. YECS-1000M

1) Description

YECS-1000M for control system displays RPM on the FND by calculating input frequency of engine & Turbocharger pick-up sensor. Also it outputs relay point about sequential logic.

This unit communicates with Analog/Communication Unit (YECS-1000A), Monitoring Box by using CAN and it communicates temperature/pressure, current status, Engine & Turbocharger RPM data.

2) Function

- Input: Input consists of 6 channels' photo-coupler.
- Output: Output consists of 12 channels' photo-coupler.
- Pick-up input: The engine pick-up signal for using control system can detect sensor whether to open or not. (Except Turbocharger)
- Communication: This unit uses CAN. (In case of normal communication, the relevant LED turns on).

3) Operation

- This unit can be set as follows information:

1. Engine / Turbocharger gear
2. Engine running "ON / OFF" RPM
3. Engine overspeed "ON" RPM
4. Turbocharger overspeed "ON" RPM
5. Cylinder number
6. Monitoring alarm "ON / OFF"
7. Alarm blocking "ON / OFF"
8. H.T press. offset
9. L.T press. offset
10. Lub oil press. Engine inlet
11. Start air press. alarm
12. Start fail time delay
13. Turbocharger type
14. Continuous MDO "ON/OFF"
15. Soft. Group
16. Jet sol valve delay time
17. Tier type select
18. Jet Sol Valve start RPM limit
19. Jet Sol Valve run RPM limit
20. Jet Sol Valve Charge air Press. limit
21. Jet Sol Valve OFF Time Delay

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- This unit is operated as follows operation:

1. READY TO START CONDITION

When it is satisfied below condition, you can start the engine.

1) Local / Remote Stop Not Set Up
2) Automatic Stop Not Set Up
3) Emergency Stop Not Set Up
4) Engine Inlet L.O Pressure is Over Than 0.08bar (or 0.08kgf/㎠, 0.008MPa)
5) Turning Gear(of Bar) Disengaged
6) Blocking/Reset Position Not Set Up
7) Tacho Failure (Main Pick-up Failure) Not Set Up
8) Filter Inlet L.O Pressure is Under Than 3.0bar (or 3.0kgf/㎠, 0.3MPa)

2. "LOCAL, REMOTE, BLOCKING/RESET" MODE SELECTION

You can use the push button on the front of YECS-1000D to select "LOCAL, REMOTE, BLOCKING/RESET" modes. Also you can start engine following selected mode. (In BLOCKING/RESET mode, you can't select START/STOP function.)

3. ENGINE START

If only "READY TO START" condition is satisfied, the engine can be started by pushing the start button.

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1) LOCAL START
   The engine can be started by pushing the start button on the front of YECS-1000D.
2) REMOTE START
   In Remote mode condition, you must start at M.S.B.D for starting the Engine.

4. START FAIL

After the engine start, if one of the following conditions is occurred, the control system will show the start fail alarm. After 30 seconds next the engine completely stops, the "START FAIL" alarm will automatically disappear.

1) The engine fails to reach 50 RPM within 5 sec after engine starting.
2) The engine fails to run engine within 20 sec after engine starting.
3) In Turning Gear (or Bar) Engaged, Local, Blocking condition, you try to run "Remote START".

5. ENGINE STOP

If one of the following conditions occurs, the control system will activate Governor stop Sol. V/V for stopping the engine.

1) Local / Remote stop.

2) Common trip(automatic stop)

- Overspeed
- L.O LOW/L.LOW Press.
- H.T WATER HIGH/H.HIGH Temp.
- Both tacho fail
- Oil Mist High Density (Option)

6. STOP FAIL. FUNCTION

After the stop sol. valve is activated, if the engine doesn't stop within 40 sec, the control system will generate stop fail alarm and activate EM'CY stop sol. valve for stopping the engine.

7. JET ASSISTANCE SYSTEM CONTROL FUNCTION

JET ASSISTANCE is function to improve the acceleration characteristics of engine so every engine plant needs it.

In the case of lack of exhaust gas output for driving the turbocharger you can solve the problem by supplying air to compressor wheel. The supplying air goes through regulator to control starting air for increasing turbocharger speed.

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Control system can regulate charge air pressure. Jet assistance control react sudden output and sudden increasing load.

(1) When the engine exceeds 80 RPM after start , control system operates Jet sol. Valve for 8 seconds(Delay time setting) and supplies air to turbocharger.
(2) When the engine become running state, if rpm drops below 97% of the rated RPM, Jet sol. valve operates. and as return to running rpm, Jet sol. valve will close.
(3) If the engine runs and rpm drops more than 5 RPM within 1 second, Jet sol. valve operates for 3 seconds.

8. TACHO FAIL FUNCTION

If a pick-up sensor cable is open or breakdown, the tacho-fail alarm will occur.

9. SHUTDOWN FUNCTION

In order to display the engine shut-down status on the YECS-1000D, this unit is inputted signal related to shut-down through the YECS-1000A and transmits data for shut-down into the YECS-1000D by CAN. Shut-down condition as follows:

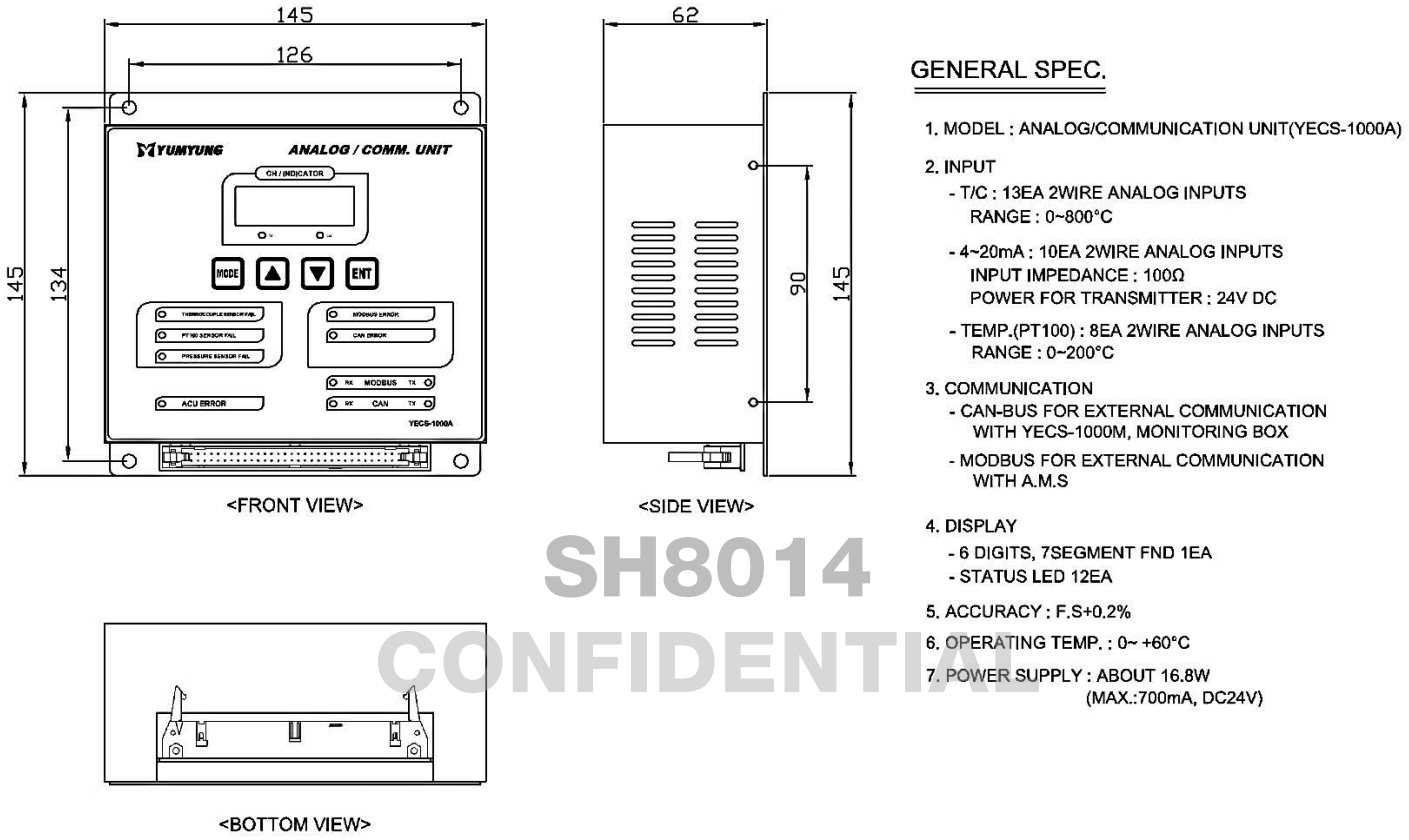
1) Over speed trip

2) L.O Low /L.Low Press. Trip

3) H.T water high / H.High Temp. Trip

4) Oil mist high density trip (Option)

1-3-1.2 (Analog/Communication Unit : YECS-1000A)



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Figure 9. YECS-1000A

1) Description

YECS-1000A converts to electric signal from all analog signal and display about the relevant analog signal of each channel on the FND. Also the inputted analog signal communicates data with YECS-1000M, Monitoring Box by using CAN.

Processing alarm logic by Control and Safety System communicates with A.M.S (alarm monitoring system) by using MODBUS (RS422/RS485).

2) Function

- Thermocouple input : 13 channels.

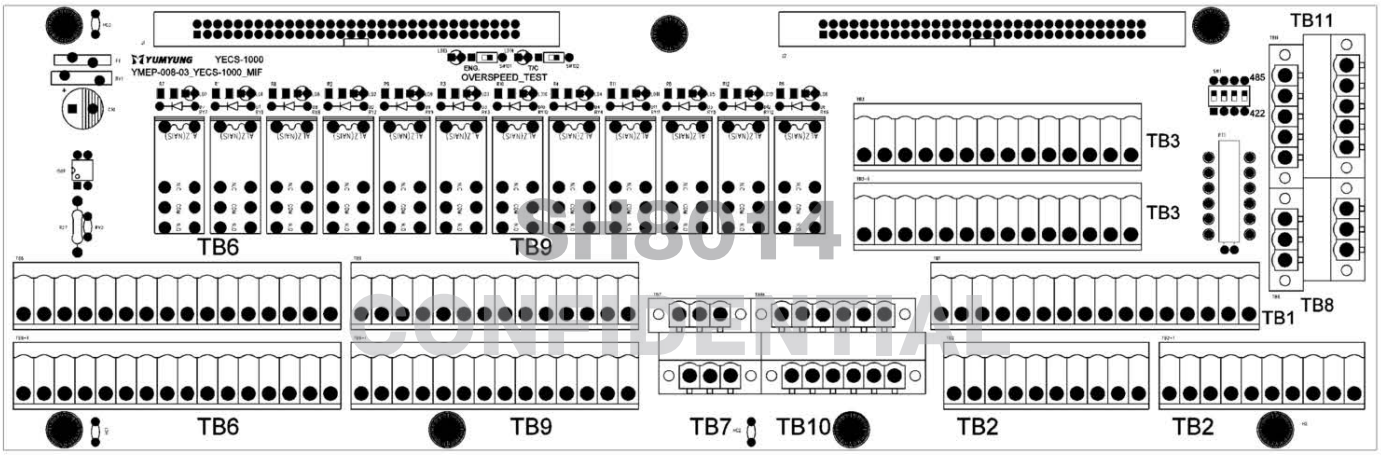
- 4~20mA input : 10 channels.

- PT-100 input : 8 channels(For temperature compensation 1 channel)
- Sensor open detection
- Deviation alarm

3) Operation

- Thermocouple input : This unit gets to input 13 channels. The measuring temperature range is 0°C~800°C and the cold junction compensation is compensated the PT100 of the Main Interface Board(YECS-1000MIF).
- 4~20mA input : This unit gets to input 10 channels and its input current is 4~20mA.
- PT-100 input : This unit gets to input 8 channels and PT100.

1-3-1.3 Main Interface Board (YECS-1000MIF)



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Figure 10. YECS-1000MIF

1) Description

The Main Interface Board (YECS-1000MIF) consists of terminal block for signal I/O, relay for digital output and spark quenchers for relay contact. This unit is connected with YECS-1000A and YECS-1000M by using flat cable, and the kind of interface signal is as follows.

- Analog signal interface (From YECS-1000A)

1. 13 channels Thermocouple signal
2. 10 channels Sink current (4~20mA) signal
3. 8 channels PT100 signal
4. 1 channels PT100 sensor for temperature compensation

- Digital input interface (From YECS-1000M).

  1. Remote stop (To M.S.B.D)
  2. Remote start (To M.S.B.D)
  3. Lub. Oil sump tank low / high level
  4. Governor fault
  5. F.O leakage tank high level

- Digital output interface (From YECS-1000M).

  1. Start sol. valve
  2. Stop sol. valve
  3. EM'CY stop
  4. Governor Stop
  5. Reset Shutdown (To Safety Control & Cable Supervision Unit [YECS-1000S])
  6. Start Failure (To M.S.B.D)
  7. Engine Stopping (To M.S.B.D)
  8. Remote (To M.S.B.D)
  9. Engine Stop Signal (To M.S.B.D)
  10. Ready to start (To M.S.B.D)

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- Digital Input Interface Safety Control & Cable Supervision Unit (from YECS-1000S)

  1. Safety Overspeed
  2. Safety L.O Low Press.
  3. Safety H.T Water High Temp.
  4. EM'CY stop
  5. Safety Oil Mist High Density (Option)
  6. Safety Cable Failure
  7. Power & System Failure
  8. Local Shutdown
  9. Safety Start
  10. Safety Tacho Failure

- MODBUS (RS422/485), CAN Communication interface

- OVERSPEED TEST SWITCH

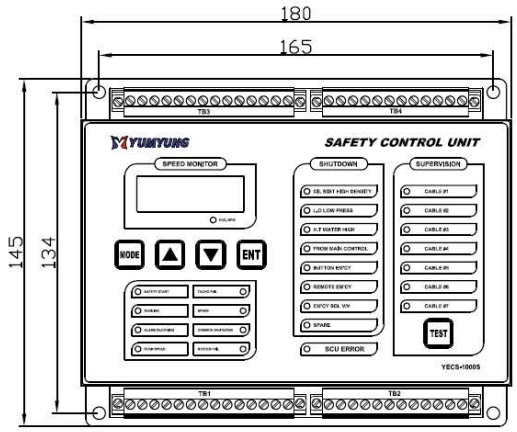
  1. ENG. : When the ENG. switch on, the LED is on and the output is 120% of ENG. input rpm.

  2. T/C. : When the T/C switch on, the LED is on and the output is 300% of T/C input rpm.

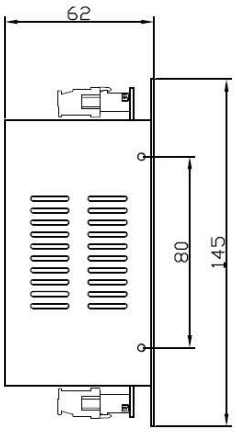
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1-3-2. Safety System

1-3-2.1 Safety Control & Cable Supervision Unit : YECS-1000S



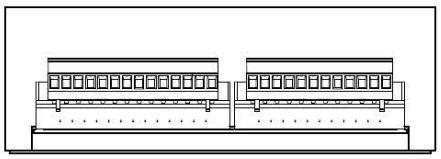
<FRONT VIEW>



<SIDE VIEW>

GENERAL SPEC.

1. MODEL : SAFETY CONTROL & CABLE SUPERVISION UNIT (YECS-1000S)
2. INPUT
   - ENG. : SQUARE AND SINE WAVE, 0~1200 /0~10kHz(POWER: +12V)
   - RELAY INPUT 19EA (DIGITAL INPUT 12EA, DIGITAL INPUT WITH CABLE SUPERVISION 7EA)
3. OUTPUT
   - DRY CONTACT : RELAY OUTPUT 10EA
4. DISPLAY
   - 6 DIGITS, 7SEGMENT FND 1EA
   - STATUS LED 25EA
5. ACCURACY : F.S+0.2%
6. POWER SUPPLY : ABOUT 24W (MAX. : 1000mA,DC24V)



<BOTTOM VIEW>

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Figure 11. YECS-1000S

1) Description

YECS-1000S is used in safety system, measures the frequency from engine pick-up sensors and display engine RPM on the FND. Also it outputs the relay contacts about logic sequence. If This relay output inputs to Safety Interface Board(YECS-1000SIF), it will generate "shut down" and it will be inputted the "shut down" signal then the EM'CY Stop Sol Valve will operate. Also this unit has function to check shutdown cable error.

2) Function

- Input: Input part consists of 19 channels photo-coupler.

- Output: Output part consists of 20 channels photo-coupler.

- Pick-up input: Engine pick-up signal used in the safety system can detect sensor whether to open or not.

- Self test: The relevant LED turns on when unit is normal condition.(if not normal condition, LED continuously turns off.

3) Operation

- This unit can be set as follows information:

1. Engine pick-up sensor teeth
2. Engine running "ON / OFF" RPM
3. Overspeed "ON" RPM
4. Alarm Blocking "ON / OFF"
5. Soft. Group

- Logic sequence

1 .OVERSPEED

1) ON : In case of exceeded overspeed RPM over than engine setting value.

2) OFF : In case of pushed the button of BLOKING / RESET which is 0RPM + Safety start ON delay time (3 seconds) + YECS-1000D.

2. ENGINE RUNNING

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1) ENGINE RUNNING- "ON"

(1) In case of engine is "engine running" – More than "ON" RPM or after 10 seconds more than 200 RPM.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is more than 3bar(or 3.0Kgf/㎠, 0.3MPa)

2) ENGINE RUNNING- "OFF"

(1) In case of engine is "Running after Running" - Engine reaches to running-OFF RPM or less than 200 RPM.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is less than 3bar(or 3.0Kgf/㎠, 0.3MPa)

3. PRE LUB. OIL PUMP

1) PRE LUB. OIL PUMP – "ON"

(1) In case of engine is less than 200 RPM.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is less than 3bar(or 3.0Kgf/㎠, 0.3MPa).

2) PRE LUB. OIL PUMP – "OFF"

(1) In case of engine is less than 200 RPM.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is more than 3bar(or 3.0Kgf/㎠, 0.3MPa).

4. START LIMITATION(OPTION)

"START LIMITATION" signal limits fuel by opening Start limit. valve.

1) START LIMITATION – "ON"

(1) In case of engine is more than 25 RPM and engine isn't running.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is less than 3bar(or 3.0Kgf/㎠, 0.3MPa).

2) START LIMITATION – "OFF

(1) In case of engine is less than 25 RPM or engine is running.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is more than 3bar(or 3.0Kgf/㎠, 0.3MPa).

5. JACKET WATER PREHEATER

1) JACKET WATER PREHEATER – "ON"

(1) In case of engine is less than 200 RPM.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is less than 3bar(or 3.0Kgf/㎠, 0.3MPa).

2) JACKET WATER PREHEATER – "OFF"

(1) In case of engine is more than "Engine running – "ON" RPM".

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is more than 3bar(or 3.0Kgf/㎠, 0.3MPa).

6. YECS-1000S operates below the functions for protecting the engine.

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1) Automatic Stop

YECS-1000S has "automatic stop" function which can find the damage of engine condition in advance. So it automatically outputs relay contact of "EM'CY SOL. V/V", "ENGINE SHUTDOWN" and it will stop engine.

After engine completely stops and eliminate the EM'CY STOP problem, you can remove the Automatic stop alarm by pushing "BLOCKING/RESET button in YECS-1000D.

- Automatic Stop condition

(1) Overspeed

(2) Low lub. oil pressure

(3) High H.T water temperature

(4) From Main Control

(5) Oil mist high density (Option)

2) Remote / Manual Emergency Stop

This function stops an engine by activating "EM'CY stop sol. v/v" and "Common Shutdown". After engine stops, if the condition which is EM'CY stop is released, you can release relay contact and LED of EM'CY stop by pressing BLOCKING/RESET button in YECS-1000D.

3) Open circuit monitor

This function can monitor the open of an important signal line in relevant engine Shutdown. The user can check the line open or not by looking at LED of "Cable Supervision" in YECS-1000S.

4) Alarm blocking

When an engine is in stop state, shutdown function is not necessary. Thus alarm blocking is enabled.

7. AVR(Automatic Voltage Regulator) START(OPTION)

"AVR START SIG." sends a signal in order to operate the AVR.

1) JACKET WATER PREHEATER – "ON"

(1) After the engine start, in case of engine RPM is more than rated RPM 25% +1sec.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is more than 3bar(or 3.0Kgf/㎠, 0.3MPa).

2) JACKET WATER PREHEATER – "OFF"

(1) In case of engine RPM in less than rated RPM 23%.

(2) In case of PRESS. SWITCH FOR L.O INLET(PSL62) is less than 3bar(or 3.0Kgf/㎠, 0.3MPa).

1-3-2.2 Safety Interface Board (YECS-1000SIF)

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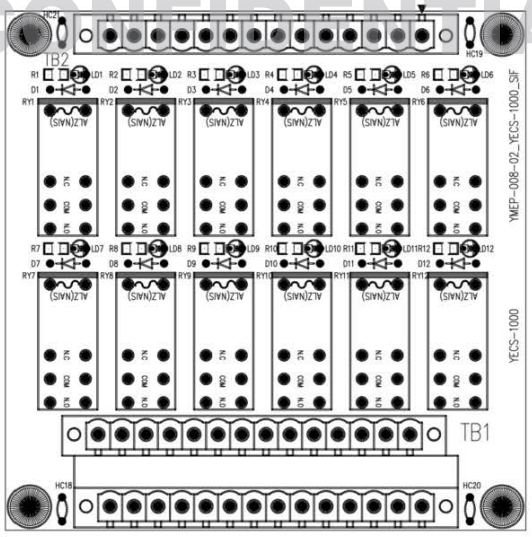


Figure 12. YECS-1000SIF

1) Description

Safety interface board (YECS-1000SIF) is operated by YECS-1000S

This unit drives 12 relays as follows.

- EM'CY Stop Sol. Valve
- Start Fuel Limit Sol. Valve(option)
- Shutdown (To M.S.B.D)
- AVR Start signal (To AVR)(option)
- Engine Running(To M.S.B.D)
- Alarm Blocking(To M.S.B.D)
- Engine Running
- Prelub. Oil Pump on Signal (To Prelub. oil pump starter)
- J.W Preheater on Signal(To J.W preheater starter)
- Spare 1
- Spare 2

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2. FUNCTION EXPLANATION

2.1 Main Control Unit(YECS-1000M)

Function	Explanation
MODE BUTTON	When unit selects setting mode or don't save setting value, this button is used.
UPWARD BUTTON	When channel increases or setting value increases, please use UPWARD BUTTON.
DOWNWARD BUTTON	When channel decreases or setting value decreases, please use DOWNWARD BUTTON.
ENT BUTTON	When setting mode selects or setting value stores, please use ENT BUTTON.
℃	When temperature is selected, this LED turns on.
bar(kgf/㎠,MPa)	When pressure is selected, this LED turns on.
RPM	When Engine RPM is selected, this LED turns on.
X10 RPM	When T/C RPM is selected, this LED turns on.
SAFETY START	When engine is a safe stop condition (0RPM+5sec), this LED turns on.
RUNNING	When engine is a running condition, this LED turns on.
TACHO FAIL	When Pick–up sensor is left out or breaks down, this LED turns on.
START FAIL	When engine is a starting fail condition (start+5sec+50RPM, start+50RPM+15sec +200RPM), this LED turns on.
MCU ERROR	It displays normal/abnormal acting condition of unit and when it is an abnormal acting condition, LED turns on.
OVERSPEED	When engine is an overspeed condition, this LED turns on.
L.O LOW PRESS.	When pressure of L.O is lower than normal value, this LED turns on.
H.T WATER HIGH TEMP.	When temperature of H.T water is higher than normal value, this LED turns on.
SPARE	-
CAN RX	When the receiving status of CAN communication is normal, this LED periodically turns on.
CAN TX	When the transmitting status of CAN communication is normal, this LED periodically turns on.

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2.2 Analog / Communication Unit(YECS-1000A)

Function	Explanation
MODE BUTTON	When unit selects setting mode or auto scan stop / start, this button is used.
UPWARD BUTTON	When channel increases or setting value increases, please use UPWARD BUTTON.
DOWNWARD BUTTON	When channel decreases or setting value decreases, please use DOWNWARD BUTTON.
ENT BUTTON	When setting mode selects or setting value stores, please use ENT BUTTON.
℃	When temperature is selected, this LED turns on.
bar(kgf/㎠,MPa)	When pressure is selected, this LED turns on.
THERMOCOUPLE SENSOR FAIL	When thermocouple sensor is error, this LED turns on.
PT100 SENSOR FAIL	When PT100 sensor is error, this LED turns on.

Function	Explanation
PRESSURE SENSOR FAIL	When sink current (4~20mA) sensor is error, this LED turns on.
MODBUS ERROR	When MODBUS communication error is occurred, this LED periodically turns on.
CAN ERROR	When CAN communication error is occurred, this LED periodically turns on.
ACU ERROR	It displays normal/abnormal acting condition of unit when unit is an abnormal acting condition, this LED turns on.
CAN RX	When the receiving status of CAN communication is normal, this LED periodically turns on.
CAN TX	When the transmitting status of CAN communication is normal, this LED periodically turns on.
MODBUS RX	When the receiving status of MODBUS communication is normal, this LED periodically turns on.
MODBUS TX	When the transmitting status of MODBUS communication is normal, this LED periodically turns on.

2.3 Safety Control Unit(YECS-1000S)

Function	Explanation
MODE BUTTON	When unit selects setting mode or don't save setting value, this button is used.
UPWARD BUTTON	When channel increases or setting value increases, please use UPWARD BUTTON.
DOWNWARD BUTTON	When channel decreases or setting value decreases, please use DOWNWARD BUTTON.
ENT BUTTON	When setting mode selects or setting value stores, please use ENT BUTTON.
RPM	When Engine RPM is selected, this LED turns on.
SPARE	When density of oil mist is high, this LED turns on. (option)
L.O LOW PRESS.	When pressure of L.O is lower than normal value, this LED turns on.
H.T WATER HIGH TEMP.	When temperature of H.T water is higher than normal value, this LED turns on.
SPARE	When density of oil mist system is fail, this LED turns on. (option)
BUTTON EM'CY	When Local EM'CY stop button was pushed, this LED turns on.
REMOTE EM'CY	When Remote EM'CY stop button was pushed, this LED turns on.
EM'CY SOL V/V	If the signal of EM'CY Sol. v/v outputs, the LED will turn on.
SAFETY	When engine is a safe stop condition (0RPM+3sec), this LED turns on.
RUNNING	When engine is a running condition, this LED turns on.
ALARM BLOCKING	When engine doesn't occur an unnecessary output in stop condition, this LED turns on.
OVERSPEED	When engine is an over speed condition, this LED turns on.
TACHO FAIL	When Pick–up sensor is left out or don't work, this LED turns on.
COMMON SHUTDOWN	When at least 1 shutdown condition is occurred, this LED turns on.
SYSTEM FAIL	If Oil Mist High Density Failure occurs, the LED will turn on.
CABLE #1~#7	When sensor cable related to shutdown is not disconnected, the corresponding LED turns off.
TEST BUTTON	This button checks a normal condition of cable supervision.

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Function	Explanation
SCU ERROR	It displays normal/abnormal acting condition of unit and when it is an abnormal acting condition, LED turns on.

2.4 Operating Unit(YECS-1000D)

Function	Explanation
START BUTTON	The Engine is started by pushing START BUTTON. (when it is local mode)
STOP BUTTON	The Engine is stopped by pushing STOP BUTTON. (for 3 seconds press the button not blocking, when it is local mode)
REMOTE BUTTON	The Engine is converted to Remote mode by pushing REMOTE BUTTON.
LOCAL BUTTON	The Engine is converted to Local mode by pushing LOCAL BUTTON.
BLOCKING/RESET BUTTON	BLOCKING/RESET BUTTON closes an engine in Remote mode, Local mode for safe working when Engine repairs or alarm cancels.
LAMP TEST BUTTON	LAMP TEST BUTTON checks a normal condition of the indicating LED.
OVERSPEED TRIP	When engine is over speed condition, "OVERSPEED TRIP" LED turns on.
L.O LOW PRESS. TRIP	When pressure of L.O is lower than normal, "L.O LOW PRESS. TRIP" LED turns on.
H.T WATER HIGH TEMP. TRIP	When temperature of H.T WATER is higher than normal, "H.T WATER HIGH TEMP. TRIP" LED turns on.
BOTH TACHO FAIL TRIP	When it detects "TACHO FAIL" in Main Control Unit and Safety Control Unit, at once, "BOTH TACHO FAIL TRIP" LED turns on.
EM'CY STOP	If Engine makes emergency stop, "EM'CY STOP" LED turns on.
Oil Mist High Density Trip	When the density of Oil Mist is high, LED Turns on.
READY TO START	If the condition for Engine working gets ready, "READY TO START" LED will turn on.

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2.5 Exhaust Gas Temperature Monitor Unit (YECS-1000E)

Function	Explanation
UPWARD BUTTON	This button sequentially checks a normal condition of channel upwards.
DOWNWARD BUTTON	This button sequentially checks a normal condition of channel downwards.
AUTO SCAN BUTTON	This button sequentially checks a normal condition of channel from upper left.
T/C INLET A,B,C	T/C INLET A,B,C checks the entered gas temperature to turbocharger.
T/C OUTLET	T/C OUTLET checks the exhausted gas temperature from turbocharger.
CYLINDER 1~9	Cylinder 1~9 check the exhausted gas temperature within cylinder 1~9.

2.6 Temperature & Pressure Monitor(YECS-1000T)

Function	Explanation
UPWARD BUTTON	This button sequentially checks a normal condition of channel upwards.
DOWNWARD BUTTON	This button sequentially checks a normal condition of channel downwards.
AUTO SCAN BUTTON	This button sequentially checks a normal condition of channel from upper left.

Function	Explanation
H.T WATER TEMP. ENGINE INLET	This button checks the entered 'H.T WATER' temperature to engine.
H.T WATER TEMP. ENGINE OUTLET	H.T WATER TEMP. ENGINE OUTLET checks the exited 'H.T WATER' temperature from Engine.
H.T WATER PRESS. ENGINE INLET	H.T WATER PRESS. ENGINE INLET checks the entered 'H.T WATER' pressure to Engine
L.T WATER TEMP. AIR COOLER INLET	L.T WATER TEMP. AIR COOLER INLET checks the entered 'L.T WATER' temperature to Air cooler.
L.T WATER TEMP. AIR COOLER OUTLET	L.T WATER TEMP. AIR COOLER OUTLET checks the exited 'L.T WATER' temperature from Air cooler.
L.T WATER PRESS. ENGINE INLET	L.T WATER PRESS. ENGINE INLET checks the entered 'LT WATER' pressure to Engine.
CHARGE AIR TEMP. AIR COOLER OUTLET	CHARGE AIR TEMP. AIR COOLER OUTLET checks the exited 'CHARGE AIR' temperature from Air cooler.
CHARGE AIR PRESS. AIR COOLER OUTLET	CHARGE AIR PRESS. AIR COOLER OUTLET checks the exited 'CHARGE AIR' pressure from Air cooler.
LUB. OIL TEMP. ENGINE INLET	LUB. OIL TEMP. ENGINE INLET checks the entered 'L.O' temperature to Engine.
LUB. OIL PRESS. FILTER INLET	LUB. OIL PRESS. FILTER INLET checks the entered 'L.O' pressure at filter to engine.
LUB. OIL PRESS. TC INLET	LUB. OIL PRESS. T/C INLET checks the entered 'L.O' pressure to turbocharger.
LUB. OIL PRESS. ENGINE INLET	LUB. OIL PRESS. ENGINE INLET checks the entered 'L.O' pressure to Engine.
FUEL OIL TEMP. ENGINE INLET	FUEL OIL TEMP. ENGINE INLET checks the entered 'F.O' temperature to Engine.
FUEL OIL PRESS. ENGINE INLET	FUEL OIL PRESS. ENGINE INLET checks the entered 'F.O' pressure to Engine.
FUEL OIL PRESS. FILTER INLET	FUEL OIL PRESS. FILTER INLET checks the entered 'F.O' pressure at filter to Engine.
START. AIR PRESS. ENGINE INLET	START. AIR PRESS. ENGINE INLET checks the entered 'START. AIR' pressure to Engine.

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3. TROUBLE SHOOTING

3.1 Safety Control Unit (YECS-1000S)

1) SHUTDOWN

Trouble	Possible cause	Troubleshooting	Remark
"L.O LOW PRESS." LED turned on.	1. "L.O LOW PRESS." Shutdown signal input. 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. Check the "X4-4,5,6" terminals in the terminal box. (when shutdown, 5-6 close) *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	In Engine running condition
"H.T WATER HIGH TEMP." LED turned on.	1. "H.T WATER HIGH TEMP." Shutdown signal input. 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. Check the "X4-7,8,9" terminals in the terminal box. (when shutdown, 8-9 close) *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	After Engine starting + 60sec
"OIL MIST HIGH DENSITY." LED turned on.	1. "OIL MIST HIGH DENSITY" Shutdown signal Input. 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. Check the "X4-16,17,18" terminals in the terminal box. (when shutdown, 17-18 close) *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	In Engine running condition
"BUTTON EM'CY" LED turned on	1. "BUTTON EM'CY" Shutdown signal input. 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output 1. Check the "X2-21,22" terminals in the terminal box. (when shutdown, 21-22 close) *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	
"REMOTE EM'CY" LED turned on	1."REMOTE EM'CY" " Shutdown signal input 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output 1. Check the "X2-29,30" terminals in the terminal box. (when shutdown, 29-30 close). *If the "Common shutdown" not output; 2. Replace the YECS-1000S module.	
"EM'CY SOL. V/V" LED turned on	1. Shutdown signal input 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. Check the Shutdown signal. *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	
"From Main Control" LED turned on	1. "Main Control" signal input 2. YECS-1000S internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. Check the terminal "TB9-112, 113" in terminal box. (when shutdown, TB9-112, 113 close) *If the "Common shutdown" not output, 2. Replace the YECS-1000S module.	

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2) SPEED MONITORING

Trouble	Possible cause	Trouble shooting	Remark
"SAFETY START" signal LED doesn't work.	1. Pick-up sensor failure. 2. YECS-1000S internal component defect by internal/external factors. 3. PRESS. SWITCH FOR L.O INLET(PSL62) component defect	1. Exchange the pick-up sensor, if it is malfunction. 2. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine stop condition
"SAFETY START" signal LED turned on.	1. Pick-up sensor failure. 2. YECS-1000S internal component defect by internal/external factors.	1. Exchange the pick-up sensor, if it is malfunction. 2. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine running condition
"RUNNING" signal LED turned on.	1. Pick-up sensor failure. 2. YECS-1000S internal component defect by internal/external factors. 3. PRESS. SWITCH FOR L.O INLET(PSL62) component defect	1. Exchange the pick-up sensor, if it is malfunction. 2. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine stop condition
"RUNNING" signal LED doesn't work.	1. Pick-up sensor failure. 2. Pick-up sensor open. 3. YECS-1000S internal component defect by internal/external factors. 4. PRESS. SWITCH FOR L.O INLET(PSL62) component defect	1. Exchange the pick-up sensor, If it is malfunction. 2. Check the terminals as follows for the cable wiring in the terminal box. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine running condition
"ALARM BLOCKING" LED turned on	1. Pick-up sensor open. 2. YECS-1000S internal component defect by internal/external factors. 3. PRESS. SWITCH FOR L.O INLET(PSL62) component defect	1. Check the pick-up sensor wire connection correctly. 2. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine running condition
"ALARM BLOCKING" LED turned off	1. Pick-up sensor is malfunction by noise or the other factors. 2. YECS-1000S internal component defect by internal/external factors. 3. PRESS. SWITCH FOR L.O INLET(PSL62) component defect	1. Check the pick-up sensor wire connection correctly. 2. Replace the YECS-1000S module. 3. Replace the PRESS. SWITCH FOR L.O INLET(PSL62)	In Engine stop condition
"OVERSPEED" signal LED turned on.	1. Pick-up sensor open. 2. YECS-1000S internal component defect by internal/external factors.	1. Exchange the pick-up sensor, if it is malfunction. 2. Replace the YECS-1000S module.	In Engine stop condition
"OVERSPEED" signal LED doesn't work.	1. Pick-up sensor failure. 2. Wrong connection of Pick-up sensor. 3. YECS-1000S internal component defect by internal/external factors.	1. Exchange the pick-up sensor, If it is malfunction. 2. Check the terminals as follows for the cable wiring in the terminal box. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Replace the YECS-1000S module.	In Engine over speed condition
"TACHO FAIL" LED turned on	1. Pick-up sensor failure. 2. Pick-up sensor open.	1. Exchange the pick-up sensor, If it is malfunction.	

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Trouble	Possible cause	Trouble shooting	Remark
	3. YECS-1000S internal component defect by internal/external factors.	2. Check the terminals as follows for the cable wiring in the terminal box. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Replace the YECS-1000S module.	
"common shutdown" LED doesn't work	1. Shutdown signal wire wrong connection. 2. YECS-1000S internal component defect by internal/external factors.	1. Check the"X2-7,8" terminals in the terminal box and common shutdown LED on the YECS-1000S module. (It is close state at shutdown) 2. Replace the YECS-1000S module.	In Engine shutdown condition
"common shutdown" LED turned on	1. Shutdown signal input. 2. YECS-1000S internal component defect by internal/external factors.	1. Check the"X2-7,8" terminals in the terminal box and common shutdown LED on the YECS-1000S module. (It is open contact in normal condition) 2. Replace the YECS-1000S module.	Not in Engine shutdown condition
"System fail" LED turned on	1. "O.M.D SYSTEM FAIL" Signal input. 2. YECS-1000S internal component defect by internal/external factors.	1. Check the"X4-19,20" terminals in the terminal box. (It is close contact in normal condition) 2. Replace the YECS-1000S module.	

3) CABLE SUPERVISION

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Trouble	Possible cause	Trouble shooting	Remark
"L.O LOW PRESS." Cable Supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100KΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X4-4,5,6" terminals for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken wire. 4. Replace the YECS-1000S module.	
"H.T WATER HIGH TEMP." Cable supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100KΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X4-7,8,9" terminals for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	
"OIL MIST HIGH DENSITY" Cable supervision LED doesn't work (OPTION)	1. Cable check. 2. Wrong connection of the Cable. 3. A 100KΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X4-16,17,18" terminals for cable wiring in the terminal box. 2. Measure the end wire of Shutdown Sensor to identify resistor value 100kΩ and install. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	

Trouble	Possible cause	Trouble shooting	Remark
"BUTTON EM'CY" Cable supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100KΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X2-21,22" terminals for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	
"REMOTE EM'CY" Cable supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100KΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X2-29,30" terminals for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	
"EM'CY SOL. V/V" Cable supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100kΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect by internal/external factors.	1. Check the "X4-12,13" terminals for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	
"To Main Control" Cable Supervision LED doesn't work	1. Cable check. 2. Wrong connection of the Cable. 3. A 100kΩ resistor for cable supervision is not installed. 4. Cable wire broken. 5. YECS-1000S internal component defect	1. Check the "TB9-112, 113" for cable wiring in the terminal box. 2. 100kΩ resistor is correct /check the connection. 3. Exchange the cable wire, if it broken. 4. Replace the YECS-1000S module.	
Lamp Test Failure	When pressed "TEST" button, all the LED is turned on. If the LED doesn't turn on, replace the YECS-1000 module.		
"Safe cable failure" Signal output	1. Sensor cable disconnection. 2. YECS-1000S internal component defect by internal/external factors.	1. Check the connection correctly and all of the cable supervision LEDs are turned on. 2. Replace the YECS-1000S module.	

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4) THE OTHER

Trouble	Possible cause	Trouble shooting	Remark
"Priming L.O pump on" signal output	1. Pick-up sensor failure. 2. Pick-up sensor open. 3. YECS-1000S internal component defect by internal/external factors.	1. Exchange the pick-up sensor, If it is malfunction. 2. Check the terminals as follows for the cable wiring in the terminal box. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Check the "X2-3,4" terminals in the terminal box. (3-4 open contact, if Eng. running state) 4. Replace the YECS-1000S module.	In Engine running condition
"Jacket-water pre-heater on" signal output	1. Pick-up sensor failure. 2. Pick-up sensor open.	1. Exchange the pick-up sensor, If it is malfunction..	

Trouble	Possible cause	Trouble shooting	Remark
	3. YECS-1000S internal component defect by internal/external factors. by internal/external factors.	2. Check the terminals as follows for the cable wiring in the terminal box. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Check the "X2-3,4" terminals in the terminal box. (5-6 open contact, if Eng. running state) 4. Replace the YECS-1000S module.	In Engine running condition
"SCU ERROR" LED continuously turned on	YECS-1000S internal component defect by internal/external factors.	Replace the YECS-1000S module.	
MODE/UP/DOWN/ENT key is no working properly	YECS-1000S internal component defect by internal/external factors.	Replace the YECS-1000S module.	
Not display RPM on the FND	1. Pick-up sensor open. 2. Pick-up sensor failure. 3. YECS-1000S internal component defect by internal/external factors.	1. Exchange the pick-up sensor, If it is malfunction. 2. Check the sensor connection as follows. SCU_TB1-1 = + input SCU_TB1-2 = Signal input SCU_TB1-3 = - input 3. Replace the YECS-1000S module.	

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3-2 Main Control Unit (YECS-1000M)

1) STATUS / ALARM

Trouble	Possible cause	Trouble shooting	Remark
"SAFETY START" LED doesn't work	1. Pick-up sensor open. 2. Wrong connection of pick-up sensor's wire. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the TB7(No.125~127) terminal for the pick-up sensor on the main terminal board. 2. Check the sensor connection as follows. No.125 = + input No.126 = Signal input No.127 = - input 3. Replace the YECS-1000M module.	In Engine stop condition
"RUNNING" LED doesn't work	1. Pick-up sensor open. 2. Wrong connection of pick-up sensor's wire 3. Wrong setting of Engine type. 4. YECS-1000M internal component defect by internal/external factors.	1. Check the TB7(No.125~127) terminal for the pick-up sensor on the main terminal board. 2. Check the sensor connection as follows. No.125 = + input No.126 = Signal input No.127 = - input 3. Check the engine model refer to setting manual. 4. Replace the YECS-1000M module.	In Engine running condition
"TACHO FAIL" LED turned on	1. Pick-up sensor open. 2. Wrong connection of pick-up sensor's wire	1. Check the TB7(No.125~127) terminal for the pick-up sensor on the Main terminal board.	

Trouble	Possible cause	Trouble shooting	Remark
	3. Pick-up sensor failure. 4. YECS-1000M internal component defect by internal/external factors.	2. Check the sensor connection as follows. No.125 = + input No.126 = Signal input No.127 = - input 3. If the engine is running state, pick-up sensor malfunction. 4. Replace the YECS-1000M module.	
"START FAIL" LED turned on	1. Pick-up sensor open. 2. Wrong setting of Engine type. 3. Pick-up sensor failure. 4. YECS-1000M internal component defect by internal/external factors.	1. Check the TB7(No.125~127) terminal for the pick-up sensor on the Main terminal board. 2. Check the sensor connection as follows. No.125 = + input No.126 = Signal input No.127 = - input	
		3. Check that RPM is displayed on the YECS-1000M module's FND & Exchange the pick-up sensor. 4. Replace the YECS-1000M module.	
"MCU ERROR" LED continuously turned on	1. YECS-1000M internal component defect by internal/external factors.	Replace the YECS-1000M module.	

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1) TRIP SHUTDOWN

Trouble	Possible cause	Trouble shooting	Remark
"OVERSPEED" signal LED turned on	1. Pick-up sensor failure. 2. YECS-1000M internal component defect by internal/external factors.	1. Exchange the pick-up sensor. 2. Replace the YECS-1000M module.	In Engine stop condition
"OVERSPEED" signal LED doesn't work	1. Pick-up sensor failure. 2. Pick-up sensor open. 3. YECS-1000M internal component defect by internal/external factors.	1. Exchange the pick-up sensor. 2. Check the terminal as follows for the cable wiring in the terminal box. No.125 = + input No.126 = Signal input No.127 = - input 3. Replace the YECS-1000M module.	In Engine overspeed condition
"L.O LOW PRESS." LED turned on	1. PI61 (Lub. Oil press. Engine inlet) is less than 2.5bar 2. YECS-1000M internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. PI61 (Lub. Oil press. Engine inlet)'s pressure check. *If the "Common shutdown" not output, 2. Replace the YECS-1000M module.	In Engine running condition
"H.T WATER HIGH TEMP." LED turned on	1. TI76 (HT water temp. outlet) is more than 100°C. 2. YECS-1000M internal component defect by internal/external factors.	*If the "Common shutdown" output, 1. TI76 (HT water temp. outlet)'s temperature check. *If the "Common shutdown" not output, 2. Replace the YECS-1000M module.	In Engine running condition

1) THE OTHER

Trouble	Possible cause	Trouble shooting	Remark
"CAN RX" signal LED continuously turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the "TB10" terminal of main interface board. TB10 (No.128, 129,134), 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000M module.	
"CAN TX" signal LED continuously turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the "TB10" terminal of main terminal board. TB10(No.128,129,134) 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wire broken. 4. Replace the YECS-1000M module.	
MODE/UP/DOWN/ENT key is no working properly	System Failure.	Replace the YECS-1000M module.	
Not display the engine RPM on the FND	1. Pick-up sensor failure. 2. Pick-up sensor open. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the TB7(No.125~127) terminals that Pick-up sensor of MIF is connected. 2. Check the wiring connection of Pick-up sensor as follows below. No.125 = + input No.126 = Signal input No.127 = - input 3. Replace the YECS-1000M module.	
Not display the T/C RPM on the FND.	1. Pick-up sensor failure. 2. Pick-up sensor open. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the TB7(No.122~123) terminals that Pick-up sensor of MIF is connected. 2. Check the wiring connection of Pick-up sensor as follows below. No.122 = Signal input No.123 = Signal input 3. Replace the YECS-1000M module.	
Not display the Temperature & Pressure on the FND.	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors. 4. YECS-1000A internal component defect by internal/external factors.	1. Replace the YECS-1000M module. 2. Replace the YECS-1000A module.	

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3-3. Analog / Communication Unit (YESC-1000A)

1) STATUS / ALARM

Trouble	Possible cause	Trouble shooting	Remark
"THERMOCOUPLE SENSOR FAIL" LED turned on	1. Wrong connection or disconnection of the sensor wire. 2. Sensor opens. 3. Sensor failure.	1. Check the thermal-coupler wiring condition. 2. Check the TB3(No.29~50D)terminals that the thermal-coupler sensor of main	

Trouble	Possible cause	Trouble shooting	Remark
	4. YECS-1000A internal component defect by internal/external factors.	interface board is connected. 3. Replace the PT100 sensor, if it is a failure. 4. Replace the YECS-1000A module.	
"PT100 SENSOR FAIL" LED turned on	1. Wrong connection or disconnection of the sensor wire. 2. Sensor opens. 3. Sensor failure. 4. YECS-1000A internal component defect by internal/external factors.	1. Check the PT100 sensor wiring condition. 2. Check the TB1(No.51~66) terminals that the PT100 sensor of main terminal board is connected. 3. Replace the PT100 sensor, if it is a failure. 4. Replace the YECS-1000A module.	
"PRESSURE SENSOR FAIL" LED turned on.	1. Wrong connection or disconnection of the sensor wire. 2. Sensor opens 3. Sensor failure. 4. YECS-1000A internal component defect by internal/external factors.	1. Check the press. sensor wiring condition. 2. Check the TB2(No.80~97B) terminals that the press. sensor of main interface board is connected. 3. Replace the press. sensor, if it is a failure. 4. Replace the YECS-1000A module.	
"ACU ERROR" Continuously Turned on	1. System Failure	1. Replace the YECS-1000A module.	
"MODBUS ERROR" LED turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the "TB8" terminal of main interface board. RS485 - TB8(No.76~81) RS422 - TB8(No.139~148), 2. Check that "X3" terminal in the terminal box is connected as follows below. RS485 - X3(No.1~6) RS422 - X3(No.7~16) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	
"CAN ERROR" LED turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. MCU internal component defect by internal/external factors.	1. Check the "TB10" terminal of main interface board. TB10(No.128,129,134), 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	
"CAN RX" signal continuously turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the "TB10" terminal of main interface board. 2. Check that "X5" terminal in the terminal box is connected as follows below. TB10(No.128,129,134), X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	
"CAN TX" signal continuously turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000M internal component defect by internal/external factors.	1. Check the "TB10" terminal of main interface board. TB10(No.128,129,134) 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	

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Trouble	Possible cause	Trouble shooting	Remark
"MODBUS RX" continuously turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000A internal component defect by internal/external factors.	1. Check the "TB8" terminal of main interface board. RS485 - TB8(No.76~81) RS422 - TB8(No.139~148), 2. Check that "X3" terminal in the terminal box is connected as follows below. RS485 - X3(No.1~6) RS422 - X3(No.7~16) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	"MODBUS ERROR" LED turned on
"MODBUS TX" continuously Turned on	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. YECS-1000A internal component defect by internal/external factors.	1. Check the "TB8" terminal of main interface board. RS485 - TB8(No.76~81) RS422 - TB8(No.139~148),	"MODBUS ERROR" LED turned on
		2. Check that "X3" terminal in the terminal box is connected as follows below. RS485 - X3(No.1~6) RS422 - X3(No.7~16) 3. Check CAN wiring broken. 4. Replace the YECS-1000A module.	
MODE/UP/DOWN/ENT key is not working properly	1. YECS-1000M internal component defect by internal/external factors.	Replace the YECS-1000A module.	
Not Display Temperature & Pressure on the FND	1. YECS-1000M internal component defect by internal/external factors.	Replace the YECS-1000A module.	

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3-4. Operating Unit (YECS-1000D)

Trouble	Possible cause	Trouble shooting	Remark
"READY TO START" LED doesn't work	1. Not in Eng. stop condition. 2. Turning gear (or bar) engage. 3. PI62(Lub. Oil press. Engine inlet) pressure is below 0.08bar. 4. Engine control mode is "Blocking reset".	1. Check the engine is stop condition. 2. The turning gear (or bar) separation. 3. PI62(Lub. Oil press. Engine inlet) pressure 0.08bar over made. (if pressure is low, refer to the manual	
	5. Main Pick-up Sensor breakaway. 6. PI61(Lub. Oil press. Engine filter) pressure is over 3bar.	reset setting) 4. Change the engine control mode. ("REMOTE" or "LOCAL") 5. Check the connection correctly for the pick-up sensor. 6. PI62(Lub. Oil press. Engine fiter) pressure 3bar below made.	
"START SOL. V/V" signal not output	1. Control mode is "BLOCKING/RESET". 2. Not in "READY TO START" condition. 3. Not in "START FAIL" condition released. 4. CAN Error.	1. Change the engine control mode. ("REMOTE" or "LOCAL") 2. Make "REMOTE TO START" condition. 3. Wait for unit "START FAIL" reset. 4. Check the LED "CAN TX" , "CAN RX" in behind of YECS-1000D module.	When the pushed "Start Button"

All FND,LED light blinked	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. Internal component defect in YECS-1000D. 4. Internal component defect in YECS-1000M.	1. Check the "TB10" terminal of main terminal board. TB10(No.128,129,134), 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000D module. 5. Replace the YECS-1000M module.	
All FND, LED not display	1. No power supply. 2. System failure.	1. Check the Main power. 2. Replace the YECS-1000D module.	

3-5. Exhaust Gas Temperature Monitor Unit (YECS-1000E)

Trouble	Possible cause	Trouble shooting	Remark
All FND,LED light blinked	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. Internal component defect in YECS-1000E. 4. Internal component defect in YECS-1000M.	1. Check the "TB10" terminal of main terminal board. TB10(No.128,129,134) 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000E module. 5. Replace the YECS-1000M module.	
All FND, LED not display	1. No power supply. 2. System failure.	1. Check the Main power. 2. Replace the YECS-1000E module.	

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3-6. Temperature & Pressure Monitor Unit (YECS-1000T)

Trouble	Possible cause	Trouble shooting	Remark
All FND,LED light blinked	1. Wrong connection of the CAN wire. 2. CAN wire broken. 3. Internal component defect in YECS-1000T. 4. Internal component defect in YECS-1000M.	1. Check the "TB10" terminal of main terminal board. TB10(No.128,129,134) 2. Check that "X5" terminal in the terminal box is connected as follows below. X5(No.3~5) 3. Check CAN wiring broken. 4. Replace the YECS-1000T module. 5. Replace the YECS-1000M module.	
All FND, LED not display	1. Not power supply. 2. System failure	1. Main power check. 2. Replace the YECS-1000T module.	

4. SETTING

4.1 Safety Control Unit (YECS-1000S)

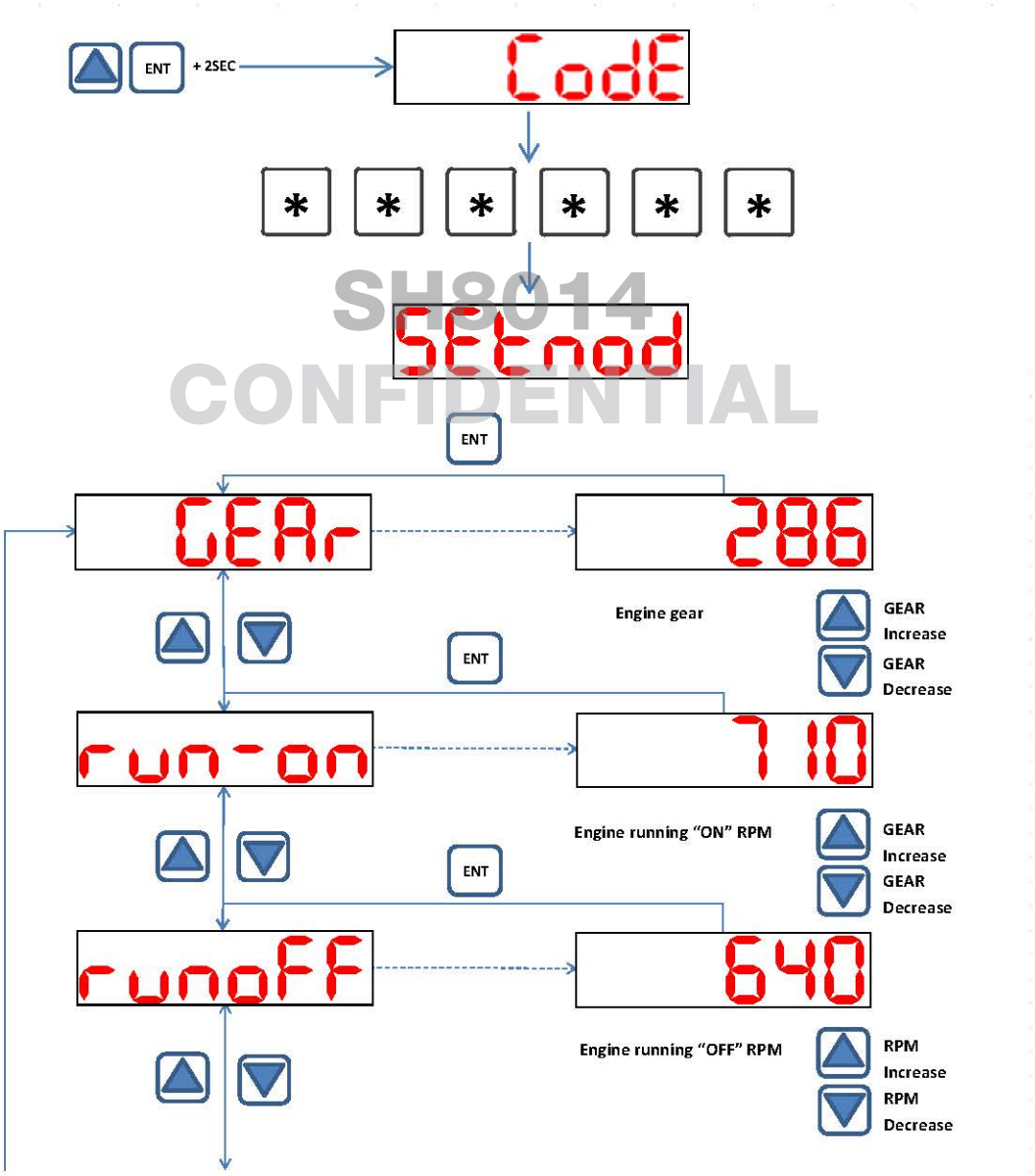
4.1.1 SET MODE

Please follow the setting process below after determining the engine type.(It will be set automatically, when fitting Soft Group on the engine type.)

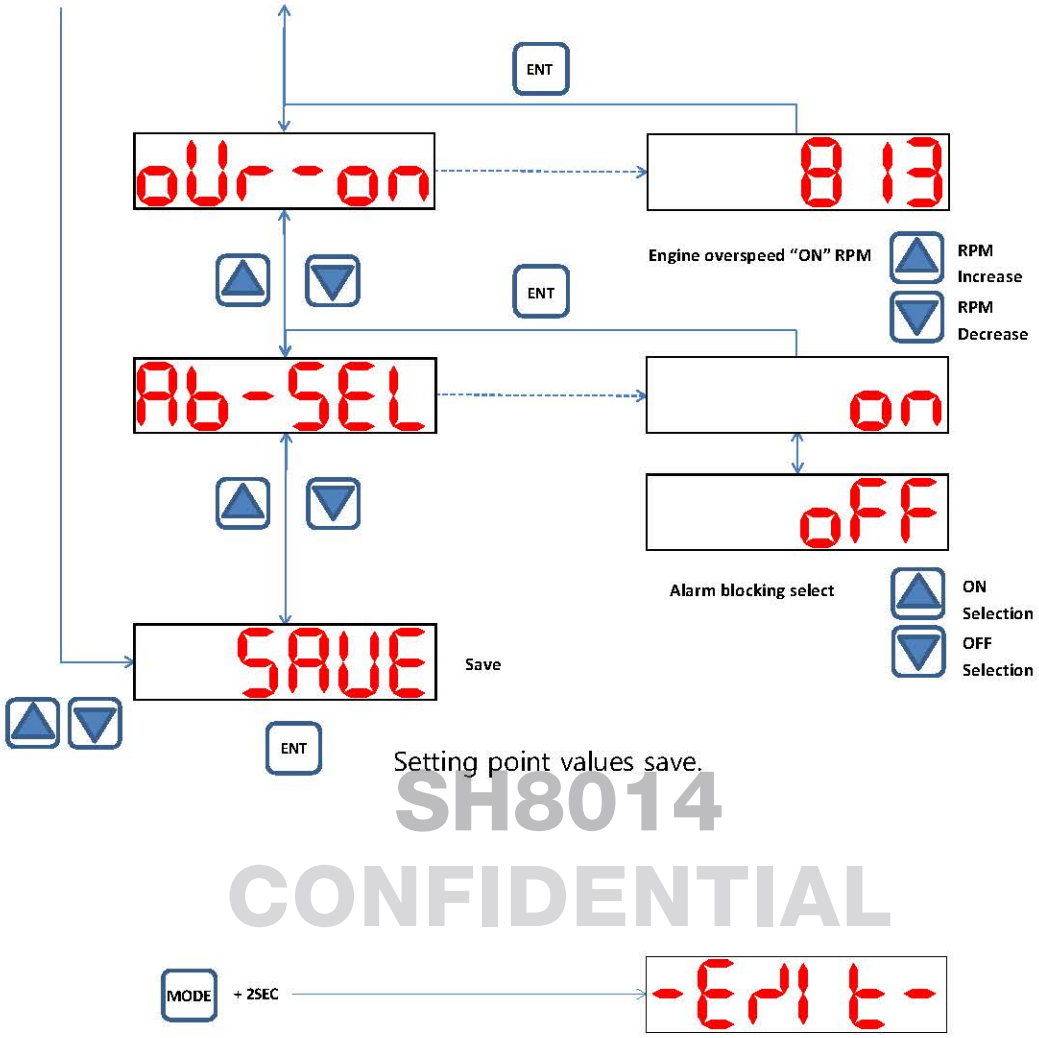
1) Engine running : Engine running "ON" RPM, Engine running "OFF" RPM

2) Overspeed : Engine Overspeed "ON" RPM

3) Etc. : Engine Gear, Alarm blocking select



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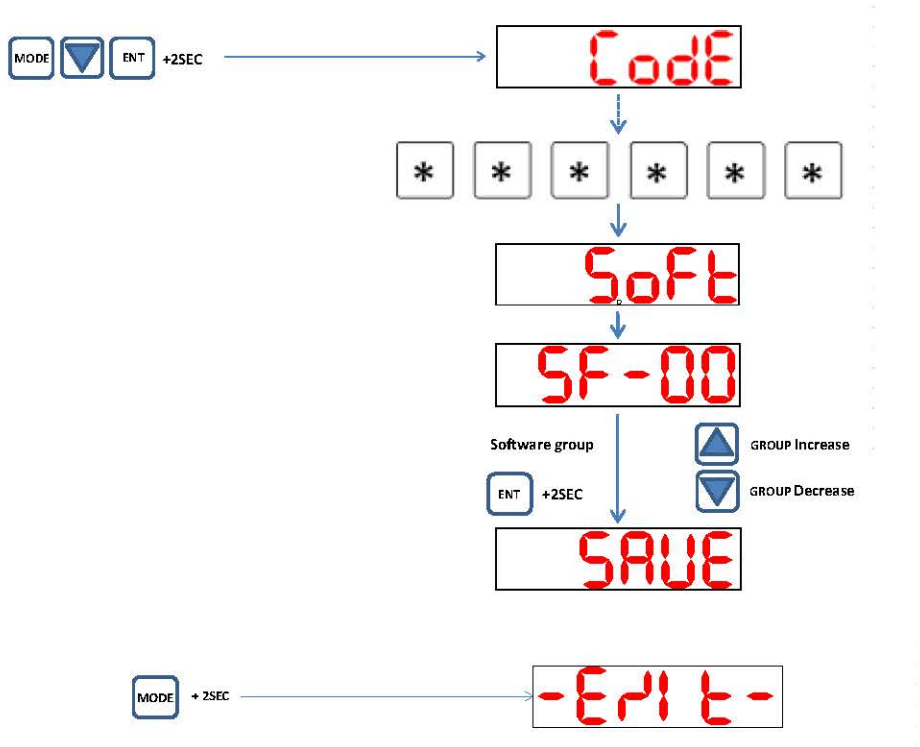


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- Notes)

After 15 seconds without any key operation, "SET2" will automatically switch to "EXIT".

4.1.2 SOFT GROUP



- Notes)

  After 15 seconds without any key operation, "SOFT GROUP" will automatically switch to "EXIT".

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- SOFT GROUP TABLE

S/N	Engine Type	Engine Gear	Engine Run "ON" RPM	Engine Run "OFF" RPM	Overspeed "ON" RPM
0	H21/32	286	710	640	813
1	H21/32	286	710	640	847
2	H21/32	286	880	700	1017
3	H21/32	286	930	730	1130
4	H25/33	282	710	640	813
5	H25/33	282	710	640	847
6	H25/33	282	880	700	1017
7	H25/33	282	930	730	1130
8	H17/28M	286	880	700	1017
9	H17/28M	286	930	730	1130
10	H17/28U(E)	256	880	700	1017
11	H17/28U(E)	286	930	730	1130
12	H32/40	42	710	640	813
13	H32/40	42	710	640	847

4.2 Main Control Unit (YECS-1000M)

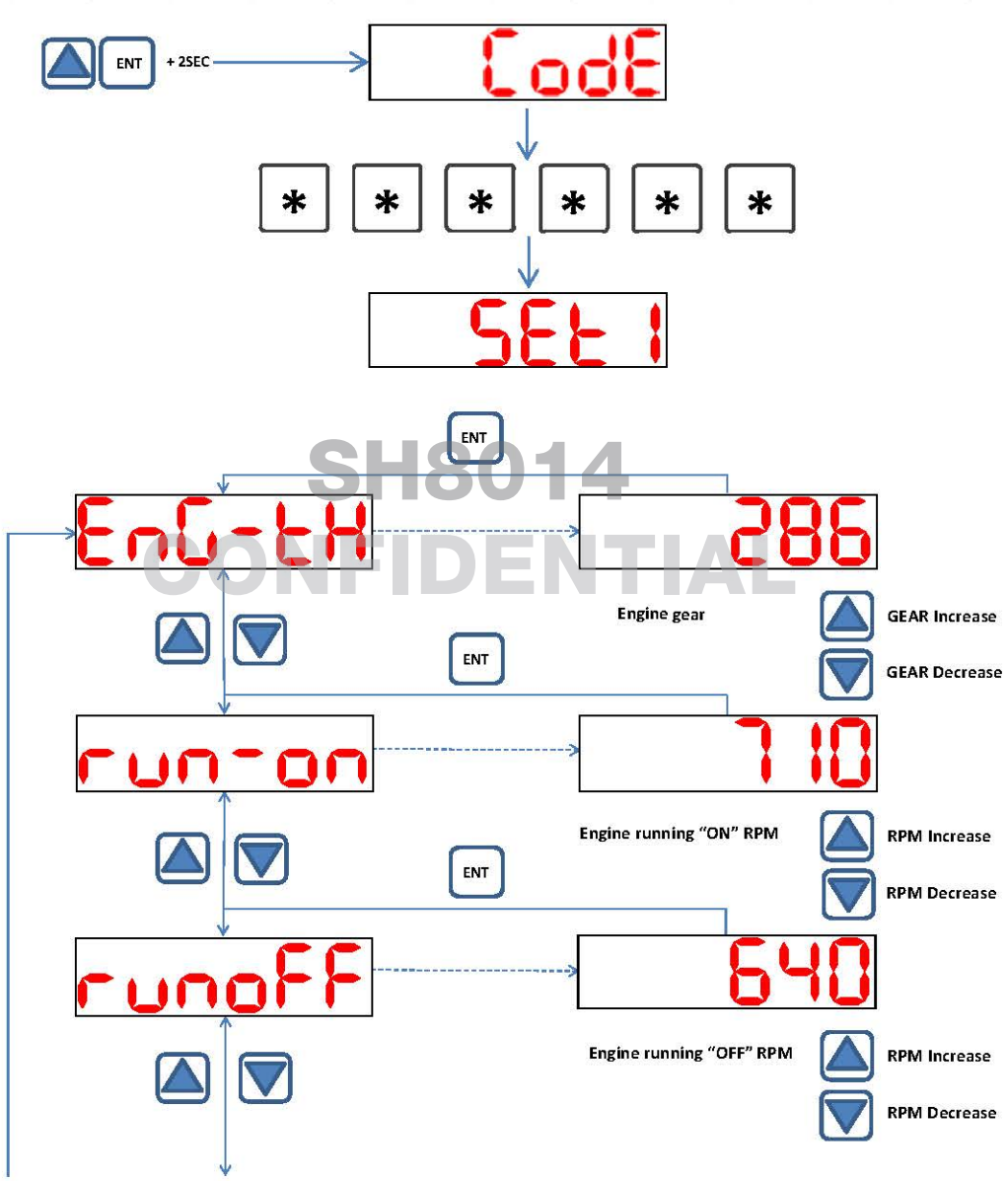
4.2.1 SET 1

Please set as follows below.(Soft Group tuned to the engine type will be set automatically)

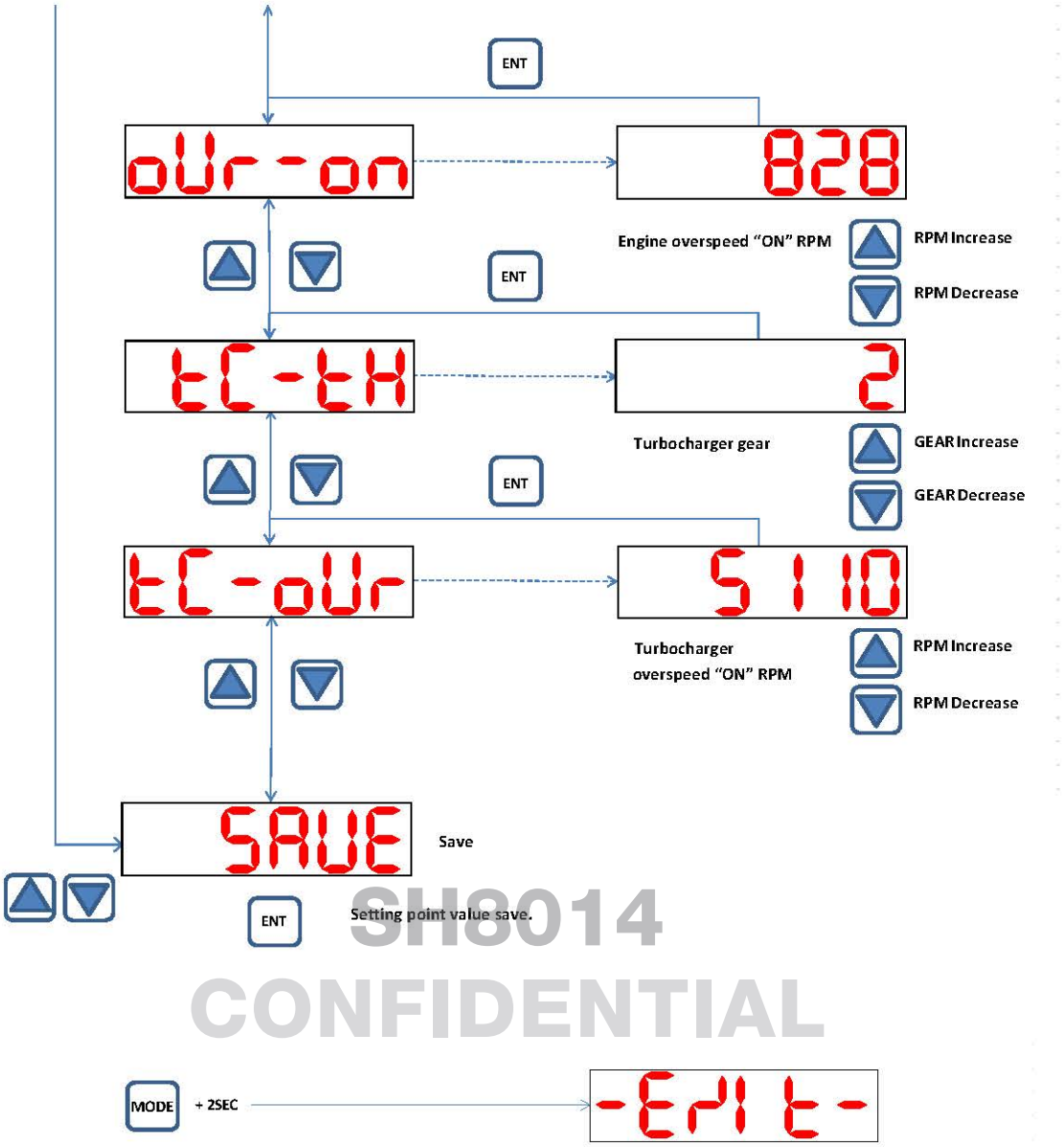
1) Engine running : Engine running "ON" RPM, Engine running "OFF" RPM

2) Overspeed : Engine overspeed "ON" RPM, Turbocharger overspeed "ON" RPM

3) Gear : Engine Gear, Turbocharger Gear



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- Notes)

After 15 seconds without any key operation, "SET2" will automatically switch to "EXIT".

4.2.2 SET 2

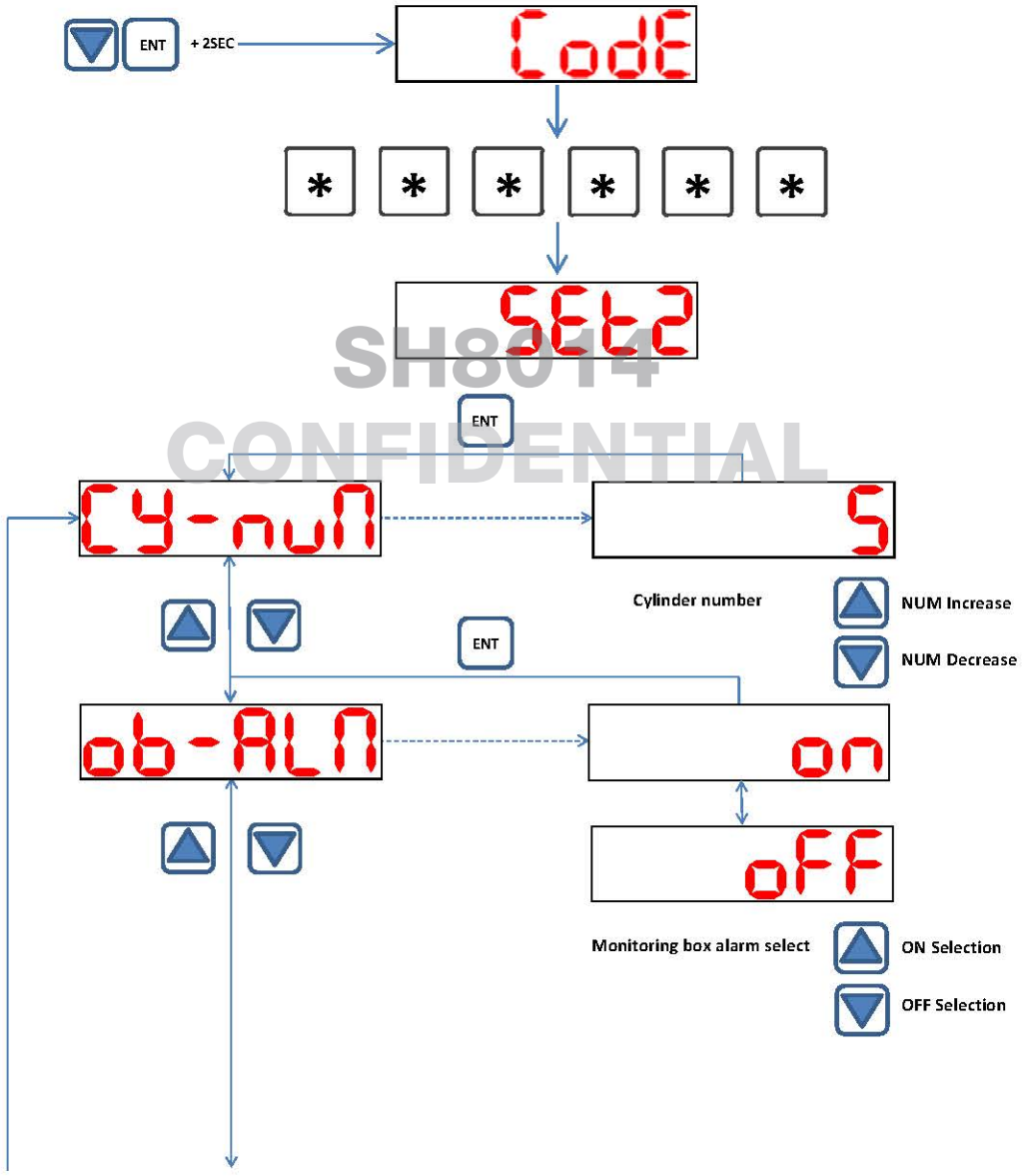
Please set as follows below.

Cylinder number, Operating box alarm, Alarm blocking select, H.T static, L.T static, Lub. Oil press engine inlet, Start air press alarm, Turbocharger Type, Start Fail Time Delay,

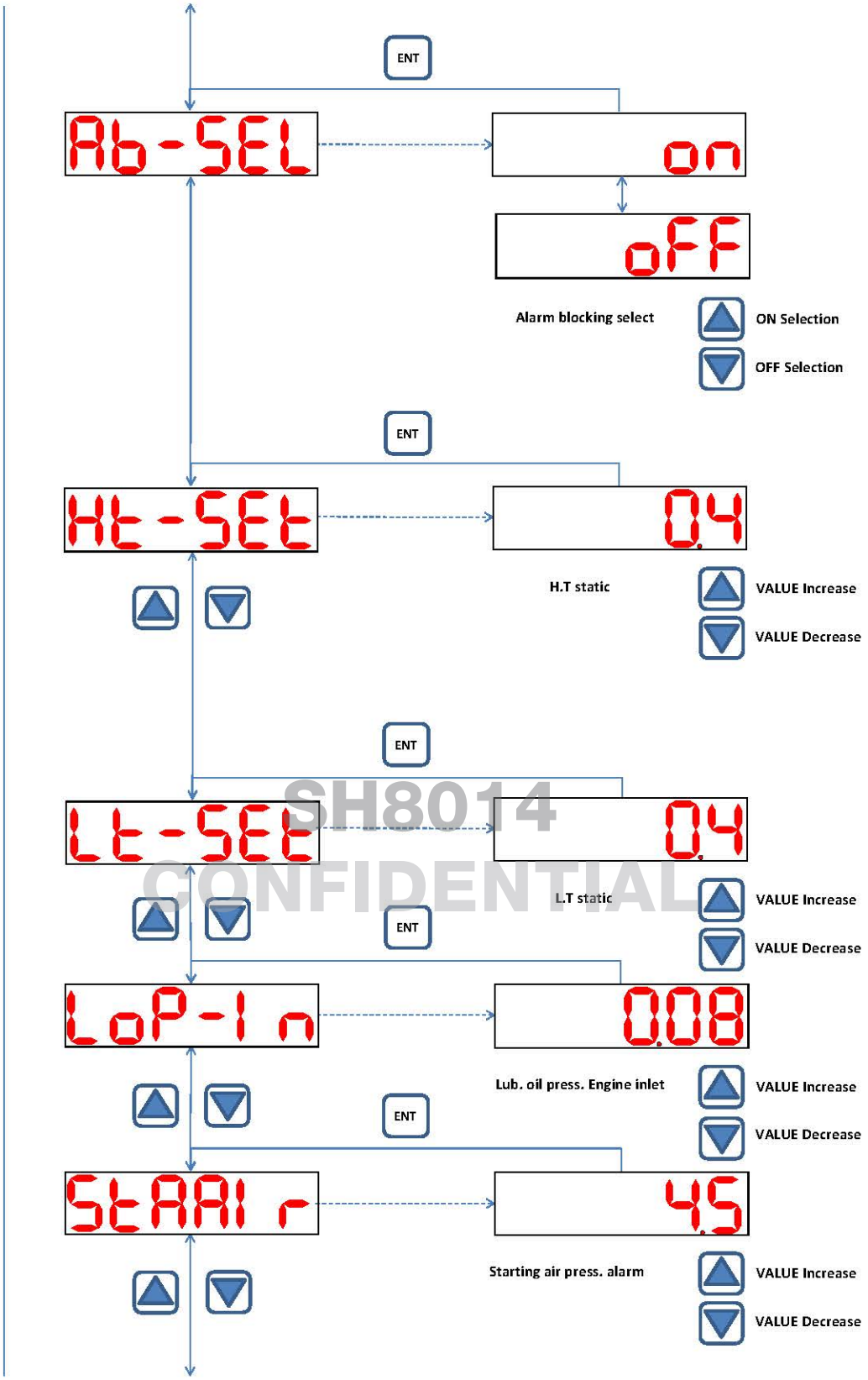
Jet Sol Valve Time Delay, Tier Select, Jet Sol Valve start RPM limit, Jet Sol Valve run RPM limit,

Jet Sol Valve Charge air Press. limit, Jet Sol Valve OFF Time Delay.

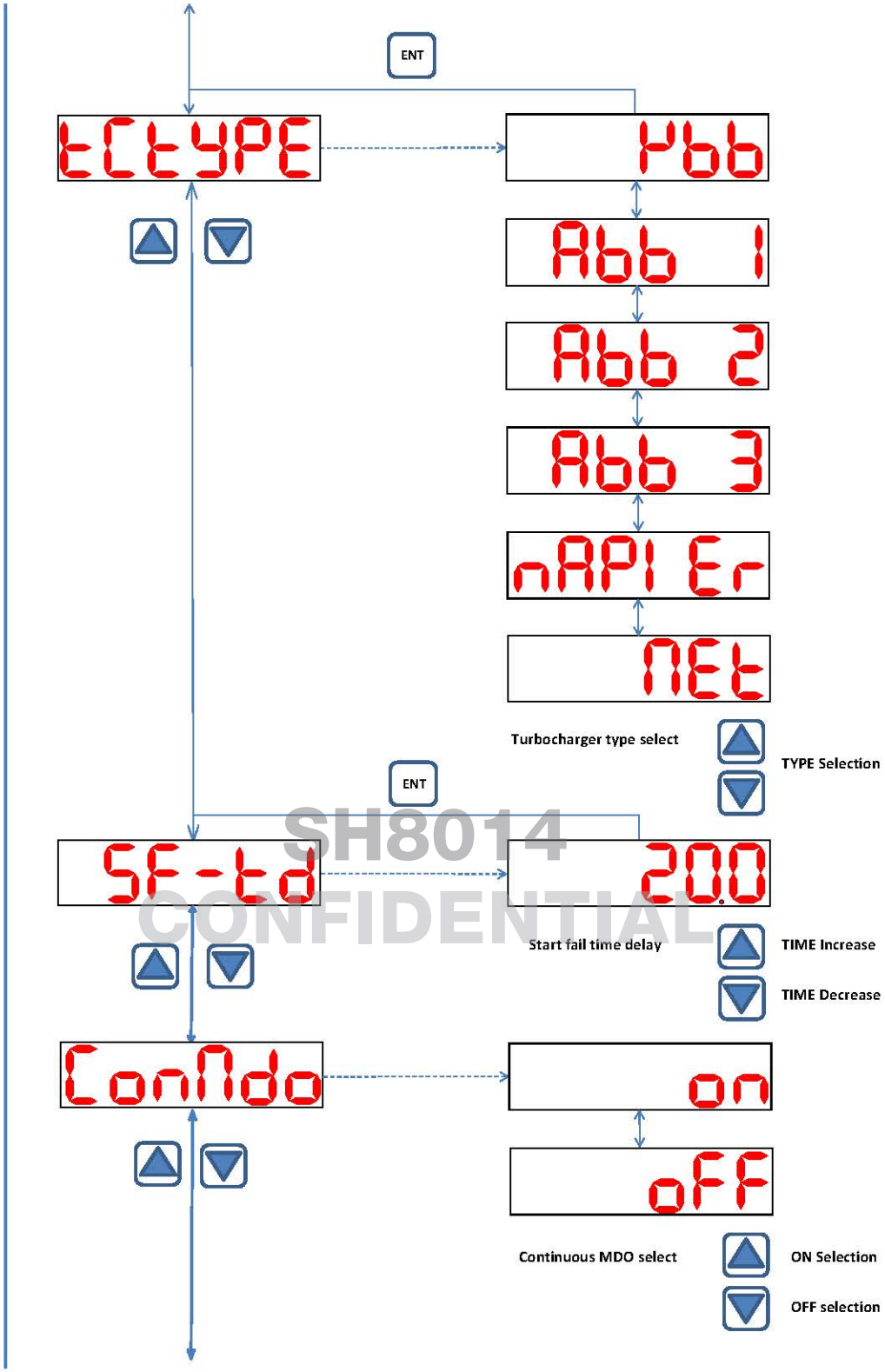
1. Bar mode



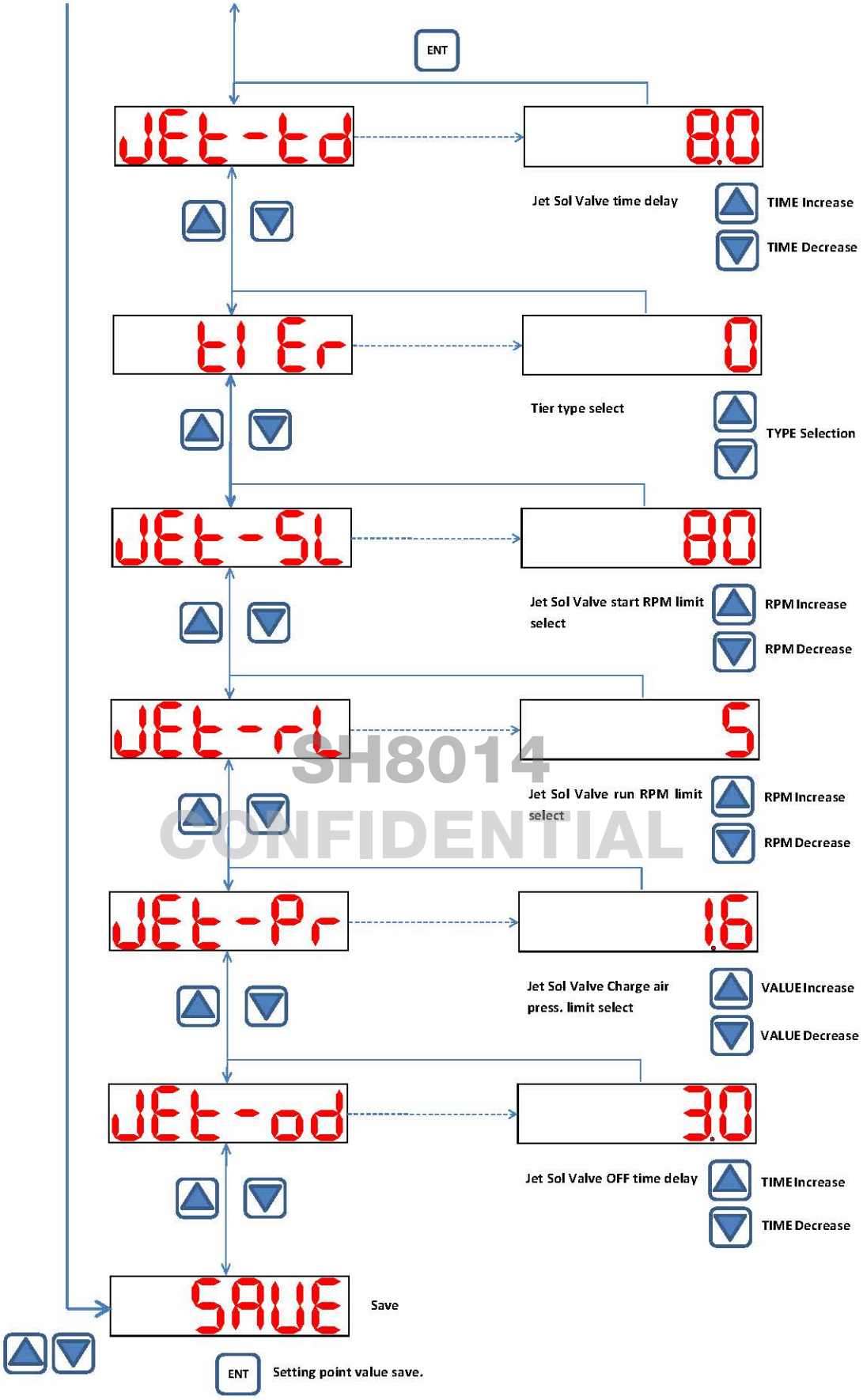
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- Notes)

  After 15 seconds without any key operation, "SET2" will automatically switch to "EXIT

- TURBOCHARGER TYPE TABLE

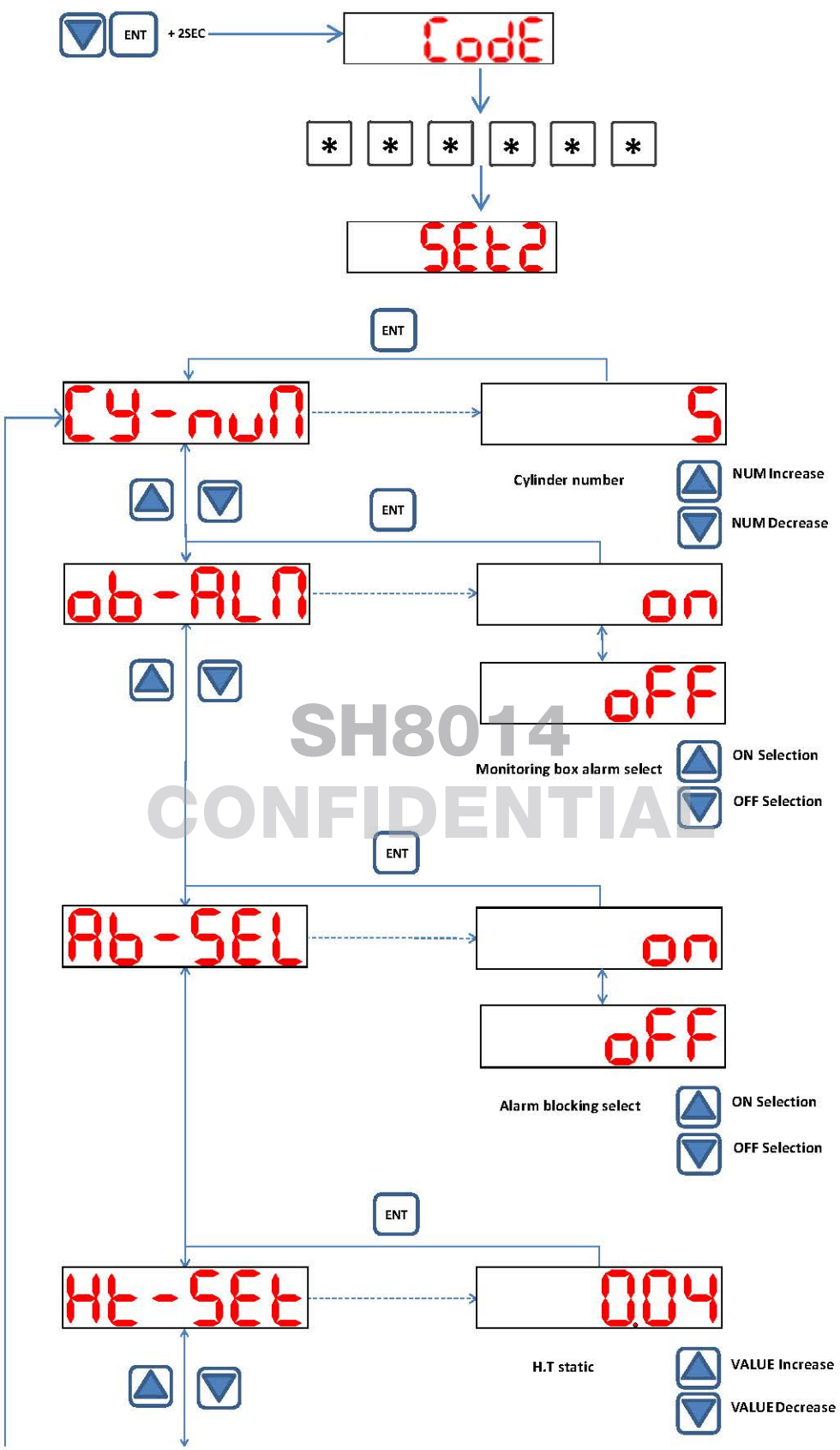
T/C Type	Lub oil T/C inlet press.	
	Press. range[bar]	Low alarm[bar]
KBB	2.0 ~ 4.0	1.5
ABB 1	2.0 ~ 3.0	1.5
ABB 2	3.2 ~ 4.5	3.0
ABB 3	1.5 ~ 2.5	1.3
NAPIER	1.5 ~ 2.5	1.3
MET	0.6 ~ 1.5	0.6

- TIER SETTING TABLE

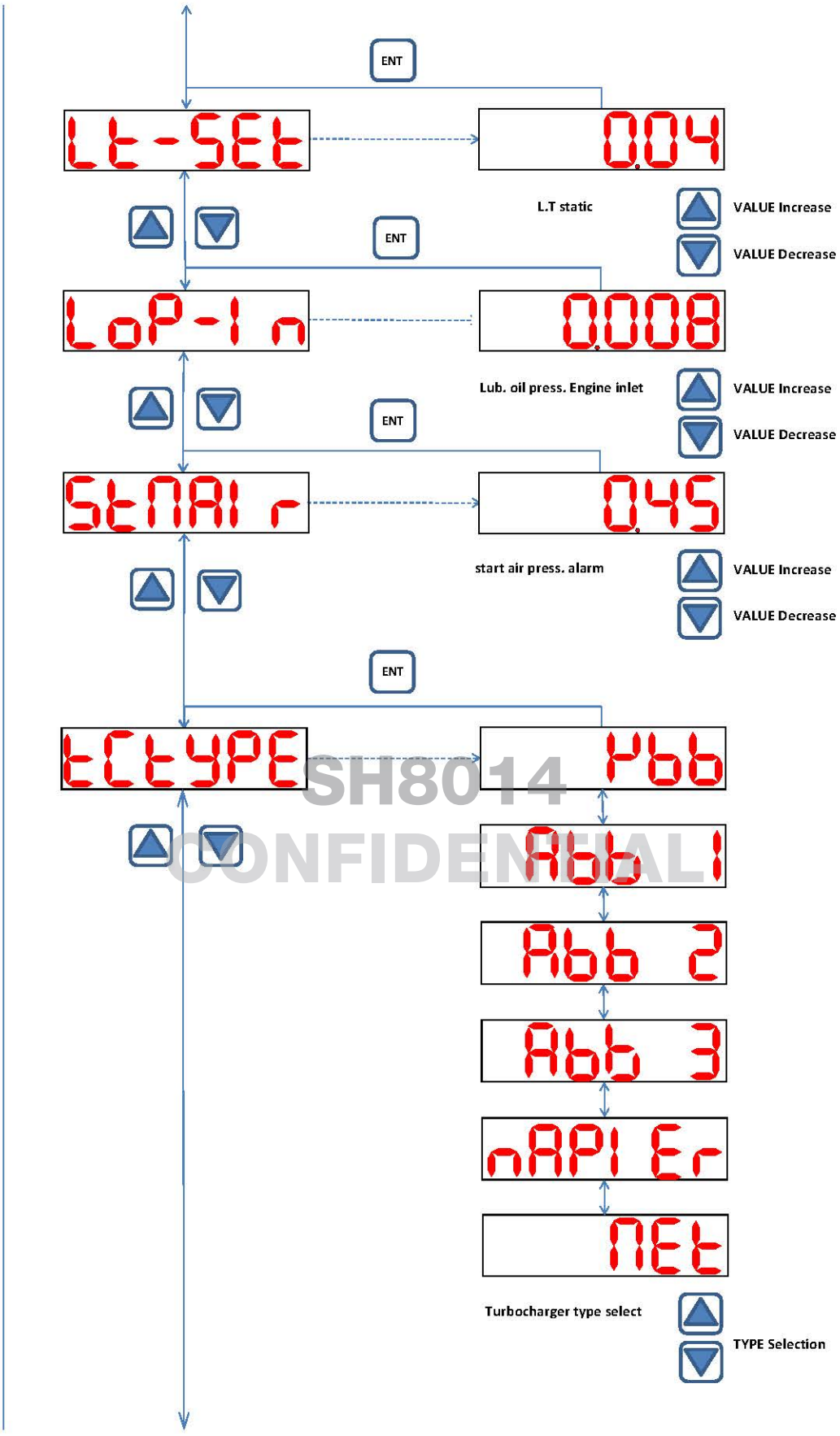
Engine Type	Charge air press. engine inlet(working range) [bar]					
	0	1	2	3	4	5
H17/28	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8
H17/28U(E)	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8	0 ~ 3.8
H21/32	0 ~ 4.3	0 ~ 4.3	0 ~ 4.3	0 ~ 5.1	0 ~ 4.3	0 ~ 4.3
H25/33	0 ~ 4.4	0 ~ 4.4	0 ~ 4.4	0 ~ 4.4	0 ~ 4.4	0 ~ 4.4
H32/40	0 ~ 4.5	0 ~ 4.5	0 ~ 4.5	0 ~ 4.5	0 ~ 4.5	0 ~ 4.5

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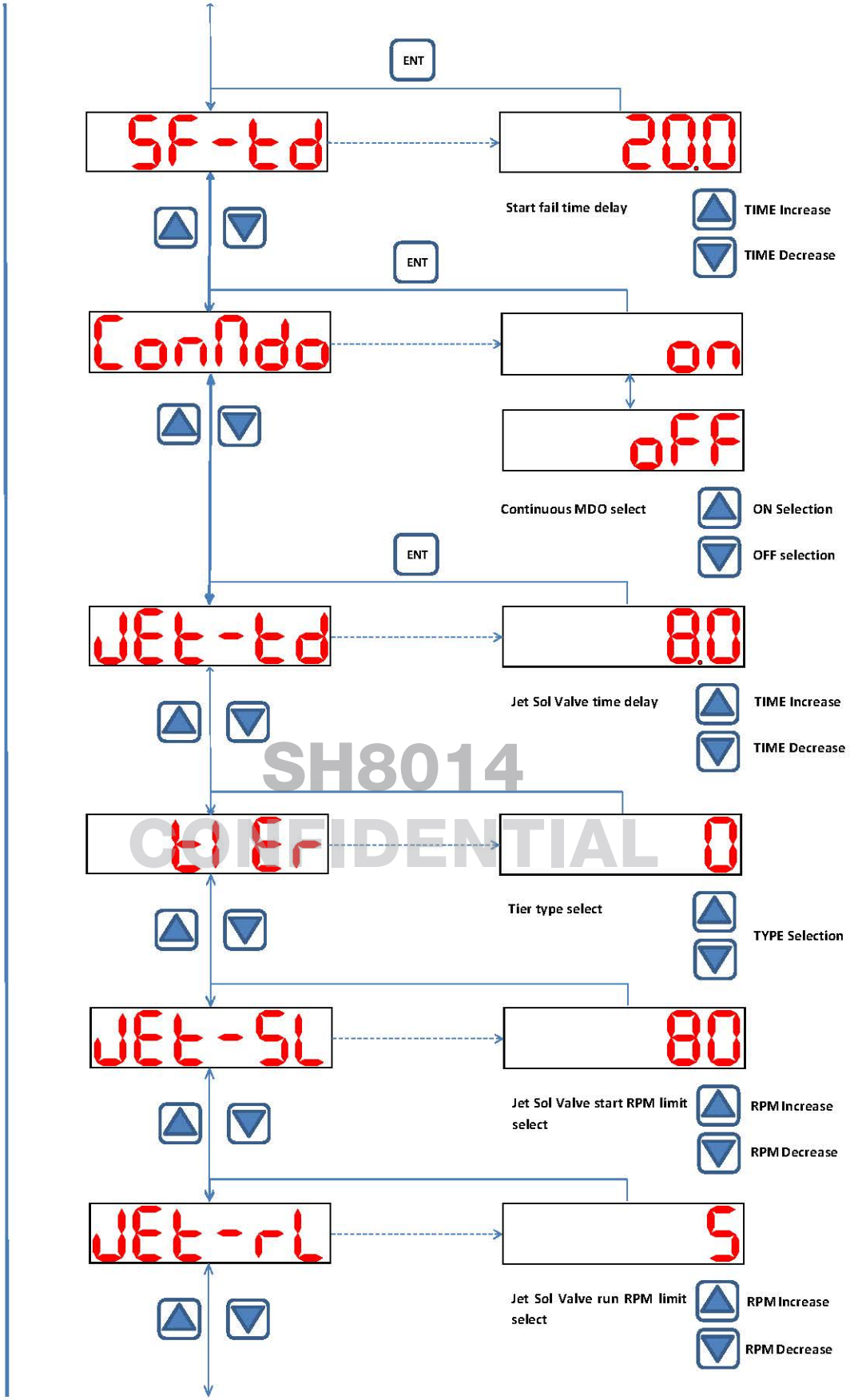
2. Mpa mode



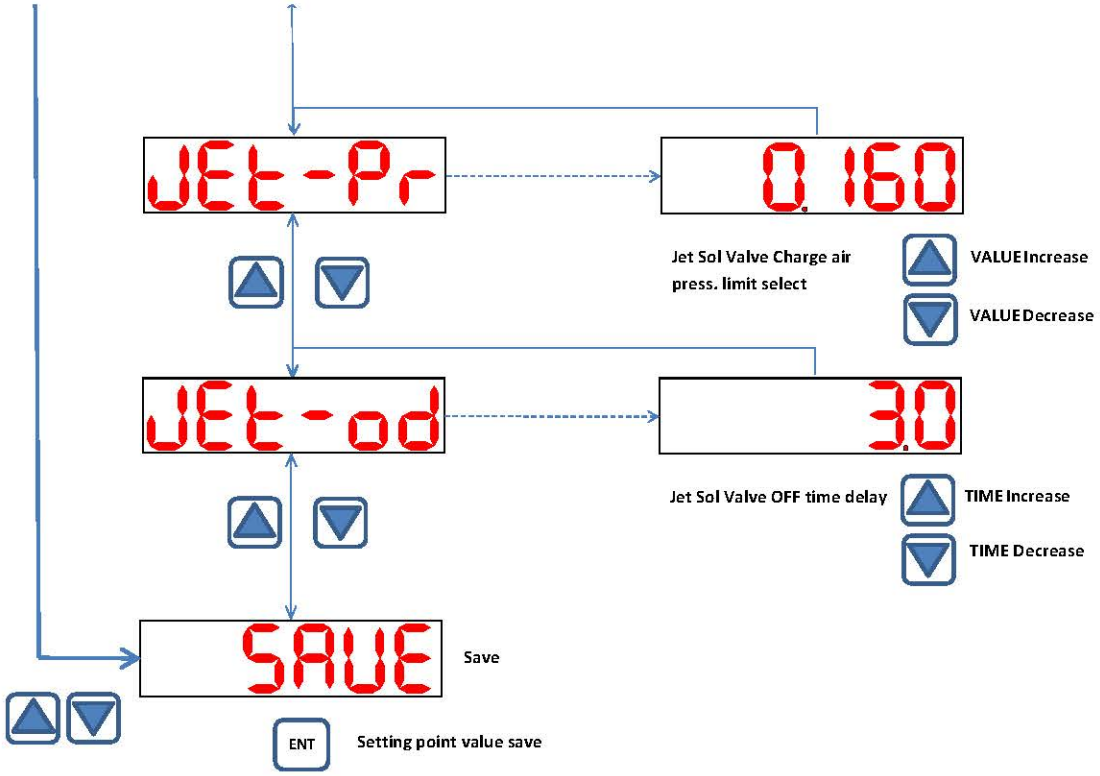
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- Notes)

  After 15 seconds without any key operation, "SET2" will automatically switch to "EXIT".

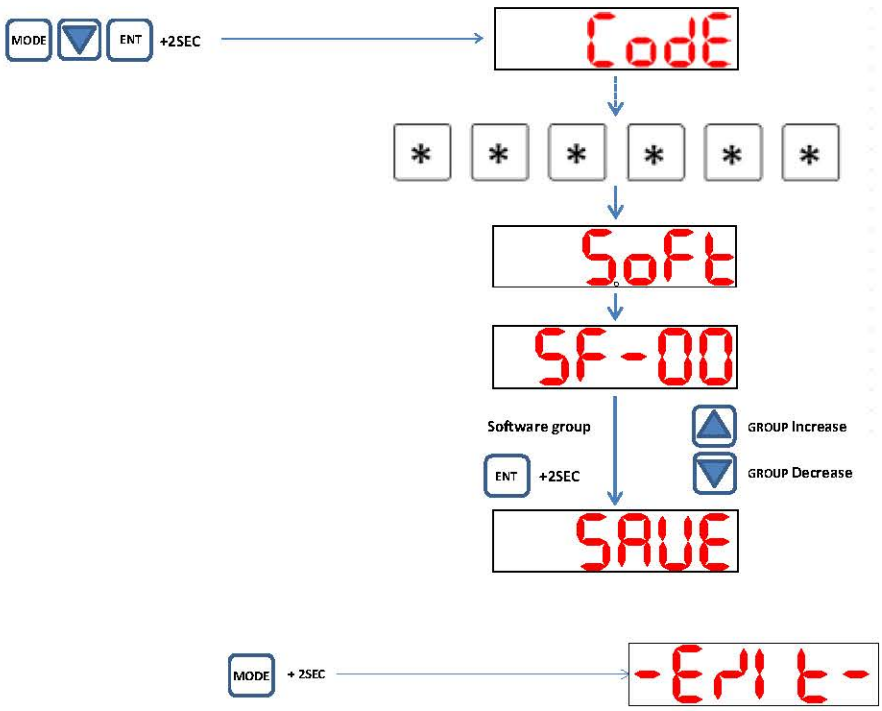
- TURBOCHARGER TYPE TABLE

T/C Type	Lub oil T/C inlet press.	
	Press. range[Mpa]	Low alarm[Mpa]
KBB	0.2 ~ 0.4	0.15
ABB 1	0.2 ~ 0.3	0.15
ABB 2	0.32 ~ 0.45	0.3
ABB 3	0.15 ~ 0.25	0.13
NAPIER	0.15 ~ 0.25	0.13
MET	0.06 ~ 0.15	0.06

- TIER SETTING TABLE

Engine Type	Charge air press. engine inlet(working range) [Mpa]					
	0	1	2	3	4	5
H17/28	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38
H17/28U(E)	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38	0 ~ 0.38
H21/32	0 ~ 0.43	0 ~ 0.43	0 ~ 0.43	0 ~ 0.51	0 ~ 0.43	0 ~ 0.43
H25/33	0 ~ 0.44	0 ~ 0.44	0 ~ 0.44	0 ~ 0.44	0 ~ 0.44	0 ~ 0.44
H32/40	0 ~ 0.45	0 ~ 0.45	0 ~ 0.45	0 ~ 0.45	0 ~ 0.45	0 ~ 0.45

4.2.3 SOFT GROUP



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- Notes)

  After 15 seconds without any key operation, "SOFT GROUP" will automatically switch to "EXIT".

- SOFT GROUP TABLE

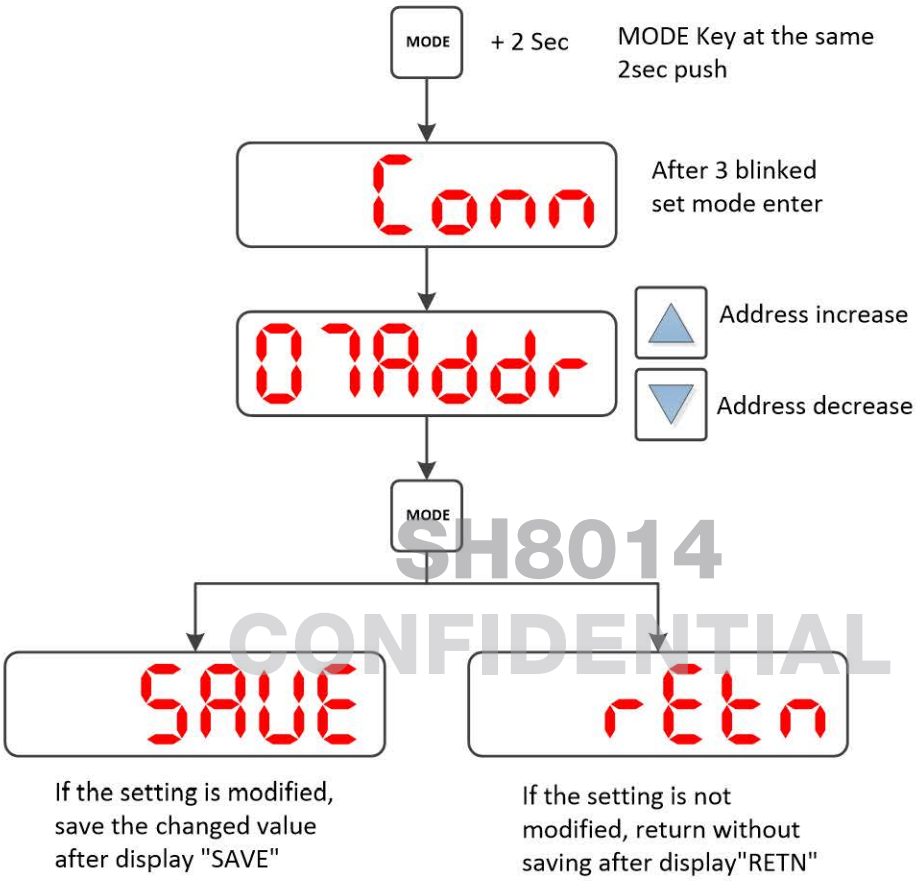
S/N	Engine Type	Engine Gear	Engine Run "ON" RPM	Engine Run "OFF" RPM	Overspeed "ON" RPM	T/C Gear
0	H21/32	286	710	640	828	2
1	H21/32	286	710	640	862	2
2	H21/32	286	880	700	1035	2
3	H21/32	286	930	730	1150	2
4	H25/33	282	710	640	828	2
5	H25/33	282	710	640	862	2
6	H25/33	282	880	700	1035	2
7	H25/33	282	930	730	1150	2
8	H17/28M	286	930	730	1035	2
9	H17/28M	286	930	730	1150	2
10	H17/28U(E)	286	880	700	1035	2
11	H17/28U(E)	286	930	730	1150	2
12	H32/40	42	710	640	828	2
13	H32/40	42	710	640	862	2

4.3 Analog / Communication Unit (YECS-1000A)

4.3.1 Communication Setting

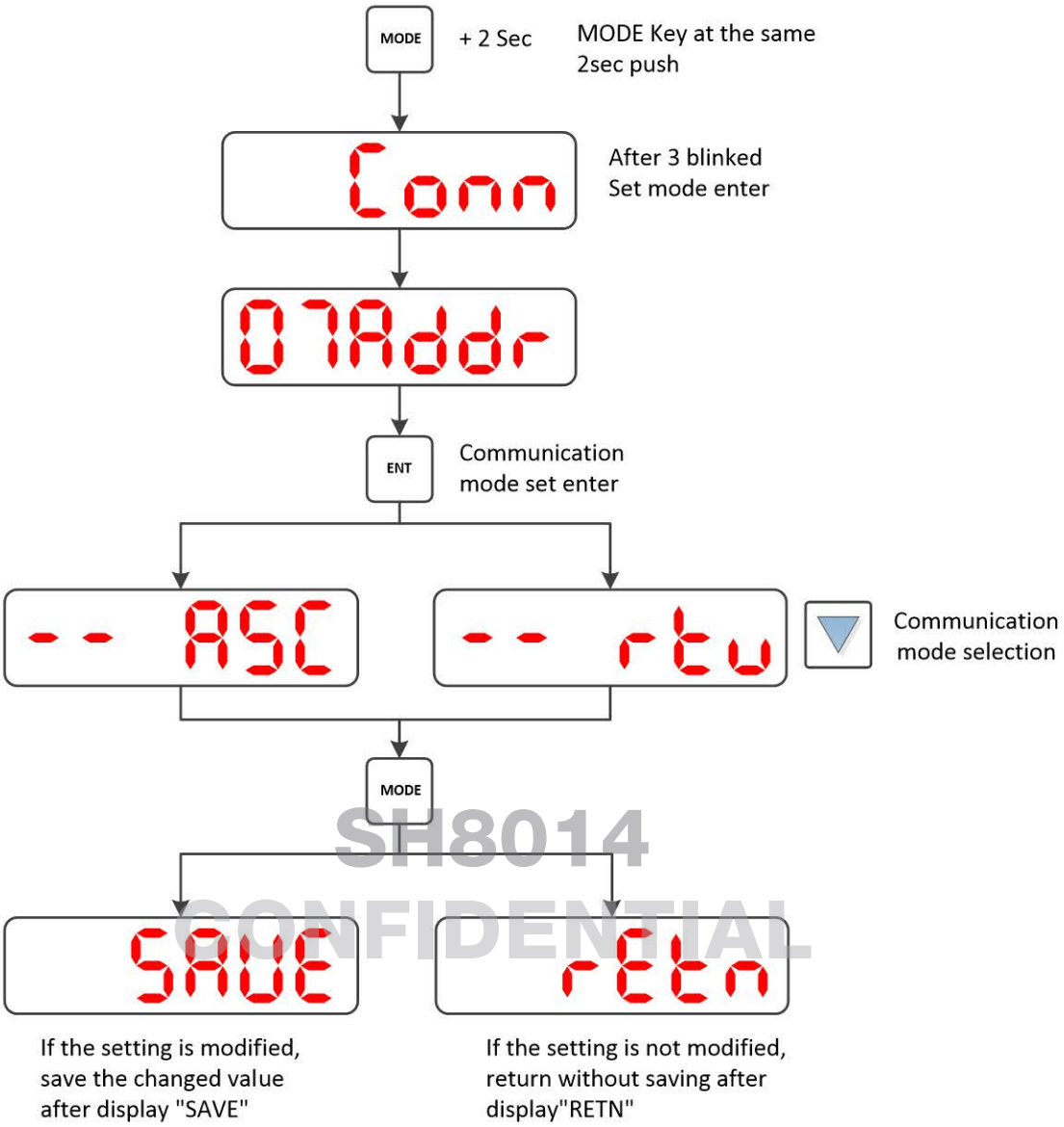
It sets an address of YECS-1000A and communication mode during the Modbus communication.

1) Modbus address setting



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2) Communication mode setting



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4.3.2 Analog Input Channel Calibration

This section explains Analog Zero/Span setting method.

Please do not set anything because It already completes the calibration when factory shipment.

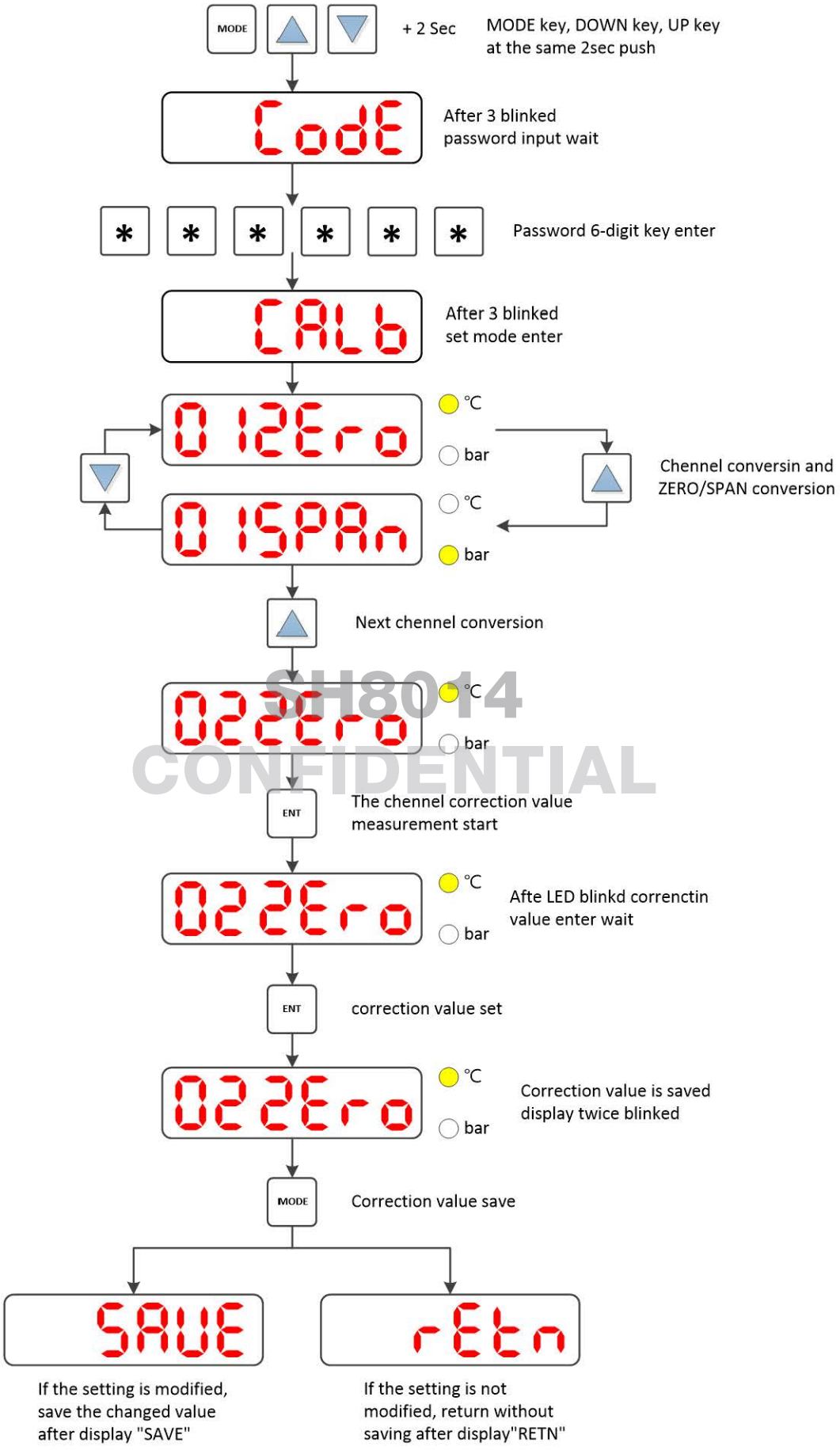
If you need to set inevitably, please contact with the manufacturer of the product, use the calibrated equipment and be well-informed of the product manual.

Input Type	Channel	Input Range	Input Signal
Pressure Sensor	1 ~ 10	See section 4.3.3	4 ~ 20mA
Thermocouple (K Type)	11 ~ 23	0℃ ~ 800℃	0 ~ 33.275mV
RTD (PT100Ω)	23 ~ 32	0℃ ~ 200℃	100 ~ 175.86Ω

Table 1. Analog Input Channel

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1) Analog Input channel Calibration



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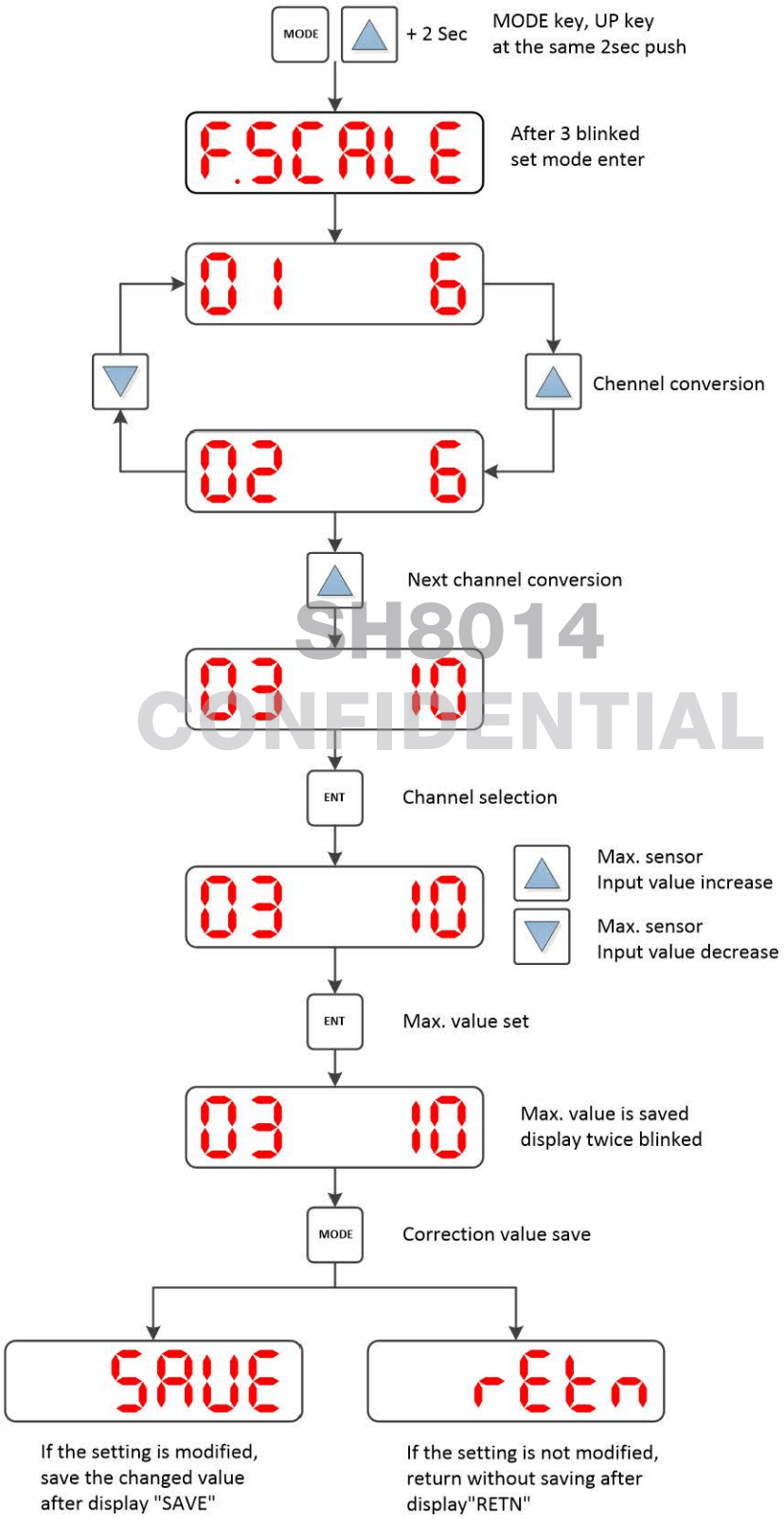
4.3.3 Analog Input Channel Descriptions.

CH.	SIGNAL NAME	SENSOR TYPE	MEASURING RANGE
1	H.T WATER PRESS. ENGINE INLET	4~20mA	0~6kg/cm2
2	L.T WATER PRESS. ENGINE INLET	4~20mA	0~6kg/cm2
3	L.O PRESS. ENGINE INLET	4~20mA	0~10kg/cm2
4	L.O PRESS. FILTER INLET	4~20mA	0~10kg/cm2
5	L.O PRESS. T/C INLET	4~20mA	0~6kg/cm2
6	F.O PRESS. ENGINE INLET	4~20mA	0~16kg/cm2
7	F.O PRESS. FILTER INLET	4~20mA	0~16kg/cm2
8	CHARGE AIR PRESS. ENGINE INLET	4~20mA	0~6kg/cm2
9	STARTING AIR PRESS. ENGINE INLET	4~20mA	0~16kg/cm2
10	SPARE	4~20mA	0~6kg/cm2
11	EXH. GAS TEMP. CYLINDER 1	THERMOCOPLE	0~800 ℃
12	EXH. GAS TEMP. CYLINDER 2	THERMOCOPLE	0~800 ℃
13	EXH. GAS TEMP. CYLINDER 3	THERMOCOPLE	0~800 ℃
14	EXH. GAS TEMP. CYLINDER 4	THERMOCOPLE	0~800 ℃
15	EXH. GAS TEMP. CYLINDER 5	THERMOCOPLE	0~800 ℃
16	EXH. GAS TEMP. CYLINDER 6	THERMOCOPLE	0~800 ℃
17	EXH. GAS TEMP. CYLINDER 7	THERMOCOPLE	0~800 ℃
18	EXH. GAS TEMP. CYLINDER 8	THERMOCOPLE	0~800 ℃
19	EXH. GAS TEMP. CYLINDER 9	THERMOCOPLE	0~800 ℃
20	EXH. GAS TEMP. INLET A	THERMOCOPLE	0~800 ℃
21	EXH. GAS TEMP. INLET B	THERMOCOPLE	0~800 ℃
22	EXH. GAS TEMP. INLET C	THERMOCOPLE	0~800 ℃
23	EXH. GAS TEMP OUTLET TC	THERMOCOPLE	0~800 ℃
24	H.T WATER TEMP. ENGINE INLET	Pt100	0~200 ℃
25	H.T WATER TEMP. ENGINE OULET	Pt100	0~200 ℃
26	L.T WATER TEMP. AIR COOLER INLET	Pt100	0~200 ℃
27	L.T WATER TEMP. AIR COOLER OUTLET	Pt100	0~200 ℃
28	L.O TEMP. ENGINE INLET	Pt100	0~200 ℃
29	F.O TEMP. ENGINE INLET	Pt100	0~200 ℃
30	CHARGE AIR TEMP. AIR COOLER OUTLET	Pt100	0~200 ℃
31	SPARE	Pt100	0~200 ℃
32	THERMOCOPLE COLD JUNCTION		

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4.3.4 Sensor Input Maximum Range Setting

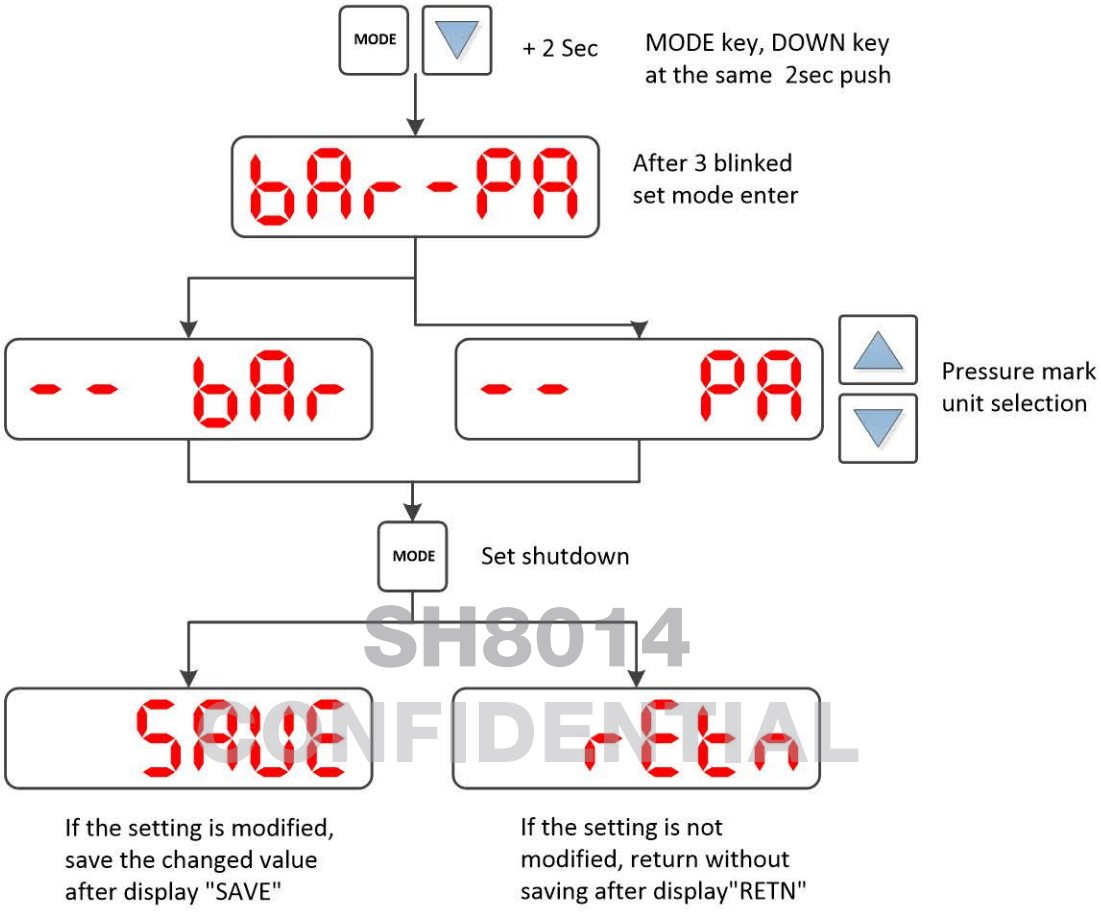
This is to set a menu for maximum pressure range of pressure sensor channel. You can set the maximum pressure value of pressure sensor which is connected setting channel until 1-50bar (0.1~5Mpa)..



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4.3.5 Pressure Display Mode Setting

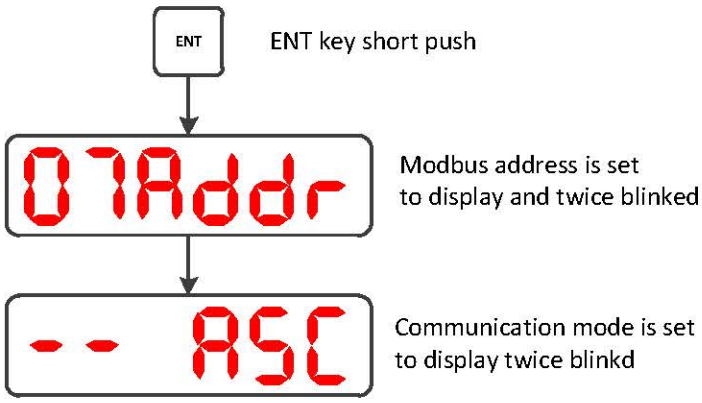
This is to set a menu for measuring value unit of pressure sensor. You can select Bar or Mpa.



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4.3.6 Check the Communication Settings

Check a set current Modbus Address, Communication Mode.



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An MPG Company

Viscous Torsional Vibration Dampers

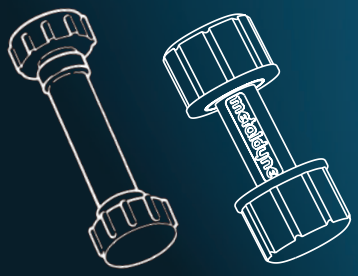
Procedure for taking samples of Silicone fluid

Méthode de prélèvement d'échantillons de silicone

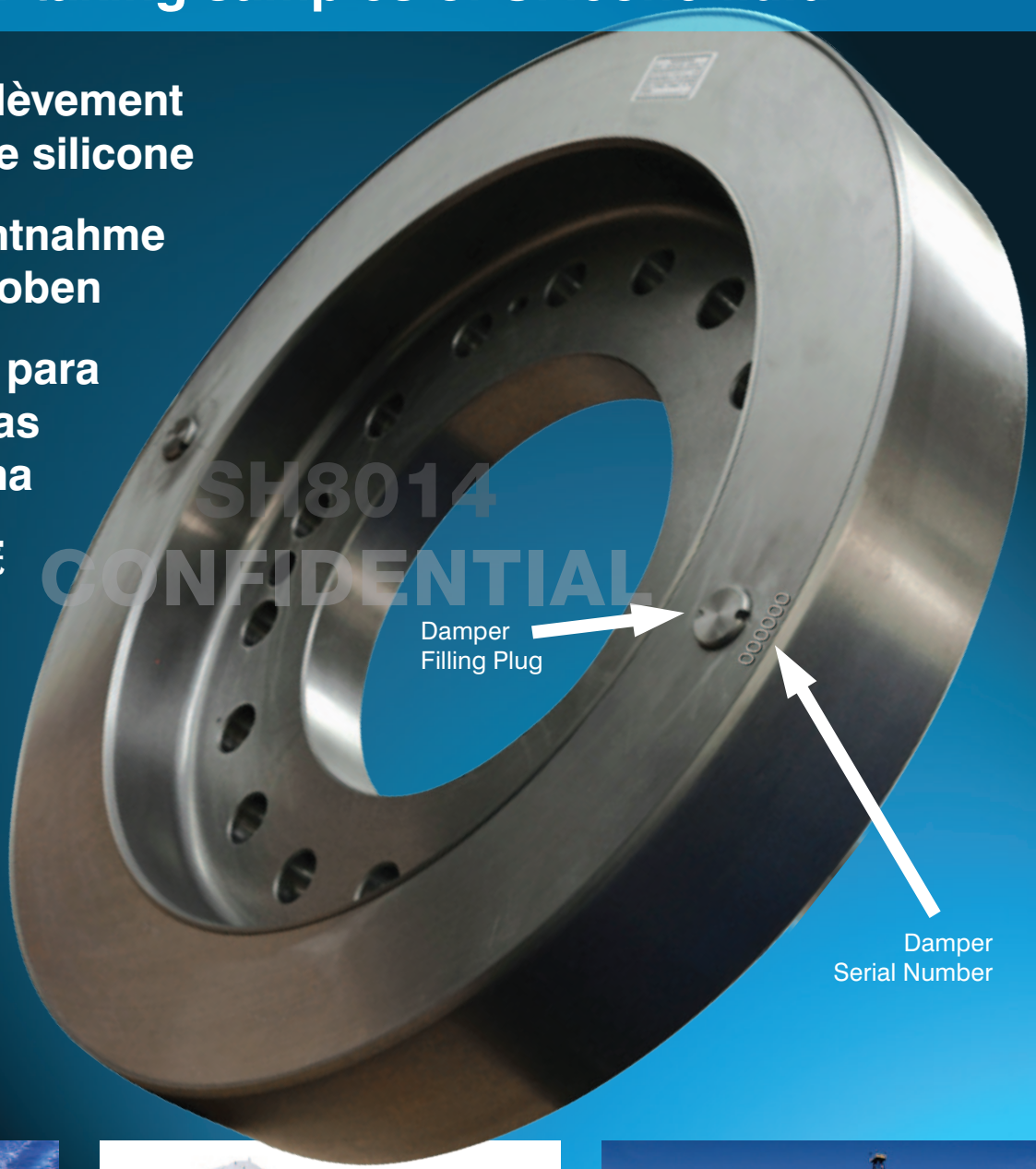
Anleitung zur Entnahme con Silikonöl-Proben

Procediminento para toma de muestras del fluido silicona

程序用于取硅氧烷流体的样品



- Sampling Container
- Tube de Prélèvement
- Proberöhrchen
- Contenedor de muestra
- 取样容器









Procedure for taking samples of silicone fluid

Fluid samples may be taken from dampers equipped with removable filling plugs. In most cases two of these are positioned diametrically opposite each other in the damper cover.

If reasonable access to one of these plugs is possible, the damper may remain on the engine during this procedure. In other cases, the damper must stand in the normal vertical position during sampling.

It is recommended that the damper is rotated until the two plugs are approximately vertical and that the damper remains in this position for a minimum period of one hour before the sampling procedure begins.

In general, two sizes of thread are used for the filling holes, therefore the sample containers are threaded differently at each end.

Méthode de prélèvement d'échantillons de silicone

Un prélèvement de fluide silicone peut être effectué sur les dampers pourvus de bouchons de remplissage. Dans la plupart des cas, deux de ces bouchons sont situés dans le couvercle du damper, et diamétralement opposés.

Dans la mesure où il est possible d'accéder à l'un de ces bouchons, le prélèvement de fluide pourra s'effectuer sans dépose préalable du damper. Si le damper doit être déposé du moteur, le prélèvement de fluide s'effectuera en plaçant le damper en position verticale.

Il est conseillé de faire tourner le damper pour placer les 2 bouchons approximativement la vertical. Le damper restera dans cette position au moins d'une heure avant de procéder au prélèvement.

En général, il y a deux tailles de filetage pour les trous de remplissage, et les éprouvettes de prélèvement ont donc un filetage différent à chaque extrémité.

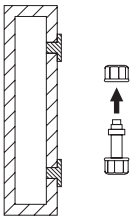
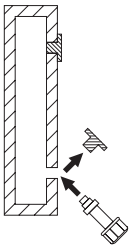
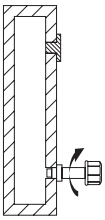
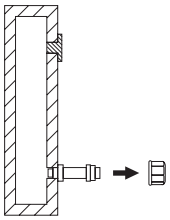
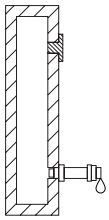
Anleitung zur Entnahme von Silikonöl-Proben

Flüssigkeitsproben können Dämpfern mit abnehmbaren Verschlußschrauben entnommen werden. Meistens sind zwei solcher Schrauben gegenüberliegend im Deckel des Dämpfers angebracht.

Wenn eine der Schrauben einigermaßen zugänglich ist, kann der Dämpfer am Motor bleiben. Im anderen Fall muß der Dämpfer demontiert und die Probeentnahme am senkrecht stehenden Dämpfer vorgenommen werden.

Es wird empfohlen, den Dämpfer zu drehen, bis die dieden Schrauben ungefähr vertikal sind, und mindestens eine Stunde so stehen zu lassen, bevor mit der Probeentnahme begonnen wird.

Es sind zwei verschiedene Gewinde in den Entnahmebohrungen üblich. Das Proberöhrchen hat deshalb unterschiedliche Gewinde an beiden Seiten.

					
English	Assuming the thread size in the damper is known, prepare sample container by removing the cap nut from the end to be inserted in the damper.	Remove filling plug keeping container ready for immediate insertion.	Screw sample container into filling hole.	Remove the other cap nut.	Allow fluid to reach the open end of the container. This may occur within seconds or over an hour dependent upon fluid conditions and other factors.
Français	Si on connaît le type de filetage dans le damper, préparer le tube de prélèvement en ôtant le bouchon écrou de l'extrémité à introduire dans le couvercle du damper.	Enlever le bouchon de remplissage; le tube de prélèvement doit être prêt à le remplacer.	Visser le tube de prélèvement dans le trou de remplissage.	Enlever l'autre bouchon écrou.	Faire venir le fluide silicone à l'extrémité ouverte du tube. Cette opération peut durer quelques secondes ou plus d'une heure, selon la nature du fluide et en fonction d'autres facteurs.
Deutsch	Je nach Gewinde Proberöhrchen durch Abnehmen der Schließkappe für das Einschrauben in den Dämpfer vorbereiten.	Verschlußschraube herausdrehen, dabei Röhrchen bereithalten.	Proberöhrchen sofort in Entnahmebohrung schrauben.	Andere Schließkappe abnehmen.	Flüssigkeit bis zum offenen Ende des Röhrchens kommen-lassen. Dies kann in Sekunden erfolgen oder wesentlich länger dauern je nach Beschaffenheit der Flüssigkeit und sonstigen Einflüssen.
Español	Considerando que el tamaño de rosca en el amortiguador es conocido, preparar el contenedor de muestra quitando su tapón roscado del extremo a insertar en el amortiguador.	Quitar el tapón de llenado de la tapa del amortiguador, teniendo el contenedor preparado para su inmediata inserción.	Roscar completamente el contenedor en el agujero de dicho tapón de llenado.	Quitar el otro tapón roscado del contenedor.	Dejar que el fluido alcance el extremo abierto del contenedor. Esto puede ocurrir en segundos o en horas, dependiendo de las condiciones del fluido y otros factores.
汉语	假设,已知阻尼器螺纹的尺寸，这时拆下样取容器的螺帽从结尾插入阻尼器。	拆下填充塞保持容器准备立即插入。	取样容器插进入填装孔。	拆下其它螺帽。	允许流体到达该容器的开口端。这可能会发生在几秒钟内或超过一个小时取决于流体条件等因素。

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Procedimiento para tomar muestras del fluido de silicona

Pueden tomarse muestras del fluido del amortiguador, en los aparatos equipados con tapón de ilenado desmontable.

En muchos casos dos de estos tapones están situados, diametralmente opuestos, en la tapa del amortiguador.

Si se dispone de un acceso razonable a uno de estos tapones, el amortiguador puede quedar en el motor durante la toma de muestras. En otros casos, el amortiguador debe situarse en posición vertical normal durante dicha operación.

Se recomienda situar el amortiguador, de forma que los dos tapónes de ilenado esten aproximadamente en posición vertical, dejandolo en esta posición por un periodo minimo de una hora antes de comenzar la toma de muestras.

En general se utilizan dos diferentes tamaños de rosca para los agujeros, por tanto los contenedores de muestra están roscados diferentes en cada extremo.

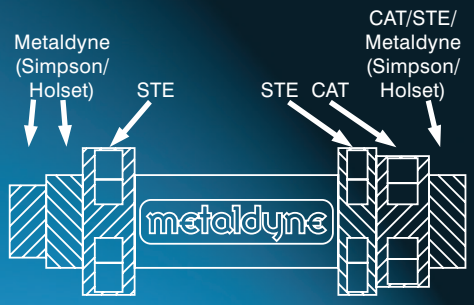
程序用于取硅氧烷流体的样品

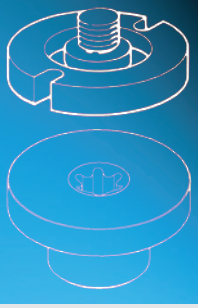
流体样本可自配取出在可移动充插头的阻尼器(减震器)。在大多数情况下，在阻尼器(减振器)罩(盖)其中的两个位于径向相对彼此。

如果合理地接触这些插头之一是可能的，该阻尼器可以在此过程中保持在引擎上。在其他情况下，阻尼器(减震器)在取样过程中必须站在正常的垂直位置。

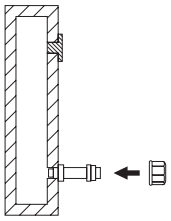
建议在阻尼器(减震器)旋转时，直到两个插头都大约垂直上，并且阻尼器(减震器)必须保持在这个位置为期最少一小时,但必须在采样过程开始的之前。

一般情况下，有两种尺寸的螺纹用于填装孔，因此，在取样容器每一端有不同的方式螺纹。





- Types of filling plug
- Types de bouchons de remplissage
- Verschlußschrauben
- Tipos detapones de ilenado
- 填装插头类型



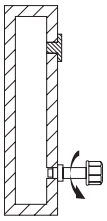
Immediately fluid flows from the open end of the container, replace the cap nut.
*** Important**
The container must be at least 75% full, to enable Metaldyne Industries to analyse the sample.

Dès que le fluide s'écoule par l'extrémité ouverte du tube, revisser le bouchon écrou.
*** Attention**
Afin de pouvoir analyser l'échantillon, le tube de prélèvement doit être remplit de 75% minimum.

Sobald Flüssigkeit austritt, Röhrchen mit Schließkappe verschließen.
*** Achtung**
Um die Analyse zu ermöglichen, muß das Proberöhrchen mindestens zu 75% gefüllt sein.

Inmediatamente que el fluido salga por el extremo abierto del contenedor, montar el tapón roscado
*** Atencion**
Para realizar el analisis de la muestra de silicona, el contenedor debe estar lleno al menos en el 75%

从容器的开口端的流体流，立即覆盖螺帽。
***重要**
如使Metaldyne的行业来分析样品，容器必须至少75 %满。



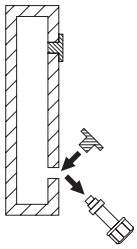
Keeping a filling plug ready for immediate insertion, unscrew the container from the filling hole.

Tenir un bouchon écrou prêt au revissage et dévisser le tube de l'orifice de remplissage.

Röhrchen aus Entnahme bohrung herausschrauben, dabei Versclußschraube bereithalten.

Tomando un tapón de llenado dispuesto para su inmediata inserción en la tapa del amortiguador, desenroscar el contenedor.

从填装孔拧松取样容器,确认保持一个填充塞及立即插入填装孔。



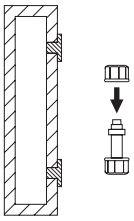
Immediately fit new plug. Tighten to 27-34 Nm and lock by disturbing cover material into the slot of the plug using a punch.
For Plug Type A, it is recommended that the old plug is re-used with a new seal and the plug tightened to match existing peining marks.

Insérer immédiatement le nouveau bouchon, le serrer à 27-34 Nm et l'immobiliser en utilisant un pointeau ou un chassegoupille qui permet de repousser le matériau du couvercle dans la fente du bouchon. Pour un bouchon du type A, il est conseillé de réutiliser l'ancien bouchon avec un joint d'étanchéité neuf et de serrer le bouchon jusqu' à la disparition des traces de fatigue.

Neue Schraube sofort einschrauben. Anziehen mit 27-34 Nm und durch Verstemmen von Deckelwerkstoff in den Stopfenschlitz sichern.
Für Type A wird empfohlen, den alten Stopfen mit neuer Dichtung wiederzuverwenden und bis zu den vorhandenen Anzugsspuren anzuziehen.

Inmediatamente poner de neuvo el tapon de llenado, aprentando con un par de 27-34 Nm y precintando con punzón, aportando materia de la tapa dentro de la muesca del tapón tipo A, se recomienda usar una nueva junta tórica apretando el tapón hasta ajuste con las marcas anteriores.

立即安装新的插件。通过干扰覆盖材料到使用冲头的插头拧紧到 18 磅英尺 （27-34 Nm）。为插头类型A，则建议旧插件重新使用一个新的密封件和插塞拧紧，以匹配现有佩宁标记。



Fit cap nut to container and ensure both cap nuts are fully screwed on but not over-tightened.
(Do not use spanners).

Remettre le bouchon écrou sur le tube et s'assurer que les 2 bouchons écrous sont bien vissés mais pas trop (ne pas utiliser de pinces).

Andere Schließkappe auf Röhrchen schrauben und sicherstellen, daß beide Kappen gut hand-fest angezogen sind. (Keine Schrauben schlüssel benutzen).

Poner el otro tapón roscado en el extremo del contenedoy asegurar que ambos tapones están roscados completamente pero no forzados. (No usar llaves).

螺帽安装在容器，并确保两件螺帽完全锁紧，但不能过度紧。（不要使用扳手）

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Dampers Mounted with Filling Plug Facing the Engine

These dampers may be sampled if reasonable access to the filling plugs is available from crankcase, proceeding as follows:-

1 Turn engine to determine which plug will provide best access for removal.

2 Loosen the plug to break peining but allow plug to remain slightly tight.

3 Turn engine until the plug is at the lowest part and leave for a minimum period of two hours.

4 Turn engine until plug is accessible; remove plug and sample as previously described.

Important

Cleanliness of sample containers, filling plugs and the damper surfaces adjacent to the filling holes is essential.

It is important to restrict the escape of fluid to an absolute minimum during these operations.

Excessive loss of fluid could affect the further performance of the damper or limit the number of further samples which may be required.

However, provided care is taken whilst sampling, at least 10 samples may be taken using our standard 1cm3 containers.

Dämpfer mit Verschlußschraube zur Motorseite

Flüssigkeitsproben können entnommen werden, wenn die Verschlußschrauben vom Kurbelgehäuse einigermaßen zugänglich sind.

1 Dämpfer drehen und feststellen, welche Schraube am besten zugänglich ist.

2 Schraube lösen, jedoch dicht anliegen lassen.

3 Dämpfer drehen bis diese Schraube ganz unten ist und mindestens zwei Stunden so stehen lassen.

4 Dämpfer drehen bis Schraube zugänglich ist und Probe entnehmen wie zuvor beschrieben.

Wichtig

Sauberkeit von Proberöhrchen, Verschlußschraube und Dämpferoberfläche um die Entnahmebohrung ist unbedingt erforderlich.

Der Verlust von Flüssigkeit ist so gering wie möglich zu halten. Übermäßiger Verlust kann die Dämpferwirkung beeinflussen bzw. die Zahl weiterer Probeentnahmen einschränken.

Bei Verwendung eines Holset Proberöhrchens (1 cm3) und Vermeidung von Flüssigkeitsverlust können mindestens zehn Proben entnommen werden.

Dampers montés avec bouchons de remplissage face au moteur

On pourra réaliser des prélèvements sur ces dampers, sous réserve d'accéder par le carter moteur aux bouchons de remplissage, comme suit:

1 Faire tourner le moteur pour positionner un des bouchons en son point le plus accessible.

2 Desserrer le bouchon, sans toutefois le dégager complètement du filetage du couvercle du damper.

3 Faire ensuite tourner le moteur de sorte que le bouchon se trouve maintenant en son point le plus bas possible, et laisser le damper au moins deux heures dans cette position.

4 Faire de nouveau tourner le moteur pour accéder au mieux au bouchon, enlever celui ci et procéder alors au prélèvement comme décrit en page précédente.

Important

Il est essentiel que les tubes de prélèvement, les bouchons de remplissage et les faces du damper voisines des orifices de remplissage soient propres.

Il est important, pendant ces opérations, de réduire au strict minimum la quantité de fluide silicone extraite du damper. Une perte excessive de fluide pourrait nuire aux performances futures du damper, et aux prélèvements pourraient être necessaires.

Toutefois, sous réserve qu'on fasse beaucoup d'attention avec le fluide silicone, on peut procéder au moins à 10 prélèvements en utilisant nos tubes standard (1cm3)

Amortiguadores montados con los tapones en el lado motor

La toma de muestras en estos amortiguadores puede efectuarse siempre que se disponga de acceso a los tapones de llenado desde el cárter, procediendo como sigue:

1 Girar el motor hasta determinar que tapón es el que quedará con mejor acceso.

2 Aflojar el tapón de llenado para romper su precinto pero permitiendo permanezca ligeramente roscada.

3 Girar el motor hasta que este tapón quede en la parte de abajo y mantener esta posición durante un periodo minimo de dos horas.

4 Girar de nuevo el motor hasta que el tapón quede otra vez accesible; quitar finalmente dicho tapón y extraer de la forma que se ha descrito anteriormente.

Importante

Es essencial la limpieza del contenedor, tapones de llenado y superficies del amortiguador adyacentes al orifico del llenado.

Es muy importante evitar las fugas de fluido al minimo posible durante estas operaciones. Excesiva pérdida podria afectar las caracteristicas del amortiguador o limitar la posibilidad de obtener nuevas muestras en el futuro.

Consiguiendose evitar cualquier perdida de fluido, por lo menos pueden ser tomades 10 muestras, si se usan nuestros contenedores "Standard" de 1 c.c.

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阻尼器(减震器)与插头相对引擎

如果合理获得备案插头可以从曲轴箱，这些阻尼器(减震器)可以如下进行采样， 则进行:

- 打开引擎，以确定哪些将提供最佳到达去除的插件。
- 松开插头打破喷丸但允许插件保持稍紧。
- 打开引擎，直到插头处于最低的过去，为期至少两个小时。
- 打开引擎,直到插头是可到达的; 如是,删除先前所描述的插头和样品。

重要事项

样品容器，备案插头和阻尼器表面相邻备案孔的清洁是必不可少的。

在这些操作时,重要为限制流体的泄漏降到最低。

流体过度损失可能会影响阻尼器(减震器)的功能。

然而，只要小心采样，为我们的标准1立方厘米的取样容器收集，至少10个样品可以取出。

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An MPG Company

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Ref: 2015

Metaldyne International (UK) Ltd

Service Department
131 Parkinson Lane, Halifax, West Yorkshire, HX1 3RD, England

Tel: +44 (0)1422 357234 Fax: +44 (0)1422 354432

www.metaldyne.co.uk www.metaldyne.com

www.damperservice@metaldyne.com
Contact: David Whitaker
Email: davidwhitaker@metaldyne.com

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METALDYNE INTERNATIONAL (UK) LTD

Crankshaft Protection Driven Equipment Life Extension

Which of these conditions does your sample look like?

Normal Condition

Original fluid is completely clear and free from debris.



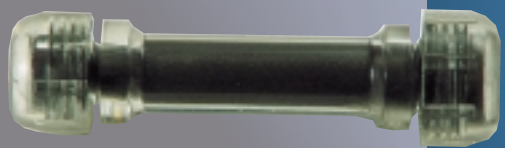
Intermediate Condition

Intermediate sample can be slightly discoloured and may contain some particles.



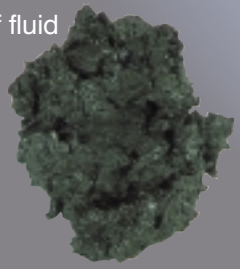
Requires Immediate Service

Dark brown to black and contaminated with metallic debris.



Emergency Condition

Solidification of fluid from failed damper.



Most engines are fitted with one or two viscous shear type torsional vibration dampers attached to the crankshaft at the opposite end to the flywheel.

Why are Dampers fitted?

The crankshaft damper is fitted to minimise the influence of torsional vibrations developing in the crankshaft. This keeps material stresses arising from these vibrations within permissible design limits. The damper, by reducing oscillations in the crankshaft to a low amplitude, prevents premature failures of the driven equipment.

How does the Metaldyne Viscous Damper work?

The damper absorbs torsional vibration energy by the shearing effect of a highly viscous silicone fluid trapped between an inertia ring and the damper casing. The shearing of the fluid generates heat which is dissipated through the external surfaces of the damper.

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Condition Monitoring

Condition monitoring of the damper is an essential preventative maintenance practice. This ensures the torsional vibration system of the vessel, generator or pump continues to function as per the design calculations, thus preventing early life failures.

The internal condition and operating efficiency of the Metaldyne viscous damper should be monitored by extracting small samples (1cc.) of silicone fluid for laboratory analysis. Removal of a silicone fluid sample is a simple process which should be initially carried out after 15,000 hours of engine operation or at the first major engine service.

Metaldyne will advise subsequent sampling intervals via the analysis report.

Special sampling kits complete with instructions are available from Metaldyne or an appointed service representative.

Metaldyne reports satisfy Survey Societies' requirements

The Metaldyne laboratory report meets all the requirements of the major survey classification societies like Lloyds, ABS, DNV, BV for marine propulsion and auxiliary power installations at the 5 year survey.

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Could torsional vibration be destroying your expensive engines and transmissions?

Damper Re-conditioning

When a damper requires re-conditioning it must be completely dismantled to enable removal of the contaminated fluid, possible machining of any internal damage and upgrade to the latest design specification.

All dampers are leak and volume checked by computerised vacuum filling rigs to ensure the correct service volume is achieved. Filling with the correct fluid viscosity grade and volume is critical or severe damage can occur.

Life expectancy of the re-conditioned damper is the same as a new supply.

Customer Options

1 Exchange Dampers are offered to owners of popular engine types to keep engine downtime to a minimum. Contact Metaldyne for details.

2 Factory Re-conditioning. By returning to our factory or service stations. Most viscous dampers over 400mm can be re-conditioned and upgraded to the latest design and quality standards.

Owner Registration

To ensure your vessel or application is protected by the Metaldyne damper condition monitoring programme, please contact us at the address below:-







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metaldyne
METALDYNE INTERNATIONAL (UK) LTD

Metaldyne International (UK) Ltd

Service Department

131 Parkinson Lane, Halifax, West Yorkshire, HX1 3RD, England

Tel: +44 (0)1422 357234 Fax: +44 (0)1422 354432

www.metaldyne.co.uk

damperservice@metaldyne.com

www.metaldyne.com

Ref: 2007

Instruction Manual for Em'cy M.G.O. Pump Unit

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II. M.G.O pump unit configuration

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2. Use of air motors in hazardous atmosphere

V. Air filter with regulator

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SIN SEUNG ELECTRIC CO.,LTD.

1. Description on Functions

Emergency Pump Unit, as an initial auxiliary engine device to be used under the BLACK- OUT condition which may occur during the sailing of ships, allows the starting of engine with the fuel supplied using the residual air pressure inside of air tank.

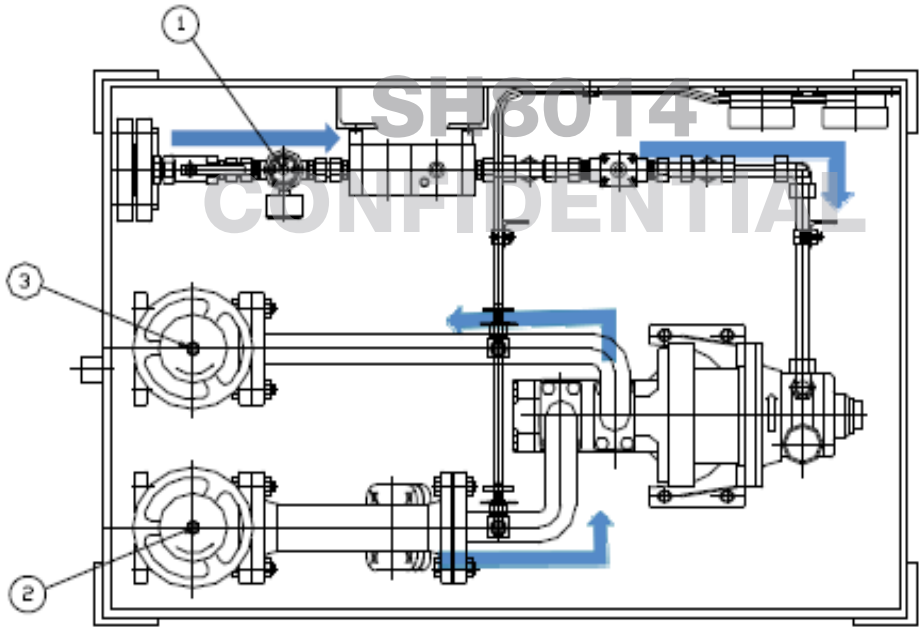
1- 1. Commissioning (Refer to the Figure 1- 1.)

1) Open the ② Inlet v/v and ③ Outlet v/v which are installed at the inlet section of oil line.

2) Operate the air motor according the pressure engaged after going through the Filter by adjusting the pressure with ① Regulator v/v of Air Line.

3) As the air motor runs and the pump begins circulation, the oil is moving to ③ Outlet through ② Inlet.

4) With above process, the oil is to be repeatedly circulated transmitting the pressure consistently with the specified pressure and required flow rate.



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< Figure 1- 1>

1- 2. Maintenance and Repair

1) When operating the pump for the first time, the pump must be operated under the fully filled condition of oil inside the pump. The Pump can be operated with the oil temperature range of - 20˚C~ +90˚C. (+40˚C~ +60˚C recommended.)

2) When the oil temperature stays below +15˚C, make sure to preheat and operate. When any excessive heat is generated, or any noise or vibration is discovered, stop the operation immediately and use after removing the cause of trouble by investigating the influence of such abnormal condition.

2. M.G.O Pump Unit Configuration

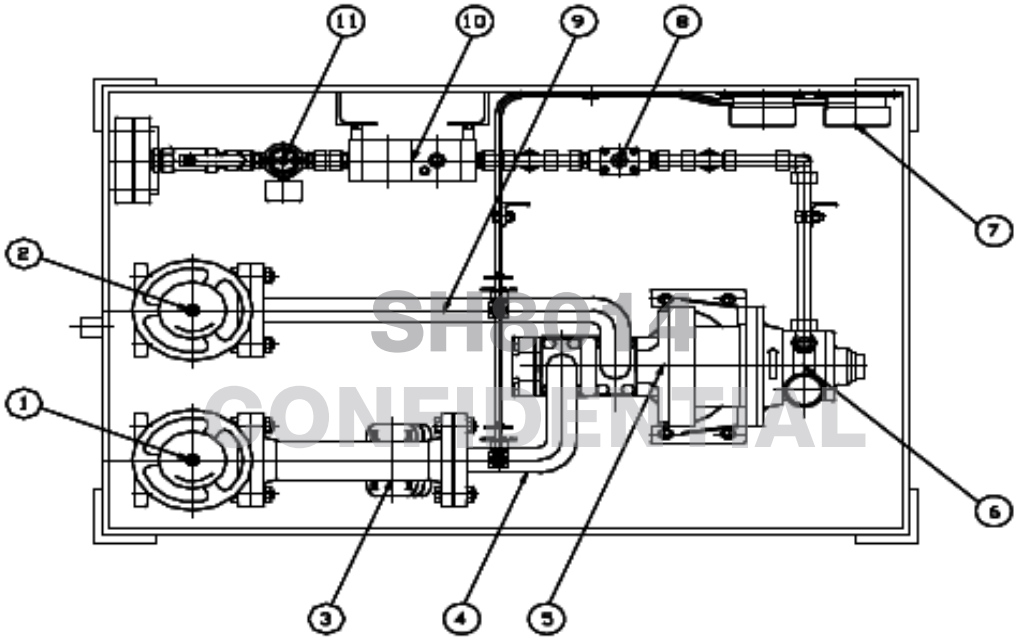
The M.G.O Pump Unit is consisted of 3 components such as ⓐ Gear pump, ⓑ Air motor, ⓒ Regulator v/v and the normal operation of unit is made with functioning of these 3 components.

ⓐ Gear Pump : Component operating the core function of unit, transferring the oil in place.

ⓑ Air Motor : Device driving the gear pump.

ⓒ Regulator v/v : Device operating the air motor as per the required pressure.

※ Adjust the air pressure with ⓒ Regulator v/v, as described above, operate ⓑ Air Motor, and transfer the oil by operating ⓐ Gear pump.



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Pos No.	Description	Spec	Q'ty
①	SD globe valve	16K-25A	1
②	SD globe valve	16K-25A	1
③	Strainer	16K-25A	1
④	Inlet pipe	25A	1
⑤	Pressure pump	Max 3600rpm	1
⑥	Air motor	100PSI / 7BAR	1
⑦	Pressure guage	0~10BAR	1
⑧	Solenoid valve	DC 24V	1
⑨	Outlet pipe	25A	1
⑩	Air filter	Max 16BAR	1
⑪	Regulator	Max 16BAR	1

III. IMO pump (Model ACE 025N3 NVBP)

1. Applications

1.1 Functionality

The Std Line (standard) ACE pump comes in two executions; Lube Line and Fuel Line. The main difference is the shaft seal design; (V-Seal) - optimized for light duty and (T-Seal) - heavy duty respectively.

The ACE pump is used for a number of different fluids:
Lubrication oil, fuel oil, vegetable oil, hydraulic oil and other hydraulic fluids, polymers, emulsions and any non-aggressive fluid with sufficient lubricating properties.

If requested, the ACE pump may be certified according to any of following classification societies: DNV, BV, LRS, ABS, RS, GL, RINA, KR, NK, RMR or CCS.

1.2 Applications

Typical applications are:

- Lubrication of diesel engines, gears, gas and steam turbines, hydro turbines and paper machines
- Circulation for cooling and filtration in large machineries, hydraulic systems and transformer oil for insulation in transformers
- As transfer pumps onboard vessels, in power plants, oil factories, refineries, tank farms etc
- Fuel supply duties for engines
- Supply and circulation of fuel oil

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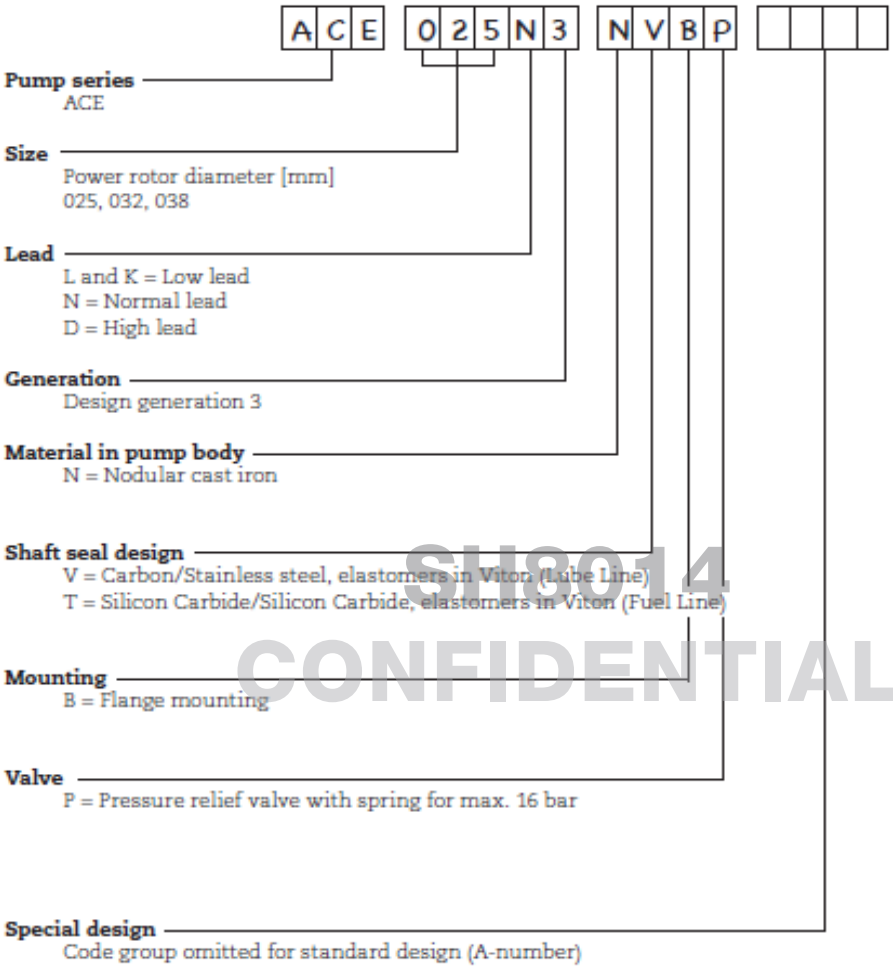
1.3 Installation

The pump is designed to be flange-mounted to its electric motor via a connecting frame and a flexible shaft coupling. By the angle bracket, the pump may be mounted horizontally or vertically.
The ACE pump can also be mounted on valve blocks called T4 or T5.

As standard, the pump is delivered including counter flanges (IMO AB design).

For more information about installation, see Installation and Start-up instruction for low pressure pumps.

2. Pump model code



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3. Technical Data

3.1 Pressure Information

Pressure relief valve

The pump is equipped with an integral pressure relief valve with internal return, limiting the differential pressure across the pump and protecting the pump. Should the discharge line be blocked, the relief valve will open by the pressure.

The valve is adjustable for different opening pressures. The value of the pressure limit can be set at the factory and should be adjusted at installation (see Installation & Start-up instruction for low-pressure pumps).

The maximum pressure accumulation varies with pump size, speed and viscosity, but will normally not exceed 4 bar.

The valve has a maximum set pressure of 16 bar.

Inlet pressure

Minimum inlet pressure (suction capability) is dependent on fluid viscosity and rotation speed. It increases with decreasing viscosity and decreasing speed. Information about minimum inlet pressure for each individual duty case can be obtained from IMO AB or pump selection software WinPump.

Maximum inlet pressure is 7 bar.

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Discharge pressure

Maximum discharge pressure is 16 bar.

Differential pressure

Maximum differential pressure is 16 bar but reduced at low viscosities according to table below

Viscosity [cSt]	1,4	2	6	10	>12
Max. diff. pressure [bar]	6,9	8	12,4	15	16

Refer to your IMO representative or use the pump selection software WinPump to determine the exact operating limits.

3.2 Driver information

Driver type

The pump is designed to be connected to an electrical motor via a flexible shaft coupling.

Speed

The maximum speed is 3600 rpm. For higher speeds, contact IMO AB.

Rotation

The pump is designed to operate in one rotational direction only, as standard clockwise when facing the shaft end. Pumps for CCW operation can be delivered on special request.

For shorter periods of time, a few minutes for emptying a discharge line, the pump may be operated in reverse direction, provided the back pressure is limited to 3 bar.

3. Technical Data

3.3 Sound level

Typical pump sound levels refer to free field conditions at a distance of 1 m from the pump. Noise of driver excluded in the quoted figures. The sound levels are measured at a discharge pressure of 5 bar, speed 2940 rpm and viscosity 40 cSt, according to ISO-3741.

Size	025	032	038
Sound level dB [A]	58	58	58

3.4 Moment of Inertia

Moment of intertia [10^{-6} kgm^2]

Size	025	032	038
Value	49	72	194

3.5 Fluid viscosity

Lube Line seal (Seal version code V):
1,4 – 800 cSt for Lube and hydraulic oil

Fuel Line seal (Seal version code T):
1,4 – 3500 cSt for Fuel oil

For higher viscosity, contact IMO AB.

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3.6 Fluid temperature

Lube Line (Seal version code V): -20 – +90 °C
Fuel Line (Seal version code T): -20 – +155 °C

4. Design

4.1 Ball bearing

The pump is fitted with an internal ball bearing which continously is being greased by the handling media.

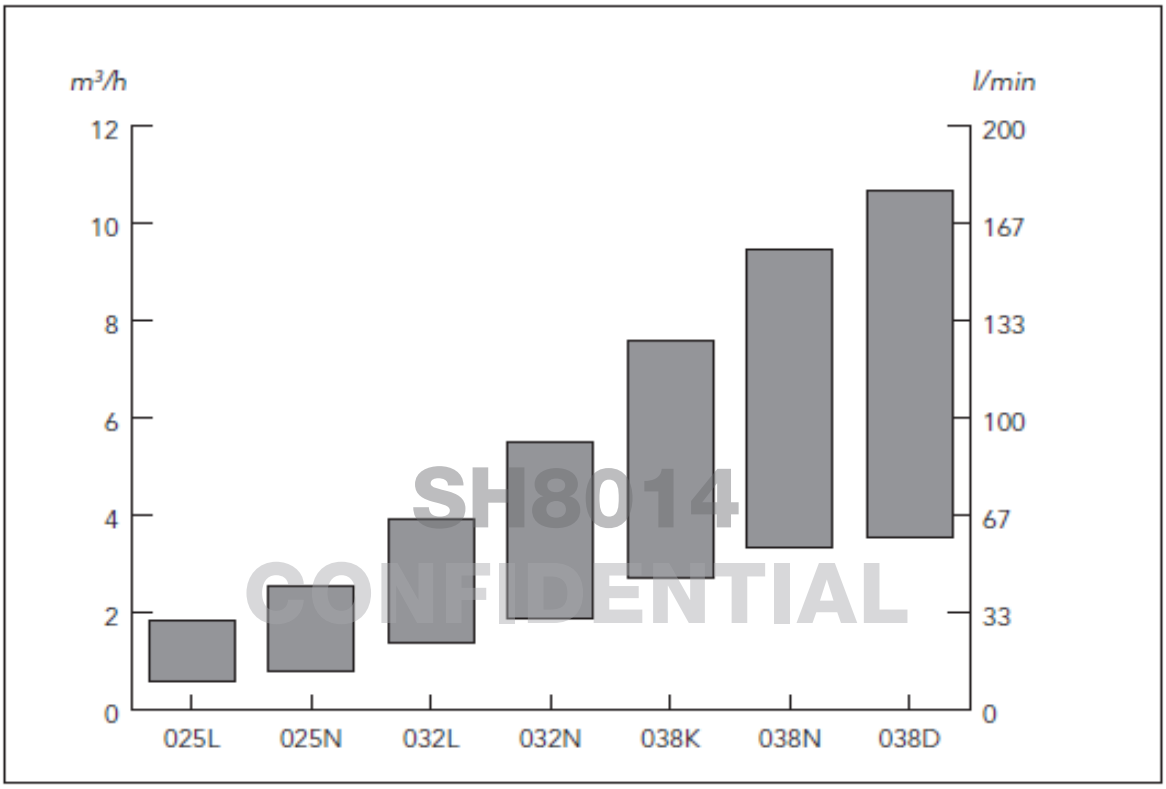
4.2 Design material

Model	Material pump	Material rotor	Material idler	Material seal	Material Elastomers
ACE NV	Nodular cast iron	Steel, surface treated	Cast iron, surface treated	Carbon/Silicon carbide	Viton
ACE NT	Nodular cast iron	Steel, surface treated	Cast iron, surface treated	Silicon carbide / Silicon carbide	Viton

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5. Performance

Typical performance values at 5 bar
Flow calculated at 26 cSt, power at 260 cSt.



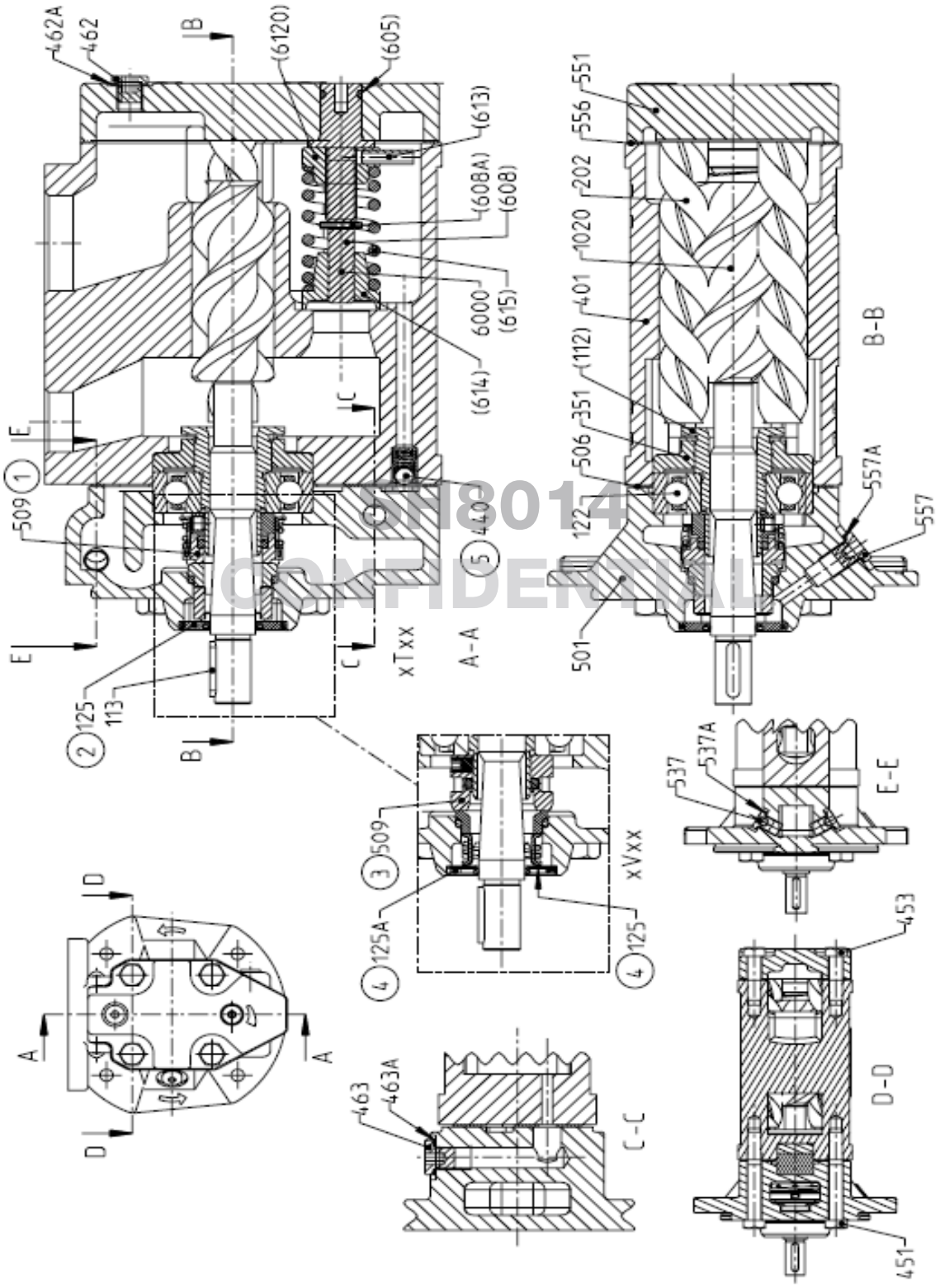
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rpm	025L l/min	kW	025N l/min	kW
1470	10,0	0,3	13,5	0,4
1770	12,9	0,4	17,7	0,5
2950	24,5	0,9	34,1	1,0
3550	30,4	1,1	42,5	1,3

rpm	032L l/min	kW	032N l/min	kW
1470	22,8	0,5	35,9	0,8
1770	29,0	0,7	44,6	1,0
2950	53,3	1,3	79,0	1,9
3550	65,6	1,7	96,4	2,4

rpm	038K l/min	kW	038N l/min	kW	038D l/min	kW
1470	45,5	1,0	55,8	1,3	59,1	1,2
1770	57,1	1,3	70,5	1,7	76,2	1,5
2950	102,9	2,5	128,4	3,2	143,9	2,9
3550	126,2	3,2	157,9	4,1	178,2	3,6

6. Sectional view



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7. List of components

Pos No	Denomination
1020	Complete power rotor
(112)	Balancing piston
113	Key
122	Ball bearing
125	Secondary seal
125A	Retaining ring
202	Idler rotor
351	Balancing bush
401	Pump body
440	Return valve
451	Screw

Pos No	Denomination
453	Screw
462	Plug
462A	Sealing washer
463	Plug
463A	Sealing washer
501	Front cover
506	Gasket
509	Shaft seal
537	Deaeration plug
537A	Sealing washer
551	Rear cover

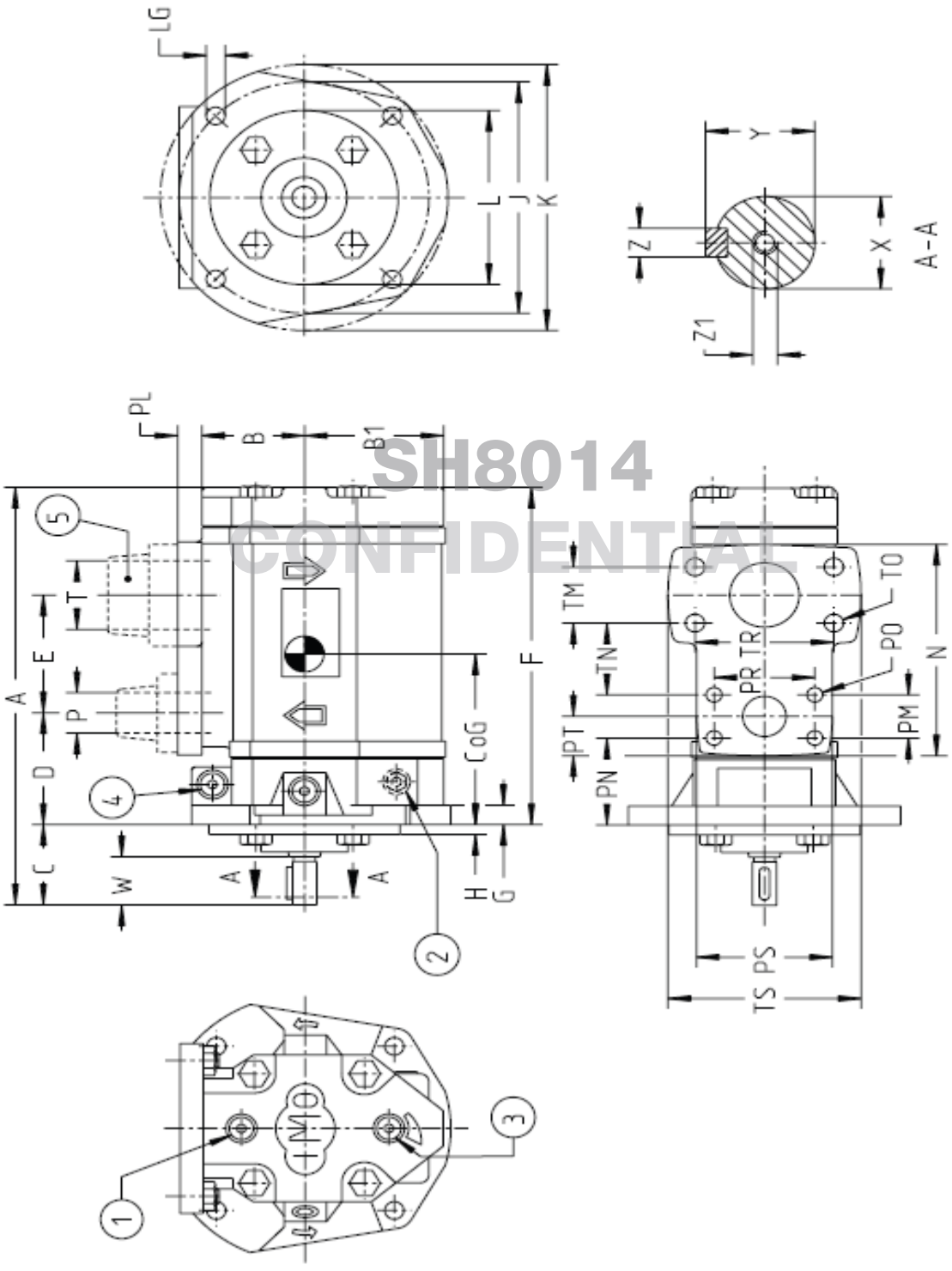
Pos No	Denomination
556	Gasket
557	Plug
557A	Sealing washer
6000	Complete valve element
(605)	O-ring
(608)	Valve spindle
(608A)	Tension pin
(6120)	Complete regulating nut
(613)	Pin
(614)	Valve piston
(615)	Valve spring

Notes:
- Components with Pos No within parenthesis are parts of subassembly

Drawing remarks:
(1) Shaft seal. Execution code xTxx
(2) Applicable for shaft seal execution code xTxx
(3) Shaft seal. Execution code xVxx
(4) Applicable for shaft seal execution code xVxx
(5) Removed from August 2011

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8. Pump dimensions



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8. Pump dimensions

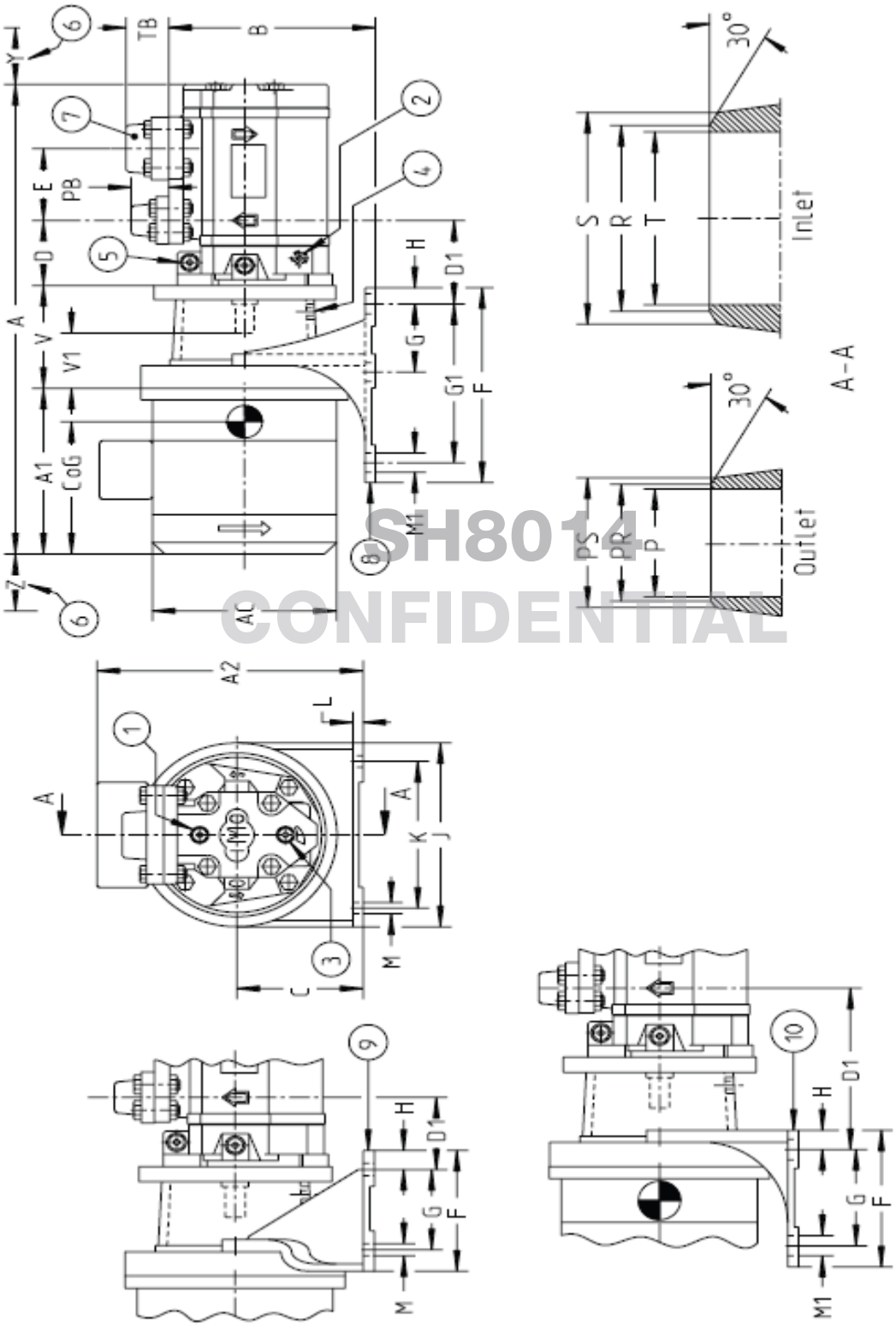
Pump size	Main dimensions								Flange dimensions					Outlet								Inlet						Shaft					Weight	
	A	B	B1	C	D	E	F	N	G	H	J	K	L[1]	LG	P	PL	PM	PN	PO	PR	PS	PT	T	TM	TN	TO	TR	TS	W	X[2]	Y	Z	Z1	CoG	kg
025	225	73	81	50	60	60	175	110	12	6	130	160	110	9	25	14	28	46	9	62	82	25	25	28	32	9	62	82	29	14	16	5	M5	75	10
032	261				68	75	211	133										54					40		41	11	90	115						92	12
038	273	83	83		75	85	223	151	15		145	170	120	11	40	15	40	55	11	90	115	33	40	40	45				34	19	21.5	6		100	15

Notes:
- Dimensions in mm
- [1] Tolerances ISO h7
- [2] Tolerances ISO j6

Drawing remarks:
(1) Inlet gauge. ISO G1/8
(2) Other side: Outlet gauge. ISO G1/8
(3) Relief valve. Turn clockwise to increase opening pressure
(4) Deviation (2x)
(5) For counter flanges dimensions see Pump unit dimensions page 12

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9. Pump Unit dimensions



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9. Pump Unit Dimensions

Pump size	IEC No	Frame size	Main dimensions											Foot dimensions								Outlet				Inlet				Dism.		Weight
			A	A1	A2	AC	B	C	D	D1	E	V	V1	F	G	G1	H	J	K	L	M	M1	P	PB	PR	PS	T	TB	R	S	Y	Z	CoG	kg
025	71	F130	481	208	213	140	171	98	60	156	60	98	48	105	70	-	19	205	180	8	9	16	25	37	27	30	25	37	27	30	68	48	283	20
	80	F165	521	238	239	160	185	112		88		108	58	90	60		15	210		12	Ø11	-										58	291	24
	90		565	272	247	178				98		118	68																			68	287	30
	100	F215	611	308	309	199	228	155		109		128	78	230	75	185	22	250	215	15	14	24										78	285	40
	112		624	321	322	215																											281	45
032	71	F130	517	208	213	140	171	98	68	164	75	98	48	105	70	-	19	205	180	8	9	16	40	42	42	49	40	42	42	49	68	48	302	22
	80	F165	557	238	239	160	185	112		96		108	58	90	60		15	210		12	Ø11	-										58	310	26
	90		601	272	247	178				106		118	68																			68	305	32
	100	F215	647	308	309	199	228	155		117		128	78	230	75	185	22	250	215	15	14	24										78	300	42
	112		660	321	322	215																											295	47
038	80	F165	569	238	239	160	195	112	75	103	85	108	58	90	60	-	15	210	180	12	Ø11	-	40	42	42	49	40	42	42	49	68	58	327	29
	90	F165	613	272	247	178				113		118	68																			68	323	35
	100	F215	659	308	309	199	238	155		124		128	78	230	75	185	22	250	215	15	14	24										78	317	45
	112		672	321	322	215																											312	50
	132	F265	744	371	373	255	268	185		130		150	100	270	95	225	23	300	265	18	34	24									70	100	309	75

Drawing remarks:
(1) Inlet gauge: ISO G1/8
(2) Other side Outlet gauge: ISO G1/8
(3) Relief valve: Turn clockwise to increase opening pressure
(4) Connecting frame drainage: ISO G3/8
(5) Deaeration (2 x)
(6) Space for distranding
(7) Butt weld counter flanges of IMO design necessary
(8) Angle bracket for frame size F215~F265
(9) Angle bracket for frame size F165
(10) Angle bracket for frames size F130

Notes:
- Dimensions in mm
- Dimensions A, A1, AC, A2 and weight are approximate values for Brook Crompton motors type WTU-DA

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10. Accessories

A bare shaft pump (Fig. 1) can be ordered with the accessories in fig. 2-8.



Fig. 1 Bare shaft pump



Fig. Set of counter flanges



Fig. 3 Connecting frame



Fig. 4 Electric motor

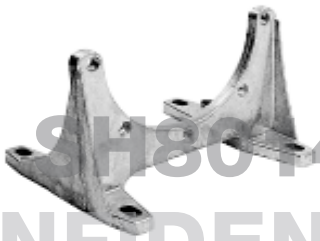


Fig. 5 Angle bracket



Fig 6. Shaft coupling

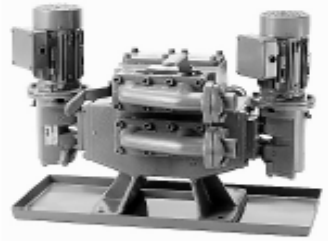


Fig 7. Valve block



Fig 8. Gauge panel

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11. Maintenance

Spare parts for these pumps are easily available from stock. For detailed information and know-how about service, see the Maintenance & Service Instruction for ACE3 pumps or contact IMO AB.

IV. Air motor

1. How to select an air motor

Air motors differ in many ways from other power sources.
These unique operating characteristics must be considered when selecting on air motor for a particular job.
It is easy to change horsepower and speed of an air motor by throttling the air inlet.
Therefore the best rule of thumb for selecting an air motor is to choose one that will provide the horsepower and torque needed using only two-thirds(2/3) of the line pressure available for overloads and starting.

*** Output power vs speed**

The output power of an air motor is relative to speed and to air line pressure.

*** Torque vs speed**

1. An air motor slows down when load increases at the same time its torque increases to a point where it matches the load.
   It will continue to provide increased torque all the way to the stalled condition, and it can maintain the stalled condition without any harm to the motor.

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1. As the load is reduced, an air motor will increase speed and torque will decrease to match the reduced load.

2. When the load on an air motor is either increased or decreased, speed can be controlled by increasing or decreasing air pressure.

3. Starting torque of an air motor is lower than
   running torque. While this provides smooth, no-shock starting, it is necessary to have additional air line pressure for starting under heavy loads.

*** Air consumption vs speed**

Air consumption increases as speed and air pressure is increased.

2. Use of air motors in hazardous atmospheres

At the present time, there are no known standards governing the operation of air motors in hazardous atmospheres.
However, there are several points regarding the safety of air motors.

First of all, an air motor is not a source of electric sparks.
However, it is possible that an article which is not part of the air motor (eq wrenches, hammers, etc.) could create a spark by sharply impacting a cast iron or aluminum case or the steel shaft of the air motor.
(Note that electric motor enclosures for both class Ⅰ and Ⅱ hazardous locations can be made of iron, steel, copper, bronze, or aluminum.)

Second, an air motor housing is not designed to contain an internal explosion, as is an explosion-proof electric motor.
The only possible internal source of ignition in an air motor is a contact between the stationary

housing components and the rotating elements that might create a spark.

The likelihood of this occurring is reduced by the fact that the contact must be made at precisely the same as a flammable or explosive gas is introduced into the air motor in a sufficient quantity to achieve a flammable or explosive mixture while overcoming the positive pressure of the driving gas.
In other words, although highly improbable, an internal explosion in an air motor is possible.

Finally, an air motor is designed to be operated by compressed air, the expansion of which in normal operation creates a cooling effect.

As a result, the temperature of the air motor will not exceed the higher of the temperatures of the surrounding atmosphere or the air delivered to the inlet.

We do not guarantee the safety of every application, but to ensure the safe operation of an air motor in your application, always follow the product directions and consult with a qualified engineer.

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V. Air filter with regulator

1. APPLICATION

The air filter regulator is designed to supply any control equipment with clean air and a controlled pressure.

1.1 Technical data

SUPPLY		0...15bar max	
RANGE	FR10	0~2.5bar/0~35psi	
	FR10.2	0~6bar/0~80psi	
	FR10.2	0~10bar/0~140psi	
DEGREE OF FILTRATION		50MICRO	
CONNECTIONS		IN	1/4" NPT
		OUT	1/4" NPT
		GAUGE	1/8"GAS
ROOM TEMPERATURE LIMIT		-55°c~80°c	
STORAGE TFMPERATURE		-60°c~110°c	
WEIGHT		480g	

2. INSTALLATION

2.1 Fitting

The air filter regulator is provided with two 1/4” NPT threaded connections.
The compressed air input is marked “IN” the reduced air output is “OUT”.

The remaining connections are reduced pressure outlets that can be both used as gauge connections (properly close the connection that is not employed).

CAUTION :

Before connecting the reduced pressure

gauge, make sure that the filter regulator is closed.

3.ADJSUTMENT

3.1 Setting

After having performed the connection shown in paragraph 2, loosen the locknut and adjusting screw.

Then tighten the locknut. By turning the screw clockwise, the output pressure increases and vice versa.

4.MAINTENANCE

4.1 Routine maintenance

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The air filter regulator is equipped with a water trap. Periodically eliminate the compensate as follow:

CAUTION :

When performing the following operation pay great attention to the exhausted working fluids.

A : Supply air to the air filter regulator

B : Loosen the bleeder screw for 30 seconds.

C : Tighten the bleeder screw.

The frequency of the previous maintenance operation depends on the amount of humidity contained in the air supply.

VI. M.G.O pump assembly material list

PIPE, FITTING, SUPPORT			
NO.	DESCRIPTION	SPEC	Q'TY
1	SHORT NIPPLE	PT3/8	1
2	JOINT NIPPLE	PT3/8 X ø12	4
3	STEEL NIPPLE	PT3/8 X Ø12(BMC)	4
4	STEEL NIPPLE	PT1/2 X Ø12	2
5	STEEL NIPPLE	PT1/4 X Ø8(BMC)	2
6	STEEL NIPPLE	PT1/4 X Ø8(BFC)	2
7	T CONNECTION BAR	Ø12	2
8	L CONNECTION BAR	Ø12	1
9	HALF SOCKET	PT1/4	2
10	HALF SOCKET	PT1/2	1
11	SOCKET PLUG	PT3/8	1
12	GASKET	PT3/8	3
13	PIPE	Ø12 X 1000	1
14	PIPE	Ø 8 X 2200	1
15	PIPE	25A	2
16	CLAMP	Ø12 X 1 HOLE	1
17	CLAMP	Ø8 X 2 HOLE	1
18	FLANGE	10K X 25A	2
19	FLANGE	30K X 15A	1
20	PAD	70 X 70 X 40	4
21	SUPPORT	25A	4
22	PIPE SUPPORT	FOR Ø12 / Ø8	3
23	MOTOR PUMP BASE		1
24	MOTOR PUMP COVER		1
25	BOLT, NUT		30
26	BALL VALVE	PT3/8	2
27	GLOBE VALVE	10K X 25A	2
28	MAIN BOX	600 X 900 X 120	1
29	GAUGE BOARD	6 X 210 X230	1
30	NAME PLATE		5
MAIN PART			
NO.	DESCRIPTION	SPEC	Q'TY
1	AIR FILTER	LF 3/8-D-MIDI	1
2	REGULATOR	2001-3C-HG	1
3	SOL V/V	VXP2140-04-5D	1
4	PRESS GUAGE	Min. : -1~4, Max.:0~10(kg/㎠.Mpa)	2
5	Y-STRAINER	10K X 25A	1
6	PUMP	MAKER : IMO	1
7	AIR MOTOR	MAKER : GAST	1

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Operations-and maintenance manual

Crankcase explosion relief valves of type HWG

Application: Oil mist-and gas explosions
Version: 1.0



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지인철 주식회사

Head Office:

348-30 Naengchon-ri, Oeidong-eup, Kyungju-si, Kyungbuk, Korea

Tel: 82-54-776-5174 Fax: 82-54-776-2769 E-Mail : hwimc@paran.com

Suwon Factory:

955, Advance Technology Complex, Goseak-dong, Kweonseon-gu, Suwon-city, Korea

Tel: 82-31-298-6323 Fax: 82-31-291-6390

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2 DESIGN OF EXPLOSION RELIEF VALVE HWG ---------- 4

3 DESIGN LIMITS ---------- 5

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6 INSPECTION AND MAINTENANCE ---------- 8

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1. INTRODUCTION.

This Operation and maintenance manual is mentioned of the following valves



Crankcase Explosion Relief Valve	
Large Group	HWG-735 HWG-645 HWG-565 HWG-480 HWG-420 HWG-345 HWG-320
Small Group	HWG-266 HWG-224 HWG-204 HWG-173 HWG-162 HWG-122

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Manufacturer:
Head Office:
Naengchon-ri, Oeidong-eup, Kyungju-si, Kyungbuk, Korea
Tel: 82-54-776-5174 Fax: 82-54-776-2769 E-Mail : hwimc@paran.com
Suwon Factory:
955, Advance Technology Complex, Goseak-dong, Kweonseon-gu, Suwon-city, Korea
Tel: 82-31-298-6323 Fax: 82-31-291-6390

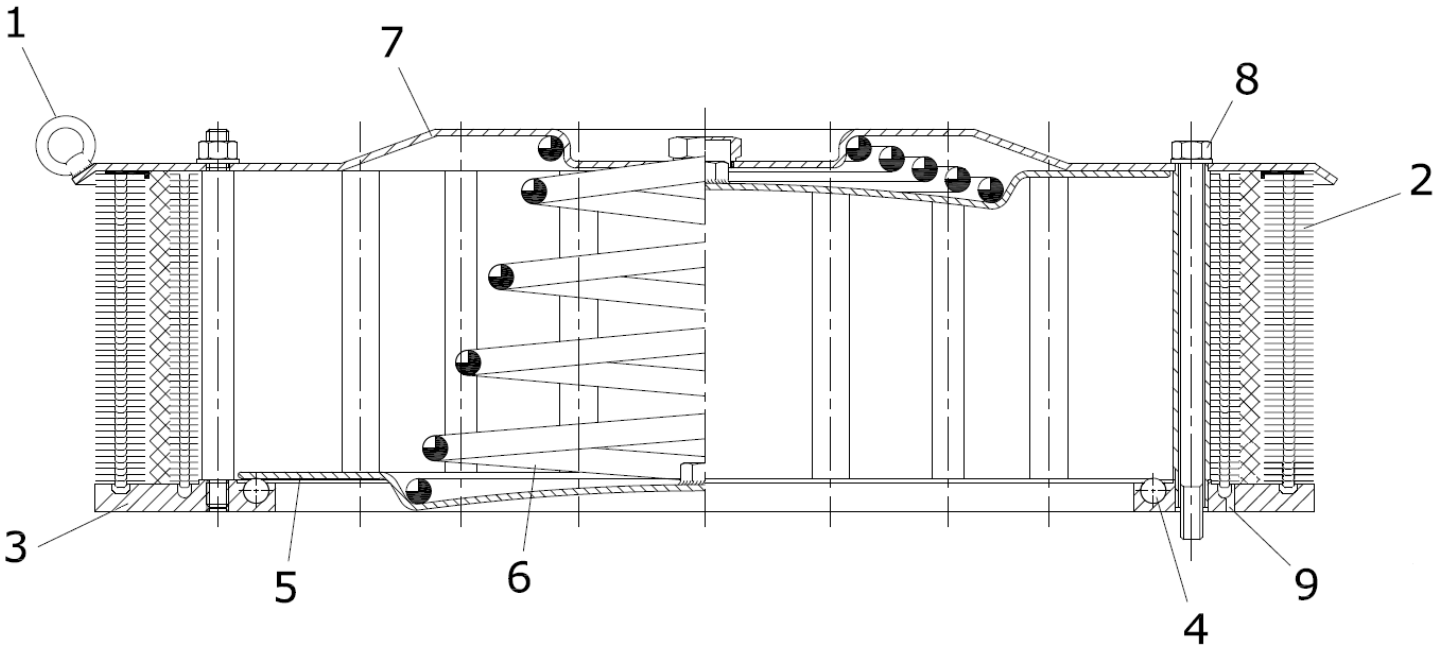
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Used Symbols:

		IACS
Safety advice Risk of injury	**Functional advice Concerning correct function**	**IACS M66 Rules Advices according IACS M66 Rules(Directive for application of Crankcase Explosion Relief Valves in ship engines)**

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2. Design of Crankcase Explosion Relief Valve HWG



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Position	Descrition
1	Eye Bolt or Nut
2	Flame Arrester consisting of Inner Trap, Mesh and Out Trap
3	Seat
4	O-Ring
5	Disc
6	Spring
7	Cover
8	Mounting Bolts for assembly on the Crankcase(This bolts are included in delivery)
9	Drain Hole(Leak oil return)

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3. Design limits

The ZIINCHEOL Crankcase Explosion Relief Valve type HWG covered in this manual is designed for protection of crankcase in ship engines and applicable up to following design limits:

Operation pressure	1 bar absolute (atmospheric condition in the crankcase)
Operating temperature	−20℃ to +100℃
Maximum Kg	100 bar *m*s⁻¹
Installation site	**The standard execution is designed for indoor use.** **For outdoor application corrosion protection has to be observed.**



Applications beyond the design limits are prohibited. ZIINCHEOL warranty and liability becomes immediately invalid in case of improper application.

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IACS **In principle Crankcase explosion relief valves work reliably in any installation position, for applications according to IACS M66 Rules only the vertical installation(as tested) of Crankcase explosion relief valves is permitted.**



ZIINCHEOL Crankcase Explosion Relief Valve type HWG are components for diesel and gas engines which necessarily require a connection to the engine to describe a functional machine.

4. Operational manual

Crankcase explosion relief valves type HWG protect man and equipment in the event of on oil mist or gas explosion.

In the event of an explosion the explosion relief valve open immediately.
The valve is designed to relieve the excess pressure during an explosion, avoid flame escape and to close rapidly after an explosion.
The valve closes absolutely tight after explosion, thus preventing oxygen or dirt to get entrained into the chamber.

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For reasons of the remaining heat, the crankcase explosion relief valve must not be touched after an explosion? Danger of severe injury!

IACS

After an explosion the flame arrester has to be exchanged at the next scheduled maintenances shutdown.
In case of visible damage of other parts, the whole valve has to be replaced.
Furthermore the instructions of the engine manufacturer have to be observed.



Work at the relief valve is not allowed if the equipment is under operation. Relief to the guidelines of the engine manufacturer.



In case of visible damage of the valve, either the Flame arrester unit or the valve has to be replaced.



The lead seal of the flame arrester must not be removed.
Disassembling the flame arrester is forbidden. ZIINCHEOL warranty and liability become invalid immediately in case of an opened lead seal.



During all manipulation of the relief valve, i.e. handling, fitting to the machine, etc. suitable protective clothing and protective gloves have to be used

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The flame arrestor must not be damaged or manipulated in any way.
Also damage of all other components has to be prevented.

5. Fitting to the machine

5.1 General assembly instructions



All work done on the valve like mounting or dismounting has to be carried out by skilled personnel wearing suitable protective clothes using appropriate tools.



Sharp edges on the valve and the weight of the valve may lead to injury of personnel. Due to improper handling the valve might drop and hurt personnel



The valve has to be mounted on the outside surface of the crankcase or protected volume. Mounting the valve in wrong way inside of the protected volume leads to a non-fulfillment of its safety function

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During fitting the valve to the machine the information stated in the assembly drawing has to be observed.

The required number of bolts has to be used, A suitable sealing has to be used to seal the seat of the valve to the crankcase or protected machine.

Additional to these instructions the assembly guidelines of the engine manufactures are valid.

It has to be observed that there is enough space for accessing the valves, to enable a visual check of the condition at any time.

The valve has a bore hole for leak oil return.

If required the leak oil return can be activated by setting a counter hole.

If the leak oil return has been activated design modifications are required to avoid oil mist-/ gas escape in counter direction (to the outside).

The explosion relief valve has to be mounted with the leak oil return hole in 6 o'clock position to maintain the backflow of the leaking oil.

The following picture shows the typical placement of explosion relief valves on a diesel engine.



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6. Inspection and maintenance

6.1 Inspection

Following visible checks have to be done on explosion relief valves during routine machine inspection.

- Damage of the flame arrester or other components requires a replacement at the next scheduled maintenance shutdown.
- The appearance of oil leakage requires an exchange of the O-Ring at the next scheduled maintenance shutdown.

6.2 Maintenance intervals

The explosion relief valve is almost maintenance free; however, the following instructions have to be observed.

After an explosion in the crankcase the flame arrester has to be exchanged. In case of visible damage of any other component the complete valve has to be replaced during the next scheduled maintenance shutdown.

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In course of the required maintenance intervals given by the engine-manufacturer the following two points have to be checked or if necessary carried out.

- In case that dirt is collected on the flame arrester, it has to be cleaned with compressed air or respectively with a non-corrosive and inflammable substance (degreaser) during standstill of the machine.



For proper operation the flame arrester has to be periodically kept clean.

- The O-Ring looses its sealing function through ageing or chemical attacks. In case of oil leakage the O-Ring has to be replaced during the next scheduled shutdown.



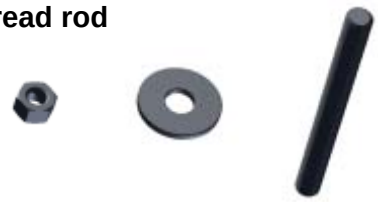
All instructions of engine manufacturers and all advices for secure operating and mounting of explosion relief valves given in the previous chapters are valid.

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6.3 Exchange and cleaning of flame arrester

Explosion relief valves of type HWG allow to exchange the complete flame arrestor, for this work following tools are required

- **1 piece thread rod of DISC NUT standard**
  (HWG-122~162 : M6 * 90 / HWG-420 : M16 * 210 / HWG-480~735 : M20 * 340)
- **1 piece Washer and 1 piece Nut of equal standard with thread rod**



The exchange of the flame arrester should be done by skilled personnel according to the assembly drawing of ZIINCHEOL with following steps:

1. **If necessary, dismantle the explosion relief valve from the crankcase.**
   Work is possible in the inside and the outside without dismantling the products.

2. Disassemble the plug (see fig.)
(HWG-122 : HEX17 / HWG-162 : HEX25 / HWG-420~735 : HEX46)

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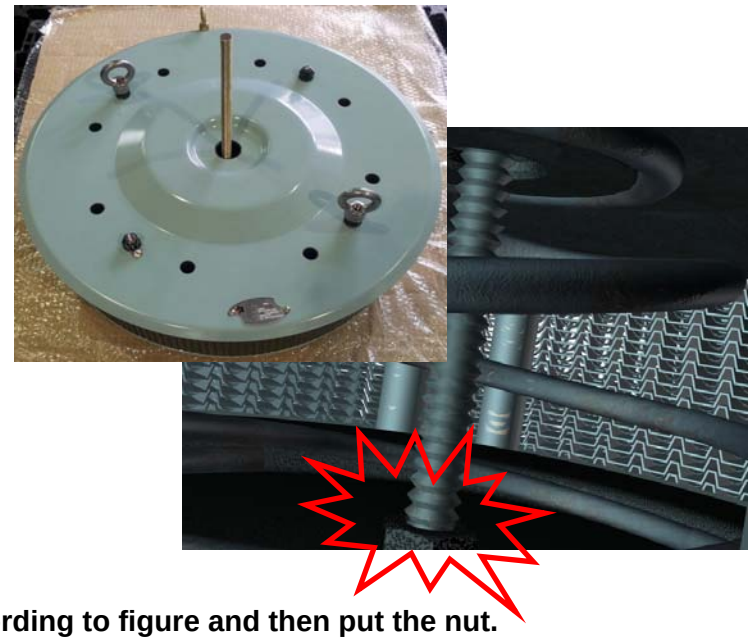




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3. Insert a thread rod in Plug Hole, and completely put Nut into the Disc according to figure.
At this point, certainly confirm the cover position(Name Plate&Eye Nut's position confirmation)

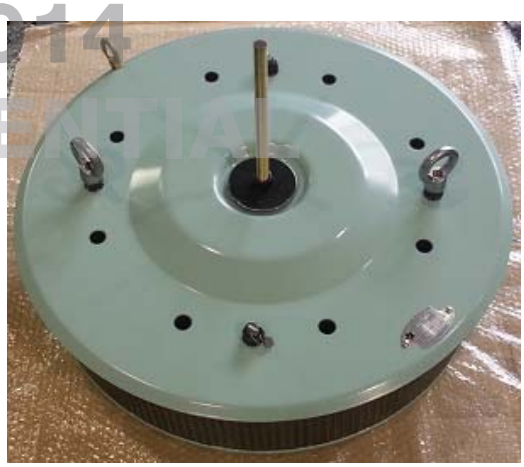




4. Put the Washer into the thread rod according to figure and then put the nut.

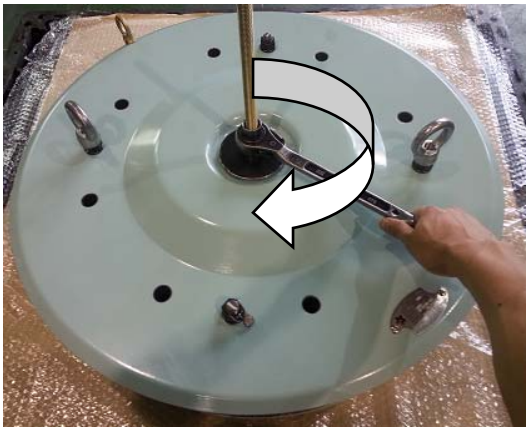
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5. When the top cover close to the nut, grease a thread rod and a nut and then continuously tighten a nut with thread rod.

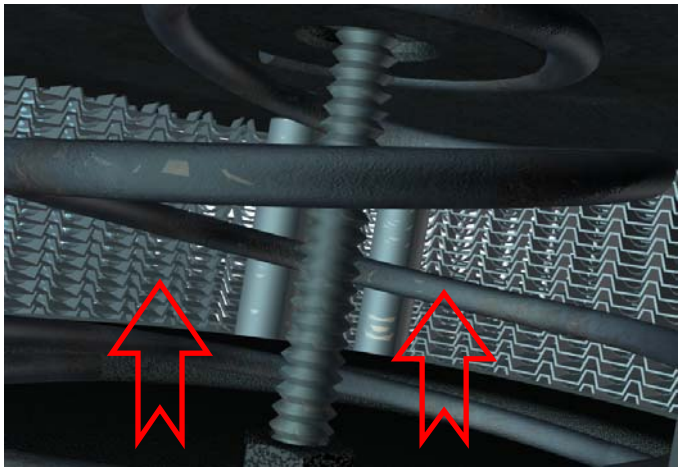




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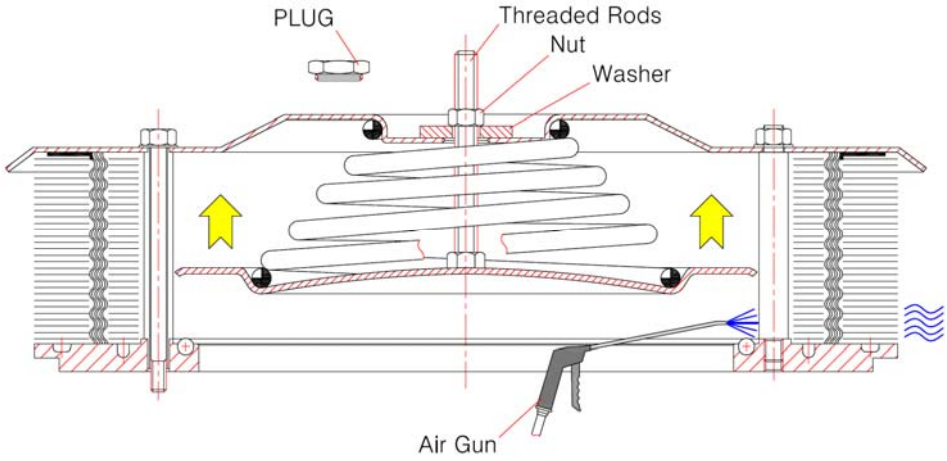
6. When continuously tightening a nut, Cover close to Disc like pictures.
As you do not look in the outsides, you shall confirm in the floor of a product.





7. Check the valve inside, clean up arrester Flame Arrester.


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8. If necessary exchange O-Ring. (See chapter 6.4)

9. Wipe cleanly Disc floor of the product which you dismantled.

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10. Now dismantle a thread rod and tighten a Plug

11. Install the valve to the machine, recommend confirming Drain Hole of a product floor.

IACS It is prohibited to disassemble the flame arrester. Disassembling expires the certification according IACS Rules M66. ZIINCHEOL warranty and liability becomes invalid immediately in case of dismantling the flame arrester.

6.4 Exchange of O-Ring

The exchange of O-Rings should be done together with the cleaning of the flame arrester and has to be carried out by skilled personnel.
Demounting of the O-Ring follows the same procedure described in the prior chapter (6.3 Exchange and cleaning of flame arrester).
Following points have to be considered additionally:

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- Remove valve plate
- Take out old O-Ring
- Clean O-Ring-insertion part
- Insert O-Ring, Apply glue on O-Ring surface.(Glue model : KF-96, Maker : Shin-Etsu)

7. Warranty

ZIINCHEOL offers warranty on material and execution for a period of 12 months after start of operation, however, this is not apply from over 18 months after delivery.

8. Table of revisions

IACS The operational manual is part of the documentation for the classification society to obtain the approvals according IACS Rules M66. ZIINCHEOL has to report to the classification society if there are any changes.

Version	Date	Author	Comment

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"BY-PASS CENTRIFUGAL FILTER" MANUAL



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HAN YOUNG MACHINERY CO.,LTD
TEL : +82 55 346 3096
FAX : +82 55 342 3053
E-mail : hygg1925@nate.com

BY-PASS CENTRIFUGAL FILTER

We recommend to read this manual before use. In case of placing an order, please, refer to the supplement(product list & drawings) at the last part of this manual.

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1. General description about By-pass Centrifugal Filter

The main purpose of lubricant use is to improve machine's efficiency by reducing power consumption and mechanical friction which can cause wear.
Originally, it is very important to prevent contamination of lubricant, but it is almost impossible on site, so, effective contaminants removal is needed to extend the lifespan of lubricant.



Fig.1 : HYMF-200F

The contaminants have some micro-abrasive particles which damage iron, copper, sand, dust and so on.
These particles are main cause of wear on piston ring, bearing, camshaft, etc.. It also can cause catalysis of oxidation which can influence to lubricant badly.
Despite using high-quality lubricant, contaminants and dust inside cause rapid degradation by blocking the way of lubricant and filter element.

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Fig.2 : HYMF-200B

Nowadays, these contaminants can be removed by Centrifugation or Filtering. The filtering can not protect an engine when damaged or plugged because its filtering medium is fabric or paper. However, Rotor of the filter does not contain anything weak except for contaminants removed in lubricant, so, it will not be plugged and can extend the lifespan of engine, exchanging cycle of lubricant & filter by removing some sharp metal micro abrasive-particles & contaminants causing degradation.
Also users can save their maintenance cost, too.
It is the best filtering equipment of lubricant and more effective than normal filtering.



Fig.3 : HYMF-400



Fig.4 : HYMF-600

2. Selection of By-pass Centrifugal Filter

In selection of its size, user should consider the quantity of engine lubricant & pressure of lubricant pump.

The quantity of lubricant have to pass through the filter by Min. 2 times/hr≥ x 5. Normally, 10~15% of pump output of engine lubricant can be used in operation.

If condition is terrible regarding engine fuel etc., bigger centrifugal filter might be installed in tolerance range of pump capacity. In addition, our product can filter various oils effectively, not only engine oil.

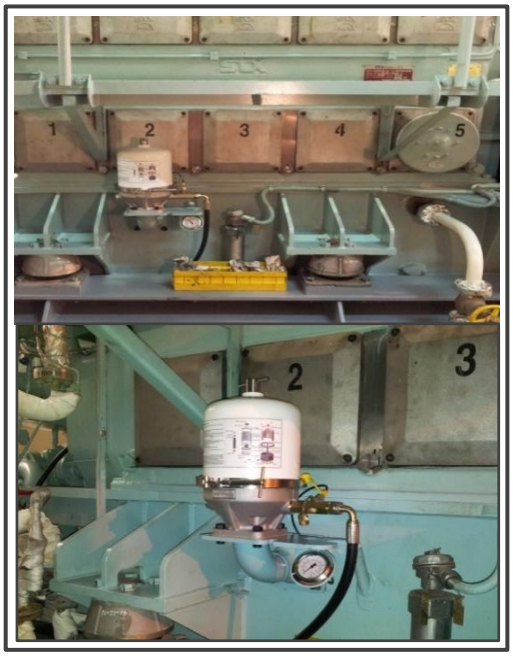


Fig.5 : Installation

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3. Operation principle & Structure of By-pass Centrifugal Filter

Caution :

In operation, it is strictly prohibited to open any components and touch.

It can damage the people and equipment.

3.1 Operation principle

First of all, inhale oil from sump tank and pressured oil by the pump will flow into the rotor witch is core part of purifier. Following supply pressure, in flowed oil will spin at high speed with 2,000~5,000RPM (by principal of action and reaction of jet power) with spouting through nozzle.

At that time, heavy & contaminated particles in remained oil inside of rotor will be attached to the edge part inside of rotor by centrifugal force.

Fig.6 is a general layout of our by-pass centrifugal filter.

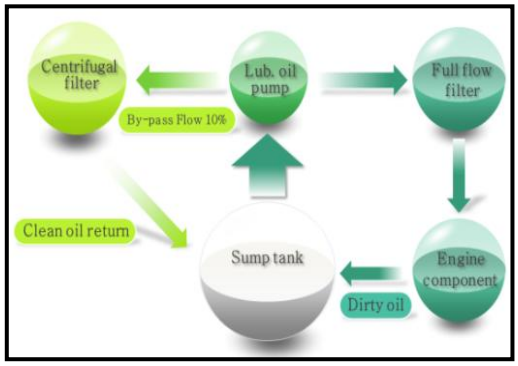


Fig.6

3.2 Structure

By-pass centrifugal filter is divided into three main parts (Base cover, Rotor, Base). Oil inlet from sump tank will be filled in rotor tube cavity through spindle(P429) & rotational tube(P413), and moved to under part of rotor(P416) through separation cone(P418). And then, it will be spoutedthrough a nozzle(P415).

In this process, Rotor part spins by jet power of spouted oil. Heavy contaminants in oil would be moved circumferential by centrifugal force and attached to a paper(P701) on internal part of rotor tube(P420).(Fig.7)

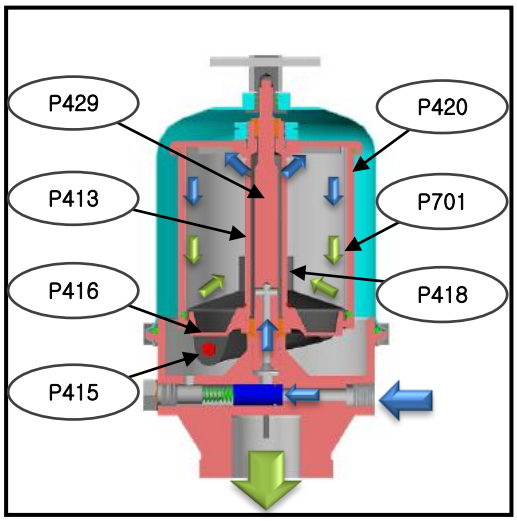


Fig.7

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4. Installation & Maintenance

Caution :

It is necessary to stop the operation of sump tank of engine & by-pass centrifugal filter for installation or exchange & inspection to related components.

Prior to operation, customers have to read and understand here below.

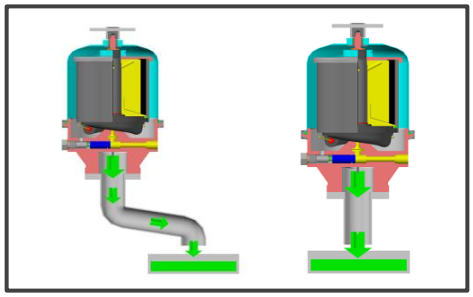
4.1 Installation

Caution :

In connecting with oil line, customers should be careful to block impurities flow into oil tube and use proper equipments which meet the standard.

By-pass centrifugal filter is a component of engine.

It is installed when making engine and possible to install additionally in previous engine, too. High pressure end oil of lubricating flow line must be supplied. The oil from by-pass centrifugal filter will flow into sump tank through the line by gravity without any pressure resistance.


Fig.8

The outlet line should be installed more higher than oil level in sump tank(Fig.8). When installation, users have to check the quantity in pump whether it is enough or not to by-pass some amount of oil in lubricating flow line without causing any problem.

In case of installation of bulk model, it is possible to use a extra pump separately to operate the filter if the quantity is not enough in oil pump.

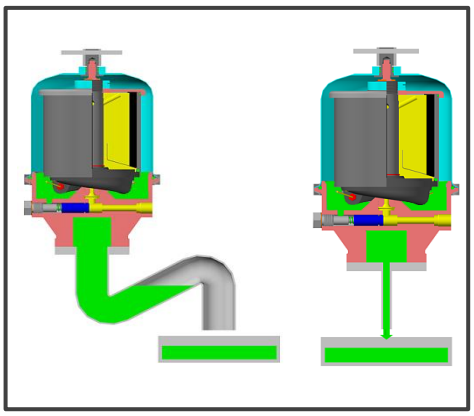


Fig.9 : Example of the wrong

The filter should be installed in a spot where easy to maintain, and use proper equipments to install strongly to prevent excessive vibration. It should be installed with 10°<. (Fig.10) Temporary tilting is not problem.

The product can be used in below oil condition:
pressure 3~7bar, Temp. 55~85℃.

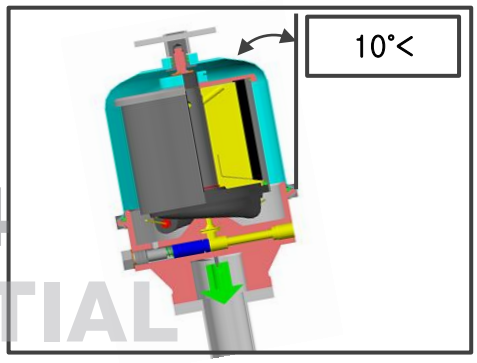


Fig.10

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4.2 Maintenance

Caution :

If purchaser change components without permission of manufacturer, manufacturer will not have any responsibilities to bad performance and damage of the product.

During operation, to prevent damage of life, it is necessary to untie band clamp, open the cover and not disassemble. If cover is untied, it can cause some accidents because oil inside of the filter can be scattered.

In case of disassembling the filter, users have to shut off an oil supply line from sump tank, and then, disassemble with proper time interval which can make remained oil naturally flowed through the nozzle.

Disassemble clamp(P409) with counterclockwise turning of its handle and cover with counterclockwise turning of its handle above. (Fig.11)

In this process, users have to be cautious because oil on inner wall of cover can be flowed down to the base.



Fig.11

With tool, disassemble cover nut(P424) with counterclockwise turning, and then, disassemble rotor cover(P423).(Fig.12)

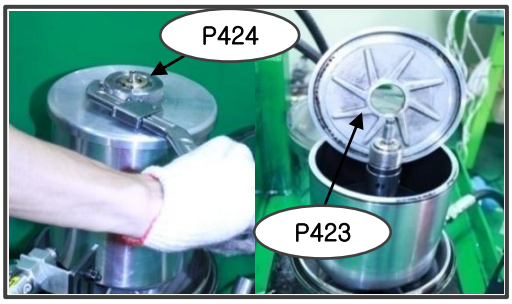


Fig.12

Disassemble rotor tube(P420) and remove the paper filter(P701) attached on its inner wall.(Fig.13)

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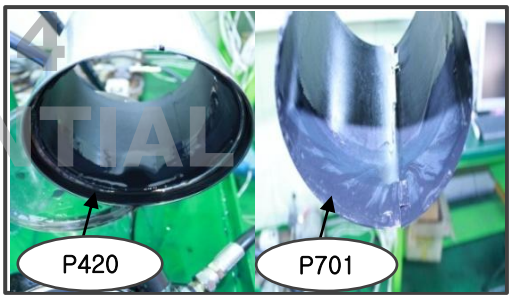


Fig.13

After disassembling the separation cone(P418), wash each components(rotor tube, rotor cover, separation cone and so on).(Fig.14)

After cleaning, assemble in reverse order.



Fig.14

Refer to attached Tag for the details about disassembling sequence.

4.3 Guidance for inspection and overhaul intervals

Please, follow this below list.

Item	Interval
- Internal materials of By-pass centrifugal filter	- After 100hrs operation or if necessary
- Exchange of internal paper filter	- After 100hrs operation or if necessary
- Leakage in connecting part of oil supply	- occasionally
- Clamping condition of related bolt & nut	- occasionally
- Disassemble and maintenance of the filter	- If necessary

4.4 Troubleshooting

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Trouble of by-pass centrifugal filter have to be remedied in early stage to prevent it from being worse.

It is very important to keep watching the by-pass centrifugal filter by engineers on their duty in order to guarantee safety and reliability of its operation.

Troubleshooting list against possible problem is mentioned as a guidance and reference will be made of detailed description in this instruction manual. In case, solution can not be found in trouble, please, contact to engine manufacturer or supplier of by-pass centrifugal filter.

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INSTRUCTION MANUAL

MODEL DAWS-BFM

NAME AIR WASTE GATE VALVE

TYPE MOTOR

SIZE 50A

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DH Controls Co., Ltd.

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1. Function

1) AWG Valve Function

The air waste gate valve protects the turbocharger and discharges surplus supply pressure to the outside of the engine for stable operation of the engine.

- Charge air pressure is decreased and exhaust gas temperature is increased with AWG Valve open position.
- Charge air pressure is increased and exhaust gas temperature is decreased with AWG Valve close position.

2) Butterfly Valve Seat Function

Butterfly Valves generally has molded o-rings on the flange face of the seat. As a result, no gaskets are required as these o-ring serve the function of a gasket.

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2. Diagram

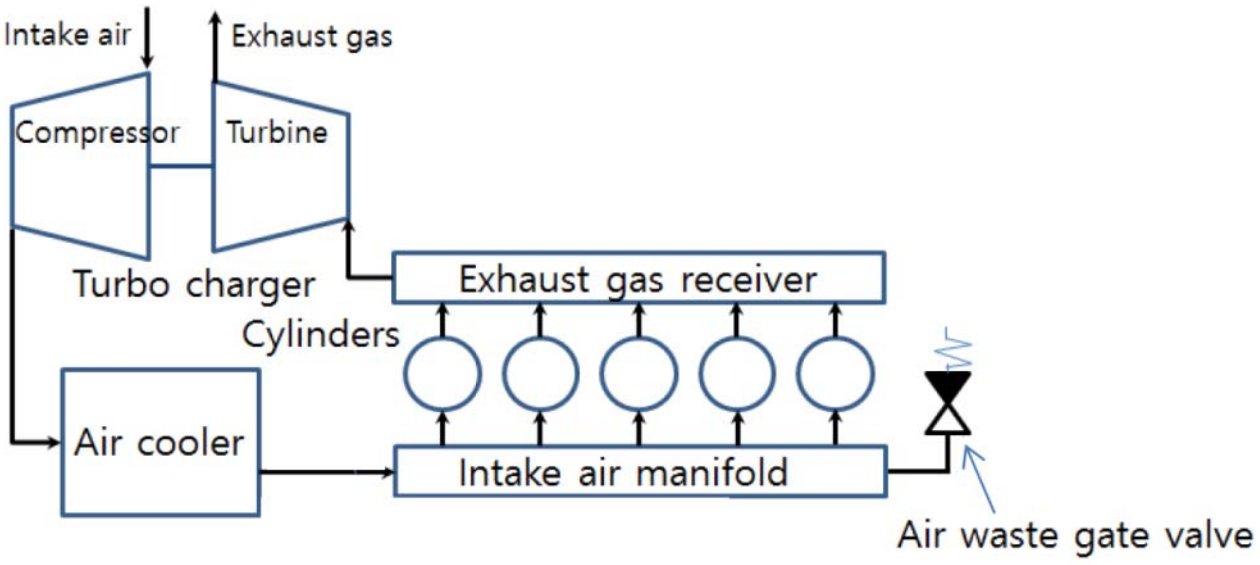


Fig 1. Combustion air system with Air waste gate valve

3. Operating of AWG Valve

Air waste gate valve is installed in the same way as a relief valve between the air cooler and the intake air manifold.

- Keep close AWG Valve during engine normal operation for safety.

- Please carefully open AWG Valve step by step when Turbocharger gas outlet temperature is lower than required.

When you open the AWG Valve, some of the air supply is discharged to the engine room. At this time, because compressed air is released to the atmospheric, noise is generated. Therefore, the silencer is attached to the outlet to reduce noise when the air supply is released through the AWG valve.

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4. Shipment & Storage

1) The seat, disc, stem, and bushing of the Air waste gate valve (Butterfly Valve) should be coated with silicone lubricant as recommended.

2) The disc should be positioned at 10° open.

3) The faces of each valve should be covered with cardboard, plywood, plastic plates, etc. to prevent damage to the seat face, disc edge , or butterfly valve interior.

4) Valves should be stored indoors with face protectors intact. Temperature should preferably

5) When valves are stored for a long time, open and close the valves once every 3 months.

6) Ship and store valves so that no heavy loads are applied to the bodies.

5. Silencer of AWG Valve

The silencer is to reduce the exhaust air of compressed air exhausted from pneumatic equipment.

Fluid	Comp. Air
Max. working pressure[note1)]	1.0Mpa
Noise effect	30dB[note2)]
Ambient and fluid temperature	5~60℃[note3)]
Effective cross section	160mm²
Sonic conductance C	32dm³ /(s · bar)
Recommended flow rate	less than 12m³ /min(ANR)
Weight	165g

note1) The primary pressure of the valve

note2) The noise effect may change depending on the air pressure circuit or pressure exhausted from the valve.

note3) If there is no risk of freezing due to water drop from the fluid, it can be used at −10 ~ 60 ℃

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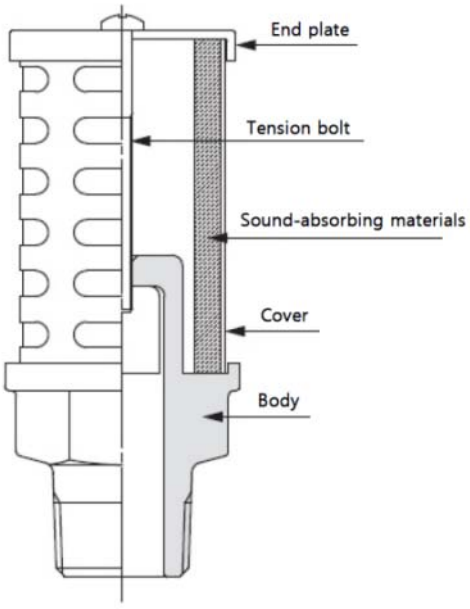


Fig 2. Silencer

1) The silencer reduces the exhaust sound of the compressed air exhausted from the pneumatic equipment. Noise except the exhaust sound cannot be reduced.

2) Sound−absorbing materials can not be exchanged. Do not disassemble.

3) Replace with a new silencer when the system function and exhaust speed degraded due to clogging

4) Be careful because there is a possibility of breakage, If you continue to use it in the clogged state.

6. Installation Procedure

<General Installation>

1) Make sure the pipeline and pipe flange faces are clean. Any foreign material such as pipe scale, metal chips, welding slag, welding rods, etc., can obstruct disc movement or damage the disc or seat.

2) The elastomer seat has molded o-rings on the face of the seat. As a result, no gaskets are required as these o-rings serve the function of a gasket.

3) Check to see that the valve disc has been positioned to a partially open position with disc edge about 6.3mm to 9.5mm from the face of the seat, approximately 10° open.

4) When the valve is fastened to the flange, taking care not to damage the seat faces of AWG valve(butterfly valve).

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5) It is not necessary to completely tighten the bolts immediately after seating the valve on the flange. After tightening the bolts loosely, Carefully open the disc to the full open position, making sure the disc does not hit the adjacent pipe I.D. After removing other equipment between the flanges, hand-tighten the installed bolts as shown in fig 3. Very slowly close the valve disc to ensure disc edge clearance from the adjacent pipe flange I.D. Now open the disc to full open and tighten all flange bolts per specification as shown in Fig 3. Finally, repeat a full close to full open rotation of the disc to ensure proper clearances.

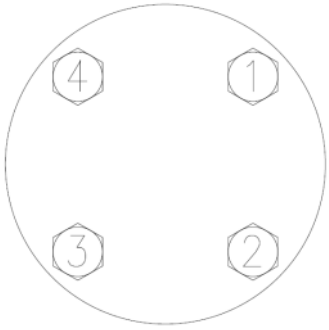
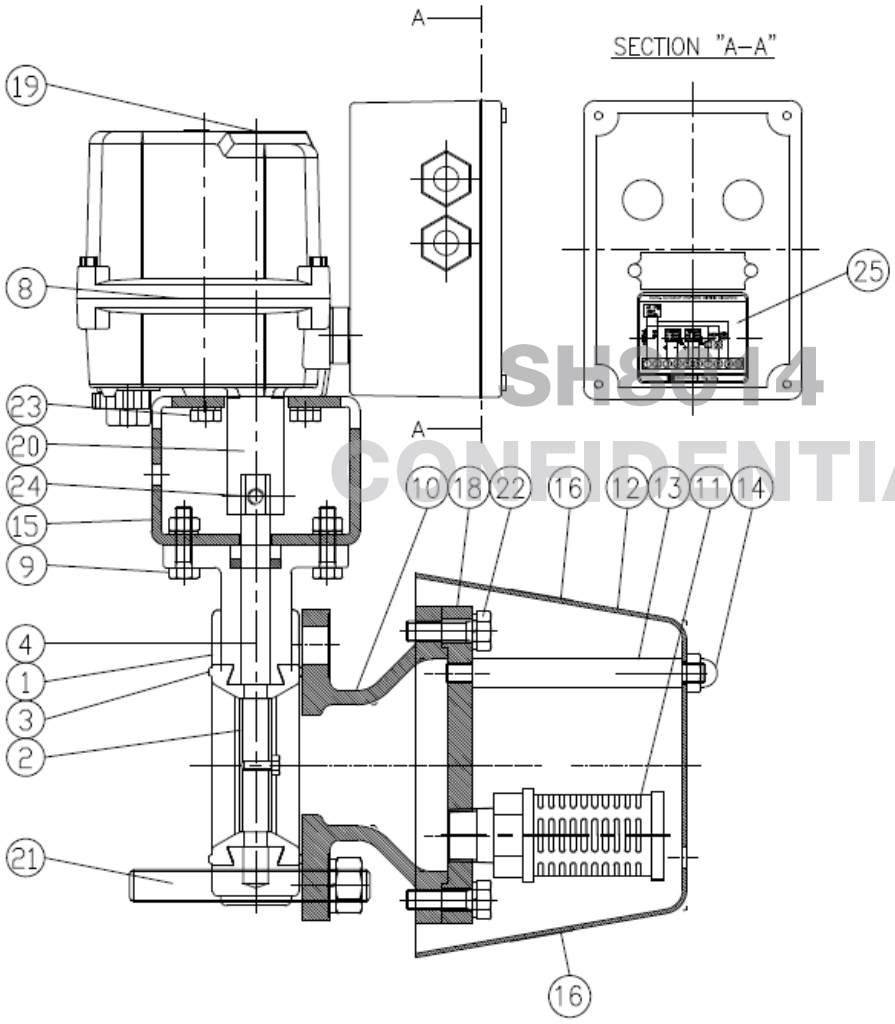


Fig 3. Recommended Bolt Tightening Sequence

7. Construction



NO.	PART NAME	Q'TY
26	MANUAL PLATE	1
25	WIRING DIAGRAM	1
24	HEX. BOLT	1
23	HEX. BOLT & S.W	4
22	HEX. BOLT & S.W	4
21	STUD BOLT/LOCK NUT/S.W	4
20	ADAPTER	1
19	INDICATOR	1
18	FLANGE	1
16	NAME PLATE	2
15	SUPPORT	1SET
14	CAP NUT	4
13	SUPPORT	4
12	COVER	1
11	SILENCER	4
10	HOUSING	1
9	HEX.BOLT/LOCK NUT/S.W	4
8	ELECTRIC ACTUATOR	1SET
4	STEM	1
3	SEAT	1
2	DISC	1
1	BODY	1

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Fig 4. Construction of AWG Valve

HQ - 006 Quarter-turn Electric Actuator

Installation, Operation & Maintenance Manual


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1. Introduction

1.1. Purpose

The purpose of this manual is to introduce and explain the installation, operation and maintenance of HQ-006 electric actuators.

1.2. Safety Notices

Safety notices in this manual outline precautions the user must take to reduce the risk of personal injury and damage to the equipment. The user(s) must read these instructions before the installation, operation or maintenance of HQ-006 electric actuators.

DANGER: *Refers to personal safety and alerts the user to danger or harm. The hazard or unsafe practice will result in severe injury or death.*

WARNING: *Refers to personal safety. Alerts the user to potential danger. Failure to follow warning notices could result in personal injury or death.*

CAUTION: *Directs the user's attention to general precautions that, if not followed, could result in personal injury and/or equipment damage.*
Notes: Highlighted information is critical to the user's understanding of the actuator's installation and operation.

2. Product Identification

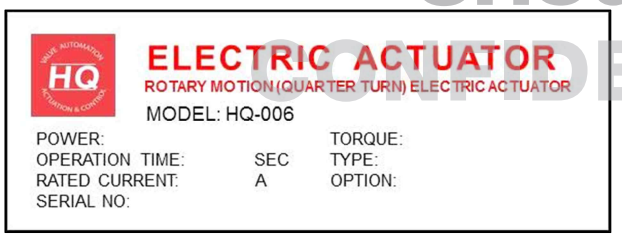
2.1. Product Identification

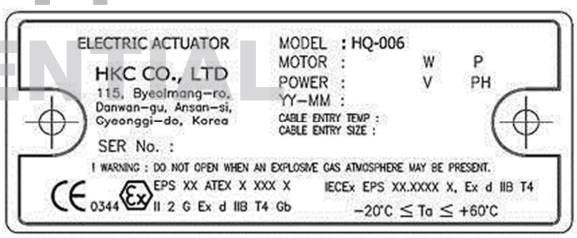
The actuator name plate is located on the opposite side of the conduit entry. The name plate contains the following:

2.1.1. Marking

① General (Sticker) ② Ex d (Stainless Steel)

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- HQ logo (trade mark)
- Model
- Electrical power supply
- Torque
- Operating time (seconds)
- Type : IECEx Ex d IIB T4, or ATEX II 2G Ex d IIB T4 Gb
- Rated current
- Option
- Serial No.

Note:

Name of manufacturer and country shall not be printed based on OEM.

2.1.2. [Applied standard

① IEC60079-0:2011, EN60079-0:2012
② IEC60079-1:2014-06, EN60079-1:2014

2.1.3. Certification

① IECEx: EPS 15.0075X, Ex d IIB T4 Gb
② ATEX: EPS 15 ATEX 1 127 X, II 2G Ex d IIB T4 Gb ----- 16 rev0]

2.2. Initial Inspection

Upon on the receipt of the actuator, the user should inspect the condition of the product and ensure that product specification stated in the name plate matches with the order sheet.

- Remove the packing wrap or wooden box carefully. Inspect the product for any physical damage that may have occurred during shipment.

- Check the product specification with product ordered. If a wrong product has been shipped, immediately report to our coordinator.

2.3. Storage

Actuators must be stored in a clean, cool and dray area. The unit should be stored with the cover installed and the conduit openings sealed. Storage must be off the floor, covered with a sealed dust protector. When actuators are to be stored outdoor, they must be stored off the ground, high enough to prevent from being immersed in water or buried in snow.

3. General Information and Features

3.1. General Information

HKC HQ-006 electric actuators are designed to provide reliable and efficient operation of 90 degree quarter turn valves, such as damper valves, etc.

3.1.1. Performance

Type	Max. output Torque	Operating time(sec.) 60/50 Hz	Duty Cycle IEC34-1	Mounting Size	Power 1 Phase	Rated Current (A) 60/50 Hz 1 Phase			Weight
	Kgf.m	90°	S4 (%)	ISO 5210	AC or DC	110V	220V	24V	kg
HQ-006	6	12/14	50	F03, F05, F07	110V, 220V ac, 24V dc	0.4 / 0.4	0.2 / 0.2	1.7	3

3.1.2. Standard Technical Data

Enclosure Rated	Weatherproof IP67
Enclosure	High grade aluminum alloy, Anti-corrosion coated
Power Supply	110 / 220V ac 1 Ph 60/50Hz, 24 V dc
Duty Type	S4 50% / S2 30min (IEC 60034)
Motor	AC reversible motor
Limit Switches	2 x open/close SPDT, 250V ac 10A rating
Auxiliary Limit Switches	2 x open/close SPDT, 250V ac 10A rating
Torque Switches	N/A
Indicator	Continuous position indicator
Manual Override	Manual handle
Space Heater	[2W --- 16 rev0]
Conduit Entries	[Standard:2 x PG13.5, Option:2 x NPT1/2", PT1/2", PF1/2" Flame proof: 2 x NPT3/4", M20, M25 ----- 16 rev0]
Lubrication	Grease moly EP
Ambient Temperature	-20 ℃~ + 60 ℃
External Coating	Dry powder polyester

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3.1.3. Optional Technical Data (Optional)

[EXD	Flame proof enclosure (Ex d IIB T4) --- 16 rev0]
WTA	Watertight Enclosure (IP68 10m / 24hr)
PIU	Potentiometer Unit (0~1KΩ)
PCU	Proportional Control Unit (input, output 0~10V DC, 4~20mA DC)
CPT	Current Position Transmitter (output 4~20mA DC)

3.1.4. Duty Cycle [1)]

Duty cycle rated IEC60034 - S4 50% / S2 30 min
Exceeding the actuator's rated duty cycle may cause thermal overload.

Note:
[1)] Type of duty according to VDE 0530 / IEC 60034-1

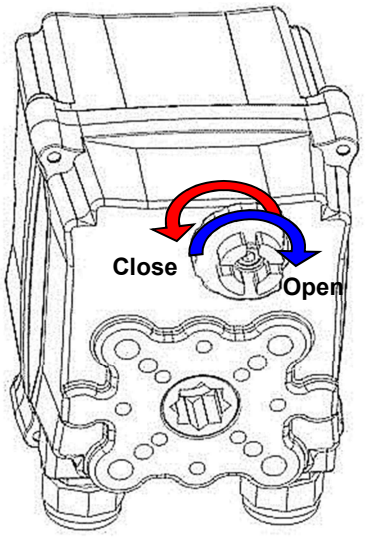
Short - time duty S2	Intermittent duty S4
The operation time at a constant load is short, so that thermal equilibrium is not reached. The pause is long enough for the machine to cool down to ambient temperature. Example, the duration of the short - time operation is limited to 15min.	The duty is a sequence of identical cycles which consist of starting time, operation time with constant load and rest period. The rest period allows the machine to cool down so that thermal equilibrium is not reached. Example, the relative on-time at S4-25% or S4-50% is limited to 25% and 50% respectively.

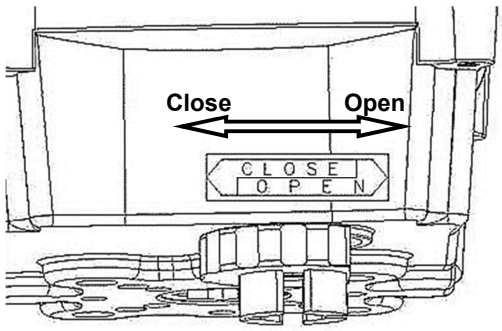
3.1.5. Heater

Condensation in the actuator is possible due to wide fluctuation of the ambient temperature. The heater integrated in the control unit prevents this in general.

3.1.6. Manual Override

HQ-006 actuators are provided with a manual system. The standard HQ-006 actuators come with a manual override nut. This nut is located on the bottom of the unit and can be easily operated with a 5M wrench. Turn the hand wheel until the valve reaches the required position (turn clockwise to fully open and counter-clockwise to fully close).





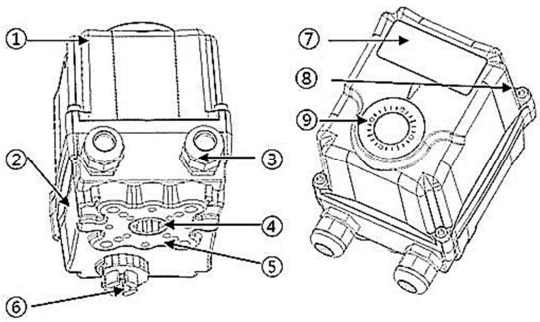
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3.1.7. Lubrication

HQ-006 electric actuator is a totally enclosed unit with permanent lubricated gear train (Moly EP Grease). Once installed, further lubrication should not be required. However, periodic preventative maintenance will extend the operating life of the actuator.

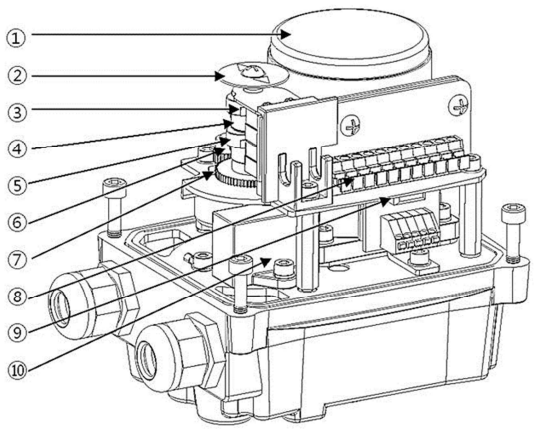
3.2. External Parts for Standard Models

External Parts	
1	Top Cover
2	Body
3	Cable Entry (PG 13.5) x 2
4	Drive Shaft (star 14mm)
5	Mounting Base (F03, F05, F07)
6	Hand Wheel
7	Name Plate
8	Cover Bolt
9	Indicator



3.3. Internal Parts for Standard Models

Internal Parts	
1	Motor
2	Indicator
3	Open Limit Switch
4	Close Limit Switch
5	Additional Open Limit Switch
6	Additional Close Limit Switch
7	Potentiometer Unit
8	Terminal
9	Heater
10	Capacitor



4. Installation

4.1. Pre-installation

Verify the actuator's nameplate to ensure correct model number, torque output, operating speed, voltage and enclosure type before installation or use.
It is important to verify that the torque output of the actuator is appropriate for the torque requirements of the valve and that the duty cycle of the actuator is appropriate for the intended application.

Model	HQ - 006[3)]
Type of protection	IECEx: Ex d IIB T4 ATEX : II 2G Ex d IIB T4 Gb
Ambient Temperature	-20 ℃ ~ +60 ℃

If remained openings on the enclosure after installation for use in potentially explosive atmosphere, the hole shall be blanked with a Ex d IIB or Ex d IIC certified blanking element.

Danger: Installation, commissioning, maintenance, repairs and modification work must only be performed by qualified personnel with extensive knowledge on how to work on explosion-proof electrical equipment.

Warning:
Read this installation, operation and maintenance manual carefully and completely before attempting to install, operate, or troubleshoot the HKC actuator.

Notes:
3) Further information can be found from the HQ-series electric actuator catalogue
Refer to the Cl.3 in this manual

4.2. Actuator Mounting

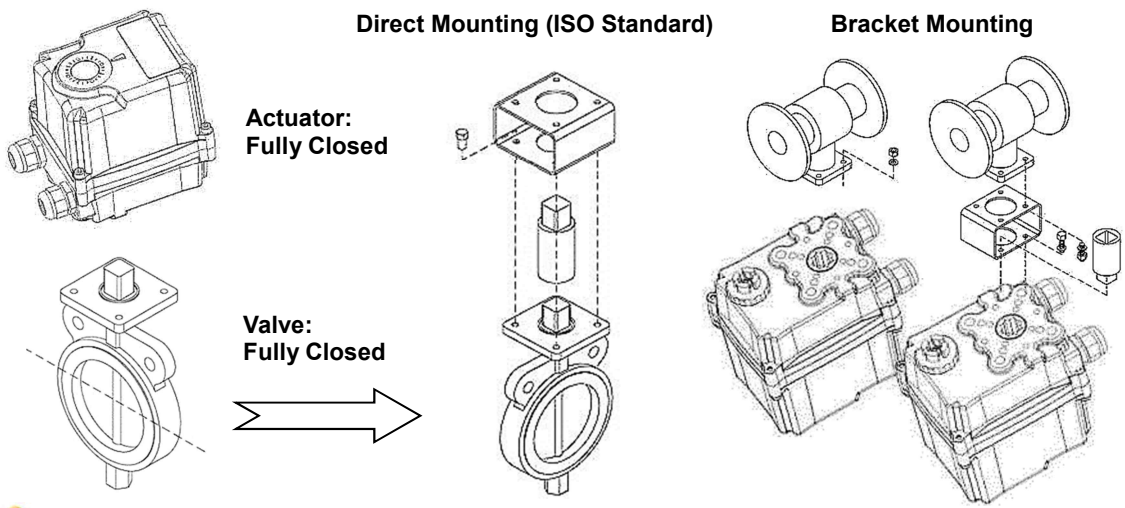
Note:
Prior to mounting, the part-turn actuator must be checked for any damage
Damaged parts must be replaced by original spare parts

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Mounting is most easily done with the valve shaft pointing vertically upward. But mounting is also possible in any other position; the actuator may be mounted in any position.
The HQ-006 series actuators are supplied with Union joints & nuts; the Union joints are removable for the ease of machining.

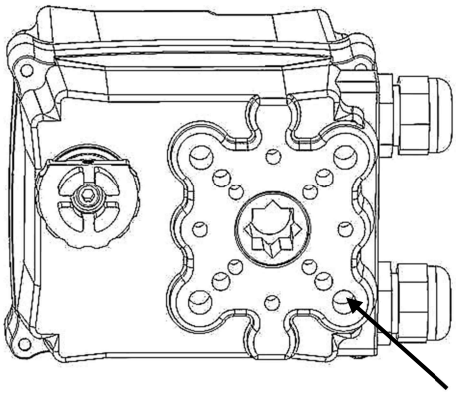
CAUTION:
Do not attempt to work on your HKC actuator without first shutting off the incoming power.
Do not attach ropes or hooks to the hand wheel for the purpose of lifting by hoist

4.2.1. Actuator Mounting Base Details

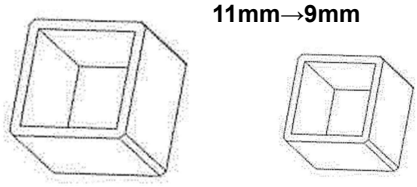


Note:
Make sure both the actuator and valve are fully closed.

Actuator Mounting Base: F03/F05 and F07



Square Adapter **14mm→11mm**
11mm→9mm



Star Adapter **14mm→11mm**
11mm→9mm



DANGER:
HAZARDOUS VOLTAGE! Make sure all incoming power is disconnected before performing the mounting.

4.3. Limit Switch Setting

4.3.1. Manually rotate the hand wheel of the actuator to fully closed position
4.3.2. Using a hex wrench, loosen the set screw in the CLOSE limit switch cam
4.3.3. Rotate the CLOSE cam towards CW limit switch lever until the switch 'clicks' (see Figure 1 below)
4.3.4. Tighten the set screw with the hex wrench
4.3.5. Manually rotate the hand wheel of the actuator to opened position
4.3.6. Using the hex wrench, loosen the set screw in the OPEN limit switch cam
4.3.7. Rotate the OPEN cam towards CCW limit switch lever until the switch 'clicks' (see Figure 2 below)
4.3.8. Tighten the set screw with the hex wrench

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DANGER:
HAZARDOUS VOLTAGE! Make sure all incoming power is disconnected before performing the mounting.

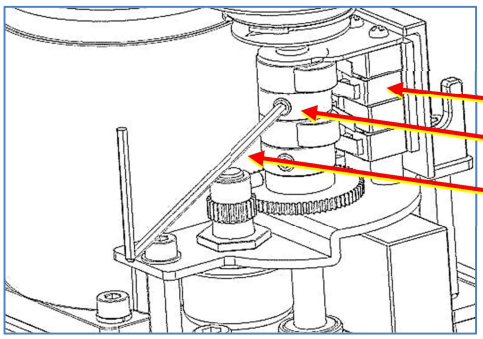


Figure 1: Close Cam Setting

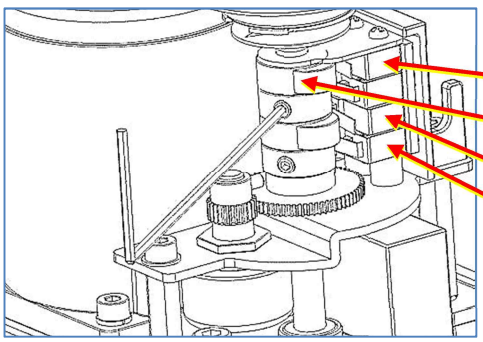


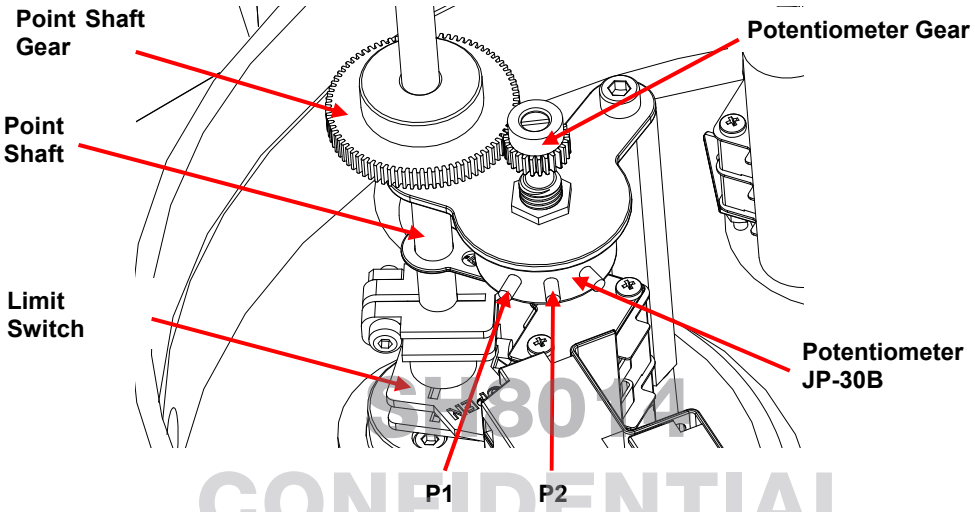
Figure 2: Open Cam Setting

4.4. Setting Potentiometer (Replacement and Setting)

The potentiometer has been calibrated at factory. However, if re-calibration is required, proceed as follows:

4.4.1. Manually rotate the hand wheel of the actuator to fully closed position.
4.4.2. While measuring the resistance between P1 (orange) and P2 (grey), gently rotate the Potentiometer Gear until it reaches between 80 - 120 Ω (100 Ω preferred).
4.4.3. Engage the Potentiometer Gear into the Point Shaft Gear and use an L-wrench to tighten the screw.

DANGER:
HAZARDOUS VOLTAGE. Make sure all incoming power is disconnected before setting the potentiometer.



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4.5. Current Position Transmitter - CPT (Optional)

The potentiometer is used for the actuator signal feedback. It reads a resistance value corresponds to the current position of the actuator and transfers to CPT card. The CPT indicates the current position of the actuator throughout the stroke by a 4 - 20mA output signal.

4.5.1. Standard Features

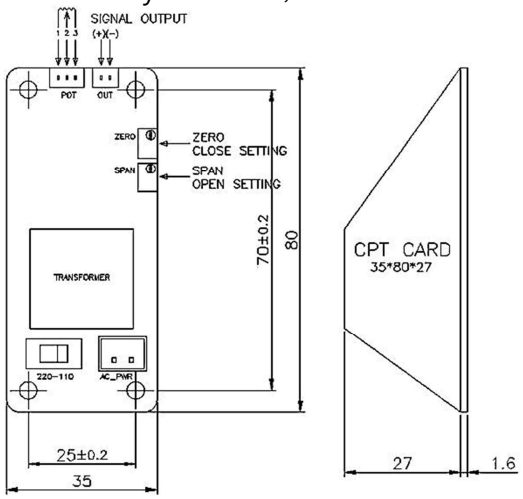
Model	CPT
Power	220(110)V ac, 50/60Hz, 2VA Max
Output Signal	4~20mA dc
Output Impedance	750Ω Max
Resolution	Min 1/1000
Position Conversion Accuracy	±0.5 ~ ±1.5%
Ambient Temperature	-20 ℃ to +60 ℃
Ambient Humidity	90% RH Max (Non-condensing)
Insulation Resistance	Above 500V dc 30MΩ
Vibration	10g, 0~34Hz

DANGER:
HAZARDOUS VOLTAGE. Make sure all incoming power is disconnected before performing the mounting.

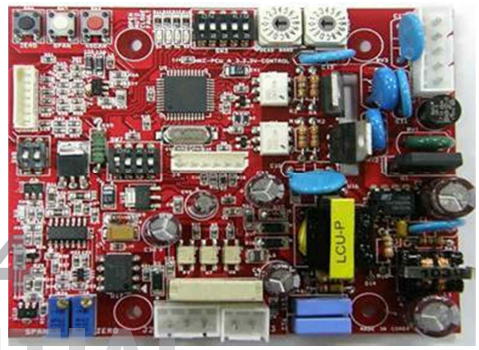
4.5.2. Calibration of Zero and Span - CPT

The settings of Zero and Span have been calibrated at the factory. However, if re-calibration is required, proceed as follows:

① Use the manual override to drive the actuator to a half open position.
② Apply power (or use the manual override) to drive the actuator to its fully closed position (clockwise rotation).
③ When the actuator is in the fully closed position, adjust the ZERO dial on the CPT board until a reading of 4mA is achieved.
④ Apply power (or use the manual override) to drive the actuator to its fully open position (counter-clockwise rotation).
⑤ When the actuator is in the fully open position, adjust the SPAN dial on the CPT board until a reading of 20mA is achieved.



4.6. Proportional Control Unit (PCU-A)



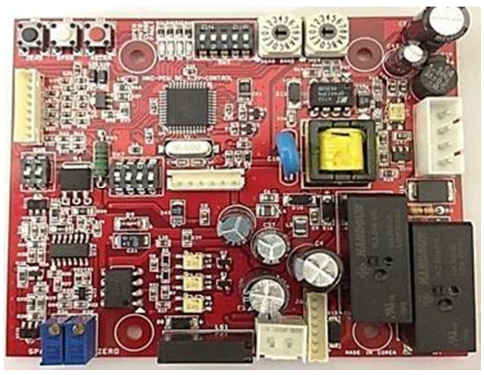
PCU-Rev-4 High Performance Controller, using 10 bit A/D converter and 8bit microprocessor technology

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PCU-Rev-4 Features	
Model	PCU-Rev-4
Power	**85 ~ 260 V ac Free Voltage ± 10%, 50/60Hz 4 VA Max**
Input Signal	4~20mA dc, 1~5V dc, 2~10V dc, 0~5V dc, 0~10V dc
Input Impedance	250Ω
Output Signal	4~20mA dc, 1~5V dc, 2~10V dc, 0~5V dc, 0~10V dc
Output Impedance	750Ω Max
Output Contact	1 (Fault monitor)
Delay Time Adjustment	0.05~7.5 seconds
Deadband Adjustment	0.12mA dc Max
Resolution Adjustment	0.0625~1mA (0.0625mA + step no. x 0.0625mA, 15 steps total)
Ambient Temperature	-10 ℃ to +60 ℃
Ambient Humidity	90% RH Max (non-condensation)

NOTE : The factory settings of the PCU card are normally set according to the customer requirements at the time of order. However, we strongly recommend that input power, signal input selection and dip switches are to be verified prior to the actuator start up.

4.7. Proportional Control Unit (PCU-D)



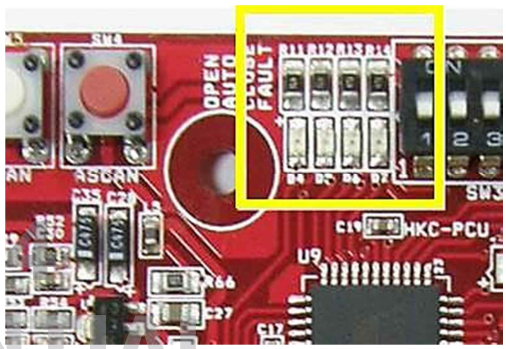
PCU-Rev-D1 High Performance Controller, using 10 bit A/D converter and 8bit microprocessor technology

PCU-Rev-D1 Features	
Model	PCU-Rev-D1
Power	24V dc Voltage ± 15% (36V dc Max)
Input Signal	4~20mA dc, 1~5V dc, 2~10V dc, 0~5V dc, 0~10V dc
Input Impedance	250Ω
Output Signal	4~20mA dc, 1~5V dc, 2~10V dc, 0~5V dc, 0~10V dc
Output Impedance	750Ω Max
Output Contact	1 (Fault monitor)
Delay Time Adjustment	0.05 ~ 7.5 seconds
Deadband Adjustment	0.12mA dc Max
Resolution Adjustment	0.0625~1mA (0.0625mA + step no. x 0.0625mA, 15 steps total)
Ambient Temperature	-25 ℃ to +60 ℃
Ambient Humidity	90% RH Max (non-condensation)

NOTE : The factory settings of the PCU card are normally set according to the customer requirements at the time of order. However, we strongly recommend that input power, signal input selection and dip switches are to be verified prior to the actuator start up.

4.7.1. LED Signal Indication

LED	State	Indication
Blue	On	Power on (auto)
	Flickering	Auto calibrating
Green	On	Fully closed
	Flickering	Closing
Red	On	Fully open
	Flickering	Opening
Yellow	On	Manual mode
	Flickering	Fault indication, either: - no input signal - wrong input wiring - wrong PIU setting

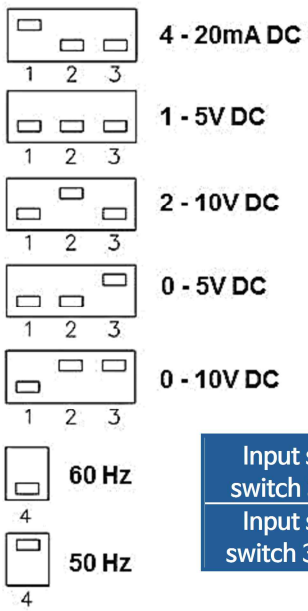


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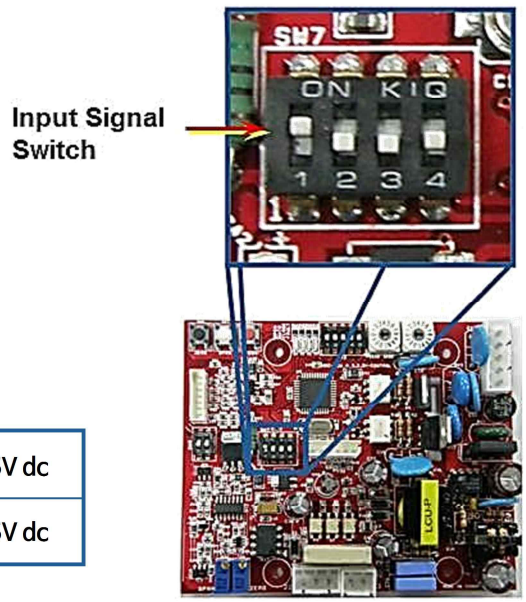
4.7.2. Setting PCU Functions

① **Selecting Input Signal**

User can select different types of input signal by adjusting the DIP switches as follows:



Input signal switch 3 "ON"	0 - 5V dc
Input signal switch 3 "OFF"	1 - 5V dc



Note:

If not specified, the factory setting of the input signal is 4 - 20mA.

② **Selecting Output Signal**

User can select different types of input signal by adjusting the DIP switches as follows:



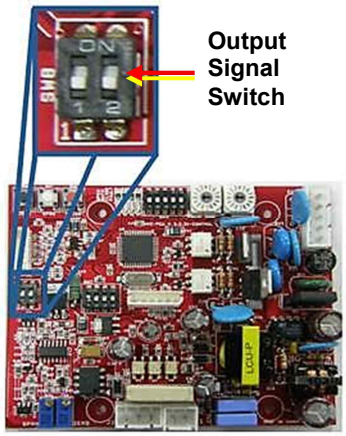
4 – 20mA dc



Input signal switch 1 "ON"	0 - 10V dc
Input signal switch 2 "OFF"	2 - 10V dc



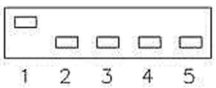
Input signal switch 1 "ON"	0 - 5V dc
Input signal switch 2 "ON"	1 - 5V dc



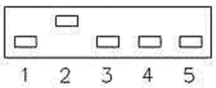
Note:
If not specified, the factory setting of the output signal is 4 - 20mA.

③ **Fail Position Setting**

User can select the fail position of the actuator in case of control signal failure by adjusting the DIP switches as follows:



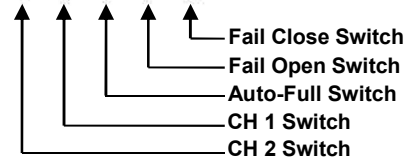
Fail Close

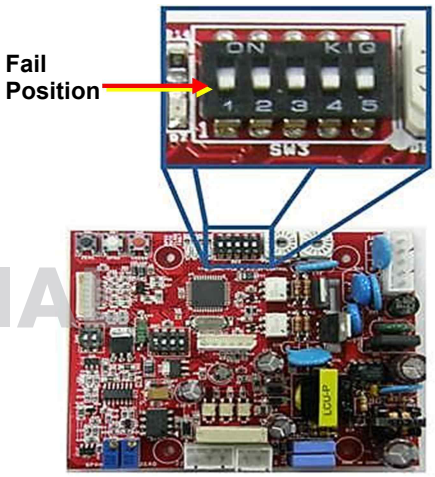


Fail Open



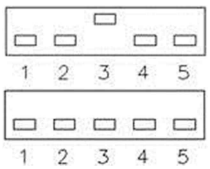
Fail Last Position





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④ **Special Signal Setting for Fully Open and Fully Closed**

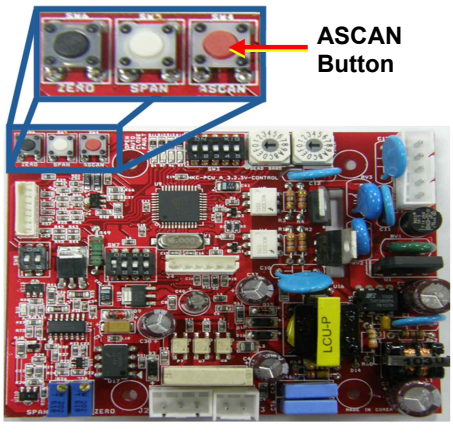


Auto-Full Switch (Switch 3) On (up)	Signal: 4.3mA	Fully Closed
	Signal: 19.7mA	Fully Open

Auto-Full Switch (Switch 3) Off (down)	Signal: 4mA	Fully Closed
	Signal: 20mA	Fully Open

⑤ **Auto Setting**

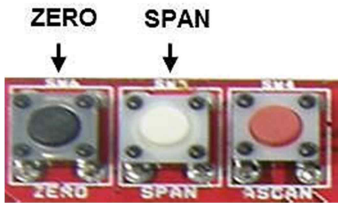
- This function is used for automatic setting of the PCU card to the predefined limits.
- While the actuator is corrected mounted on the valve, check input power, input and output signal connections. Press ASCAN button once, regardless of the position of the actuator, then the actuator will perform the Auto Setting motion:
  1) The blue LED flicker
  2) Opening (the red LED flickering) for 5 seconds
  3) Pause for 2 seconds



4) Fully closing (the green LED flickering)
5) Pause (the green LED on) for 3 seconds
6) Fully opening (the red LED flickering)
7) Pause (the red LED on) for 3 seconds
8) Moving back to the previous position

NOTE:
Since the unit is already set at the factory, no further setting is required unless the user has adjusted the mounting state of Limit Switch or the Potentiometer.

⑥ **Manual Operation**



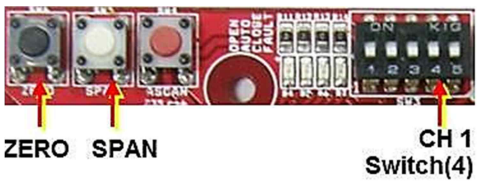
- This function allows the user to manually operate the actuator.
- To access this function, press the ZERO (black) and SPAN (white) buttons simultaneously for 2 seconds and the yellow LED will be lit to indicate that the actuator is in Manual Operation mode
- Pressing the ZERO button will move the actuator to close and pressing the SPAN button will move the actuator to open
- If no operation occurs within 5 seconds, the PCU automatically terminates the Manual Operation mode or alternatively press the ZERO and SPAN buttons simultaneously for 2 seconds. In either case, the yellow LED will be lit off to indicate the termination of the Manual Operation Mode.

Note:
During the Manual Operation mode, the input signal is ignored.

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⑦ **Customizing Set-points (CH 1 Switch)**

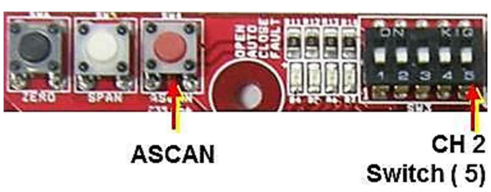
Set-points	Adjustable Range
Fully Closed	3 - 8mA DC
Fully Open	16 - 21mA DC



- This function is used when the user wants to set different set-points for fully open and fully closed positions.
- For example, if the user wants to assign 5mA as the set-point for fully closed position, first of all switch-on (move up) the CH1 switch (switch 4). Supply a 5mA signal and push the ZERO button once. Hereafter, the actuator will acknowledge 5mA signal as the set-point for fully closed position and transmits 4mA feedback signal. Similarly, for setting the set-point for the fully open position, supply the desired signal (for example, 19mA) and push the SPAN button once. Switch-off (move down) the CH1 switch to complete the setting.

⑧ **Reversal Acting (CH 2 Switch)**

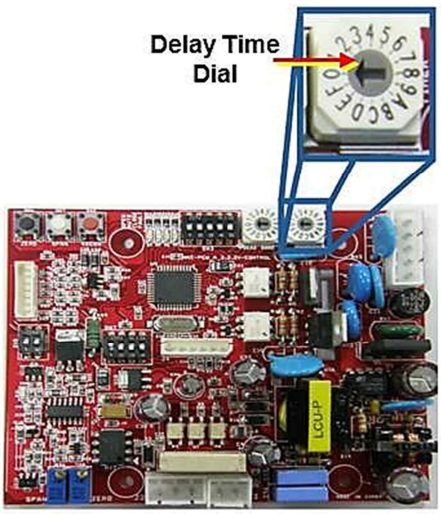
CH 2 Switch (Switch 5) On (up)	4mA DC	Fully Open
	20mA DC	Fully Closed
CH 2 Switch (Switch 5) Off (down)	4mA DC	Fully Closed
	20mA DC	Fully Open



- This function allows the user to reverse the input and output signals for the operation of the actuator.
- For standard operation (CH 2 switch down), the input signal of 4mA operates the actuator to fully close and the actuator transmits the output signal of 4mA. However, when CH 2 switch is on (move up) the input signal of 4mA operates the actuator to fully open and still transmits 4mA output signal.
- Manually move the actuator to half-open position and push ASCAN button once to execute the Auto Setting (see 4.10.2 ⑤). Supply signal and check the operation.

⑨ **Delay Time**

- The actuator starts to move if and only if the change in the input signal value is greater than the resolution set value (see 4.8.2 J) and when the signal value is maintained for the duration of the delay time.
- This prevents malfunction of the actuator caused by unwanted signals in the input signal such as noise and interferences
- Turning the Delay Time Dial in clockwise direction will increase the delay time (Range 0.05 to 7.5 seconds).



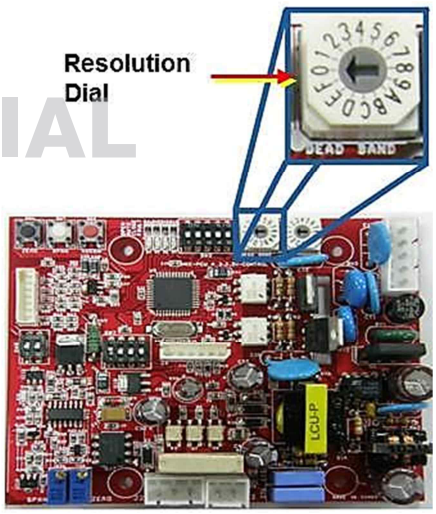
Dial	0	1	2	3	4	5	6	7
sec	0.05	0.2	0.4	0.6	0.8	2.5	3.0	3.5

Dial	8	9	A	B	C	D	E	F
sec	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5

⑩ **Resolution**

- The deadband adjusts the limits of the valve's deviation between an actual position and a target position. The deadband is set to 0.12mA DC Max.
- Resolution indicates the extent of the reaction on the input signal.
- Low resolution setting may cause the actuator to hunt or to unnecessarily respond to a fluctuating input signal.
  If so, the resolution must be increased.
- Turning the Resolution Dial in clockwise direction will increase the resolution (Range 0.0625mA to 1mA).

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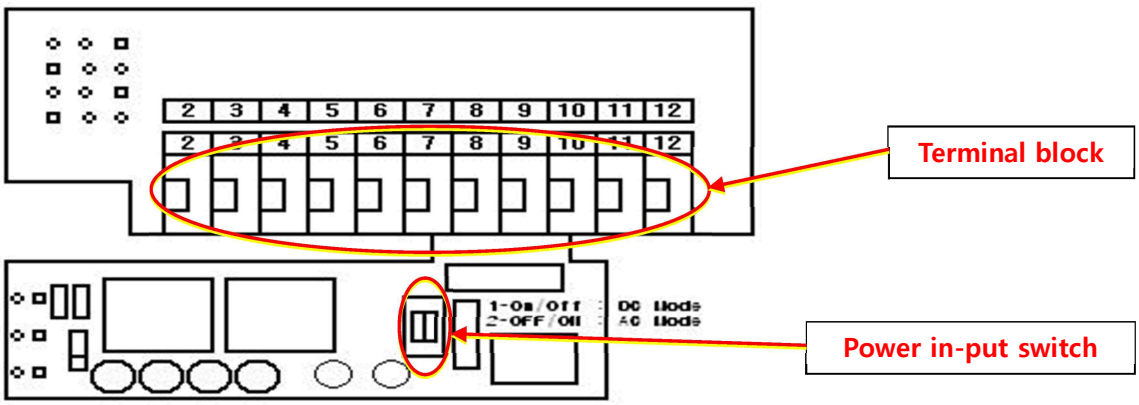
Dial	0	1	2	3
mA DC	0.0625	0.125	0.1875	0.25

Dial	4	5	6	7
mA DC	0.3125	0.375	0.4375	0.5

Dial	8	9	A	B
mA DC	0.5625	0.625	0.6875	0.75

Dial	C	D	E	F
mA DC	0.8125	0.875	0.9375	1

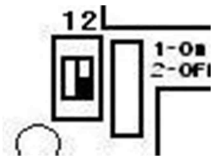
4.8. AC/DC Multi-Board



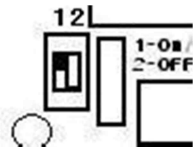
4.8.1. Terminal block

2	Close Lamp
3	None
4	Open Lamp
5	None
6	Lamp Com
7	Power 24V ac/dc (dc + input terminal)
8	Close signal
9	Open signal
10	None
11	None
12	Power 24V ac/dc (dc - input terminal)

4.8.2. Power in-put switch



As using for ac Mode, #1 switch turn on "ON" and #2 switch turn off "OFF"



As using for dc Mode, #1 switch turn off and #2 swithc turn on

NOTE: Don't turn on both switch #1 and #2 at the same time that become a reason of damage of the board

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5. Operation

5.1. Electrical Connections and Preliminary Test

WARNING:

- *When working in potentially explosive atmospheres, observe the European Standards EN 60079-14 "Electrical Installation in Hazardous Areas" and EN 60079-17 "Inspection and Maintenance of Electrical Installations in Hazardous Areas". Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.*
- *For cable entries that are not used, user or installer shall close by Ex d IIB or Ex d IIC certified blanking element, Ex d type of protection of the enclosure is maintained during operation.*
- *Flameproof enclosure! Treat cover with care. Gap surfaces must not be damaged in any way. Do not jam cover during fitting.*

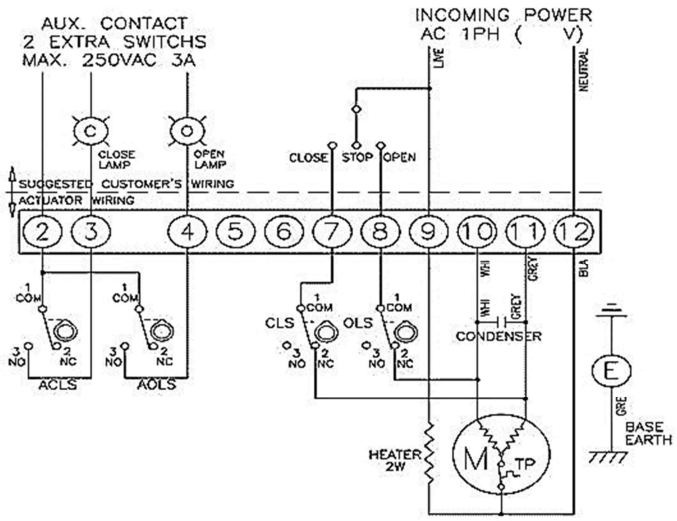
5.1.1. For testing purposes, loosen the bolts on the actuator cover and remove the cover.
5.1.2. Make sure that the power supply voltage is in accordance with the data on the nameplate of the actuator.
5.1.3. Connect wires according to the enclosed wiring diagram (see Chapter 2)
5.1.4. Manually move the valve to half-open position. Then electrically operate the actuator to fully open position and check if the motor rotates in correct direction; standards units are counter-clockwise to open.
5.1.5. Test the actuator and check whether the limit switches work correctly
5.1.6. After the testing, check that all cable glands are correctly tightened. Applicable cable glands should be selected to meet the application's condition. It is recommended to use the grade of IP67 cable gland or higher in potentially explosive sites.
5.1.7. Put the back the cover and tighten the bolts.

DANGER:

HAZARDOUS VOLTAGE. No electrical power should be connected until all wiring and limit switch adjustments have been completed. Once the power is supplied to the unit, exercise caution when the cover is not installed.

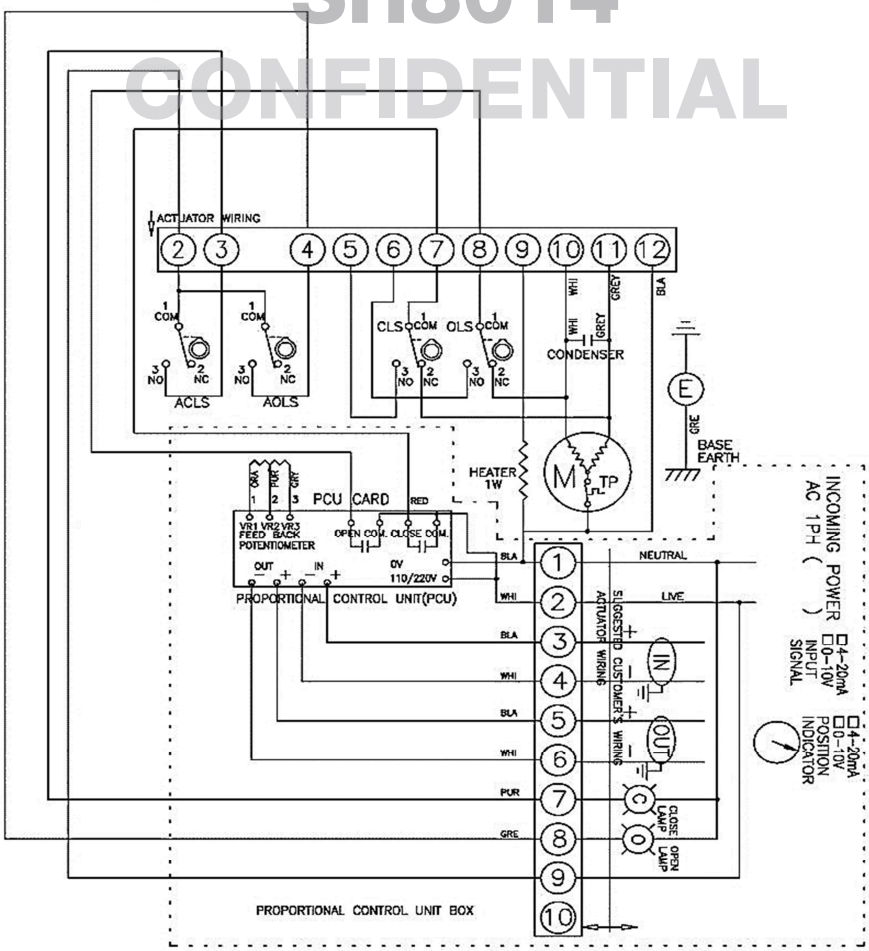
5.2. Wiring Diagrams for Standard Models

5.2.1. HQ-006 On/Off type



5.2.2. HQ-006 PCU type

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6. Maintenance

6.1. Maintenance



CAUTION:

- ✓ *Turn off all power before attempting to perform maintenance on the actuator.*
- ✓ *POTENTIALLY HIGH PRESSURE VESSEL. Before removing or disassembling your actuator, ensure that the valve or other actuated device is isolated and not under pressure.*

Under the normal conditions, maintenance should be carried out at six month intervals. But when the conditions are more severe, more frequent inspections may be advisable.

6.1.1. Ensure that the actuator is properly aligned with the valve or other actuated device
6.1.2. Ensure that all wirings are insulated, connected and terminated properly
6.1.3. Ensure that all screws are present and tight
6.1.4. Ensure cleanness of internal electrical devices
6.1.5. Ensure that conduit connections are properly installed and are dry
6.1.6. Check the internal devices for any condensation
6.1.7. Check the power to the internal heater
6.1.8. Check the enclosure of O-ring seals and verify that the O-rings are not pinched between flange
6.1.9. Verify the declutch mechanism
6.1.10. Visually inspect the open/close cycle
6.1.11. Inspect the identification labels for wear and replace it if necessary



WARNING:

Treat cover with care. Gap surfaces must not be damaged or dirtied in any way. Do not jam the cover during fitting.

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6.2. Tools

6.2.1. Metric Allen Key (Hex Wrench) × 1
6.2.2. Screw Driver × 1
6.2.3. Metric Spanner × 1
6.2.4. Wrench 200mm × 1
6.2.5. Wrench 300mm × 1
6.2.6. Wire Stripper Long Nose × 1
6.2.7. Multi-meter (AC, Dc, Resistance) × 1
6.2.8. PCU Board Option: DC Signal Generator (4 - 20mA DC) × 1
6.2.9. PCU & CTU Board Option: 1mA Ammeter (0 - 25mA)

7. Trouble Shooting

The following instructions are listed in the order of the most common difficulties encountered during the installation and start-up.

Symptom	Probable Cause	Corrective Action
Motor will not run	Open in control circuit	Refer to appropriate wiring diagram and check for continuity
	Insulation resistance breakdown in motor	Perform megger Test
No power available to actuator	Tripped circuit breaker	Reset circuit breaker
Manual Override Nut hard to turn	Valve stem improperly lubricated	Lubricate with grease
	Actuator lubrication has broken down	Clean out old grease and replace with recommended lubricant
	Valve packing gland too tight	Loosen packing gland nuts as necessary
	Jammed valve	Refer to valve maintenance

Symptom	Probable Cause	Corrective Action
Valve only opens or closes partially with motor	Limit switch improperly set	Check setting and reset if necessary
Manual Override Nut will not operate valve	Stripped gearing	Replace as necessary
	Broken hand wheel shaft	Replace as necessary
	Broken valve stem	Repair or replace as necessary
Motor runs but will not operate valve	Stripped gearing	Replace as necessary

7.1. The actuator does not respond

7.1.1. Visually inspect the actuator to check no shipping or handling damage has occurred
7.1.2. Verify the line voltage supplied to the actuator; check that the line voltage matches with the rating on the actuator's nameplate
7.1.3. Check the internal wiring against the supplied wiring diagram of the actuator
7.1.4. Check the limit switch cams

7.2. The actuator is supplied with power but does not operate

7.2.1. Verify the line voltage supplied to the actuator; check that the line voltage matches with the rating on the actuator's nameplate.
7.2.2. Check that the actuator torque is greater than the valve torque
7.2.3. Check the limit switch cams
7.2.4. Check that the torque switches have not been tripped
7.2.5. Check the mechanical travel stop adjustment
7.2.6. Verify that the actuator against the rotation of the valve (standard units are counter-clockwise rotation to open)
7.2.7. Check for any corrosion and condensation that any of the electrical or mechanical devices have not been contaminated
7.2.8. Verify that coupler/bracket is correctly installed and is not causing any binding

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7.3. Actuator runs erratically

7.3.1. Check the ambient temperature
7.3.2. Verify that the duty cycle has not been exceeded
7.3.3. Check the position of manual override lever

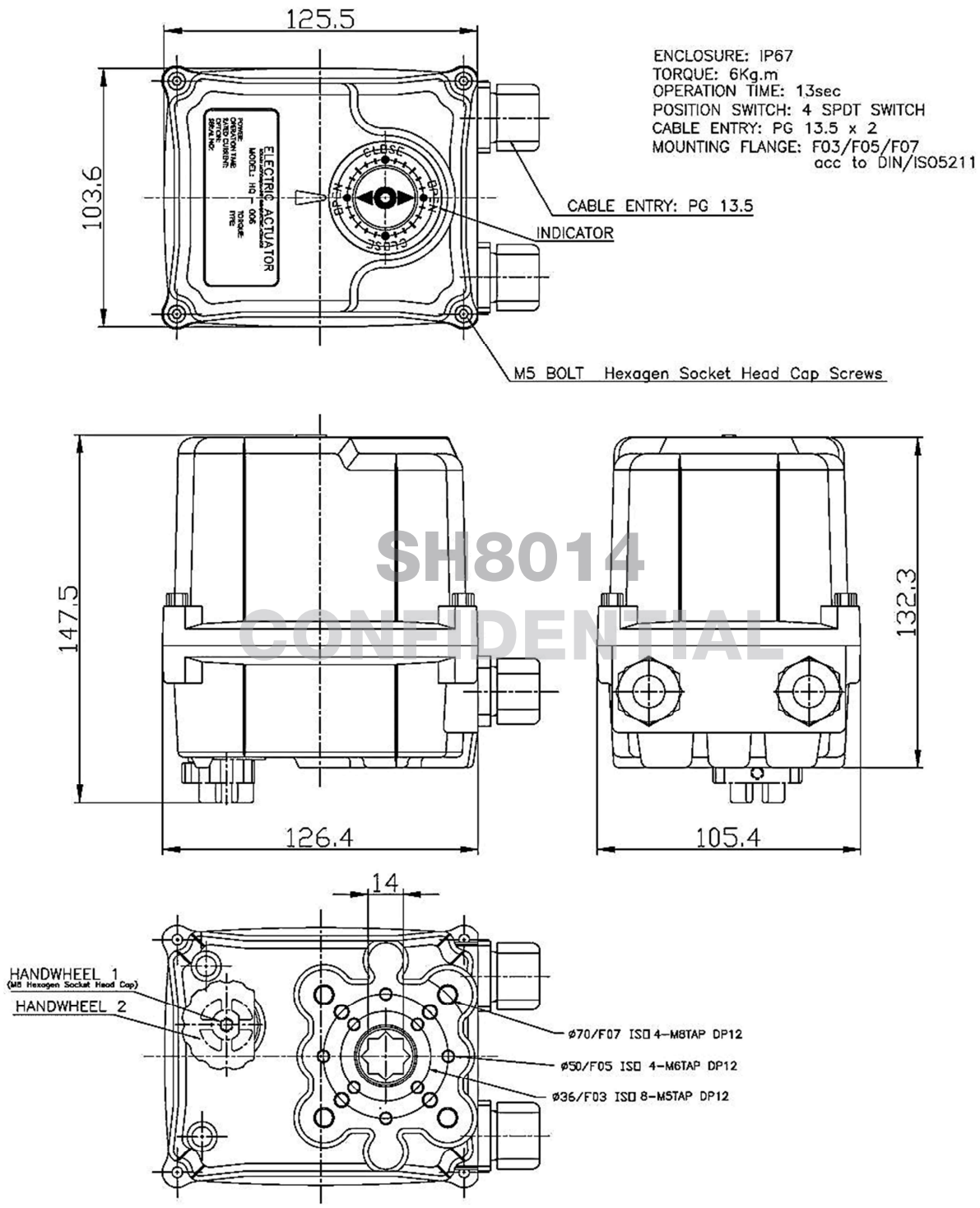
7.4. Optional Equipment(s)

7.4.1. **Potentiometer Current Position Transmitter**
- Check the resistance value
- Check potentiometer gear for jamming
- Check ZERO and SPAN calibration
- Check the board for any damage

7.4.2. **Current Position Transmitter**
- Verify the input signal
- Check the configuration of the dip switches
- Check the board for any damage

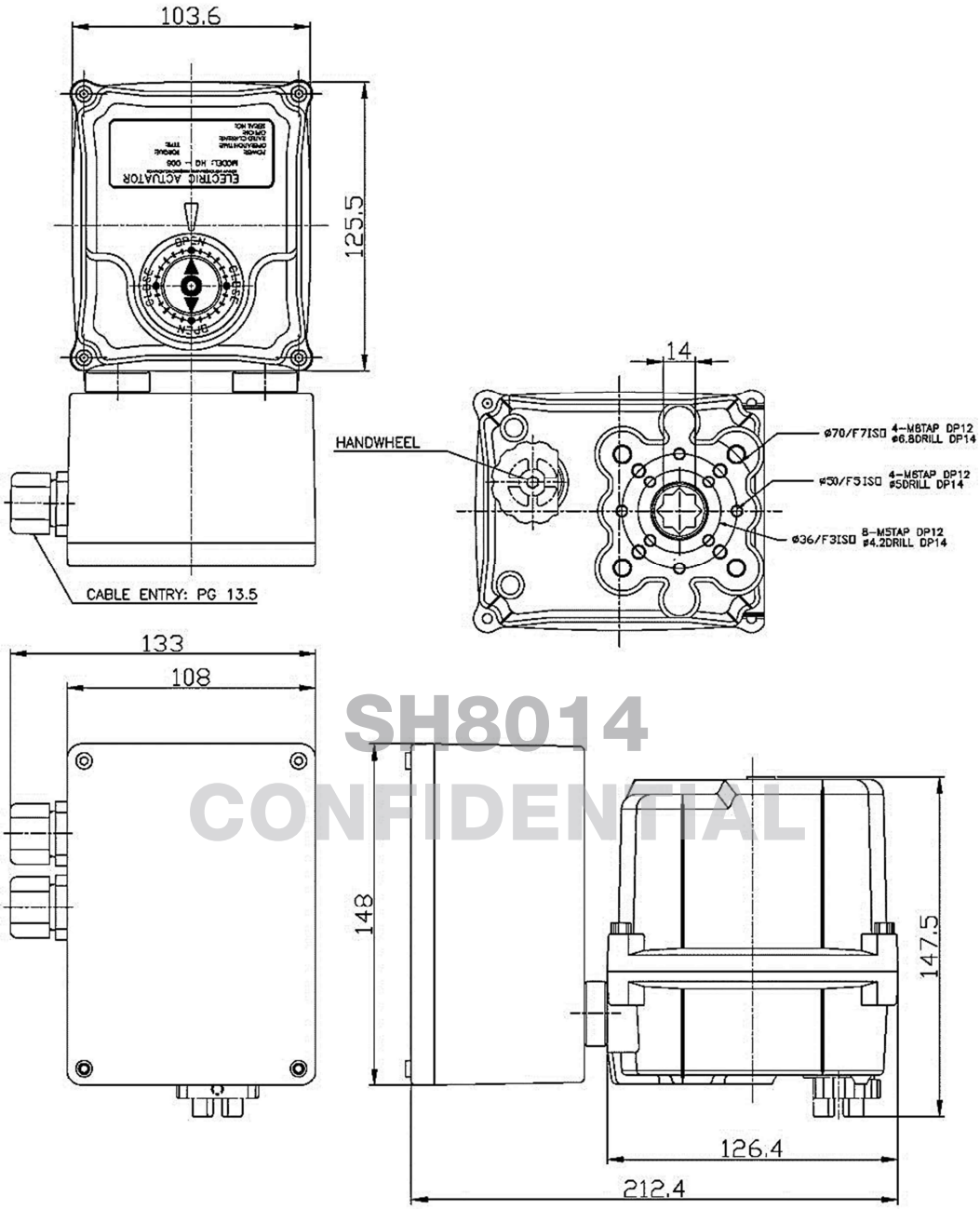
8. Dimensions

8.1. HQ-006 On/Off Type



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8.2. HQ-006 PCU Type



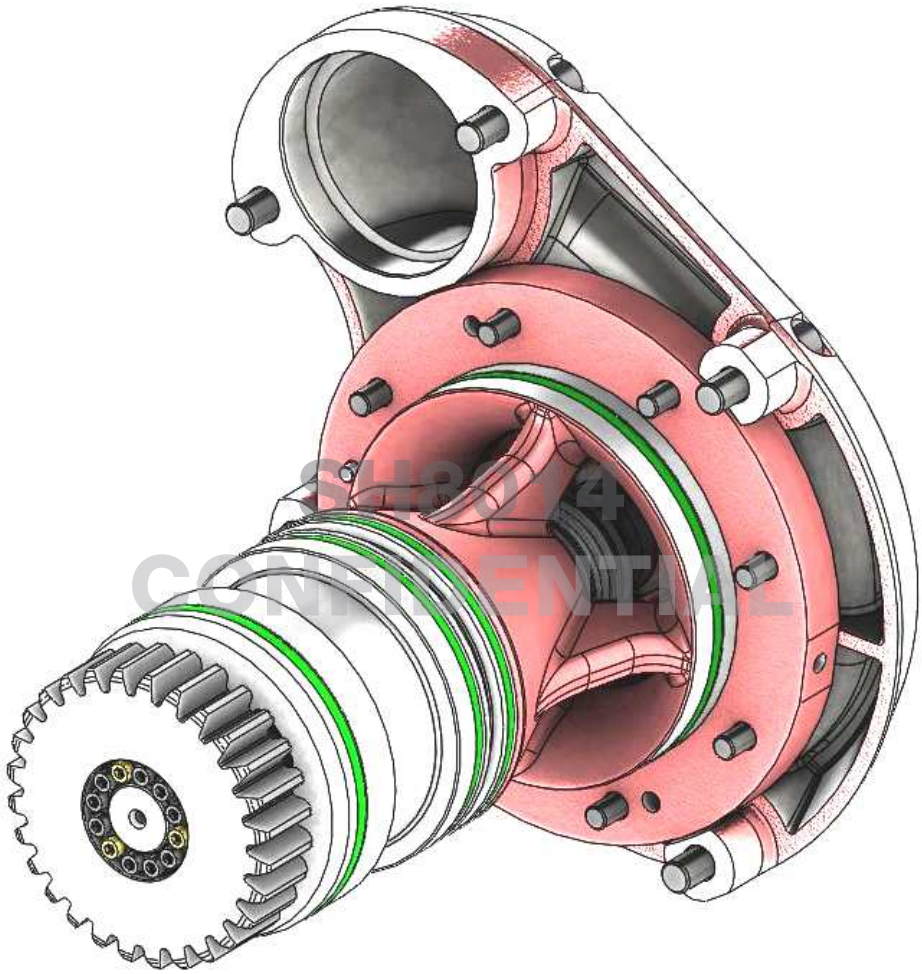
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Note:
For more detail information regarding this product, please contact the ***manufacturer or your supplier.***

HKC Co., Ltd.
Sales Office Tel: +82 2 2138 8266, Fax: +82 2 2138 8269
Head Office & Plant Tel: +82 31 488 8266, Fax: +82 31 488 8269
Address (Seonggok-dong) 155, Byeolmang-ro, Danwon-gu, Ansan-si, Gyeonggi-do,15417 South Korea
Website www.hkcon.co.kr

Operating Manual & Maintenance Procedure

- H21/32 & H25/33 Cooling Water Pump



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주식회사 제일정공

uz022@unitel.co.kr

Operating manual JI-OP-CWP-007

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1. 구조 *(Structure)*

(1) 이 펌프는 펌프하우징, 펌프커버, 샤프트, 임펠러 등으로 이루어져 있다.

(2) 이 펌프는 임펠러가 회전하는 원심력을 이용해서 물을 바깥 둘레로 뿜어내서 펌프 작용을 하게 된다.

(3) 임펠러는 펌프커버 내부에 있으며, 임펠러 깃의 원심력을 통해 유체의 압력 및 운동에너지를 공급한다.

(4) 펌프커버는 임펠러를 통과한 유체의 에너지 손실을 최소화 할 수 있도록 물을 안내 해주는 역할을 한다.

(5) 임펠러 바깥지름 주위에 고정된 안내날개가 없는 구조의 벌류트가 형성되어있는 구조로서, 벌류트 펌프의 한 종류이다.

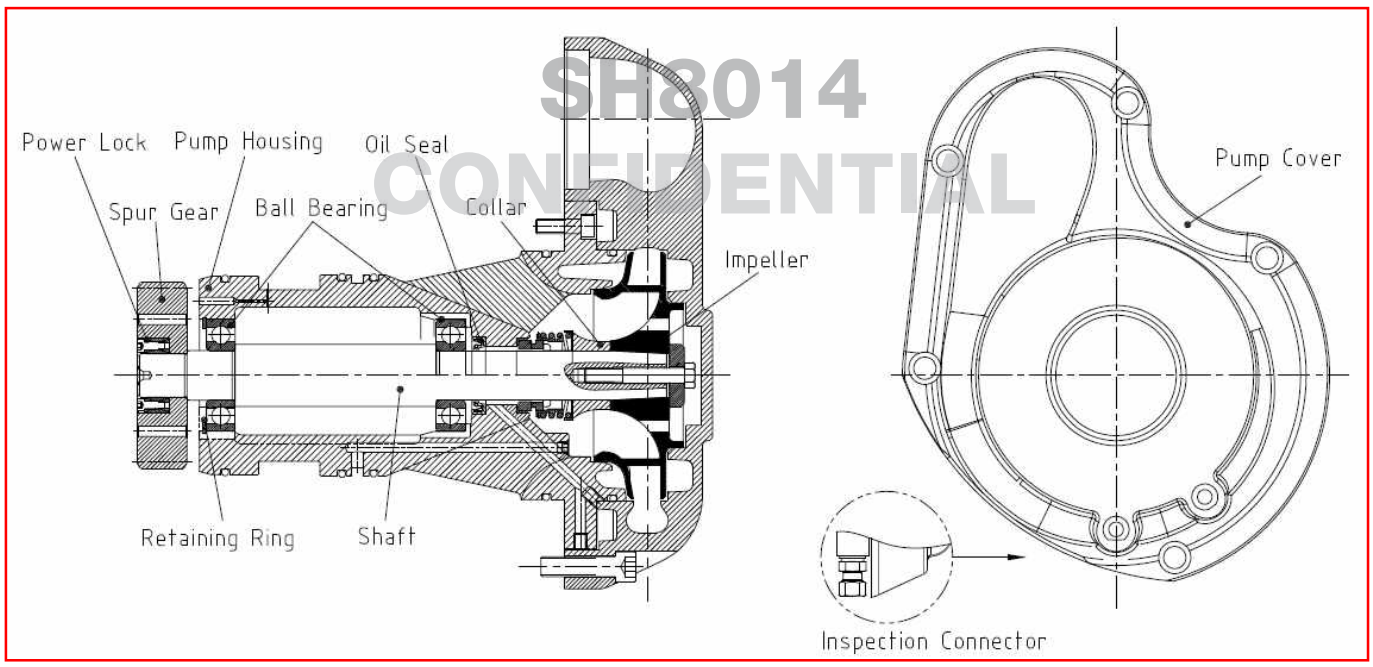
(1) This pump is consist by Pump Housing, Pump Cover, Shaft, Impeller, etc.

(2) This pump is working by pumping the water to the outer side using the centrifugal force by rotation of Impeller.

(3) Impeller is located on inner Pump Cover and supply a pressure and kinetic energy of the fluid through the centrifugal force of the Impeller vanes.

(4) Pump Cover serves to guide the water to minimize the energy loss of the fluid passing through the Impeller.

(5) Impeller is a structure which has a volute without fixed guide vane around the outer diameter, the type of the volute pump.



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Fig. 1 Cooling Waterl Pump Design Details

2. 운반 *(Transport)*

; 운반 시 다음과 같이 취급하여야 한다.

(1) 펌프를 들어올릴 시 아이볼트를 이용해 케이싱이 부착 될 홀에 장착시킨 후 로프를 사용하여 운반하고, 안전에 유의한다.
(2) 펌프 외부에 충돌이 없도록 한다.

; It shall be handling as follows during transport.

(1) When lift up the Pump, attach the Eye-Bolt to the Hole for attach the Casing, and then using a rope for transport and pay attention to safety.
(2) Avoid conflicts outside of the Pump.

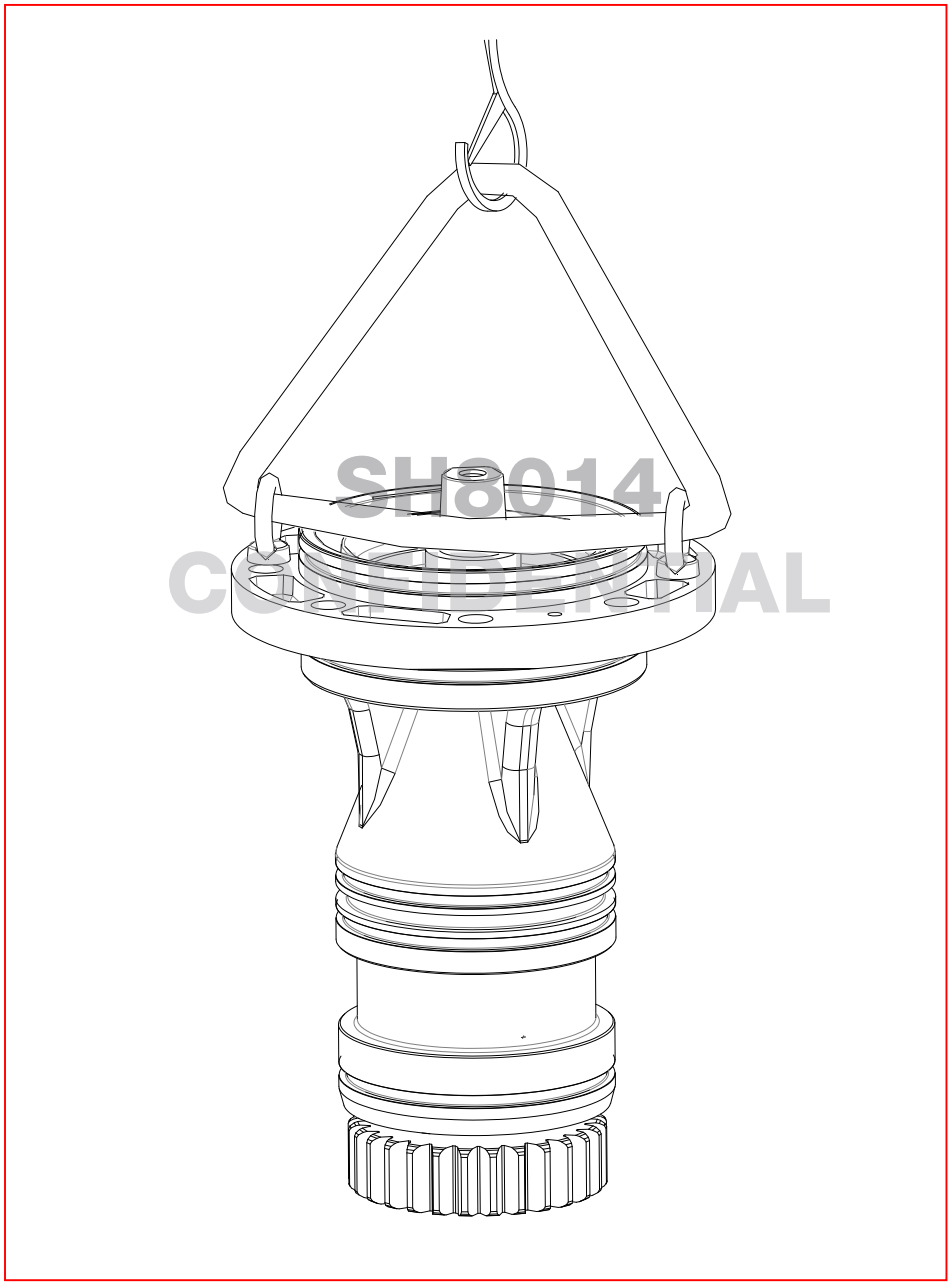

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Fig. 2 Lifting Pump

3. 펌프의 설치 *(Installation of the Pump)*

; 펌프는 가능하면 오일탱크에서 가까운 곳에 설치하되 흡입수두는 될 수 있는 한 적게, 흡입 파이프는 짧게 배관해야 한다. 아울러 흡입관의 굽힘부와 기타 연결부도 가능하면 적게 하여야 한다.

(1) 흡입 쪽에 스트레이너를 설치하여 펌프를 보호하여야 한다.
(2) 흡입관에서 공기가 흡입되지 않도록 해야 한다.
(3) 흡입과 토출 쪽의 방향은 바르게 조립되어야 한다.

(4) 설치 전 각 유로는 깨끗해야 한다.

; Install the Pump as near the oil tank as possible, but the suction head is as less as possible, the intake pipe should be short. In addition, the bend of the suction and other connections should be less.

(1) Install the strainer in the inlet side for protect the Pump.
(2) Air should not sucked in the suction pipe.
(3) Direction of the inlet side and outlet side should be assembled correctly.
(4) Each oil passageway should be clean before installation.

4. 작동 *(Operation)*

; 설치, 재 조립 후의 작동은 다음과 같이 실행한다.

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4.1 작동 전

(1) 볼트와 너트의 결합이 풀리지 않았는지 점검한다.

(2) 펌프커버 토출방향으로 펌프가 회전하는지 점검한다.
(3) 흡입 스트레이너가 막히지는 않았는가 확인하고 필요시 필터 청소를 한다.

4.2 작동

(1) 엔진을 시동시킨 후 회전방향, 진동, 소음, 전류계 등에 이상이 없는지 확인한다.
(2) 펌프 축과 베어링 접촉면 등은 오일에 의해 윤활 되어야 하며 절대로 윤활 되지 않은 건조상태로 작동되어서는 안 된다.
(3) 펌프케이싱에 액체가 가득 찰 때까지 펌프를 작동하면 안 된다.
액체는 메카니컬 씰 윤활제 역할을 한다.
메카니컬 씰을 보호하기 위해 펌프는 건조된 상태에서 작동되지 않도록 해야 한다. 그렇지 않으면, 메카니컬 씰은 심각한 손상이 유발된다.

; Operation after installation and re-assembly is carried out as follows.

4.1 Before operation

(1) Check whether the combination of nuts and bolts has not loosened.
(2) Check the direction of the outlet side.
(3) Check whether inlet strainer was clogged and clean the filter if necessary.

4.2 Operation

(1) After start the engine, check the spin rotation, vibration, noise and an AC ammeter etc.
(2) The Pump shaft and bearing contact surfaces are to be lubricated by the oil and do not run dry.

(3) A centrifugal pump will not function until the pump casing has been filled with liquid.
The liquid also serves as coolant for the Mechanical seal. For protect the Mechanical seal the pump do not run dry. Otherwise, Mechanical seal will be seriously damaged.

5. 정비 *(Maintenance)*

5.1 작동중의 주의

(1) 설계 조건의 한계 범위 내에서 조심스럽게 작동한다. (급격한 동작 또는 정지는 펌프, 샤프트, 임펠러의 파손 및 진공계의 고장을 일으키므로 이러한 가동은 삼가야한다.)
(2) 진동, 소음 압력게이지와 전류계를 점검한다. 만약 이상한 상태가 발생하면, 곧바로 펌프를 세운다.

(3) 펌프 최대 압력 설정이 초과되지 않도록 한다. 이는 펌프 뿐만 아니라, 엔진에도 심각한 손상이 발생 될 수 있다.
(4) 자동시동 및 정지기능이 있을 경우 작동간격 및 시동 및 정지시의 압력을 점검해야 한다.

(5) 스트레이너의 청결 상태를 확인한다.

5.1 Caution during operation

(1) It operates carefully within the limits of the design condition. (Notice: Sudden operating or stop can cause damage or breakage to the Pump, Shaft, Impeller and the vacuum system.)
(2) Check the vibration, noise, pressure gauge and ammeter. If the abnormal state is generated, stop the engine immediately.
(3) Keep within its max pressure setpoint. If the setpoint is over the range, it is damaged pump including whole engine.
(4) If there are automatic start and stop function, should check the operating interval and pressure of start & stop.
(5) Check the cleanliness of the strainer.

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5.2 정지 시 주의

(1) 펌프 정지시 송출밸브를 닫고, 흡입밸브를 닫는다.

(2) 펌프를 오랜 기간 동안 작동하지 않은 경우, 엔진 운전을 통한 주기적인 회전을 시켜야 한다.

5.2 정지 시 주의

(1) When the pump stop, close the Outlet valve and then close the inlet valve.
(2) If the pump does not work for a long time, it needs a periodic rotating by operate an engine.

6. 검사 *(Inspection)*

6.1 주기적 검사

; 이상 상태의 경우를 제외하고 다음의 방법에 의해 주기적 검사를 실시하며, 조건과 일치하는 검사계획을 운전자가 세우는 것이 바람직하다.

6.1 Periodic Inspection

; Test periodic as below. Except, for the abnormality condition, It is desired that make inspection plan which is match with condition by operator

Check list	Description	Check period	Remarks
Inlet and outlet	Abnormalities of pressure gauge readings.	At Regular Intervals	Inspection Records
Noise	Noise status of inside of the pump and bearing.		
Lubricating oil	Pollution status		
Leaks	Appearance checking for leakage check.		
Mechanical Seal	Check the Leakage - See page 2. **NOTE** : A very small amount of leakage (15 Drops/10min) is normal, even when Mechanical Seal are new.		

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6.2 검사 및 참조

; 미끄럼 부위를 측정하고 마모 한계에 준한다.

(1) 분해부품을 세척하여 먼지 및 오물을 제거한다.

(2) 필요 시 회전부위는 완전히 잠금 장치를 채운다.
(3) 각 조립부는 마킹 표시에 일치되게 조립한다.

(4) 구동기어의 치면에 깨끗한 윤활유로 충분히 주유한다.
(5) 체결볼트 등이 확실히 고정되어 있는지 확인한다.
(6) 조립 후 손으로 축을 회전시킬 때 부드럽게 돌아가는지 점검한다.

6.2 Inspection and reference

; Measure the sliding parts and follow the wear limit.

(1) Remove dust and dirt by washing the decomposed parts.
(2) Lock the rotating part if necessary.
(3) Each assembly part is assembled to match the Marking displayed.
(4) Apply clean lubricating oil to the gear teeth.
(5) Make sure that the fastening bolts are securely fixed.
(6) Check it spins smoothly when rotating shaft by hand after assembly.

Items	Measure	Check cycle
Shaft	Check the scratch of the sliding surface, and check the flexure of combined state of the shaft.	When Overhaul
O-ring	Replace all O-rings new ones. (Be careful not to damage the sealing surface.)	When Overhaul
Assembly bolt	Check whether the assembly bolt relaxation.	When Overhaul
Mechanical Seal	Replace in case of cured, crack, wear and damage. Replace all packing new ones.	When Overhaul
Impeller	Replace in case of wear and damage.	When Overhaul
Bearings	Replace in case of wear and noise.	When Overhaul

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7. 주의사항 *(Notes)*

(1) 보수를 하기 전 꼭 엔진을 차단한다.
(2) 펌핑 용액이 무엇인지 확인하고 비상시 행동을 숙지한 후 작업을 한다.
(3) 작업시 보호장치와 안전운전을 확인한다.

(4) 이러한 장비에 능숙한 사람이 보수한다.
(5) 취급 설명서를 숙지한 후 작업한다.
(6) 오링, 조인트, 등을 교체할 때 충분한 공간이 확보되었는지 확인한다.

(1) Shut off the engine before repair.
(2) Check the pumped solution and understand emergency action before working.
(3) Check the protection device and safe operation when working.
(4) The skilled person will repair the equipment.
(5) Before the work, read the manual.
(6) When exchange o-ring and joint, make sure of enough space.

8. 고장과 대책 *(Malfunctions and Remedy)*

8.1 펌프 고장

; 만약 다음 표에 지정되지 않은 또는 특정 원인을 추적 할 수 없는 오작동이 발생할 경우 제조업체에 문의한다.

8.1 Pump Malfunctions

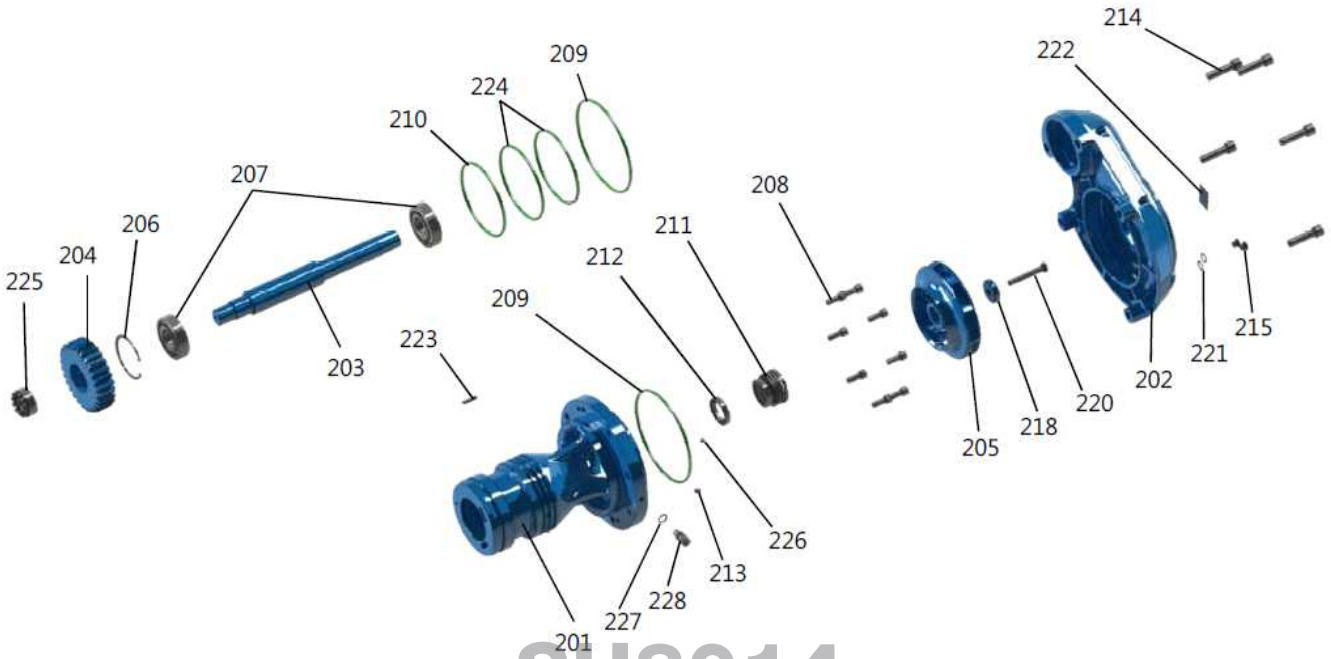
; If malfunctions occur that are not specified in following table or cannot be traced to specified causes, please consult manufacturer.

Malfunction	Cause	Action
Inability to full capacity of the pump	When the air was come in from Inlet process.	Check the inlet passageway.
Inability to start	When starting conditions are not suitable.	Check the start-up situation like engines.
The water isn't running	No enough fluid on pump suction passageway.	Back to full capacity Check the air in the suction passageway and remove the cause.
	Inlet valve and outlet valve was closed.	Inspect and open it fully.
	When strainer and suction side was clogged.	Cleaning after disassembly.
	The debris on the impeller.	Remove the debris after disassembly.
	The rotating direction is reversed.	Check the driving direction like engine.
Bad flow	When the air was come in.	Investigate whether air was come in.
	Lack of the flooding depth due to lowered water level.	Secure the enough flooding depth.
	Debris on the impeller.	Remove the debris after disassembly.
Water come out in the first time, but it stopped immediately	No enough water in inlet passageway.	Back to full capacity.
	When the air was come in.	Removing the cause after investigate inlet passageway.
	When the air remains in the inlet passageway.	Repair the inlet line.
Overload	When the rotation speed is too high.	Adjust the rotation speed to specified value.
	Operating except specified flow and pressure.	Follow the specified value.
	When the rotating body is contact with the Bearing housing.	Removing the cause.
	Debris is mixing.	Clean the absorption tank and make a plan to prevent of debris inflow.
Bearing fever	When fuel is not enough.	Check the supply line so that the appropriate amount of filling.
	Lubricating oil is non-regulatory product.	Exchange the oil.
	When the deviated shaft center.	Adjusting the shaft center in a normal.
The vibration of the Pump	When a part of the Impeller was blocked.	Remove the debris after disassembly.
	When Impeller is broken.	Exchange the impeller after disassembly.
	Too low outlet flow rate.	Operating in the vicinity of regular flow.
	The shaft center of the pump and motor was deviated.	Adjusting the shaft center in a normal.
	Bearing was broken.	Inspection, repair or exchange.

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9. 분해도 *(Exploded View)*

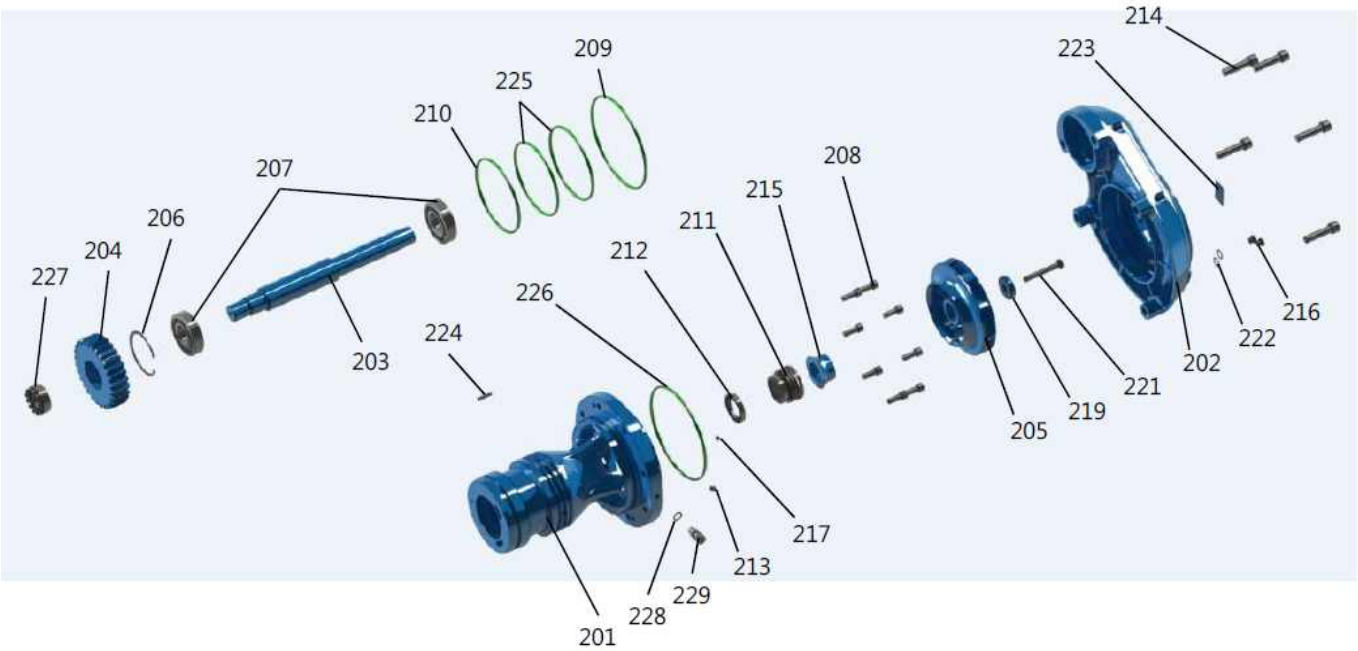
9.1 PUMP TYPE – H21/32



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NO	DESCRIPTION	Q'TY	NO	DESCRIPTION	Q'TY
201	PUMP HOUSING	1EA	215	PLUG(PF1/4)	2EA
202	PUMP COVER	1EA	216	PLUG(PT1/8)	1EA
203	SHAFT	1EA	BLANK		
204	SPUR GEAR	1EA	218	WASHER	1EA
205	IMPELLER	1EA	BLANK		
206	RETAINING RING	1EA	220	BOLT(M12X80)	1EA
207	BALL BEARING	2EA	221	PACKING(PF1/4)	2EA
208	SOCKET BOLT(M12X30)	8EA	222	NAME PLATE	1EA
209	O-RING(G190)	2EA	223	SPRING PIN(Ø8X32)	1EA
210	O-RING(G150)	1EA	224	O-RING(G152)	2EA
211	MECHANICAL SEAL	1EA	225	POWER LOCK	1EA
212	OIL SEAL(S40)	1EA	BLANK		
213	SET SCREW(M10X8)	1EA	227	PACKING	1EA
214	SOCKET BOLT(M16X60)	5EA	228	CONNECTOR	1EA

9.2 PUMP TYPE – H25/33



NO	DESCRIPTION	Q'TY
201	PUMP HOUSING	1EA
202	PUMP COVER	1EA
203	SHAFT	1EA
204	SPUR GEAR	1EA
205	IMPELLER	1EA
206	RETAINING RING	1EA
207	BALL BEARING	2EA
208	SOCKET BOLT(M12X30)	8EA
209	O-RING(G190)	1EA
210	O-RING(G150)	1EA
211	MECHANICAL SEAL	1EA
212	OIL SEAL(S40)	1EA
213	SET SCREW(M10X8)	1EA
214	SOCKET BOLT(M16X60)	5EA
215	COLLAR	1EA

NO	DESCRIPTION	Q'TY
216	PLUG(PF1/4)	2EA
217	PLUG(PT1/8)	1EA
BLANK		
219	WASHER	1EA
BLANK		
221	BOLT(M12X80)	1EA
222	PACKING(PF1/4)	2EA
223	NAME PLATE	1EA
224	SPRING PIN(Ø8X32)	1EA
225	O-RING(G152)	2EA
226	O-RING(G192)	1EA
227	POWER LOCK	1EA
228	PACKING	1EA
229	CONNECTOR	1EA
BLANK		

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10. 정비점검 절차 *(Maintenance Procedure)*

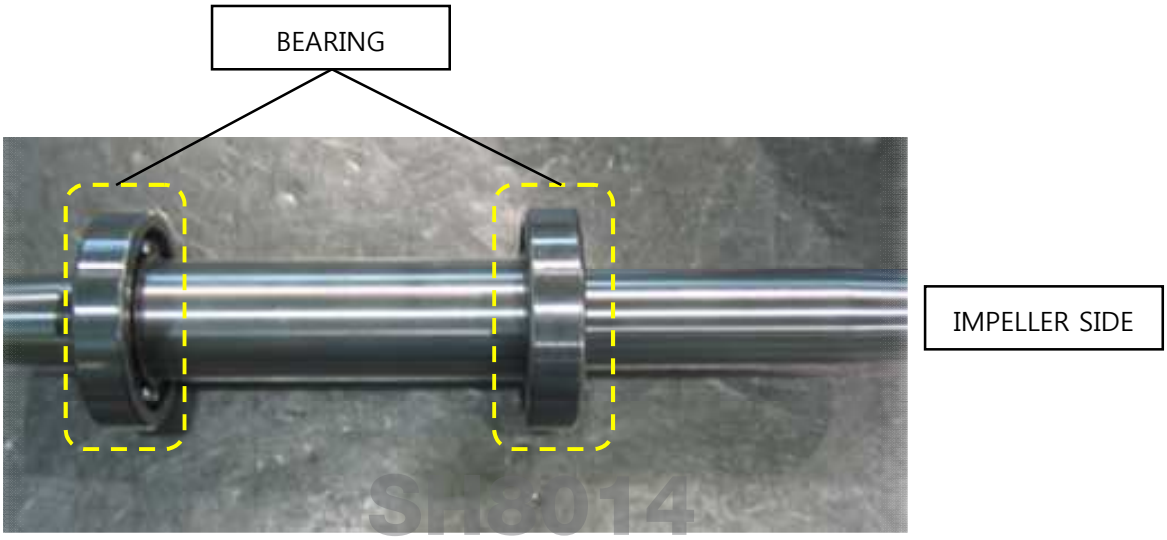
청수펌프의 조립(※분해는 조립의 역순)

1. 베어링 내측에 그리스 도포 후 직각도를 고려하여 프레스에서 베어P링을 조립한다.

Cooling water Pump assembly (※Disassemble it in reverse order)

1. After spraying the grease on the inner Bearing, assemble the Bearing on the Press machine with considering squareness.

.



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Fig. 3 Bearings mounted on shaft

2. 플러그에 록타이트 620을 도포 후 아래 그림 과 같이 2곳에 플러깅 하고, 스프링 핀 조립 한다.

2. After applying 'Loctite 620' to the plug, two-plugging as shown in figure below, after assemble the spring pin.



(1) Plug plugging (2) Set Screw plugging (3) Spring Pin assemble

Fig. 4 Plugging with Loctite 620

3. 오일 씰을 아래 그림과 같은 전용 조립치구를 사용하여 펌프 하우징에 조립하되 홈이 있는 방향이 위로 향하도록 한다.

3. Assemble the Oil-seal to the Pump housing by using special assembly jig as shown in figure below, the direction of the groove must facing up.

알 림 *조립 시 오일 씰의 외경에 그리스를 도포하고 그림 5 처럼 고무 망치를 이용하여 조립하되 무리한 핏팅이 되지 않도록 한다.*

NOTICE *Apply grease to the outside diameter of The oil seal during assembly and Figure 5 But excessive fitting assembly is like using a rubber mallet Do not be.*



Fig. 5 Assembly of oil seal

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4. 먼저 조립된 축을 고무 망치를 이용하여 그림 6와 같이 펌프 하우징에 조립한다.

4. The shaft which is sub-assembled together with bearing is mounted on pump housing by rubber hammer as shown in Fig.6.

알 림 *부품 조립 방향에 주의 한다.*

NOTICE *Pay attention to the assembling direction.*



Fig. 6 Assembly of sub-assembled shaft into housing

5. 상기 1항에서 먼저 조립된 축을 프레스를 이용하여 아래 그림과 같이 펌프 하우징에 조립 후 스냅 링을 장착한다.

5. Using the Press machine, sub-assembled shaft (Assembled at paragraph 1) to the Pump housing as shown in figure below, and then equip the Snap-ring.



Fig. 7 Assembly of Shaft & Snap-ring into Pump housing

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6. 샤프트와 스퍼기어 접촉면을 깨끗하게 닦은 다음, 오일을 얇게 도포하여 사용한다.

6. Verify that the SHAFT and the inner surface of the SPUR GEAR are clean and lightly oiled.

알 림 ***오일은 실리콘 또는 몰리브덴계의 윤활제를 절대로 사용하지 않는다. 그렇지 않은 경우, 마찰계수와 전달토크를 감소시킬 수 있다.***

NOTICE ***Do not use silicone or molybdenum lubricants. Otherwise, friction coefficient will reduce, and standard torque will not be achieved.***

파워록의 체결 볼트를 분리한 후 샤프트에 조립한다.

파워록이 잘 들어가지 않는 경우에는 체결볼트를 조금 풀어 느슨하게 하거나, 살짝 두드려서 조립한다.

After removing the tightened bolts, it is assembled in SHAFT.
If POWER LOCK does not fit well, loosen fastening bolts a little loose or lightly tapping.

알 림 ***파워록을 해머 등을 사용하여 강제로 조립하지 말아 주십시오. 제품 손상이 되어 사고의 원인이 된다.***

NOTICE ***Do not hit the product with a hammer. This will severely damage the product and possibly lead to accidents.***

6-1. 파워록의 체결볼트를 분리 후 조립용 핸드 렌치를 사용하여 가볍게 조립한다.

6-1. After removing the tightening bolts from POWER LOCK, using Hand wrench for assemble it lightly.

알 림 ***볼트는 토크 렌치를 사용하여 대각선방향으로 체결 한다.***

NOTICE ***Tighten the bolts diagonally with a wrench tool.***

6-2. 샤프트가 회전하지 않도록 고정 한다.
토크렌치를 사용하여 규정 토크의 1/4(4.3N·m)로 체결용 볼트를 우선적으로 체결하고, 그림8과 같은 순서대로 체결한다.

6-3. 규정 토크의 1/2(8.5 N·m)로 체결한다.
6-2항과 같은 방법으로 체결 과정을 반복한다.

6-4. 토크렌치를 사용하여 규정 토크(17N·m)까지 완전히 조인 후, 6-3항과 같은 방법으로 체결 과정을 반복한다.

6-5. 다시 한 번 모든 볼트를 규정 체결 토크 값까지 원주 방향으로 순서대로 완전히 체결한다.
볼트가 더 이상 돌아가지 않는지 확인한다.

6-1. The shaft is fixed so as not to rotate .
torque wrench to tighten the fastening bolts to the1/4(4.3N·m) of the specified torque first, and torque it as shown in Figure 8.

6-2. Tighten 1/2(8.5 N·m) of the specified torque. As a same way with 6-2, repeat tightening process.

6-3. Fully tighten to the specified torque(17N·m) with torque wrench, and repeat the tightening process in the same way as 6-3.

6-4. Once again, torque the all bolts to the specified torque in the circumferential direction completely. Make sure the bolt does not go back anymore.



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Fig. 8 Assembly of POWER LOCK

알 림 *파워록 조립, 분해 후 다시 이용하는 경우에는 변형, 볼트 늘어짐 등에 주의한다.*
파워록 변형, 늘어짐이 발생한 경우 재사용 할 수 없습니다.
새로운 것으로 교환 한다.

NOTICE *Be careful not to have the Locking Element deformed and its bolts sagged after being assembled and disassembled.*
The deformation or sagging will make the Lock become obsolete, so it must be Replaced with new one.

7. 메카니컬 씰의 고정체 와 회전체를 아래 그림과 같이 조립한다.

7. Assemble the fixing seal and rotating seal of the Mechanical seal as shown in the figure below.



(1) Applied Silicone oil on the outer of Fixing seal



(2) Clean the Seal face side seal



(3) Rotating seal assembly

Fig. 9 Assembly of seat ring of Mechanical Seal

8. 임펠러를 아래 조립치구를 이용하여 규정된 토크로 볼트 조임 절차대로 조립한다.

8. Assemble the Impeller as a bolt tightening procedure by specified torque using assembly jig as a below.

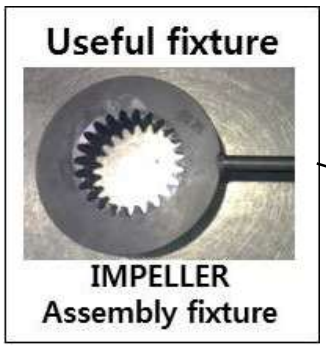
(1) 임펠러에 체결되는 볼트에 록타이트 242 도포 후 조립한다.

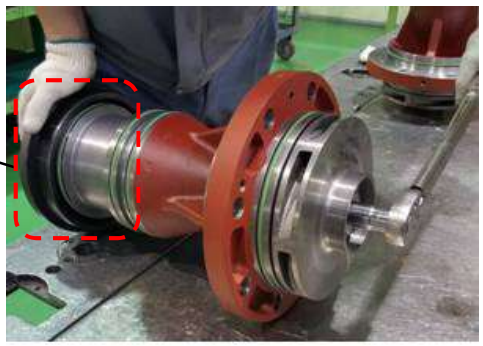
(1) Before assembly, apply 'Loctite 242' on the bolt that using at the Impeller.

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TYPE	TORQUE
H21/32	120Nm
H25/33	120Nm

Fig.10 Assembly of Impeller and bolt & Washer

9. 규정된 오링에 손상이 없도록 주의하면서 장착한다.

9. Install it with care for prevent the damage to the specified O-ring.

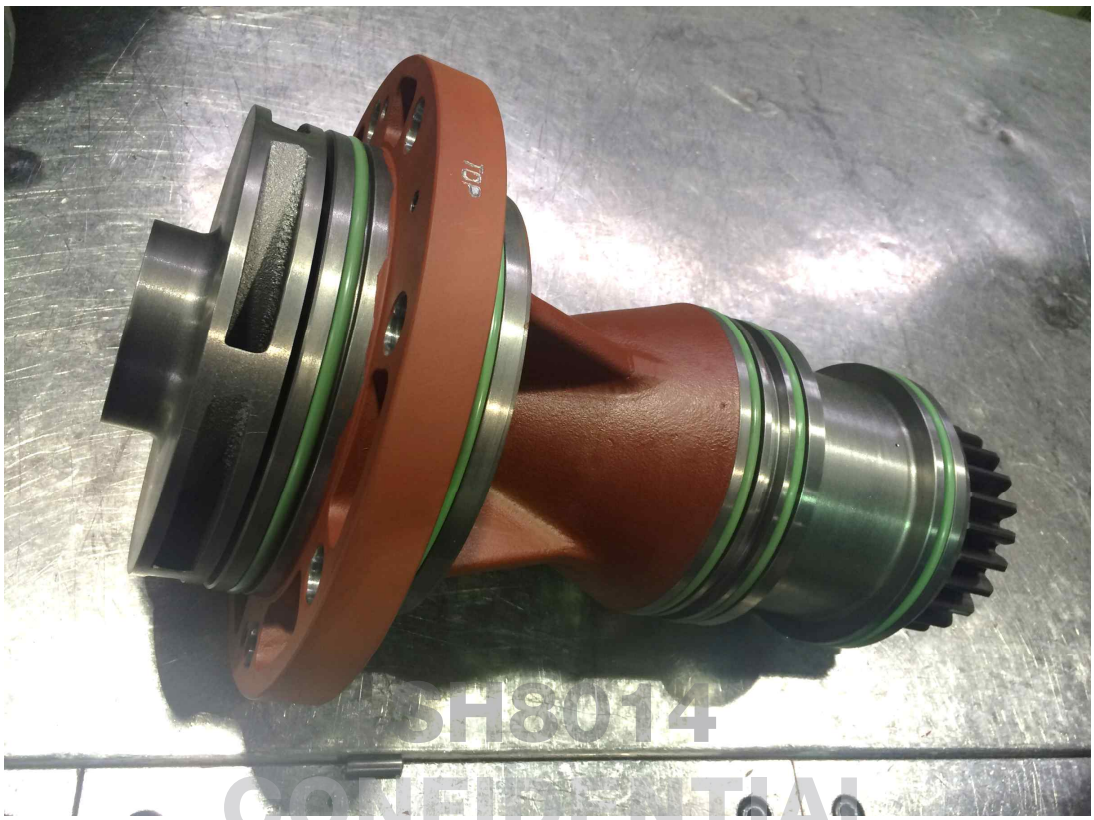


Fig.11 Assembly of O-RING & C.W PUMP Complete

HYUNDAI
HEAVY INDUSTRIES
ENGINE & MACHINERY

Doc No. : K2M0-IR20KB-0255
Date : 2020.05.27
Project : SH8014
Engine Type : 9H21/32
Engine No. : KBA007104
Eng. MCR : 1980 kW
Gen. MCR : 1880 kW
Owner : NEDA MARITIME
Class : LR

SHOP TEST RESULT FOR DIESEL ENGINE

HYUNDAI HiMSEN
Hi-Touch **M**arine & **S**tationary **EN**gine

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QUALITY MANAGEMENT DEPARTMENT
HHI - EMD

Rev.	Prepared	Checked	Approved	Description
2				
1				
0	K.K.KIM 2020.06.09	W.K.LEE 2020.06.09	J.S.KIM 2020.06.09	

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

SPECIFICATION OF ENGINE & ACCESSORIES

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

DESCRIPTION		NO.1 D/G	NO.2 D/G	NO.3 D/G
Engine	Eng.No.	KBA007104 -1	KBA007104 -2	KBA007104 -3
	Type	9H21/32		
	Power × rpm	1980 kW × 900 rpm		
	Firing Order	1 - 3 - 5 - 7 - 9 - 8 - 6 - 4 - 2		
Generator	Model	HFC7 636-08P		
	Output & Volt	2350 kVA 1880 kW × 450 V		
	Current & Hz	3015.1 A 60 Hz		
	Pole & PF	08 P 3 PHA PF 0.8		
	Ser.No.	2020087RAL00201	2020087RAL00202	2020087RAL00203
Turbocharger	Type	A140-M65		
	Max. rpm & Temp.	44400 rpm 630 ℃		
	Maker	ABB		
	Ser.No.	HT593008	HT593009	HT593010
Governor	Type	UG 25+		
	Maker	WOODWARD		
	Ser.No.	20231175	22097951	22097952
Air Cooler	Cooling Surface	-		
	Maker	Donghwa Entec.		
	Ser.No.	190573A1	190573A2	190573A3
Lub.Oil Cooler	Cooling Surface	-		
	Maker	KTC		
	Ser.No.	KOS2003-158	KOS2003-159	KOS2003-160

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USED OIL AT SHOP TEST

Description		Fuel Oil	Lub.Oil
Kind of Oil		RMA10(ISO 8217-2017)	XTeer TPEO 4012
Specific Gravity (15/4℃)		0.8811	0.8765
Flash Point (℃)		92	-
Viscosity	50℃/cSt	7.652	-
	40℃/cSt	-	116.0
Carbon Residue (wt%)		0.6	-
Ash (wt%)		0.01	-
Water & Sediment (vol%)		0.05	-
Sulfur (wt%)		0.203	-
Net.Cal.Value (kcal/kg)		10104	-

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MEASURING RECORD (No. 1 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-1**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Time	hh:mm	11:20~11:50		11:50~12:20		12:20~12:50		12:50~13:50		12:50~13:50		13:50~14:10	
Ambient Press. / Temp.	mbar/℃	1013.0	23.9	1013.0	23.8	1014.0	23.4	1013.0	23.3	1013.0	23.5	1014.0	24.0
Load Point	%	**25%**		**50%**		**75%**		**100%**				**110%**	
Engine Speed	rpm	900		900		900		900				900	
Generator Load	kW	451.3		931.3		1407.9		1882.2				2076.3	
Generator Efficiency	%	91.17		94.07		94.81		95.06				95.33	
Engine Load	kW	495.0		990.0		1485.0		1980.0				2178.0	
Fuel oil consumption	kg/h	-		194.400		-		376.800				-	
specific consumption	g/kW.h	-		196.364		-		190.303				-	
at ISO conditions	g/kW.h	-		193.319		-		187.268				-	
Governor Indicator Position	%	28.0		40.0		55.0		70.0		70.0		75.0	
Turbocharger Speed	rpm	20,290		29,810		35,890		40,570		40,550		42,330	
Lub. Oil Press. Inlet Filter	kg/㎠	5.50		5.40		5.30		5.20		5.20		5.10	
Lub. Oil Press. Inlet Engine	kg/㎠	4.85		4.70		4.55		4.46		4.51		4.43	
Lub. Oil Temp. Inlet engine	℃	68.0		69.0		69.0		67.0		68.0		68.0	
H.T. Water Press. Inlet Engine	kg/㎠	3.40		3.50		3.60		3.80		3.80		3.90	
H.T. Water Temp. Inlet/Outlet Engine	℃	76.0	78.0	76.0	80.0	75.0	80.0	75.0	81.0	75.0	81.0	75.0	82.0
L.T. Water Press. Inlet Air Cooler	kg/㎠	3.20		3.30		3.40		3.40		3.60		3.60	
L.T. Water Temp. Inlet/Outlet Air Cooler	℃	36.0	37.0	36.0	39.0	37.0	43.0	37.0	48.0	37.0	48.0	37.0	50.0
Lub. Oil Press. Inlet Turbocharger	kg/㎠	4.20		3.90		3.80		3.70		3.60		3.60	
Fuel Oil Press. Inlet/Outlet Engine	kg/㎠	6.30	6.10	6.10	5.80	5.80	5.50	5.40	5.20	5.30	5.00	5.30	5.00
Fuel Oil Temp. Inlet Engine	℃	33.0		34.0		35.0		36.0		38.0		38.0	
Charge Air Press. After A/C	kg/㎠	0.60		1.70		2.90		4.20		4.20		4.70	
Charge Air Temp. After A/C	℃	37.0		39.0		41.0		43.0		43.0		44.0	
Exh. Gas Temp. T/C Outlet	℃	329		356		333		325		324		332	
Exh. Gas Temp. T/C Inlet A/B	℃	412	424	473	483	498	507	528	538	528	537	550	567
Exhaust Gas Backpressure Outlet T/C	mmWC	50		160		310		520		520		610	

Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit				No.1	375	10.0	82	-	395	15.0	125	-	418	20.0	164	-	451	25.0	202	-	453	25.0	202	-	475	27.0	212	-
				No.2	394	10.0	84	-	405	15.0	126	-	427	20.0	164	-	464	25.0	201	-	464	25.0	201	-	486	27.0	212	-
				No.3	386	10.0	84	-	391	15.0	126	-	408	20.0	164	-	440	25.0	200	-	440	25.0	200	-	460	27.0	212	-
				No.4	384	10.0	83	-	409	15.0	125	-	436	20.0	163	-	469	25.0	202	-	468	25.0	202	-	490	27.0	212	-
				No.5	390	10.0	82	-	414	15.0	124	-	436	20.0	164	-	468	25.0	202	-	466	25.0	202	-	489	27.0	212	-
				No.6	393	10.0	80	-	411	15.0	124	-	432	20.0	162	-	469	25.0	200	-	468	25.0	199	-	491	27.0	212	-
				No.7	369	10.0	82	-	395	15.0	124	-	417	20.0	165	-	449	25.0	200	-	448	25.0	200	-	469	27.0	212	-
				No.8	379	10.0	81	-	398	15.0	124	-	424	20.0	163	-	458	25.0	202	-	458	25.0	202	-	483	27.0	212	-
				No.9	375	10.0	80	-	399	15.0	125	-	422	20.0	162	-	458	25.0	200	-	459	25.0	200	-	481	27.0	210	-
				mean	**382.8**	**10.0**	**82.0**	**-**	**401.9**	**15.0**	**124.8**	**-**	**424.4**	**20.0**	**163.4**	**-**	**458.4**	**25.0**	**201.0**	**-**	**458.2**	**25.0**	**200.9**	**-**	**480.4**	**27.0**	**211.8**	**-**
Gen. Brg Temp.				℃	50				52				55				56				57				58			

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★Safety Device Test

1. **Overspeed Stop** **1016/1035** rpm
2. **Lub. Oil Low Pressure Stop** **3.00** bar
3. **H.T-Water High Temperature Stop** **93.80** ℃
4. **Engine Stop** **O.K**
5. **Start Interlock(Turning Gear)** **O.K**
6. **Both Tacho Fail Stop** **O.K**

Overhaul Inspection : **6** CYL. **11** BRG.

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MEASURING RECORD (No. 2 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-2**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Time	hh:mm	11:20~11:50		11:50~12:20		12:20~12:50		12:50~13:50				13:50~14:10	
Ambient Press. / Temp.	mbar/℃	1013.0	23.9	1013.0	23.8	1014.0	23.4	1013.0	23.3	1013.0	23.5	1014.0	24.0
Load Point	%	**25%**		**50%**		**75%**		**100%**				**110%**	
Engine Speed	rpm	900		900		900		900				900	
Generator Load	kW	451.3		931.3		1407.9		1882.2				2076.3	
Generator Efficiency	%	91.17		94.07		94.81		95.06				95.33	
Engine Load	kW	495.0		990.0		1485.0		1980.0				2178.0	
Fuel oil consumption	kg/h	-		194.400		-		377.200				-	
specific consumption	g/kW.h	-		196.364		-		190.505				-	
at ISO conditions	g/kW.h	-		193.319		-		187.467				-	
Governor Indicator Position	%	28.0		40.0		55.0		70.0		70.0		75.0	
Turbocharger Speed	rpm	20,840		30,090		36,120		40,790		40,760		42,560	
Lub. Oil Press. Inlet Filter	kg/㎠	5.60		5.50		5.40		5.30		5.30		5.30	
Lub. Oil Press. Inlet Engine	kg/㎠	4.94		4.82		4.71		4.57		4.56		4.56	
Lub. Oil Temp. Inlet engine	℃	68.0		68.0		68.0		67.0		68.0		68.0	
H.T. Water Press. Inlet Engine	kg/㎠	3.40		3.50		3.70		3.80		3.70		3.80	
H.T. Water Temp. Inlet/Outlet Engine	℃	76.0	79.0	-	79.0	76.0	80.0	75.0	81.0	75.0	81.0	75.0	81.0
L.T. Water Press. Inlet Air Cooler	kg/㎠	3.40		3.40		3.60		3.70		3.70		3.80	
L.T. Water Temp. Inlet/Outlet Air Cooler	℃	36.0	36.0	36.0	39.0	36.0	42.0	37.0	47.0	37.0	47.0	37.0	48.0
Lub. Oil Press. Inlet Turbocharger	kg/㎠	4.30		4.10		3.90		3.78		3.80		3.70	
Fuel Oil Press. Inlet/Outlet Engine	kg/㎠	6.60	6.30	6.30	6.00	5.90	5.60	5.50	5.40	5.50	5.30	5.40	5.10
Fuel Oil Temp. Inlet Engine	℃	34.0		36.0		37.0		39.0		39.0		40.0	
Charge Air Press. After A/C	kg/㎠	0.70		1.70		2.90		4.20		4.20		4.70	
Charge Air Temp. After A/C	℃	37.0		39.0		40.0		42.0		42.0		43.0	
Exh. Gas Temp. T/C Outlet	℃	352		354		332		330		329		340	
Exh. Gas Temp. T/C Inlet A/B	℃	435	430	481	483	501	507	538	544	537	544	561	569
Exhaust Gas Backpressure Outlet T/C	mmWC	50		150		300		520		520		580	

Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit				No.1	377	10.0	83	-	399	15.0	124	-	428	20.0	162	-	468	25.0	199	-	471	25.0	200	-	490	27.0	210	-
				No.2	400	10.0	82	-	423	15.0	123	-	444	20.0	161	-	480	25.0	198	-	482	25.0	198	-	502	27.0	210	-
				No.3	379	10.0	82	-	407	15.0	124	-	429	20.0	162	-	469	25.0	200	-	472	25.0	200	-	493	27.0	210	-
				No.4	391	10.0	82	-	410	15.0	123	-	429	20.0	159	-	465	25.0	197	-	465	25.0	198	-	485	27.0	208	-
				No.5	378	10.0	81	-	403	15.0	124	-	422	20.0	159	-	459	25.0	198	-	461	25.0	198	-	481	27.0	208	-
				No.6	389	10.0	81	-	410	15.0	124	-	435	20.0	156	-	472	25.0	197	-	473	25.0	198	-	496	27.0	208	-
				No.7	353	10.0	82	-	384	15.0	124	-	409	20.0	163	-	441	25.0	199	-	443	25.0	199	-	464	27.0	210	-
				No.8	366	10.0	80	-	399	15.0	123	-	434	20.0	160	-	475	25.0	198	-	478	25.0	198	-	502	27.0	210	-
				No.9	369	10.0	82	-	393	15.0	123	-	416	20.0	161	-	457	25.0	200	-	459	25.0	200	-	480	27.0	210	-
				mean	**378.0**	**10.0**	**81.7**	**-**	**403.1**	**15.0**	**123.6**	**-**	**427.3**	**20.0**	**160.3**	**-**	**465.1**	**25.0**	**198.4**	**-**	**467.1**	**25.0**	**198.8**	**-**	**488.1**	**27.0**	**209.3**	**-**
Gen. Brg Temp.				℃	50				51				54				55				56				56			

SH8014
CONFIDENTIAL

★Safety Device Test

1. **Overspeed Stop** **1016/1034** rpm
2. **Lub. Oil Low Pressure Stop** **3.05** bar
3. **H.T-Water High Temperature Stop** **93.30** ℃
4. **Engine Stop** **O.K**
5. **Start Interlock(Turning Gear)** **O.K**
6. **Both Tacho Fail Stop** **O.K**

Overhaul Inspection : **-** CYL. **-** BRG.

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MEASURING RECORD (No. 3 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-3**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Time	hh:mm	11:20~11:50		11:50~12:20		12:20~12:50		12:50~13:50		12:50~13:50		13:50~14:10	
Ambient Press. / Temp.	mbar/℃	1013.0	23.9	1013.0	23.8	1014.0	23.4	1013.0	23.3	1013.0	23.5	1014.0	24.0
Load Point	%	**25%**		**50%**		**75%**		**100%**				**110%**	
Engine Speed	rpm	900		900		900		900				900	
Generator Load	kW	451.3		931.3		1407.9		1882.2				2076.3	
Generator Efficiency	%	91.17		94.07		94.81		95.06				95.33	
Engine Load	kW	495.0		990.0		1485.0		1980.0				2178.0	
Fuel oil consumption	kg/h	-		194.400		-		377.200				-	
specific consumption	g/kW.h	-		196.364		-		190.505				-	
at ISO conditions	g/kW.h	-		193.319		-		187.467				-	
Governor Indicator Position	%	28.0		40.0		55.0		70.0		70.0		75.0	
Turbocharger Speed	rpm	20,780		30,130		36,170		40,790		40,810		42,590	
Lub. Oil Press. Inlet Filter	kg/㎠	5.60		-		5.40		5.30		5.30		5.30	
Lub. Oil Press. Inlet Engine	kg/㎠	4.97		4.80		4.66		4.56		4.56		4.46	
Lub. Oil Temp. Inlet engine	℃	68.0		68.0		67.0		67.0		67.0		68.0	
H.T. Water Press. Inlet Engine	kg/㎠	3.40		3.40		3.60		3.70		3.70		3.80	
H.T. Water Temp. Inlet/Outlet Engine	℃	75.0	78.0	75.0	79.0	74.0	79.0	-	80.0	74.0	80.0	74.0	81.0
L.T. Water Press. Inlet Air Cooler	kg/㎠	3.40		3.40		3.50		3.60		3.60		3.70	
L.T. Water Temp. Inlet/Outlet Air Cooler	℃	36.0	36.0	36.0	39.0	36.0	42.0	36.0	47.0	36.0	47.0	37.0	49.0
Lub. Oil Press. Inlet Turbocharger	kg/㎠	4.30		4.00		3.90		3.70		3.80		3.70	
Fuel Oil Press. Inlet/Outlet Engine	kg/㎠	6.70	6.30	6.40	6.10	6.10	5.80	5.80	5.70	5.70	5.50	5.70	5.30
Fuel Oil Temp. Inlet Engine	℃	35.0		38.0		37.0		38.0		39.0		39.0	
Charge Air Press. After A/C	kg/㎠	0.60		1.70		3.00		4.20		4.20		4.70	
Charge Air Temp. After A/C	℃	37.0		38.0		39.0		41.0		42.0		42.0	
Exh. Gas Temp. T/C Outlet	℃	361		356		325		325		325		332	
Exh. Gas Temp. T/C Inlet A/B	℃	438	434	482	481	498	500	532	539	532	539	553	561
Exhaust Gas Backpressure Outlet T/C	mmWC	50		150		280		490		500		590	

Exh.gas Temp / Pump Index / Firing Press / Gen. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit	No.1	365	10.0	82	-	386	15.0	124	-	410	20.0	162	-	456	25.0	200	-	456	25.0	200	-	479	27.0	210	-
	No.2	399	10.0	85	-	423	15.0	125	-	437	20.0	163	-	482	25.0	202	-	482	25.0	201	-	503	27.0	210	-
	No.3	395	10.0	83	-	408	15.0	125	-	429	20.0	162	-	456	25.0	200	-	458	25.0	200	-	477	27.0	210	-
	No.4	391	10.0	84	-	410	15.0	124	-	428	20.0	159	-	464	25.0	198	-	465	25.0	199	-	484	27.0	208	-
	No.5	383	10.0	81	-	406	15.0	124	-	429	20.0	161	-	464	25.0	199	-	466	25.0	199	-	488	27.0	208	-
	No.6	377	10.0	80	-	395	15.0	123	-	420	20.0	158	-	462	25.0	197	-	464	25.0	198	-	485	27.0	210	-
	No.7	386	10.0	82	-	406	15.0	124	-	425	20.0	161	-	461	25.0	200	-	460	25.0	200	-	482	27.0	210	-
	No.8	368	10.0	80	-	396	15.0	123	-	418	20.0	163	-	458	25.0	201	-	458	25.0	201	-	480	27.0	210	-
	No.9	364	10.0	80	-	397	15.0	124	-	425	20.0	162	-	466	25.0	202	-	465	25.0	202	-	488	27.0	210	-
	mean	**380.9**	**10.0**	**81.9**	**-**	**403.0**	**15.0**	**124.0**	**-**	**424.6**	**20.0**	**161.2**	**-**	**463.2**	**25.0**	**199.9**	**-**	**463.8**	**25.0**	**200.0**	**-**	**485.1**	**27.0**	**209.6**	**-**
Gen. Brg Temp.	℃	48				49				51				53				54				54			

SH8014
CONFIDENTIAL

★Safety Device Test

1. **Overspeed Stop** **1016/1035** rpm
2. **Lub. Oil Low Pressure Stop** **2.90** bar
3. **H.T-Water High Temperature Stop** **93.60** ℃
4. **Engine Stop** **O.K**
5. **Start Interlock(Turning Gear)** **O.K**
6. **Both Tacho Fail Stop** **O.K**

Overhaul Inspection : **-** CYL. **-** BRG.

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

SETTING TABLE (NO. 1 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-1**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Atomizer

Mark No. : H21FV2

Injection Hole : 10 Holes X φ 0.35 mm X 148˚

Clearance of Valves

Inlet Valve : 0.5 ㎜ (Cold Condition)

Exhaust Valve : 0.5 ㎜ (Cold Condition)

Adjustment of Fuel Injection Pump

[UNIT : mm]

Cylinder No.	1	2	3	4	5	6	7	8	9
Thrust Plate	13.40	13.40	13.60	13.40	13.40	13.20	13.40	13.40	13.40
Shim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Index by Maximum Supply of F.O	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Crankshaft Deflection

Crankshaft Axial Clearance : 0.54mm

[UNIT : 1/100mm]

	Cylinder No.	1	2	3	4	5	6	7	8	9
Cold Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	0	+1.0	+1.0	0	+1.0	+3.0	0	-4.0	-10.0
	Top T	-1.0	+1.0	+1.0	+1.0	+4.0	+5.0	+2.0	-7.0	-23.0
	Exhaust Side S	0	+1.0	+1.0	+1.0	+2.0	+3.0	0	-4.0	-12.0
	Near Bottom Y	0	0	0	0	+1.0	0	0	-1.0	-1.0
	Vertical Deflection	-1.0	+1.0	+1.0	+1.0	+3.5	+5.0	+2.0	-6.5	-22.5
	Horizontal Deflection	0	0	0	-1.0	-1.0	0	0	0	+2.0
Hot Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	-1.0	+1.0	0	0	0	+2.0	+1.0	-4.0	-10.0
	Top T	-2.0	+1.0	-1.0	-1.0	+1.0	+3.0	-1.0	-9.0	-23.0
	Exhaust Side S	-1.0	0	-1.0	-1.0	0	+1.0	0	-5.0	-12.0
	Near Bottom Y	0	0	0	0	0	0	0	0	-1.0
	Vertical Deflection	-2.0	+1.0	-1.0	-1.0	+1.0	+3.0	-1.0	-9.0	-22.5
	Horizontal Deflection	0	+1.0	+1.0	+1.0	0	+1.0	+1.0	+1.0	+2.0

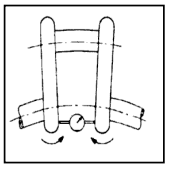
SH8014 CONFIDENTIAL

* Vertical Deflection : dv = T-(X+Y) / 2, Horizontal Deflection : dh = P-S

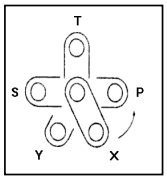
Reference Temperature Data for Hot Condition

Room Temperature : 23.3 ℃

Lub. Oil Temperature in Oil Sump : 67 ℃



"Closing" of The Crankthrow is Considered Negative.



Viewed from the front end
Start in Position X.
Turn Counter Clockwise.

The permissible deflection of crankshaft
Unless otherwise stated the values refer to cold engine

[UNIT : 1/100mm]

For the crank nearest the flywheel (Cold Condition)	New or recently overhauled engine, permissible	-26 ~ +12
	Operating engine, contact engine maker (Check alignment immediately)	-28 ≥ or+17 ≤
For the other cranks (Cold Condition)	New or recently overhauled engine, permissible	-13 ~ +13
	Operating engine, check alignment immediately	-15 ≥ or+15 ≤

* The values measured under hot condition are only for reference due to the following reason;

- If the values measured under cold condition satisfy the above mentioned specification, we guarantee any values measured under hot condition.

SETTING TABLE (NO. 2 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-2**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Atomizer

Mark No. : H21FV2

Injection Hole : 10 Holes X φ 0.35 mm X 148˚

Clearance of Valves

Inlet Valve : 0.5 ㎜ (Cold Condition)

Exhaust Valve : 0.5 ㎜ (Cold Condition)

Adjustment of Fuel Injection Pump

[UNIT : mm]

Cylinder No.	1	2	3	4	5	6	7	8	9
Thrust Plate	13.40	13.40	13.40	13.40	13.20	13.40	13.40	13.60	13.40
Shim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Index by Maximum Supply of F.O	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Crankshaft Deflection

Crankshaft Axial Clearance : 0.54mm

[UNIT : 1/100mm]

Cylinder No.		1	2	3	4	5	6	7	8	9
Cold Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	0	+1.0	0	+1.0	+2.0	+2.0	+1.0	-5.0	-12.0
	Top T	-1.0	0	+1.0	+2.0	+2.0	+5.0	0	-10.0	-23.0
	Exhaust Side S	0	+1.0	+1.0	+1.0	+1.0	+2.0	0	-5.0	-12.0
	Near Bottom Y	0	0	0	0	0	0	0	-1.0	-1.0
	Vertical Deflection	-1.0	0	+1.0	+2.0	+2.0	+5.0	0	-9.5	-22.5
	Horizontal Deflection	0	0	-1.0	0	+1.0	0	+1.0	0	0
Hot Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	0	0	-1.0	+1.0	+2.0	-1.0	-6.0	-3.0	-11.0
	Top T	-2.0	-1.0	-1.0	-1.0	-1.0	+3.0	-1.0	-12.0	-25.0
	Exhaust Side S	-1.0	0	0	-1.0	+1.0	+2.0	-1.0	-6.0	-3.0
	Near Bottom Y	0	0	0	0	0	0	0	0	-1.0
	Vertical Deflection	-2.0	-1.0	-1.0	-1.0	-1.0	+3.0	-1.0	-12.0	-24.5
	Horizontal Deflection	+1.0	0	-1.0	+2.0	+1.0	-3.0	-5.0	+3.0	-8.0

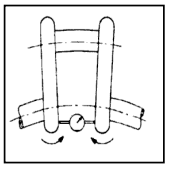
SH8014 CONFIDENTIAL

* Vertical Deflection : dv = T-(X+Y) / 2, Horizontal Deflection : dh = P-S

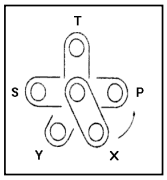
Reference Temperature Data for Hot Condition

Room Temperature : 23.3 ℃

Lub. Oil Temperature in Oil Sump : 67 ℃



"Closing" of The Crankthrow is Considered Negative.



Viewed from the front end
Start in Position X.
Turn Counter Clockwise.

The permissible deflection of crankshaft
Unless otherwise stated the values refer to cold engine

[UNIT : 1/100mm]

For the crank nearest the flywheel (Cold Condition)	New or recently overhauled engine, permissible	-26 ~ +12
	Operating engine, contact engine maker (Check alignment immediately)	-28 ≥ or+17 ≤
For the other cranks (Cold Condition)	New or recently overhauled engine, permissible	-13 ~ +13
	Operating engine, check alignment immediately	-15 ≥ or+15 ≤

* The values measured under hot condition are only for reference due to the following reason;

- If the values measured under cold condition satisfy the above mentioned specification, we guarantee any values measured under hot condition.

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

SETTING TABLE (NO. 3 D/G)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-3**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Atomizer

Mark No. : H21FV2

Injection Hole : 10 Holes X φ 0.35 mm X 148˚

Clearance of Valves

Inlet Valve : 0.5 ㎜ (Cold Condition)

Exhaust Valve : 0.5 ㎜ (Cold Condition)

Adjustment of Fuel Injection Pump

[UNIT : mm]

Cylinder No.	1	2	3	4	5	6	7	8	9
Thrust Plate	13.40	13.40	13.40	13.10	13.20	13.00	13.40	13.40	13.40
Shim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Index by Maximum Supply of F.O	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Crankshaft Deflection

Crankshaft Axial Clearance : 0.56mm

[UNIT : 1/100mm]

Cylinder No.		1	2	3	4	5	6	7	8	9
Cold Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	-2.0	0	+1.0	+2.0	+3.0	+3.0	+1.0	-4.0	-12.0
	Top T	-1.0	0	+1.0	+2.0	+4.0	+6.0	+3.0	-8.0	-23.0
	Exhaust Side S	-2.0	+1.0	0	+1.0	+2.0	+3.0	+1.0	-4.0	-12.0
	Near Bottom Y	0	0	0	0	0	0	0	-1.0	-2.0
	Vertical Deflection	-1.0	0	+1.0	+2.0	+4.0	+6.0	+3.0	-7.5	-22.0
	Horizontal Deflection	0	-1.0	+1.0	+1.0	+1.0	0	0	0	0
Hot Condition	Near Bottom X	0	0	0	0	0	0	0	0	0
	Camshaft Side P	-1.0	-1.0	+1.0	+1.0	+2.0	+3.0	+1.0	-5.0	-10.0
	Top T	-1.0	-1.0	-1.0	-1.0	+2.0	+3.0	-1.0	-10.0	-25.0
	Exhaust Side S	0	0	-1.0	0	0	+1.0	0	-5.0	-14.0
	Near Bottom Y	0	0	0	0	0	0	0	0	-1.0
	Vertical Deflection	-1.0	-1.0	-1.0	-1.0	+2.0	+3.0	-1.0	-10.0	-24.5
	Horizontal Deflection	-1.0	-1.0	+2.0	+1.0	+2.0	+2.0	+1.0	0	+4.0

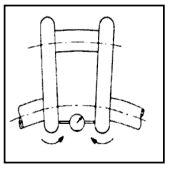
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* Vertical Deflection : dv = T-(X+Y) / 2, Horizontal Deflection : dh = P-S

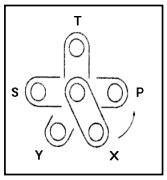
Reference Temperature Data for Hot Condition

Room Temperature : 23.3 ℃

Lub. Oil Temperature in Oil Sump : 67 ℃



"Closing" of The Crankthrow is Considered Negative.



Viewed from the front end
Start in Position X.
Turn Counter Clockwise.

The permissible deflection of crankshaft
Unless otherwise stated the values refer to cold engine

[UNIT : 1/100mm]

For the crank nearest the flywheel (Cold Condition)	New or recently overhauled engine, permissible	-26 ~ +12
	Operating engine, contact engine maker (Check alignment immediately)	-28 ≥ or+17 ≤
For the other cranks (Cold Condition)	New or recently overhauled engine, permissible	-13 ~ +13
	Operating engine, check alignment immediately	-15 ≥ or+15 ≤

* The values measured under hot condition are only for reference due to the following reason;

- If the values measured under cold condition satisfy the above mentioned specification, we guarantee any values measured under hot condition.

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

GOVERNOR TEST
GENERATOR PARALLEL RUNNING TEST

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

1. GOVERNOR TEST

No. 1 D/G

LOAD %		SPEED VARIATION						GOV' SETTING	GOV. TYPE	UG 25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	20231175
100	0	60.0	63.2	5.33%	62.0	3.33%	2.8sec		SPEED DROOP	6
0	33	62.0	60.0	3.23%	61.2	1.29%	2.2sec		STABILITY	5
33	66	61.2	58.2	4.90%	60.6	0.98%	3.0sec		-	-
66	100	60.6	59.0	2.64%	60.0	0.99%	2.2sec		-	-

No. 2 D/G

LOAD %		SPEED VARIATION						GOV' SETTING	GOV. TYPE	UG 25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	22097951
100	0	60.0	63.0	5.00%	62.0	3.33%	2.8sec		SPEED DROOP	6
0	33	59.9	60.2	0.50%	61.2	2.17%	1.6sec		STABILITY	5
33	66	61.2	59.0	3.59%	60.8	0.65%	2.8sec		-	-
66	100	60.8	59.0	2.96%	60.0	1.32%	2.2sec		-	-

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No. 3 D/G

LOAD %		SPEED VARIATION						GOV' SETTING	GOV. TYPE	UG 25+
FROM	TO	BEF.Hz	MOM.Hz	DIFF. %	PER.Hz	DIFF. %	TIME		SERIAL NO.	22097952
100	0	60.0	63.2	5.33%	62.0	3.33%	2.8sec		SPEED DROOP	6
0	33	62.0	60.0	3.23%	61.2	1.29%	1.8sec		STABILITY	5
33	66	61.2	58.6	4.25%	60.7	0.82%	2.8sec		-	-
66	100	60.7	59.0	2.80%	60.0	1.15%	2.0sec		-	-

2. PARALLEL RUNNING TEST

D/G NO.	LOAD	%	75	100	80	60	40	20	40	60	80	100	75
	VOLTAGE	V	449.6	449.2	449.2	450.4	451.2	451.6	451.2	450.8	450.0	449.2	449.6
	FREQUENCY	Hz	60.0	59.5	59.9	60.3	60.7	61.1	60.7	60.4	59.9	59.5	60.0
NO.1	OUTPUT	kW	1408.8	1879.2	1500.0	1123.2	746.4	376.8	751.2	1128.0	1492.8	1874.4	1408.8
NO.2	OUTPUT	kW	1404.0	1816.8	1502.4	1120.8	736.8	369.6	746.4	1113.6	1497.6	1826.4	1408.8
NO.3	OUTPUT	kW	1416.0	1881.6	1509.6	1125.6	751.2	379.2	753.6	1125.6	1509.6	1879.2	1416.0

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MECHANICAL VIBRATION MEASUREMENT

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Measured by
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	J.S.Kim / QM

HYUNDAI HiMSEN

Measurement Equipment

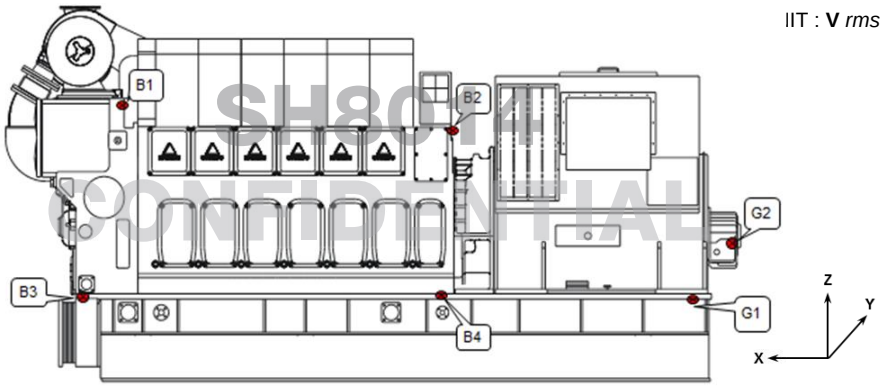
Manufacture	Type	Mechanical connection	Measured value	Recorded value	Measurement Equipment
RION	VM - 61	magnetic	velocity	velocity	-
RION	VM - 82	magnetic	velocity	velocity	O

Vibration Measurement Location and Limit Value

Measuring Points (ISO 8528-9)		Direction	Limit Value	Remarks
B1	**Front End Top Edge**	**X , Y , Z**	**≤ 28 ㎜/s (Vrms)**	**ISO 10816-6**
B2	**Back End Top Edge**	**X , Y , Z**		
B3	**Front End of Base Frame**	**X , Y , Z**		
B4	**Front End of Generator Base Frame**	**X , Y , Z**		
G1	**Rear End of Generator Base Frame**	**X , Y , Z**	**≤ 18 ㎜/s (Vrms)**	**ISO 8528-9**
G2	**Generator Bearing(NDE)**	**X , Y , Z**		

Measurement points

IIT : **V** *rms* (mm/s)



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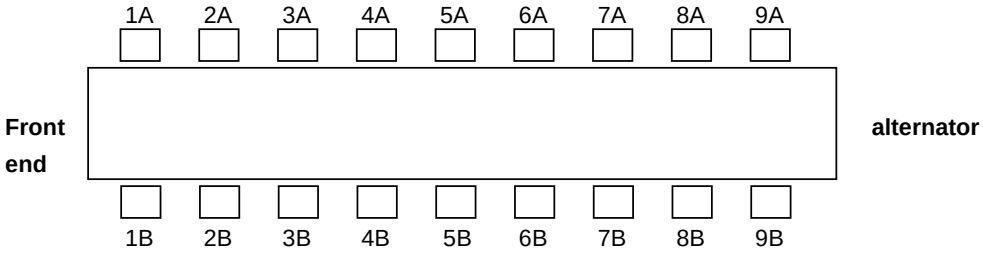
Item / D/G	Measuring Point	axial (X)	transverse (Y)	vertical (Z)	Remarks
NO.1 D/G	B1	5.0	6.0	6.0	▶Coupling : Disc coupled [with Generator]
	B2	4.0	8.0	7.0	
	B3	4.0	7.0	5.0	▶Erection : Rubber Mount
	B4	4.0	5.0	6.0	Type : RD214D-65 Shore A
	G1	4.0	7.0	14.0	
	G2	6.0	9.0	14.0	
NO.2 D/G	B1	5.0	5.0	5.0	
	B2	4.0	7.0	6.0	▶Load % : 100%
	B3	4.0	6.0	5.0	▶Running hours : 1 Hr
	B4	5.0	5.0	5.0	
	G1	3.0	7.0	12.0	
	G2	5.0	7.0	12.0	
NO.3 D/G	B1	7.0	7.0	6.0	
	B2	6.0	8.0	6.0	
	B3	7.0	7.0	5.0	
	B4	6.0	6.0	5.0	
	G1	6.0	9.0	12.0	
	G2	8.0	8.0	13.0	

HEIGHT OF RESILIENT SUPPORTS IN LOADED CONDITION

Test Date : 2020.05.27

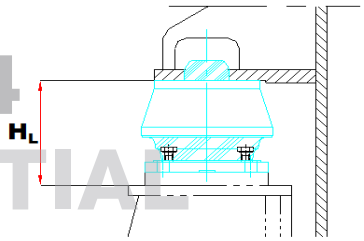
Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

Mount Type : RD214D-65 Shore A



H_L = Height of resilient support in loaded condition

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Note ! This flexible elements must be loaded for at least 48 hours, before measurements are taken

Resilient support NO.		1A	2A	3A	4A	5A	6A	7A	8A	9A	Remarks
		1B	2B	3B	4B	5B	6B	7B	8B	9B	
H_L (㎜)	No. 1 D/G	166.5	165.5	166.5	166.0	-	-	-	-		
		165.5	166.0	166.0	166.0	-	-	-	-		
	No. 2 D/G	165.5	166.5	166.0	166.0	-	-	-	-		
		166.0	166.0	166.0	166.0	-	-	-	-		
	No. 3 D/G	165.5	166.0	166.0	166.0	-	-	-	-		
		166.0	166.0	166.0	165.5	-	-	-	-		

REMARK.:

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

CALCULATION SHEET OF F.O. (50%)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Engine No.			No.1D/G	No.2D/G	No.3D/G	Remarks
Output	Load	%	50%	50%	50%	
	Engine Speed	rpm	900	900	900	
	Generator Output	kW	931.3	931.3	931.3	
	Generator Efficiency	%	94.07	94.07	94.07	
	Engine Output	kW	990.0	990.0	990.0	
		PS	1346.0	1346.0	1346.0	
Actual Measurement	Time	min/sec	10min 0.00sec	10min 0.00sec	10min 0.00sec	
	F.O. Consumption	kg	32.400	32.400	32.800	
		kg/h	194.400	194.400	196.800	
	SFOCamb	g/kW.h	196.364	196.364	198.788	
		g/PS.h	144.425	144.425	146.208	
ISO Convers. Factor	**Ambient Air Temp.**	℃	23.8	23.8	23.8	
	(Ta-25)×0.05	%	-0.06	-0.06	-0.06	
	Ambient Air Press.	mbar	1013.0	1013.0	1013.0	
	(Pa-1000)×0.007	%	0.0910	0.0910	0.0910	
	C.W. to Air Cooler	℃	36	36	36	
	(Tcw-25)×0.07	%	0.77	0.77	0.77	
	Low Calorific Value	kcal/kg	10104	10104	10104	
	(42700/LCV) [kJ/kg]	%	1.00950	1.00950	1.00950	
	dSFOC [100+(Ta-25)×0.05 -(Pa-1000)×0.007 +(Tcw-25)×0.07]/100 x(42700/LCV)		1.0158	1.0158	1.0158	
S.F.O.C(ISO)		**g/kW.h**	**193.319**	**193.319**	**195.706**	
= SFOCamb / dSFOC		**g/PS.h**	**142.186**	**142.186**	**143.941**	

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All values based on ISO 3046/1 conditions

Ambient air temperature : 25 ℃

Ambient air pressure : 1000 mbar

Cooling water for air cooler : 25 ℃

Marine diesel oil(MDO). Lower calorific value : 42,700 kJ/kg (10,200 kcal/kg)

For other reference conditions, the SFOC is to be corrected by :

Ambient air temperature	**rise**	**10℃**	**0.5 %**
Ambient air pressure	**rise**	**10mbar**	**-0.07 %**
Cooling water for air cooler	**rise**	**10℃**	**0.7 %**
Lower calorific value	**rise**	**1%**	**-1.0 %**

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

CALCULATION SHEET OF F.O. (100%)

Test Date : 2020.05.27

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**LR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Engine No.			No.1D/G	No.2D/G	No.3D/G	Remarks
Output	Load	%	100%	100%	100%	
	Engine Speed	rpm	900	900	900	
	Generator Output	kW	1882.2	1882.2	1882.2	
	Generator Efficiency	%	95.06	95.06	95.06	
	Engine Output	kW	1980.0	1980.0	1980.0	
		PS	2692.0	2692.0	2692.0	
Actual Measurement	Time	min/sec	30min 0.00sec	30min 0.00sec	30min 0.00sec	
	F.O. Consumption	kg	188.400	188.600	188.000	
		kg/h	376.800	377.200	376.000	
	SFOCamb	g/kW.h	190.303	190.505	189.899	
		g/PS.h	139.968	140.116	139.671	
ISO Convers. Factor	**Ambient Air Temp.**	℃	23.3	23.3	23.3	
	(Ta-25)×0.05	%	-0.085	-0.085	-0.085	
	Ambient Air Press.	mbar	1013.0	1013.0	1013.0	
	(Pa-1000)×0.007	%	0.0910	0.0910	0.0910	
	C.W. to Air Cooler	℃	37	37	36	
	(Tcw-25)×0.07	%	0.84	0.84	0.77	
	Low Calorific Value	kcal/kg	10104	10104	10104	
	(42700/LCV) [kJ/kg]	%	1.00950	1.00950	1.00950	
	dSFOC [100+(Ta-25)×0.05 -(Pa-1000)×0.007 +(Tcw-25)×0.07]/100 x(42700/LCV)		1.0162	1.0162	1.0155	
S.F.O.C(ISO)		**g/kW.h**	**187.268**	**187.467**	**187.001**	
= SFOCamb / dSFOC		**g/PS.h**	**137.736**	**137.882**	**137.539**	

SH8014 CONFIDENTIAL

All values based on ISO 3046/1 conditions

Ambient air temperature : 25 ℃

Ambient air pressure : 1000 mbar

Cooling water for air cooler : 25 ℃

Marine diesel oil(MDO). Lower calorific value : 42,700 kJ/kg (10,200 kcal/kg)

For other reference conditions, the SFOC is to be corrected by :

Ambient air temperature	**rise**	**10℃**	**0.5 %**
Ambient air pressure	**rise**	**10mbar**	**-0.07 %**
Cooling water for air cooler	**rise**	**10℃**	**0.7 %**
Lower calorific value	**rise**	**1%**	**-1.0 %**

HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MEASURING RECORD for NOx EMISSION TEST (Tier Ⅱ)

Test Date : 2020.05.26

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-1**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**KR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Test NO.		01		02		03		04		05	
Time	hh:mm	10:10-10:30		10:30-10:50		10:50-11:10		11:10-11:30		11:30-11:50	
Ambient Press. / Temp.	mbar/℃	1013.0	20.9	1013.0	22.1	1013.0	22.5	1013.0	22.9	1013.0	22.7
Intake Air Humidity / Temp.	%RH/℃	52.2	22.1	51.1	23.1	49.0	23.5	48.9	23.7	48.6	24.2
Load Point	%	**100%**		**75%**		**50%**		**25%**		**10%**	
Engine Speed	rpm	900		900		900		900		900	
Generator Load	kW	1882.2		1407.9		931.3		451.3		162.1	
Generator Efficiency	%	95.06		94.81		94.07		91.17		81.89	
Engine Load	kW	1980.0		1485.0		990.0		495.0		198.0	
Fuel oil consumption	kg/h	369.600		280.800		194.200		112.800		60.000	
specific consumption	g/kW.h	186.667		189.091		196.162		227.879		303.030	
at ISO conditions	g/kW.h	184.257		186.538		193.475		224.713		298.850	
Governor Indicator Position	%	70.0		55.0		40.0		28.0		20.0	
Turbocharger Speed	rpm	40,280		35,960		30,000		20,940		14,050	
Lub. Oil Press. Inlet Filter	kg/㎠	5.20		5.30		5.40		5.50		5.50	
Lub. Oil Press. Inlet Engine	kg/㎠	4.47		4.58		4.64		4.75		4.85	
Lub. Oil Temp. Inlet engine	℃	66.0		68.0		67.0		68.0		67.0	
H.T. Water Press. Inlet Engine	kg/㎠	3.10		3.10		3.10		3.10		3.10	
H.T. Water Temp. Inlet/Outlet Engine	℃	76.0	82.0	77.0	81.0	77.0	80.0	76.0	79.0	77.0	78.0
L.T. Water Press. Inlet Air Cooler	kg/㎠	2.20		1.90		1.90		1.90		1.90	
L.T. Water Temp. Inlet/Outlet Engine	℃	35.0	48.0	35.0	46.0	35.0	42.0	35.0	38.0	35.0	36.0
Lub. Oil Press. Inlet Turbocharger	kg/㎠	3.70		3.80		3.90		4.10		4.30	
Fuel Oil Press. Inlet/Outlet Engine	kg/㎠	5.6	5.4	5.7	5.4	5.9	5.6	6.0	5.7	6.0	5.7
Fuel Oil Temp. Inlet Engine	℃	33		34		34		35		35	
Charge Air Press. After A/C	kg/㎠	4.13		2.90		1.72		0.65		0.22	
Charge Air Temp. After A/C	℃	50.0		47.0		43.0		40.0		39.0	
Exh.Gas Temp. T/C Outlet	℃	310		320		340		350		310	

Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit				No.1	449	24.0	205	-	429	20.0	167	-	409	15.0	128	-	383	10.0	86	-	305	7.0	56	-
				No.2	457	24.0	206	-	432	20.0	168	-	416	15.0	128	-	400	10.0	86	-	332	7.0	56	-
				No.3	437	24.0	205	-	415	20.0	167	-	403	15.0	128	-	389	10.0	87	-	319	7.0	56	-
				No.4	460	24.0	206	-	434	20.0	166	-	416	15.0	129	-	389	10.0	86	-	334	7.0	56	-
				No.5	459	24.0	205	-	432	20.0	166	-	418	15.0	128	-	392	10.0	86	-	322	7.0	57	-
				No.6	460	24.0	205	-	430	20.0	168	-	418	15.0	129	-	397	10.0	86	-	330	7.0	56	-
				No.7	443	24.0	206	-	418	20.0	166	-	404	15.0	130	-	376	10.0	87	-	296	7.0	56	-
				No.8	452	24.0	205	-	423	20.0	166	-	406	15.0	128	-	384	10.0	86	-	321	7.0	57	-
				No.9	452	24.0	204	-	426	20.0	166	-	418	15.0	128	-	383	10.0	86	-	313	7.0	56	-
				mean	**452.1**	**24.0**	**205.2**	**-**	**426.6**	**20.0**	**166.7**	**-**	**412.0**	**15.0**	**128.4**	**-**	**388.1**	**10.0**	**86.2**	**-**	**319.1**	**7.0**	**56.2**	**-**

Exhaust Gas Temp. Inlet T/C A/B	℃	523	531	499	507	483	491	449	453	358	361
Exhaust Gas Backpressure Outlet T/C	mmWC	510		310		160		60		30	

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HYUNDAI HEAVY INDUSTRIES ENGINE & MACHINERY

MEASURING RECORD for NOx EMISSION TEST (Tier Ⅲ)

Test Date : 2020.05.26

Project	Engine Type	Engine Number	Eng. MCR	Gen. MCR	Owner	Class	Evaluated. By	Operated. By
SH8014	**9H21/32**	**KBA007104-1**	**1980 kW**	**1880 kW**	**NEDA MARITIME**	**KR**	B.S.Jung	S.H.Lee

HYUNDAI HiMSEN

Test NO.			01		02		03		04		Remark
Time		hh:mm	13:00-13:30		13:30-14:00		14:00-14:30		14:30-15:00		
Ambient Press. / Temp.		mbar/℃	1013.0	23.9	1013.0	23.9	1012.0	23.8	1012.0	23.3	
Intake Air Humidity / Temp.		%RH/℃	48.4	24.5	47.6	24.6	47.3	24.8	46.6	25.2	
Load Point		%	**100%**		**75%**		**50%**		**25%**		
Engine Speed		rpm	900		900		900		900		
Generator Load		kW	1882.2		1407.9		931.3		451.3		
Generator Efficiency		%	95.06		94.81		94.07		91.17		
Engine Load		kW	1980.0		1485.0		990.0		495.0		
Fuel oil consumption		kg/h	372.000		280.800		195.600		112.800		
specific consumption		g/kW.h	187.879		189.091		197.576		227.879		
at ISO conditions		g/kW.h	185.177		186.371		194.730		224.653		
Governor Indicator Position		%	70.0		55.0		40.0		28.0		
Turbocharger Speed		rpm	40,270		35,970		30,000		20,940		
Lub. Oil Press. Inlet Filter		kg/㎠	5.10		5.20		5.30		5.40		
Lub. Oil Press. Inlet Engine		kg/㎠	4.41		4.53		4.64		4.71		
Lub. Oil Temp. Inlet engine		℃	67.0		66.0		68.0		68.0		
H.T. Water Press. Inlet Engine		kg/㎠	3.30		3.20		3.20		3.10		
H.T. Water Temp. Inlet/Outlet Engine		℃	77.0	83.0	76.0	81.0	76.0	80.0	76.0	79.0	
L.T. Water Press. Inlet Air Cooler		kg/㎠	2.10		2.00		2.00		1.90		
L.T. Water Temp. Inlet/Outlet Engine		℃	35.0	50.0	35.0	46.0	35.0	41.0	35.0	38.0	
Lub. Oil Press. Inlet Turbocharger		kg/㎠	3.60		3.70		3.90		4.10		
Fuel Oil Press. Inlet/Outlet Engine		kg/㎠	5.4	5.1	5.7	5.2	5.8	5.4	5.9	5.5	
Fuel Oil Temp. Inlet Engine		℃	35		36		36		37		
Charge Air Press. After A/C		kg/㎠	4.14		2.88		1.70		0.65		
Charge Air Temp. After A/C		℃	51.0		47.0		44.0		40.0		
Exh.Gas Temp. T/C Outlet		℃	310		320		350		350		

Exh.gas Temp	Pump Index	Firing Press	Gen. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit				No.1	449	24.0	205	-	432	20.0	169	-	405	15.0	128	-	383	10.0	86	-
				No.2	458	24.0	206	-	436	20.0	168	-	413	15.0	128	-	399	10.0	86	-
				No.3	438	24.0	205	-	419	20.0	167	-	402	15.0	128	-	391	10.0	87	-
				No.4	464	24.0	206	-	440	20.0	166	-	415	15.0	129	-	390	10.0	86	-
				No.5	461	24.0	205	-	440	20.0	166	-	420	15.0	129	-	393	10.0	86	-
				No.6	462	24.0	205	-	439	20.0	166	-	416	15.0	129	-	397	10.0	86	-
				No.7	442	24.0	205	-	425	20.0	167	-	404	15.0	128	-	375	10.0	87	-
				No.8	456	24.0	205	-	429	20.0	166	-	407	15.0	128	-	381	10.0	86	-
				No.9	451	24.0	204	-	433	20.0	166	-	411	15.0	128	-	382	10.0	86	-
				mean	453.4	**24.0**	205.1	-	432.6	**20.0**	166.8	-	410.3	**15.0**	128.3	-	387.9	**10.0**	**86.2**	-

Exhaust Gas Temp. Inlet T/C A/B	℃	521/525/533	505/509/514	482/485/489	447/445/454		
Exhaust Gas Backpressure Outlet T/C	mmWC	510	310	170	65		
SCR System	Injection Rate of Reductant	l/h	19.9	14.9	9.2	4.2	
	Exh.Gas Temp. at SCR In/Out	℃	312 / 318	320 / 325	336 / 338	346 / 344	
	Exh.Gas Press Loss at SCR	mbar	2.47	1.98	1.41	0.84	

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No	Description	Dwg No.	Remark
1	TECHNICAL ENGINE SPECIFICATION	B94-307119-8.2	
2	HEAT CALCULATION DIAGRAM	B94-167252-4.0	
3	LUB.OIL IN BASE FRAME	B94-000419-0.4	
4	INSTALLATION AND COMMISSIONING GUIDE	B94-180669-0.9	
5	ARR.OF HOLDING DOWN BOLTS	B92-307421-2.1	
6	INSTRUCTION FOR RESILIENT MOUNTING	B94-091431-5.7	
7	GENERAL ARRANGEMENT	B90-309087-5.1	
8	OVERHAUL DIMENSION OF MAIN COMPONENTS	B90-306768-7.1	
9	BASIC SYMBOL	B92-088640-0.2	
10	FUEL OIL SYSTEM	B92-308358-0.0	
11	LUBRICATING OIL SYSTEM	B92-308359-2.0	
12	COOLING WATER SYSTEM	B92-139694-7.2	
13	COMPRESSED AIR SYSTEM	B92-175544-1.0	
14	COMBUSTION AIR SYSTEM	B92-304968-9.0	
15	FLEXIBLE HOSE FOR EXTERNAL CONNECTION	B94-312350-7.1	
16	PRESSURE REGULATING VALVE FOR MDO INLET	B92-100775-1.1	
17	PRESSURE REGULATING VALVE FOR MDO OUTLET	B92-100776-3.1	
18	PRESSURE REGULATING VALVE FOR HFO INLET	B93-106206-4.0	
19	EMERGENCY MDO/MGO PUMP UNIT	B91-159929-7.3	
20	PRE-LUBRICATING OIL PUMP	B92-161311-3.A	
21	SHUT-OFF VALVE FOR COOLING WATER	B92-165276-5.5	
22	EXPANSION JOINT FOR T/C OUTLET	B93-040263-9.1	
23	RUBBER HOSE FOR T/C CLEANING	B12-116265-8.8	
24	ELECTRIC PREHEATER FOR JACKET WATER	B91-306523-7.2	
25	STARTING BOX & TERMINAL BOX	B94-185596-5.2	
26	POWER SUPPLY UNIT FOR TERMINAL BOX	B94-168016-4.2	
27	PRE-L.O.P/P & J.W.PREHEATER STARTER	B94-185601-1.3	
28	LIST OF SPARE PARTS	B94-307120-7.2	
29	LIST OF TOOLS	B94-307121-9.0	

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PLAN HISTORY	ENGINE	HYUNDAI-HiMSEN
	TYPE	3 x 9H21/32 - 900rpm(HR)
	MESSRS	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : TECHNICAL ENGINE SPECIFICATION FOR DIESEL GENERATOR ENGINE

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Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
				*		5
				*		4
				*		3
20200413	PBK	KCM	PJK	*	For working	2
20191230	PBK	KCM	PJK	*	Chg. Gas data	1
20191114	CWS	KCM	PJK	*	For approval	0

Similar drawing No.:	Replacement for Ident. No.:		
Licensor Ident. No.:	Type: 9H21/32(HR)	Confidential : B	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No.:	Description: TECHNICAL ENGINE SPECIFICATION		Ident.no.: B94-307119-8
Page. No. 01 OF 10			

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1. GENERAL

1.1 RULES AND REGULATIONS

The diesel engine shall be complied with the requirements of the following rules and regulations of the latest issue.

. Classification Society : LR
. Application Standards : KS, JIS or DIN
. Miscellaneous : Engine manufacturer's standards

1.2 INSTALLATIONS

The engine is directly coupled with disc plate to the alternator and placed together on the common base frame fabricated in steel plate.
The genset is mounted with resilient vibration-free isolators onto the hull foundation.

1.3 PIPE CONNECTION FLANGES

Pipe connection flanges of the engine connected to the hull piping are provided in accordance with JIS standards if not mentioned otherwise.
All counter flanges are to be provided by shipyard.

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1.4 LANGUAGE

All name/instruction plates are written in English.

1.5 PAINTING

All parts of casting surfaces are coated with anti-corrosive primer and finally painted of the engine exterior surfaces in Munsell no. 5 PB 4/4

1.6 FUEL OIL

The engine together with proper external feed system can be operated on Residual marine fuels of viscosity up to 700 cSt at 50℃, which corresponds to the grades of ISO8217(2017).
The viscosity at engine inlet should be kept as follows depending on the used fuel oil.

* Residual fuel oil (HFO): 12 ~ 18 cSt.
* Distillated fuel oil (MDO/MGO): 2 ~ 14 cSt. (Recommended stable viscosity at engine inlet: Min. 3 cSt)

1.7 LUBRICATING OIL

For the engine, a HD-lubricating oil (heavy duty) corresponding to at least type CD Commercial Class D according to the API service system has to be used.
The viscosity with SAE 40 (145 cSt at 40℃) is always to be used.

2. PRINCIPAL PARTICULARS

2.1 DIESEL ENGINE

Vertical in-line, 4-cycle, direct injection, single acting, trunk piston type with exhaust turbocharged and charge air cooled design

. Model	: 9H21/32	(HR)
. No. of cylinder	: 9	
. Cylinder bore x piston stroke	: 210 mm x 320 mm	
. Out-put at MCR	: 1980 kW at 900 rpm according to ISO 3046/1	
. Brake-mean effective pressure	: 26.5	kg/cm^2
. Mean piston speed	: 9.6	m/s
. Maximum combustion pressure	: **	kg/cm^2
. Dry weight of genset (approx.)	: Refer to General arrangement drawing	
. No. of diesel engine	: 3	set(s)/ship
. Rotating direction (seen from flywheel)	: Clock-wise	

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**) Note

. Please refer to the actual data on the shop test result for each project.

. Allowable deviation of individual cylinders from average of total cylinders : ± 5 kg/cm^2

2.2 ALTERNATOR

. Supplier	: Shipyard
. Maker	: Hyundai-Electric
. Alternator model	: HFC7 638-08P
. Alternator capacity	: 1,880 kW / 60 Hz / 450 VAC

3. DESCRIPTION OF MAJOR COMPONENTS

3.1 CHARGE AIR COOLER

. Tube with fin type, one stage, attached water mist catcher.

3.2 TURBOCHARGER

. Pulse charging type, un-cooled casings, no water connections
. Lubrication by engine system oil with SAE 40.
△2 . Model : A140, Maker : ABB

3.3 GOVERNOR

. Speed adjustment (synchronizer), speed droop and load limit controls are standard feature.
△2 . Model : UG25 P3+, Maker : Woodward

3.4 TURNING FOR FLYWHEEL

. Manual turning by ratchet with turning rod.

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3.5 COMPRESSED AIR SYSTEM

. Supply of compressed air of max. 30 kg/cm^2 is required from the starting air reservoir, and the compressed air is reduced through a pressure regulating valve for starting the engine by air motor starter.

3.6 COOLING WATER SYSTEM

. The cooling water system consists of a low temperature system and a high temperature system.
. Both HT cooling water pump and HT thermostatic valve are mounted on engine.

3.7 FUEL OIL SYSTEM

. The fuel injection equipments comprise an injection pump, a connection block, an injection pipe and an injection valve, which are installed on each cylinder in line. Fuel oil safety filter, duplex manual 50 micron, is mounted on engine.

3.8 LUBE OIL SYSTEM

. The engine driven main L.O pump, electric motor driven prelubricating pump, 15 micron safety filter, and pressure regulating valve are mounted on engine.

3.9 ENGINE CONTROL AND MONITORING SYSTEM

. All media systems are equipped with temperature sensors and pressure sensors for local reading on engine monitoring panel and remote reading on ship's system. Transmission to the alarm system in control room is made by MODBUS communication.
. The numbers and types of pressure/temperature sensors are chosen according to engine manufacturer's standard and requirement of classification societies.
. The engine has shut-down functions as standard for lubricating oil pressure low, cooling water temperature high and for overspeed.

3.10 ENGINE SHUT-DOWN AND OVERSPEED STOP

. The engine shut-down and overspeed trip can be done by an electro pneumatic on-off valve.

3.11 MATERIAL SPECIFICATION OF MAJOR COMPONENTS

. Engine block	:	Gray cast iron
. Front end block	:	Gray cast iron
. Crankshaft	:	Forged, hardened and tempered Cr-Mo steel
. Connecting rod	:	Forged, hardened and tempered Cr-Mo steel
. Piston	:	Maker standard
. Cylinder head	:	Spherical graphite cast iron
. Cylinder liner	:	Special alloy cast iron
. Exhaust and inlet valve spindles	:	Heat treated Cr-Mn-Si alloy
. Fuel injection pump & valve	:	Maker standard
. Turbocharger	:	Maker standard
. Governor	:	Maker standard

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4. ENGINE AUXILIARY EQUIPMENT

The following accessory components are equipped on the engine except (*) marked components which shall be delivered separately.
The quantities of components are provided as per each engine, unless otherwise mentioned.

4.1 FUEL OIL SYSTEM

. Fuel injection equipment on each cylinder
. Fuel leakage tank with level switch
. Fuel oil safety filter, duplex manual (50 micron)
(*) . Air motor driven emergency MGO pump unit (1 set/ship)
(*) . Pressure control valves on external fuel piping (each 1 pc/ship)

4.2 LUBRICATING OIL SYSTEM

. Engine driven lube oil pump
. Plate type lube oil cooler
. Lube oil thermostatic valve, wax type
. Duplex lube oil filter (15 micron)
. Pressure regulating valve
. Electric motor driven prelubricating pump
. Centrifugal by-pass filter

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4.3 COOLING WATER SYSTEM

. Engine driven HT-cooling water pump
. HT-cooling water thermostatic valve, wax type
. Electric preheater
(*) . Cooling water shut-off valve for cooling water inlet

4.4 AIR INTAKE AND COMPRESSED AIR SYSTEM

. Intake mat filter on turbocharger as standard specification
. Air motor starter for engine starting
. Main starting / emergency starting valve
. On-off valve for engine stop and over speed stop

4.5 COMBUSTION AIR AND EXHAUST SYSTEM

. Charge air cooler with water mist catcher, one stage
. Exhaust gas turbocharger, pulse charging
. Water cleaning device for turbocharger compressor
. Wet cleaning device for turbocharger turbine
. Expansion joint for turbocharger outlet
. Air Waste Gate valve (AWG Valve) for SCR operation.

4.6 CONTROL AND MONITORING SYSTEM

. Governor for speed control
. Safety system
  - Overspeed trip
  - High HT-water temperature trip
  - Low lubricating oil pressure trip
. Supervision module
  - Main control unit
  - Operation box
  - Monitoring of temperature / pressure
  - Monitoring of exhaust gas temperature
(*) . Control box for prelubricating oil pump and J.W.heater starter (1 group panel/ ship)
(*) . Control panel for AWG
(*) . Power supply unit

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4.7 MISCELLANEOUS

. Resilient mounting with conical rubber elements
(*) . Flexible hoses for external pipe connections
. Engine gallery with ladder

5. SPARE PARTS AND TOOLS

The spare parts and tools are provided in accordance with engine manufacturer's standards practice and the requirement or recommendation of each relevant classification society.

5.1 STANDARD SPARE PARTS ---------- One(1) set per ship

5.2 STANDARD TOOLS ---------- One(1) set per ship

6. WORKSHOP TEST

The engine shop trial is carried out in accordance with engine manufacturer's standard practice and the requirement of each relevant classification society. The shop trial shall be done under the engine being coupled with alternator and use of RMA 10 Grade(ISO 8217 : 2017) or equivalent.

6.1 START-UP

6.2 LOAD TEST in % of engine output
. 30 minutes at 25% load (*)
. 30 minutes at 50% load (*)
. 30 minutes at 75% load
. 60 minutes at 100% load
. 30 minutes at 110% load (**)

(*) : Test report review as per HHI's standard practice
(**) : Only available at engine workshop

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6.3 FUEL CONSUMPTION MEASUREMENT at 50% & 100% load of MCR

6.4 GOVERNOR TEST by 3-step load application

6.5 PARALLEL RUNNING TEST

6.6 SAFETY FUNCTION TEST for emergency trip

6.7 MECHANICAL VIBRATION MEASUREMENT at MCR only

6.8 OVERHAUL INSPECTION in one(1) cylinder per ship

6.9 NOx CERTIFICATION according to IMO NOx regulation

6.10 CRANKSHAFT DEFLECTION MEASUREMENT at both cold and hot condition

7. ENGINE CHARACTERISTICS

7.1 ENGINE PERFORMANCE

	. Specific fuel oil consumption *)	: approx 189	g/kWh +5% at MCR
⚠1	. Combustion air consumption	: 12,367	kg/h, tolerance +/- 5%
⚠1	. Exhaust gas flow	: 12,739	kg/h, tolerance +/- 5%
	. Allowable exhaust gas back pressure	: 0.05	kg/cm^2, max.
	. Engine noise level	: Max.110	dB(A) in IMO limit.
	. NOx emission	: Max.9.2	g/kWh in IMO limit
	. Load-up application	: 3	steps

*) The SFOC value is stated under condition of
- . ISO 3046/1 reference condition
- . Fuel oil based on RMA 10 Grade(ISO 8217 : 2017) or equivalent, Lower calorific value 42,700 kJ/kg at shop test
- . With engine driven pumps(L.O pump and H.T cooling water pump only)

7.2 REFERENCE UTILITIES

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. HT & LT cooling water volume on engine	: 354	liter
. Minimum water volume on expansion tank	: 100 + (*)	liter / 3 engine(s)
. Minimum expansion tank height	: 5 meter above the crankshaft level	
. Maximum air source for engine starting	: 30	kg/cm^2 compressed air
. Fuel oil supply pump (head)	: 0.65	m^3/h x 4 kg/cm^2/engine
. Fuel oil booster pump (head)	: 1.31	m^3/h x ** kg/cm^2/engine

(*) : Min. 10% of the HT & LT water volume of additional engine(s).
(**) : 8 kg/cm^2 at engine inlet (F1 connection)
Note : Cooling water pressure at engine inlet to be kept under 2.5 kg/cm^2 by shipbuilder.

7.3 LIST OF CAPACITY

. Minimum ambient air temp. for starting	: 0	℃
. Minimum preheating of jacket for starting	: 60	℃
. Minimum preheating of lube oil for starting	: 40	℃
. Maximum ambient temperature of E/R	: 45	℃
. Air consumption per start(Incl. jet air)	: 2.30	Nm^3
. Capacity of engine driven pumps		
. Lubricating oil pump	: 65	m^3/h Gear
. HT-cooling water pump	: 50	m^3/h Centrifugal

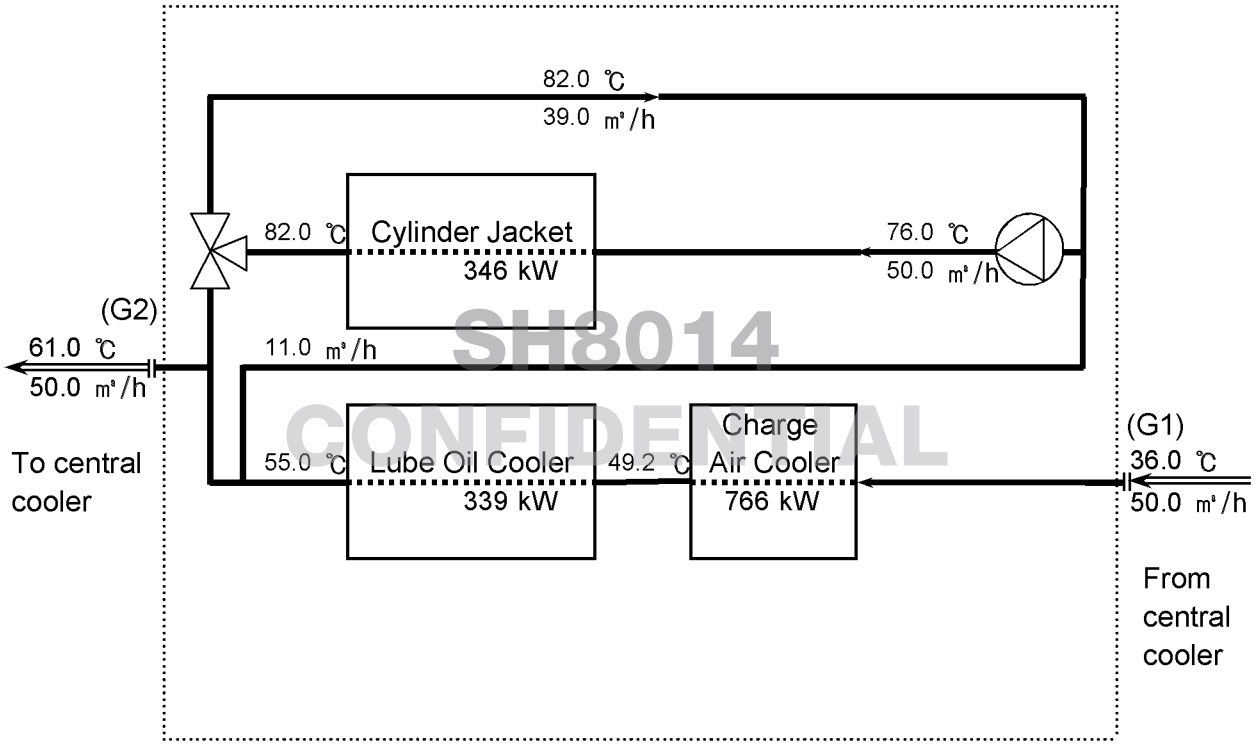
Heat Dissipation (Tropical condition, Tolerance 10%)

Cylinder jacket	:	346	kW
Lubricating oil	:	339	kW
LT-Charge air	:	766	kW

HT-Water Pump : 50 ㎥/h

HT-Thermostatic Valve : 82 ℃ Set

Cooling Media : 36 ℃ / **Max**, External Fresh Water



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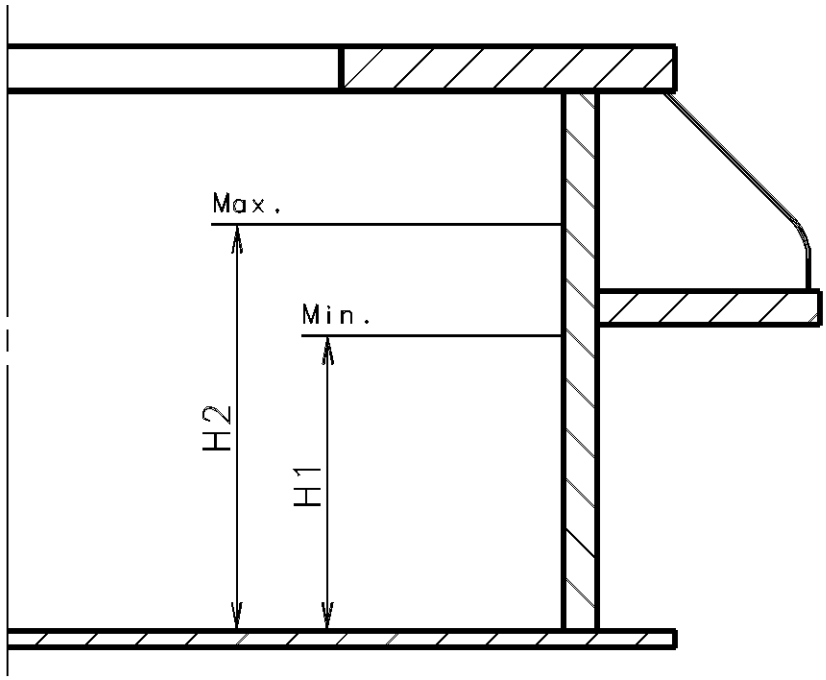
C.W. inlet temp : 36 ℃ , then C.W. outlet temp : 61.0 ℃
C.W. flow rate : 50.0 ㎥/h

* At different C.W. inlet temp., the outlet temp. and flow will be changed accordingly.

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No.
				*	*	Replaced by Ident. No. :	5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
20170403	YYC	SWS	RYS	*	*	For IMO Nox Tier III (HR) New design	0

Similar Drawing No. :			Replacement of Ident. No. :	
Scale : N.S.	Size : A4	Type : 9H21/32 - 900 rpm - 1 String	Page No. : 01 (01)	
Info. No. :	Description : HEAT CALCULATION DIAGRAM			Ident. No. : B94-167252-4

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Type H21/32	Unit	5 Cyl.	6 Cyl.	7 Cyl.	8 Cyl.	9 Cyl.
Min.level H1	mm	320	320	320	320	320
Max.level H2	mm	400	400	400	400	400
Min.volume	liter	750	840	940	1080	1140
Max.volume	liter	930	1040	1170	1350	1420

Standard for surface roughness(ISO 1302-1978)

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
$R_a$max.(μm)	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)

Basic size range(mm)	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

Supplement Dwg no.:

Projection:

Mass (kg):

Material / Blank:

Licensor's Ident. no.: —

Dist.:

Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
070608	KKH	KSR	KSR	*	*	Added to 5 cyl.	4
041203	GJH	RYS	RYS	*	*	CHANGED VOLUME	3
031208	GJH	RYS	RYS	*	*	MIN. CHANGED.	2
030610	GJH	KSR	KSR	*	*	Added to 1000RPM	1
011029	PDS	PDS	LJH	*	*		0

Similar Drawing No.: —

Replacement of Ident. No.:

Scale: 1 : 1

Size: A4

Type: H21/32(900/1000rpm)

Page No.: 01 (01)

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Info. No.: -

Description: LUB. OIL IN BASE FRAME

Ident. No.: B94-000419-0

CAD Drawing - do not correct by hand

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PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN DIESEL ENGINE
	MESSRS	ENGINE BUYER

TITLE : INSTALLATION & COMMISSIONING GUIDANCE

- INDEX LIST -

1. FUEL OIL SPECIFICATION & FUEL OIL QUALITY (P.12) ---------- B94-180665-3
2. LUBRICATING OIL (P.8) ---------- B94-180666-5
3. COOLING WATER TREATMENT (P.7) ---------- B94-176487-8
4. LOW LOAD OPERATION (P.2) ---------- B94-180668-9
5. PRESERVATION AND STORAGE (P.11)----------B94-029033-0

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Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
20200603	KWJ	KCM	PJK	*	Updated Cooling Water Treatment	9
20200519	KWJ	KCM	PJK	*	Updated Fuel Oil Specification&List of Lubricating oil	8
20200311	KWJ	KCM	PJK	*	Updated List of Lubricating oil	7
20191218	KWJ	KCM	PJK	*	Updated Fuel oil specification	6
20191209	KWJ	KCM	PJK	*	Updated List of Lubricating oil & Preservation and storage of engine	5
20190306	JDH	KCM	PJK	*	Updated List of Lubricating oil & Cooling Water Treatment	4
20190213	JDH	KCM	PJK	*	Updated Fuel Oil Specification & Lubricating Oil Specification	3
20181205	JDH	KCM	PJK	*	Change fuel oil quality	2
20180207	JDH	PJK	KHS	*	Change lubricationg oil chart	1
20170720	LDJ	BYJ	RKS	*	First issue	0

Similar drawing No.:	Replacement for Ident. No.:		
Licensor Ident. No.:	Type: DIESEL ENGINE	Page. No.: 01 (41)	Confidential : B
Info. No.:	Description: INSTALLATION & COMMISSIONING GUIDANCE	Ident.no.: B94-180669-0	

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PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN DIESEL ENGINE & DF ENGINE
	MESSRS	ENGINE BUYER

TITLE : FUEL OIL SPECIFICATION & FUEL OIL QUALITY

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Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
						6
						5
						4
20200519	KWJ	KCM	PJK	*	Updated Fuel oil specification	3
20191218	KWJ	KCM	PJK	*	Updated Fuel oil specification	2
20190320	JDH	KCM	PJK	*	Updated. Fuel Oil Specification & Fuel Oil Quality	1
20170904	YYC	SWS	RYS	*	First issue	0

Similar drawing No.:	Replacement for Ident. No.:
Licensor Ident. No.:	Type: DIESEL ENGINE & DF ENGINE
Info. No.:	Description: FUEL OIL SPECIFICATION & FUEL OIL QUALITY
Page. No.: 01 OF 12	Ident.no.: B94-180665-3

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

1. 일반사항

엔진은 최고 700cSt at 50℃의 점도를 가진 잔사유(HFO)로 운전 가능하다. 이 값은 ISO8217(2017)에 따라 RMK700의 등급에 해당된다. 이 엔진은 저 점도의 혼합 연료뿐만 아니라 정제유(MDO/MGO)로도 운전 가능하다.

요구되는 정제유 (MDO/MGO)의 품질은 ISO8217 (2017) 내에 ISO-F-DMA, DFA, DMZ, DFZ, DMB 그리고 DFB 등급에 따르고 있다.

연료는 아래와 같이 엔진에 공급되기 전 정제되고 예열되어야 한다.

2. 연료 처리 과정

1) 정제

잔사유는 항상 고체 입자, 소금 및 물 등으로 오염되어 있기 때문에 원심분리기로 반드시 정제되어야 한다.

연료의 고체 오염물질은 피스톤 링과 실린더 라이너의 과도한 마모를 유발하거나, 연료 분사 펌프와 연료 분사 밸브의 고착을 일으킬 수 있다.

연료 내에서의 액체 오염 물질은 배기 시스템과 터보과급기 뿐만 아니라 연료 분사 펌프와 연료 분사 밸브의 부식 및 공동현상을 일으킬 수 있다.

그러므로 적합한 분리 장치가 외부 연료 시스템에 설치되어야 한다. 잔사유(HFO/MDO(RMA)) 및 정제유(MGO/MDO)는 선상에서 쉽게 오염되기 때문이다.

연료의 원심분리는 원심분리기 메이커 메뉴얼에 따른다.

1. General

The engine can be operated on Residual fuel oil (HFO) of viscosity up to 700cSt at 50℃, which corresponds to the grades of ISO8217(2017). It can be also operated on blended fuels of lower viscosity as well as distillate fuel oil (MDO/MGO).

The quality requirements for MDO/MGO shall be in accordance with ISO-F-DMA, DFA, DMZ, DFZ, DMB and DFB grade in ISO8217(2017).

The fuel should be cleaned and preheated before entering the engine as follows.

2. Fuel Treatment

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1) Purification

Residual fuel oil should be purified by centrifuging because the fuel oils are always contaminated with solid particles, salt and water etc.

Solid contaminants in the fuel oils can cause excessive wear to the piston rings and cylinder liners or seizure of fuel injection pump and fuel valve.

Liquid contaminants in the fuel oils can cause fouling of exhaust systems and turbochargers as well as corrosion and cavitations of fuel injection pumps and fuel valves.

Therefore qualified separation equipment should be included in the external fuel oil system not only for HFO/MDO(RMA) but also for MDO/MGO which is easily contaminated on board.

Fuel oil separation should be carried out accordance with separator maker's manual.

2) 가열

엔진으로 들어가는 RMB30 이상 RMK700 이하의 잔사유(HFO)는 12 ~ 18 cSt의 점도를 유지하고 있어야 한다. (단, 정제유 및 RMA10 잔사유(MDO)의 엔진 입구에서의 요구 점도:2~14 cSt(권장되는 안정적 엔진 입구 점도 : 최소 3 cSt)) 그러나, 점도는 연료의 물성치 및 온도에 따라 변한다. 중유(HFO)의 최대 예열 온도는 155℃로 제한되어 있으며, 이는 연료 시스템에서 연료의 기포발생을 막기 위해서 이다. 따라서, 연료는 공급자의 권고대로 가열되어야 한다.

온도에 대한 연료의 대표적인 점도 선도가 다음 페이지에 나타나 있다.

3) 점도의 제어(잔사유)

12 ~ 18 cSt의 분사 점도를 유지하기 위해, 가열기는 연료가 엔진 연료 시스템에 들어가기 전에 자동 점도 조절기에 의해 제어되어야 한다.

⚠ 경 고 *고 점도 또는 저 점도로 인해 연료분사 시스템에 심각한 손상을 초래할 수 있습니다.*

2) Heating

The viscosity of residual fuel oil(HFO) between RMB30 and RMK700 to the engine should be kept within the value of 12 ~ 18 cSt. (Viscosity range at engine inlet for distillate fuel oil and RMA10 fuel oil(MDO) :2~14 cSt(Recommended stable viscosity at engine inlet: Min. 3 cSt)) However, the viscosity varies depending on the properties and the temperature of the fuel oil. Maximum preheating temperature of HFO is limited up to 155℃ to avoid vaporing in fuel system. Therefore, the fuel should be heated according to the suppliers' recommendation.

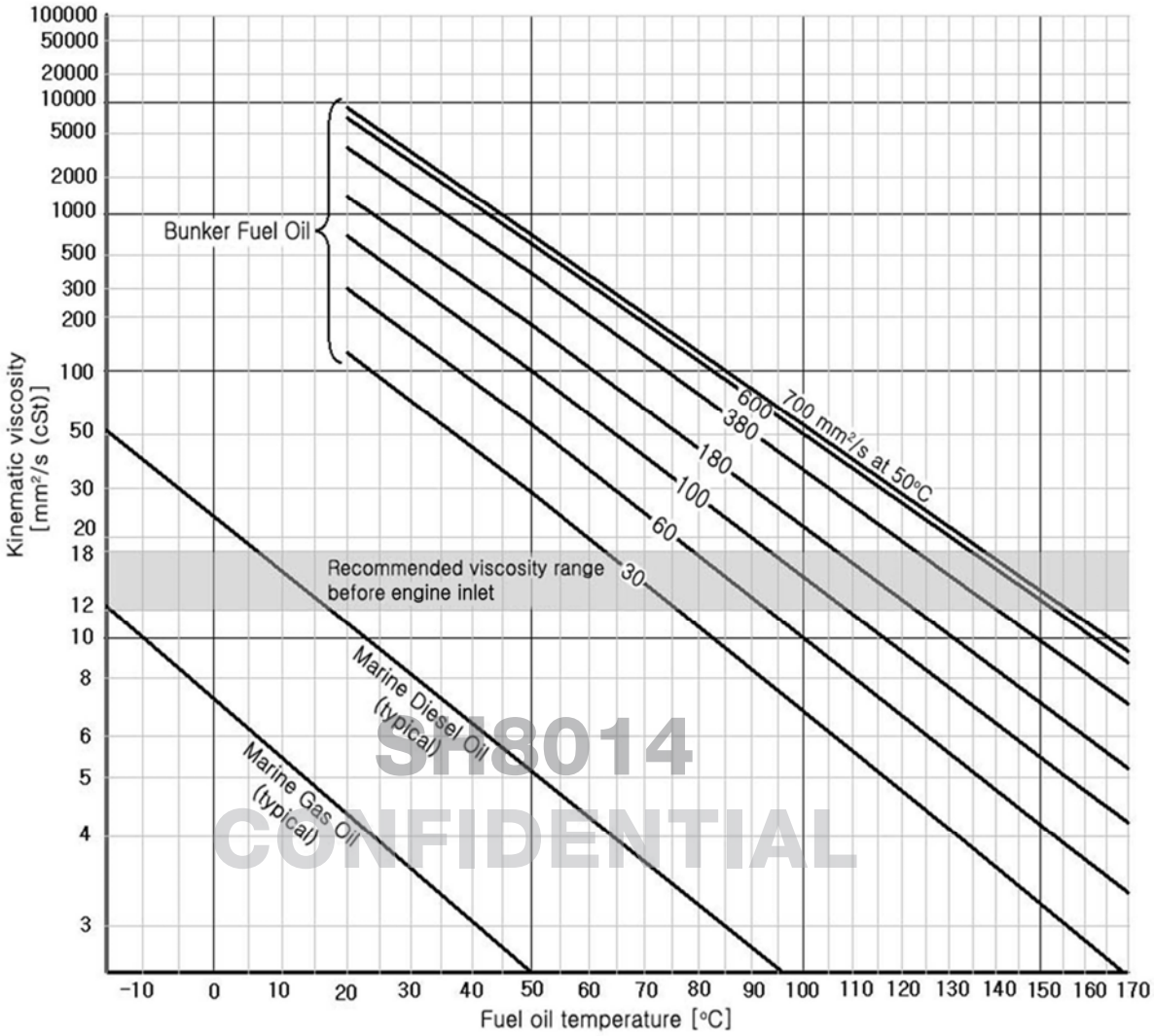
A typical fuel oil viscosity diagram regarding temperature is next page.

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3) Viscosity Control(Residual fuel oil)

In order to ensure correct injection viscosity of 12 ~ 18 cSt, the heater are to be controlled by an automatic viscosity controller before the fuel enters into the engine fuel system.

⚠ WARNING ***Higher or lower viscosity may cause serious damages on fuel injection system.***



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3. 저유황유 사용 가이드

1) 저유황유(0.5%이하 황 함유 연료유)는 동일 연료 등급 안에서 각 배치별로도 다양한 특성(고점도에서 저점도, 밀도, 유동점)을 갖는다.

2) 점도계를 엔진 입구에 설치하여 적절하게 작동시킨다.

3) 가열 혹은 냉각 장치를 설치하여 적절하게 작동시킨다.

4) 연료유간 호환성 문제를 피하기 위해 다른 배치의 연료유 혼합을 제한한다.
만약 피할수 없다면 다른 배치의 연료유 호환성 (ASTM D4740, "spot-test") 여부를 체크한다.

3. Guidance of using Low sulfur fuels

1) Low sulfur fuels(max. 0.5% sulfur fuels) show diverse characteristics(e.g. high to low viscosity, density and pour point) from batch to batch.

2) Ensure that the viscometer before the engine is installed and working properly.

3) Ensure that heating and cooling equipment is installed and working properly.

4) Do not mix different fuel batches to avoid compatibility issues.
If mixing cannot be avoided, check compatibility(ASTM D4740, "spot-test")of the different fuel batches.

5) 상이한 점도간 0.5% S 저 유황유의 교체 관련 사항은 매뉴얼 G05300 을 참조한다.

6) 연료유 오토 백 플러싱 필터의 청소 주기가 증가한다면, 엔진 보호를 위해 반드시 연료유 처리 시스템은 최적화 시켜야 한다.

5) For change-over between 0.5% S VLSFO with different viscosity, see the manual Sec. No. G05300.

6) When the number of cleaning cycles for the automatic back flushing filter increased, the fuel oil treatment system must be optimized to protect engine.

4. 표준 연료 특성치

엔진은 정격 출력의 감소 없이 다음과 같은 사양을 가진 연료로 연속 운전되도록 설계되었다.

4. Standard Fuel Oil Characteristics

The engine is designed to operate continuously on the fuels with the following specifications without reduction of the rated output.

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Distillate Fuel Oil

Characteristics		Unit	Limit	Category ISO-F-							Test Method Reference
				DMX	DMA	DFA	DMZ	DFZ	DMB	DFB	
Kinematic viscosity at 40°C		mm^2/s [a]	max.	5.5	6.0		6.0		11.0		ISO 3104
			min.	1.4	2.0		3.0		2.0		
Density at 15°C		kg/m^3	max.	-	890.0		890.0		900.0		ISO 3675 or ISO 12185
Cetane index		-	min.	45	40		40		35		ISO 4264
Sulfur [b]		mass %	max.	1.0	1.0		1.0		1.5		ISO 8754 ISO 14596 ASTM D4294
Flash point		°C	min.	43.0	60.0		60.0		60.0		ISO 2719
Hydrogen sulfide		mg/kg	max.	2.0	2.0		2.0		2.0		IP 570
Acid number		mg KOH/g	max.	0.5	0.5		0.5		0.5		ASTM D664
Total sediment by hot filtration		mass %	max.	-	-		-		0.10 [c]		ISO 10307-1
Oxidation stability		g/m^3	max.	25	25		25		25 [d]		ISO 12205
Fatty acid methyl ester(FAME)[e]		volume %	max	-	-	7.0	-	7.0	-	7.0	ASTM D7963 or IP579
Carbon residue: micro method on the 10% volume distillation residue		mass %	max.	0.3	0.30		0.30		-		ISO 10370
Carbon residue: micro method		mass %	max.	-	-		-		0.30		ISO 10370
Cloud point [f]	Winter	°C	max.	-16	report		report		-		ISO 3015
	summer	°C	min	-16	-		-		-		
Cold filter plugging point [f]	Winter	°C	max.	-	report		report		-		IP 309 OR IP 612
	summer	°C	min	-	-		-		-		
Pour point (upper) [f]	Winter	°C	max.	-	-6		-6		0		ISO 3016
	summer	°C	max.	-	0		0		6		
Appearance		-	-	Clear and bright [g]					[c]		
Water		volume %	max.	-	-		-		0.30 [c]		ISO 3733
Ash		mass %	max.	0.01	0.01		0.01		0.01		ISO 6245
Lubricity, corrected wear scar diameter (WSD 1,4) at 60°C [h]		µm	max.	520	520		520		520 [d]		ISO 12156-1

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a) *1 mm^2/s = 1 cSt*

b) *Notwithstanding the limits given, a purchaser shall define the maximum sulfur content in accordance with relevant statutory limitations. See Introduction of ISO 8217:2017.*

c) *If the sample is not clear and bright, the total sediment by hot filtration and water tests shall be required. See 6.8 and 6.12 of ISO 8217:2017.*

d) *If the sample is not clear and bright, the test cannot be undertaken and therefore, compliance with this limit cannot be shown.*

e) *See 5.1 and Annex A ISO 8217:2017.*

f) *Pour point cannot guarantee operability for all ships in all climates. The purchaser should confirm that the cold flow characteristics (pour point, cloud point, cold filter plugging point) are suitable for the ship's design and intended voyage. See 6.11 ISO 8217:2017.*

g) *If the sample is dyed and not transparent, then the water limit and test method as given in 6.12. ISO 8217:2017 shall apply.*

h) *This requirement is applicable to fuels with a sulfur content below 500 mg/kg (0.050 mass %).*

Residual Fuel Oil

Characteristics	Unit	Limit	Category ISO-F-											Test method reference
			RMA	RMB	RMD	RME	RMG				RMK			
			10	30	80	180	180	380	500	700	380	500	700	
Kinematic viscosity at 50°C	mm^2/s [a]	max.	10.0	30.0	80.0	180.0	180.0	380.0	500.0	700.0	380.0	500.0	700.0	ISO 3104
Density at 15°C	kg/m^3	max.	920.0	960.0	975.0	991.0	991.0				1,010.0			ISO 3675 or ISO 12185
CCAI	-	max.	850	860	860	860	870				870			
Sulfur [b]	mass %	max.	Statutory requirements *)											ISO 8754 ISO 14596 ASTM D4294
Flash point	°C	min.	60.0	60.0	60.0	60.0	60.0				60.0			ISO 2719
Hydrogen sulfide	mg/kg	max.	2.0	2.0	2.0	2.0	2.0				2.0			IP 570
Acid number [c]	mg KOH/g	max.	2.5	2.5	2.5	2.5	2.5				2.5			ASTM D664
Total sediment aged	mass %	max.	0.1	0.1	0.1	0.1	0.1				0.1			ISO 10307-2
Carbon residue: micro method	mass %	max.	2.5	10.0	14.0	15.0	18.0				20.0			ISO 10370
Pour point (upper) [d] winter	°C	max.	0	0	30	30	30				30			ISO 3016
Pour point (upper) [d] Summer	°C	max.	6	6	30	30	30				30			ISO 3016
Water	volume %	max.	0.30	0.50	0.50	0.50	0.50				0.50			ISO 3733
Ash	mass %	max.	0.04	0.07	0.07	0.07	0.10				0.15			ISO 6245
Vanadium	mg/kg	max.	50	150	150	150	350				450			IP 501, IP 470 or ISO 14597
Sodium	mg/kg	max.	50	100	100	50	100				100			IP 501, IP 470
Aluminum plus silicon	mg/kg	max.	25	40	40	50	60				60			IP501, IP 470 or ISO 10478
Used lubricating oils (ULO) calcium and zinc; or calcium and phosphorus	mg/kg	-	Do not use if : calcium > 30 and zinc > 15 or calcium > 30 and phosphorus > 15											IP 501 or IP 470 IP 500

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a) *1 mm^2/s=1 cSt*

b) *The purchaser shall define the maximum sulfur content in accordance with relevant statutory limitations.*

c) *See Annex H of ISO 8217:2017.*

d) *The purchaser should confirm that this pour point is suitable [or the ship's intended area of operation.*

*) *International statutory requirements*

This document specifies allowable minimum flash point limits following the provisions given in the SOLAS convention. MARPOL Annex VI, which controls air pollution from ships, includes a requirement that either the fuel shall not exceed a specified maximum sulfur content or an approved equivalent alternative means be used. During the lifetime of this document, regional and/or national bodies may introduce their own local emission requirements, which can impact the allowable sulfur content, for example, the EU Sulphur Directive. It is the purchaser's and the user's responsibility to establish which statutory requirements are to be met and specify on that basis the corresponding maximum fuel sulfur content to the supplier.

1. 연료 특성

1) 점도

엔진의 연료 점도는 중유의 경우 12 ~18 cSt, 경유의 경우 2~14 cSt 의 범위 안에 있어야 한다. 이것은 점도가 연료의 특성에 따라 변하기 때문에, 오일 공급자가 제시하는 적당한 가열에 의해 원하는 점도의 연료를 얻을 수 있다.

2) 밀도

만일 연료의 밀도가 최대 밀도 (15℃에서 991 kg/m^3) 보다 크다면, 원심 분리에 의해 제거되지 않는 수분과 고체 불순물 때문에 연료는 사용될 수 없다. 최대 밀도 (15℃에서 1010 kg/m^3) 인 연료를 사용하기 위해서는 특별한 원심 분리 장치가 설치되어야 한다.

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3) 유황

연료의 황 성분을 적절히 유지하는 것이 중요하다. 연료에 다량의 황 성분은 연소실 주변에 저온 부식의 위험을 증가시킨다. 그리고 고온 침전물의 생성을 촉진하기도 한다. 따라서 중성화를 위한 윤활유의 적절한 알칼리를 유지시키는 것이 바람직하다.

4) 재

재 성분은 천연 원유 또는 연료를 정제 시 발생하는 오염물질로부터 생성된다. 고체 성분은 대부분 연료의 원심분리로 제거할 수 있다. 그러나 연소 후 재로 변형될 수 있는 바나듐이나 소듐과 같은 용해성 성분이 있다.

1. Fuel Characteristics

1) Viscosity

The viscosity of fuel oil to the engine should be kept within the value of 12 ~18 cSt (Heavy fuel oil) and 2~14 cSt (Diesel fuel oil) which could be achieved by proper heating recommended by fuel supplier as the viscosity varies depending on the properties of the fuel oil.

2) Density

If the density of the fuel oil is above the maximum density (991 kg/m^3 at 15℃), the fuel cannot be used because of water and solid contaminants which are not removed by a centrifuging. The special centrifuging system should be installed to use the fuel oil with the maximum density (1010 kg/m^3 at 15℃).

3) Sulfur

It is important to keep proper sulfur contents in the fuel oil. The high sulfur content in the fuel may increase the risk of low temperature corrosion in the combustion chamber and contribute to the formation of high temperature deposit. It is also recommended to keep the proper alkalinity of the lubricating oil for neutralizing.

4) Ash

The ash content comes from natural crude oil and also from contamination during treatment of the fuel. The solid ingredients can be removed mostly by centrifuging of the fuel. However there are soluble compounds such as vanadium and sodium, which can be transformed as ash after combustion.

어떠한 형태로든 재가 엔진 부품의 기계적인 마모와 연소실에서의 불순물을 촉진시키므로, 사전에 주의 깊은 분석을 통해 제거 하여야 한다.

5) 바나듐과 소듐

바나듐은 오일에 용해 되어져 있으며 대부분 원유로부터 발생한다. 그러나 소듐은 물에 용해 되어져 있으며 바닷물에 의한 오염된 연료 뿐만 아니라 원유로부터 발생된다. 바나듐과 소듐은 연소 후에 부식성의 재로 만들어지므로, 이것들은 가능한 한 빨리 제거해야 한다. 소듐 성분은 배기 밸브와 터보과급기에 매우 부식성이 강하고 해로운 바나듐 재의 녹는 점을 낮추는데 기여를 한다. 따라서 소듐은 중량으로 바나듐 성분의 1/3 보다 작아야 한다.

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6) 콘라드슨 카본

다량의 콘라드슨 카본은 연료의 연소 성능을 떨어뜨리고, 특히 낮은 엔진 출력에서 연소실과 저 출력에서의 배기 시스템에 침전물의 형성을 유발시킨다.

7) 아스팔트

다량의 아스팔트 성분은 저 부하에서 배기 시스템뿐만 아니라 연소실에 침전물 생성을 촉진시키며, 연료 분사 펌프를 고착 시킬 수 있다. 또한 연료 시스템에 지나친 원심 슬러지와 침전물을 발생시킬 수 있다.

As the ash in any form promotes mechanical wear of engine parts and harmful deposits in the combustion chamber, the ash components should be carefully analyzed and removed in advance.

5) Vanadium and Sodium

Vanadium is oil – soluble and comes from crude oil mostly. However sodium is water-soluble and comes from crude oil as well as contaminated fuel by salt water. As vanadium and sodium become corrosive ash after combustion, these should be removed as possible. Sodium compounds contribute to lower the melting point of vanadium ash, which is very corrosive and harmful to exhaust valves and turbocharger. Therefore, compounds should be less than 1/3 of vanadium contents in weight.

6) Conradson Carbon

Including much conradson carbon may impair combustion properties of the fuel and cause deposit formation in combustion chamber and exhaust system particularly at low engine output.

7) Asphaltenes

High asphaltenes content may contribute to deposit formation in combustion chamber as well as exhaust system at low loads and stick the fuel injection pump. It also causes excessive centrifuge sludge and deposits in the fuel system.

8) 수분

표준화된 증류 시험에 의해서 수분 성분을 측정할 수 있다. 수분은 연료 분사 펌프의 부식 및 공동현상 그리고 배기 시스템과 터보 과급기의 상태악화 등을 야기시킨다. 수분 성분은 원심 분리에 의해 최대 0.2%까지 줄여야 한다.

9) 연마입자

연료는 알루미늄과 실리콘으로 구성된 연마입자에 의해 오염될 수 있다. 만일 효율적인 연료의 처리가 수행되지 않으면 분사 장치와 실린더 라이너 / 피스톤 링에 비정상적 마모가 발생할 수 있다. 알루미늄과 실리콘은 엔진 입구 전단에서 최대 15 mg/kg까지 줄여야 한다.

8) Water

The water content can be measured by a standardized distillation test. The water causes corrosion and cavitations of the fuel injection pump and fouling of the exhaust system and turbochargers. The water content should be reduced to maximum 0.2% by centrifuging

9) Abrasive Particles

Fuel oil can be contaminated by abrasive particles composed of aluminium and silicon. If the efficient fuel treatment is not applied, these fine catalysts can cause abnormal wear on injection system and cylinder liners / piston rings. The aluminium plus silicon should be reduced to maximum 15 mg/kg before engine inlet.

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2. 점화 특성

점화 특성은 연료 분사와 연소 사이의 간격을 나타내는 점화 지연과 관계가 있다. 만일 낮은 부하나 연소실에서의 저온 혹은 저압 상태에서 엔진이 작동된다면, 점화 지연은 길어진다. 처음 시동 시, 충분하게 예열하지 못한 엔진은 낮은 점화 특성으로 손상을 입을 수가 있다. 중유의 점화 특성을 얻기 위해 CCAI (Calculated Carbon Aromaticity Index) 방정식이 이용될 수 있다.

2. Ignition Quality

The ignition quality is related to the ignition delay that is the intervals between fuel injection and combustion. If the engine is operated at low load or in the condition of low temperature or pressure in the combustion chamber, the ignition delay is lengthened. During first operating, the engine can be damaged by the low ignition quality without sufficient preheating. The equation of CCAI (Calculated Carbon Aromaticity Index) developed by Shell can be used to get the ignition quality of the heavy fuel oil.

Calculated Carbon Aromaticity Index

$$CCAI = D - 81 - 141 \log [\log (V_k + 0.85)]$$

D = density (kg/m^3 at 15℃)

V_k = viscosity (cSt at 50)

알 림 *만일 CCAI값이 증가되었다면, 점화 특성은 감소된 값을 갖는다. 높은 CCAI 값을 갖는 연료는 연소 성능에 문제가 발생할 수도 있다.*

불량 점화를 예방하기 위해, 시동 전에 엔진은 충분히 예열되어야 하며, 냉각 시스템과 분사 시스템이 정상 작동해야 한다.

NOTICE ***If the value of CCAI is increased, the ignition quality has decreased value. The fuel oil with high CCAI value may be happened a combustion problem.***

To prevent any troubles about poor ignition quality, engine should be preheated sufficiently before starting and has proper functions of cooling system and injection system.

CCAI의 지침조건은 G05100의 Fuel oil specification을 참조한다.

The CCAI guidelines are specified in G05100 (Fuel oil specification).

3. 비 에너지

잔사유와 증류유의 순 비 에너지와 총 비 에너지는 다양한 국제 기준으로 계산된다. 일반적인 경우에는 연료 공급처에 의해 제공된 비 에너지가 연소열 계산에 사용된다. 하지만 비 에너지가 제공되지 않을 경우, 아래의 방정식을 통하여 순 비 에너지와 총 비 에너지를 계산 할 수 있다.

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잔사유의 경우.

$N = (46.704 - 8.802\rho^2 10^{-6} + 3.167\rho 10^{-3}) \times [1 - 0.01(w + a + s)] + 0.0942s - 0.02449w$

$G = (52.190 - 8.802\rho^2 10^{-6}) \times [1 - 0.01(w + a + s)] + 0.0942s$

증류유의 경우.

$N = (46.423 - 8.792\rho^2 10^{-6} + 3.170\rho 10^{-3}) \times [1 - 0.01(w + a + s)] + 0.0942s - 0.02449w$

$G = (51.916 - 8.792\rho^2 10^{-6}) \times [1 - 0.01(w + a + s)] + 0.0942s$

3. Specific Energy

From light distillates to residual fuels, net & gross specific energy can be tested or calculated according to various international standards. Basically, the specific energy value provided by fuel supplier is adapted for the determination of the heat of combustion. If it is not supplied from fuel supplier, it can be calculated by the specification of other properties as the equations given below.

For residual fuels,

$N = (46.704 - 8.802\rho^2 10^{-6} + 3.167\rho 10^{-3}) \times [1 - 0.01(w + a + s)] + 0.0942s - 0.02449w$

$G = (52.190 - 8.802\rho^2 10^{-6}) \times [1 - 0.01(w + a + s)] + 0.0942s$

For marine distillate fuels,

$N = (46.423 - 8.792\rho^2 10^{-6} + 3.170\rho 10^{-3}) \times [1 - 0.01(w + a + s)] + 0.0942s - 0.02449w$

$G = (51.916 - 8.792\rho^2 10^{-6}) \times [1 - 0.01(w + a + s)] + 0.0942s$

여기서.
N = 순 비 에너지[MJ/kg]
G = 총 비 에너지[MJ/kg]
ρ = 15℃ 밀도[kg/m3]
w = 수분 함유량[질량 %]
a = 재 함유량[질량 %]
s = Sulfur content [mass %]

참고) Ref. ISO 8217:2017(E)

* 실제 비 에너지 계측법(예시, ASTM D240)이 위에서 제시된 비 에너지 계산 방정식보다 우선 적용된다.

where
N = Net specific energy [MJ/kg]
G = Gross specific energy [MJ/kg]
ρ = Density at 15℃ [kg/m^3]
w = Water content [mass %]
a = Ash content [mass %]
s = Sulfur content [mass %]

Ref. ISO 8217:2017(E)

* Refer to that the actual specific energy test method (for example ASTM D 240) takes priority over the secific energy calculation method as above

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PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN DIESEL ENGINE
	MESSRS	ENGINE BUYER

TITLE : LUBRICATING OIL CHART

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Date	Des.	Chk.	Appd	A.C	Replaced by Ident. No.:	R
						9
						8
						7
20200519	KWJ	KCM	PJK	*	Updated List of Lubricating oil	6
20200311	KWJ	KCM	PJK	*	Updated List of Lubricating oil	5
20191209	KWJ	KCM	PJK	*	Updated List of Lubricating oil	4
20190306	JDH	KCM	PJK	*	Updated List of Lubricating oil	3
20190213	JDH	KCM	PJK	*	Updated List of Lubricating oil	2
20180207	JDH	PJK	KHS	*	Updated List of Lubricating oil	1
20170720	KCM	KJC	RYS	*	Changed text and cover	0

Similar drawing No.:	Replacement for Ident. No.:
Licensor Ident. No.:	Type: DIESEL ENGINE
Info. No.:	Confidential : B
Page. No. 01 OF 08	Description: LUBRICATING OIL CHART
	Ident.no.: B94-180666-5

HYUNDAI HEAVY INDUSTRIES CO., LTD.

1. 윤활유의 품질

윤활유는 엔진 시스템에 있어서 중요한 역할을 하며 다음과 같이 요약될 수 있다.

- 마찰력과 마모를 줄이기 위한 미끄럼 부분의 윤활
- 엔진 부품들의 냉각 (피스톤, 베어링 등)
- 피스톤 링의 시일링
- 세정제의 분산
- 연소 부산물의 중화

따라서 엔진 시스템 오일은 사용연료와 운전조건에 따라 이러한 기능을 충족시키도록 윤활유 공급자 또는 전문가와 상이하여 최종 선택하여야 한다. 추천할 만한 윤활유 상표는 별도로 목록이 되어 있고 새로운 윤활유의 기본적인 구비조건은 아래와 같다.

1. Quality of Lubricating Oil

Lubricating oil has significant roles for the engine system, which can be summarized as below;

- Lubrication of the sliding parts to reduce friction and wear.
- Cooling of the engine parts (piston, bearing, etc).
- Sealing of piston ring.
- Dispersion of detergent.
- Neutralization of combustion by products.

Therefore, engine system oil should be finally selected to fulfill these functions depending on the fuel used and the operating condition after consulting with lubricating oil supplier or specialist. The recommendable brand names of the lubricants are listed separately and the basic requirements of new oil are as follows:

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Oil grade	API service grade CD (MIL-L/2104C and D) for heavy duty marine diesel engine.
Viscosity	SAE 40(120-180 cSt @ 40 ℃)
Flash Point	Over 220 ℃
Pour Point	-15 ℃

BN은 아래와 같은 문제 발생을 피하기 위해 윤활유의 BN과 연료의 황 함유량이 균형을 이루는 것이 중요하므로 세심하게 선택 되어야 한다

- 고 유황 연료 + 저 BN 윤활유

→ 과도한 부식 마모

- 저 유황 연료 + 고 BN 윤활유

→ 피스톤 상부의 과도한 퇴적물 형성

→ 실린더 라이너 표면에 래커링 현상 발생

BN (Base Number, Alkalinity) should be selected carefully because it is important that proper balance is maintained between the BN coming from the lube oil and the fuel sulfur level by choosing proper lube oil in order to avoid following problems.

- High sulfur fuel + Low BN lube oil

→ Excessive corrosive wear

- Low sulfur fuel + High BN lube oil

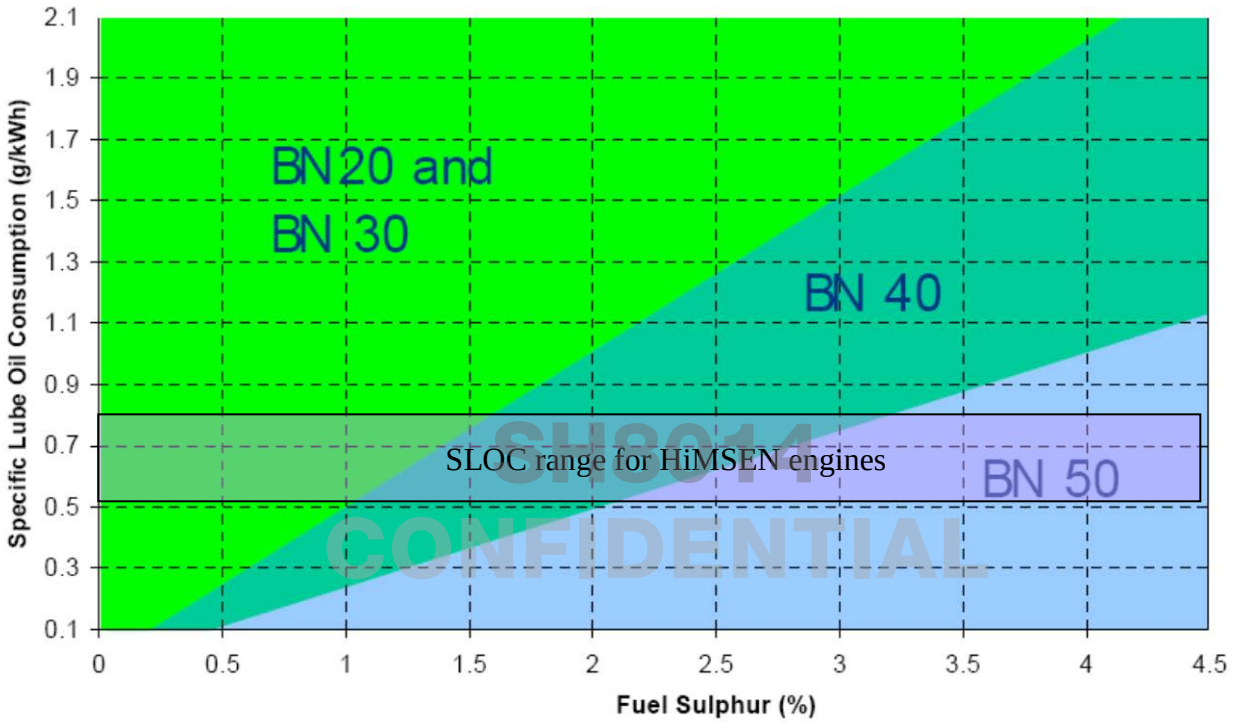
→ Excessive top land deposit formation

→ Lacquering formation on cylinder liner surface

⚠ 경 고 *윤활유를 다른 종류와 혼합하지 마십시오. 혼합되면 엔진에 심각한 문제가 발생될 수 있습니다.*

⚠ WARNING ***Do not mix the lubricating oil with different brands, which may cause serious problem on the engine.***

- Typical recommended BN depending on the fuel sulfur contents and SLOC (g/kWh) only for guidance



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[Reference: CIMAC recommendation number 29/2008 'Guide lines for the lubrication of medium speed diesel engine']

2. 윤활유 상태 점검

윤활유 품질은 다양한 발생원에 의해 노화 및 오염물로 인해 차츰 변화될 것이다. 전형적인 오염물은 연소실의 검정분진 및 소립자, 스며든 응축수, 소금기, 파손된 소립자 그리고 오일 자체의 산화물들이다.

그러므로, 공급자 또는 전문가에 의한 윤활유 상태의 규칙적인 점검은 적어도 3개월 마다 하는 것이 강력 추천된다. 이 경우에 점도, 인화점, BN, 불용성 및 수분성분과 특성에 대한 분석이 점검에 포함되어야 한다.

2. Checking of Lubricating Oil Condition

The quality of the lubricating oil will be changed slowly due to ageing and contamination via various sources. The typical contaminators are soot and particles from combustion chamber, penetrated or condensed water and salt, wear particles, and oxidation of oil itself, etc.

Therefore, regular checking of lubricating oil condition by supplier or specialist, at least every three months interval, is strongly recommended. In this case, the checking should include at least the analysis of Viscosity, Flash point, BN, insoluble, and water content and the nature.

실험실 점검 사이의 기간 동안에는 윤활유 공급자가 권고하는 간단한 시험 방법이 윤활유 품질에 대한 유익한 정보를 제공 할 것이다.

During the intervals between laboratory checking, a simple test method proposed by oil supplier will be also informative on the quality of oil.

점검을 위한 오일의 올바른 샘플링은 분석에 대한 정확한 평가를 하는데 결정적인 요소이다. 견본 오일은 엔진가동 중에 여과된 후에 취해져야 하며 견본 오일의 용기는 샘플링 되기 전에 매우 깨끗해야 한다.

Correct sampling of oil for checking is critical for correct evaluation of the analysis. The sample oil should be taken after the filter during engine running. The container for sample oil should be cleaned thoroughly before sampling.

모든 점검결과는 경향 평가가 기록되고 남겨져서 신뢰성 있는 엔진 운전에 도움이 되어야 한다.

All checking results should be recorded and kept for trend evaluation, which contribute to reliable engine operation.

3. 윤활유의 조건

엔진 내 윤활유의 상태는 다음의 범주 내에 있는 것이 추천된다.

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3. Condition of Lubricating Oil

The condition of lubricating oil inside the engine is recommended to be within the following range;

Ingredients	Tolerable range	Test method
BN:	max. 50 % of initial value.	ISO 3771
Viscosity	min. –20 % and max. 30 % of new oil.	ISO 3104
Flash Point	min. 180 ℃	ISO 2719
Water content	below 0.3 %(volume)	ISO 3733
n-Pentan insoluble	max. 2.5 %(mass)	ASTM D-893/B

윤활유의 상태는 독립 변수가 아니라 전체적인 것으로 평가 되어야 한다. 윤활유의 교체 또는 충진은 해석결과에 기초한 오일 공급자의 의견을 묻도록 하고 있다.

The condition of the lubricating oil should be evaluated not by a single parameter but as a whole. Replacement or filling of the lubricating oil is recommended to consult the oil supplier based on the analysis results.

매개 변수들의 돌연한 변화는 엔진의 비정상적인 운전 상태나 시스템의 기능 장애를 나타낼 수 있으므로 그 원인 조사와 오류 조치는 윤활유의 교체에 앞서 실시되어야 한다.

As a sudden change of parameters may indicate abnormal operating condition or malfunction of the system, investigating the cause and remedying the fault should precede replacing the lubricating oil.

알 림 *특히, BN 값이 최초 값의 50% 이하로 떨어졌을 때 윤활유는 교체되어야 하며, 윤활유 소모량만큼 주기적으로 보충하는 것이 중요하다.*

어떤 변수가 허용한계에 있다면 오일을 전면 교체하는 대신 일부 방법들로 오일을 정상상태로 바꾸는데 효과가 있을 수 있다. 어떤 경우에 이러한 것은 적절한 처리나 강력한 정제작용 또는 오일을 부분적으로 보충함으로써 달성될 수 있다

⚠ 경 고 *인화점이 150℃ 미만이면 크랭크 케이스의 폭발 위험이 있을 수 있습니다.*

4. 윤활유의 정제

엔진 필터에 추가하여 윤활유에 정제장치를 설치하도록 권고하고 있다.

부착된 원심분리 필터는 경유로 운전하는 엔진에 추천된다. 원심형 정제장치는 중유로 운전하는 엔진에 필요하다.

저 점도를 만들기 위해서 가열된 윤활유를 계속해서 원심 분리하도록 권고하는 것은 보다 효과적인 정제작업을 위한 것이다. 유량과 예열온도에 대해서는 정제 장비 메이커의 권고사항을 따르도록 하고 있다. (보통 85~95 ℃)

엔진 운전 중인 동안에는 계속해서 윤활유를 원심분리 하는 것을 추천한다. 이것은 윤활유가 공급 될 때 윤활유 속에 포함 된 이물질이 즉시 제거 될 수 있다. 동시에 윤활유를 예열 하는데 적은 양이 필요하기 때문에 에너지를 절감 할 수 있는 방범 이기도 하다.

NOTICE ***Lubricating oil should be replaced when BN value is below 50% of initial value and it is important to refill with (top-up) dissipated amounts of lubricating oil periodically.***

If any parameter reaches tolerable limit, some measures instead of entire replacement of the oil may be effective for recovering the oil to normal condition. In some cases, this can be achieved by proper treatment or by intensive purification or by partial filling (top-up) of the oil.

⚠ WARNING ***If flash point is below 150 ℃, there may be a risk of crank case explosion.***

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4. Purifying of Lubricating Oil

In addition to engine filter, it is recommended to install a purifying device for the lubricating oil.

A built on centrifugal filter is recommended for the engine running on marine diesel oil. A centrifugal type purifier is required for the engine running on heavy fuel oil.

Continuous centrifuging with heated lubricating oil for lower viscosity is recommended for more effective purifying. It is recommended to follow the purifier maker's recommendation for the flow rate and preheating temperature (normally 85-95 ℃).

It is recommended to separate the oil on the engine while operating. In this way, the dirt can be removed immediately when it is supplied to the engine. At the same time energy is saved because it is necessary to warm up the oil only by a little.

여러 대의 엔진에 한 대의 원심 분리기가 설치 되는 경우는 한 번에 한 대의 엔진만 연결하여야 한다. 이것은 한 엔진으로부터 다른 엔진으로의 윤활유가 흡입 / 배출되는 것을 방지한다. 모든 엔진의 정제를 위해서는 순차적으로 운전 중인 엔진을 각각 분리하여 정제 하는 것을 추천한다.

If only one separator is installed to several engine, it is only connected with one engine at a time. This is to ensure that there is no suction and discharging from one engine to another. It is recommended to split up the time so that there is separation on all engines, which are operating in turns.

알 림 *일부 경우, 오염과 BN 수치 저하를 막기 위해 윤활유를 물로 세척하는 것은 허용되지 않습니다.*

NOTICE ***In any case, cleaning the lubricating oil by water is not allowed to avoid contamination and decreasing of BN value.***

5. 다른 설비용 윤활유

엔진시스템 오일은 엔진의 구동부와 터보과급기를 포함한다. 그렇지만 유압 가버너는 자체의 규격이 요구되며 지침서에 언급되어 있다.

5. Lubricating Oil for Other Machinery

The engine system oil covers moving parts of the engine and turbocharger. However, hydraulic governor requires own specification and refer to the manual for the governor.

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Oil brand	Engine system lubricating oil			Governor oil
Oil company	Brand name	SAE	BN*)	
Shell	Mysella S3 N40	40	5	1) Same as Engine system L.O 2) Refer to the governor manual for detailed L.O specification, volume of governor. 3) Initial filling: Oil filled 4) Electrical (Digital) Governor: Not applied
	Shell Gadinia S3 40		12	
	Shell Argina S2 40		20	
	Shell Argina S3 40		30	
	Shell Argina S4 40		40	
	Shell Argina S5 40		50	
TOTAL (Lubmarine)	Aurelia LNG	40	5	
	Nateria X 405		5.2	
	DISOLA M 4012		12	
	DISOLA M 4015		14	
	AURELIA TI 4020		20	
	AURELIA TI 4030		30	
	AURELIA TI 4040		40	
	AURELIA TI 4055		55	
Chevron (Taxaco, Caltex)	Geotex LA	40	5.2	
	DELO SHP 40		12	
	DELO 1000 Marine 40		12	
	TARO 20 DP 40(X)		20	
	TARO 30 DP 40(X)		30	
	TARO 40 XL 40(X)		40	
	TARO 50 XL 40(X)		50	
ExxonMobil	Pegasus 705	40	5.3	
	Pegasus 805		6.2	
	Pegasus 905		6.2	
	Pegasus 1		6.5	
	Mobilgard ADL 40, Mobil Delvac 1640		12	
	Mobilgard 412		15	
	Mobilgard M420		20	
	Mobilgard M430		30	
	Mobilgard M440		40	
BP (Castrol)	CASTROL Duratex L	40	4.5	
	CASTROL MLC 40		12	
	CASTROL MHP 154		15	
	CASTROL TLX Xtra 204		20	
	CASTROL TLX Xtra 304		30	
	CASTROL TLX Xtra 404		40	
	CASTROL TLX Xtra 504		50	
	CASTROL TLX Xtra 554		55	
SK Lubricants	SUPERMAR 13TP 40	40	13	
	SUPERMAR 24TP 40		24	
	SUPERMAR 30TP 40		30	
	SUPERMAR 40TP 40		40	
LUKOIL	Navigo TPEO 12/40	40	12	
	Navigo TPEO 15/40		15	
	Navigo TPEO 20/40		20	
	Navigo TPEO 30/40		30	
	Navigo TPEO 40/40		40	
	Navigo TPEO 50/40		50	
	Navigo TPEO 55/40		55	

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Oil brand	Engine system lubricating oil			Governor oil
Oil company	Brand name	SAE	BN*)	
Gulf Oil Marine	GulfSea Power MDO 4012, SeaLub Power MDO 4012	40	12	1) Same as Engine system L.O 2) Refer to the governor manual for detailed L.O specification, volume of governor. 3) Initial filling: Oil filled 4) Electrical (Digital) Governor: Not applied
	GulfSea Power MDO 4015, SeaLub Power MDO 4015		15	
	GulfSea Power MDO 4020, SeaLub Power MDO 4020		20	
	GulfSea Power 4030, SeaLub Power 4030		30	
	GulfSea Power 4040, SeaLub Power 4040		40	
	GulfSea Power 4055, SeaLub Power 4055		55	
ENI S.p.A.	AGIP CLADIUM 120	40	12	
	AGIP CLADIUM 300		30	
	AGIP CLADIUM 400		40	
	AGIP CLADIUM 500S		50	
Petronas	PETRONAS Disrol 50	40	6	
	PETRONAS Disrol 120		12	
	PETRONAS Disrol 300		32	
	PETRONAS Disrol 400		42	
	PETRONAS Disrol 500		51	
AEGEAN	ALFAMAR 430	40	30	
	ALFAMAR 440		40	
	ALFAMAR 450		50	
	ALFAMAR 455		55	
SINOPEC TPEO	SINOPEC TPEO 4012	40	12	
	SINOPEC TPEO 4015		15	
	SINOPEC TPEO 4020		20	
	SINOPEC TPEO 4030		30	
	SINOPEC TPEO 4040		40	
	SINOPEC TPEO 4050		50	
Hyundai Oilbank	Hyundai XTeer HGSL 40	40	4.5	
	Hyundai XTeer TPEO 4012		12	
	Hyundai XTeer TPEO 4015		15	
	Hyundai XTeer TPEO 4020		20	
	Hyundai XTeer TPEO 4030		30	
	Hyundai XTeer TPEO 4040		40	
	Hyundai XTeer TPEO 4050		50	
Petro-Canada	Sentinel 445	40	4.7	
Oil volume	See the separate data for sump volume as per each engine type.			UG-25+: 2.1 Liter Europa : 1.5 Liter

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This list is given as guidance only.

) Refer to Sheet No. G06100 when BN value selected

*) Lubricating oil quantity (Initial filling: Oil empty, Without oil overflow system)

: **Please see the drawing for "L.O in baseframe" in Approval/Working/Final drawing**

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PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN ALL TYPE
	MESSRS	ENGINE BUYER

TITLE : COOLING WATER TREATMENT

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Date	Des.	Chk.	Appd	A.C	Replaced by Ident. No.:	R
						5
						4
						3
20200603	KWJ	KCM	PJK	*	Updated Cooling Water Treatment	2
20190307	JDH	KCM	PJK	*	Updated Cooling Water Treatment	1
20170720	JDH	SWS	RYS	*	First issue	0

Similar drawing No.:	Replacement for Ident. No.:

Licensor Ident. No.:	Type: ALL TYPE	Confidential : B	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No.:	Description: COOLING WATER TREATMENT		Ident.no.: B94-176487-8
Page. No. 01 OF 07			

냉각수의 품질

엔진의 냉각수는 부식 방지제를 첨가하기 전에 하기 표의 요구사항을 만족하는 증류수 (탈염수) 또는 청수가 사용 가능하다. 이것은 효과적인 냉각을 유지하고, 시스템의 부식을 예방하기 위한 필요 조건이다. 처리되지 않은 냉각수는 공기로부터 이산화탄소를 흡수하여 부식성을 갖기 때문에 냉각수의 요구 조건에 가장 적합한 증류수 (탈염수)라 하더라도 냉각수를 냉각수 계통에 투입하기 전 부식 방지제를 추가하여야 한다.

Quality of Cooling Water

The cooling of the engine should be only distilled (demineralized) or fresh water, which should be checked and treated to satisfy following requirements below table before adding corrosion inhibitor. It is necessary for keeping effective cooling and preventing corrosion of the system. Though the distilled water matches best to the requirements for cooling water, it is necessary to add corrosion inhibitor before applying cooling water to engine cooling water system because untreated cooling water absorbs carbon dioxide from the air and then becomes corrosive.

pH	7 to 9
Total hardness as $CaCO_3$	max. 75 ppm(mg/l)
Chlorides Cl^-	max. 80 ppm(mg/l)
Sulphates as SO_4^{2-}	max. 100 ppm(mg/l)
Silica as SiO_2	max. 60 ppm(mg/l)
Residue after evaporation	max. 400 ppm(mg/l)

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알 림 *염화물과 유황 성분은 방지제를 첨가하더라도 부식성이 있습니다.*

해수나 심지어는 아주 적은 양이더라도 해수로부터 오염된 청수는 부식성이 강하고 침전물 형성의 우려가 높기 때문에 엔진의 냉각수로 사용되어서는 안 된다.

빗물은 일반적으로 심하게 오염되어 있으므로 부식성이 강해서 냉각수로 사용되어서는 안 된다.

수돗물(식수)은 냉각 시스템 내부에 석회질 침전물 형성의 위험 때문에 냉각수로서 사용되어서는 안 된다. 하지만 만일 정수기로부터 만들어진 증류수를 사용할 수 없다면, 수돗물은 성분에 따라 연수 처리 등을 거친 후에 냉각수로 사용될 수 있다.

NOTICE ***Chloride and Sulphate are corrosive even in the presence of an inhibitor.***

Sea water or fresh water contaminated by sea water even in small amount is not allowed to be used as cooling water of the engine due to high risk of severe corrosion and deposits formation in the system.

Rainwater is heavily contaminated and highly corrosive in general, which is also not recommended as cooling water.

Tap water (drinking water) is not recommended as cooling water due to risk of chalk deposit formation inside the cooling system. However, if the distilled water, for example from fresh water generator, is not available, tap water may be used as cooling water after softening and some other treatments according to the ingredients.

냉각수의 처리

냉각수는 적절히 처리되어야 하며 부식 방지제도 첨가되어야 한다. 냉각수의 분석 및 처리는 믿을 수 있는 전문가에게 의뢰하는 것이 바람직하다. 그렇지 않을 경우에는, 공급자가 제공하는 지침서에 따라 엄격하게 그 처리 절차를 준수해야 한다.

다음과 같은 처리 약품들이 추천된다.

Treatment of Cooling Water

Cooling water should be treated properly and corrosion inhibitor should be added. The analysis and treatment of cooling water are recommended to be carried out by a famous and familiar specialist. Otherwise, keep the treatment procedures strictly according to the instructions from the supplier.

Some recommended products are listed as follows:

Manufacturer	Brand Name	Constituent	Delivery Form	Recommended Dosage
Chevron (FAMM)	DELO XLI(Havoline XLI)	Carboxylates	Liquid	75 liter / 1,000 liter
VECOM	Cooltreat NCLT	Nitrite	Liquid	48 liter / 1,000 liter
Wilhelmsen Chemicals	Rocor NB	Nitrite, Borate	Liquid	63 liter / 1,000 liter
NALCO	NALCOOL2000	Nitrite, Borate	Liquid	128 liter / 1,000 liter
	TRAC100	Molybdate, silicate	Liquid	17.5 liter / 1,000 liter
	TRAC108	Nitrite, Borate	Liquid	28 liter / 1,000 liter
GE Water & Process Technologies	CorrShield NT4200	Nitrite	Liquid	30 liter / 1,000 liter
Shell	Shipcare Cooling Water Treat	Nitrite, Borate	Liquid	128 liter / 1,000 liter

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알 림 *부식방지제가 첨가된 냉각수 관리는 부식방지제 제조사의 지침을 따르십시오.*

NOTICE ***Follow the guidelines of corrosion inhibitor manufacturer for cooling water treatment.***

알 림 *유성 방지제는 냉각 표면에 부착되어 냉각 효과에 영향을 미치므로, 이것은 냉각수용으로 사용할 수 없으며 아질산-붕산 염 제품을 사용하는 것이 바람직합니다.*

NOTICE ***Oily inhibitors adhere to cooling surface and influence cooling efficiency, which are not recommended for cooling water. Only nitrite-borate based inhibitors are recommended.***

알 림 *다른 종류의 제품이나 특성을 가진 방지제를 서로 혼합하여 사용하지 마십시오*

NOTICE ***Do not mix the inhibitors of different types or properties.***

⚠ 경 고 *부식 방지제는 독성이 있거나 위험할 수 있으므로 취급 시, 엄격한 규제가 필요합니다.*

⚠ WARNING ***Some inhibitors may be toxic and hazardous. Strict control is required when handling inhibitors.***

부동액 첨가

만약 선박건조, 운항 중 엔진의 냉각수의 온도가 어는 점 이하로 내려가는 환경에 노출될 경우 부동액을 사용해 주어야 한다. 부동액 투입 전 반드시 라인을 청소해야 한다. 또한 기존 냉각수만 사용할 때와 같이 부동액 사용 시에도 엔진 및 부품의 부식, 부패방지를 위하여 약품을 함께 사용해야 하며, 반드시 약품과 부동액과의 반응 여부를 업체를 통해 확인해야 한다.

부동액의 주 원료는 Ethylene Glycol로 사용 농도에 따른 어는점 변화는 아래와 같다.

Use of Antifreeze

If the cooling water of the engine is exposed to the environment below a certain point of temperature, antifreeze should be added. Before adding antifreeze, the engine line must be cleaned. In accordance with cooling water usage, the corrosion inhibitor should be used with antifreeze and the reaction between two must be checked before use by each maker. The main ingredient of antifreeze is Ethylene Glycol which has different freezing points according to its content rates as follows:

Antifreeze (Volume %)	20	25	30	35	40	45	50	55
Water (Volume %)	80	75	70	65	60	55	50	45
Freezing Points (℃)	-10.5	-13.5	-16.5	-20.5	-26.5	-31.5	-37.5	-43.5

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알 림 *부동액의 사용은 냉각수의 물성치를 엔진 냉각이 어려워지는 조건으로 변화(비열의 감소, 점도의 증가로 인한 압력 손실 증가, 낮은 열전도 계수로 인한 열 교환기 효율 감소) 시킨다. 또한, 높아진 끓는 점은 엔진의 고온 부에서 발생할 수 있는 핵 비등 냉각을 억제하여 고온부품의 열 부하가 증가한다. 이와 같이 엔진에서 부동액의 사용은 냉각시스템의 성능을 저하시킬 수 있으므로 냉각수의 어는 문제가 발생되지 않는 환경에서는 부동액을 사용을 가능한 추천하지 않는다. 부득이하게, 부동액을 사용할 경우 55% 이상을 사용하여도 어는점이 더 이상 내려가지 않기 때문에 그 이상 사용하는 것은 추천하지 않으며, 부동액을 사용할 경우 부동액의 비율에 따라 엔진 출력 제한이 된다. 즉, 부동액 비율 20%부터 부동액 1% 증가 시 엔진 출력은 0.22% 감소된다. 예를 들어, 부동액 40% 적용 시 엔진 출력은 95.6%로 제한된다. 또한, 부동액 사용 여부와 관계 없이 부식방지제는 반드시 적용되어야 한다.*

NOTICE ***In case of using antifreeze, it makes it difficult for engine to cool down due to change in cooling water's properties (specific heat decrease, pressure loss increase due to viscosity increase, heat exchanger efficiency decrease due to low heat conduction coefficient). Also, engine's thermal load will increase because increased boiling point will restrain the cooling effect of nucleate boiling. For such a reason, antifreeze is not recommended to use unless it is absolutely necessary. When using antifreeze inevitably, it is not recommended to use antifreeze more than 55% of the total mixture since it does not affect further decrease of freezing point. Thus, it is recommended to use up to 50% maximum. Starting from 20% antifreeze, engine power is to be de-rated 0.22% per 1% antifreeze in the cooling water. (Ex. When using 40% antifreeze, maximum engine power is 95.6 %.) Corrosion inhibitor must be used regardless of antifreeze in the cooling water.***

부동액 속에 불순물이 많으면, 어는점을 정확하게 낮추지 못하기 때문에 청정도 관리(NAS1638 / ISO4406)가 된 제품을 사용하여야 하며, 관리등급은 NAS8(ISO19/17/14) 등급을 추천한다.

청정도 관리가 되는 아래 제품을 추천한다

If there are impurities in antifreeze, it cannot decrease the freezing points accurately, so antifreeze must be managed by Cleanness Level (NAS1638 / IOS4406) with the specification level below NAS8 (ISO19/17/14). Some recommended products are listed as follows:

Manufacturer	Brand Name	Delivery Form
Petrobank (Offshore Petrochemicals & Service)	Tectyl EG(NAS8)	Liquid

냉각수와 시스템의 점검

냉각수는 사용함에 따라 오염되거나 증발에 의해서 그 특성이 변할 수 있다. 따라서, 냉각수뿐만 아니라 시스템은 운전 중에 주기적으로, 가능하면 일주일에 한번은 점검되어야 한다. 이러한 테스트는 순환중인 냉각수를 채취하여 방지제 메이커가 제공하는 테스트 킷을 이용할 수도 있다. 그러나, 전문가에 의한 냉각수의 시험은 정기적으로 적어도 3개월마다 실시하는 것이 바람직하다.

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Checking Cooling Water and the System

The property of the cooling water may be changed during service due to contamination or evaporation. Therefore, the cooling water itself and the system should be checked periodically during service, preferably once a week. These tests may be done by means of test kits from inhibitor maker with sample water from the circulating system. However, laboratory test of the sample water by specialist is also recommended regularly at least every three months.

모든 점검 결과는 기록 및 보존되어야 하고, 그 추이를 분석하여야 한다. 이것은 올바른 냉각수 처리와 함께 신뢰할 수 있는 엔진 운전에 도움이 된다.

All checking results should be recorded and kept for trend evaluation, which contribute to reliable engine operation with right cooling water treatment.

만일 테스트 결과에서 냉각수의 성분이 갑자기 혹은 점진적으로 변화되었다면, 그 원인 분석을 위해 냉각수 시스템을 점검하여야 한다. 변화들 중에는 다음과 같은 사항이 원인이 될 수 있는 것이 있다.

If test result shows that the contents of cooling water changes suddenly or gradually, the cooling water system should be checked to trace the cause. Some of the changes may indicate the cause as follows:

염화물 성분이 증가할 때 :

- □ 해수가 냉각수로 침투하였는지 그 가능성을 점검한다.
- □ 해수를 포함하는 시스템 예를 들어, 해수에 의해 냉각된 청수 냉각기 등을 점검한다.

Chloride content increasing:

- □ Check possibility of seawater penetrating into cooling water.
- □ Check the system which includes sea water, for example fresh water cooler cooled by sea water.

pH 값이 감소하거나 유황 성분이 증가할 때 :

- □ 냉각수가 배기 가스에 의해서 오염되었는지를 점검한다.
- □ 실린더 헤드를 수압 테스트로 검사한다.

알 림 *만일 점검 후 냉각수의 품질이 제한치를 초과 하였다면, 냉각수는 새롭게 수처리된 것으로 완전히 교체해야 합니다.*

pH value decreasing or sulphate content increasing:

- □ Check if cooling water is contaminated by exhaust gas.
- □ Check cylinder head by hydraulic pressure test.

NOTICE ***If the quality of the cooling water after checking exceeds control limit by water treatment, the cooling water should be replaced completely by newly treated water.***

냉각수 시스템의 청소

만일 냉각수 시스템에서 비정상적인 침전물 또는 녹이 검출되었다면, 시스템을 철저히 청소한 다음, 새롭게 처리된 냉각수로 완전히 교체한다.

냉각수 시스템의 청소는 특수 화학 약품<HANYU CLEAN TECH RR-R/RR-RO>or equivalent 를 사용하여 기름기 및 녹을 제거하는 세척과정이 포함된다. 타 제품을 사용할 경우 인체에 유해할 수 있으므로, 믿을 수 있는 전문 회사에 냉각수 시스템의 청소를 의뢰하는 것이 바람직하다. 그렇지 않으면, 그 세척제 공급업체의 지침을 엄격하게 준수해야 한다.

⚠ 경 고 *산세 작업은 인체에 대단히 위험한 작업이므로 보호장구를 철저히 갖추어야 합니다. 예를 들어, 시스템 근처에 있는 모든 사람은 최소한 보호 안경과 보호 장갑을 착용해야 합니다.*

알 림 *산세 작업 도중에 산에 의해서 윤활유가 오염되는 것을 피하기 위해 세심한 주의가 요구됩니다. 산세 작업 후, 즉시 엔진 윤활유의 산성도를 확인하고, 다음날 다시 재점검 하십시오.*

Cleaning of Cooling Water System

If any deposit or rust is abnormally detected in the cooling water system, the system should be cleaned thoroughly and then the cooling water also should be refilled up completely by newly treated water.

The cleaning of the cooling system includes degreasing and descaling procedures which need special <HANYU CLEAN TECH RR-R/RR-RO>or equivalent chemicals. As the chemicals may be hazardous, the cleaning of the cooling water system is recommended to be carried out by reliable specialist firm. Otherwise it should be done strictly in accordance with instructions from the supplier of cleaning chemicals.

⚠ WARNING ***Descaling process by acid is hazardous, which needs protective equipment for human body, for example, everybody near the system should put on protective glasses and gloves at least.***

NOTICE ***Careful attention is required to avoid contamination of lubricating oil by acid during descaling process. Check the acid content of lubricating oil of the engine directly after descaling work of the cooling system by acid and check again next day.***

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냉각수의 보충

냉각 시스템을 청소하고 난 직후, pH 값이 약 7일 때까지 철저하게 시스템을 물로 씻어내고 나서 물을 빼낸다.

냉각수 팽창 탱크를 증류수로 채운다. 이때 냉각수 처리 작업을 위한 여유를 남겨놓고 채운다.

메이커의 지침서에 따라서 방지제 희석용액을 준비하여 팽창 탱크에 첨가한다.

팽창 탱크의 표준 수위까지 증류수를 추가한다.

부식 방지제의 정착을 위해 메이커의 추천에 따라 엔진을 가동시키거나, 최소 24시간동안 가동시킨 후, 확인을 위해서 냉각수 품질을 점검한다.

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만일 증발, 누수 또는 정비 시 배수로 인하여 냉각수의 양이 줄어들면, 냉각수를 보충하여 탱크의 수위를 유지해야 한다.

증발을 보충하기 위한 냉각수는 증류수가 되어야 한다. 반면에 누수나 배수 때문에 손실된 냉각수는 동일하게 처리된 냉각수이어야 한다. 냉각수를 첨가한 후에는, 냉각수 성분들이 올바른 농도인지 확인해야 한다.

알 림 *냉각수는 적어도 2년 간격으로 새롭게 정제된 냉각수로 전면 교체하십시오.*

알 림 *냉각수의 폐기는 관련 법규에 따라 처리해야 합니다.*

Filling-Up of Cooling Water

Directly after cleaning process of the cooling system, flush the system thoroughly with water until pH value to be about 7, and then drain the water.

Fill up the system with distilled water until the water level of the expansion tank to have margin for treatment.

Prepare the solution of inhibitor according to the instruction from the maker and add the solution into the expansion tank.

Add distilled water more to the normal level of the expansion tank.

Run the engine for settlement according to the inhibitor maker's recommendation or at least for 24 hours and then check the quality of the water for confirmation.

If the amount of cooling water is reduced due to evaporation or leakage or drainage for maintenance, the water level of the tank should be maintained by adding water.

Water for compensating evaporation should be distilled water, while the water for loss due to leakage or drainage should be same treated water. After adding the water, checking of the quality of the water should be carried out to confirm the correct concentration of the ingredients.

NOTICE ***Replace cooling water completely with newly treated water with interval of at least every two years.***

NOTICE ***Waste cooling water should be treated in compliance with governing laws.***

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PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN DIESEL ENGINE & DF ENGINE
	MESSRS	ENGINE BUYER

TITLE : LOW LOAD OPERATION

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Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
20170904	YYC	SWS	RYS	*	First issue	0

Similar drawing No.:	Replacement for Ident. No.:
Licensor Ident. No.:	Type: DIESEL ENGINE & DF ENGINE
Info. No.:	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Page. No.: 01 OF 02	Description: LOW LOAD OPERATION
	Ident.no.: B94-180668-9

20% 이하의 부하로 엔진이 운전되면 불완전 연소로 인하여 공기와 배기 가스 통로 및 연소실 내부가 오염된다. 따라서 장기간 저 부하 운전은 가능하면 피해야 한다. 그러나, 만일 장시간 연속적으로 20%의 부하 보다 낮게 엔진을 운전하는 것이 불가피하다면, 엔진 내부의 오염을 최소한 하기 위해서 다음과 같은 조치가 수행되어야 한다.

Operating the engine with the load of below 20% may cause incomplete combustion and result fouling of combustion chamber as well as air and exhaust gas flow passages. Therefore, long term low load operation should be avoided as possible. However, if it is inevitable to operate the engine at lower than 20% load for a long time continuously, following measures should be carried out to minimize contamination of the engine inside.

□ 운전 시간은 다음과 같이 제한되어야 한다.

◆ 무 부하 운전 시 (Safety test, 길들이기 운전의 경우는 예외) : 1분(최대 5분 이내)

◆ 15% 부하 이하의 경유 운전 또는 20% 부하 이하의 중유 운전 시 : 아래 그래프 참조

□ Load 70% 이상에서 세정 운전 시간 : 아래 그래프 참조

□ 터빈은 보다 자주 세척해야 한다.

□ Operating duration should be restricted as below.

◆ Idle running (Exception: Safety test, Running-in operation) : 1min(max. 5 min)

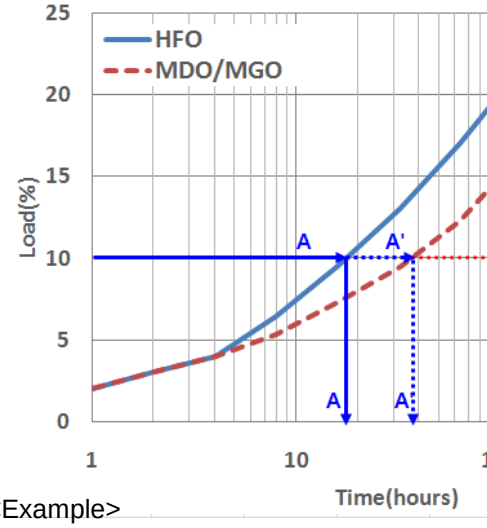
◆ Running below 15% on MDO/MGO or below 20% on HFO : See below graph

□ Flushing operating duration at not less than 70% of full load : See below graph

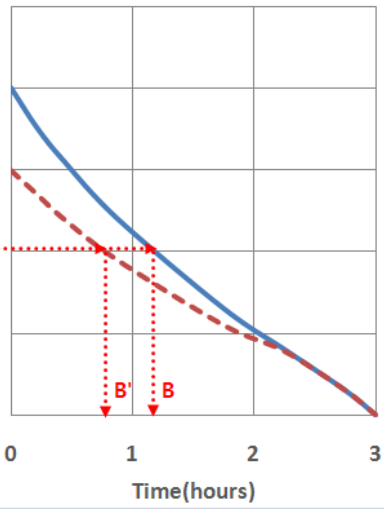
□ More frequent cleaning of turbine is recommended.

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Time Limits for Low-load Operation



Minimum Duration of Flushing Operation



<Example>

- Time Limits for low load operation : HFO 17 hours(Line A), MDO/MGO 37 hours(Line A')
- Minimum Duration of flushing operation : HFO 1.15 hours(line B), MDO/MGO 0.75 hours(Line B')

HYUNDAI HiMSEN

Engine Type	INSTRUCTION	Page No.
ALL		1/11
Information No.	**Title**	**Identification No.**
000000	PRESERVATION AND STORAGE OF ENGINE	B94-029033-0.

Date	Designed	Checked	Approved	Change / Replacement	R
2010-01-04	KNS	JSC	KBY	Developed (Replacement for B94-002216-3)	0
2012-12-28	PMU	JSC	AGH	Added treatment for cooling water system	1
2013-08-12	PMU	JSC	LCS	Changed figure for caution plate	2
2014-01-22	PMU	KJC	RYS	Added 2.5 & volatile corrosion inhibitor spec.	3
2014-09-15	PMU	KJC	RYS	Add. Engine type for H25/33V	4
2014-12-17	SON	DYJ	KSH	Add. Engine type for H35DF, H27DF	5
2015-07-03	JMK	YJH	RYS	Add. 4.4.3 & 4.5.3 (Filling the nitrogen gas)	6
2015-12-09	JDH	KJC	RYS	Deleted 2.2.2	7
2017-01-26	PMU	YJH	RYS	Chg. VCiR-329 -> VpCI-329 & Add. Engine types	8
2019-04-05	JMK	YJH	KHS	Chg. Pressure(1 bar -> 0.5 bar_3,7,9 page)	9
2019-11.28	JMK	GJH	KHS	Add. Engine type for H22CDF	A

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이 문서 도면은 현대중공업의 자산이므로 당사의 승인 없이 이 문서 도면을 제 3자에게 양도, 복사, 판매 하거나, 이 문서 도면에 의해 부품을 제작하여 제 3자에게 판매하는 것은 불법입니다.

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3.7 The Others
4. Packing
5. Preservation
6. Removal of Preservation before Initial Start
7. Preservation of Tools and Spare Parts

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1. 개요

이 사양서는 현대중공업 힘센엔진에 적용되는 부품의 일반적인 사양을 충족시키기 위해 공급자에게 적용되는 것이다.

본 사양서는 도면에 언급되지 않은 사항을 규제하며, 부품 제조에 대한 주사양서는 도면이다.

제작 도면 및 사양서 내용과 상이한 제조에 대해서는 현대중공업 엔진기계사업본부 힘센엔진 기술(설계)부문 또는 품질경영부문의 서면 확인을 득하여야 한다.

1. Introduction

This standard is an instruction for suppliers in order to guarantee that their products always meet the general specifications of 4-stroke HiMSEN engine of HHI-EMD.

The order drawings are prior to this general specification, the limit values specified in this specification are only valid if they are not specified in the drawings.

All exceptions and special applications concerning the contents of order drawings are valid if confirmed in writing by HiMSEN engineering or Quality management department of HHI-EMD.

2. 적 용

이 규정은 힘센 디젤 엔진의 공장 시운전후 출고 전의 방청 작업 그리고 엔진의 보관 및 선내 탑재(또는 현장 설치)후 엔진의 초기 운전 전까지의 방청 관리 지침을 규정한다.

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2. Application

This standard generally applies to HiMSEN engine for the protection against corrosion before engine delivery, storage, before initial starting and long time standstill of engine.

3. 출고 전 방청 작업

3.1 냉각수 계통

3.1.1. 공기 냉각기, 윤활유 냉각기를 포함한 고온 및 저온 냉각수 계통의 냉각수를 최대한 배출시킨 후 잔존 냉각수를 제거하기 위해 압축 공기로 냉각수 배관 입구에서 출구 쪽으로 불어서 제거한다.

3.1.2. 표면에 이물질, 녹 등을 완전히 제거한 후 기화성 방청 제<VCiR-3P 또는 유사 제품(VpCI-377)>를 에어건을 이용하여 가능한 한 계통 내 깊숙이 (기화가스가 도달하기 용이한 거리30cm이내) 골고루 분무 시키고 기화가스의 손실을 방지하기 위해 블라인드 커버로 밀폐시킨다.

기화성 방청제의 사용량은 방청 기간, 포장 방법, 온도, 습도, 밀폐 정도에 따라 달라질 수 있으며 통상적으로 1m3 당 50~100g을 사용한다.

3.1.3. 내부 공기를 배출 시킨 후 질소 가스를 0.5 bar까지 충진한다.

3. Preservation before delivery

3.1 Cooling Water System

3.1.1. Drain the cooling water from the HT-and LT-system including the charge air cooler and lube oil cooler, and then blow air from inlet to outlet of cooling water piping system to remove the remaining water.

3.1.2. Spray the volatile corrosion inhibitor<VCiR-3P or similar(VpCI-377)> into the system as deeply as possible (effective distance of the vapor is under 30cm) by using air-gun or similar after removing impurities, rust, etc. And then seal up those systems with blind covers to prevent from the loss of vapor.

A dose of volatile corrosion inhibitor is usually 50~100g per 1m3 but it would be changeable depending on the period of preservation, method of packing, temperature, humidity and grade of sealing.

3.1.3. Discharge the air in system and fill the nitrogen gas to 0.5 bar.

3.2 연료유 계통

3.2.1. 연료유 필터 및 배관 계통의 연료유를 완전히 배출시킨다.

3.3 윤활유 계통

3.3.1. 필터, 쿨러, 배관 등 계통내의 윤활유를 배출시킨다.

3.3.2. 크랭크 챔바 및 썸프 탱크를 깨끗이 소제한다.

3.3.3. 다음 부위를 윤활성 방청유 < BW-70PSJ, Mobilux EP 004(Mobil-plex44) 또는 유사 제품 >을 도포한다.

- 크랭크 챔바, 연접 봉, 크랭크 축,
- 피스톤 하부, 실린더 라이너 및 기타 내부 구동 부위
- 캠 샤프트 챔바, 캠 샤프트 및 로울러
- 기어 챔바 및 기어
- 실린더 헤드 톱 커버 내부 및 로커 기어

본 방청유는 추후 엔진의 운전시 별도의 제거 절차 없이도 베어링 등 관련 윤활, 구동 부분의 윤활 역할을 겸해야 하고 부품의 손상, 수명 단축 등 해가 있어서는 아니 되며 엔진의 운전 중 엔진 시스템 윤활유와 희석되어 자연 제거되어야 하며 시스템 윤활유와 희석되어 운전되어도 아무런 해가 없어야 하므로 유사 제품 선정 시는 특별한 주의가 요구된다.

3.4 연소실

3.4.1. 인디케이팅 콕 또는 분사 밸브 장착 홀을 통하여 윤활성 방청유 < BW-70PSJ, Mobilarama524 또는 유사 제품 >을 연소실 내부에 기통당 0.5 리터씩 분무 주입한 후 크랭크 샤프트를 2~3회 회전시킨다.

3.5 흡기 라인

표면에 이물질, 녹 등을 완전히 제거한 후 기화성 방청 제 < VCiR-3P 또는 유사 제품(VpCI-377)>를 에어 건을 이용하여 가능한 한 계통 내 깊숙이 (기화가스가 도달하기 용이한 거리30cm이내) 골고루 분무 시키고 기화가스의 손실을 방지하기 위해 커버로 밀폐시킨다.

3.2 Fuel Oil System

3.2.1. Drain the fuel oil thoroughly from the piping system and fuel oil filter.

3.3 Lubricating Oil System

3.3.1. Drain the lubricating oil from the system including the cooler and filter.

3.3.2. Clean up inside of the crankcase and oil sump tank.

3.3.3. Coat the following components with a lubricity rust preventative agent < BW-70PSJ, Mobilux EP 004(Mobil-plex44) or similar >.

- Crankcase inside, Connecting Rod, Crankshaft,
- Piston lower, Cylinder Liner and other moving parts
- Camshaft, Cam Roller and Chamber inside
- Gear Train and chamber inside
- Cylinder Head Top Cover inside and Rocker Gear

The rust protection oil should also have proper lubricity as lubricating oil and not deteriorate moreover, even if mixed with the system oil during engine running, the fundamental properties of the system lubricating oil causing any possible defect of the engine moving parts, thus pay close attention to use adequate product if a similar one is chosen.

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3.4 Combustion Chamber

3.4.1. Inject corrosion preventing fluid < BW-70PSJ, Mobilarama524 or similar > in a quantity of 0.5 liter per each cylinder into the combustion chambers through the indicator valves, and then turn the crankshaft by 2~3 revolutions.

3.5 Intake Air Chamber

Spray the volatile corrosion inhibitor < VCiR-3P or similar(VpCI-377)> into the system as deeply as possible (effective distance of the vapor is under 30cm) by using air-gun or similar after removing impurities, rust, etc. And then seal up those systems with blind covers to prevent from the loss of vapor.

기화성 방청제의 사용량은 방청 기간, 포장 방법, 온도, 습도, 밀폐 정도에 따라 달라질 수 있으며 통상적으로 1m3 당 50~100g을 사용한다.

3.6 엔진 외부 가공면

3.6.1. 엔진 외부의 가공 면 중 미 페인트 부위를 소제한 후 외부 방청유 < TECTYL-506, Mobilarma 247 또는 유사 제품 >을 도포한다.

3.7 기타

3.7.1. 분사 펌프 및 조속기용 컨트롤 연결 봉 및 축의 연결부 및 운동 부분은 소제 후 < Mobil 1 Synthetic Grease 또는 유사 제품 >을 바른다.

3.7.2. 터보챠져의 배기 출구 관은 합판 또는 적절한 소재로 막고 밀봉 처리한다. 터보챠저의 드레인 밸브를 열어 놓는다.

3.7.3. 터보챠져의 에어필터를 함석으로 감싸서 밀봉한다.

3.7.4. 각 배관의 외부 연결 구 및 모든 열려있는 구멍은 플라스틱 플러그, 블라인드 커버 등을 사용하여 밀봉한다.

3.7.5. 전장 컨트롤 박스 및 터미널 박스의 고무 패킹, 그랜드 씰링 등 밀봉 상태의 이상 여부를 점검한다.

3.7.6. 기화성 방청제의 사용량은 방청 기간, 포장 방법, 온도, 습도, 밀폐 정도에 따라 달라질 수 있으며 통상적으로 1m3 당 50~100g을 사용한다.

4. 포장

4.1 엔진 인도 전, 물 및 습기가 유입되지 않도록 방수 천막으로 포장한다.

A dose of volatile corrosion inhibitor is usually 50~100g per 1m3 but it would be changeable depending on the period of preservation, method of packing, temperature, humidity and grade of sealing.

3.6 External Machined Surface

3.6.1. Clean up all unpainted area of external machined surfaces and then coat them with a layer of protective agent < TECTYL-506, Mobilarma 247 or similar >.

3.7 The Others

3.7.1 Grease all hinging parts with < Mobil 1 Synthetic Grease or similar >, and apply protective agent < TECTYL-506, Mobilarma 247 or similar > to the rest parts of control linkage between the fuel pumps and governor after thoroughly cleaning up.

3.7.2. Seal up the turbocharger gas outlet with a plate. Keep the turbocharger drain valve open.

3.7.3. Cover up the turbocharger air filter with a sheet.

3.7.4. Seal up all opening parts of piping system with plastic cap or blind cover.

3.7.5. Check the sealed condition of the packing and gland seals of the electric control and terminal boxes.

3.7.6. A dose of volatile corrosion inhibitor is usually 50~100g per 1m3 but it would be changeable depending on the period of preservation, method of packing, temperature, humidity and grade of sealing.

4. Packing

4.1 The engine should be kept close wrapping up with a waterproof tarpaulin against rain and moisture when the engine is delivered.

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4.2 엔진 인도 중 포장이 손상되지 않도록 수시 점검하여 조치한다.

5. 보관

5.1 엔진 인도 전 혹은 인도 후 보관은 공기가 잘 통하는 옥내에 보관을 원칙으로 하고, 옥내 보관할 경우 인도 시 포장된 천막을 제거한 후 보관한다.

5.2 보관 시 공기 냉각기 및 윤활유 냉각기의 동파를 방지하기 위해 공기 냉각기 및 윤활유 냉각기의 배출밸브 및 플러그를 개방하여 잔류 수를 완전히 배출 시킨다.

5.3 냉각수 계통의 블라인드 커버는 5.4와 5.5항에 기재된 기화성 방청제 추가 시 외에는 엔진 운전 전까지 밀폐 상태를 유지를 위하여 분해되어서는 안 된다.
기화성 방청제가 내부에 투입되어 있는 시스템의 블라인드 커버에는 경고 스티커가 적용된다.

5.4 3개월 미만 보관중의 방청 관리

5.4.1. 보관 시 아래와 같은 양의 기화성 방청제< VCiR-3L 또는유사제품(VpCI-329)>를 썸프 탱크에 주입한다.

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4.2 The condition of waterproof tarpaulin tent should be occasionally checked and repaired during delivery.

5. Preservation

5.1 In principle, the engine should be kept under the nice airy roof with removing waterproof tarpaulin wrapped during delivery.

5.2 Drain the cooling water from the HT-and LT-system including the charge air cooler and lube oil cooler with opening all drain valves of the coolers in order to prevent the coolers from a possible frozen damage.

5.3 Do not open the blind covers of cooling water line until engine stating to keep the sealed condition except in case of addition of Volatile Corrosion Inhibitor(Section 4.4 & 4.5)
The caution stickers applies to blind cover contained the Volatile Corrosion Inhibitor.

5.4 **Preservation Under 3 months**

5.4.1. Fill up the Volatile Corrosion Inhibitor < VCiR-3L or similar(VpCI-329) > into the sump tank as much as below before storing.

(단위: L)

	H17/28	H21/32 H21C H22CDF	H25/33 H27DF	H25/33V	H32/40 H35DF H35G H32C	H32/40V H35FDV H35GV
5	1.1	2.2	-	-	-	
6(12)	1.3	2.5	3.1	4.0	5.2	6.7
7(14)	1.4	2.8	3.5	4.6	5.9	7.8
8(16)	1.6	3.1	3.9	5.1	6.6	8.9
9(18)	-	3.4	4.3	5.6	7.3	10.0
10(20)	-	-	-	6.1	-	11.2

(Unit: L)

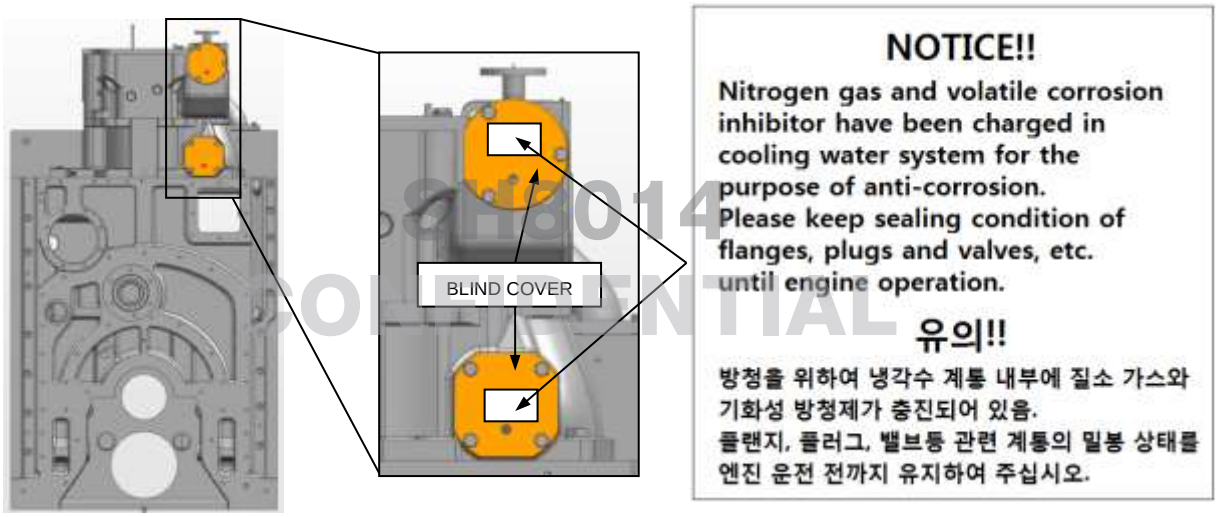
	H17/28	H21/32 H21C H22CDF	H25/33 H27DF	H25/33V	H32/40 H35DF H35G H32C	H32/40V H35FDV H35GV
5	1.1	2.2	-	-	-	
6(12)	1.3	2.5	3.1	4.0	5.2	6.7
7(14)	1.4	2.8	3.5	4.6	5.9	7.8
8(16)	1.6	3.1	3.9	5.1	6.6	8.9
9(18)	-	3.4	4.3	5.6	7.3	10.0
10(20)	-	-	-	6.1	-	11.2

5.4.2. H.T & L.T Water In/Outlet의 블라인드 커버 및 마지막 실린더의 Cyl. Head & Water Guide Jacket 블라인드 커버를(그림.1) 분해 후 아래와 같은 양의 기화성 방청제< VCiR-3P 또는 유사제품(VpCI-377)>를 각 라인에 투입한다.

기화성 방청제는 고체 가루 상태 및 물에 녹더라도 녹 방지 효과를 유지하지만, 고체 상태에서 최적의 성능을 발휘합니다. 따라서 기화성 방청제를 투입 시 가능한 고체 가루 상태를 유지할 수 있도록 엔진 내부에 Drain 되지 않은 물을 피하여 투입하도록 하십시오.

5.4.2. Fill up the Volatile Corrosion Inhibitor < VCiR-3P or similar(VpCI-377)> into the blind covers of H.T & L.T Water In/Outlet Line and Cyl. Head & Water Guide Jacket of last cylinder as much as below.

The Volatile Corrosion Inhibitor preserves the anticorrosion performance also in water dissolved condition, but it works best in solid powder state. Therefore, when inserting the Volatile Corrosion Inhibitor, keep it away from any water that has not been drained in order to preserve its solid powder state.



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[FIGURE.1]

(1개의 라인 기준 사용량, 단위: g)

	H17/28	H21/32 H21C H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	50	50	-	-	-	
6(12)	50	50	100	100	150	150
7(14)	50	50	100	100	150	150
8(16)	50	50	100	100	150	150
9(18)	-	50	100	100	150	150
10(20)	-	-	-	100	-	150

(Recommended amount per each line, Unit: g)

	H17/28	H21/32 H21CH H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	50	50	-	-	-	
6(12)	50	50	100	100	150	150
7(14)	50	50	100	100	150	150
8(16)	50	50	100	100	150	150
9(18)	-	50	100	100	150	150
10(20)	-	-	-	100	-	150

5.4.3. 내부 공기를 배출 시킨 후 질소가스를 0.5 bar까지 충진한다.

5.4.3. Discharge the air in system and fill the nitrogen gas to 0.5 bar.

5.4.4. 월 1회 외부의 도장 상태에 이상이 없는지 확인한다.

5.5 3개월 이상 보관중의 방청 관리

5.5.1. 3개월에 1회씩 아래와 같은 양의 기화성 방청제<VCiR-3L 또는 유사제품(VpCI-329)>를 썸프 탱크에 주입한다.

(단위: L)

	H17/28	H21/32 H21C H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	1.1	2.2	-	-	-	
6(12)	1.3	2.5	3.1	4.0	5.2	6.7
7(14)	1.4	2.8	3.5	4.6	5.9	7.8
8(16)	1.6	3.1	3.9	5.1	6.6	8.9
9(18)	-	3.4	4.3	5.6	7.3	10.0
10(20)	-	-	-	6.1	-	11.2

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5.5.2. H.T & L.T Water In/Outlet의 블라인드 커버 및 마지막 실린더의 Cyl. Head & Water Guide Jacket 블라인드 커버를(그림.2) 분해 후 아래와 같은 양의 기화성 방청제<VCiR-3P 또는 유사제품(VpCI-377)>를 투입한다.

5.4.4. Check the painting condition, once a month, and repair if necessary.

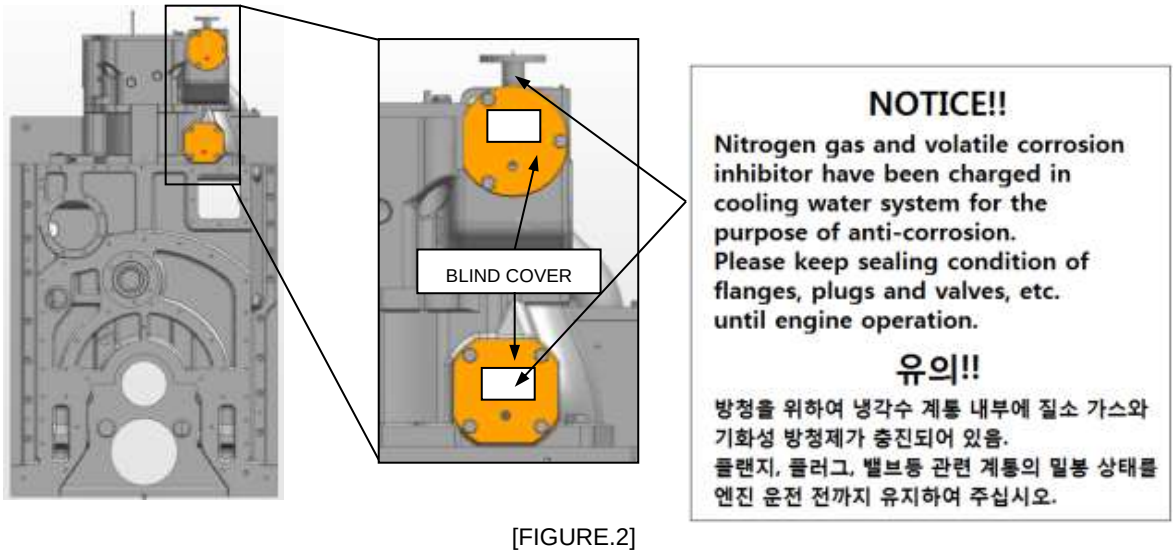
5.5 Preservation over 3 months

5.5.1. Fill up the Volatile Corrosion Inhibitor<VCiR-3L or similar(VpCI-329)> into the sump tank as much as below once in 3 months.

(Unit: L)

	H17/28	H21/32 H21C H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	1.1	2.2	-	-	-	
6(12)	1.3	2.5	3.1	4.0	5.2	6.7
7(14)	1.4	2.8	3.5	4.6	5.9	7.8
8(16)	1.6	3.1	3.9	5.1	6.6	8.9
9(18)	-	3.4	4.3	5.6	7.3	10.0
10(20)	-	-	-	6.1	-	11.2

5.5.2. Fill up the Volatile Corrosion Inhibitor<VCiR-3P or similar(VpCI-377)> into the blind covers of H.T & L.T Water In/Outlet Line and Cyl. Head & Water Guide Jacket of last cylinder as much as below.



[FIGURE.2]

(1개의 라인 기준 사용량, 단위: g)

	H17/28	H21/32 H21C H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	50		-	-	-	
6(12)	50	50	100	100	50	150
7(14)	50	50	100	100	150	150
8(16)	50	50	100	100	150	150
9(18)	-	50	100	100	150	150
10(20)	-	-	-	100	-	150

5.5.3. 내부 공기를 배출 시킨 후 질소가스를 0.5 bar까지 충진한다.

5.5.4. 월 1회 외부의 도장 상태에 이상이 없는지 확인한다.

5.5.5. 3개월 1회씩 크랭크 챔바 커버, 캠샤프트 챔바 커버, 기어 챔바 커버 및 실린더 헤드 톱 커버를 열고 크랭크 챔바, 라이너, 피스톤, 연접 봉, 크랭크 샤프트, 캠, 롤러, 기어, 로커 암 및 기타 구동부의 발청 여부를 점검한다. 필요시 윤활성 방청유< BW-70PSJ, Mobilux EP 004(Mobil-Plex44) 또는 유사 제품>을 도포한다.
발청 시 녹을 깨끗이 제거한 다음 전술한 방청유를 도포한다.

5.5.6. 발청 점검이 끝나면 인디케이팅 콕 또는 분사 밸브 장착 홀을 통하여 윤활성 방청유<BW-70PSJ, Mobilarama524 또는 유사 제품>을 연소실 내부에 기통당 0.5 리터씩 분무 주입한 후 크랭크 샤프트를 2~3회 회전시킨다.

6. 최초 운전 전 방청 처리의 제거

6.1 엔진의 외부를 세척유를 사용하여 소제한다.

6.2 엔진 내부의 윤활성 방청유는 별도로 제거할 필요가 없다.

(Recommended amount per each line, Unit: g)

	H17/28	H21/32 H21C H22CDF	H25/33, H27DF	H25/33V	H32/40, H35DF H35G H32C	H32/40V H35FDV H35GV
5	50		-	-	-	
6(12)	50	50	100	100	50	150
7(14)	50	50	100	100	150	150
8(16)	50	50	100	100	150	150
9(18)	-	50	100	100	150	150
10(20)	-	-	-	100	-	150

5.5.3. Discharge the air in system and fill the nitrogen gas to 0.5 bar.

5.5.4. Check the painting condition, once a month, and repair if necessary.

5.5.5. After opening up all covers of crankcase, camshaft, gearcase and cylinder heads, check if any corroded part is founded on the crank chamber, cyl. liner, piston, connecting rod, crankshaft, cam, gears, rocker arm and other engine moving components, once in 3 months. If a corrosion be developed, coat a protective oil<BW-70PSJ, Mobilux EP 004(Mobil-Plex44) or similar> after thoroughly rubbing off the rust.

5.5.6. After checking up the corroded parts, inject corrosion preventing fluid<BW-70PSJ, Mobilarama524 or similar> in a quantity of 0.5 liter per each cylinder into the combustion chambers through the indicator valves, and then turn the crankshaft by 2~3 revolutions.

6. Removal of Preservation before Initial Starting

6.1 Clean up the outside of the engine with turpentine or petroleum.

6.2 It is not necessary to remove preservation oil coated inside of engine.

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6.3 썸프 탱크 내부에 투입된 액상 기화성 방청제 및 냉각수 계통에 투입된 흰색 가루형상의 방청제는 별도 제거할 필요가 없다.

6.4 연료 유 계통 및 분사밸브에 주입된 방청유는 별도로 제거할 필요가 없다.

6.5 흡기 챔바의 기화성 방청제는 엔진 블럭 커버를 열어 제거한다.

7. 공구 및 예비 부품의 방청

7.1 각 공구 및 예비품의 방청은 “품질 사양” 및 각 도면에 표기된 사양에 따른다.

7.1.1. 공구 및 예비품의 방청

항목	구분	방청	비고 (방청제 사양)
공구	가공품	-방청 처리 -비닐 포장	BW70PSJ
	일반품	-인산염 피막 처리 -비닐 밀폐포장	
예비품		-방청 처리 -비닐포장 또는 기름종이 포장	Tectyle 506
기타 보기재		-방청 처리 -비닐 밀폐포장	

7.2 보관은 옥내 또는 밀폐된 상자에 하고 옥외 보관 시는 방수 천막으로 상자를 포장하여 물이 유입되지 않도록 한다.

7.3 공구 및 예비 품을 사용시 방청유를 제거하고 경유 또는 유사한 세척제로 소제한다.

7.4 단기 보관 시는 윤활유에 담가서 보관 또는 그리스를 도포
하여 보관한다.

6.3 It is not necessary to remove the liquefied Volatile Corrosion Inhibitor inside of sump tank and Volatile Corrosion Inhibitor(white powder) inside of cooling water system.

6.4 It is not necessary to obstinately remove the correction protection fluids applied on the internal side of the engine system which could mixable with the system media.

6.5 Open the cover for air chamber and clean up the the Volatile Corrosion Inhibitor inside of it.

7. Preservation of Tool and Spare Part

7.1 The anti-corrosion for tools and spare parts should be treated in accordance with “Quality Specification” and instruction of its drawing.

7.1.1. Preservation of Tool and Spare Part

Item	Sect.	Process of Anti-corrosion	Remarks (Spec.)
Tool	Machined goods	-Anti-corrosion treatment -Wrapping with vinyl	BW70 PSJ
	Unmachined goods	-Parkerizing -Sealing up with vinyl	
Spare		-Anti-corrosion treatment -Wrapping with vinyl or oil paper	Tectyle 506
Auxiliary part		- Anti-corrosion treatment - Sealing up with vinyl	

7.2 Store tools and spare parts in house or waterproof box. Storage box should be packed with water proof tarpaulin when storage box is left at outdoor or the open air yard.

7.3 Cleaning for tools and spare parts can be made with petroleum or similar cleaning solvent.

7.4 Tools and spare parts should be kept in lubricating oil or covered with grease for short time storage.

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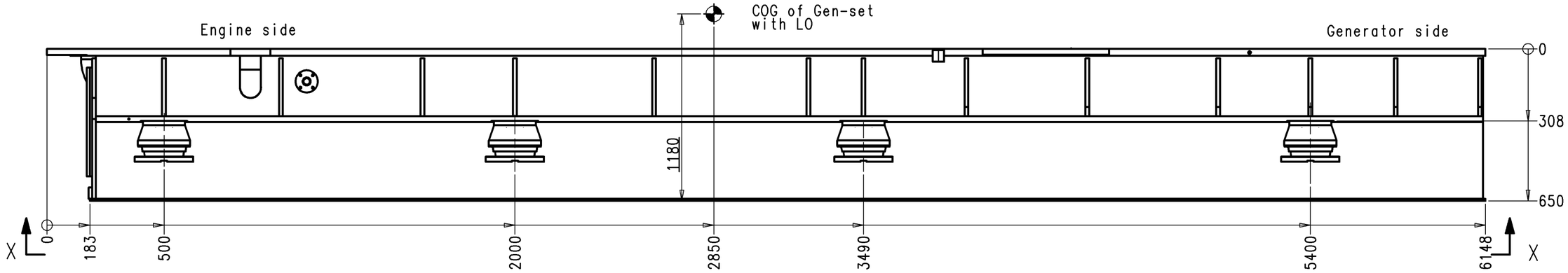
7.5 출고 시 포장

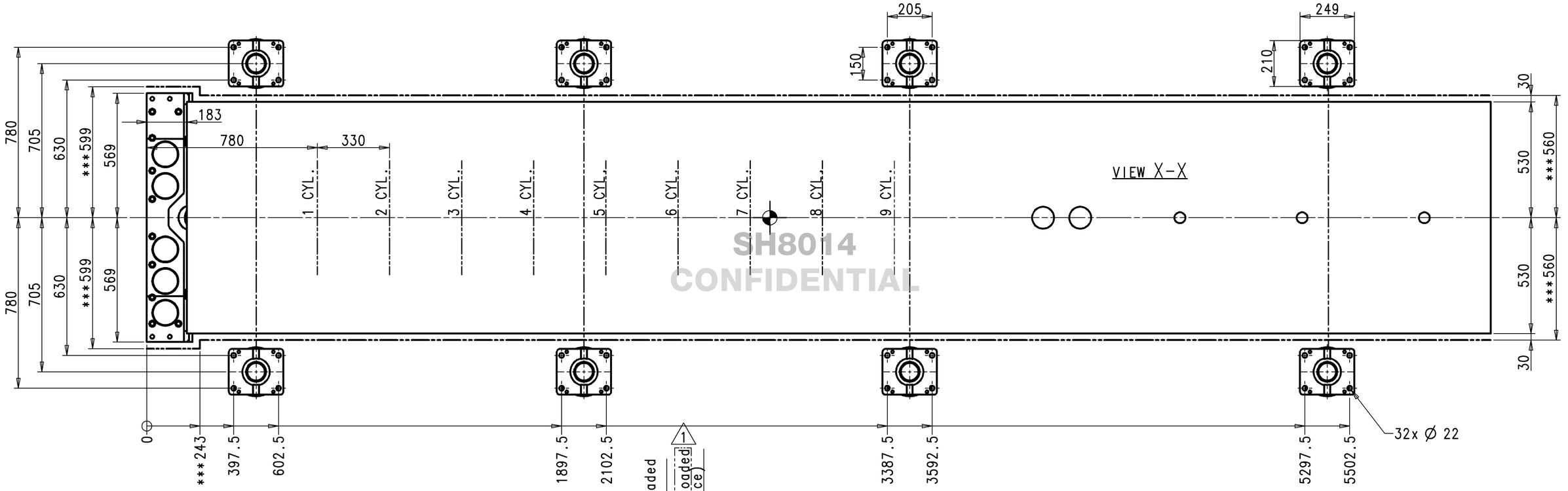
항목	구분	출고 시 포장
Tool	가공품	1.Tool Box(Steel) 이용 2.Tool Box내에 실리카겔 추가 비치
	일반품	
Spare		-경량 부품: Spare Box -중량 부품: Wooden Box +실리카겔 비치
기타 보기재		-Wooden Box+실리카겔 비치

7.5 Delivery packing

Item	Sect.	Delivery packing
Tool	Machined goods	1.Using Tool Box(Steel) 2.Put Silica gel in the Tool Box
	Unmachined goods	
Spare		-Light Part: Spare Box -Heavy Part: Wooden Box + Silica gel
Auxiliary part		-Wooden Box + Silica gel

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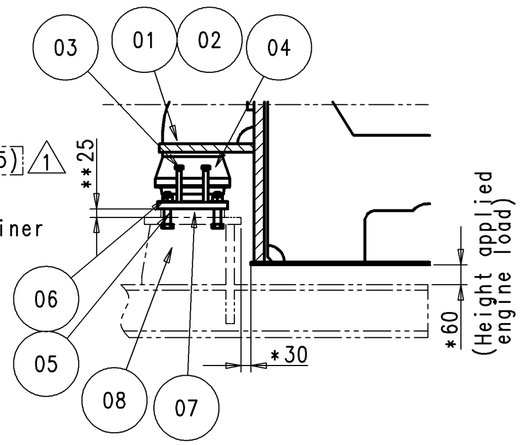


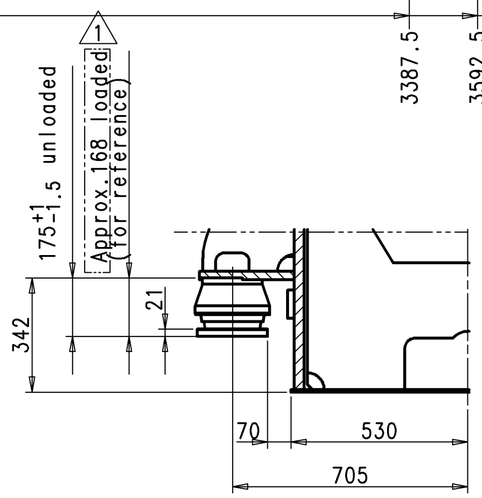
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POS 1 M20 screw
POS 2 Washer
POS 3 M14 jacking screw
POS 4 Resilient mounting (RD241D-65) ⚠1
POS 5 M20 foundation bolt
POS 6 Self locking nut
POS 7 Steel liner or Adjustable liner
POS 8 Bracket

POS 3-5-6-7-8 delivered by shipyard

POS 1 Torque 250 Nm
POS 5 Torque 400 Nm
(STRENGTH CLASS 8.8)





* Min. necessary distance.
** Min. thickness of steel liner

Note
---------- with *** marked dimension is the necessary space for installation of D/G set.

For Generator HFC7 638-08P
(Outline DWG. : 3H-003256-0)

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-11-12	HMC	GJH	KHS			Add. Note & chg. dim.		1
2019-11-05	HMC	GJH	KHS					0

Similar Drawing No.	Licensor's Drawing No.	LIC. Material / Blank	Material / Blank: ASS'Y; Mass(kg): -
Previous Drawing No.	Supplement Drawing No.		
Engine / Product Type: H21/32	Title: HOLDING DOWN BOLTS ARR'T	Projection	Units: mm kg; Distribution: A82
	Description: FOR SH8014_3X9H21/32-900RPM	Scale: 1:1	Information No.: 211100; Security: B
	Drawing No.: B92-307421-2	Page No.: 1/1	Size: A2

HYUNDAI HEAVY INDUSTRIES

Tolerances for dimensions without tolerance indication (ISO 2968-1989)							
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.	Basic size range(mm)	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
	Permissible deviations: Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

Standard for surface roughness												
The basic symbolic and class number are in according with ISO 1302-1978												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

3D IGS CAD Drawing - do not correct by hand. "Confidential"
This drawing, together with its supplements is the property of HHI and subject to copyright protection. A2(420mm*594mm)
이 도면은 현대중공업의 자산이므로 당사의 승인 없이 이 도면을 제 3자에게 양도, 복사, 판매하거나, 이 도면에 의해 부품을 제작하여 제 3자에게 판매하는 것은 불법입니다.

HIMSEN *QUALITY SPECIFICATION*

Information No.	Description :	Identification No.	
011000	Instruction for Resilient Mounting	B94-091431-5	
	Engine Type : H17/28E(U), H21/32, H25/33, H32/40, H35G, H35DF,H27DF	Page No. 1/10	B

Date	Design	Checked	Approve	Complet	Action	Change	R
130501	CIG	JSC	LCS				0
130509	CIG	JSC	LCS			Added Engine type, Note (Method1, 22)	1
131127	CIG	PJK	LCS			Added Engine type(H35G, H35DF)	2
150602	MHL	BYJ	KHS			Added Engine type(H27DF)	3
150915	KIJ	YJH	RYS			Chg. Note(7,8,12,14,15)	4
151216	JDH	YJH	RYS			Corrected table 1,2	5
160819	JHC	YJH	RYS			Chg. Internal buffer gap distance(6,9 page Table.1)	6
170209	JHC	YJH	RYS			Chg. Internal buffer gap distance(6,9 (Loggers))	7

목 차

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2. 설치방법
   2.1. 설치방법 1
   2.2. 설치방법 2

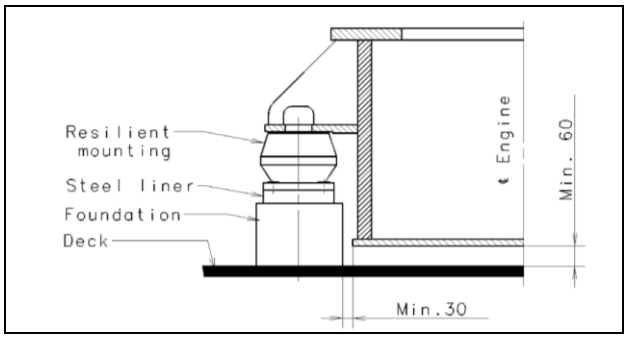
CONTENT

1. Summary
2. Method of installation
   2.1. Method of installation 1
   2.2. Method of installation 2

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개요

발전기 세트는 디젤엔진과 발전기 그리고 이들을 지지하는 Common Base Frame으로 구성된다. 발전기 세트는 외부의 연결 장치에 독립적으로 운전될 수 있도록 Common Base Frame의 받침대에 연결되는 원뿔형의 탄성 지지대에 의해 기초에 설치된다.



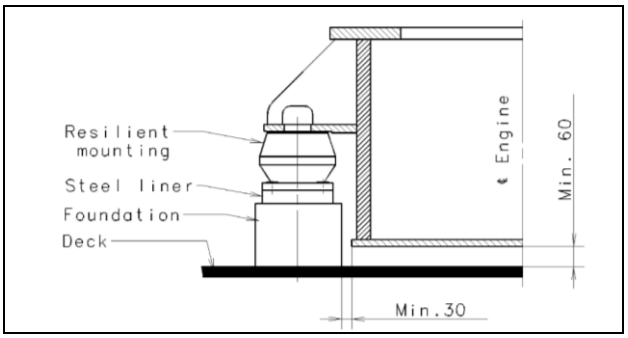
발전기 세트의 모든 장치들은 외부 연결 장치의 영향을 받지 않도록 유연하게 연결되어야 한다. 외부 장치와 유연 연결 장치 없이 연결되거나 접합 되어서는 안 된다.

탄성지지대는 몇 개의 원뿔형 지지대로 구성되어 있다. 탄성지지대의 수량과 위치는 발전기 세트 사양에 의해 결정된다.

탄성지지대의 높이는 부하상태와 무부하상태 간에 2-11mm정도의 차이가 난다.

Summary

The Generating Set is composed with a diesel engine, generator and common base frame which supports them. To perform independently against the external system, the generating set is mounted foundation by resilient mounting coupled on a bracket of a common base frame, shaped conical.



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For all equipment of a generating set are not influenced by external system, generating set should be connected flexibly. Do not connect or weld the equipment of generating set to external utilities without flexible connections.

Resilient mounting of the generating set is made with a number of conical mountings. The number and the position depend on the specifications of the generating set.

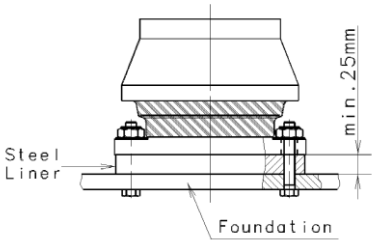
The height of the resilient mounting is different about 2-11mm when the loaded condition compare with un-loaded condition.

설치방법

탄성지지대의 설치하는 방법에는 아래에 명시되는 2가지 방법이 있다.

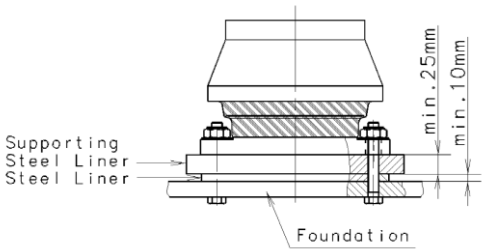
1. Foundation과 탄성지지대 하부 사이에 착탈이 가능한 Steel liner를 삽입한다. Steel Liner 치수는 각각의 탄성 지지대에 맞게 결정되어야 한다. 높이는 최소한 25mm가 되어야 한다.

Method 1



2. Foundation과 탄성지지대 하부 사이에 2개의 Steel liner를 삽입한다. 위의 steel liner는 착탈이 가능하여야 하며 최소한 25mm가 되어야 한다. 아래의 steel liner는 각각의 탄성 지지대에 맞게 높이를 결정(최소 10mm)하고 Foundation에 용접한다.

Method 2



• 설치방법에 상관없이 Steel Liner(최소높이 25mm)는 탄성지지대의 교체를 용이하게 하기 위해 필요하다.

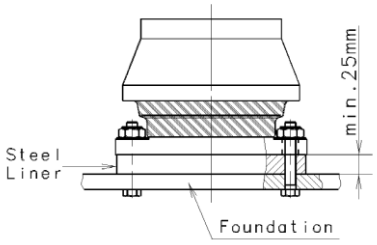
Note : 일반적으로 발전기세트는 엔진과 발전기가 Common base frame에 조립된 상태로 공급된다. 그러므로 엔진과 발전기는 정렬이 된 상태로 공급되지만, 엔진을 운전하기 전에 Crankshaft deflection 값이 허용치 안에 드는지 확인 하여야 한다.

Method of Installation

There are two methods for installation of the resilient mounting.

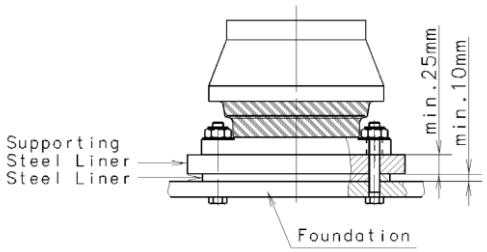
1. Insert the loose steel liner between the foundation and the bottom of resilient mounting. The dimension of steel liner should be adjusted to exact measurement (min. 25mm) for each resilient mounting

Method 1



2. Insert two steel liners between the foundation and bottom of resilient mounting. The above liner should be loose and extended at least 25mm. The below liner is adjusted to exact measurement (min. 10mm) for each resilient mounting and welded to the foundation.

Method 2



• Irrespective of the method of installation, steel liner(min.25mm) is necessary to facilitate a possible future replacement of the resilient mountings.

Note : Normally, the generating set is delivered with engine and alternator mounted on the common base frame. Although engine and alternator have been adjusted by the factory, it is recommended to check the crankshaft deflection is under allowable tolerances before starting up the generating set.

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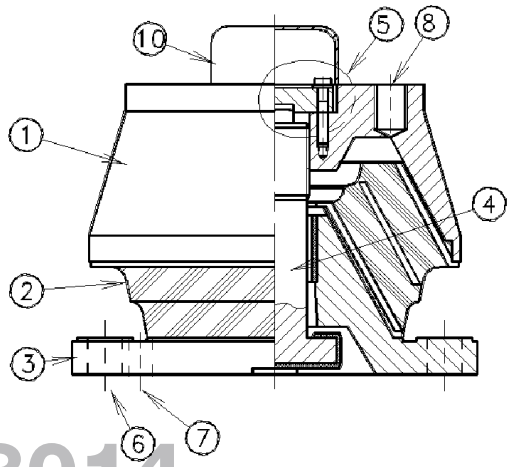
설치 방법 1

일반적으로 탄성 지지대는 Common base frame에 부착되어 공급된다. 이 경우에는 아래의 2번부터 시행하고 만약 부착되어 있지 않다면 Base frame에 탄성 지지대를 부착하고 다음을 시행한다.

Method of Installation 1

If the resilient mountings have been mounted to the common base frame (It's normal), perform after the below No. 2. Otherwise perform bellow after clinging the resilient mounting to the base frame.

Pos. 1 Top casting
Pos. 2 Rubber element
Pos. 3 Base casting
Pos. 4 Internal buffer
Pos. 5 Locking devices
Pos. 6 Mounting hole
Pos. 7 Tapped hole(M14)
Pos. 8 Tapped hole(M20)
Pos.10 Protection cap



<Fig.1>

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1. 탄성지지대의 Top casting과 Base frame을 4개의 Bolt (Pos 8)로 고정한다.
2. Protection cap(Pos 10)을 제거하고 Locking장치(Pos 5)(Bolt, Lock ring등)를 분해한다.
3. Jacking bolt를 Tap Hole(Pos 7)에 설치한다. 이때 Foundation과 탄성지지대 사이의 간격은 최소한 25mm가 되어야 한다. (Fig.2)
4. 엔진을 내린다.
5. 모든 Jacking bolt가 Foundation에 완전히 밀착되었는지 확인한다.
6. Internal buffer(Pos 4)가 자유롭게 돌아가는지 확인한다.

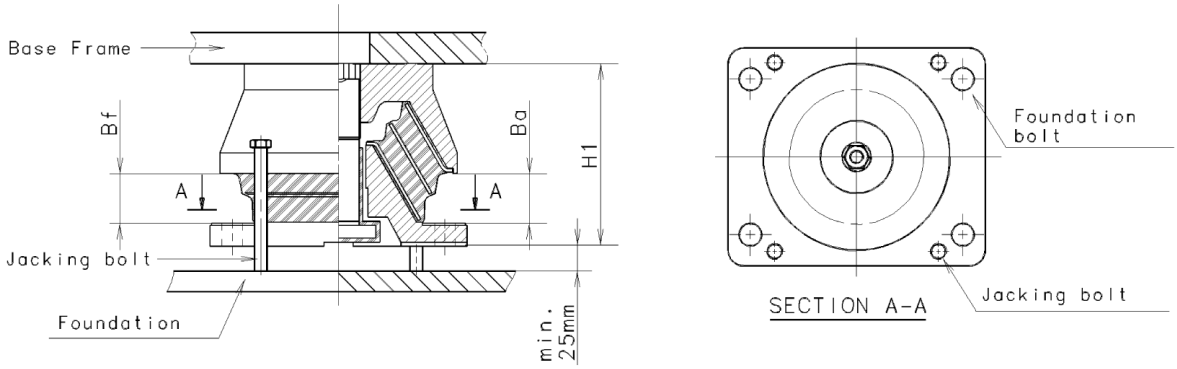
*NOTE : Internal buffer가 자유롭게 돌아가지 않는다면 Internal buffer를 시계방향으로 돌려 풀림 상태가 되게 한다.

1. Fix the top casting of the resilient mounting to the base frame by using 4 bolts(Pos 8).
2. Remove Protection cap(Pos 10) and loosen locking devices(Pos 5)(bolts, locking ring, etc.)
3. Install the jacking bolt at tapped hole(Pos 7). At this time, the distance between the foundation and resilient mounting should be at least 25mm. (Fig.2)
4. Lower the generating set until it rests completely on the foundation.
5. Check all jacking bolts are in full contact with the foundation.
6. Turn the internal buffer(Pos 4) in order to check that they could be moved freely,

*NOTE : If the internal buffer is not turned freely, make it release by turning it clockwise.

7. 탄성지지대가 충분히 변형이 되도록 최소 48시간이 지난 후 H1 높이를 측정하여 참조 값과 비교한다. (Fig.2)

7. Measure the height H1 of each resilient mounting after min.48 hours to ensure that resilient mounting is fully deflected. And compare with the reference loaded height (Fig.2)



<Fig.2>

8. 각 탄성지지대의 Bf/Ba 또는 H1 높이를 비교하여 그 차이가 2mm를 넘어서는 안 된다. 하중이 고르게 분산되도록 탄성지지대 간 높이 차이는 최소화 되어야 한다.
또한 Bf (f:선두방향) 와 Ba (a:선미방향)의 차이가 0.6mm를 넘어서는 안 된다.

8. The difference of loaded height Bf/Ba or H1 of each resilient mounting should not exceed 2mm and should ideally be less to ensure that individual mounting is not overloaded.
Also the difference between Bf (f:forward direction) and Ba (a:afterward direction) should not exceed 0.6mm.

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*Note : 만약, 높이차이가 위의 기준을 초과한다면, jack bolt를 이용하여 높이를 조절한다. (편차가 큰 부분부터 조절한다)

*Note : If the difference exceeds the limits, level the resilient mounting by adjusting the jack bolts (adjusting from the largest deviation)

9. 탄성지지대 하부와 Foundation간의 높이를 측정한다. 가능한 정밀하게 제작하기 위해 여러 지점에서 높이를 측정한다.

9. Measure the height on several points to obtain the highest possible accuracy between the bottom of the resilient mounting and the foundation.

10. 측정된 값을 반영하여 Steel liner를 가공한다. 이때 Steel liner의 높이는 탄성지지대의 교체 작업을 위하여 최소한 25mm가 되어야 한다.

10. Machine the steel liner which reflects the measured value. Make sure that the minimum height of steel liner is 25mm for a future replacement of resilient mounting.

11. Steel liner에 Hole을 가공한다. Hole의 위치 및 치수는 탄성지지대의 Base casting의 치수를 참고한다.

11. Drill the mounting hole at the steel liner according to the base casting dimension.

12. Internal buffer를 시계 반대 방향(위로 이동)으로 돌려 Base casting에 접촉시킨다.

13. 크레인이나 유압장치를 이용하여 발전기세트를 들어 올린다.

14. 모든 Jacking bolt를 제거한다.

15. Steel liner를 위치 시킨다.

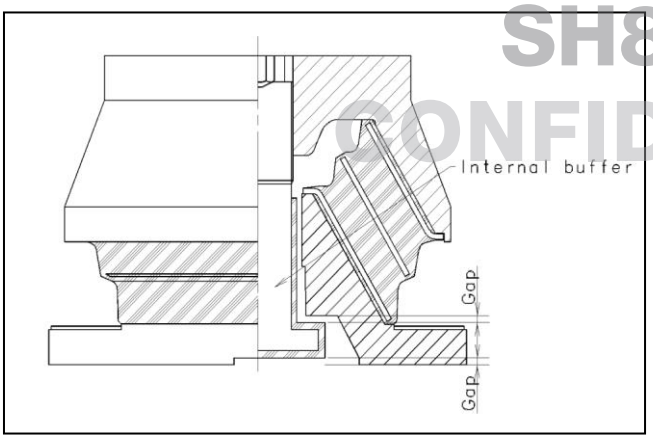
16. 완전히 안착될 때까지 발전기세트를 내린다.

17. Internal buffer를 시계방향(아래로 이동)으로 돌려 Steel liner에 완전히 닿게 한다.

18. Internal buffer를 반시계방향(위로 이동)으로 돌려 Base casting에 닿게 한다.

19. Internal buffer를 시계방향(아래로 이동)으로 (A)바퀴 돌려 Base casting과 Steel liner사이의 Gap을 동일하게 한다.(Fig.3) Gap은 업체별로 상이하므로 하기 표 참조한다.

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<Fig.3>

20. Feeler gauge를 base casting 홈에 삽입하여 Steel liner와 internal buffer와의 거리가 바르게 조절 되었는지 확인한다. (M11100 참조)

21. Locking장치를 체결하여 internal buffer를 고정시킨다. (Top lock ring의 경우, top lock ring을 조금씩 돌려 가장 가까운 hole을 찾아 fixing bolt로 고정한다.)

22. 탄성 지지대와 Steel liner를 Foundation에 4개의 볼트로 결합한다. (Steel liner는 용접하지 않는다.)

23. 모든 작업을 완료한 다음 각각의 탄성지지대의 Internal buffer와 Steel liner의 간극을 재 확인한다

12. Turn the internal buffer anti-clockwise(upwards) until it contacts the base casting to secure the loaded height of each resilient mounting.

13. Lift the generating set by means of a crane or a hydraulic jack

14. Remove all jacking bolt

15. Position the steel liner.

16. Lower the generating set until it rests completely.

17. Turn the internal buffer clockwise(downwards) until it makes contact with the steel liner.

18. Turn the internal buffer anti-clockwise(upwards) until it makes contact with the base casting

19. Turn the internal buffer clockwise(downwards) to make the gap distance of base casting and steel liner become same by rotating (A) turns. Refer to the following table because gap is different by maker.

Maker	Type	Gap	No. of turns to set the gap (A)
Rubber Design Youil Ensys	RD214-YE7000--	4mm	2 turns
Vulkan Loggers	T90-ST EVOLO 633-	6mm	3 turns

<Table.1>

20. Check the gap distance by putting a feeler gauge into a groove of base casting. (Refer to M11100)

21. Lock the internal buffer by fastening the locking device. (In case of top lock ring, turn it to nearest thread hole, then secure with the fixing bolts)

22. Fix the resilient mounting and steel liner to the foundation with four bolts (Do not weld the steel liner)

23. After completing all installations, reconfirm the clearance between the internal buffer and steel liner.

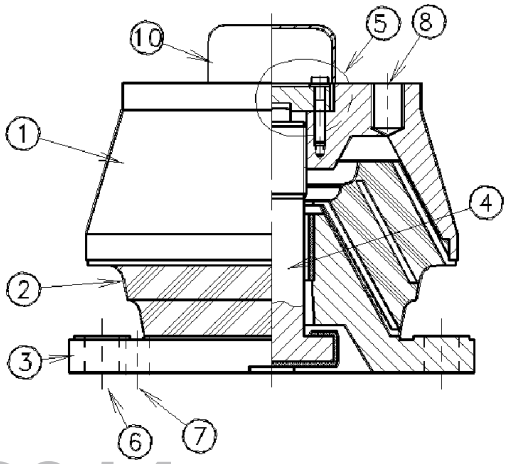
설치 방법 2

일반적으로 탄성 지지대는 Common base frame에 부착되어 공급된다. 이 경우에는 아래의 2번부터 시행하고 만약 부착되어 있지 않다면 Base frame에 탄성 지지대를 부착하고 다음을 시행한다.

Method of Installation 2

If the resilient mountings have been mounted to the common base frame (It's normal), perform after the below No. 2. Otherwise perform bellow after clinging the resilient mounting to the base frame.

Pos. 1 Top casting
Pos. 2 Rubber element
Pos. 3 Base casting
Pos. 4 Internal buffer
Pos. 5 Locking devices
Pos. 6 Mounting hole
Pos. 7 Tapped hole(M14)
Pos. 8 Tapped hole(M20)
Pos.10 Protection cap



<Fig.1>

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1. 탄성지지대의 Top casting과 Base frame을 4개의 Bolt (Pos 8)로 고정한다.
2. Protection cap(Pos 10)을 제거하고 Locking장치(Pos 5)(Bolt, Lock ring등)를 분해한다.
3. Jacking bolt용 Tap hole과 탄성지지대 하부 casting의 치수를 반영한 Mounting hole이 가공되어 있는 Supporting steel liner(Min.25mmt)가 필요하다. Supporting steel liner를 Fig.2와 같이 Dowel pin으로 탄성지지대에 부착한다.
   Jacking bolt를 Supporting steel liner의 Tap Hole(Pos 7)에 설치한다. 이때 Foundation과 Supporting steel liner 사이의 간격은 최소한 10mm가 되어야 한다. (Fig.2)
4. 엔진을 내린다.
5. 모든 Jacking bolt가 Foundation에 완전히 밀착되었는지 확인한다.
6. Internal buffer(Pos 4)가 자유롭게 돌아가는지 확인한다.

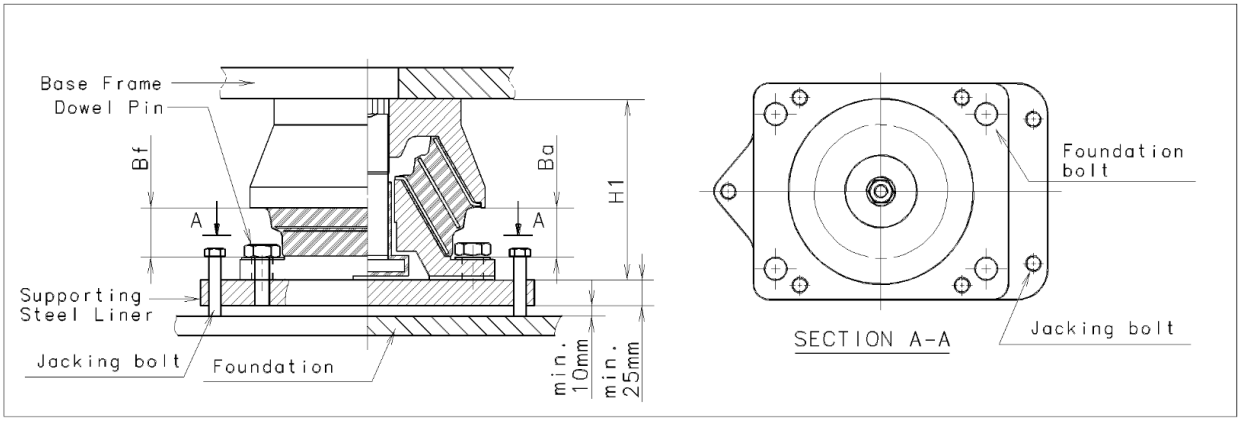
*NOTE : Internal buffer가 자유롭게 돌아가지 않는다면 Internal buffer를 시계방향으로 돌려 풀림 상태가 되게 한다.

1. Fix the top casting of the resilient mounting to the base frame by using 4 bolts(Pos 8).
2. Remove Protection cap(Pos 10) and loosen locking devices(Pos 5)(bolts, locking ring, etc.).
3. Supporting steel liner(Min.25mmt), complete with tapped holes for jacking bolts and mounting holes drilled according to base casting dimensions, are required. Assemble the supporting steel liner to the resilient mounting by means of the dowel pins. Install the jacking bolt at tapped hole.(Pos 7) in supporting steel liner. At this time, the distance between the foundation and supporting steel liner should be at least 10mm. (Fig.2)
4. Lower the generating set until it rests completely on the foundation.
5. Check all jacking bolts are in full contact with the foundation.
6. Turn the internal buffer(Pos 4) in order to check that they could be moved freely,

*NOTE : If the internal buffer is not turned freely, make it release by turning it clockwise.

7. 탄성지지대가 충분히 변형이 되도록 최소 48시간이 지난 후 H1 높이를 측정하여 참조 값과 비교한다. (Fig.2)

7. Measure the height H1 of each resilient mounting after min.48 hours to ensure that resilient mounting is fully deflected. And compare with the reference loaded height (Fig.2)



<Fig.2>

8. 각 탄성지지대의 Bf/Ba 또는 H1 높이를 비교하여 그 차이가 2mm를 넘어서는 안 된다. 하중이 고르게 분산되도록 탄성지지대 간 높이 차이는 최소화 되어야 한다.
또한 Bf (f:선두방향) 와 Ba (a:선미방향)의 차이가 0.6mm를 넘어서는 안 된다.

8. The difference of loaded height Bf/Ba or H1 of each resilient mounting should not exceed 2mm and should ideally be less to ensure that individual mounting is not overloaded.
Also the difference between Bf (f:forward direction) and Ba (a:afterward direction) should not exceed 0.6mm.

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*Note : 만약, 높이차이가 위의 기준을 초과한다면, jack bolt를 이용하여 높이를 조절한다. (편차가 큰 부분부터 조절한다)

*Note : If the difference exceeds the limits, level the resilient mounting by adjusting the jack bolts (adjusting from the largest deviation)

9. Supporting steel liner하부와 Foundation간의 높이를 측정한다. 가능한 정밀하게 제작하기 위해 여러 지점에서 높이를 측정한다.

10. 측정된 값을 반영하여 Steel liner를 가공한다. 이때 Steel liner의 높이는 최소한 10mm가 되어야 한다. Supporting steel liner의 높이는 탄성지지대의 교체 작업을 위하여 최소한 25mm가 되어야 한다.

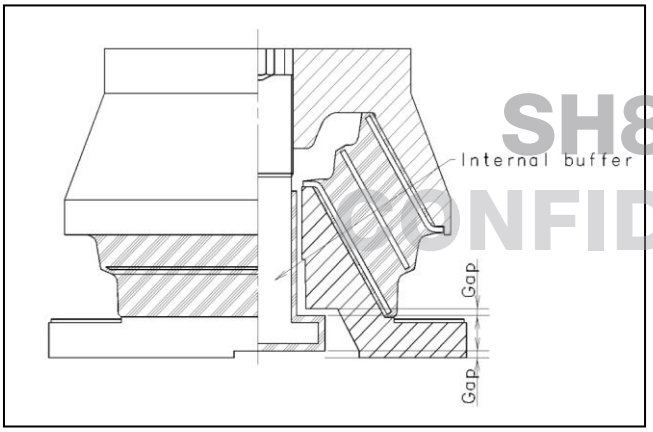
11. Steel liner에 Hole을 가공한다. Hole의 위치 및 치수는 탄성지지대의 Base casting의 치수를 참고한다.

9. Measure the height on several points to obtain the highest possible accuracy between the bottom of the supporting steel liner and the foundation.

10. Machine the steel liner which reflects the measured value. Make sure that the minimum height of steel liner is 10mm and the minimum height of supporting steel liner is 25mm for a future replacement of resilient mounting.

11. Drill the mounting hole at the steel liner according to the base casting dimension.

12. 크레인이나 유압장치를 이용하여 발전기세트를 약간 들어 올린다.
13. 모든 Jacking bolt를 제거한다.
14. Steel liner를 위치 시킨다.
15. 발전기세트를 완전히 안착될 때까지 내린다.
16. Internal buffer를 시계방향(아래로 이동)으로 돌려 Supporting steel liner에 완전히 닿게 한다.
17. Internal buffer를 반시계방향(위로 이동)으로 돌려 Base casting에 닿게 한다.
18. Internal buffer를 시계방향(아래로 이동)으로 (A)바퀴 돌려 Base casting과 Supporting steel liner사이의 Gap을 동일하게 한다.(Fig.3) Gap은 업체별로 상이하므로 하기 표 참조한다.



<Fig.3>

19. Feeler gauge를 base casting 홈에 삽입하여 Supporting steel liner와 internal buffer와의 거리가 바르게 조절 되었는지 확인한다. (M11100 참조)
20. Locking장치를 체결하여 internal buffer를 고정시킨다. (Top lock ring의 경우, top lock ring을 조금씩 돌려 가장 가까운 hole을 찾아 fixing bolt로 고정한다.)
21. Dowel Pin을 제거한다.
22. 탄성 지지대와 Supporting steel liner, Steel liner를 Foundation에 4개의 볼트로 결합한다.
23. 아래의 Steel liner를 Foundation에 용접한다.
(Supporting steel liner는 용접하지 않는다.)
24. 모든 작업을 완료한 다음 각각의 탄성지지대의 Internal buffer와 Steel liner의 간극을 재 확인한다.

12. Lift the generating set slightly by means of crane or hydraulic jack.
13. Remove all jacking bolt
14. Position the steel liner.
15. Lower the generating set until it rests completely.
16. Turn the internal buffer clockwise(downwards) until it makes contact with the supporting steel liner.
17. Turn the internal buffer anti-clockwise(upwards) until it makes contact with the base casting
18. Turn the internal buffer clockwise(downwards) to make the gap distance of base casting and supporting steel liner become same by rotating (A) turns. Refer to the following table because gap is different by maker.

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Maker	Type	Gap	No. of turns to set the gap (A)
Rubber Design Youil Ensys	RD214-YE7000-	4mm	2 turns
Vulkan Loggers	T90-ST-EVOLO 633	6mm	3 turns

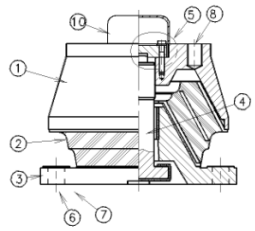
<Table.1>

19. Check the gap distance by putting a feeler gauge into a groove of base casting. (Refer to M11100)
20. Lock the internal buffer by fastening the locking device. (In case of top lock ring, turn it to nearest thread hole, then secure with the fixing bolts)
21. Remove the dowel pins.
22. Fix the resilient mounting and supporting steel liner/steel liner to the foundation with four bolts
23. Weld the lower steel liner to the foundation.
(Do not weld the supporting steel liner)
24. After completing all installations, reconfirm the clearance between the internal buffer and steel liner.

※ 업체별 탄성지지대 도면 (B92-091433-9)

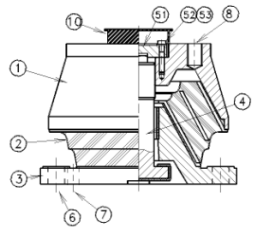
※ Resilient mounting drawing by maker (B92-091433-9)

Pos. 1 Top casting
Pos. 2 Rubber element
Pos. 3 Base casting
Pos. 4 Internal buffer
Pos. 5 Locking devices
Pos. 6 Mounting hole
Pos. 7 Tapped hole(M14)
Pos. 8 Tapped hole(M20)
Pos.10 Protection cap



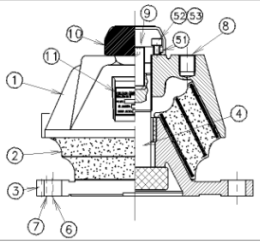
<General Parts list>

Pos.51 Top lock ring
Pos.52 Fixing bolt
Pos.53 Spring washer
Pos.10 Protection cap



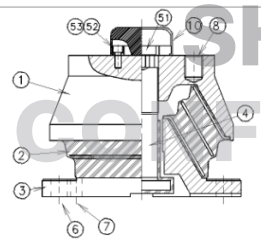
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Pos.51 Top lock ring
Pos.52 Fixing bolt
Pos.53 Spring washer
Pos. 9 Hexagon socket screw
Pos.10 Protection cap
Pos.11 Identification plate



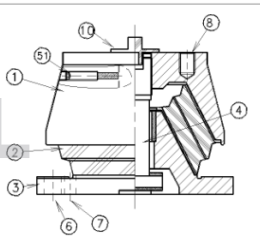
<Vulkan, T90-ST- >

Pos.51 Top lock ring
Pos.52 Fixing bolt
Pos.53 Spring washer
Pos.10 Protection cap



<Youil Ensys, YE7000- >

Pos.51 Locking screw
Pos.10 Protection cap



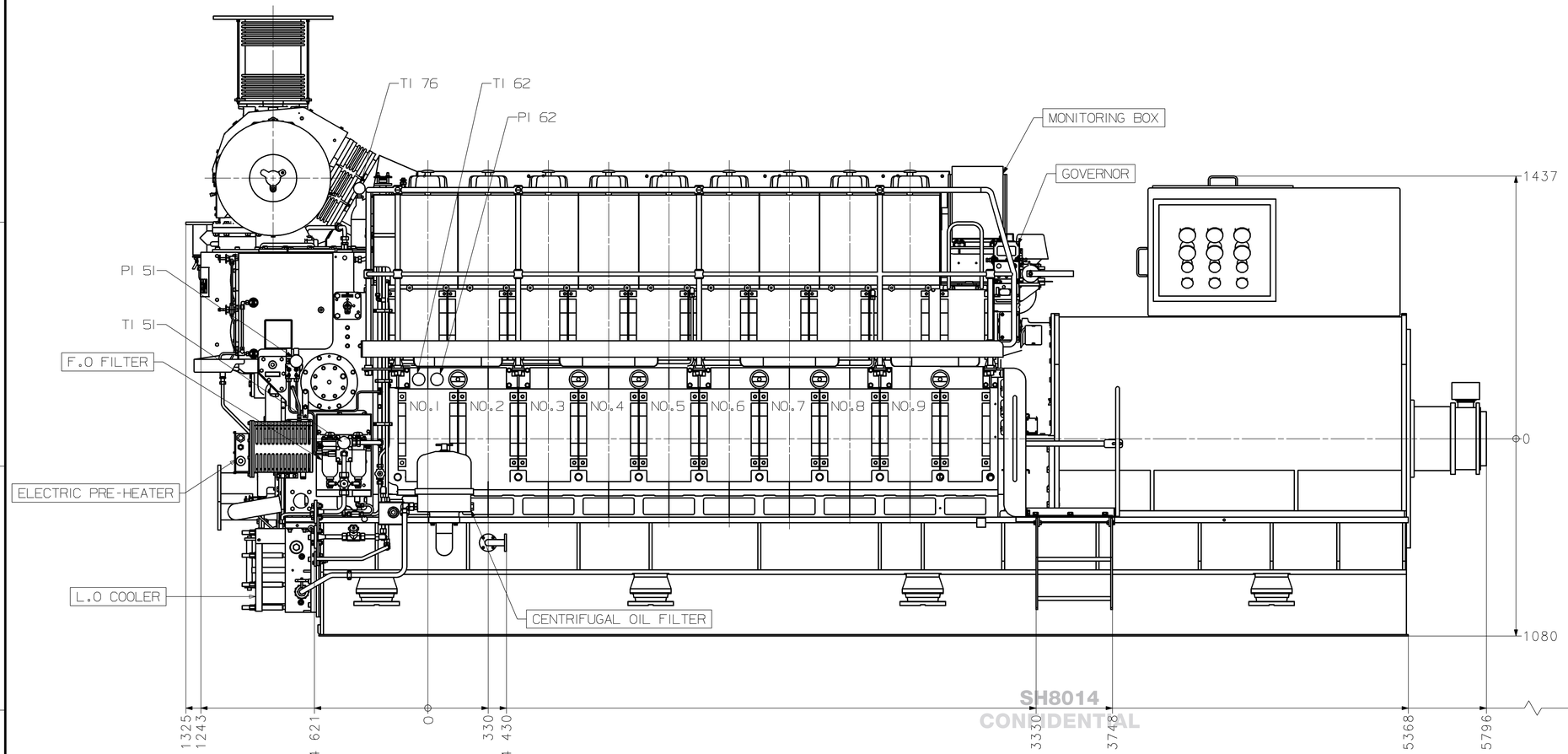
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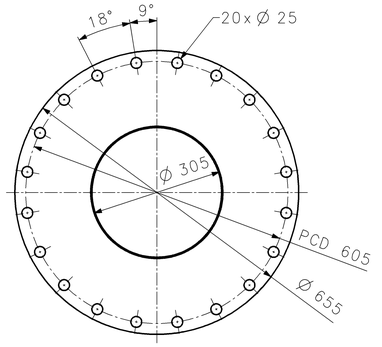
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NOTICE

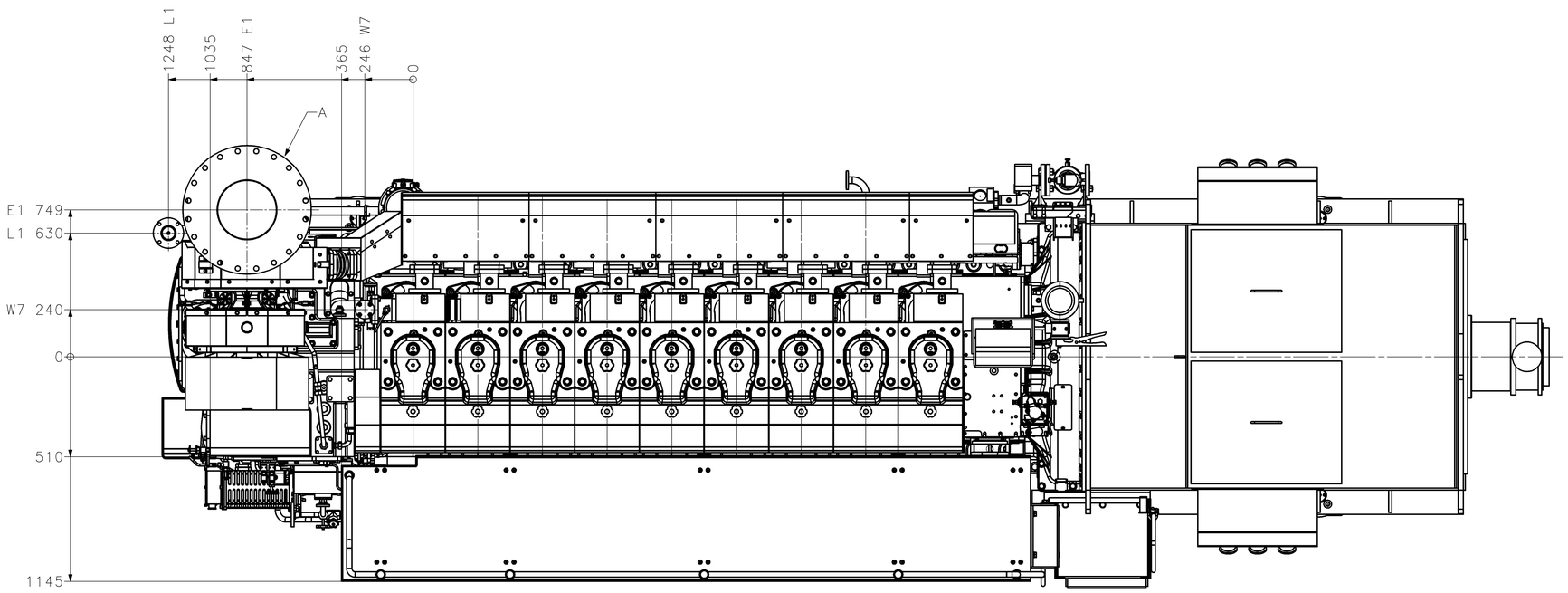
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DETAIL A



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* NOTE *

1. DRY WEIGHT OF GENSET
   -1) DIESEL ENGINE & BASE FRAME : 25.3 ton
   -2) ALTERNATOR (HFC7 638-08P) : 7.4 ton
   -3) TOTAL WEIGHT : 32.7 ton

NO.		DESCRIPTION	PIPE SIZE	FLANGE/FITTINGS	REMARK
D2		OIL DRAIN	Ø 15	BITE TYPE CONN.	LEAD TO WASTE OIL TANK
	F6	WASTE OIL FROM D/G BLOCK (OD Ø 12)			
	F3	WASTE OIL FROM F.O FILTER & D/G BLOCK(OD Ø 15)			
D1		WATER DRAIN	Ø 15	BITE TYPE CONN.	LEAD TO BILGE HOLDING TANK
	E4	DRAIN FROM TURBOCHARGER (OD Ø 20)			
	-	AIR COOLER VENT (OD Ø 10)			
	-	C.W DRAIN (OD Ø 10)			
E3-3		DRAIN FROM AIR COOLER	OD Ø 10	-	LEAD TO BILGE HOLDING TANK
E3-2		DRAIN FROM No.1 CYLINDER	OD Ø 10	-	
E3-1		DRAIN FROM LAST CYLINDER	OD Ø 8	-	
E2		WATER WASHING INLET FOR TURBINE SIDE	OD Ø 12	-	HOSE COUPLING
E1		EXHAUST GAS OUTLET	500A	-	SEE DETAIL A
A1		COMPRESSED AIR INLET	40A	30K JISB 2220	
W7		VENTING TO EXPENSION TANK	25A	5K JISB 2220	
W2		L.T FRESH WATER OUTET	100A	5K JISB 2220	
W1		L.T FRESH WATER INLET	100A	5K JISB 2220	
L5		LUB. OIL TO C.W SHUT OFF VALVE	Ø 8	PF 1/4	
L4		LUBRICATING TO SERARATOR	25A	5K JISB 2220	
L2		LUBRICATING OIL FROM SERARATOR	25A	5K JISB 2220	
L1		LUBRICATING OIL SUPPLY	25A	5K JISB 2220	
		OIL VAPOUR DISCHARGE	65A	5K JISB 2220	
F4		FUEL OIL RECYCLING	15A	5K JISB 2220	LEAD TO F.O SETTLING (OVER FLOW) TANK
F2		FUEL OIL OUTLET	25A	16K JISB 2220	
F1		FUEL OIL INLET	25A	16K JISB 2220	

Date	Designed	Checked	Approved	Action code	Ex/changes(Utility)	Change / Replacement	ECN No.	Rev
2020-02-03	KKC	JCL	DYJ			Chg. terminal box position		1
2019-11-22	MCM	JCL	KHS					0

Similar Drawing No. | Licensor's Drawing No. | LIC. Material / Block | Material / Block | Mass(kg)
Previous Drawing No. | Supplement Drawing No. | | COMPOSITE | 0.00

Engine / Product Type: H21/32

Title: GENERAL ARRANGEMENT

Description: 9H8014'S - 9H600RPM

Drawing No.: B90-309087-5 Page No. 1/2

Projection | Units: mm kg | Distribution: P8B
Scale: 1:10 | Information No.: 200000 | Security: B
Size: A0

HYUNDAI HEAVY INDUSTRIES

Tolerances for dimensions without tolerance indication (ISO 2968-1989)							
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufatured by machining.	Basic size range(mm)	~ 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations Medium series		±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness											
The basic symbolic and class number are in according with ISO 1302-1978											
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max.μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

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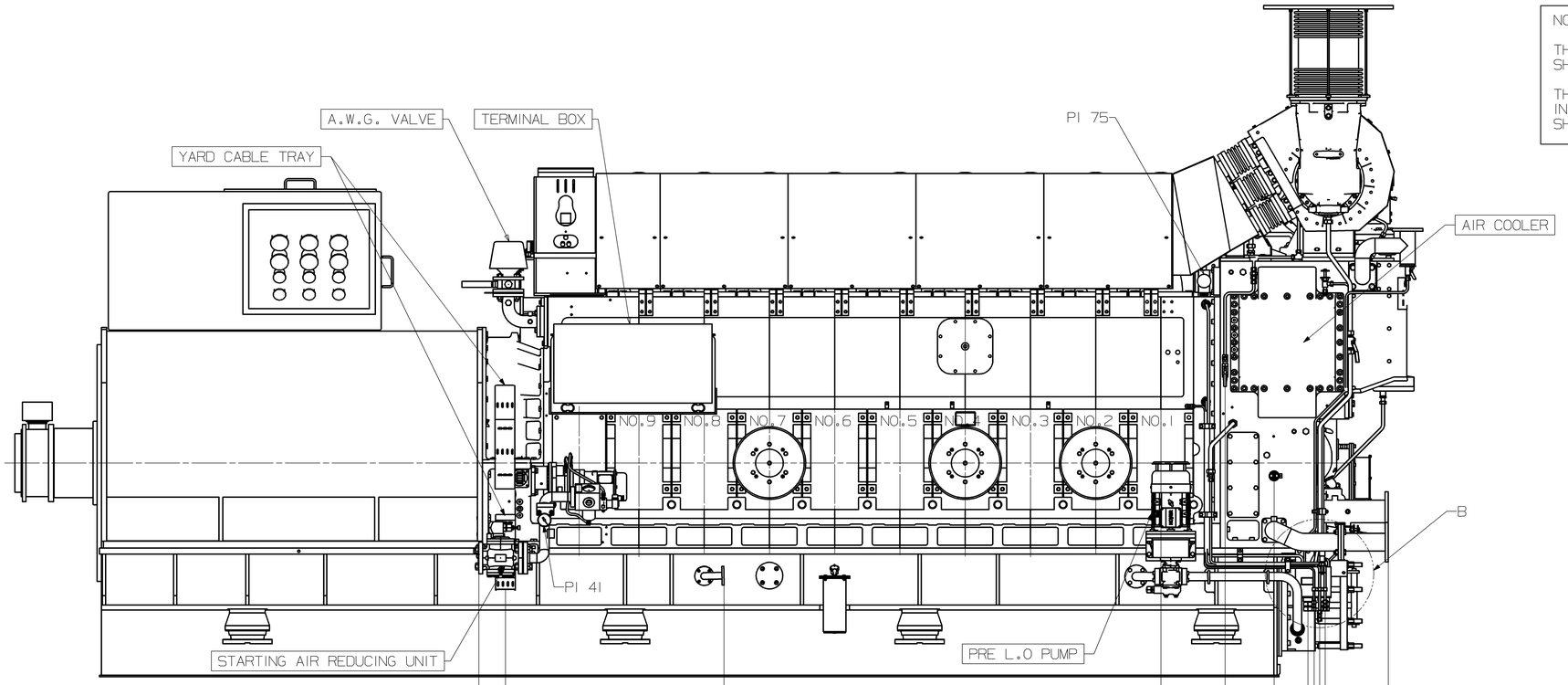
"Confidential"
30 DAS Drawing - do not correct by hand.

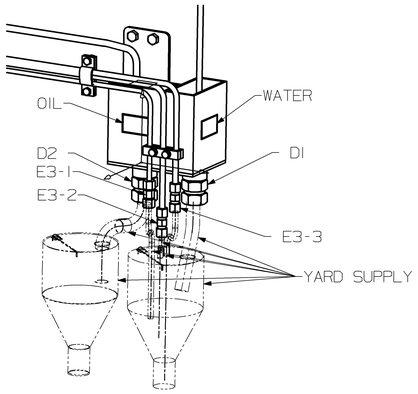
H5EF-K220-010(R0)

NOTICE

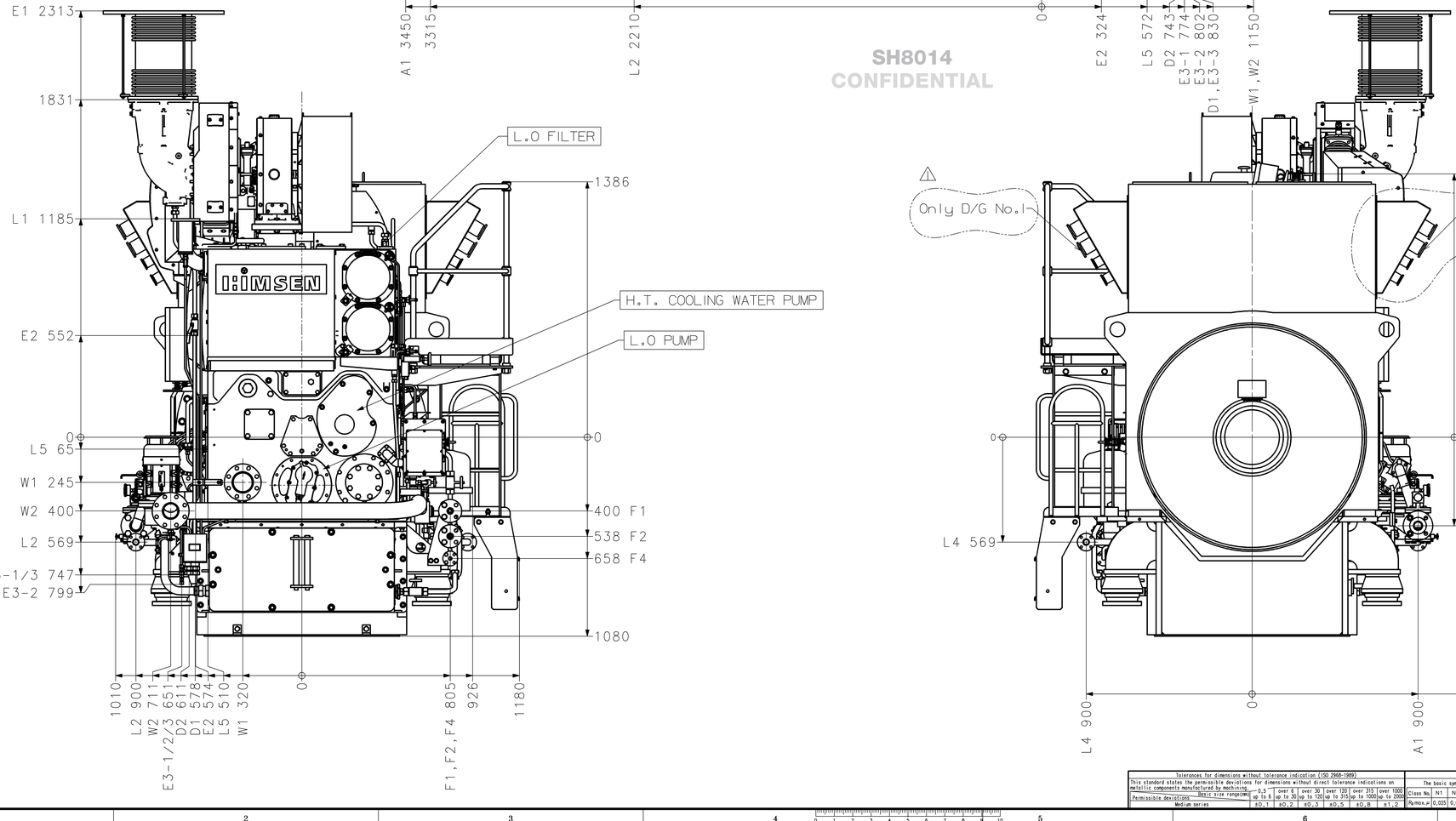
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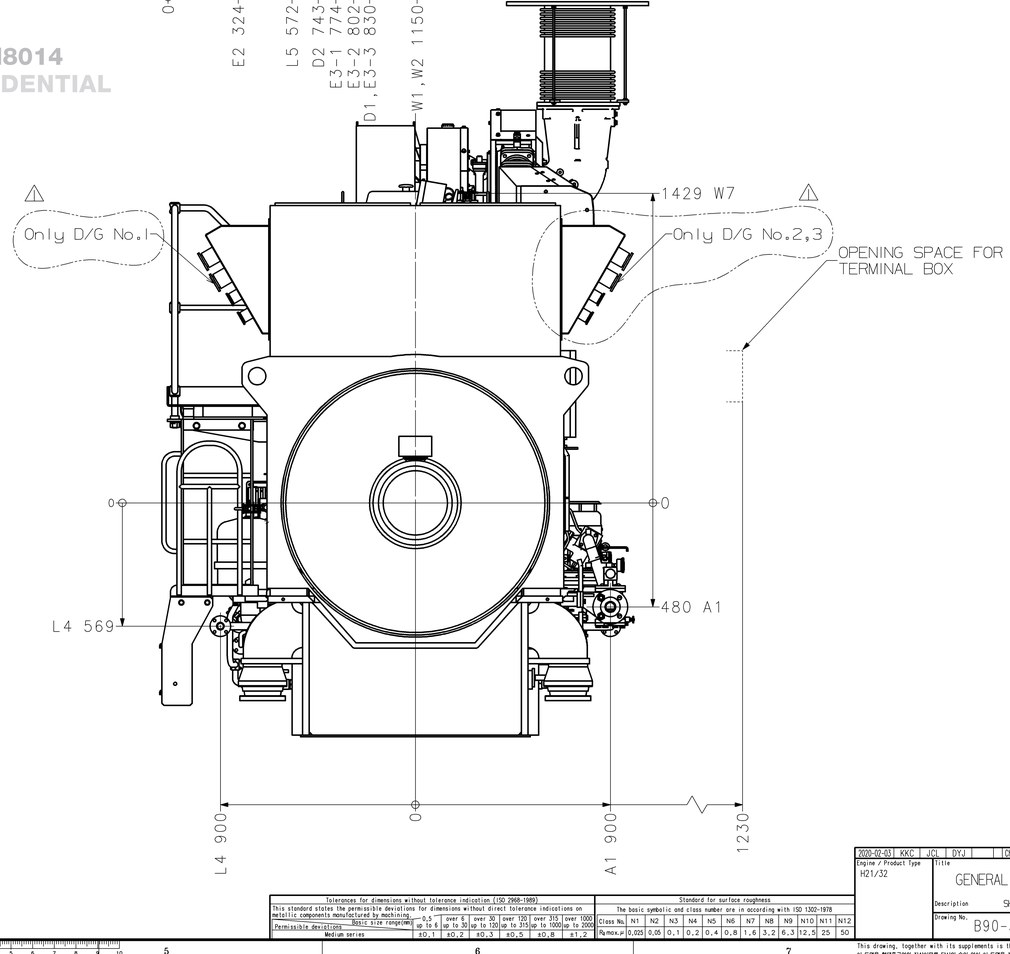
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DETAIL B





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Tolerances for dimensions without tolerance indication (ISO 2768-1989)							
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.	Basic size range(mm)	0.5 ~ 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations	Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness											
The basic symbolic and class number are in according with ISO 1302-1978											
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max.μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

2020-02-03	KKC	JCL	DYJ		Chg. terminal box position

Engine / Product Type: H21/32

Title: GENERAL ARRANGEMENT

Description: SH8014*5 - SH900RPM

Drawing No.: B90-309087-5

Page No.: 2/2

Projection	Units	Distribution
	mm kg	P8B

Scale	Information No.	Security
1:10	200000	B

Size: A0

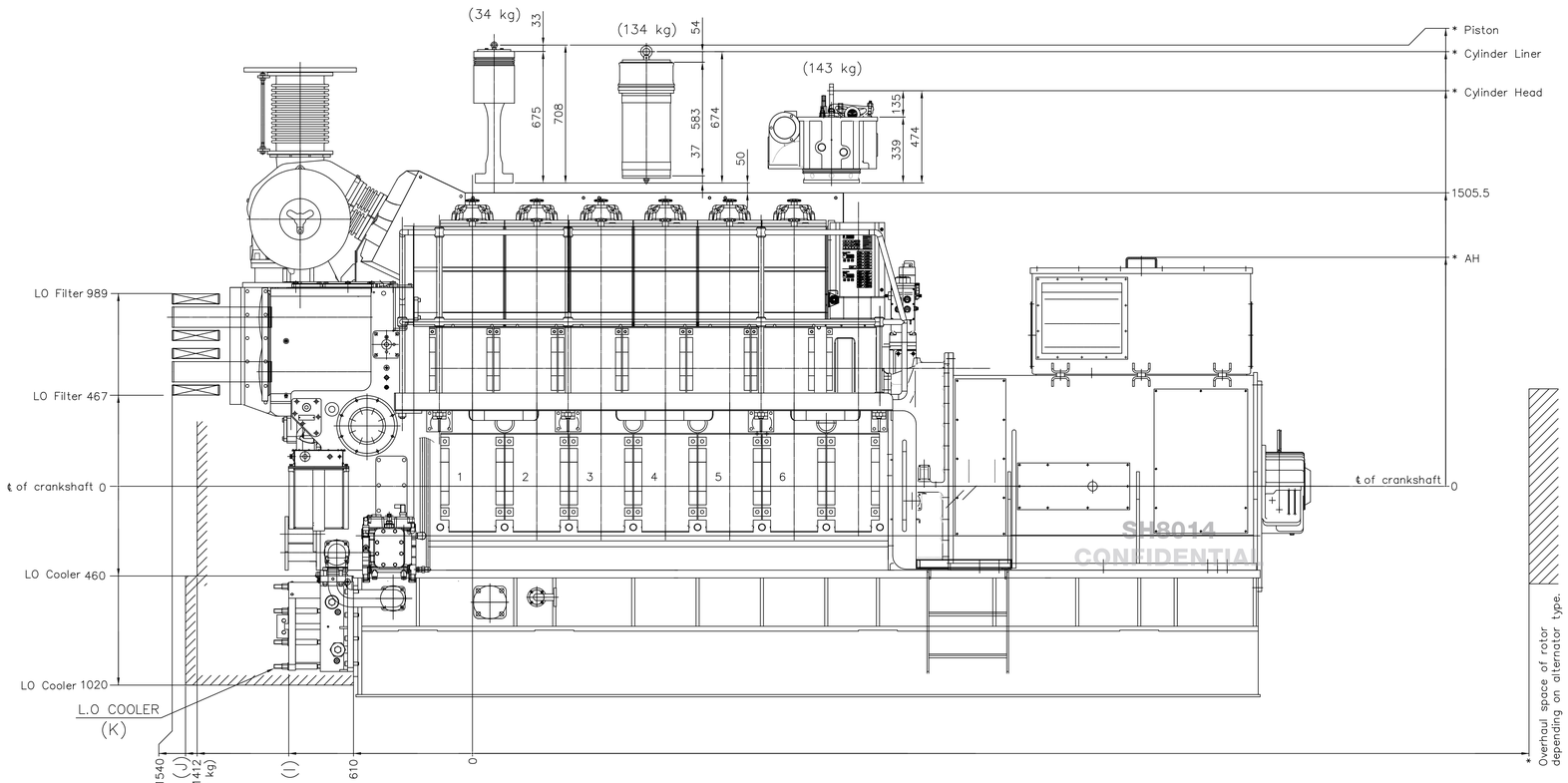
HYUNDAI HEAVY INDUSTRIES

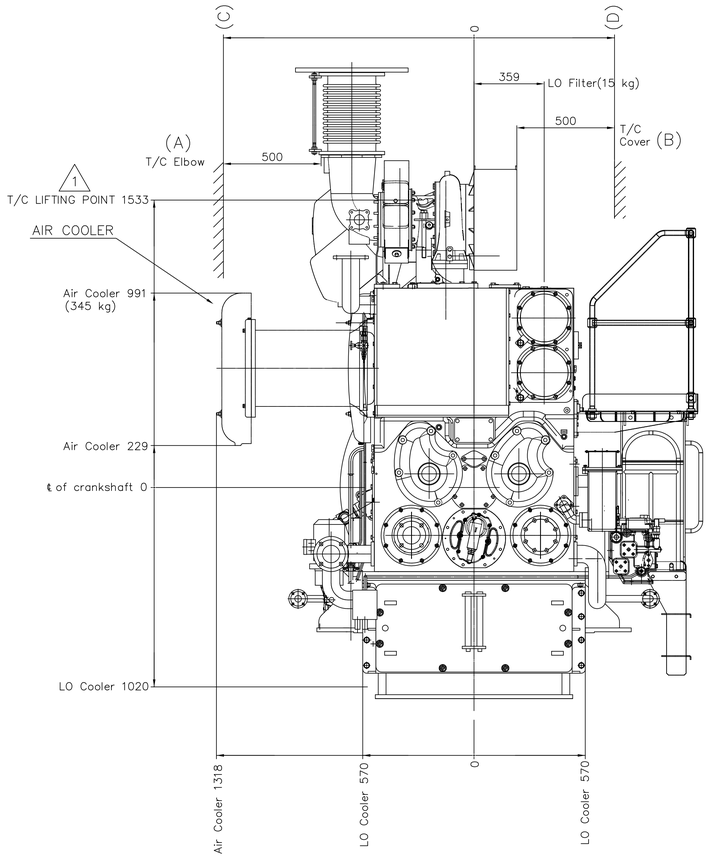
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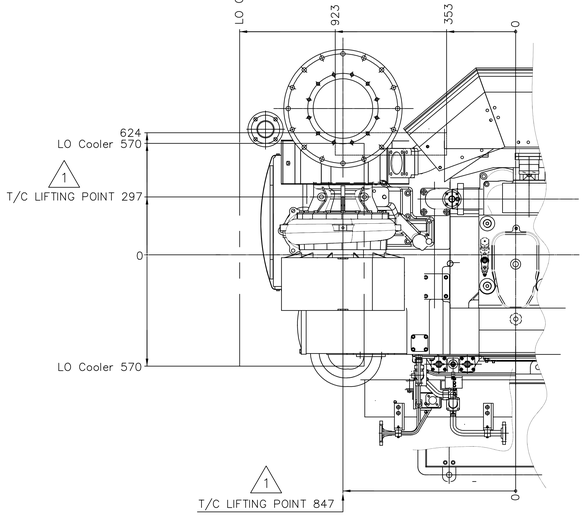
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HSEF-M220-010(R0)

Overhauling Passing The Alternator For H21/32







Type	A	B	C	D
5H21/32-720,900rpm 6H21/32-720rpm	18 kg	19 kg	1282 mm	719 mm
6H21/32-900rpm 7H21/32-720,900rpm 8H21/32-720rpm	25 kg	27 kg	1282 mm	719 mm
8H21/32-900rpm 9H21/32-720,900rpm	40 kg	40 kg	1439 mm	773 mm

Type	I	J	K(EMPTY)
5H21/32 6H21/32	984	1410	221
7H21/32	997	1510	229
8H21/32	1017	1510	238
9H21/32	1049	1510	255

*)For dimensions for overhauling of each component, refer to the below table.

Case	Height for Overhauling(mm)		
	Cyl. Head	Cyl. Liner	Piston
Alternator Height(AH) ≤ 1506mm	2030	2230	2264
Alternator Height(AH) > 1506mm	AH + 524	AH + 724	AH + 758

*) For dimensions and overhauling space of Alternator, refer to the General Arrangement drawing for the specific project.

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General Tolerance Unless Noted

Casting ‡		Cl	Cz
Length	~100	1.0	1.5
	100~	1.5	2.0
	400~	2.0	3.0
	1000~	3.0	4.0
	2000~	4.0	5.0
Thickness	~3	±	1.0
	3~	0.5	1.0
	10~	1.0	1.5
	30~	1.5	2.0
	80~	2.0	3.0
	140~	2.0	4.0

Machining ‡			
	Wt	Wz	Wk
~4	0.1	0.1	0.2
4~10	0.1	0.1	0.3
10~30	0.1	0.2	0.5
30~80	0.1	0.2	1.0
80~120	0.1	0.2	2.0
120~180	0.1	0.2	3.0
180~250	0.2	0.4	4.0
250~315	0.3	0.5	5.0
315~400	±	4.0	6.0
400~500	±	5.0	7.0
500~	±	6.0	8.0

Welding ‡			
	Wt	Wz	Wk
~100	1	1	1
~150	1	1	4
~200	1	1	6
~300	1	1	11
~400	1	1	14
~500	1	10	18
~1000	1	12	21
1000~	1	14	24

Standard For Surface Roughness

Marks	Ra	Rmax
~		25
▽	6.3	100
▽▽	1.6	25
▽▽▽	6.35	
▽▽▽▽	0.85	

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range ¶mm	up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations						
Medium series	\0,1	\0,2	\0,3	\0,5	\0,8	\1,2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max.¶	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2020-03-10	HKJ	GJH	DYJ			Add. Dimension		1
2020-02-12	HKJ	DJH	DYJ					0

Similar Drawing No. | Licensor's Drawing No. | UC Material / Blank | Material / Blank | Mass(kg)

Previous Drawing No. | Supplement Drawing No.

Engine / Product Type: H21/32

Title: OVERHAUL DIMENSION OF MAIN COMPONENTS

Description

Drawing No.: B90-306768-7 | Page No.: 1/2

Projection | Units: mm kg | Distribution: A82

Scale: 1:11 | Information No. | Security: B

Size: A0

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3D CAD Drawing - do not correct by hand. "Confidential"

HSEF-K220-010(R0)

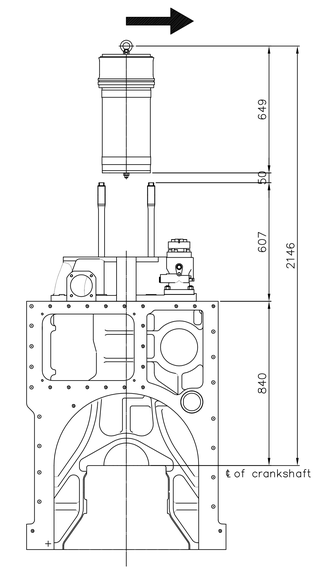
General Tolerance Unless Noted		
Casting ±		
Lengths		C1 / C2
	~100	1.0 / 1.5
	~250	1.5 / 2.0
	~400	2.0 / 3.0
	~630	3.0 / 4.0
	~1000	4.0 / 5.0
	1000 ~	7.0 /
Thickness	~6	0.5 / 1.0
	~18	1.0 / 1.5
	~30	1.5 / 2.0
	~50	2.0 / 3.0
	~80	2.0 / 4.0

Machining ±			
	M	K	N
~6	0.05	0.1	0.25
~30	0.1	0.2	0.5
~120	0.15	0.3	0.8
~315	0.2	0.5	1.25
~1000	0.3	0.8	2.0
~2000	0.5	1.2	3.0
~4000	0.8	2.0	4.0
~8000	1	3.0	5.0
~12000	-	4.0	6.0
~16000	-	5.0	7.0
~20000	-	6.0	8.0

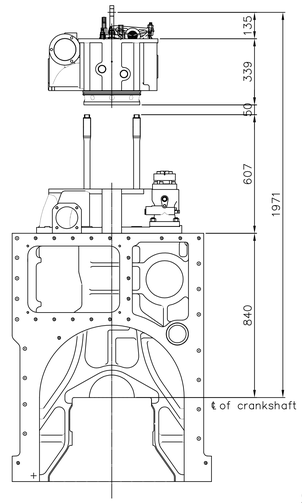
Welding ±			
	M	K	N
~100	1	1	2
~315	1	3	4
~630	2	4	6
~1000	3	7	9
~1600	4	9	11
~2500	5	11	14
~4000	6	13	16
~6300	7	15	20
~10000	8	17	24

Standard For Surface Roughness	
Marks	Ra (Rmax)
~	
▽	1000
▽▽	250
▽▽▽	6.30
▽▽▽▽	0.85

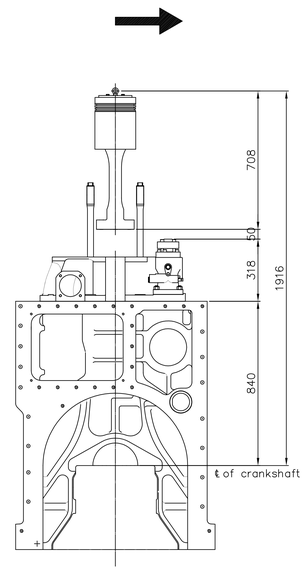
Overhauling At The Service Side For H21/32



Cylinder Liner



Cylinder Head



Piston

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*) For dimensions and overhauling space of Alternator, refer to the General Arrangement drawing for the specific project.

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2020-03-10	HKJ	GJH	DYJ			Add. Dimension		1
2020-02-12	HKJ	GJH	DYJ					0

Similar Drawing No.		Licensor's Drawing No.	
Previous Drawing No.		Supplement Drawing No.	
Engine / Product Type	H21/32	Title	OVERHAUL DIMENSION OF MAIN COMPONENTS
Description		Drawing No.	B90-306768-7
Page No.	2/2	UC Material / Blank	
Material / Blank		Mass(kg)	
Projection		Units	mm kg
Distribution	A82	Scale	1:11
Information No.		Security	B
Size	A0		HYUNDAI HEAVY INDUSTRIES

Tolerances for dimensions without tolerance indication (ISO 2968-1989)							
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.							
Permissible deviations	Basic size range (mm)	0.5 ~ up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
	Medium series	\0.1	\0.2	\0.3	\0.5	\0.8	\1.2

Standard for surface roughness												
The basic symbolic and class number are in according with ISO 1302-1978												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Rgmax.μ	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

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3D CAD Drawing - do not correct by hand.

NO.	SYMBOL	SYMBOL DESIGNATION
1. GENERAL CONVENTIONAL SYMBOLS		
1.1		PIPE
1.2		PIPE WITH INDICATION OF DIRECTION OF FLOW
1.3		VALVES,GATE VALVES, COCKS AND FLAPS
1.4		APPLIANCES
1.5		INDICATING AND MEASURING INSTRUMENTS
1.6		HIGH PRESSURED PIPE
1.7		TRACING
1.8		ENCLOSURE FOR SEVERAL COMPONENTS ASSEMBLED IN ONE UNIT
2. PIPES AND PIPE JOINT		
2.1		CROSSING PIPES,NOT CONNECTED
2.2		CROSSING PIPES,CONNECTED
2.3		TEE PIPE
2.4		FLEXIBLE PIPE
2.5		EXPANSION PIPE (CORRUGATED) GENERAL
2.6		JOINT, SCREWED
2.7		JOINT, FLANGED
2.8		JOINT, SLEEVE
2.9		JOINT, QUICK-RELEASING
2.10		EXPANSION JOINT WITH GLAND
2.11		EXPANSION PIPE
2.12		CAP NUT
2.13		BLANK FLANGE
2.14		SPECTACLE FLANGE
2.15		ORIFICE ON FLANGE
2.16		ORIFICE ON CONNECTOR
2.17		LOOP EXPANSION JOINT
2.18		SNAP-COUPLING
2.19		PNEUMATIC FLOW OR EXHAUST TO ATMOSPHERE
2.20		RUBER COMPENSATOR
3. VALVES,GATE VALVES,COCKS AND FLAPS		
3.1		VALVE, STRAIGHT THROUGH
3.2		VALVE, ANGLE
3.3		VALVE, THREE-WAY
3.4		NON-RETURN VALVE(FLAP), STRAIGHT
3.5		NON-RETURN VALVE(FLAP), ANGLE
3.6		NON-RETURN VALVE(FLAP) STRAIGHT SCREW DOWN
3.7		NON-RETURN VALVE(FLAP) ANGLE SCREW DOWN
3.8		SAFETY/RELIEF VALVE
3.9		ANGLE SAFETY/RELIEF VALVE
3.10		SELF-CLOSING VAVLE
3.11		QUICK-OPENING VALVE
3.12		QUICK-CLOSING VALVE
3.13		REGULATING VALVE
3.14		BALL VALVE(-COCK)
3.15		BUTTERFLY VALVE
3.16		GATE VALVE
3.17		DOUBLE-SEATED CHANGEOVER VALVE
3.18		SUCTION VAVLE CHEST
3.19		SUCTION VALVE CHEST WITH NON RETURN VALVES
3.20		DOUBLE-SEATED CHANGEOVER VALVE,STRAIGHT
3.21		DOUBLE-SEATED CHANGEOVER VALVE,ANGLE
3.22		COCK,STRAIGHT THROUGH
3.23		COCK,ANGLE
3.24		COCK,THREE-WAY,L-PORT IN PLUG
3.25		COCK,THREE-WAY,T-PORT IN PLUG
3.26		COCK,FOUR-WAY,STRAIGHT THROUGH IN PLUG
3.27		COCK,WITH BOTTOM CONNECTION
3.28		COCK,STRAIGHT THROUGH WITH BOTTOM CONNECTION
3.29		COCK,ANGLE,WITH BOTTOM CONNECTION
3.30		COCK,THREE-WAY,WITH BOTTOM CONNECTION
3.31		THERMOSTATIC VALVE
3.32		VALVE WITH TEST FLANGE / COCK
3.33		3-WAY VALVE WITH REMOTE CONTROL(ACTUATOR)
3.34		NON-RETURN VALVE(AIR)
3.35		3/2 SPRING RETURN VALVE ,NORMALLY CLOSED
3.36		2/2 SPRING RETURN VALVE ,NORMALLY CLOSED
3.37		3/2 SPRING RETURN VALVE CONTR. BY SOLENOID
3.38		REDUCING VALVE
3.39		ON/OFF VALVE CONTROLED BY SOLENOID AND PILOT DIRECTIONAL VALVE AND WITH SPRING RETURN
3.40		SHUT-OFF VALVE
3.41		3-WAY TEST COCK
4. CONTROL AND REGULATION PART		
4.1		HAND-OPERATED
4.2		REMOTE CONTROL
4.3		SPRING
4.4		MASS
4.5		FLOAT
4.6		PISTON
4.7		MEMBRANE
4.8	M	ELECTRIC MOTOR
4.9		ELECTRO-MAGNETIC
4.10		MANUAL (AT PNEUMATIC VALVE)
4.11		PUSH BUTTON
4.12		SPRING
4.13		SOLENOID
4.14		SOLENOID AND PILOT DIRECTIONAL VALVE
4.15		BY PLUNGER OR TRACER
5.APPLIANCES		
5.1		MUDBOX
5.2		FILTER OR STRAINER
5.3		MAGNETIC FILTER
5.4		SEPARATOR
5.5		STEAM TRAP
5.6		CENTRIFUGAL PUMP
5.7		GEAR OR SCREW PUMP
5.8		HAND PUMP(BUCKET)
5.9		HAND PUMP(BUCKET)
5.10		VARIOUS ACCESSORIES (TEXT TO BE ADDED)
5.11		PISTON PUMP
5.12		HEAT EXCHANGER
5.13		ELECTRIC PRE-HEATER
5.14		AIR FILTER
5.15		AIR FILTER WITH MANUAL CONTROL
5.16		F.O FLOWMETER
5.17		AIR FILTER WITH AUTOMATIC DRAIN
5.18		WATER TRAP WITH MANUAL CONTROL
5.19		AIR LUBRICATOR
5.20		SILENCER
5.21		FIXED CAPACITY PNEUMATIC MOTOR WITH ON DIRECTION OF FLOW
5.22		SINGLE ACTING CYLINDER WITH SPRING RETURNED
5.23		DOUBLE ACTING CYLINDER WITH SPRING RETURNED
5.24		AUTO DRAIN TRAP
5.25		BUFFER PISTON / SHOCK ABSORBER
5.26		WATER TANK
5.27		PRESSURE GOVERNOR
5.28		FLOW CONTROL VALVE
6. FITTINGS		
6.1		FUNNEL/WASTE TRAY
6.2		DRAIN
6.3		WASTE TRAY
6.4		WASTE TRAY WITH PLUG
6.5		TURBOCHARGER
6.6		FUEL OIL PUMP
6.7		BEARING
6.8		WATER JACKET
6.9		OVERSPEED DEVICE
7.READING INSTR.WITH ORDINARY DESIGNATIONS		
7.1		SIGHT FLOW INDICATOR
7.2		OBSERVATION GLASS
7.3		LEVEL INDICATOR
7.4		DISTANCE LEVEL INDICATOR
7.5		RECORDER
7.6	CODE NO.	MEASURING DEVICE SENSOR MOUNTED ON ENGINE/UNIT READING/IDENTIFICATION MOUNTED IN A PANEL ON THE ENGINE/UNIT
7.7	CODE NO.	MEASURING DEVICE SENSOR MOUNTED ON ENGINE/UNIT READING/IDENTIFICATION OUTSIDE THE ENGINE/UNIT
7.8	CODE NO.	MEASURING DEVICE LOCAL READING
7.9	CODE NO. 1	MEASURING DEVICE SENSOR MOUNTED ON ENGINE/UNIT READING/IDENTIFICATION IN A PANEL ON THE ENGINE/UNIT AND READING/INDICATION OUTSIDE THE ENGINE/UNIT

8. LETTER FOR INSTRUMENTS			
CODE	EXPLANATION		
	1ST LETTER	2ND LETTER	3RD LETTER
A		ALARM	
B		COUNTER	
C	CONTAMIN -ATION	CONTROL	
D	DIFFERENTIAL	DETECTOR	
E		ELEMENT	
F	FLOW		
G			
H			HIGH
I	CURRENT	INDICATOR	INDICATOR
J	POWER		
K			
L	LEVEL		LOW
M	OIL MISTER		
N	NOISE		
O	OIL		
P	PRESSURE	PRESSURE	
Q			
R		RECORDER	
S	SPEED	SWITCH	
S		SHUT DOWN	
T	TEMPERATURE	TRANSMITTER	
U	VOLTAGE		
V	VISCOSITY		
W	MASS		
X			
Y			
Z	POSITION		SHUT DOWN

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Tolerances for dimensions without tolerance indication (ISO 2768-1989)								
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.	Basic size range(mm)	up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations	Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

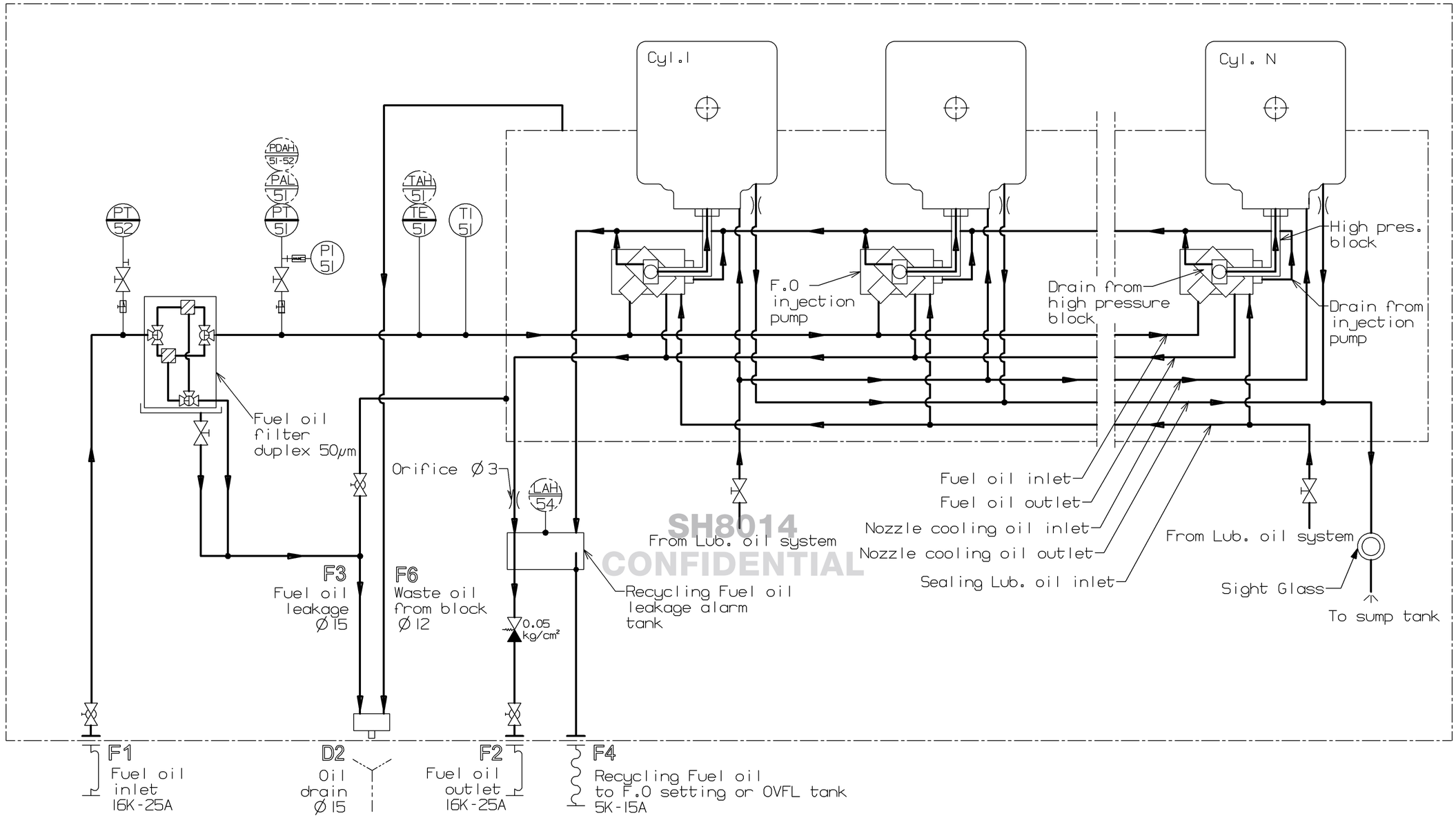
Standard for surface roughness												
The basic symbolic and class number are in according with ISO 1302-1978												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2016-01-12	JJO	KJC	RYS			Del. Cloud mark.		2
2015-12-07	JJO	KJC	RYS			Chg. 7.9 symbol		1
2014-03-24	SYH	KJC	KJC					0

Similar Drawing No. B92-078045-0	Licensor's Drawing No. 1631472-4.1	LIC. Material / Blank	Material / Blank	Mass(kg)
Previous Drawing No.	Supplement Drawing No.			
Engine / Product Type: ALL TYPE	Title: BASIC SYMBOLS FOR PIPING DIAGRAM	Projection	Units: mm kg	Distribution
	Description	Scale: -	Information No.: 372356	Security: B
	Drawing No.: B92-088640-0	Page No.: 01/01	Size: A2	HYUNDAI HEAVY INDUSTRIES

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1. Specification for piping system

System	Press. kg/cm²	Temp. °C	Nom.dia.	Thickness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark
Fuel oil in/out	10	150	Ø22	2.0	DIN 1630 St37.4	15	Flange type	JIS G3101 SS400	-
Fuel oil leaked	-	-	Ø12	1.5	DIN 1630 St37.4	-	Bite type	S45C-N	-
			Ø15	2.0					
Fuel oil recycling	10	150	Ø18	2.0	DIN 1630 St37.4	15	Flange type	JIS G3101 SS400	-
			Ø15	2.0					
-	-	-	-	-	-	-	-	-	-

Tolerances for dimensions without tolerance indication (ISO 2768-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

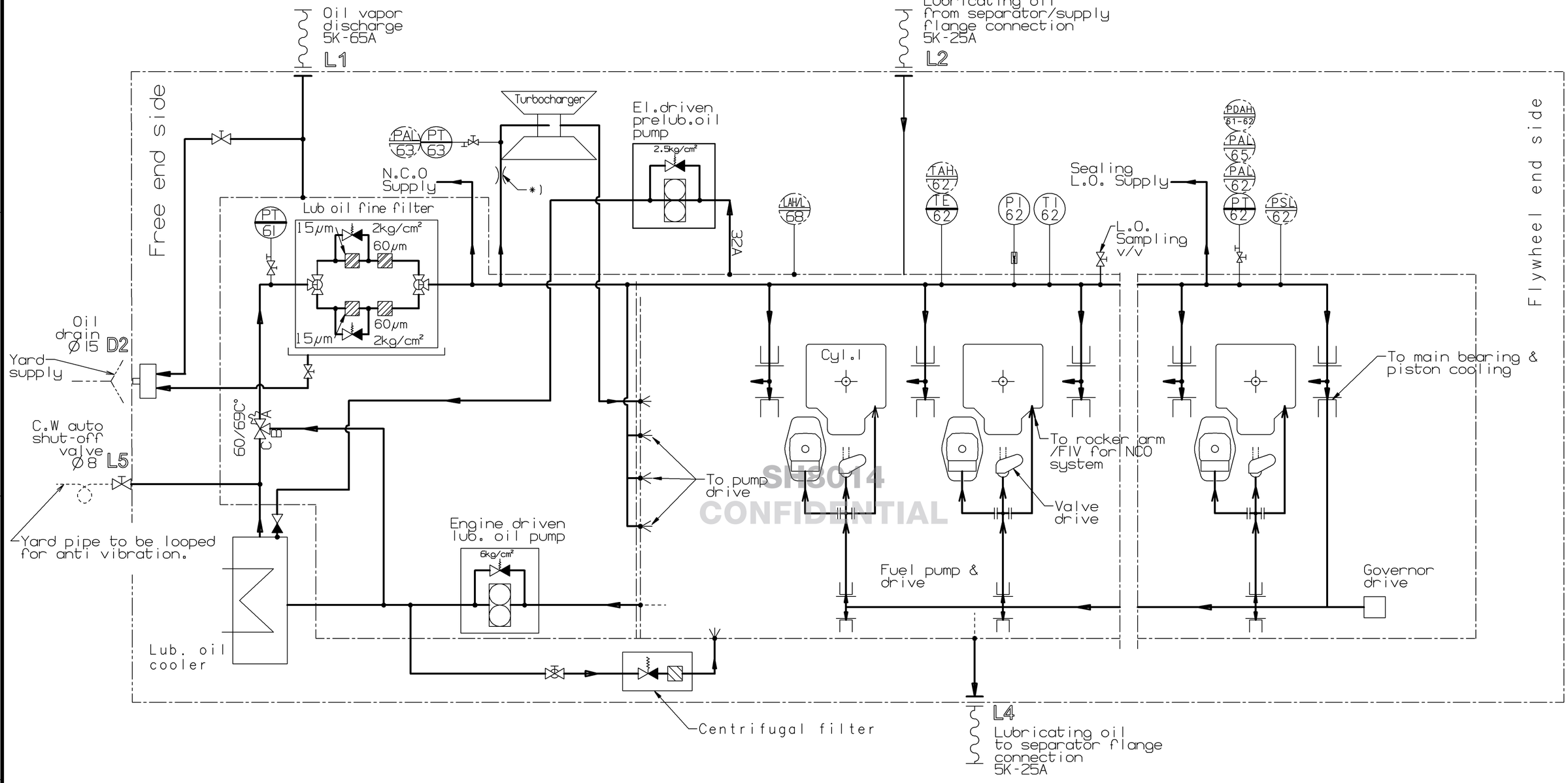
Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-11-19	MSM	JCL	KHS					0

Similar Drawing No. B92-306535-6
Previous Drawing No.
Engine / Product Type H21/32
Licensor's Drawing No.
Supplement Drawing No.
I.C. Material / Blank
Material / Blank COMPOSITE
Mass(kg) 0.00
Title FUEL OIL SYSTEM
Description
Projection
Units mm kg
Distribution P82
Scale 1:1
Information No. D09002
Security B
Drawing No. B92-308358-0
Page No. 1/1
Size A2

HYUNDAI HEAVY INDUSTRIES

HSEF-K220-005(R0)

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3D NX CAD Drawing - do not correct by hand. "Confidential"



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NOTE

1. L1 Conn.
   - The crankcase vent pipe from each engine is led independently to the top of the funnel or manifold.
   - The vent pipe should have a continuous upward gradient of minimum 10 degrees without high point or low point.

2. L4 Conn.
   - It is recommended to apply the branch piping in L4(To purifier) connection line by shipyard in order to drain the lube oil from engine sump tank.

3. T/C L.O. inlet orifice size : Orifice size is decided according to engine operation condition during shop test.

1. Specification for piping system

System	Press. kg/cm²	Temp. °C	Nom.dia.	Thickness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark
Lub oil engine in/out	6	70	25A	3.4	JIS G3454 STPG370	9	Flange type	JIS G3101 SS400	-
Pre-lub oil pump inlet			32A	3.6					-
T.C lub.oil in/-outlet			Ø20	2.5	DIN 1630 St37.4		Bited type	S45C-N	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-

Tolerances for dimensions without tolerance indication (ISO 2768-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range(mm)	0.5 ~ up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-11-19	MSM	JCL	KHS					0

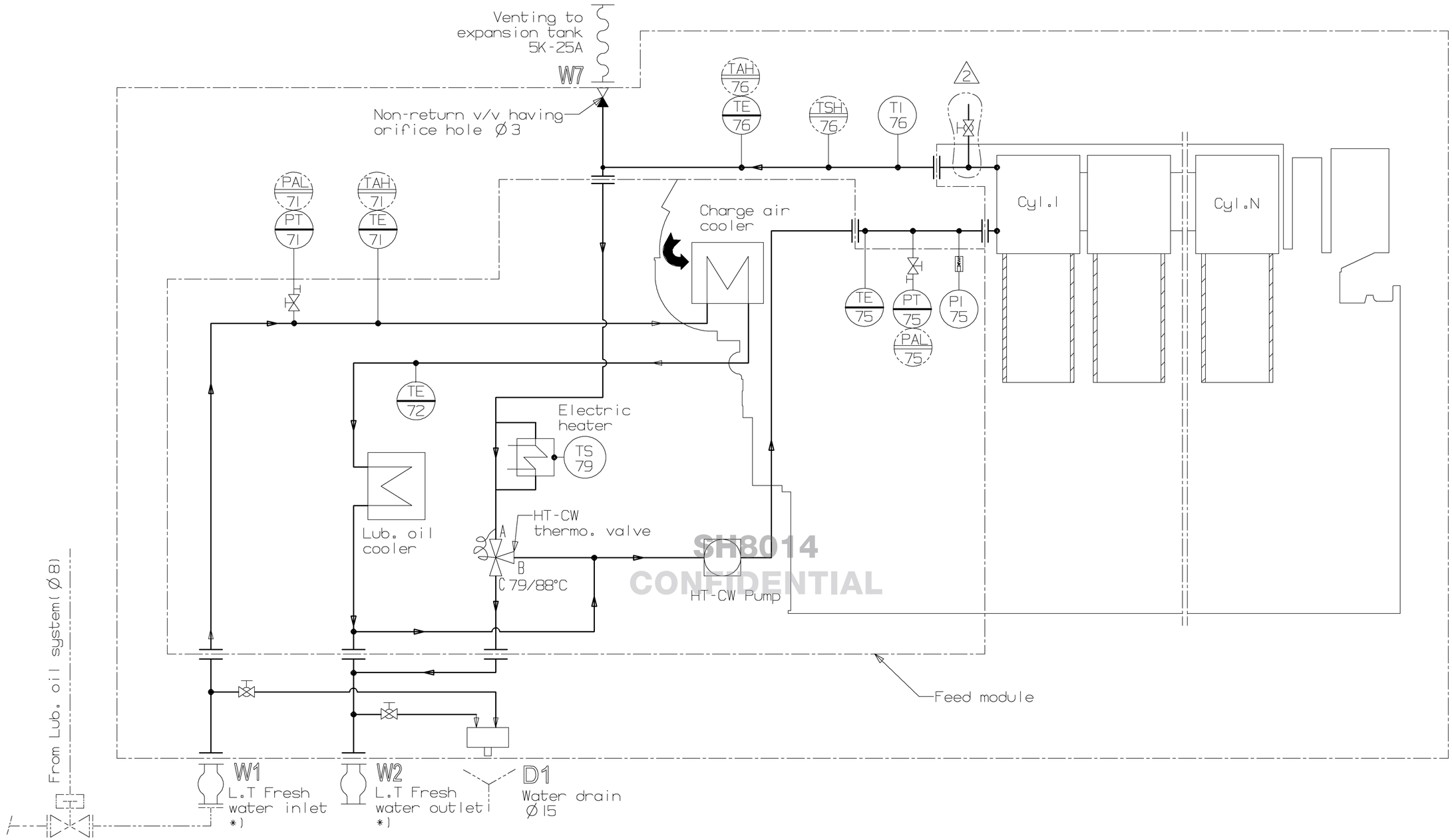
Similar Drawing No. B92-306538-1	Licensor's Drawing No.	I.C. Material / Blank	Material / Blank: COMPOSITE; Mass(kg): 0.00
Previous Drawing No.	Supplement Drawing No.		
Engine / Product Type: H21/32	Title: LUBRICATING OIL SYSTEM	Projection	Units: mm kg; Distribution: P82
	Description	Scale: 1:1	Information No.: D09004; Security: B
	Drawing No.: B92-308359-2	Page No.: 1/1	Size: A2

HYUNDAI HEAVY INDUSTRIES

HSEF-K220-005(R0)

3D NC CAD Drawing - do not correct by hand. *Confidential*

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* Note
- Engine inlet cooling water pressure should be kept under 2.5 kg/cm2 by shipyard
- It is recommended to install a non-return vavle in external piping respectively after engine CW outlet(W2) to prevent any reverse flow from other equipment.

*)Water connection

Cyl.	W1 Connection pipe size	W2 Connection pipe size
5,6	5K-80A	5K-80A
7,8,9	5K-100A	5K-100A

1. Specification for piping system

System	Press, kg/cm²	Temp. °C	Nom.dia.	Thickness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark
L.T cooling water in/out	4.5	85	100A	6.0	JIS G3454 STPG370	7	Flange type	JIS G3101 SS400	-
			80A	5.5					
Water drain	-	-	Ø10	1.5	DIN 1630 St37.4	-	Bite type	S45C-N	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Permissible deviations / Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

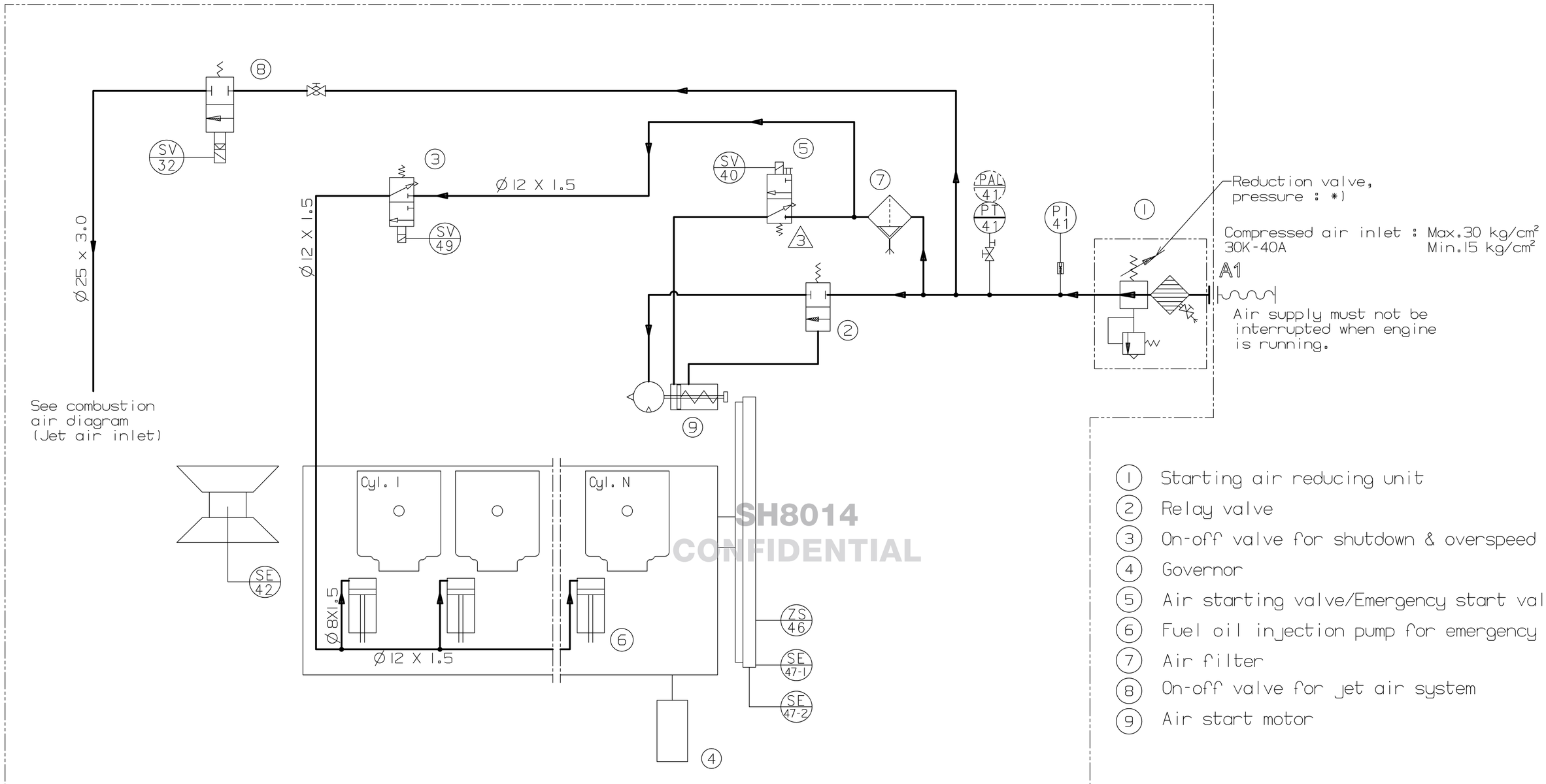
Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2016-03-04	KHG	KJC	RYS			Add.Symbol		2
2016-02-19	SYH	KJC	RYS			Chg.Note		1
2015-07-14	SYH	KJC	RYS			D1,D2 - ø15		0

Similar Drawing No.	Licensor's Drawing No.	I.C. Material / Blank	Material / Blank: COMPOSITE; Mass(kg): 0.00
Previous Drawing No.	Supplement Drawing No.		
Engine / Product Type: H21/32	Title: COOLING WATER SYSTEM	Drawn: user	Distribution: A82
	Description: D1,D2 - ø15	Scale: 1:1	Information No.: D09008; Security: C
Projection	Units: mm kg	Drawing No.: B92-139694-7	Page No.: 1/1; Size: A2

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1. Starting air reducing unit
2. Relay valve
3. On-off valve for shutdown & overspeed stop
4. Governor
5. Air starting valve/Emergency start valve
6. Fuel oil injection pump for emergency stop
7. Air filter
8. On-off valve for jet air system
9. Air start motor

*)Starging Air Reducing Unit Set Pressure

Cyl.	Reducing v/v Set Pressure	Safety v/v pressure
5, 6, 7	7 kg/cm²	Setting pressure +10%
8, 9	9 kg/cm²	

1. Specification for piping system

System	Press. kg/cm²	Temp. °C	Nom.dia.	Thickness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark
Compressed air	*)	-	40A	3.7	JIS G3454 STPG370	*)x1.5	Flange type	JIS G3101, SS400	-
Control air	*)	-	Ø10	1.5	DIN 1630 St37.4, JIS H3300 C1220T-1/2H	*)x1.5	Bite type	S45C-N, Copper alloy	-
			Ø8						-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-

Tolerances for dimensions without tolerance indication (ISO 2768-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Permissible deviations / Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

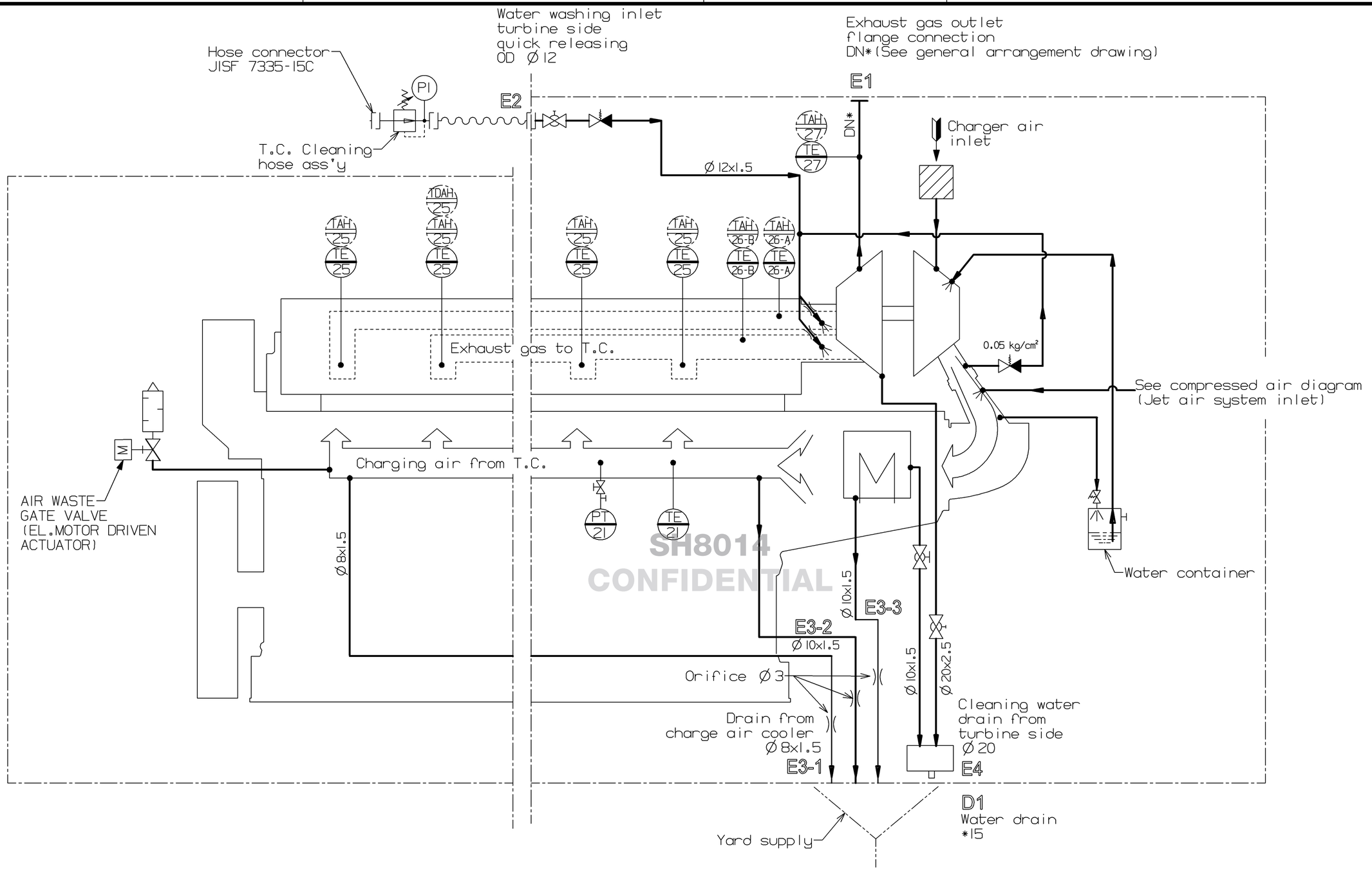
Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2017-04-03	PSY	SWS	RYS					0

Similar Drawing No.	Licensor's Drawing No.	LIC. Material / Blank	Material / Blank: COMPOSITE; Mass(kg): 0.00
Previous Drawing No.	Supplement Drawing No.		
Engine / Product Type: H21/32	Title: COMPRESSED AIR SYSTEM	Projection	Units: mm kg; Distribution: P82
	Description: DEL. JET CYLINDER	Scale: 1:1	Information No.: D09006; Security: B
	Drawing No.: B92-175544-1	Page No.: 1/1	Size: A2

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NOTE : The condensate water mixed with the compressed charge air is drained through E3-1, E3-2, E3-3 connections. These connections should be arranged to shipyard's scupper in order to prevent splashing.

1. Specification for piping system

System	Press. kg/cm²	Temp. °C	Nom.dia.	Thickness	Mat'l	Test press.	Pipe con. type	Pipe con. mat'l	Remark
T/C washing	-	-	Ø20	2.5	DIN 1630 St.37.4, JIS H3300 C1220T-1/2H	-	Bite type	S45C-N, Copper alloy	-
			Ø12	1.5					
			Ø10	1.5					
Charge air drain	4.5	55	Ø12	1.5	DIN 1630 St.37.4, JIS H3300 C1220T-1/2H	7	Bite type	S45C-N, Copper alloy	-
			Ø10	1.5					
			Ø8	1.5					

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-06-24	KGI	YJH	KHS					0

Similar Drawing No.		Licensor's Drawing No.	
Previous Drawing No.		Supplement Drawing No.	
Engine / Product Type	H21/32	Title	COMBUSTION AIR SYSTEM
Description		Drawing No.	B92-304968-9
Page No.	1/1	Size	A2
M'ter'l / Blank	COMPOSITE	Mass(kg)	0.00
Projection		Units	mm kg
Distribution			P82
Scale	1:1	Information No.	D09010
Security			B

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3D MK CAD Drawing - do not correct by hand. "Confidential"

Conn. No.	Description	Drawing No.	Part No.	Q'ty/ Eng.	Mass/ kg	Connection flange
A1	Starting air inlet	B92-078063-7	B99-062325-8	1	8.48	JIS B 2220, 30K-40A
F1/F2	F.O. inlet/outlet	B92-126206-0	-	2	3.20	JIS B 2220, 16K-25A
F4	Recycling fuel oil	B12-134804-9	B19-188117-6	1	1.22	JIS B 2220, 5K-15A
L1	Oil vapor discharge △1	B92-087683-4	B99-070463-6	1	6.07	JIS B 2220, 5K-65A
L2,L4	L.O. supply & from / to separator	B12-134804-9	B19-118009-0	2	2.12	JIS B 2220, 5K-25A
W1,W2	L.T. fresh water in/outlet	B92-020525-9	B19-127776-4	2	5.35	JIS B 2220, 5K-100A
W7	Venting to expansion tank	B92-087683-4	B99-047239-9	1	2.37	JIS B 2220, 5K-25A
W1,W2	Guard	B93-015145-7	B99-007145-1	2	1.48	5K-100A

* Specification *

1. Flexible to be type approved according to the demands of the classification society.
   신축관은 선급이 정하는 규정에 따라 형식승인을 득 할것.

2. For quality instruction see draw. no. B14-122897-3.
   품질사양서는 도면번호 B14-122897-3

3. For installation instruction see draw. no. B91-071160-0.
   설치 시방서는 도면번호 B91-071160-0을 볼 것.

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Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2020-02-13	KKC	JCL	DYJ			Chg. L1 CONN., description		1
2020-02-06	KKC	JCL	DYJ					0

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

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Permissible deviations \ Basic size range (mm)	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Similar Drawing No.		Licensor's Drawing No.		LIC. Material / Blank	Material / Blank: COMPOSITE; Mass(kg): 40.84
Previous Drawing No.		Supplement Drawing No.			
Engine / Product Type: H32/40	Title: LIST OF FLEXIBLE HOSE CONNECTION			Projection	Units: mm kg; Distribution: P82
	Description: 7-9H21/32(KR선급 이외) △1			Scale: 1:1	Information No.: 301012; Security: B
	Drawing No.: B94-312350-7		Page No.: 1/1	Size: A4	HYUNDAI HEAVY INDUSTRIES

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3D NX CAD Drawing - do not correct by hand. "Confidential"

INSTALLATION PROCEDURE FOR EXHAUST GAS & INTAKE BELLOW(Fig.2)

배기가스용 신축관 및 흡기용 신축관 설치 시방서(그림 2)

NOTE : The exhaust pipe must not be exerted any force against gas outlet on the engine.
기관실의 배기관은 어떠한경우에도 엔진상부의 가스출구쪽으로 모든 물리적인힘이 작용되어 영향을 주지말아야한다.

The sturdy fixed-point support must be provided for the bellows on the turbocharger.
과급기용 신축관의 고정지지대는 매우견고하게 고정되어야 한다.

It should be positioned, immediately above the bellows in order to prevent the transmission of forces, resulting from the weight, thermal expansion or lateral displacement of the exhaust piping, to the turbocharger.
고정지지대의 위치는 기관실 배관의 무게, 축방향의변위(팽창)등의 물리적인 변동이 과급기에 전달되는것을 피하기 위하여는 신축관의 바로위에 설치되어야한다.

INSTALLATION PROCEDURE
설치를위한 시방서

1. The generating set(or engine)should be installed in its final position before any external pipes are connected.
모든 배관들의 연결은 발전기세트(엔진)가 최종으로 설치완료후에 연결할것.

2. Remove the counter flange from the enigne connection, if fitted.
엔진쪽 연결용 배관에 기관실연결용 후렌지가 부착되었으면 제거할것.

3. Fasten the counter flange temporarily to the outlet side of the bellows.
신축관의 출구쪽에 상대후렌지를 임시로 설치할것.

For the correct orientation of the bellows(flow direction) see the dimensional drawing.
정확한 가스의 흐름방향은 상세도면을 참조할것.

4. Fasten the bellow to the engine temporarily.
신축관을 엔진에 임시로 설치할것.

5. Align the external pipe to the counter flange.
기관실용 배관과 후렌지를 일직선으로 정열시킬것.

No axial,lateral or angular deflection of the bellow is allowed.
신축관은 횡, 축, 비틀림등 변형이 없을것.

Length between engines flange and ship's flange must coincide within ±5mm.
엔진후렌지와 선박 후렌지사이 거리의 공차는 ±5mm범위내에 있어야 한다.

6. The eccentric axis of flanges must coincide within ±2mm(Det.1)
후렌지와 후렌지 주축 편심은 ±2mm 범위 이내에 들어야한다.

Observe that the pipe clamping with bracket must be very rigid in order to prevent vibration and movement of the exhaust gas pipe.
배기관의 이동 및 진동을 방지하기위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주지할것.

Most problems with bursting and vibrations originate from poor clamping and support.
파열 및 진동등 대부분의 문제점들은 부실한 고정 및 지지에서 발생된다.

Especially the support in the axial direction must be rigid.
특별히 축방향의 지지대는 필히 고정되어야한다.

7. Put some temporary protection cover between the flange in order to prevent debris from falling into the turbocharger.
과급기 내부에 이물질이 인입되는것을 방지하기위한 보호용 커버를 임시로 설치할것.

8. Tack weld the counter flange to the external pipe.
기관실 배관에 후렌지를 가 용접할것.

9. Remove the bellow and weld the flange finally to the external pipe.
신축관을 제거하고 기관실 배관에 후렌지를 완전하게 용접할것.

10. Remove the protection cover.
Place the bellows with gaskets between the flanges.
후렌지와 가스켓트 사이의 보호용 커버를 제거할것.
후렌지 사이에 가스켓과 볼로우즈를 조립할것.

11. Lubricate the threads of the connection screw with heat resistant grease and tighten first until finger tight. Finally tighten the screw in a diagonal sequence.
연결용 볼트의 나사부에 내열성 그리스를 바르고 손으로 조인후 대각순으로 완전히 조일것.

12. Remove the guide bar between the flanges of the bellow.
신축관의 후렌지 사이에있는 지지대를 제거할것.

INSTALLATION PROCEDURE FOR LOOP EXPANSION PIPE(Fig.1)

연료유용 신축관의 설치시방서(그림1)

NOTE : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the loop expansion pipe by used the jig.
후렌지사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within ±2mm.
엔진후렌지와 선박후렌지사이 거리는 ±2mm 범위 이내에 들어야한다.

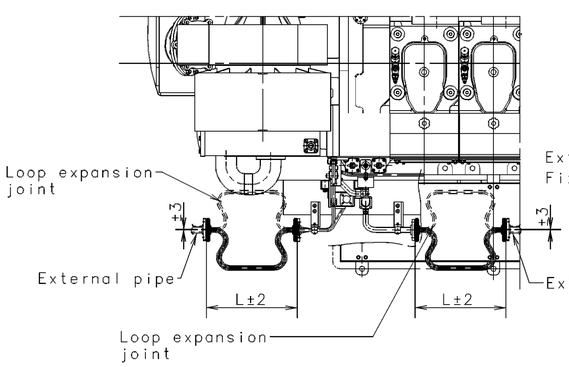
The eccentric axis of flanges must coincide within ±3 mm
플렌지와 플렌지 주축의 편심은 ±3mm 범위내에 있어야 한다.

Please observe at normal operating condition that not heavy vibration occurs in expansion loop(amplitude must not exceed 0.5mm).
정상 운전 상태에서 루프의 큰진동이 발생하지 않는지 관찰한다. (진폭은 0.5mm를 초과 하지않아야 한다.)

Please observe at start/stop operating condition that not heavy vibration occurs in expansion loop(amplitude must not exceed 5.0mm).
시동/정지 운전 상태에서 루프의 큰진동이 발생하지 않는지 관찰한다. (진폭은 5.0mm를 초과 하지않아야 한다.)

The flange is fitted with 4 bolts, and can be installed in any of the 4 possible direction.
후렌지 볼트는 4개의 볼트로 고정되며, 4방향 모두 설치 가능하다.

If necessary 4 extra bolt-holes may be made in flanges of loop expansion joint(min. 10mm from existing holes).
만약 신축관의 방향 진환을 위해 후렌지의 볼트구멍을 추가 가공시에는 기존의 구멍과 최소 10mm이상 떨어져야한다.



(Figure 1)

INSTALLATION PROCEDURE FOR COOLING WATER,LUB OIL,MIST GAS,STARTING AIR FLEXIBLE HOSE(Fig.2)

냉각수, 윤활유, 윤활유기화가스, 시동공기용 신축관의 설치시방서(그림2)

Note : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the hose by used the jig.
후렌지사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within L±5mm.
엔진후렌지와 선박 후렌지사이 거리의 공차는 L±5mm범위내에 있어야 한다.

The eccentric axis of flanges must coincide within ±3mm.
후렌지와 후렌지 주축 편심은 ±3mm 범위 이내에 들어야한다.

INSTALLATION PROCEDURE FOR COMPENSATOR(Fig.3,Fig.4)

신축관의 설치시방서(그림3, 그림4)

NOTE : The internal LENGTH 'L' between the flanges must be in accordance with actual drawing of the hose by used the JIG.
후렌지사이의 길이 'L'은 JIG를 사용하여 실제 신축관 도면의 길이를 따를것.

Length between engines flange and ship's flange must coincide within L±2mm.
엔진 후렌지와 선박 후렌지사이 거리는 L±2mm 범위 내에 들어야 한다.

The eccentric axis of flanges must coincide within ±3mm.
후렌지와 후렌지 주축사이의 편심은 ±3mm 범위내에 있어야 한다.

The expansion joint, compensator must be mounted without any twist.
신축관은 설치시 어떠한 뒤틀림도 없어야 한다.

The external connection to the expansion joint. compensator has to be rigidly fixed.
신축관 설치시 기관실 배관은 단단하게 고정할 것.

Abrasion from adjacent structures, moving part or other hoses must be avoided.
신축관 보호를 위해 주변의 어떠한 구조물과도 간섭이 있어서는 안 된다.

The expansion joint, compensator must be mounted visible above floor level.
신축관은 잘 보일수 있도록 바닥위에 설치되어야 한다.

In case of need guard must be installed before install compensator.
신축관 보호용 guard는 필요 설치시 방진관 조립전에 가설시킬 후 신축관 설치후 제결완료할것.

INSTALLATION PROCEDURE
설치를위한 시방서

1. The generating set(or engine)should be installed in its final position before any external pipes are connected.
모든 배관들의 연결은 발전기세트(엔진)가 최종으로 설치완료후에 연결할것.

2. Remove the counter flange from the enigne connection, if fitted.
엔진쪽 연결용 배관에 기관실연결용 후렌지가 부착되었으면 제거할것.

3. Fasten the fixed flange of the jig to the engine side a gasket(1.5t) between the flanges(jig should be ready by shipyard).
엔진쪽 후렌지에 가스켓트(1.5T)를 삽입후 jig를 부착할것9(jig는 조선소가 준비한다.).

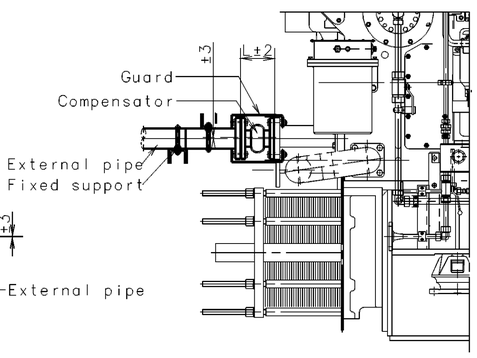
4. Lubricate the threads of the connection screw with grease and tighten first until finger tight. Finally tighten the screw in a diagonal sequence using a socket wrench.
연결용 볼트의 나사부에 그리스를 바르고 손으로 조인후 토크크 렌치를 사용하여 대각순서대로 완전하게 조일것.

5. Connect the free end of the jig to the external piping.
기관실쪽의 배관에 jig의 끝단를 연결할것.

6. Align the external pipe to the flange of the jig.
기관실용 배관과 후렌지를 일직선으로 정열시킬것.

7. Anchor the external pipe to the steel structure with fixed support close to the flange.
기관실 배관은 고정용 지지대를 사용하여 철구조물에 후렌지와 가까운곳에 고정할것.

Observe that the pipe clamping with bracket must be very rigid in order to prevent vibration and movement of the external pipe.
기관실 배관의 이동및 진동을 방지하기 위하여 지지대에 배관의 고정은 강력하게 고정되어야 하는것을 주지할것.



(Figure 3)

Most problems with bursting and vibrations originate from poor clamping and support.
파열 및 진동등 대부분의 문제점들은 부실한 고정 및 지지에서 발생된다.

8. Tag weld the counter flange to the external pipe.
기관실 배관에 후렌지를 가 용접할것.

9. Remove the jig and weld the flange finally to the external pipe.
- the welded part should be grinded and the projecting part should be removed after weld.(Refer fig.4)
기관실 배관을 분리하여 후렌지를 완전하게 용접할 것. -반드시 용접부분을 그라인딩하여 돌출분 제거(그림4참조)

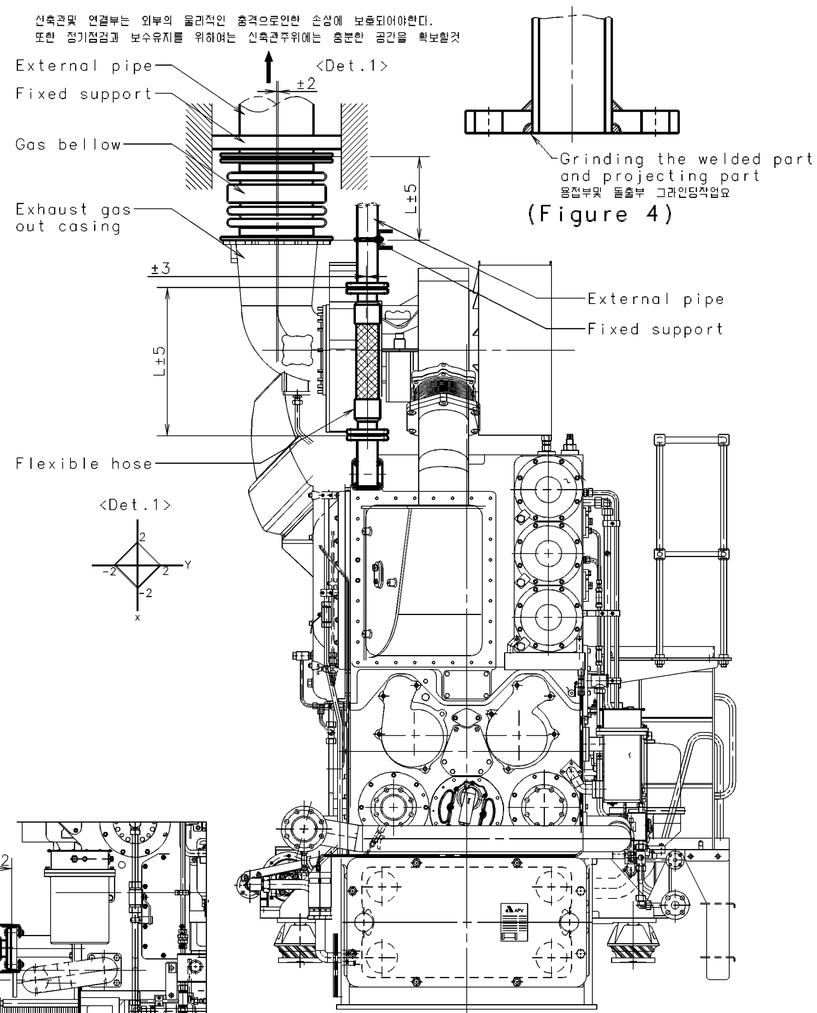
10. Fasten the external pipe must be in line on the connection side and then fixed.
기관실 배관을 설치하여 일직선으로 정열한후 고정할 것.

11. Remove the jig and gasket between external pipe and the engine side pipe.
기관실 배관과 엔진쪽 파이프 사이의 jig와 가스켓트를 제거할 것.

12. Connect the compensator both the external pipe and the engine pipe. Axial, lateral or angular deflection of the compensatoris allowed within allowable tolerance.
신축관을 기관실 배관과 엔진측 배관에 연결할 것.
신축관은 횡, 축, 비틀림 변형은 허용 공차내의 범위를 유지하여야 한다.

13. The compensator must be protection from external mechanical damage.
There must be enough space around the compensator connection for regular supervision and maintenance.

신축관및 연결부는 외부의 물리적인 충격으로인한 손상에 보호되어야한다.
또한 정기점검과 보수유지를 위해서는 신축관주위에는 충분한 공간을 확보할것



(Figure 4)

(Figure 2)

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Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
$R_a$max. value μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining

Nom.measurement mm	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations						
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

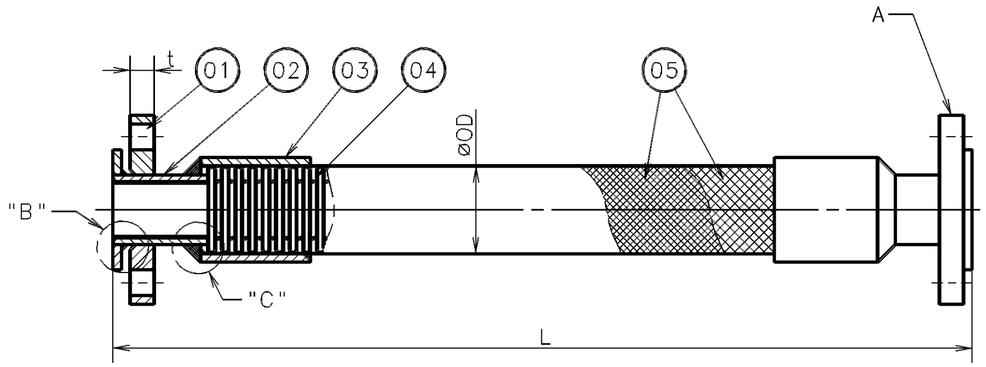
Supplement Drawing No.:						Projection:	Mass (kg):	Material / Blank:
Plan history		As-built				Licensor's ident. no.: 1602393-7.0	Dist.: P82	Licensor's Material / Blank:
Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement		C.No
				*	*	Replaced by Ident. No.:		9
				*	*			8
				*	*			7
190213	JJO	YJH	KHS	*	*	Chg. text		6
160428	JJO	KJC	RYS	*	*	Added text		5
141223	KYH	KJC	LYS	*	*	Added text		4
130629	BJW	BJW	LCS	*	*	Added text		3
110906	JDH	JSC	AGH	*	*	Changed note		2
110901	JDH	JSC	AGH	*	*	Added note-intake gas bellows		1
110401	KHG	YSB	AGH	*	*			0

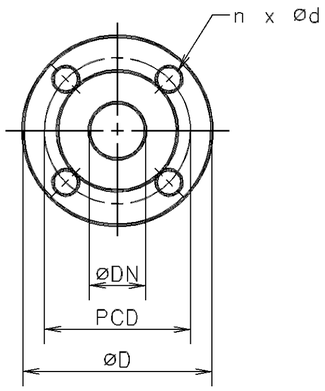
Similar Drawing No.: B11-122888-0 | Replacement of Ident. No.:
Scale: - | Size: A1 | Type: | Page No.: 01(01) | Confidential: B
Info. No.: 372358
Description: Installation instruction for flexible connection
Ident. No.: B91-071160-0

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

CAD Drawing - do not correct by hand

HSEF-k210-010(R1) 현대중공업(주) 엔진사업본부 A1(841mmx594mm)변형없이

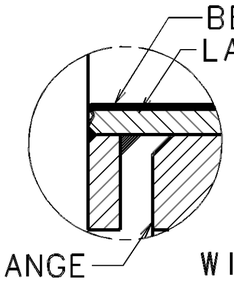




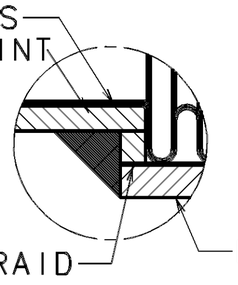
Specification

1. Max. working pressure :1.6 MPa, 3 MPa (16bar,30bar)
2. Hose assembly test pressure :3MPa,4.5MPa (30bar,45bar)
3. Service temperature range : -20 ~ +100°C
4. Medium : Starting air,control air
5. Flange connection : 16K, 30K JIS B 2220
6. Pressure test for flexible hose to be carried out according to the demands of the classification society. Flexible hose는 선급이 정하는 규정에 따라 압력 테스트할 것.
7. A: Pipe to be stamped with actual test pressure and DN-number after pressure test. A부에 실제 압력 test 및 DN 번호를 표기할 것.
8. For welding instruction see draw. no. B14-100443-8. 용접시방은 B14-100443-8 에 따라 실시할 것.
9. Steel part to be painted with YEOL COAT QT606(SILVER) after sanding & pickling except for machined surface. 기계가공면을 제외한 steel부분은 산세와 샌딩후 내열페인트 YEOL COAT QT606(은색)페인팅 할것.

Detail B



Detail C



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No.	Part no.	Info. no.	Nominal press. dia.	L(mm)	Flange dimensions				Flexible hose				Mass. (kg)
					PCD	D	t	nxd	OD	Bending radius	Burst press 20°C, kgf/cm2 (MPa)	Hose type	
1	B99-030338-3	172359	16K-20	500	75	100	14	4x15	33.7	160	180 (18MPa)	Annuar corrugated U-shaped	2.67
2	B19-102547-7	172359	16K-25	500	90	125	14	4x19	51.6	170	170 (17MPa)		3.74
3	B19-102548-9	172359	16K-32	500	100	135	16	4x19	63.8	180	160 (16MPa)		5.44
4	B19-102549-0	172359	16K-40	500	105	140	16	4x19	77.8	200	120 (12MPa)		6.12
5	B19-102550-0	172359	16K-50	500	120	155	16	8x19	85.2	225	120 (12MPa)	6	6.90
6	B19-102551-1	172359	16K-65	500	140	175	18	8x19	102.8	250	90 (9MPa)		8.80
7	B19-127791-6	172359	30K-20	500	85	120	18	4x19	33.7	160	180 (18MPa)		3.90
8	B19-102552-3	172359	30K-25	500	95	130	20	4x19	51.6	170	170 (17MPa)		4.94
9	B19-102553-5	172359	30K-32	500	105	140	22	4x19	63.8	180	160 (16MPa)		6.70
5 10	B99-062325-8	172359	30K-40	500	120	160	22	4x23	77.8	200	120 (12MPa)		8.48
11	B19-102555-9	172359	30K-50	500	130	165	22	8x19	85.2	225	120 (12MPa)	6	9.00
12	B99-026639-8	172359	30K-65	500	160	200	24	8x23	102.8	250	90 (9MPa)		13.68
3 13	B99-047058-9	172359	30K-50	440	130	165	22	8x19	85.2	225	120 (12MPa)		8.23

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	kg/unit	REMARKS
05	122872-3-05	Double Wire braid	SUS304	1	-	-
04	122872-3-04	Bellows	SUS316L	1	-	-
03	122872-3-03	Braid end	SS400	2	-	-
02	122872-3-02	Lab joint	SS400	2	-	-
01	122872-3-01	Flange	SS400	2	-	-

Supplement Drawing No.: | Projection: | Mass (kg): | Material / Blank:

Licensor's Ident. no.: 1608223-3.0 | Dist.: P82 | Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
160113	SYH	KJC	RYS	*	*	Del. Cloud mark.	7
150923	KGI	KJC	RYS	*	*	Chg.mass.	6
150513	SYH	KJC	RYS	*	*	Chg.No.10 Part No.	5
140411	KIJ	SWS	RSK	*	*	Changed Note.(Deleted No.10)	4
130718	BJW	KJC	LCS	*	*	Added no. 13	3
121127	SYH	YSB	AGH	*	*	Modified test	2
111211	SYH	YSB	AGH	*	*	Changed Spec.	1
111103	BJW	YSB	AGH	*	*	Added 16K-20A	0

Similar Drawing No.: | Replacement of Ident. No.: B12-122872-3.9

Scale: 1:2.5 | Size: A2 | Type: - | Page No.: 01(01) | Confidential: B | HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info. No.: 372359 | Description: SWIVEL TYPE METALLIC FLEXIBLE HOSE | Ident. No.: B92-078063-7

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Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

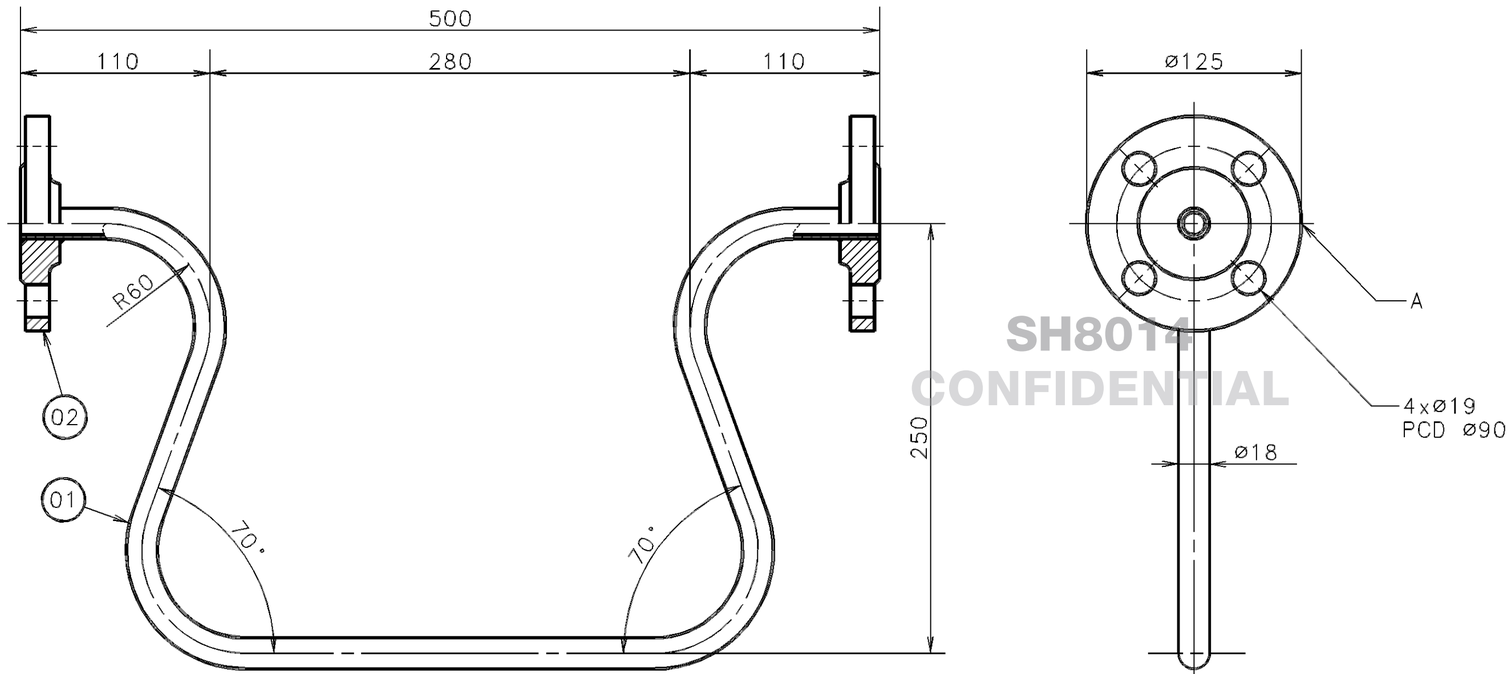
Nom.measurement mm	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations: Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

HSEF-k210-011(R1) | 현대중공업(주) 엔진사업본부 | A2(594mmx420mm)트레이싱

CAD Drawing - do not correct by hand

Specification

1. Working pressure : 1 MPa (10 bar)
2. Test pressure : 2.1 MPa (21 bar)
3. Working temperture : Max.150°C
4. Medium : Fuel oil
5. Flange connection : JIS B2220 16K 25A
6. Pipe to be pressure tested according to the demands of the classification society.
   파이프는 선급이 정하는 규정에따라 압력 테스트할 것.
7. A:"Pipe to be stamped with actual test pressure after pressure-test".
   A부에 실제 압력 테스트한 것을 표기할 것.
8. For welding instruction see draw. no. B14-100443-8
   용접시방은 B14-100443-8 에 따라 실시할 것.
9. To be painted with YEOL COAT QT606(SILVER) after sanding&pickling expect machined part.
   기계가공면을 제외한 부분은 산세와샌딩후 내열페인트 YEOL COAT QT606(은색)페인팅 할것.



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POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	kg/unit	REMARKS
02	122870-0-02	Flange JIS 16K-25A	SF440A	2	-	-
01	122870-0-01	Pipe ø18x2.0x1085	St37.4	1	-	-

Supplement Drawing No.:
Projection:
Mass (kg): 3.20
Material / Blank:
Licensor's Ident. no.: 1607282-6.0
Dist.: P82
Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
KHA	150130	KIJ	KJC	RSY	*	*	Add.flange type.	1
KHA	140410	KIJ	SWS	RSK	*	*	Changed Note(Deleted No.10)	0

Similar Drawing No.: B12-122870-0.9
Replacement of Ident. No.:

Scale: 1:2.5
Size: A2
Type: -
Page No.: 01(01)
Confidential: B
Info. No.: 372354
Description: Loop expansion joint
Ident. No.: B92-126206-0

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

HSEF-k210-011(R1)
현대중공업(주) 엔진사업본부
A2(594mmx420mm)표준상제

CAD Drawing - do not correct by hand

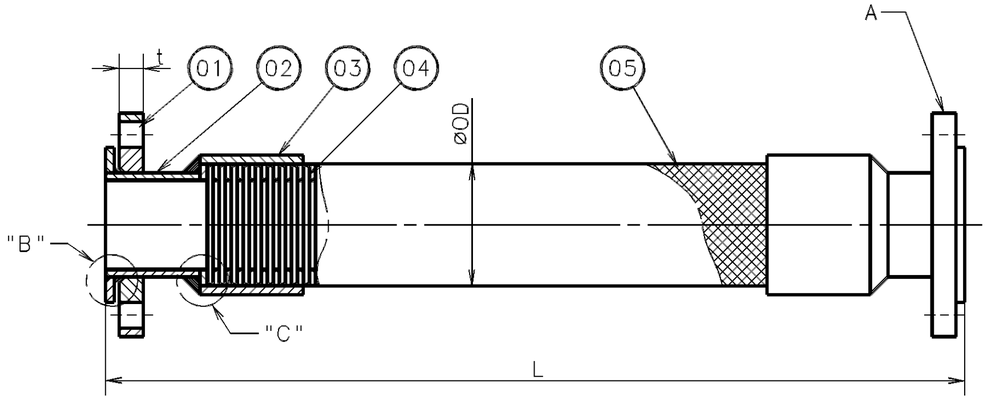
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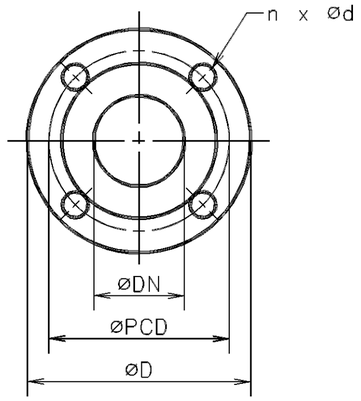
Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
$R_a$max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

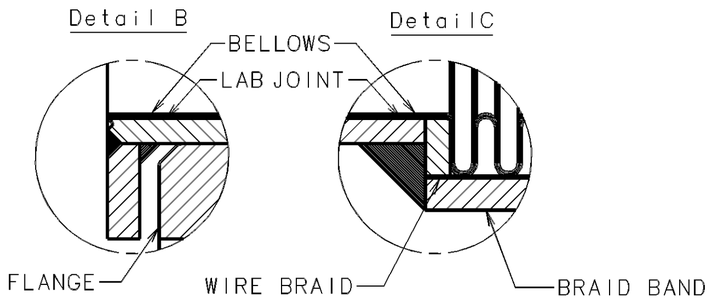
Nom.measurement / Permissible deviations mm	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2





Specification

1. Max. working pressure : 0.6 MPa (6 bar)
2. Hose assembly test pressure : 1.2 MPa (12 bar)
3. Service temperture range : -20 ~ +150°C
4. Medium : Diesel fuel oil, lubrcating oil
   control air, fresh water
   leakage fuel oil
5. Flange connection : JIS B2220 PN05
6. Flexible hose to be pressure tested according to the demands of the classification society.
   Flexible hose는 선급이 정하는 규정에따라 압력 테스트할 것.
7. A:"Pipe to be stamped with actual test pressure after pressure-test" and DN-number.
   A부에 실제 압력 test 및 DN 번호를 표기할 것.
8. For welding instruction
   see draw. no. B14-100443-8.
   용접시방은 B14-100443-8 에 따라 실시할 것.
9. Steel part to be painted with YEOL COAT QT606(SILVER) after sanding&pickling expect machined part.
   기계가공면을 제외한 steel부분은 산세와샌딩후 내열페인트 YEOL COAT QT606(은색)페인팅 할것.



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No.	Part no.	Info. no.	Nominal press dia.	L(mm)	Flange dimensions				Flexible hose				Mass. (kg)
					PCD	D	t	nxd	OD	Bending radius	Burst press 20±c, kgf/cm2 (Mpa)	Hose type	
1	4 B99-013208-8	172359	5K-15	500	60	80	9	4x12	28.3	130	280 (28Mpa)	Annuar corrugated U-shaped	1.42
2	B19-102536-0	172359	5K-20	500	65	85	10	4x12	33.7	160	200 (20Mpa)	3	1.70
3	1 B99-047239-9	172359	5K-25	500	75	95	10	4x12	51.6	170	170 (17Mpa)		2.32
4	B19-102538-3	172359	5K-32	500	90	115	12	4x15	63.8	180	160 (16Mpa)		3.91
5	B19-102539-5	172359	5K-40	500	95	120	12	4x15	77.8	200	120 (12Mpa)		4.50
6	B19-102540-4	172359	5K-50	500	105	130	14	4x15	85.2	225	120 (12Mpa)		5.34
7	5 B99-070463-6	172359	5K-65	500	130	155	14	4x15	102.8	250	90 (9Mpa)		6.07
8	B19-102542-8	172359	5K-80	500	145	180	14	4x19	119.0	275	65 (6.5Mpa)		8.90
9	B19-102543-0	172359	5K-100	500	165	200	16	4x19	143.3	350	55 (5.5Mpa)		9.60
10	B19-102544-1	172359	5K-125	600	200	235	16	8x19	145.0	425	45 (4.5Mpa)	3	12.0
11	B19-102545-3	172359	5K-150	600	230	265	18	8x19	172.0	500	38 (3.8Mpa)		16.0
12	B19-102546-5	172359	5K-200	600	280	320	18	8x23	230.0	750	35 (3.5Mpa)		24.0
13	7 B99-089292-7	172359	5K-15	400	60	80	9	4x12	28.3	130	280 (28Mpa)		1.20

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	kg/unit	REMARKS
05	122871-1-05	Single Wire braid	SUS304	1	-	-
04	122871-1-04	Bellows	SUS316L	1	-	-
03	122871-1-03	Braid band	SS400	2	-	-
02	122871-1-02	Lab joint	SS400	2	-	-
01	122871-1-01	Flange	SS400	2	-	-

Supplement Drawing No.:
Projection:
Mass (kg):
Material / Blank:
Licensor's Ident. no.: 1608223-3.0
Dist.: P82
Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
KHA 170620	KNE	KKH	KHS	*	*	Add.Part No.	7
KYJ 160113	SYH	KJC	RYS	*	*	Del. Cloud mark.	6
LSM 151209	SYH	KJC	RYS	*	*	Chg.Part No.	5
LSM 151008	SYH	KJC	RYS	*	*	Chg.Part No.	4
KHA 150923	KGI	KJC	RYS	*	*	Chg.mass.	3
KHA 140410	KIJ	SWS	RSK	*	*	Changed Note(Deleted No.10)	2
LHR 130502	SYH	KJC	LCS	*	*	Changed Note & Part No.	1
120613	HSK	JSC	AGH	*	*	Changed Temp.range(-20~100°C-->-20~150°C)	0

Similar Drawing No.: B12-122871-1.9
Replacement of Ident. No.:
Scale: 1:2.5
Size: A2
Type: -
Page No.: 01(01)
Confidential: B
Info. No.: 372359
Description: Swivel type Metallic flexible hose
Ident. No.: B92-087683-4
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

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Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

COMPENSATOR.

Medium: Sea and fresh cooling water

Working temperature: 90°C

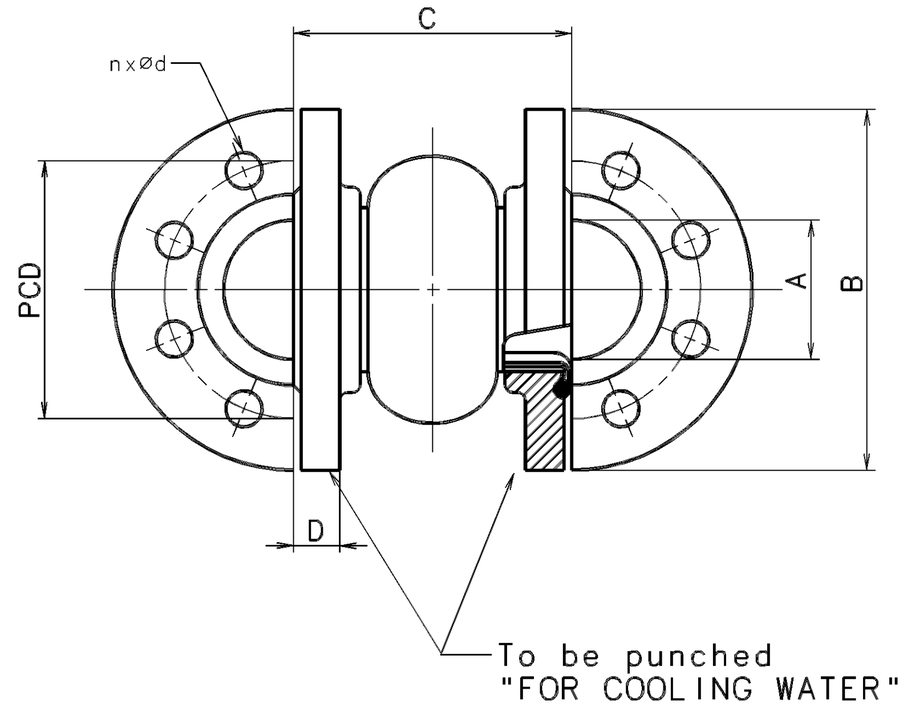
Working pressure : 0.5 MPa (5 bar)

Test pressure : 1 MPa (10 bar)

Material
Flange: SS400
Liner: EPDM (EPT)
Reinforcem: nyloncord
Cover: EPDM (EPT)

CLASSIFICATION:
Shall be in accordance with
the rules of classification valid

LLOYDS REGISTER OF SHIPPING.
DET NORSKE VERITAS.
BUREAU VERITAS.
GERMANISHER LLOYD.
AMERICAN BUREAU OF SHIPPING.
U.S. COAST GUARD.
USSR REGISTER OF SHIPPING.
KOREAN REGISTER OF SHIPPING.



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No.	Part no.	Info. no.	Nominal press dia.	C(mm)	Flange dimensions				A	Movement			Weight (kG)
					PCD	B	D	nxd		Axial comp.	Axial expen.	Lateral	
1	B19-189261-0	172359	5K-25	130	75	95	10	4x12	25	30	10	10	0.96
2	B19-126328-9	172359	5K-32	130	90	115	12	4x15	32	30	10	10	1.52
3	B19-126329-0	172359	5K-40	130	95	120	12	4x15	40	30	10	10	1.86
4	B19-126330-0	172359	5K-50	150	105	130	14	4x15	50	30	10	10	2.35
5	B19-127602-4	172359	5K-65	150	130	155	14	4x15	65	30	10	10	3.27
6	B19-127775-2	172359	5K-80	150	145	180	14	4x19	80	40	10	10	4.15
7	B19-127776-4	172359	5K-100	150	165	200	16	8x19	100	40	10	10	5.35
8	B19-127778-8	172359	5K-125	150	200	235	16	8x19	125	40	10	10	7.00
9	B19-127780-9	172359	5K-150	150	230	265	18	8x19	150	40	10	10	9.65
10	B19-127783-4	172359	5K-200	175	280	320	20	8x23	200	45	15	15	13.50
11	B19-127785-8	172359	5K-250	175	345	385	22	12x23	250	45	15	15	20.40

Supplement Drawing No.:				Projection:	Mass (kg):	Material / Blank:
				Licensor's Ident. no.: –	Dist.: P82	Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
150923	KGI	KJCRYS		*	*	for Cooling water(5K-EPDM)	0

Similar Drawing No.: B12-130471-9.9 Replacement of Ident. No.:

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Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement / Permissible deviations mm	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

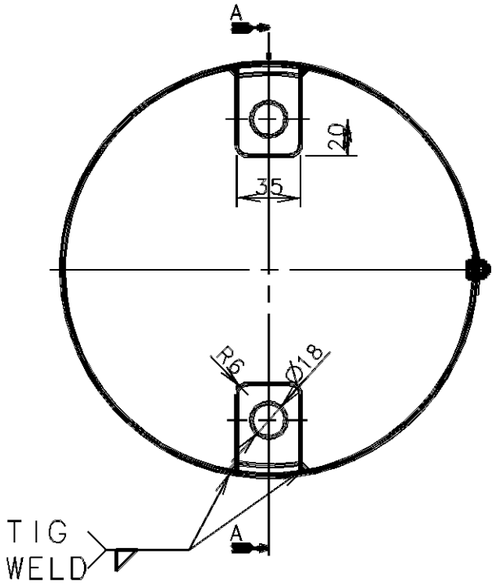
Scale: – Size: A2 Type: – Page No.: 01(01) Confidential: B

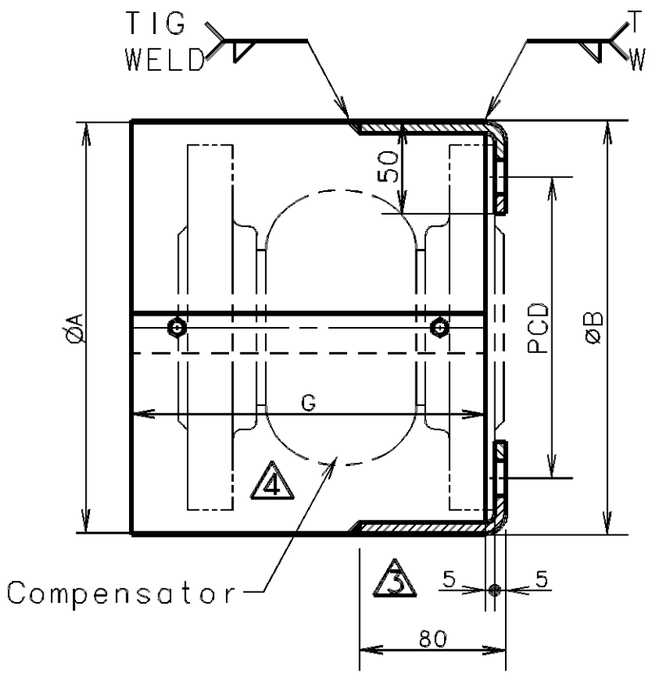
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info. No.: 399986 Description: Compensator Ident. No.: B92-020525-9

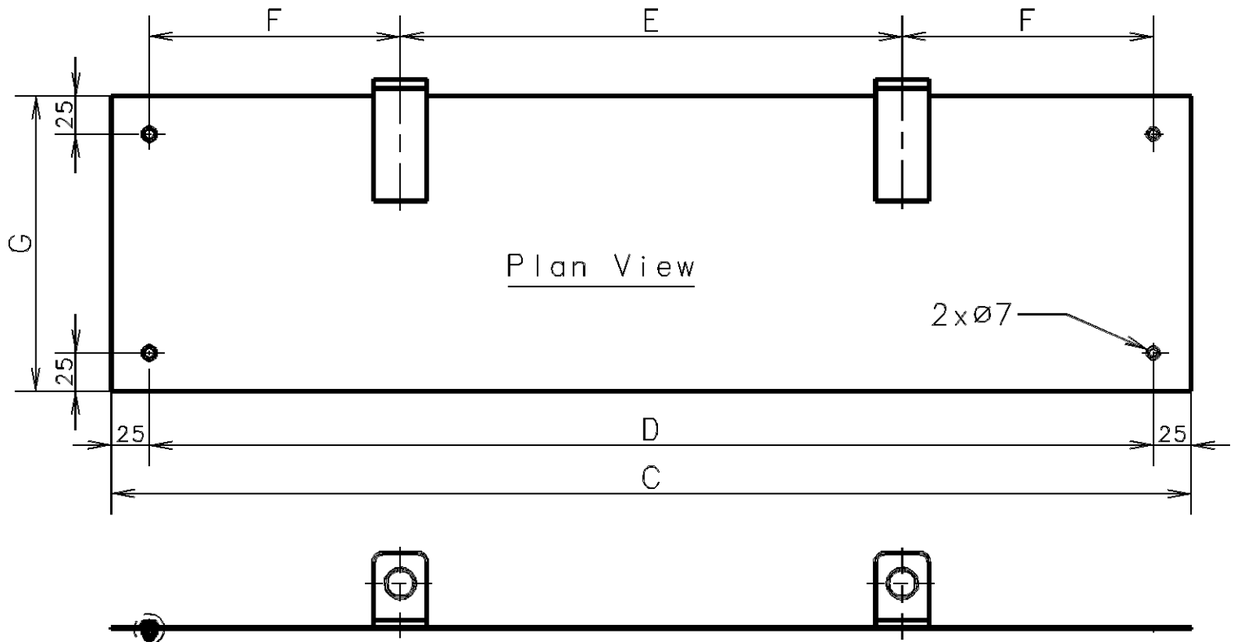
HSEF-k210-011(R1) 현대중공업(주) 엔진사업본부 A2(594mmx420mm)표준설계

CAD Drawing - do not correct by hand





A - A





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DN	PCD	ØA	ØB	C	D	E	F	G	PART NO.	MASS(kg)
25	75	135	137	474	424	212	106	170	B19-195517-6	1.03
32	90	155	157	537	486	243	122	170	B19-195518-8	1.11
40	95	160	162	553	502	251	126	170	B19-195519-0	1.13
50	105	170	172	584	534	267	133.5	195	B99-007142-6	1.29
65	130	195	197	663	613	307	153.5	195	B99-007143-8	1.41
80	145	210	212	710	660	330	165	195	B99-007144-0	1.48
100	165	230	232	773	723	362	181	195	B99-007145-1	1.58
125	200	265	267	882	832	416	208	195	B99-007146-3	1.75
150	230	295	297	975	925	463	231.5	195	B99-007147-5	1.89
200	280	345	347	1134	1084	542	271	195	B99-007148-7	2.05
250	345	410	412	1338	1288	644	322	195	B99-007149-9	2.37
4 80	145	210	212	710	660	330	165	175	B99-078354-7	1.48
4 100	165	230	232	773	723	362	181	175	B99-078355-9	1.58

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Standard for surface roughness

The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value μm	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Permissible deviations	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

							Change / Replacement	C.No
					*	*	Replaced by Ident. No.:	9
LSM	160721	SYH	KJC	KHS	*	*	Add. 80A,100A(G=175)	8
KYJ	160113	SYH	KJC	RYS	*	*	Del. Cloud mark.	7
	150923	KGI	KJC	RYS	*	*	Add.weight.	6
	140211	SYH	KJC	RYS	*	*	Added material	5
	110706	BJW	YSB	AGH	*	*	Added reference	4
	110221	SJH	YSB	AGH	*	*	Changed dimension	3
	100329	JHS	JHS	KSR	*	*	Deleted dimension	2
	060117	JHS	JCM	SJR	*	*	Added 25A,32A,40A	1
	051118	DYJ	JCM	SJR	*	*		0

Supplement Drawing no.:

Projection:

Mass (kg):

Material / Blank: SUS304 5

Licensor's Ident. no.: 1627358-0

Dist.:

Licensor's Material / Blank:

Similar Drawing No.:

Replacement of Ident. No.:

Scale: –

Size: A3

Type: –

Page No.: 01(01)

Confidential: B

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info. No.: 399988

Description: GUARD FOR 5K COMPENSATOR

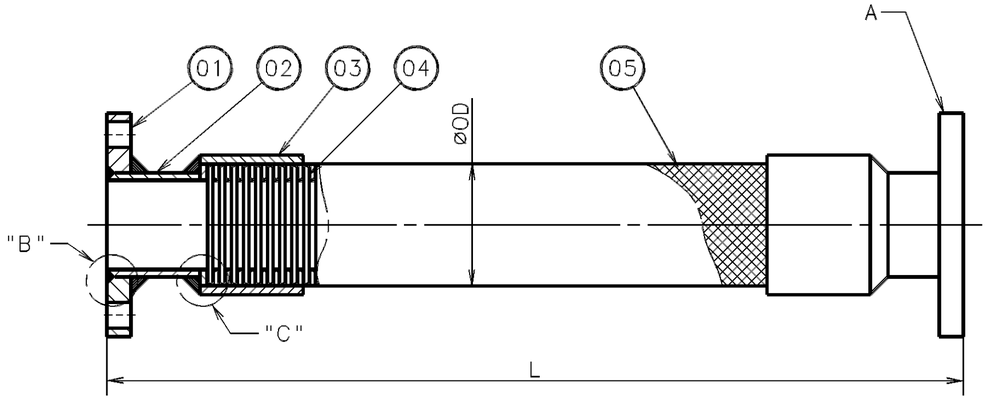
Ident. No.: B93-015145-7

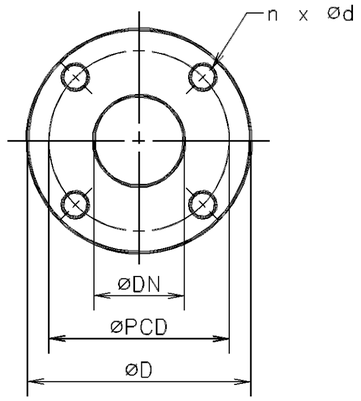
HSEF-k210-012(R1)

현대중공업(주) 엔진사업본부

A3(420mmx297mm)트레싱지

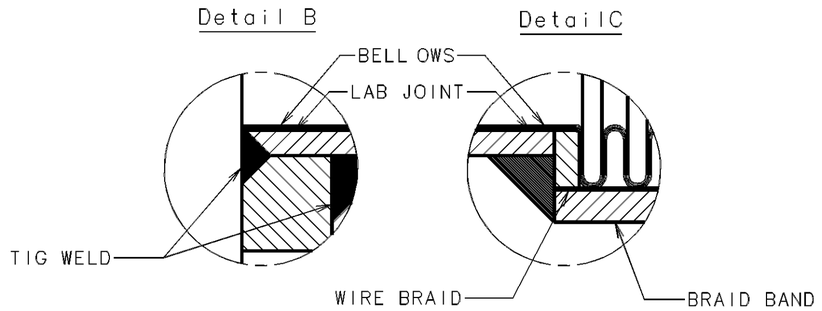
CAD Drawing - do not correct by hand





Specification

1. Max. working pressure : 6bar
2. Hose assembly test pressure : 12bar
3. Service temperture range : -20 ~ +100°C
4. Medium : Diesel fuel oil, lubrcating oil
   control air
   leakage fuel oil
5. Flange connection : JIS B2220 PN05
6. Flexible hose to be pressure tested according to the demands of the classification society.
   Flexible hose는 선급이 정하는 규정에따라 압력 테스트할 것.
7. A:"Pipe to be stamped with actual test pressure after pressure-test" and DN-number.
   A부에 실제 압력 test 및 DN 번호를 표기할 것.
8. For welding instruction
   see draw. no. B14-100443-8.
   용접시방은 B14-100443-8 에 따라 실시할 것.
9. Steel part to be painted with YEOL COAT QT606(SILVER) after sanding&pickling expect machined part.
   기계가공면을 제외한 steel부분은 산세와샌딩후 내열페인트
   YEOL COAT QT606(은색)페인팅 할것.



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No.	Part no.	Info. no.	Nominal press dia.	L(mm)	Flange dimensions				Flexible hose				Mass. (kg)
					PCD	D	t	nxd	OD	Bending radius	Burst press (20±c,kfg/cm2)	Hose type	
1	B19-188117-6	172359	5K-15	500	60	80	9	4x12	28.3	130	280	Annuar corrugated U-shaped	1.22
2	B19-188118-8	172359	5K-20	500	65	85	10	4x12	33.7	160	200		1.50
3	B19-118009-0	172359	5K-25	500	75	95	10	4x12	51.6	170	170		2.12
4	B19-188120-9	172359	5K-32	500	90	115	12	4x15	63.8	180	160		3.51
5	B19-188121-0	172359	5K-40	500	95	120	12	4x15	77.8	200	120		4.10
6	B19-188122-2	172359	5K-50	500	105	130	14	4x15	85.2	225	120		4.94
7	B19-188123-4	172359	5K-65	500	130	155	14	4x15	102.8	250	90		5.47
8	B19-188124-6	172359	5K-80	500	145	180	14	4x19	119.0	275	65		8.30
9	B19-188125-8	172359	5K-100	500	165	200	16	4x19	143.3	350	55		8.80
10	B19-188126-0	172359	5K-125	600	200	235	16	8x19	145.0	425	45		11.00
11	B19-188127-1	172359	5K-150	600	230	265	18	8x19	172.0	500	38		14.80
12	B19-188128-3	172359	5K-200	600	280	320	18	8x23	230.0	750	35		22.40

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
-	-	-	-	-	-	-
05	134804-9-05	Single Wire braid	SUS304	1	-	-
04	134804-9-04	Bellows	SUS316L	1	-	-
03	134804-9-03	Braid band	SS400	2	-	-
02	134804-9-02	Lab joint	SS400	2	-	-
01	134804-9-01	Flange	SS400	2	-	-

Supplement Drawing No.:

Projection:

Mass (kg):

Material / Blank:

Licensor's Ident. no.: 1608223-3.0

Dist.: P82

Licensor's Material / Blank:

	Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
	180706	JJO	HSR	KHS	*	*	Replaced by Ident. No.: B92-187309-0 (9)	9
	170118	JJO	SWS	RYS	*	*	Del. no.06(Ring plate)& Note. 11	8
KHA	150923	KGI	KJC	RYS	*	*	Chg.mass.	7
CYS	141124	KHG	KJC	RYS	*	*	Deleted spec. no. 10	6
SJH	130322	KHG	KJC	LCS	*	*	Corrected text	5
SJH	121204	BJW	SWS	AGH	*	*	Changed Spec.	4
	120815	BJW	SWS	AGH	*	*	Changed Spec.	3
	120706	BJW	SWS	AGH	*	*	Changed Spec.	2
	111211	SYH	YSB	AGH	*	*	Changed Spec.	1
	000719	DYJ	DYJ	SMH	*	*		0

Similar Drawing No.:

Replacement of Ident. No.:

Scale: 1:2.5

Size: A2

Type: -

Page No.: 01(01)

Confidential: B

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info. No.: 372359

Description: Fixed type Metallic flexible hose

Ident. No.: B12-134804-9

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Standard for surface roughness

The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)

This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

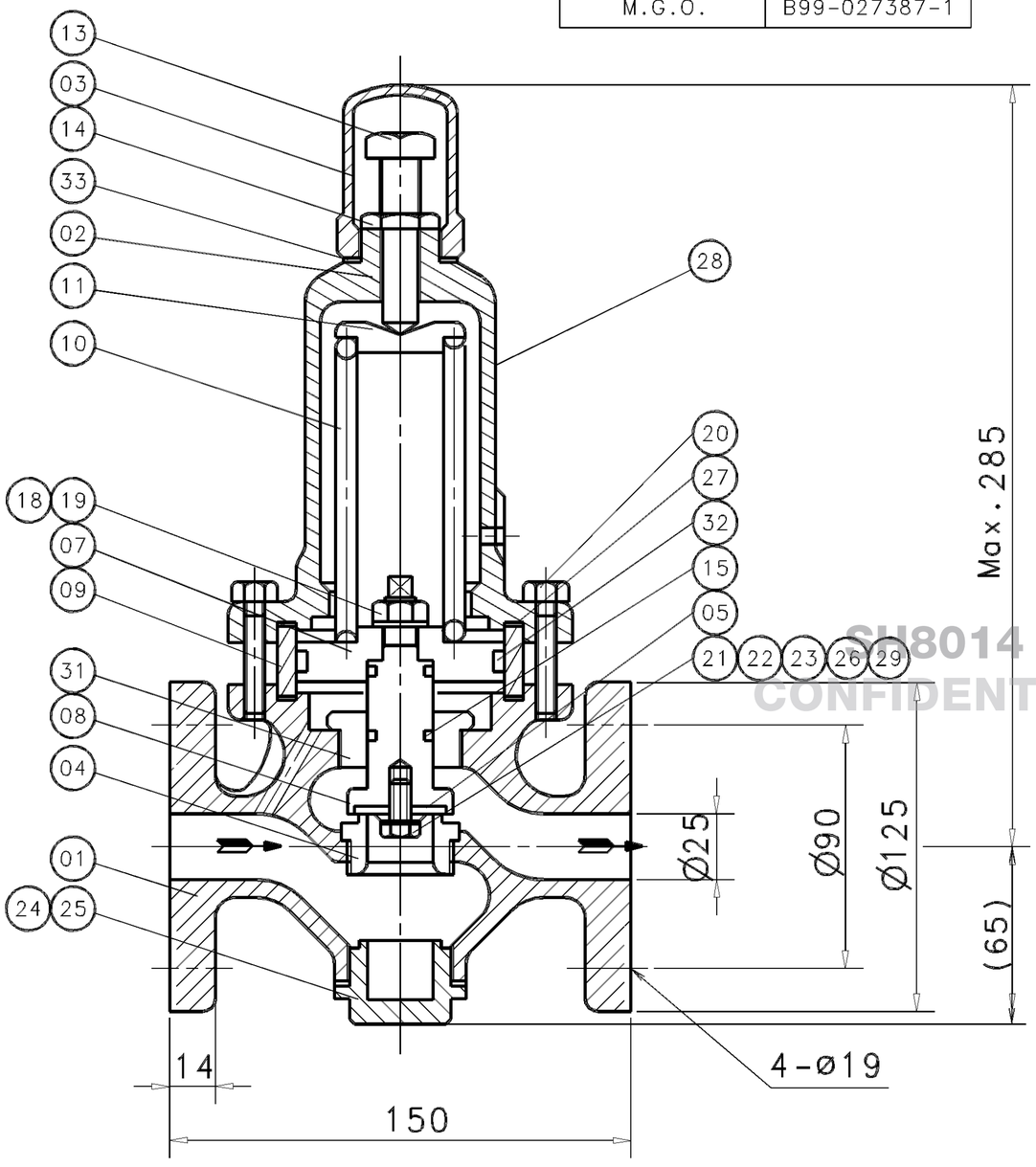
Nom.measurement ㎜ / Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

HSEF-k210-011(R1)

현대중공업(주) 엔진사업본부

A2(594mmx420mm)프로젝션

DESCRIPTION	PART NO.
M.D.O.	B99-027386-0
M.G.O.	B99-027387-1



SPECIFICATION

1. Setting pressure : 2 bar(0.2 MPa)
2. Test pressure : 9 bar(0.9 MPa)
3. Working pressure : Max.6 bar(0.6 MPa)
4. Working temperature : Max.55°C
5. Medium : MDO/MGO
6. Flange size : JISB2220 16K-25
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.

⚠9. COATING : OUTSIDE - GALVANY IZ180N 75㎛

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
33	-	GASKET	TBAAF2100	1	-	또는 AFM37
32	-	O-RING	FPM2	1	-	-
31	-	STEM GUIDE	SUS304	1	-	-
30	-	-	-	-	-	-
29	-	PLUG	S45C	1	-	-
28	-	NAME PLATE	SUS304	1	-	-
27	-	GASKET	TBAAF2100	1	-	또는 AFM37
26	-	AIR PIN	C3712BE	2	-	-
25	-	PLUG	SUS304	1	-	-
24	-	GASKET	TBAAF2100	1	-	또는 AFM37
23	-	DISC LOCK BOLT	SUS304	1	-	-
22	-	SPRING WASHER	SWRM10	1	-	-
21	-	DISC SCREW	8.8	1	-	-
20	-	BOLT	8.8	6	-	-
19	-	STEM LOCK NUT	8	1	-	-
18	-	SPRING WASHER	SWRM10	1	-	-
17	-	-	-	-	-	-
16	-	-	-	-	-	-
15	-	O-ring	FPM2	2	-	-
14	-	LOCK NUT	SUS304	1	-	-
13	-	ADJUST SCREW	8.8	1	-	-
12	-	-	-	-	-	-
11	-	T-SPRING SEAT	SS 400	1	-	-
10	-	SPRING	SWOSC-V	1	-	-
09	-	CYLINDER	STKM13C	1	-	-
08	-	STEM	SUS304	1	-	-
07	-	PISTON	SUS304	1	-	-
06	-	-	-	-	-	-
05	-	DISC	FPM2	1	-	-
04	-	SEAT	SUS304	1	-	-
03	-	Cap	FC 200	1	-	-
02	-	SPRING CASE	SRPG370	1	-	-
01	-	Body	FCD 400	1	-	-

Supplement Drawing No.:

Projection:

Mass (kg): 10.5

Material / Blank:

Licensor's Ident. no.:

Dist.:

Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
KYJ	HSK	KJC	LCS	*	*	Corrected spec.	1
KYJ	HSK	KJC	LCS	*	*	Added spec.	0

Similar Drawing No.:

Replacement of Ident. No.:

Scale: 1:2

Size: A2

Type: -

Page No.: 01(01)

Confidential: B

Info. No.: 399974

Description: Pressure regulating valve for M.D.O./M.G.O outlet(2bar)

Ident. No.: B92-100775-1

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

HSEF-k210-011(R1)

현대중공업(주) 엔진사업본부

A2(594mmx420mm)트레싱지

CAD Drawing - do not correct by hand

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Standard for surface roughness

The basic symbols and class numbers are in accordance with ISO 1302-1978.

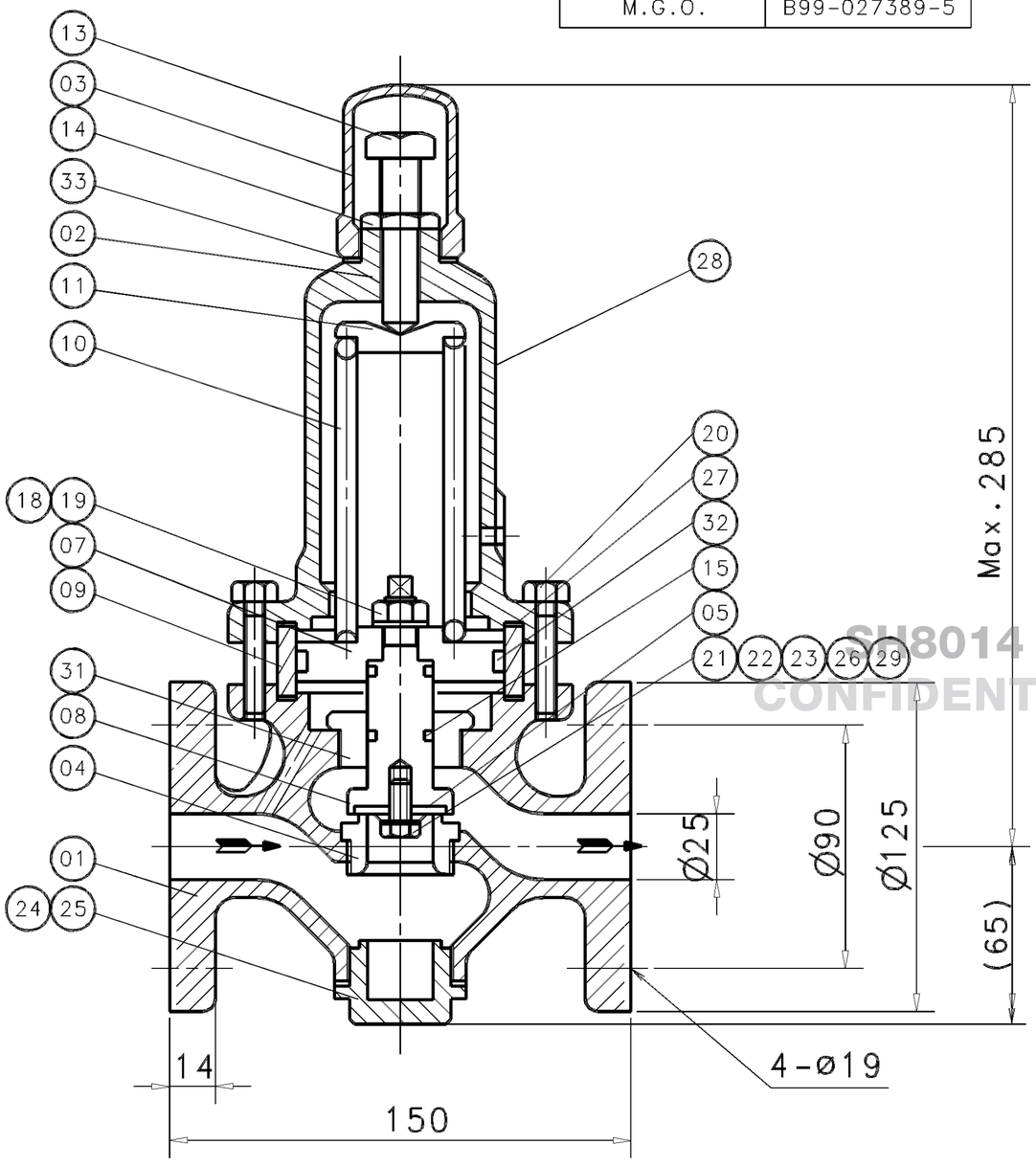
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)

This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

DESCRIPTION	PART NO.
M.D.O.	B99-027388-3
M.G.O.	B99-027389-5



SPECIFICATION

1. Setting pressure : 6 bar(0.6 MPa)
2. Test pressure : 9 bar(0.9 MPa)
3. Working pressure : 6 bar(0.6 MPa)
4. Working temperature : Max.55°C
5. Medium : MDO/MGO
6. Flange size : JISB2220 16K-25
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.
⚠1 9. COATING : OUTSIDE - GALVANY IZ180N 75㎛

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
33	-	GASKET	TBAAF2100	1	-	또는 AFM37
32	-	O-RING	FPM2	1	-	-
31	-	STEM GUIDE	SUS304	1	-	-
30	-	-	-	-	-	-
29	-	PLUG	S45C	1	-	-
28	-	NAME PLATE	SUS304	1	-	-
27	-	GASKET	TBAAF2100	1	-	또는 AFM37
26	-	AIR PIN	C3712BE	2	-	-
25	-	PLUG	SUS304	1	-	-
24	-	GASKET	TBAAF2100	1	-	또는 AFM37
23	-	DISC LOCK BOLT	SUS304	1	-	-
22	-	SPRING WASHER	SWRM10	1	-	-
21	-	DISC SCREW	8.8	1	-	-
20	-	BOLT	8.8	6	-	-
19	-	STEM LOCK NUT	8	1	-	-
18	-	SPRING WASHER	SWRM10	1	-	-
17	-	-	-	-	-	-
16	-	-	-	-	-	-
15	-	O-ring	FPM2	2	-	-
14	-	LOCK NUT	SUS304	1	-	-
13	-	ADJUST SCREW	8.8	1	-	-
12	-	-	-	-	-	-
11	-	T-SPRING SEAT	SS 400	1	-	-
10	-	SPRING	SWOSC-V	1	-	-
09	-	CYLINDER	STKM13C	1	-	-
08	-	STEM	SUS304	1	-	-
07	-	PISTON	SUS304	1	-	-
06	-	-	-	-	-	-
05	-	DISC	FPM2	1	-	-
04	-	SEAT	SUS304	1	-	-
03	-	Cap	FC 200	1	-	-
02	-	SPRING CASE	SRPG370	1	-	-
01	-	Body	FCD 400	1	-	-

Supplement Drawing No.:

Projection:

Mass (kg): 10.5

Material / Blank:

Licensor's Ident. no.:

Dist.:

Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
SJH	HSK	KJC	LCS	*	*	Corrected Spec.	1
KYJ	HSK	KJC	LCS	*	*	Changed spec.	0

Similar Drawing No.:

Replacement of Ident. No.:

Scale: 1:2

Size: A2

Type: -

Page No.: 01(01)

Confidential: B

Info. No.: 399974

Description: Pressure regulating valve for M.D.O./M.G.O.inlet(6bar)

Ident. No.: B92-100776-3

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CAD Drawing - do not correct by hand

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Standard for surface roughness

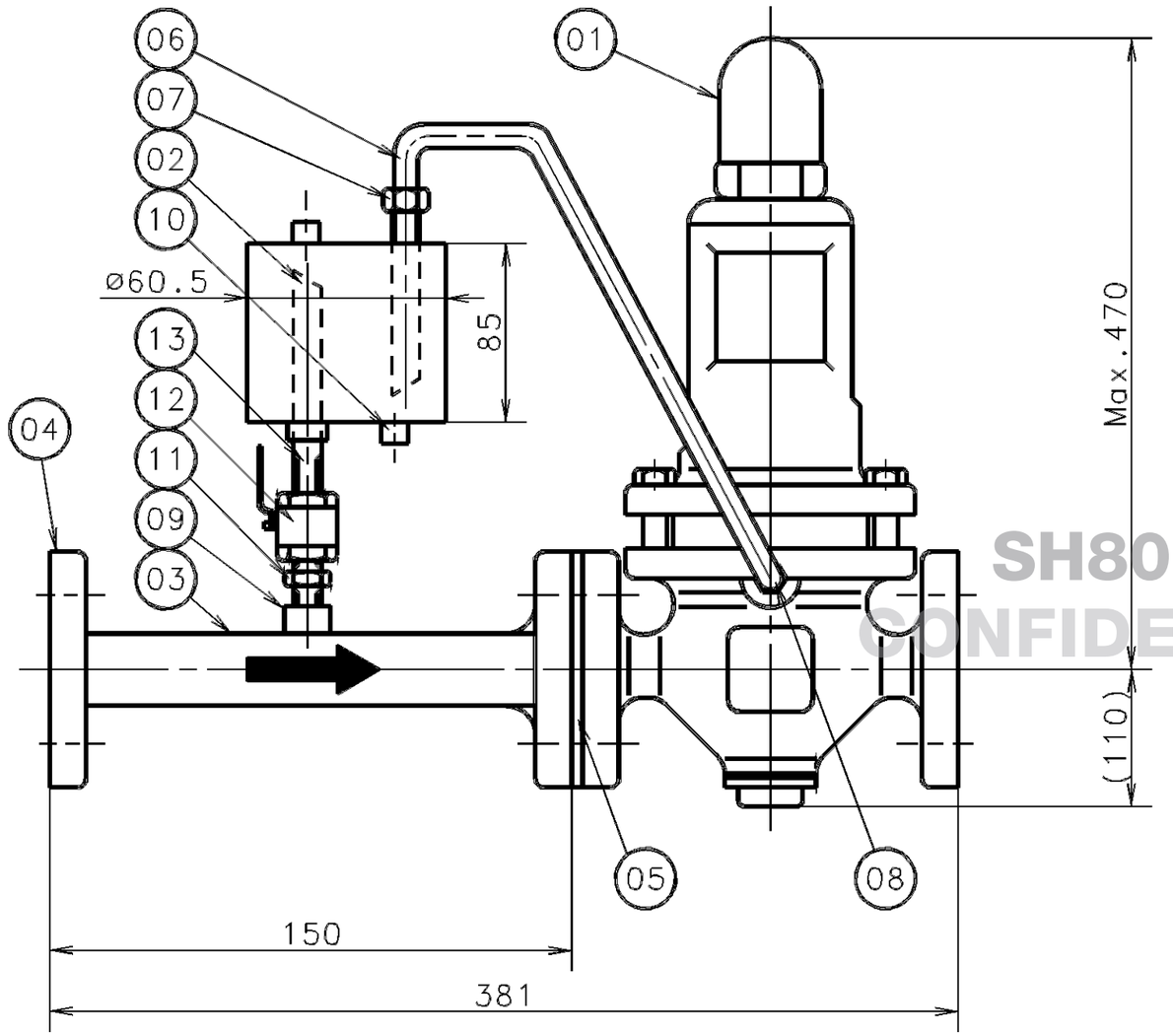
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)

This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2



* SPECIFICATION

1. Setting pressure : 9 bar (0.9 MPa)
2. Test pressure : 15 bar (1.5 MPa)
3. Working pressure : 10 bar (1.0 MPa)
4. Working temperature : 150°C
5. Medium : Heavy fuel oil
6. Flange size : JIS B 2220 16K-50
7. Flow direction to be marked.
8. Setting pressure & Description to be marked on name plate.
9. COATING : OUTSIDE - GALVANY IZ180N 75㎛

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
13	-	Connector	SUS304	1	-	-
12	-	Ball valve	SUS304	1	-	-
11	-	Nipple	SUS304	1	-	-
10	-	Plug	SS400	2	-	-
09	-	Boss	S45C-N	1	-	-
08	-	Connector	SUS304	1	-	-
07	-	Connector	S45C-N	2	-	-
06	-	Tube	St37.4	1	-	-
05	-	Gasket	Non-Asbestos	1	-	-
04	-	Flange(16K-50)	SS400	2	-	-
03	-	Pipe(50A)	STPG370	-	-	#40
02	-	Oil separator	STPG370	1	-	-
01	B12-125147-5	Regurating valve	FCD400	1	-	-

SH8014
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Supplement Drawing no.:

Projection: Mass (kg): 31.5

Material / Blank:

Licensor's Ident. no.: Dist.:

Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
				*	*		5
				*	*		4
				*	*		3
				*	*		2
				*	*		1
130710	KHG	KJC	LCS	*	*		0

Similar Drawing No.: B93-106183-8 Replacement of Ident. No.:

Scale: N/S Size: A3 Type: - Page No.: 01(01) Confidential: B

Info. No.: 399974

Description: Pressure regulating valve for HFO inlet (9bar)

Ident. No.: B93-106206-4

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Standard for surface roughness

The basic symbols and class numbers are in accordance with ISO 1302-1978.

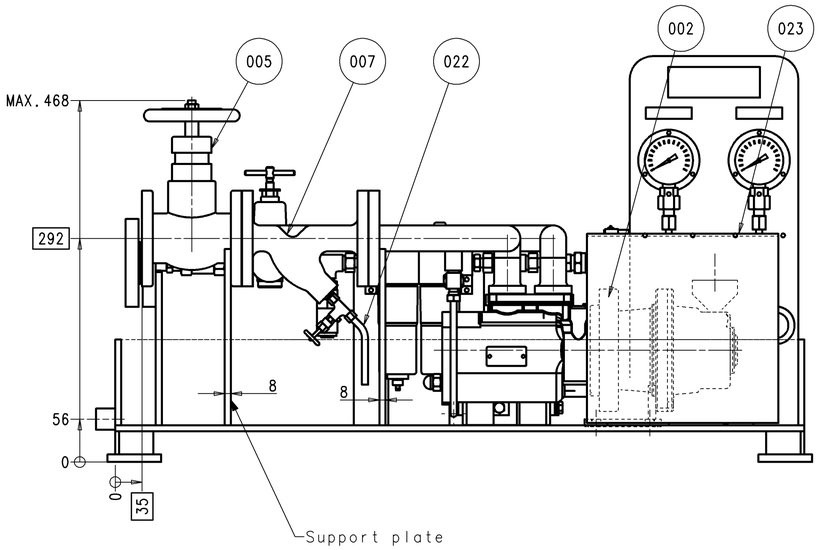
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

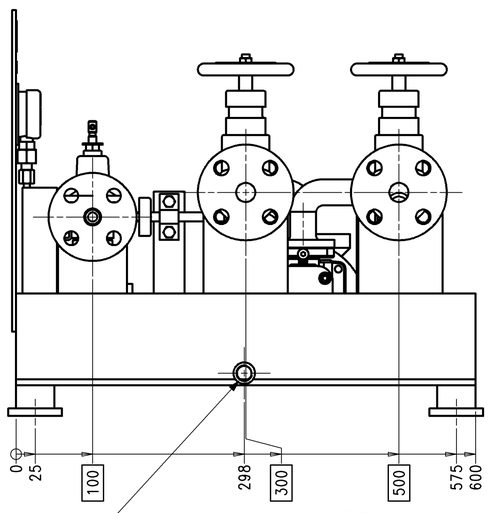
Tolerances for dimensions without tolerance indication(ISO 2768-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Per-missible deviations	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

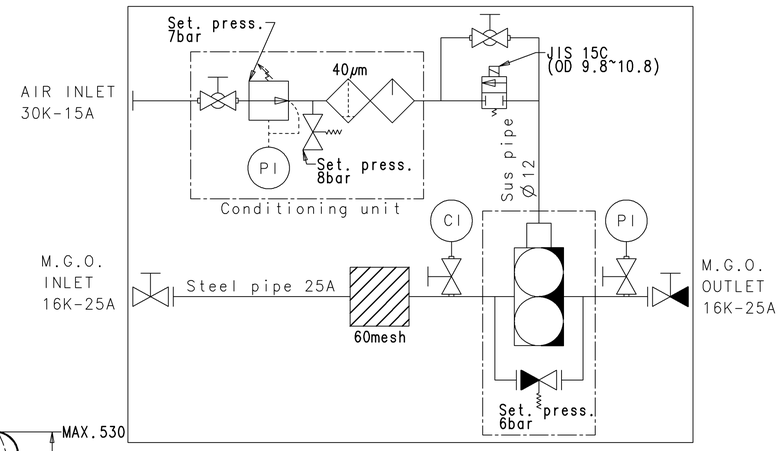
CAD Drawing - do not correct by hand

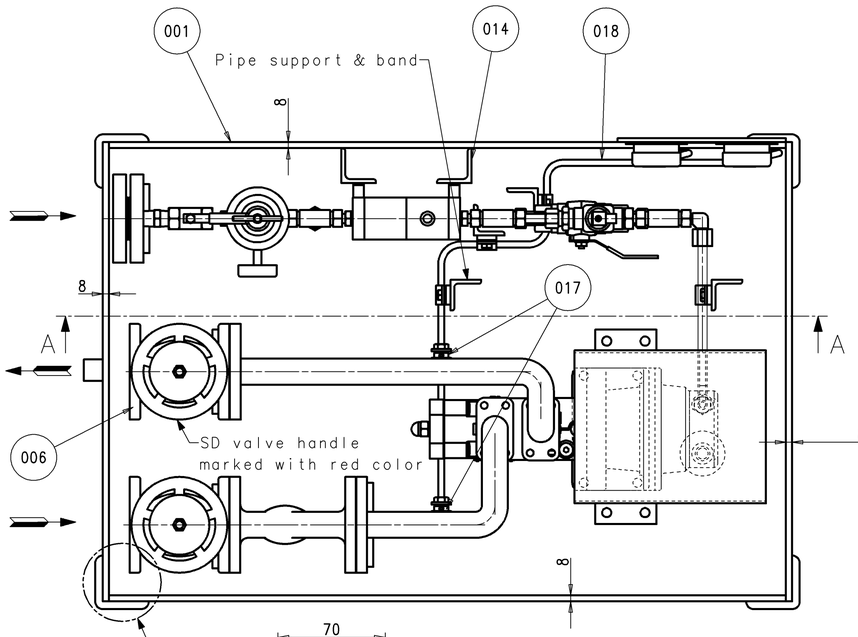


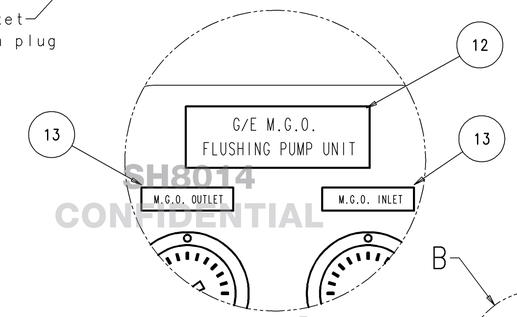


* SPECIFACTION

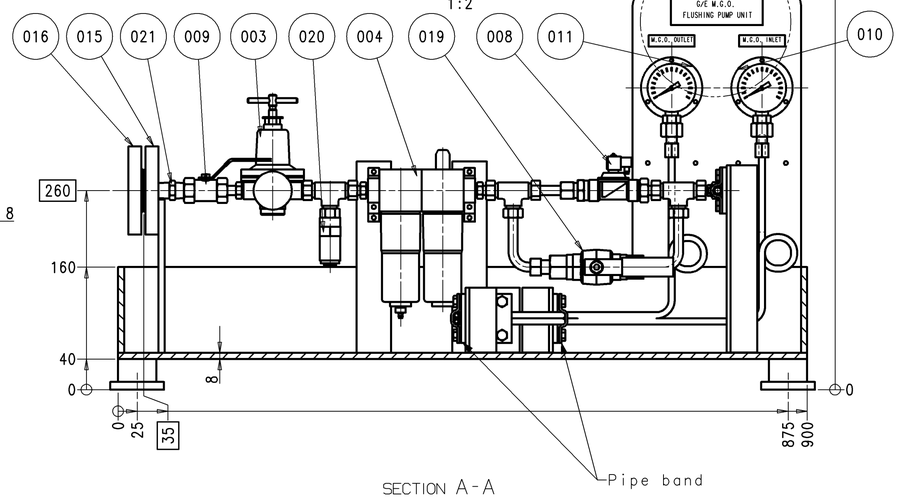
1. PUMP
   - 1-1. CAPACITY : 1.68m³/h x 6bar (6.1kg/cm², 0.6MPa)
   - 1-2. PUMP TYPE : SCREW PUMP
   - 1-3. FLUID VISCOSITY : Min. 1.5cSt
2. AIR MOTOR
   - 2-1. MOTOR TYPE : GAST 4AM-ARV-119
   - 2-2. AIR CONSUMPTION : 120m³/h at FREE AIR
   - 2-3. INLET PRESSURE : 5-7bar (5.1-7.1kg/cm², 0.5-0.7MPa)
   - 2-4. SPEED : 3000 rpm
   - 2-5. POWER : 0.51kW
3. SOLENOID VALVE : DC24V, ENERGIZED TO OPEN TYPE
4. AIR CONDITIONING UNIT
   - 4-1. MAX. SUPPLY PRESSURE : 30bar (30.6kg/cm², 3MPa)
5. PAINTING
   - 5-1. PRIMARY COATING : KORAMEL PRIMER MP120 TWO COATING WITH 30㎛
   - 5-2. TOP COATING : KORAMEL ENAMEL LT313 TWO COATING WITH 20㎛
6. PIPE MATERIAL : STPG370-S
7. QUALITY INSTRUCTION : B14-126773-5
8. NO.10 GAUGE RANGE : -760mmHg(OR EQUIVALENT) ~ 4bar (4.1kg/cm², 0.4MPa)
9. NO.11 GAUGE RANGE : 0 ~ 10bar (10.2kg/cm², 1MPa)



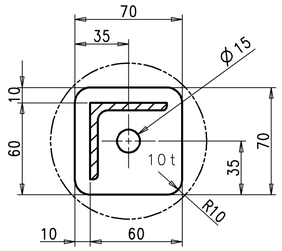




DETAIL B
1:2



SECTION A-A



DETAIL C

⚠ *모든 VALVE, FLANGE CONN.에 NAME PLATE 부착할 것.

Part No.	Gauge Unit
B99-123141-7	bar
B99-123142-9	kg/cm²
B99-123143-0	MPa & kg/cm² (dual scale)

Pos No.	Drawing No.	Drawing Title	Material	Q'ty	Net Weight	Remarks
023		PROTECTION COVER	SS400	1	-	
022		DRAIN PIPE	C1220T-1/2H	1	-	
021		DOUBLE NIPPLES PT1/2xPT1/2	SUS316L	1	-	
020		SAFETY VALVE	-	1	-	
019		BALL VALVE Ø12	SUS	1	0.20	
018		PIPE Ø8	SUS	2	-	
017		STOP VALVE Ø8	SUS316L	2	0.30	
016		COUNTER FLANGE	SF440A	1	1.23	
015		FLANGE 30K-15	SF440A	1	1.23	
014		EQUAL ANGLE	SS400	2	0.63	
013		NAME PLATE FOR PRESS.GAUGE	SUS	2	-	
012		NAME PLATE FOR UNIT	SUS	1	-	
011		DISCHARGE PRESSURE GAUGE	SUS	1	0.2	
010		SUCTION PRESSURE GAUGE	SUS	1	0.2	
009		BALL VALVE	SUS	1	0.25	
008		SOLENOID VALVE PT1/2	-	1	0.25	
007		STRAINER 16K-25	FC200	1	4.70	
006		SD GLOBE VALVE 16K-25	FC200	1	5.44	
005		GLOBE VALVE 16K-25	FC200	1	5.20	
004		AIR FILTER WITH LUBRICATOR	-	1	1.33	
003		PRESSURE REDUCING VALVE	-	1	0.48	
002		AIR MOTOR WITH PUMP	-	1	13.0	
001		FRAME BOX 8t	SS400	1	50.0	

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-06-26	KGI	YJH	KHS			Add. note.(Name plate)		3
2019-05-29	KGI	YJH	KHS			Chg. pad detail & spec.		2
2019-04-10	KGI	YJH	KHS			Cor. error.(Pump set. press.)		1
2019-04-04	KGI	YJH	KHS					0

Similar Drawing No. B91-140139-0 | Licensor's Drawing No. | LIC. Material / Blank | Material / Blank | Mass(kg)
Previous Drawing No. | Supplement Drawing No. | | COMPOSITE | 150.00

Engine / Product Type: HiMSEN

Title: G/E M.G.O. FLUSHING PUMP UNIT

Projection | Units: mm kg | Distribution: P82

Scale: 1:4 | Information No.: 198309 | Security: B

Drawing No.: B91-159929-7 | Page No.: 1/1 | Size: A1

HYUNDAI HEAVY INDUSTRIES

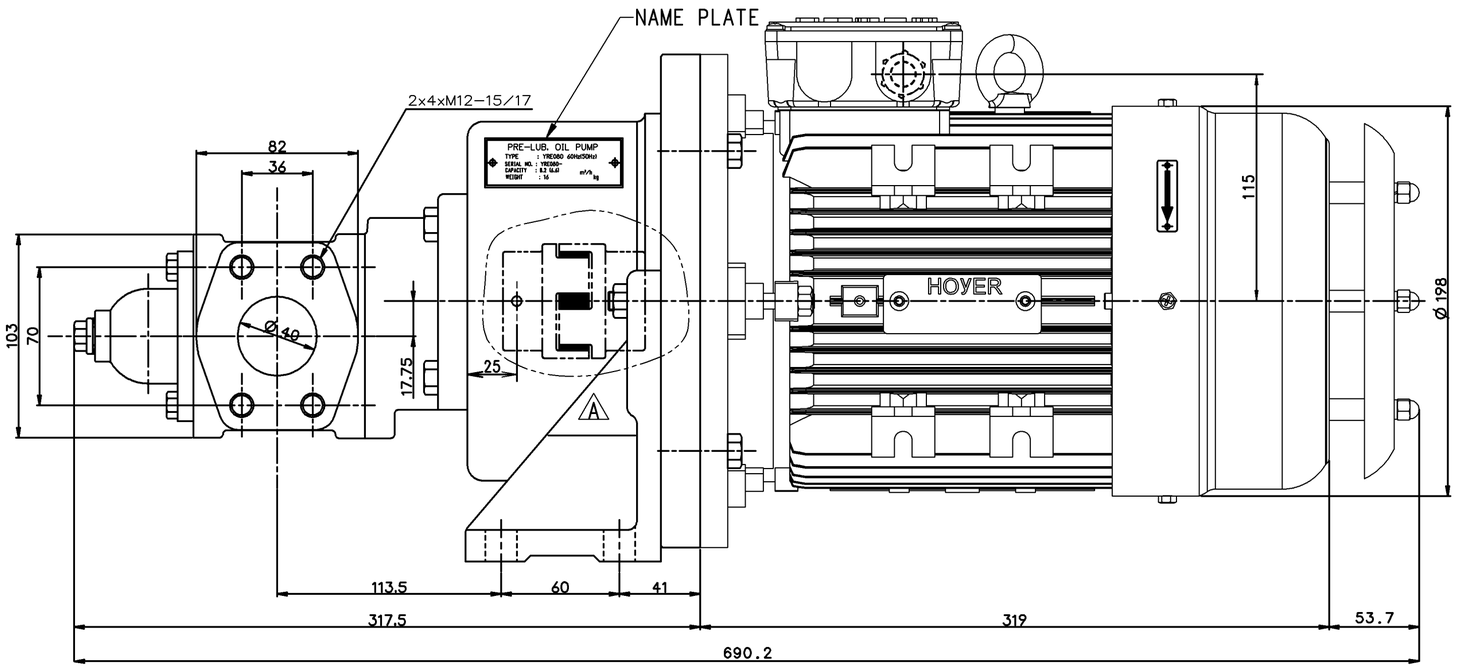
Tolerances for dimensions without tolerance indication (ISO 2968-1989)							
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.	Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations	Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

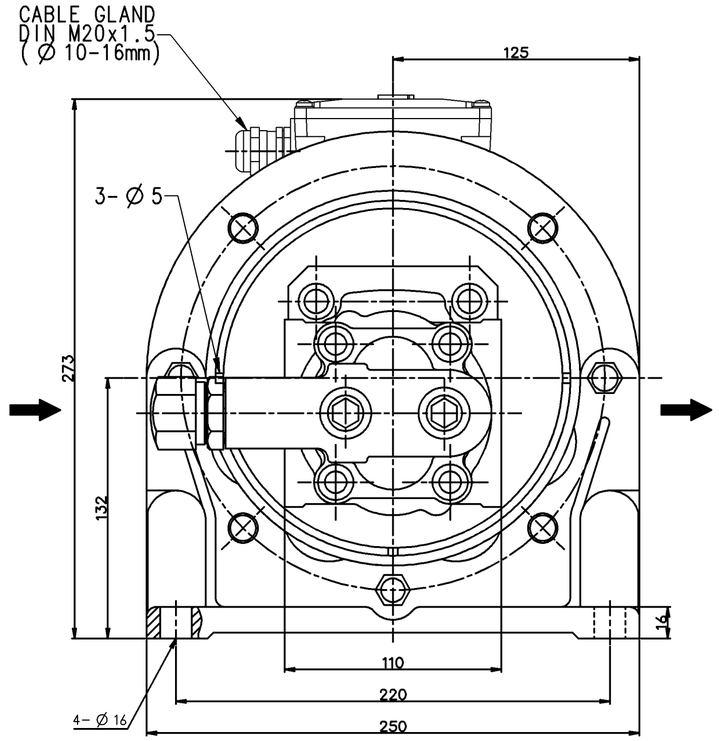
Standard for surface roughness												
The basic symbolic and class number are in according with ISO 1302-1978												
Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

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⚠A PUMP-DATA

Maker	: YURIM
Type	: YRE080
rpm	: 3,450 / 2,880
Capacity(m³/h)	: 8.2 / 6.6 (-5% ~ +10%)
Discharge press.(bar)	: 0.5-2.0
Suction press.(bar)	: -0.4
Housing hydraulic test press.(bar)	: 10
Requ. power(Start condition, kW)	: 2.1 / 1.7
Fluid	: Lub oil SAE30/40
Viscosity(mm²/s)	: 97-105/+40°C
Fluid temp.(°C)	: +40°C (+10°C~+90°C)
Weight(kg)	: 16
Press. relief valve	: yes
Valve set. range(bar)	: 2-4
Valve set. press.(bar)	: 2

⚠A MOTOR-DATA

Maker	: HOYER
Type	: MS 100L-2
Voltage(V)	: 440-480(D) / 380-415(D)
Frequency(Hz)	: 60 / 50
rpm	: 3,450 / 2,880
Frame No.	: 100L
Protection	: IP55
Insulation	: F
Temp. rise class	: B
Start current(A)	: 44.5 / 40.9
Nominal current(A)	: 6.1 / 6.2
Power output(kW)	: 3.6 / 2.9
Weight(kg)	: 22
Ambient temp.	: +50°C
Winding heating	: 50VA 16V
Efficiency(%)	: 83.0 / 81.8
Power factor	: 0.88 / 0.89
Type of constrction	: B5
Earth	: In/Out
Cooling mothod	: IC411
Application	: IEC60034-1
Enclosure protection	: IEC60034-5

PRE-LUB.OIL PUMP
TYPE :
SERIAL NO.:
CAPACITY : m^3/h
WEIGHT : kg

NAME PLATE DETAIL

CONNECTION DIAGRAM
MAIN: U1 V1 W1 — 440-480V/60Hz, 380-415V/50Hz
HEATER(OPTION): U1 V1 — 16V

⚠A* Hytrel 재질 jaw coupling spider 적용 (연속 운전 시간 개선)

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-05-13	KGI	YJH	KHS			Chg. Design & spec.		A
2018-08-23	AJH	PJK	KHS			Chg. dim		9
2018-06-26	AJH	HSR	KHS			Add. dim		8
2018-01-18	AJH	HSR	KHS			Chg. voltage.		7
2017-10-10	BHG	SWS	KHS			Chg. spec.		6
2017-10-10	BHG	SWS	KHS			Chg. spec.		5
2017-08-23	BHG	SWS	RYS			Add. spec.		4
2017-05-12	BHG	SWS	RYS			Chg. & Add. spec, dim		3
2017-01-26	BHG	SWS	RYS			Add. diagram & NOTE		2
2016-09-21	BHG	SWS	RYS			Chg. dim		1

Similar Drawing No.	Licensor's Drawing No.	LIC. Material / Blank	Material / Blank	Mass(kg)
Previous Drawing No.	Supplement Drawing No.		COMPOSITE	38.00
Engine / Product Type: H21/32	Title: PRE LUBRICATING OIL PUMP	Projection	Units: mm kg	Distribution: P82
	Description	Scale: 1:2	Information No.: 165008	Security: B
	Drawing No.: B92-161311-3	Page No.: 1/1	Size: A2	HYUNDAI HEAVY INDUSTRIES

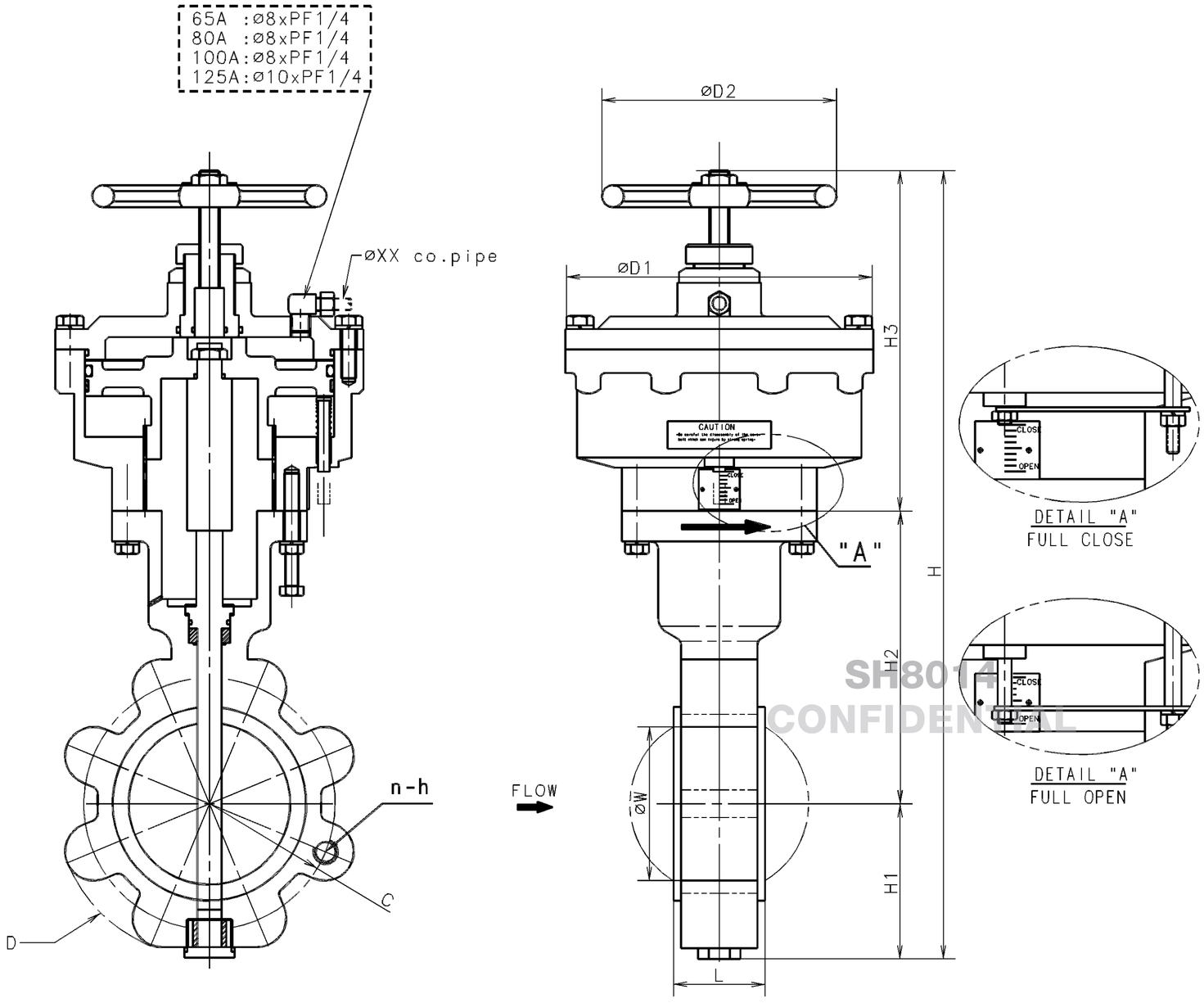
Tolerances for dimensions without tolerance indication (ISO 2968-1989)
This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations: Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness
The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

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3D IMI CAD Drawing - do not correct by hand. *Confidential*
HSEF-K220-005(R0)



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* Final Paint : According to engine spec.
* Name plate(Mat'l:SUS316)부착하여 공급 할 것.

SPECIFICATION

1. Test pressure : 7.5 bar(0.75MPa)
2. Working pressure : Max. 3.0 bar(0.3MPa)
3. Opening start L.O. pressure : 2.7 bar(0.27MPa)
4. Full opening L.O. pressure : 4.0 bar(0.4MPa)
5. Full close press : 2.0 bar(+10%)
6. Medium : Sea water, Fresh water
7. Flange size : JIS B 2220 5K

Part no.	N.D	Dimension				Eng. Type
		D	C	n-h	L	
B99-028933-8	65A	155	130	4-M12	47	H17/28U
B99-010153-0	80A	180	145	4-M16	47	H17/28, 5,6H21/32, 5H21C
B99-010154-2	100A	200	165	8-M16	56	7~9H21/32,H25/33,H27DF,6~9H21C
B99-010155-4	125A	235	200	8-M16	59	H32/40(V),H35DF,H35/40G(V)

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Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
$R_a$max. value ㎛	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Permissible deviations						
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Supplement Drawing No.:
Projection:
Mass (kg):
Material / Blank:
Licensor's Ident. no.:
Dist.: P82
Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
				*	*		8
				*	*		7
				*	*		6
180914	KGI	PJK	KHS	*	*	Chg. note	5
170407	KNE	KKH	KHS	*	*	Add. Engine type(H21C)	4
170209	SYH	SWS	RYS	*	*	Chg. note & Add. material	3
170110	SYH	SWS	RYS	*	*	Add. Note	2
161021	SYH	KJC	RYS	*	*	Add. Flow Mark	1
160921	SYH	KJC	RYS	*	*	Replaced from B92-036671-8	0

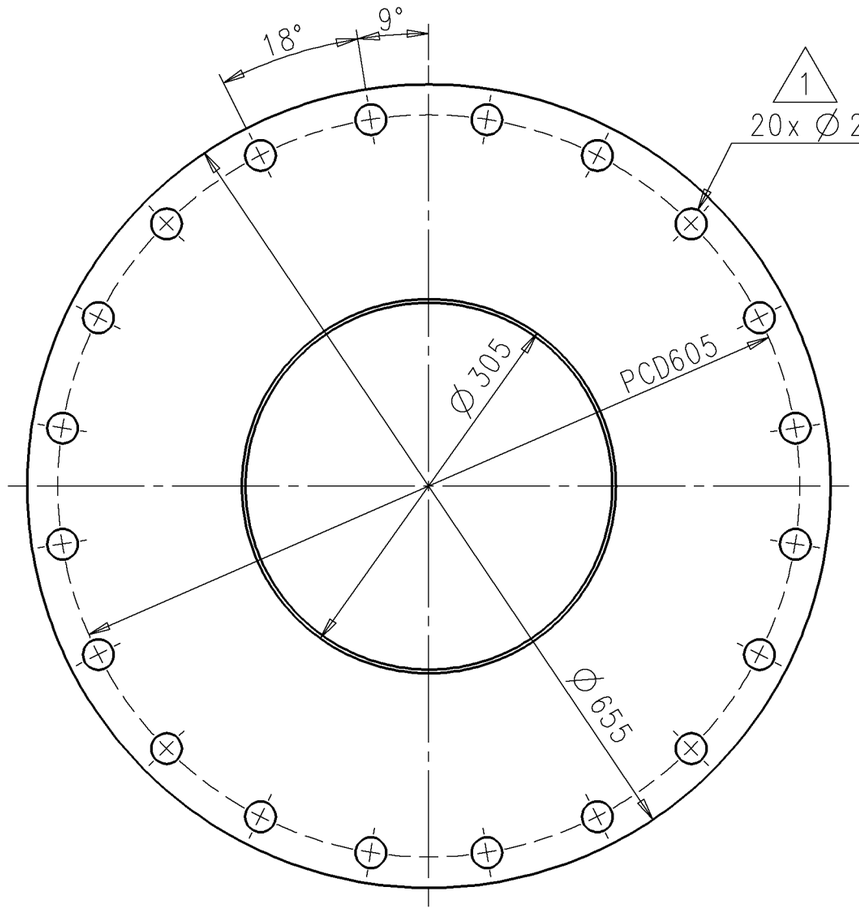
Similar Drawing No.:
Replacement of Ident. No.: B92-036671-8

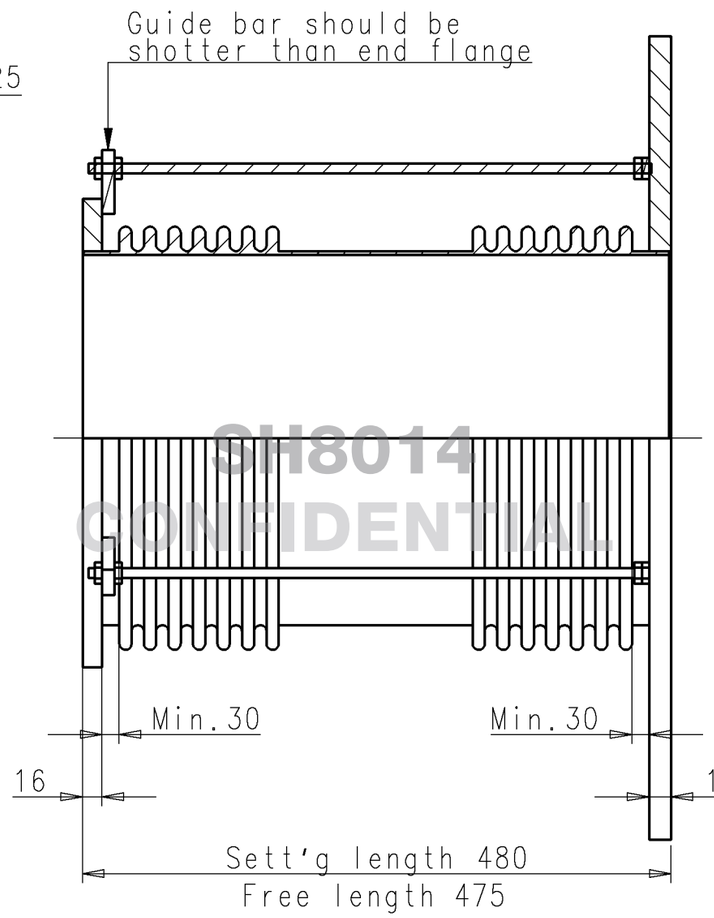
Scale: N/S
Size: A2
Type: -
Page No.: 01(01)
Confidential: B
HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. No.: 399945
Description: Water shut-off valve
Ident. No.: B92-165276-5

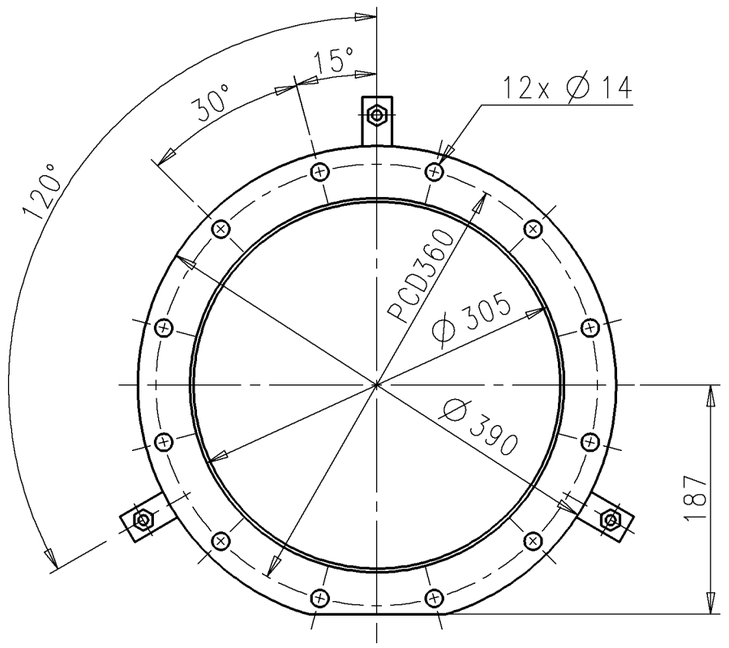
CAD Drawing - do not correct by hand

HSEF-k210-011(R1)
현대중공업(주) 엔진사업본부
A2(594mmx420mm)트레싱지

Max.working conditions		Movement		SPRING RATE		Bellows			Life cycle	* Material		
Temp °C	Pressure Bar	Axial in mm (lateral=0)	Lateral in mm (axial=0)	Axial C_A N/mm	Lateral C_L N/mm	Number of convolut.	Number of plyes	One ply in mm		Flange	Bellows	Sleeve
550	0.1	±80	±40	① Maker standard					min.7000	SS400	SUS321	SUS304







*TURBOCHARGER TPS57, HPR5000, A140, ST5
TPS61, HPR6000, A145, ST6

NOTE
- All welds of belliws to be inspeted color check.
- Heat resistance silver paint to be applied with 2 coats.
- Flow direction to be marked on the body as an arrow.
- The length to be setted with 3pcs guide bar, but no longer then setting length

302 To be marked with B93-040263-9

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Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2015-12-31	CHK	HSR	KHS			Chg. Dimension & Note		1
2012-09-24	JDH	JSC	AGH					0

Similar Drawing No.	Licensor's Drawing No.	LIC. Material / Blank	Material / Blank: COMPOSITE; Mass(kg): 75.40
Previous Drawing No.	Supplement Drawing No.		
Engine / Product Type: H25/33 H21/32	Title: EXPANSION JOINT FOR T/C OUTLET; Description: (L=480 500A)	Drawn: ChoBongGuk	Distribution: A82
		Scale: 1:5	Information No.: 198002; Security: B
Projection	Units: mm kg	Drawing No.: B93-040263-9	Page No.: 1/1; Size: A3; HYUNDAI HEAVY INDUSTRIES

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Basic size range(mm) / Permissible deviations	0,5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2

Standard for surface roughness

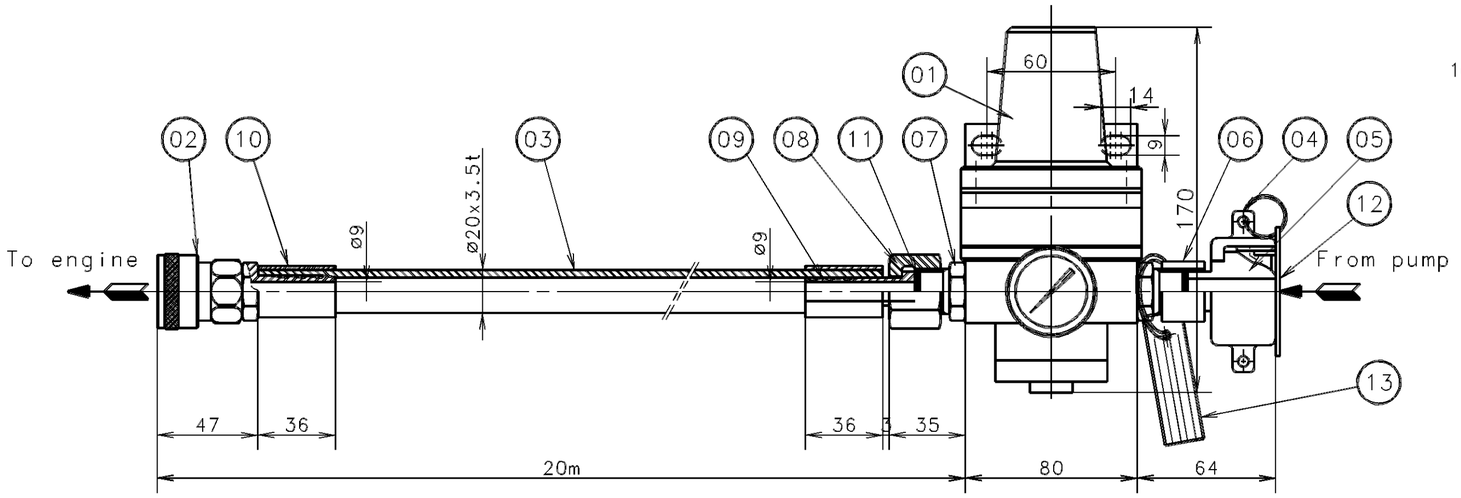
The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. μ	0,025	0,05	0,1	0,2	0,4	0,8	1,6	3,2	6,3	12,5	25	50

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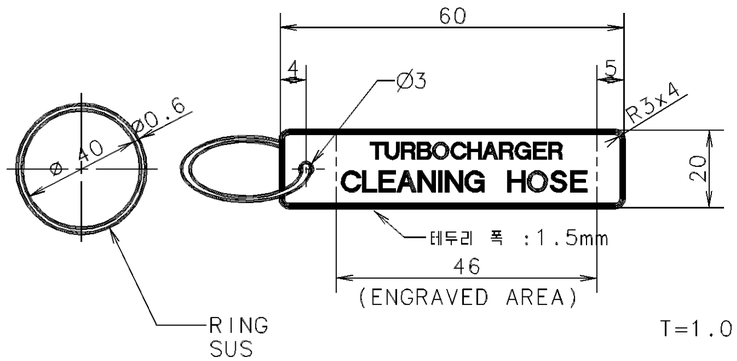
HSEF-K220-003(R0)



SPECIFICATION

1. Test pressure	:	1.0 MPa (10 bar,10 kg/cm^2)
2. Inlet pressure	:	Max. 0.7 MPa (7 bar,7 kg/cm^2)
3. Operating range	:	0.01 ~ 0.7 MPa (0.1 ~ 7 bar, 0.1~7 kg/cm^2)
4. Hose bursting press.	:	17 MPa (170 bar,170 kg/cm^2)
5. Temperature range	:	-5°C~60°C
6. Pump side connection	:	Hose connector for JIS F7334-hose valve
7. Hi-coupler type	:	ASIA NIPPLE SH400-1/2"
8. Medium	:	Fresh water 청수
9. Hose color	:	Blue 청색
10. Regulating valve Rc1/2	:	0.01 ~ 0.7 MPa (0.1 ~ 7 bar, 0.1~7 kg/cm^2)

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* NOTE
1. Material : SUS304(1.0t)
2. Color : Pantone 10c(버탕색)
   글자색 Al재질로 할 것.
3. 글자체 : HY견고딕
4. 부착방법 :Ring SUS type
5. 표면은 투명한 비닐로 보호할 것.
6. 글자 크기는 전체 여백을 간암하여 적당한 크기로 할것.
7. 양면 열처리 할 것. (양면 인쇄할 것.)
8. NAME PLATE와 RING을 조립하여 공급 할 것

DETAIL-NAME PLATE

POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	KG/UNIT	REMARKS
13	-	Name Plate	SUS304	1	-	-
12	-	Plastic cover	Plastic	1	0.01	-
11	-	Gasket	C1100P-0	2	0.01	-
10	-	Hose band	SUS304	2	0.04	-
09	-	Hose connector	SUS304	1	0.06	-
08	-	Union nut PF1/2	SUS304	1	0.05	-
07	-	Nipple PT1/2xPF1/2	SUS304	2	0.26	-
06	-	Socket PF1/2x25	SUS304	1	0.05	-
05	JISF 7335-15C	Hose connector	C3604BD	1	0.50	-
04	JISF 7335-15C	Union nut M42x2	C3604BD	1	0.50	-
03	B-08series-ø13	Viny chloride resin hose	-	1	2.58	ø12x3.5tx20m
02	SH400-1/2"	Hi-coupler socket 1/2"	SUS304	1	0.20	-
01	IR402-04BG	Regulating valve Rc1/2	-	1	1.00	

Supplement Drawing No.:

Projection:

Mass (kg): 5.26

Material / Blank:

Licensor's Ident. no.:

Dist.:

Licensor's Material / Blank:

Date	Des.	Chk.	Appd.	A.C.	E	Change / Replacement	C.No
				*	*	Replaced by Ident. No.:	9
160112	SYH	KJC	RYS	*	*	Del. Cloud mark.	8
111208	BJW	YSB	AGH	*	*	Added kg/cm^2	7
091009	SJH	JHS	KSR	*	*	Changed name plate spec.	6
090905	SJH	JHS	KSR	*	*	Changed name plate.	5
070618	JCL	JCM	SJR	*	*	Corrected text	4
040302	JHS	SMH	SMH	*	*	Changed test pressure	3
020124	JJO	SMH	SMH	*	*	Revised specification	2
990708	JHS	JHS	KSW	*	*	Added No.13	1
951015	KHG	SMH	LCS	*	*		0

KYJ

Similar Drawing No.: B13-100381-1.2

Replacement of Ident. No.:

Scale: 1 : 2

Size: A2

Type: -

Page No.: 01(01)

Confidential: B

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info. No.: 592534

Description: Turbochager cleaning hose

Ident. No.: B12-116265-8

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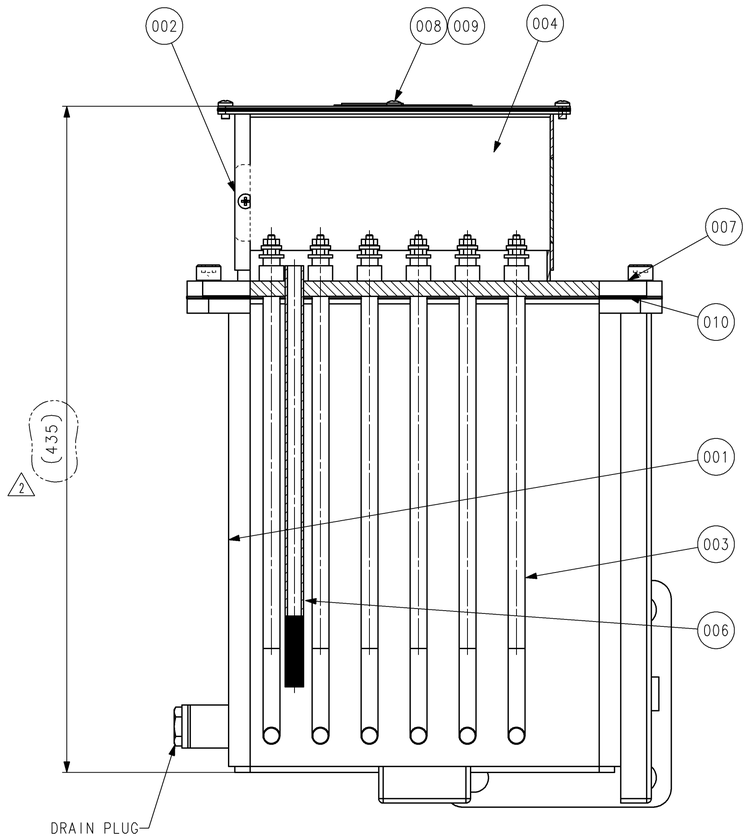
Standard for surface roughness
The basic symbols and class numbers are in accordance with ISO 1302-1978.

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
R_a max. value ㎛	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

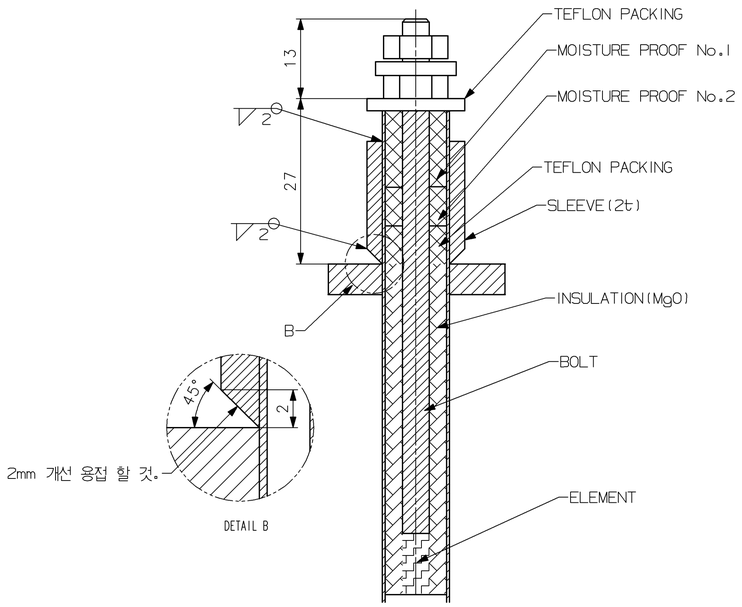
Tolerances for dimensions without tolerance indication(ISO 2768-1989)
This standard states the permissible deviations for dimension without direct tolerance indications on metallic components manufactured by machining.

Nom.measurement mm / Permissible deviations	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

CAD Drawing - do not correct by hand

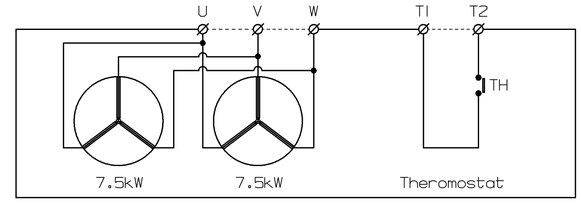


ELEMENT DETAIL



Specification

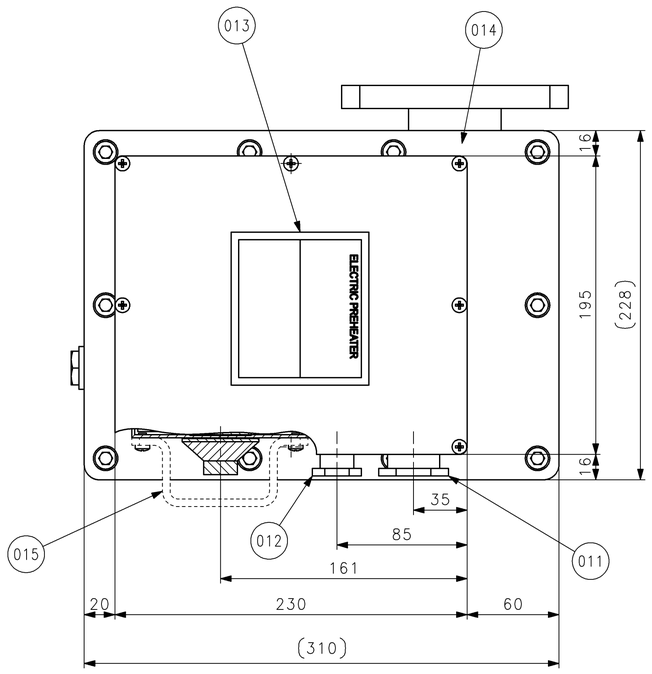
1. Heater capacity : 15kW
2. Medium : Fresh water
3. Work. press. : 5.0bar (Hydro test press. : 7.5bar)
4. Work. temp. : Max. 150C°
5. Thermostat temp. control range : 10~110C°
6. Thermostat temp. setting : 70C°
7. Protection class : IP44
8. Power source : AC 440V 3Ø 60Hz
9. Rated current : 19.7A±5%
10. 용접 결함이 없도록 할 것.
    (필요 시 비파괴검사 실시 할 것.)

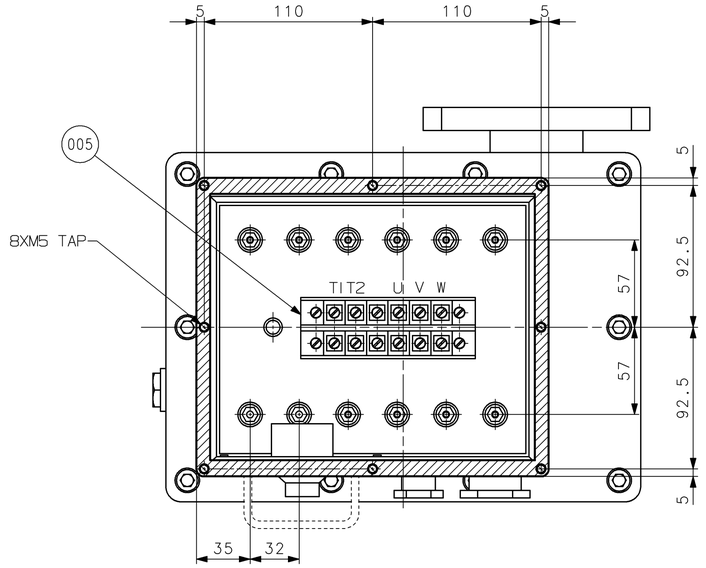


Electric connection diagram

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No.	PART No.	BV선급	REMARKS
01	B99-129090-0	X	
02	B99-129091-1	0	





POS NO	DRAWING NO	DESCRIPTION	MAT'L	Q'TY	kg/unit	REMARKS
015	-	PROTECTION COVER FOR DIAL	ACRYL	1	-	-
014	B93-306560-3	PROTECTION COVER	SS400	1	-	-
013	B93-034815-4	CAUTION PLATE	PC	1	-	-
012	-	CABLE GLAND JIS B 15	-	1	-	-
011	-	CABLE GLAND JIS B 25	-	1	-	-
010	B93-020602-7	GASKET	AFM37G	1	-	-
009	B93-020603-9	GASKET	AFM37G	1	-	-
008	JIS B 1101	MACHINE SCREW M5	SWRH62A	8	-	-
007	JIS B 1176	SOCKET HEAD BOLT M10X35	SCM435A	10	-	-
006	-	MECHANICAL THERMOSTAT	-	1	-	-
005	-	TERMINAL 60AX6P	-	1	-	-
004	-	TERMINAL COVER	SS400	1	-	-
003	-	ELEMENT TUBE Ø11x1.0t	ASS'Y	6	-	-
002	-	TERMINAL HOUSING	SS400	1	-	-
001	B93-306525-0	ELECTRIC HEATER CHAMBER	ASS'Y	1	-	-

Date	Designed	Checked	Approved	Action code	Exchangeability	Change / Replacement	ECN No.	Rev
2019-12-18	KGI	JCL	DYJ			Chg. dim		2
2019-11-21	KGI	JCL	KHS			Chg. design & Add. spec.		1
2019-11-06	KGI	JCL	KHS					0

Similar Drawing No. B91-100700-4	Licensor's Drawing No.	LIC. Material / Blank	Material / Blank	Mass(kg)	
Previous Drawing No.	Supplement Drawing No.		ASS'Y	18.98	
Engine / Product Type H21/32	Title ELECTRIC PRE-HEATER ASS'Y	Projection	Units mm kg	Distribution P82	
	Description 15KW	Scale 1:2	Information No. 270002	Security B	
	Drawing No. B91-306523-7	Page No. 1/1	Size A1	HYUNDAI HEAVY INDUSTRIES	

Tolerances for dimensions without tolerance indication (ISO 2968-1989)

This standard states the permissible deviations for dimensions without direct tolerance indications on metallic components manufactured by machining.

Permissible deviations / Basic size range(mm)	0.5 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 315	over 315 up to 1000	over 1000 up to 2000
Medium series	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2

Standard for surface roughness

The basic symbolic and class number are in according with ISO 1302-1978

Class No.	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra max. μ	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

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3D NX CAD Drawing - do not correct by hand.
This drawing, together with its supplements is the property of HHI and subject to copyright protection. A1(594mm*841mm)
이 도면은 현대중공업의 자산이므로 당사의 승인 없이 이 도면을 제 3자에게 양도, 복사, 판매하거나, 이 도면에 의해 부품을 제작하여 제 3자에게 판매하는 것은 불법입니다.

PLAN HISTORY	ENGINE TYPE	HYUNDAI - HiMSEN 3 x 9H21/32 - 900rpm
	MESSRS.	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : G/E AUTOMATIC CONTROL SYSTEM

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: COVER	Ident.no.: B94-185596-5
Page.no.: 01 OF 32		

GENERAL SPECIFICATION

1. CLASS & RULE : LR

2. AMBIENT TEMP. : 45°C

3. CONSTRUCTION OF PANEL
   - MOUNTING METHOD : WALL MOUNTING
   - MATERIAL : SHEET STEEL
   - PAINT COLOR ┌ MONITORING BOX : RAL 7032 ⚠
     └ TERMINAL BOX : RAL 7032
   - PROTECTION DEGREE OF PANEL : IP44

4. NAME PLATE
   - LETTER : ENGLISH
   - MATERIAL : MAKER STANDARD

5. ELECTRIC SOURCE / ENGINE
   - DC24V x 2 FEEDERS

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6. CABLE (INTERNAL)
   - POWER CIRCUIT : 0.6/1kV, 0.75mm?~1.25mm?
     FLAME RETARDANT TYPE

7. DISTINGUISH BETWEEN COLOR OF CABLE LUG CAP
   - D.C POWER CIRCUIT : P (WHITE) , N (BLACK)
   - CONTROL CIRCUIT : WHITE WITH NUMBERING

8. SCOPE OF SUPPLY
   - MONITORING BOX : 1 SET / ENGINE
   - TERMINAL BOX : 1 SET / ENGINE

9. COMMUNICATION METHOD
   - RS485 or RS422

10. TYPE APPROVAL CERTIFICATE NUMBER
   - 13/10024

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200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
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191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: GENERAL SPECIFICATION	Ident.no.: B94-185596-5
Page.no.: 02 OF 32		

FUNCTION DESCRIPTION

1. READY TO START CONDITION
   1-1. LOCAL/REMOTE STOP NOT SET UP
   1-2. AUTOMATIC STOP NOT SET UP
   1-3. EM'CY STOP NOT SET UP
   1-4. ENGINE INLET L.O PRESSURE IS OVER THAN 0.08kgf/cm² (WITH TIME DELAY 60SEC)
      * ENGINE CAN BE STARTED FOR 10 MINUTES WITHOUT PRE LUBRICATING AFTER PRE LUB. OIL PRESSURE(MIN.0.08bar) WAS ESTABLISHED PREVIOUSLY.
   1-5. TURNING BAR DISENGAGED
   1-6. BLOCKING/RESET POSITION NOT SET UP
   1-7. TACHO FAILURE(SE47-1 PICK-UP FAILURE) NOT SET UP

2. START
   2-1. LOCAL-REMOTE POSITION S/W SELECTION
      - LOCAL POSITION : LOCAL START PUSH-BUTTON ON
      - REMOTE POSITION : REMOTE START SIGNAL ON
   2-2. WHEN READY TO START IS ACTIVATED, THE ENGINE CAN BE STARTED

3. STOP
   3-1. LOCAL-REMOTE POSITION S/W SELECTION
      - LOCAL POSITION : LOCAL STOP PUSH-BUTTON ON - SET TO LOCAL POSITION
      - REMOTE POSITION : REMOTE STOP SIGNAL ON - SET TO REMOTE POSITION
   3-2. START FAIL. CONDITION(AUTO. STOP)
   3-3. COMMON TRIP CONDITION
      (OVERSPEED, L.O LOW PRESS., H.T WATER HIGH TEMP., BOTH TACHO FAIL., EM'CY STOP)

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4. BLOCKING/RESET
   4-1. ENGINE START BLOCKING
   4-2. RESET SHUTDOWN : IF PRESS. THE RESET BUTTON WHEN THE SAFETY STOP STATE, THE ENGINE WILL RETURN TO NORMAL CONDITIONS IN SHUTDOWN STATE.

5. SHUTDOWN
   5-1. OVERSPEED (ABOVE RATING SPEED 113%~115%)
   5-2. L.O LOW PRESS.
   5-3. H.T WATER OUTLET HIGH TEMP.
   5-4. BOTH TACHO FAIL.
   5-5. EM'CY STOP

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191113	GML	HJL	PJH	*	For approval	0

FUNCTION DESCRIPTION

6. CABLE SUPERVISION (CABLE CUTTING DETECTION)
   6-1. L.O INLET PRESS. SWITCH CABLE BREAK
   6-2. H.T WATER OUTLET TEMP. SWITCH CABLE BREAK
   6-3. EM'CY STOP BUTTON(FROM M.S.B.D) CABLE BREAK
   6-4. EM'CY STOP(ENGINE SIDE) CABLE BREAK
   6-5. EM'CY STOP SOL. VALVE CABLE BREAK
   6-6. FROM MAIN CONTROL SHUTDOWN CABLE BREAK

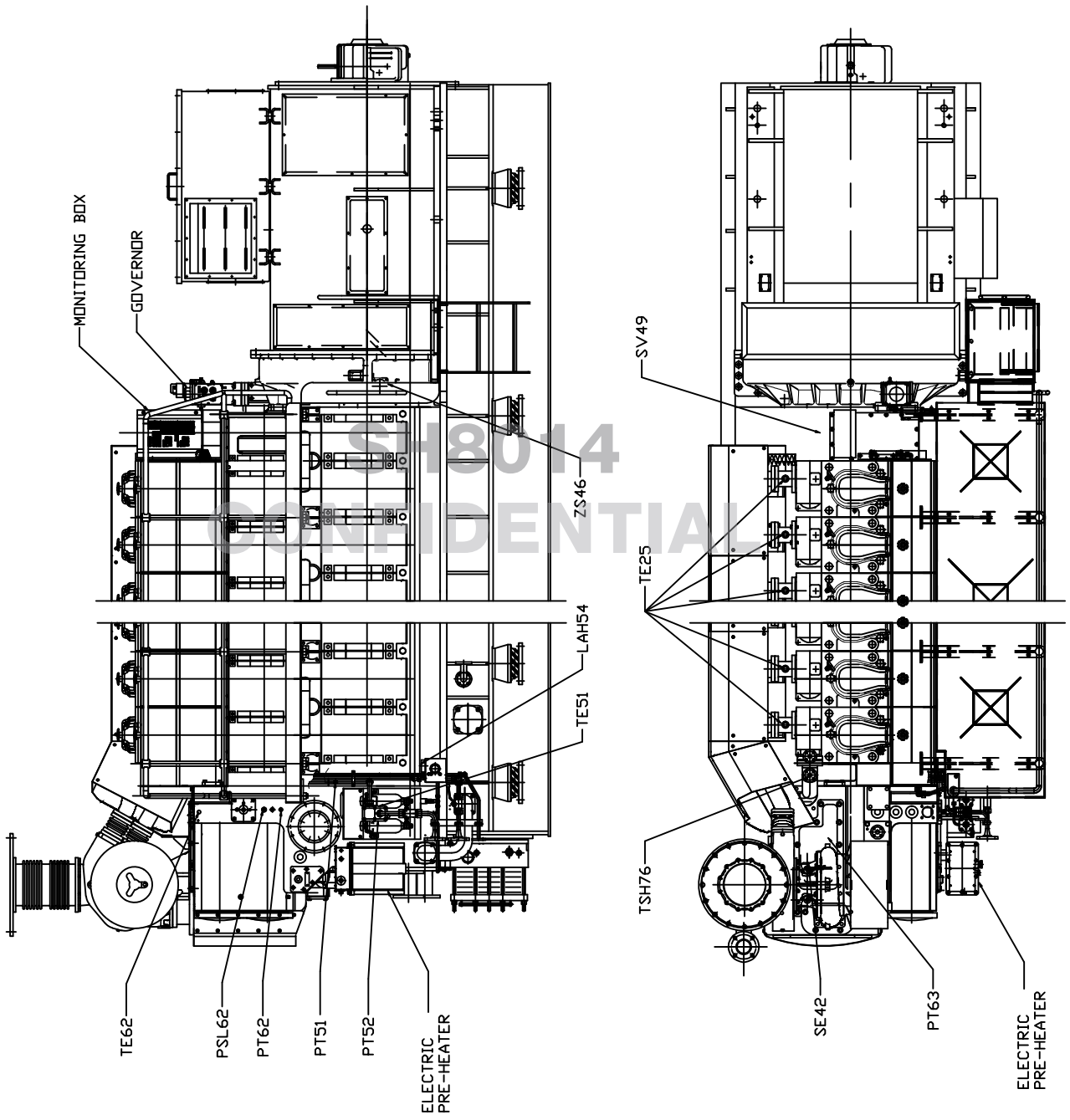
7. ALARM BLOCKING
   DURING THE ENGINE IS STANDSTILL, L.O PRESS. IS CONDITION OF LOW PRESS.
   IN THIS CASE, THE SAFETY SYSTEM IS SHUTDOWN CONDITION OF AUTOMATIC STOP.
   SO, TO PREVENT UNNECESSARY ENGINE SHUTDOWN CONDITION AT THE TIME OF ENGINE STANDSTILL, THE SAFETY SYSTEM USED THE FUNCTION OF ALARM BLOCKING.
   THE SAFETY SYSTEM IS ALSO READY TO GENERATE ALARM BLOCKING SIGNAL TO BE SENT TO ALARM SYSTEM ON THE YARD.

8. START FAIL.
   AFTER THE ENGINE WAS STARTED, IF ONE OF THE FOLLOWING CONDITIONS IS OCCURRED, THE CONTROL SYSTEM GENERATES THE START FAIL. ALARM.
   THE START FAILURE ALARM IS TURN OFF AFTER 30 SEC. OR AT THE ENGINE RUNNING STATE.
   8-1. THE ENGINE FAILS TO REACH 50 RPM WITHIN 5 SECONDS AFTER ENGINE STARTING.
   8-2. THE ENGINE FAILS TO REACH RUNNING RPM WITHIN 20 SECONDS (OR SET TIME) AFTER ENGINE STARTING.

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191113	GML	HJL	PJH	*	For approval	0

CODE	NAME	Remarks
SE42	PICK-UP FOR TURBOCHARGE RPM	
ZS46	LIMIT SWITCH FOR TURNING DEVICE	
TE62	L.O TEMP. ENGINE INLET	
TE51	F.O TEMP. ENGINE INLET	
TE25	EXHGAS TEMP. CYL.NO 1-9	
PT63	L.O PRESS. TURBOCHARGER INLET	
PT62	L.O PRESS. ENGINE INLET	
PT52	F.O PRESS. FILTER INLET	
PT51	F.O PRESS. ENGINE INLET	
LAH54	LEVEL SWITCH FOR F.O LEAKAGE TANK	
PSL62	PRESS.SWITCH FOR L.O INLET	
TSH76	TEMP. SWITCH FOR H.T WATER OUTLET	

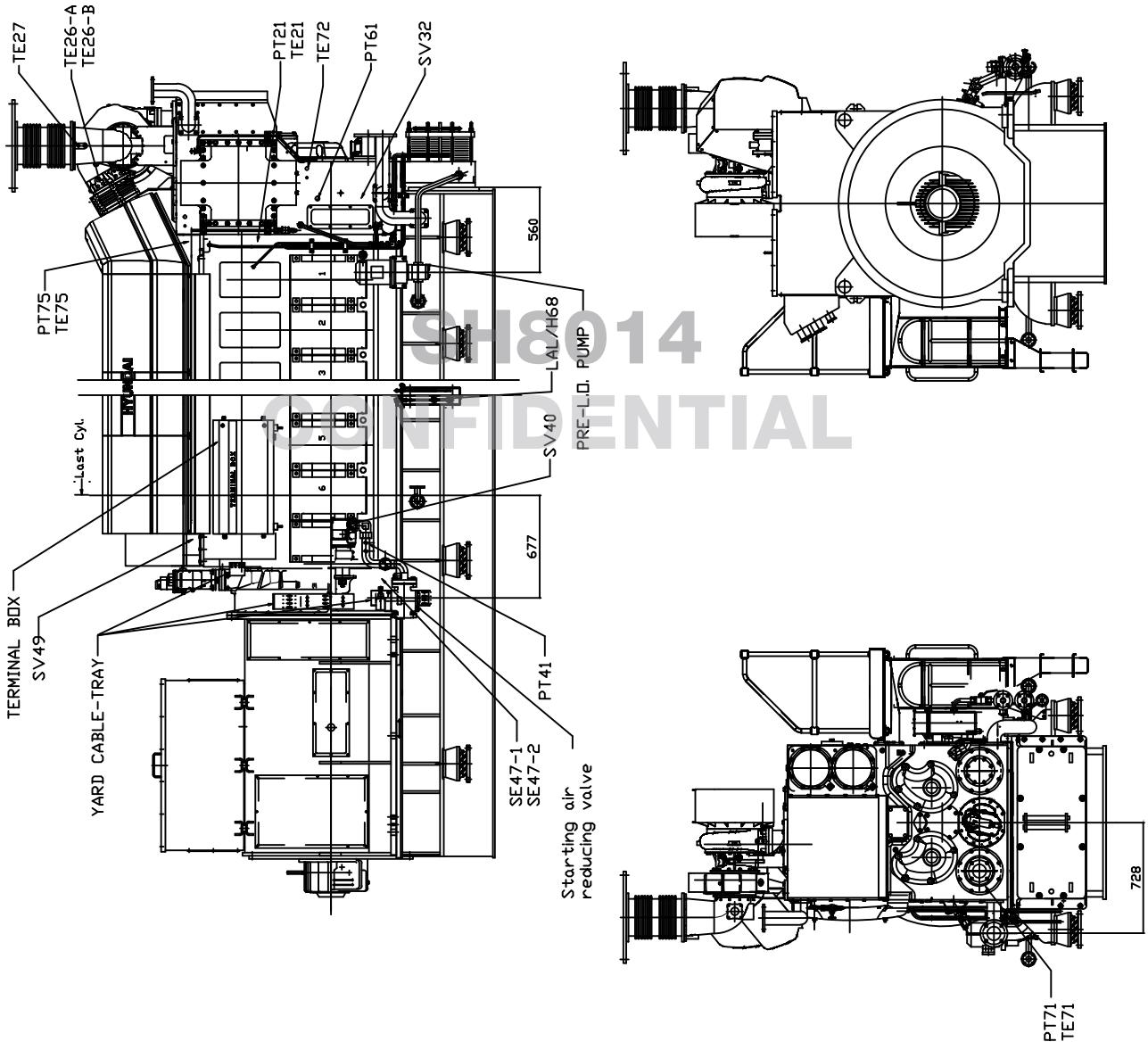


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191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: ARR. SENSOR POSITION	Ident.no.: B94-185596-5
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CODE	NAME	Remarks
SV32	JET ASSIST SYSTEM SOLENOID VALVE	
SV49	EMERGENCY STOP SOLENOID VALVE	
SV40	AIR STARTING SOLENOID VALVE	
TE76	H.T WATER TEMP. ENGINE OUTLET	
TE75	H.T WATER TEMP. ENGINE INLET	
TE72	L.T WATER TEMP. AIR COOLER OUTLET	
TE71	L.T WATER TEMP. AIR COOLER INLET	
TE27	EXHGAS TEMP. OUTLET	
TE26	EXH. GAS TEMP. INLET A,B	
TE21	CHARGE AIR TEMP. AIR COOLER OUTLET	
PT75	H.T WATER PRESS. ENGINE INLET	
PT71	L.T WATER PRESS. ENGINE INLET	
PT61	L.O PRESS. FILTER INLET	
PT41	STARTING AIR PRESS. ENG. INLET	
PT21	CHARGE AIR PRESS. ENGINE INLET	
SE47-2	SAFETY PICK-UP FOR ENGINE RPM	
SE47-1	CONTROL PICK-UP FOR ENGINE RPM	
LAL/H68	LEVEL SWITCH FOR L.O SUMP TANK	



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191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: ARR. SENSOR POSITION	Ident.no.: B94-185596-5
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1. SAFETY SENSOR FOR ENGINE SHUTDOWN

CODE	NAME	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY
PSL62	PRESS. SWITCH FOR L.O. INLET	1~10 kgf/cm²	3.0 kgf/cm²	N.O CONTACT	0 s
PT62	L.O. PRESS. ENGINE INLET	0~10 kgf/cm²	2.5 kgf/cm²	4~20mA	0 s
TSH76	TEMP. SWITCH FOR H.T WATER OUTLET	20~150 °C	95 °C	N.O CONTACT	0 s
TE76	H.T. WATER TEMP. ENGINE OUTLET	0~200 °C	100 °C	Pt100	0 s
SE47-1	CONTROL PICK-UP FOR ENGINE RPM	0~1200 RPM	1035 RPM	0~10KHz	0 s
SE47-2	SAFETY PICK-UP FOR ENGINE RPM	0~1200 RPM	1017 RPM	0~10KHz	0 s

2. SWITCH SENSOR FOR ALARM

CODE	NAME	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY
LAL/H 68	LEVEL SWITCH FOR L.O. SUMP TANK	-	-	N.C CONTACT	30 s
LAH 54	LEVEL SWITCH FOR F.O. LEAKAGE TANK	-	-	N.C CONTACT	5 s
SE42	PICK-UP FOR TURBOCHARGER RPM	0-80000 RPM	② 42350 RPM	0~3KHz	10 s

3. PRESSURE TRANSMITER FOR ALARM/INDICATION

	CODE	NAME	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY
	PT75	H.T. WATER PRESS. ENGINE INLET	0~6 kgf/cm²	0.4+STATIC kgf/cm²	4~20mA	3 s
	PT71	L.T. WATER PRESS. ENGINE INLET	0~6 kgf/cm²	0.4+STATIC kgf/cm²	4~20mA	3 s
	PT62	L.O. PRESS. ENGINE INLET	0~10 kgf/cm²	3.5 kgf/cm²	4~20mA	3 s
	(PAL65)	PRELUB. OIL LOW PRESS.	-	0.08 kgf/cm²	-	60 s
	PT61	L.O. PRESS. FILTER INLET	0~10 kgf/cm²	-	4~20mA	-
*	PDAH61-62	DIFF. PRESS. HIGH FOR L.O. FILTER	-	2 kgf/cm²	-	10 s
	PT63	L.O. PRESS. TURBOCHARGER INLET	0~6 kgf/cm²	3 kgf/cm²	4~20mA	3 s
	PT51	F.O. PRESS. ENGINE INLET	0~16 kgf/cm²	HFO:6 kgf/cm² MDO:1 kgf/cm²	4~20mA	5 s
	PT52	F.O PRESS. FILTER INLET	0~16 kgf/cm²	-	4~20mA	-
*	PDAH51-52	DIFF. PRESS. HIGH FOR F.O. FILTER	-	1.5 kgf/cm²	-	10 s
	PT21	CHARGE AIR PRESS. ENGINE INLET	0~6 kgf/cm²	INDICATION	4~20mA	-
	PT41	STARTING AIR PRESS. ENGINE INLET	0~16 kgf/cm²	5~7H : 4.5kgf/cm² 8~9h : 7.5kgf/cm²	4~20mA	10 s

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* NOTE : PDAH61-62 -> PT61-PT62 diff. press. high alarm (for MODBUS communication)
PDAH51-52 -> PT52-PT51 diff. press. high alarm (for MODBUS communication)

4. LOCAL INSTRUMENT

CODE	NAME	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY
PI75	PRESS. GUAGE FOR H.T WATER ENGINE INLET	0~6 kgf/cm²			
PI62	PRESS. GUAGE FOR L.O ENGINE INLET	0~10 kgf/cm²			
PI51	PRESS. GUAGE FOR F.O ENGINE INLET	0~16 kgf/cm²			
TI76	THERMOMETER FOR H.T WATER ENGINE OUTLET	0~120 °C			
TI62	THERMOMETER FOR L.O ENGINE INLET	0~120 °C			
TI51	THERMOMETER FOR F.O ENGINE INLET	0~120 °C			

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200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
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191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: SENSOR LIST 1	Ident.no.: B94-185596-5
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5. TEMPERATURE SENSOR FOR ALARM/INDICATION

CODE	NAME	MEASURING RANGE	SET POINT	SIGNAL TYPE	TIME DELAY
TE27	EXH. GAS TEMP. OUTLET	0~800 °C	450 °C	THERMOCOUPLE	3 s
TE26-A	EXH. GAS TEMP. INLET A	0~800 °C	620 °C	THERMOCOUPLE	10 s
TE26-B	EXH. GAS TEMP. INLET B	0~800 °C	620 °C	THERMOCOUPLE	10 s
② TE26-C	EXH. GAS TEMP. INLET C	0~800 °C	620 °C	THERMOCOUPLE	10 s
TE25-1	EXH. GAS TEMP. CYL. NO.1	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-2	EXH. GAS TEMP. CYL. NO.2	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-3	EXH. GAS TEMP. CYL. NO.3	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-4	EXH. GAS TEMP. CYL. NO.4	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-5	EXH. GAS TEMP. CYL. NO.5	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-6	EXH. GAS TEMP. CYL. NO.6	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-7	EXH. GAS TEMP. CYL. NO.7	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-8	EXH. GAS TEMP. CYL. NO.8	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE25-9	EXH. GAS TEMP. CYL. NO.9	0~800 °C	580 °C	THERMOCOUPLE	60 s
TE75	H.T. WATER TEMP. ENGINE INLET	0~200 °C	INDICATION	Pt100	-
TE76	H.T. WATER TEMP. ENGINE OUTLET	0~200 °C	90 °C	Pt100	3 s
TE71	L.T. WATER TEMP. AIR COOLER INLET	0~200 °C	45 °C	Pt100	3 s
TE72	L.T. WATER TEMP. AIR COOLER OUTLET	0~200 °C	INDICATION	Pt100	-
TE62	L.O. TEMP. ENGINE INLET	0~200 °C	80 °C	Pt100	3 s
TE51	F.O. TEMP. ENGINE INLET	0~200 °C	HFO : 150 °C	Pt100	3 s
TE21	CHARGE AIR TEMP. AIR COOLER OUTLET	0~200 °C	INDICATION	Pt100	-

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* TE25 TEMPERATURE DEVIATION IS MONITORED AFTER ENGINE RUN +300SEC TIME DELAY. SET VALUE OF ALARM IS AVE ± 70 WITH 60SEC. TIME DELAY.

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6. ELECTIC EQUIPMENT

CODE	NAME	INPUT VOLTAGE	CURRENT	POWER CONSUMPTION
SV40	AIR STARTING SOLENOID VALVE	24VDC	-	6W
SV49	EMERGENCY STOP SOLENOID VALVE	24VDC	-	9W
ZS46	LIMIT SWITCH FOR TURNING BAR	24VDC	0.4 A	-
GOV	UG25+P3 WOODWARD GOV.	24VDC	-	MAX. 32W
SV32	JET ASSIST SYSTEM SOLENOID VALVE	24VDC	-	9W
	POWER FOR MONITORING BOX	24VDC	-	21.6W
	COMMUNICATION WITH MONITORING BOX	-	-	-

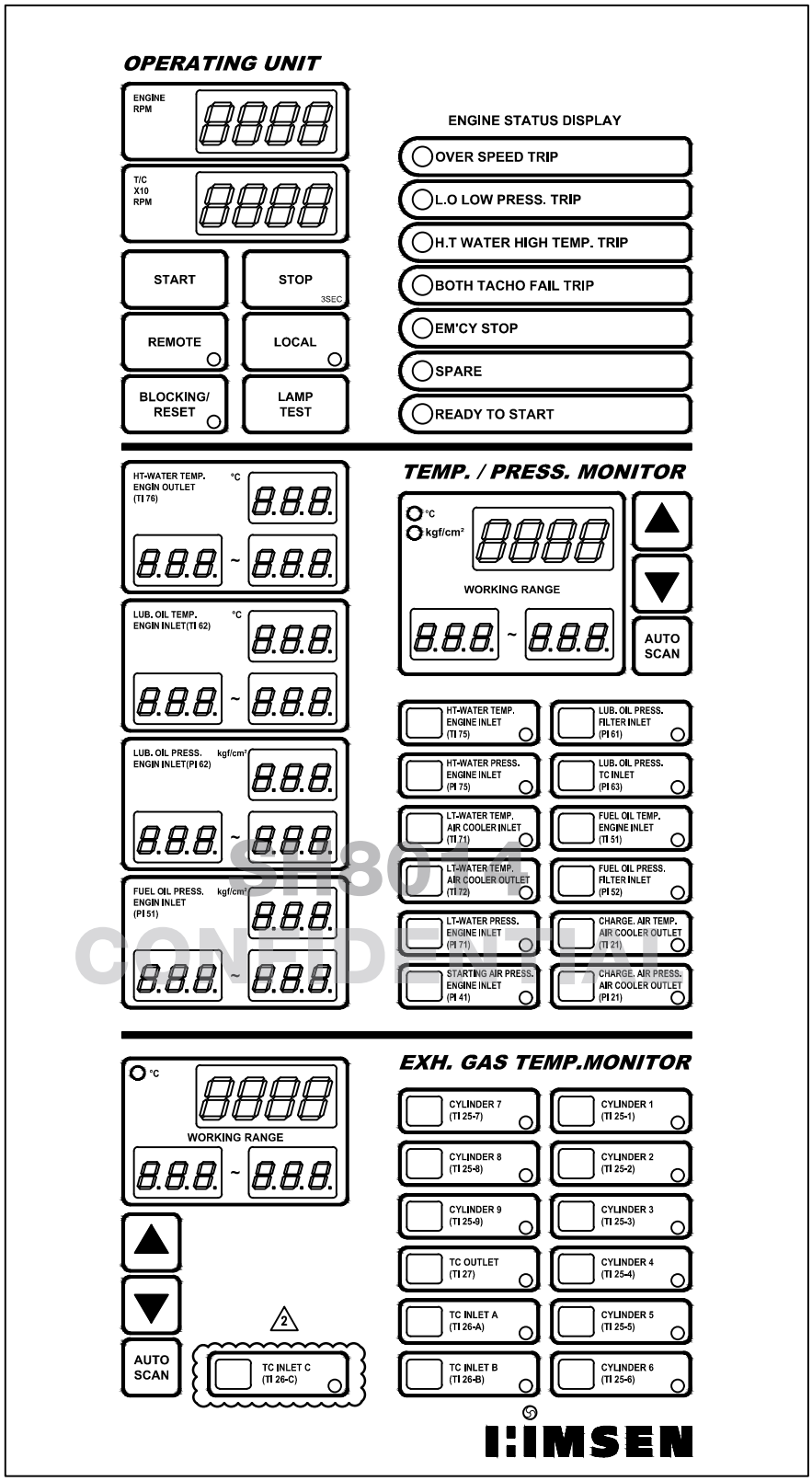
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191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: SENSOR LIST 2	Ident.no.: B94-185596-5
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Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: SYSTEM CONFIGURATION	Ident.no.: B94-185596-5
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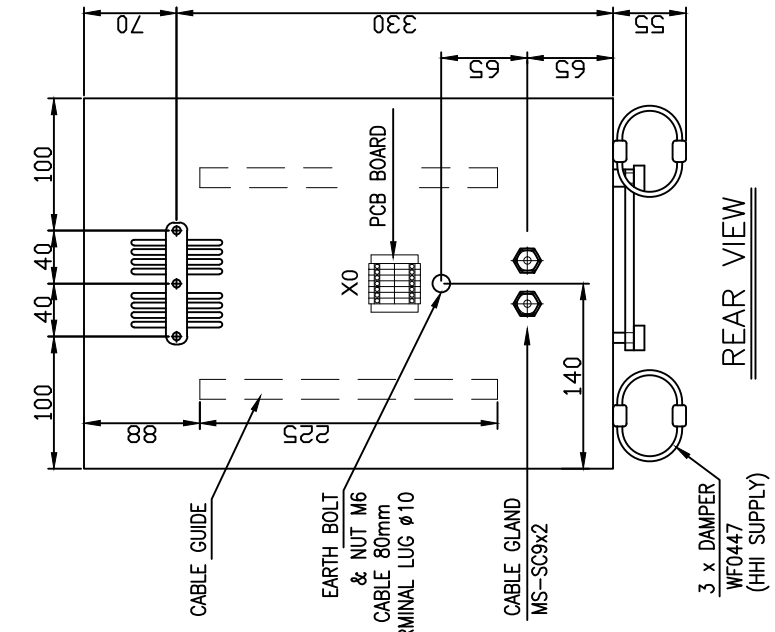
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* NOTE

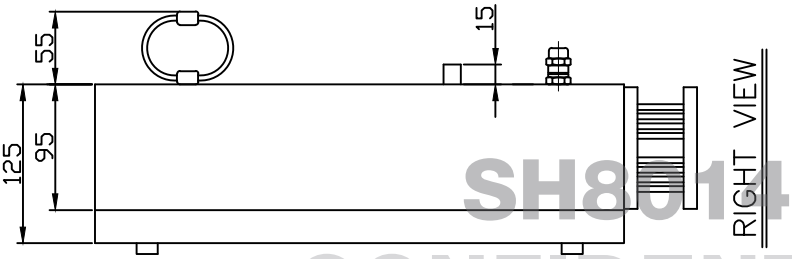
1. MATERIAL : MAKER STANDARD
2. LETTER & SYMBOL COLOR : MAKER STANDARD

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

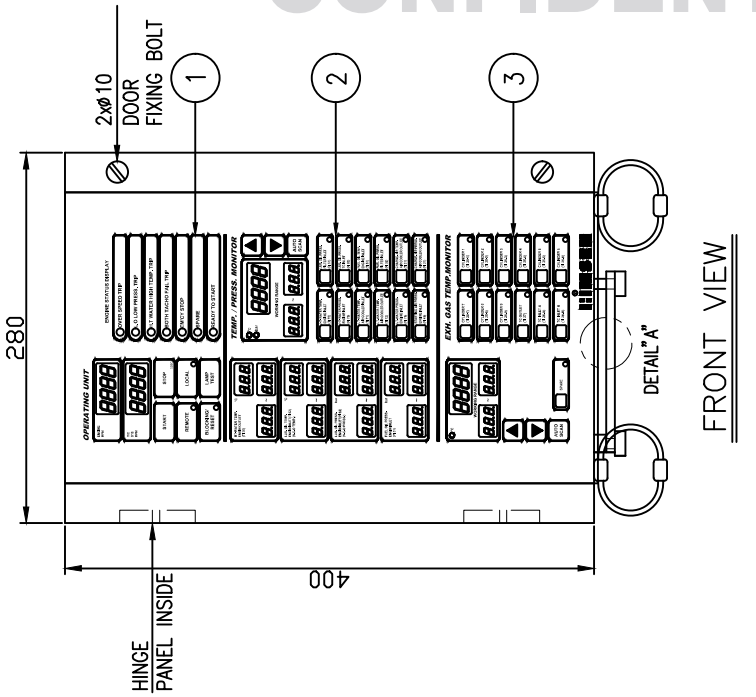
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: MONITORING BOX SCREEN PLATE	Ident.no.: B94-185596-5
Page.no.: 10 OF 32		



REAR VIEW



RIGHT VIEW

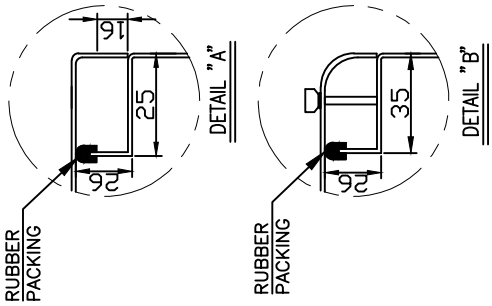


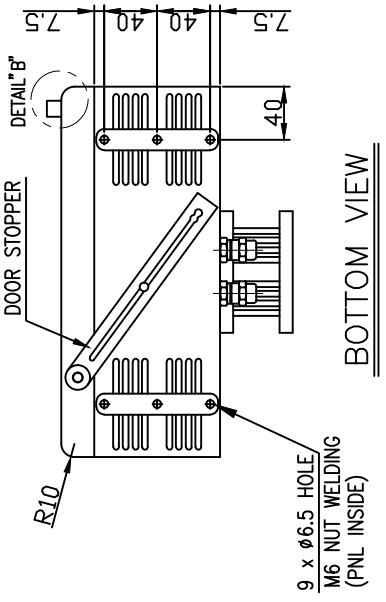
FRONT VIEW

①	OPERATING UNIT (REMARK : YECS-1000D)
②	TEMP./PRESS. MONITORING UNIT (REMARK : YECS-1000T)
③	EXH. GAS TEMP. MONITORING UNIT (REMARK : YECS-1000E)

NOTE

1. ENCLOSURE PROTECTION : IP44
2. MATERIAL : SPHC, 2.3t
3. PAINT COLOR : RAL 7032
4. MS-SC CABLE GLAND NUT : SM-PE TYPE
5. WEIGHT : About 11kg
6. PCB BOARD: FOR POWER & SIGNAL



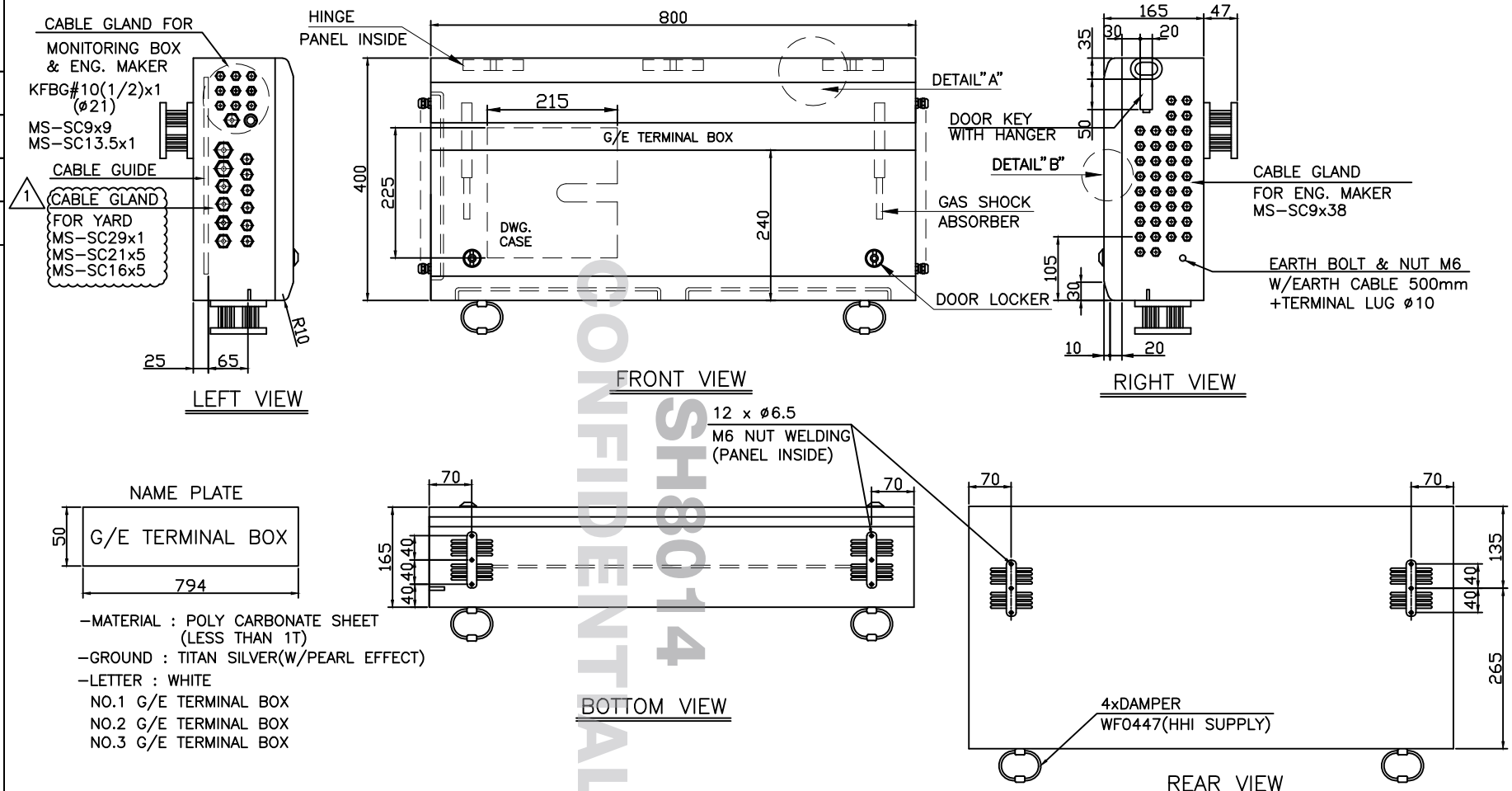


BOTTOM VIEW

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

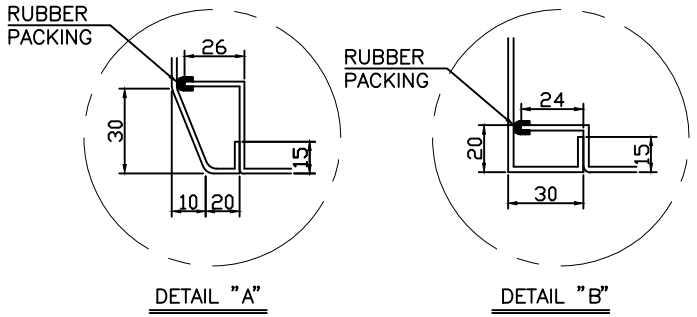
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: MONITORING BOX OUTLINE VIEW	Ident.no.: B94-185596-5
Page.no.: 11 OF 32		



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NOTE

1. ENCLOSURE PROTECTION : IP44
2. MATERIAL : SPHC, 3.2t(BOTTOM PLATE) others 2.3t
1. 3. PAINT COLOR : RAL 7032
4. A CONNECTION DIAGRAM SHALL BE PROVIDED IN A VINYL CASE.
5. CABLE GLAND FOR ENG. MAKER : MS-SC9x38
6. CABLE GLAND MONITORING BOX & ENG. MAKER : MS-SC9x10, MS-SC13.5x1
1. 7. CABLE GLAND FOR YARD : MS-SC29x1, MS-SC21x5, MS-SC16x5
8. MS-SC CABLE GLAND NUT : SM-PE TYPE
9. WEIGHT : about. 37kg
10. DRAWING CASE : 215x225x15



R.	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2	200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)
1	200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)
0	191113	GML	HJL	PJH	*	For approval

Licenser Ident.no.:

Type: 9H21/32

Description: TERMINAL BOX OUTLINE VIEW

Ident.no.: B94-185596-5

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Info.no.:

Page.no.: 12 OF 32

①	U2	Safety Control & Cable Supervision Unit(Symbol : U2, Remarks : YECS-1000S)
②	U3	Main Control Unit (Symbol : U3, Remarks : YECS-1000M)
③	U1	Analog / Communication Unit (Symbol : U1, Remarks : YECS-1000A)
④	P4	Safety Interface Board (Symbol : P4, Remarks : YECS-1000SIF)
⑤	P1	Main Interface Board (Symbol : P1, Remarks : YECS-1000MIF)
⑥	4F1,2	Main Circuit Breaker (M.C.B)
⑦	TERMINAL BLOCK X1~X4 (WDK2.5N : BEIGE 47EA) (WEIDMULLER)	
⑧	TERMINAL BLOCK X5 (RKD2.5 RD : 1EA, RKD2.5 YE : 1EA, RKD2.5 BG : 3EA) (CONTA-CLIP)	
⑨	TERMINAL BLOCK ; X1 (ZSI 2.5 ; 1EA) (WEIDMULLER) FUSE : X1 (G20/0.5A/F : 1EA) (WEIDMULLER)	

SP-8018
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: TERMINAL BOX INNER VIEW	Ident.no.: B94-185596-5
Page.no.: 13 OF 32		

Info.no.:

License Ident.no.:

Type: 9H21/32

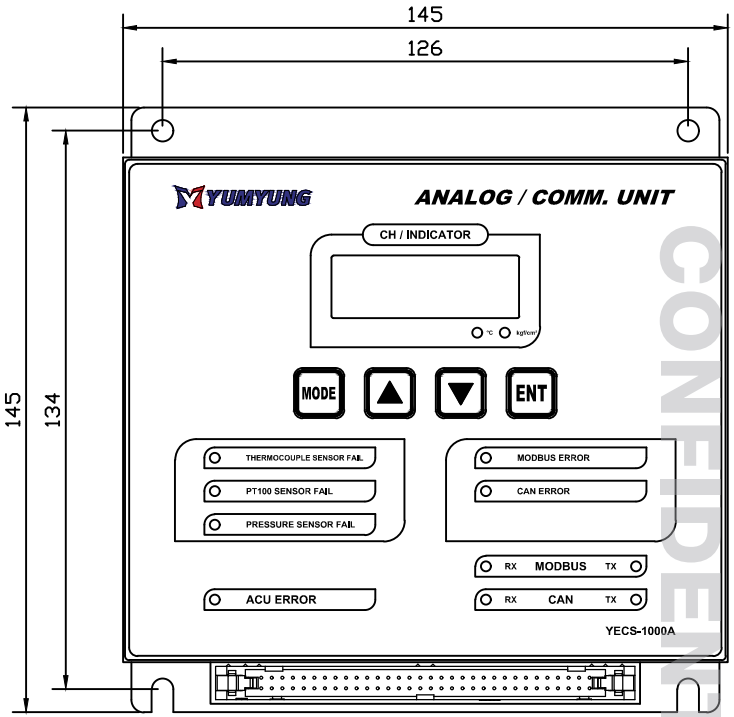
Description: "U1" ANALOG/COMMUNICATION UNIT

Ident.no.: B94-185596-5

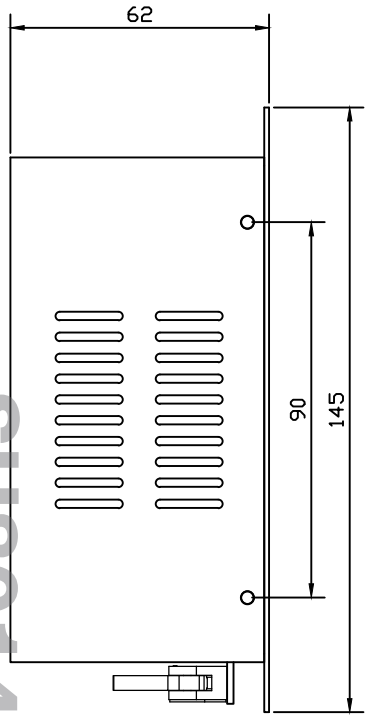
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

R	Replace by Ident.no.:	A.C	Appd.	Chk.	Des.	Date
5						
4						
3						
2	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	*	*	PJH	GML	200319
1	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	*	*	PJH	HJL	GML	200218
0	For approval	*	*	PJH	HJL	GML	191113

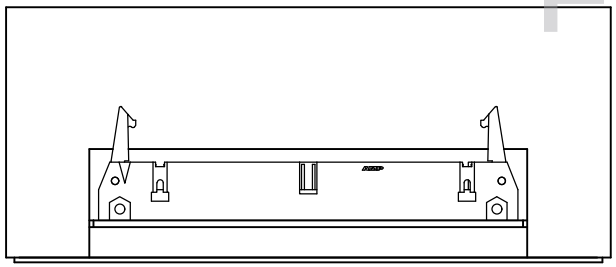
CONFIDENTIAL SH8014



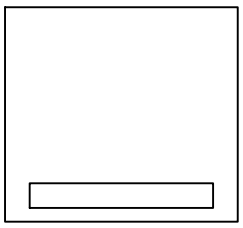
<FRONT VIEW>



<SIDE VIEW>



<BOTTOM VIEW>



ANALOG INPUT
from MAIN INTERFACE BOARD(YECS-100MIF)

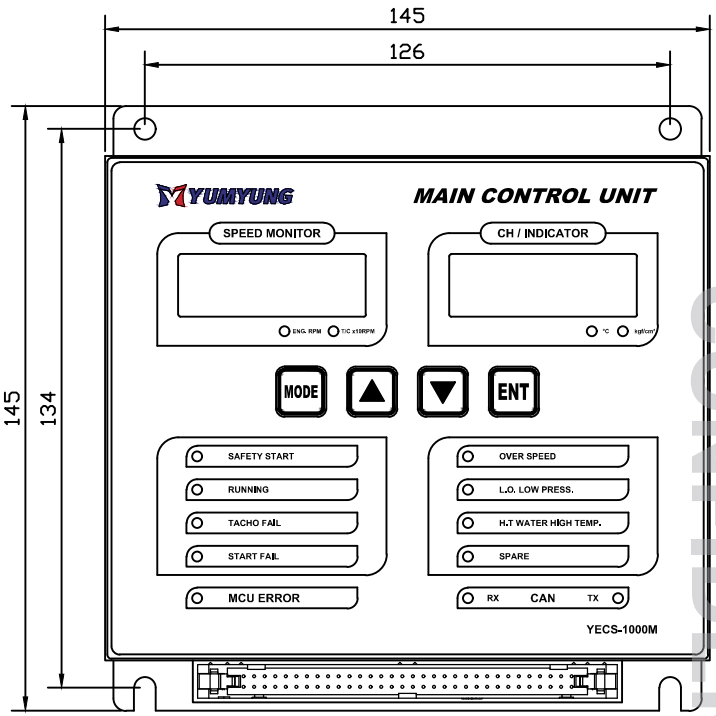
<WIRING DIAGRAM>

GENERAL SPEC.

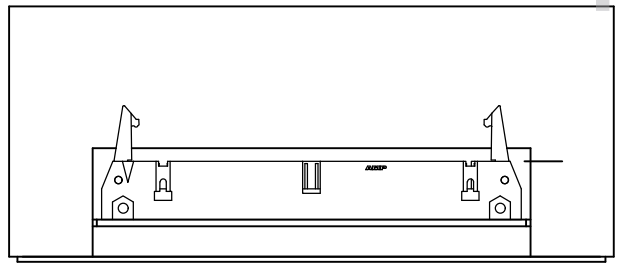
1. MODEL : ANALOG/COMMUNICATION UNIT(YECS-1000A)
2. INPUT
   - T/C : 13EA 2WIRE ANALOG INPUTS
     RANGE : 0~800°C
   - 4~20mA : 10EA 2WIRE ANALOG INPUTS
     INPUT IMPEDANCE : 100?
     POWER FOR TRANSMITTER : DC24V
   - TEMP.(PT100) : 8EA 2WIRE ANALOG INPUTS
     RANGE : 0~200°C
3. COMMUNICATION
   - CAN-BUS FOR EXTERNAL COMMUNICATION WITH YECS-1000M, MONITORING BOX
   - MODBUS(RS485/422) FOR EXTERNAL COMMUNICATION WITH A.M.S
4. DISPLAY
   - 6 DIGITS, 7SEGMENT FND 1EA
   - STATUS LED 12EA
5. ACCURACY : F.S± 0.2%
6. OPERATING TEMP. : 0~+60°C
7. POWER SUPPLY : ABOUT 16.8W
   (MAX.:700mA, DC24V)

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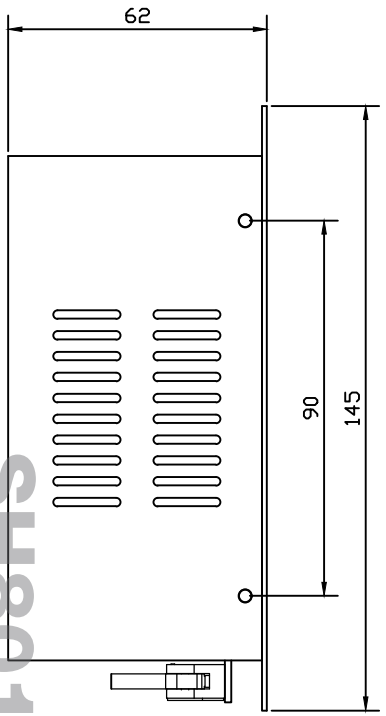
SH8014



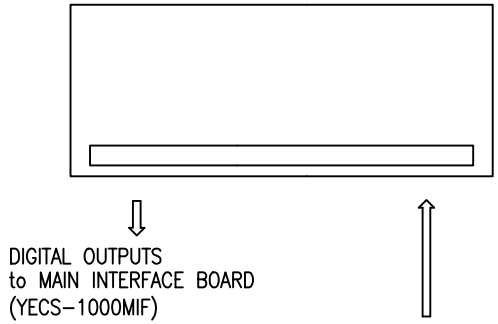
<FRONT VIEW>



<BOTTOM VIEW>



<SIDE VIEW>



<WIRING DIAGRAM>

GENERAL SPEC.

1. MODEL : MAIN CONTROL UNIT(YECS-1000M)
2. INPUT : BINARY 20EA
   - ENG. : SQUARE AND SINE WAVE, 0~1200 /0~10kHz (POWER: +15V)
   - T/C : SQUARE AND SINE WAVE, 0~80000 / 0~3kHz (POWER: +15V)
3. OUTPUT
   - DRY CONTACT : 12EA PHOTO COUPLER, MAX. 20mA
4. COMMUNICATION
   - CAN-BUS FOR INTERNAL COMMUNICATION WITH THE YECS-1000A, MONITORING BOX
5. DISPLAY
   - 6 DIGITS, 7SEGMENT FND 2EA
   - STATUS LED 15EA
6. ACCURACY : F.S±0.2%
7. POWER SUPPLY : ABOUT 14W (MAX.:1000mA, DC24V)

R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2	200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)
1	200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)
0	191113	GML	HJL	PJH	*	For approval

License Ident.no.:

Info.no.:

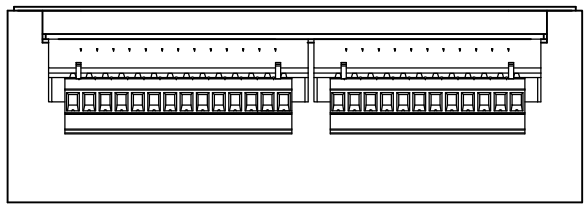
Page.no.: 15 OF 32

Type: 9H21/32

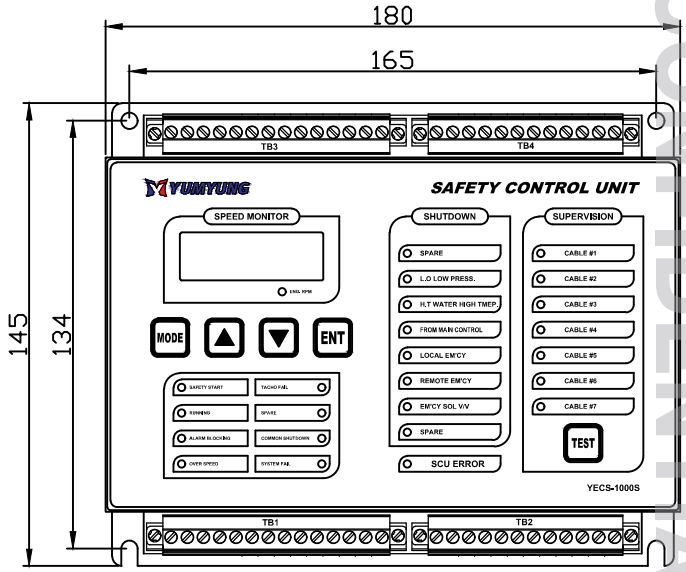
Description: "U3" MAIN CONTROL UNIT

Ident.no.: B94-185596-5

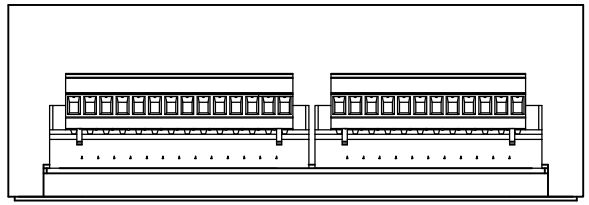
HYUNDAI HEAVY INDUSTRIES CO.,LTD.



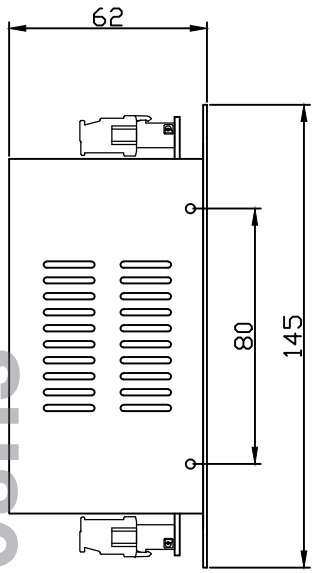
<TOP VIEW>



<FRONT VIEW>



<BOTTOM VIEW>



<SIDE VIEW>

GENERAL SPEC.

1. MODEL : SAFETY CONTROL & CABLE SUPERVISION UNIT (YECS-1000S)
2. INPUT
   - ENG. : SQUARE AND SINE WAVE, 0~1600 /0~10kHz (POWER: +12V)
   - RELAY INPUT 19EA (DIGITAL INPUT 12EA, DIGITAL INPUT WITH CABLE SUPERVISION 7EA)
3. OUTPUT
   - DRY CONTACT : RELAY OUTPUT 10EA
4. DISPLAY
   - 6 DIGITS, 7SEGMENT FND 1EA
   - STATUS LED 25EA
5. ACCURACY : F.S±0.2%
6. POWER SUPPLY : ABOUT 10W (MAX. : 1000mA, DC24V)

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R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2	200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)
1	200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)
0	191113	GML	HJL	PJH	*	For approval

Licenser Ident.no.:

Type: 9H21/32

Info.no.:

Page.no.: 16 OF 32

Description: "U2" SAFETY CONTROL & CABLE SUPERVISION UNIT

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Ident.no.: B94-185596-5

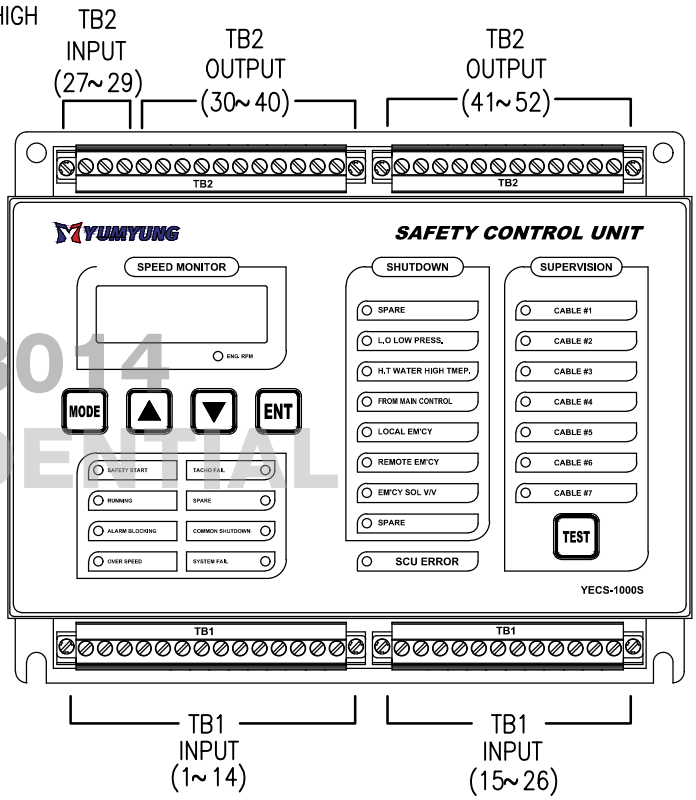
TB2

– OUTPUT –

30 : SAFETY OVERSPEED
31 : SAFETY L.O LOW PRESS.
32 : SAFETY H.T WATER HIGH TEMP.
33 : EM'CY STOP
34 : SPARE
35 : COMMON 1
(USE TO AGREE POWER SUPPLY LEVEL OF YECS-1000M AND YECS-1000MIF.)
36 : SAFETY CABLE FAILURE
37 : POWER & SYSTEM FAILURE
38 : LOCAL SHUTDOWN
39 : SAFETY START
40 : SAFETY TACHO FAILURE
41 : COMMON 2
(USE TO AGREE POWER SUPPLY LEVEL OF YECS-1000M AND YECS-1000MIF.)
42 : EM'CY STOP VALVE
43 : SPARE
44 : COMMON SHUTDOWN
45 : ABOVE RATED RPM25%+1SEC(ON) OR L.O PRESS. HIGH
BELOW RATED RPM23%(OFF)
46 : ENGINE RUNNING
47 : ALARM BLOCKING
48 : ENG. RUNNING
49 : START/STOP PRELUB OIL PUMP
50 : START/STOP J.W. RPEHEATER
51 : ENG. RUNNING
52 : COMMON 3
(USE FOR POWER SUPPLY TO RELAY →DC24V)

– INPUT –

27.29 : POWER SUPPLY (SAFETY SYSTEM)
28 : GND



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TB1

– INPUT –

01~03 : ENGINE RPM SAFETY PICK-UP 286 imp/rev
04 : GND
05,18 : LUB.OIL INLET LOW PRESS. SHUTDOWN
06,19 : H.T. WATER OUTLET HIGH TEMP. SHUTDOWN
12,25,29 : 0V COMMON
13 : SPARE
15 : TERMINAL BOARD RESET SHUTDOWN
(FROM CONTROL SYS.)
17 : SAFETY UNIT OVERSPEED TEST/TEST MODE
20 : EM'CY STOP (FROM MSBD)
21 : MAIN SHUTDOWN (FROM CONTROL SYS.)
22 : SPARE
23 : EM'CY STOP (PRELUB OIL PUMP STARTER)
24 : CABLE SUPERVISION FOR EM'CY STOP SOL. V/V
(FROM P4 RELAY OUTPUT UNIT)
26 : GND
27,29 : DC SOURCE

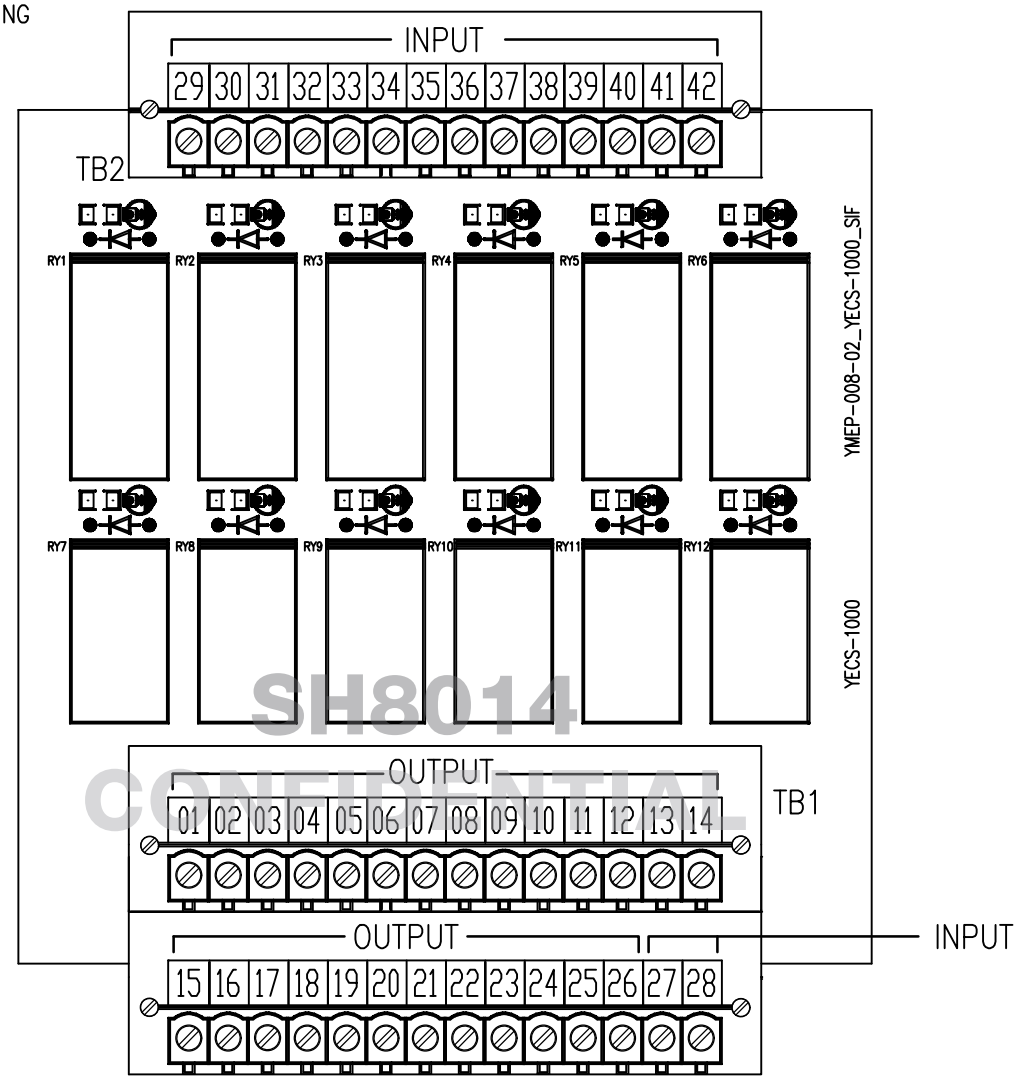
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: "U2" YECS-1000S INFORMATION	Ident.no.: B94-185596-5
Page.no.: 17 OF 32		

TB2

– INPUT –

31 : EM'CY STOP SOL. VALVE
32 : SPARE
33 : COMMON SHUTDOWN
34 : ABOVE RATED RPM 25%+1sec
BELOW RATED RPM 23%
35 : ENGINE RUNNING
36 : ALARM BLOCKING
37 : ENG.RUNNING
38 : START/STOP PRELUB.OIL PUMP
39 : START/STOP J.W. RPEHEATER
41,42 : COMMON3 (USE FOR POWER SUPPLY TO RELAY ⟶ DC24V)



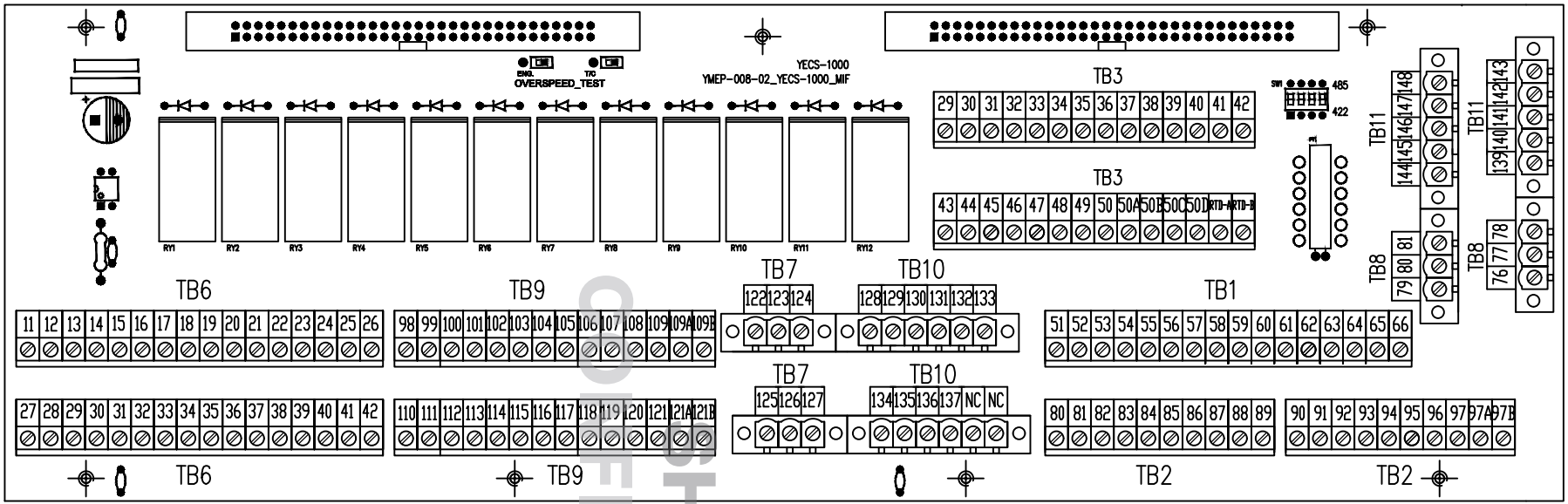
SH8014
CONFIDENTIAL

TB1

– OUTPUT –

01,02 : EM'CY STOP SOL. V/V
03,04 : SPARE
05,06 : SHUTDOWN (TO M.S.B.D)
07,08 : ABOVE RATED RPM25%+1SEC(ON) OR L.O PRESS. HIGH
BELOW RATED RPM23%(OFF)
09,10 : ENG.RUNNING (TO M.S.B.D)
13,14 : ALARM BLCOCKING(TO A.M.S)
15,16 : ENG.RUNNING
17,18 : START/STOP PRELUB. OIL PUMP
(TO RPELUB.OIL PUMP STARTER)
19,20 : START/STOP J.W PREHEATER
(TO J.W PREHEATER STARTER)
25,26 : GND (PCB INSIDE)

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0



TB1

–INPUT–

51,52 : H.T – WATER TEMP. ENGINE INLET TRANSMITTER (PT100)
53,54 : H.T – WATER TEMP. ENGINE OUTLET TRANSMITTER (PT100)
55,56 : L.T– WATER TMEP. AIR COOLER INLET TRANSMITTER (PT100)
57,58 : L.T– WATER TMEP. AIR COOLER OUTLET TRANSMITTER (PT100)
59,60 : LUB.OIL TEMP. ENGINE INLET TRANSMITTER (PT100)
61,62 : FUEL OIL TEMP. ENGINE INLET TRANSMITTER (PT100)
63,64 : CHARGE AIR TEMP. AIR COOLER OUTLET TRANSMITTER (PT100)
65,66 : SPARE(91?)

TB2

–INPUT–

80,81 : H.T WATER PRESS. ENGINE INLET TRANSMITTER (4~20mA)
82,83 : L.T WATER PRESS. ENGINE INLET TRANSMITTER (4~20mA)
84,85 : LUB. OIL PRESS. ENGINE INLET TRANSMITTER (4~20mA)
86,87 : LUB. OIL PRESS. FILTER INLET TRANSMITTER (4~20mA)
88,89 : LUB. OIL PRESS. T/C INLET TRANSMITTER (4~20mA)
90,91 : FUEL OIL PRESS. ENGINE INLET TRANSMITTER (4~20mA)
92,93 : FUEL OIL PRESS. FILTER INLET TRANSMITTER (4~20mA)
94,95 : CHARGE AIR RPESS. AIR COOLER OUTLET TRANSMITTER (4~20mA)
96,97 : START AIR PRESS. ENGINE INLET TRANSMITTER (4~20mA)
97A,97B : SPARE(6.4k?)

TB8

–MODBUS COMMUNICATION (RS485)–

79,80,81 : IF RS485 CONNECTION TO ALARM SYSTEM
76,77,78 : IF RS485 CONNECTION TO ALARM SYSTEM

TB3

–INPUT–

29,30 : EXH. GAS TEMP. CYL. 1 (THERMOCOUPLE NiAl–NiCr)
31,32 : EXH. GAS TEMP. CYL. 2 (THERMOCOUPLE NiAl–NiCr)
33,34 : EXH. GAS TEMP. CYL. 3 (THERMOCOUPLE NiAl–NiCr)
35,36 : EXH. GAS TEMP. CYL. 4 (THERMOCOUPLE NiAl–NiCr)
37,38 : EXH. GAS TEMP. CYL. 5 (THERMOCOUPLE NiAl–NiCr)
39,40 : EXH. GAS TEMP. CYL. 6 (THERMOCOUPLE NiAl–NiCr)
41,42 : EXH. GAS TEMP. CYL. 7 (THERMOCOUPLE NiAl–NiCr)

TB3

–INPUT–

43,44 : EXH. GAS TEMP. CYL. 8 (THERMOCOUPLE NiAl–NiCr)
45,46 : EXH. GAS TEMP. CYL. 9 (THERMOCOUPLE NiAl–NiCr)
47,48 : EXH. GAS TEMP. INLET A T/C (THERMOCOUPLE NiAl–NiCr)
49,50 : EXH. GAS TEMP. INLET B T/C (THERMOCOUPLE NiAl–NiCr)
50A,50B : EXH. GAS TEMP. INLET C T/C (THERMOCOUPLE NiAl–NiCr)
50C,50D : EXH. GAS TEMP. OUTLET T/C (THERMOCOUPLE NiAl–NiCr)
RTD–A,RTD–B : EXH. GAS TEMP. COMPENSATION SENSOR

TB7

–INPUT–

122,123 : T/C RPM PICK–UP FOR INDICATION 2 imp/rev.
125,126,127 : ENGINE RPM CONTROL PICK–UP 286 imp/rev

TB11

–MODBUS COMMUNICATION (RS422)–

144,145,146,147,148 : IF RS422 CONNETION TO ALARM SYSTEM
139,140,141,142,143 : IF RS422 CONNETION TO ALARM SYSTEM

TB6

–INPUT–

27 : SAFETY OVERSPEED
28 : SAFETY L.O LOW PRESS.
29 : SAFETY H.T WATER HIGH TEMP.
30 : EM'CY STOP
31 : SPARE
32 : COMMON1 (USE TO AGREE POWER SUPPLY LEVEL OF YECS–1000M AND YECS–1000MIF.)
33 : SAFETY CABLE FAILURE
34 : POWER & SYSTEM FAILURE
35 : LOCAL SHUTDOWN
36 : SAFETY START
37 : SAFETY TACHO FAILURE
38 : COMMOM2 (USE TO AGREE POWER SUPPLY LEVEL OF YECS–1000M AND YECS–1000MIF.)
39,40 : SPARE
41,42 : TURNING BAR START INTERLOCK

TB9

–OUTPUT–

98,99 : START SOL V/V
102,103 : GOV. STOP SIG.
106,107 : START FAIL (TO M.S.B.D)
108,109 : ENG. STOPPING (TO M.S.B.D)
111 : JET SYSTEM SOL V/V
114,115 : REMOTE (TO M.S.B.D)
116,117 : ENG. STOP SIG. (TO M.S.B.D)
118,119 : CONTROL SOURCE FAIL (TO A.M.S)
120,121 : READY TO START (TO M.S.B.D)

TB10

–MONITOR BOX COMMUNICATION(CAN)–

128 : MONITORING BOX(CAN H)
129 : MONITORING BOX(CAN L)
134 : MONITORING BOX(SH)

–INPUT–

135 : POWER SUPPLY(0V)
136 : GND
137 : POWER SUPPLY(DC24V)

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R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2	200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)
1	200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)
0	191113	GML	HJL	PJH	*	For approval

Page.no.: 19 OF 32

Info.no.:

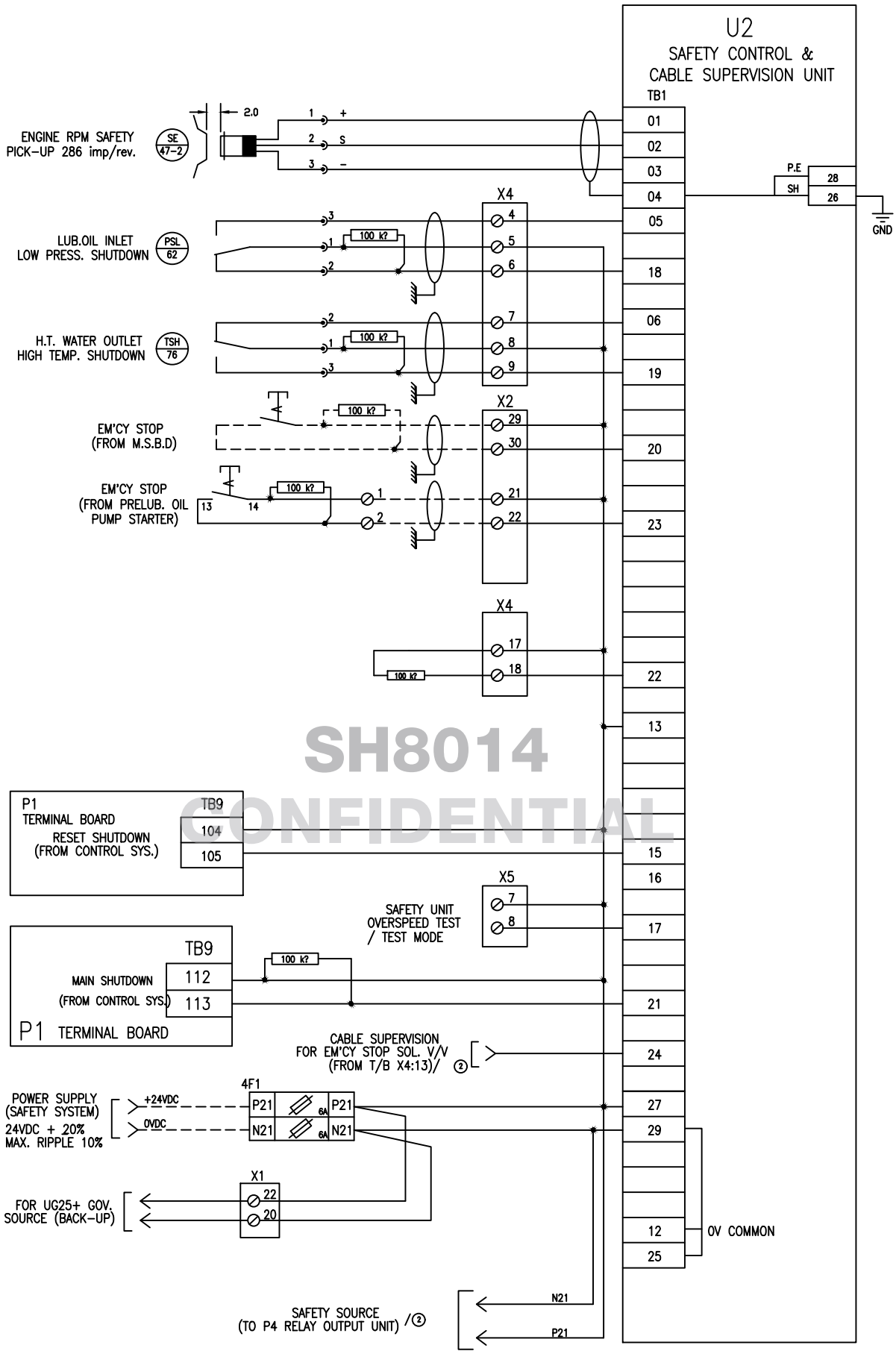
License Ident.no.:

Type: 9H21/32

Description: "P1" MAIN INTERFACE BOARD INFORMATION

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

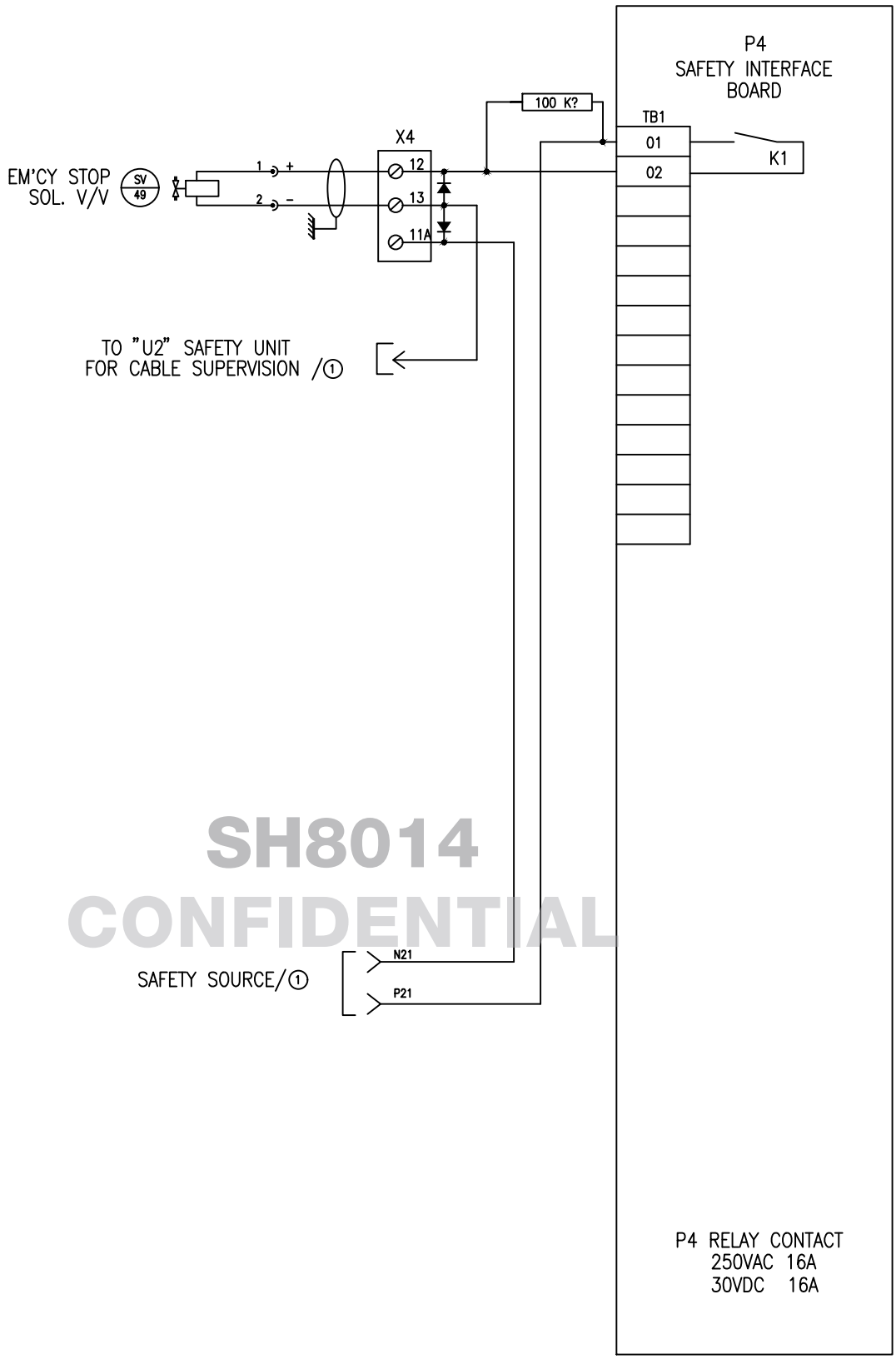
Ident.no.: B94-185596-5



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
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						4
						3
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200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 20 OF 32		

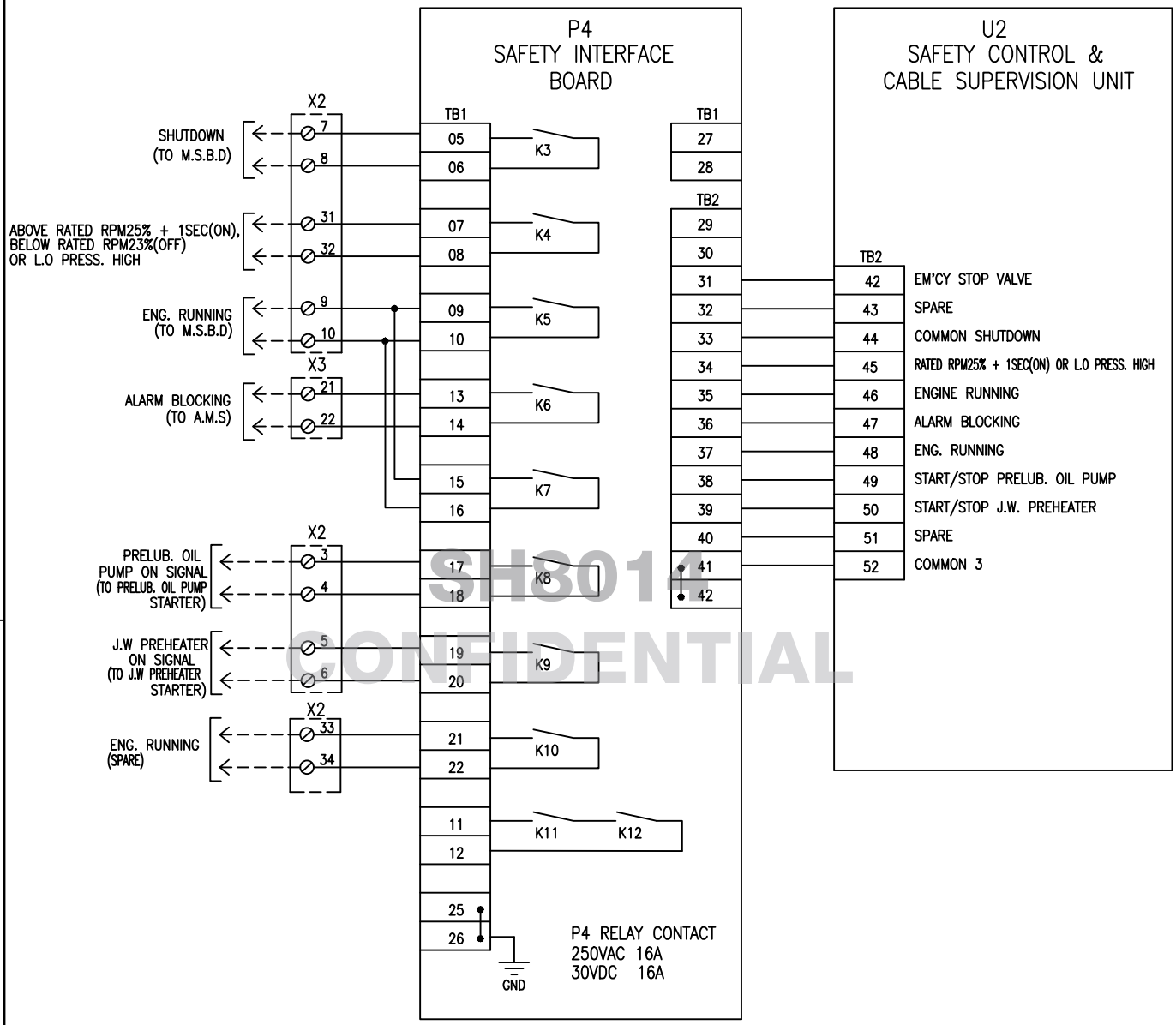


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2

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 21 OF 32		

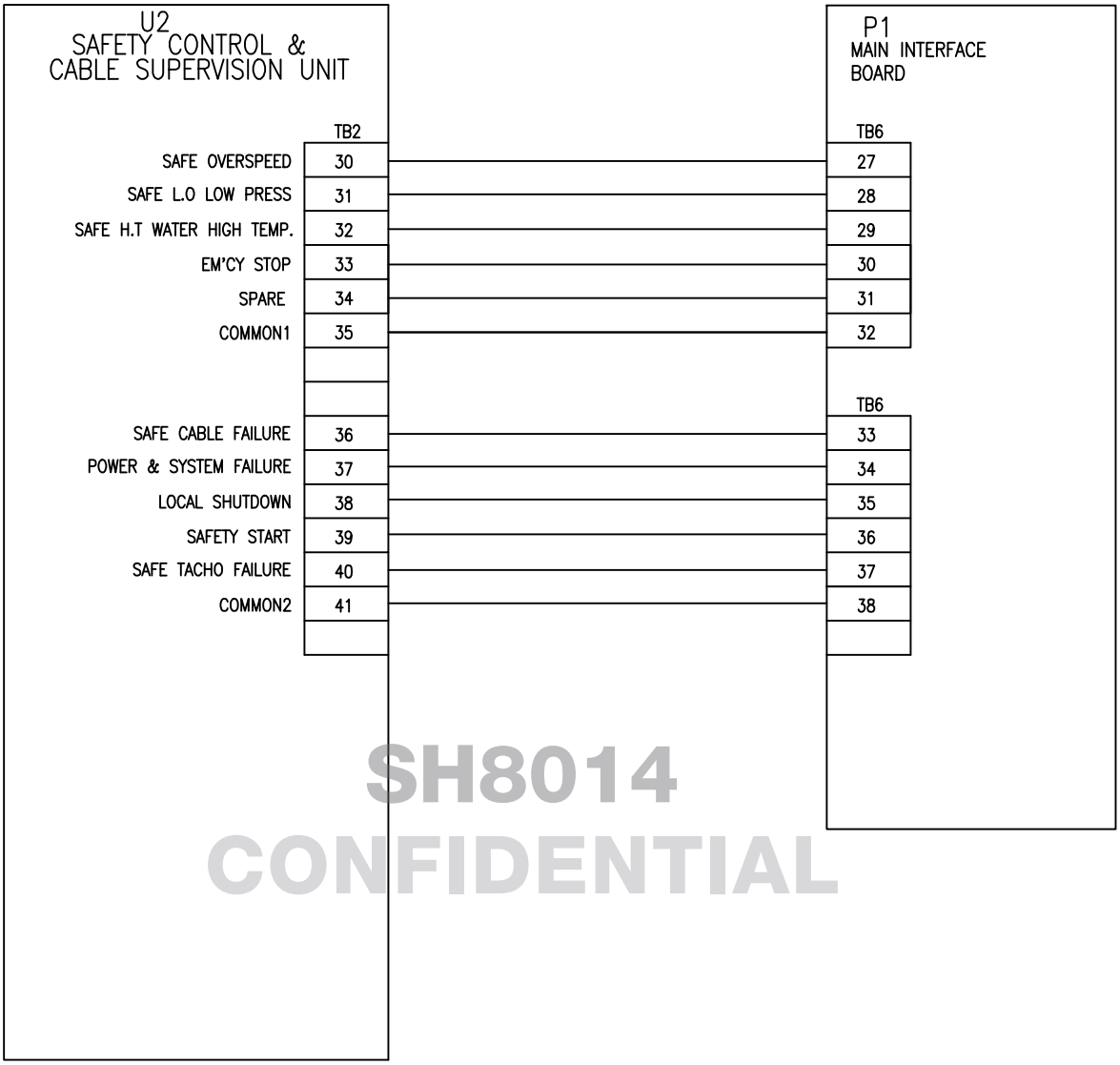


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3

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
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						4
						3
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200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 22 OF 32		

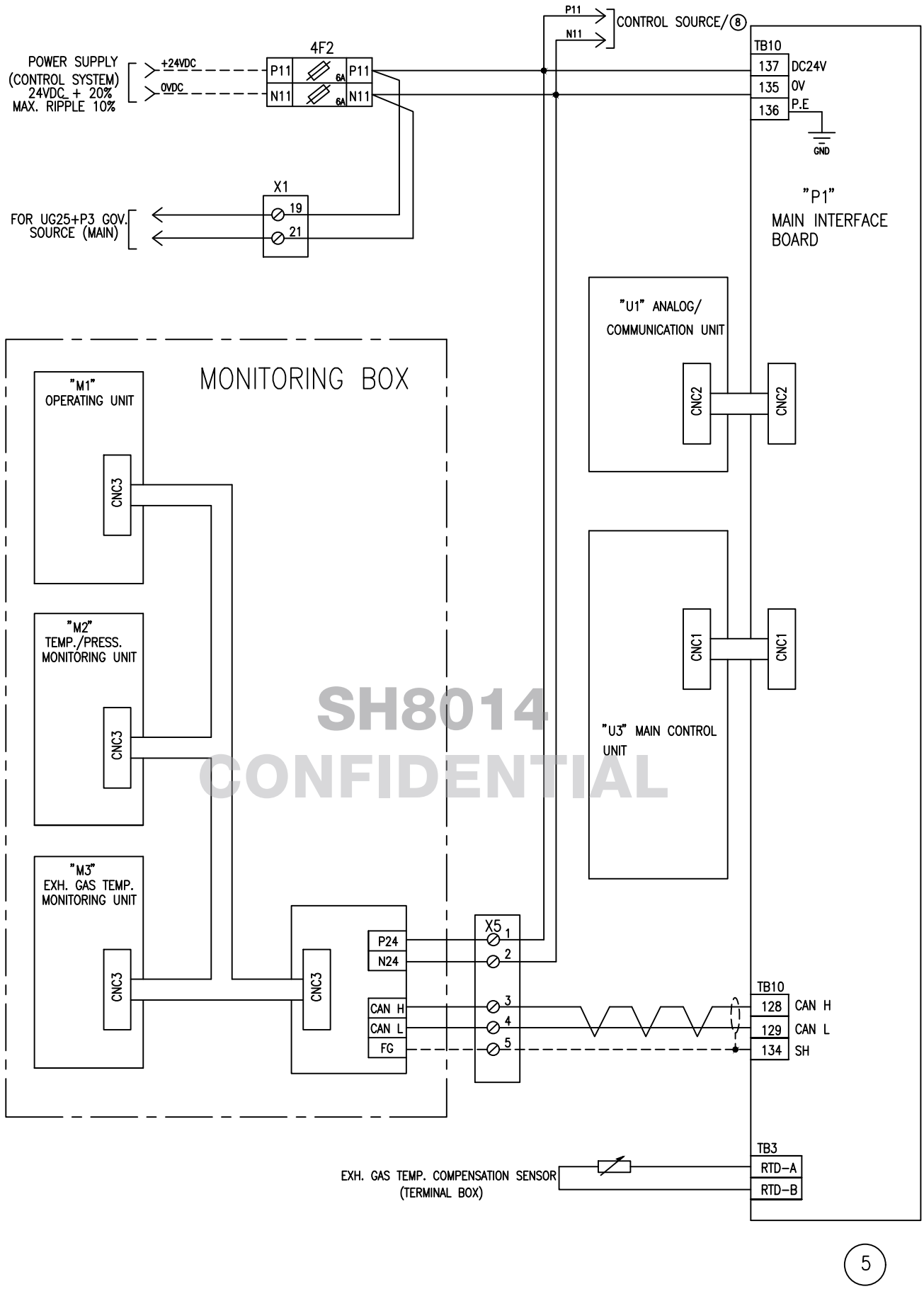


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4

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
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						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 23 OF 32		

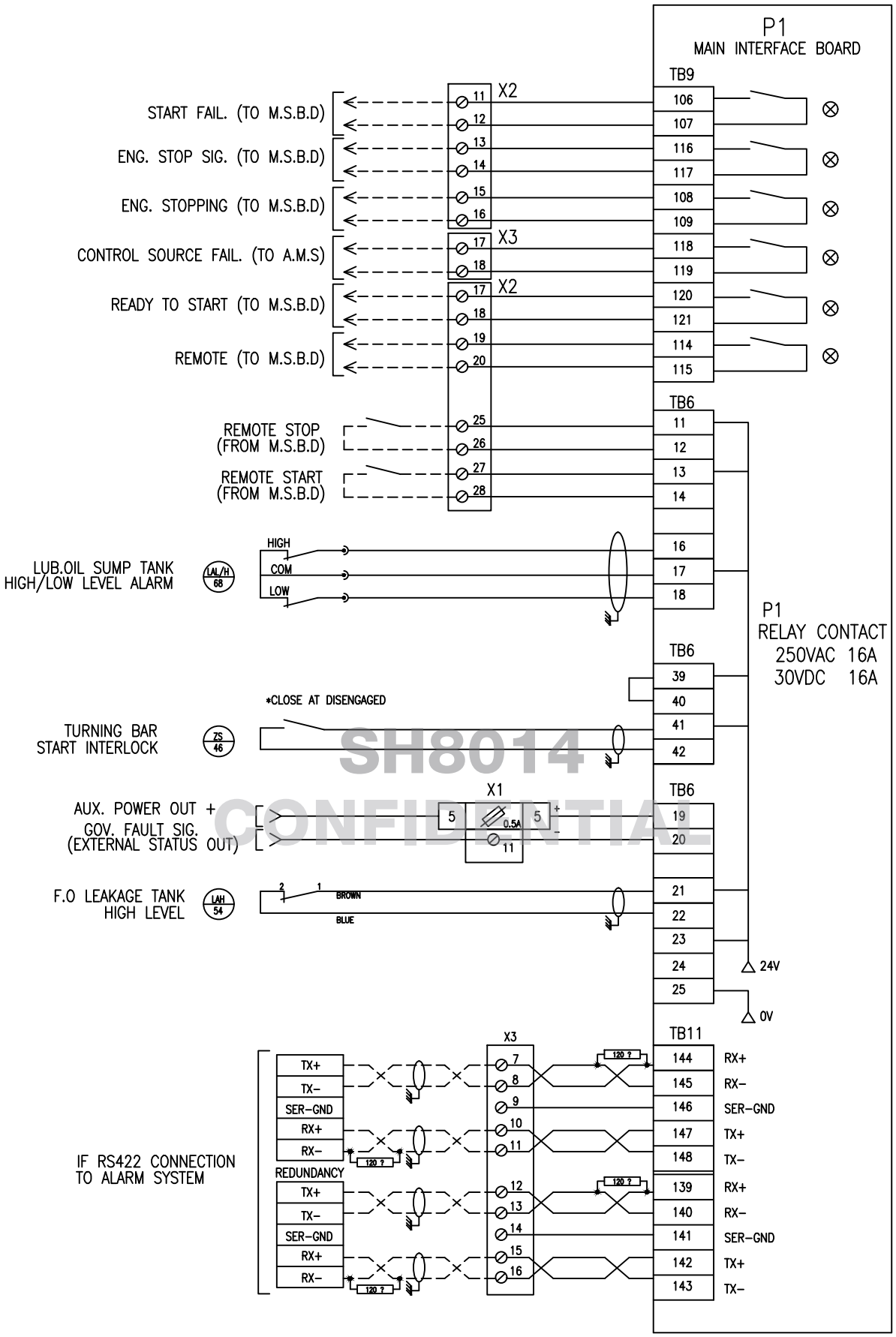


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5

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 24 OF 32		

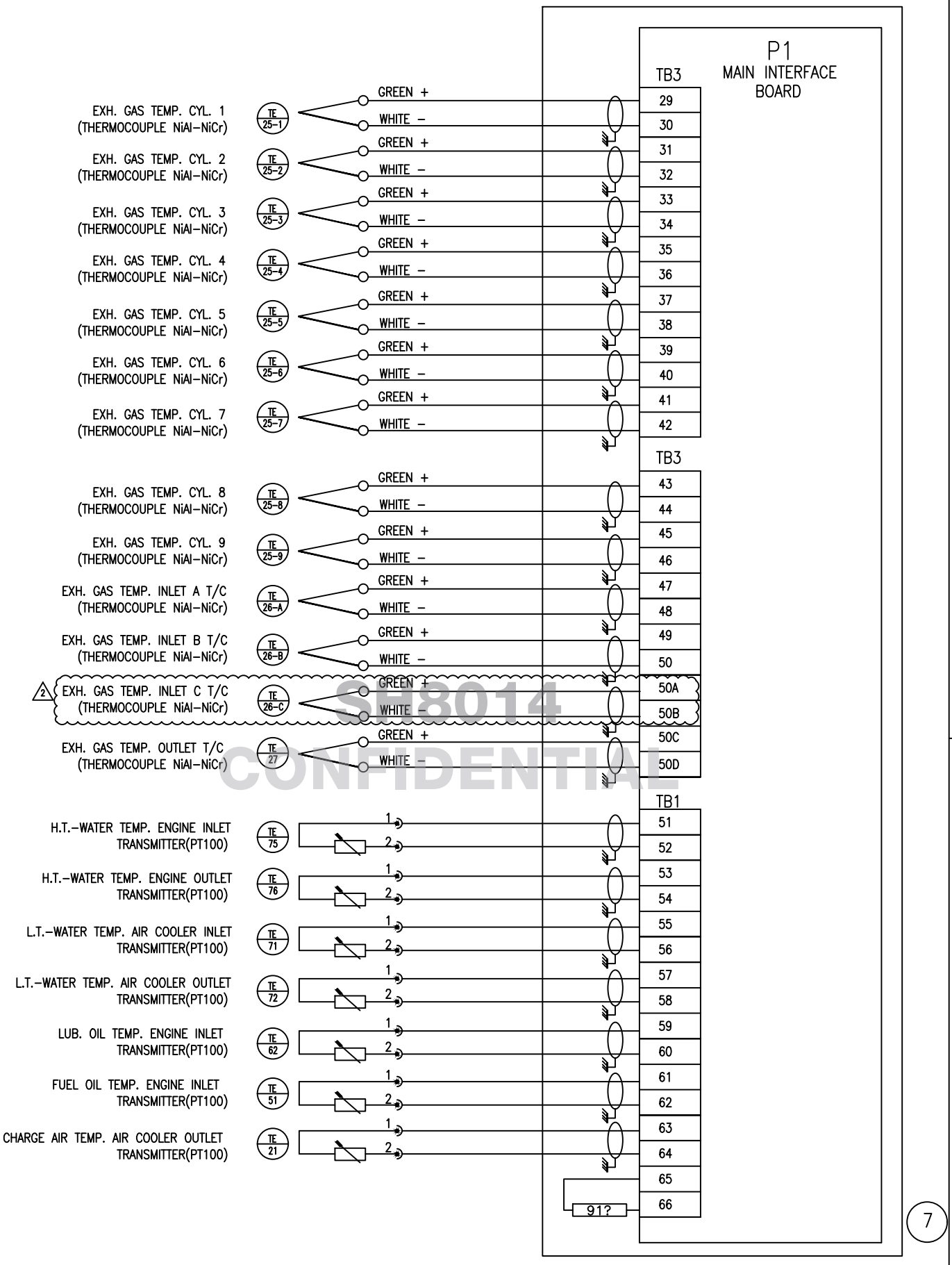


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6

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

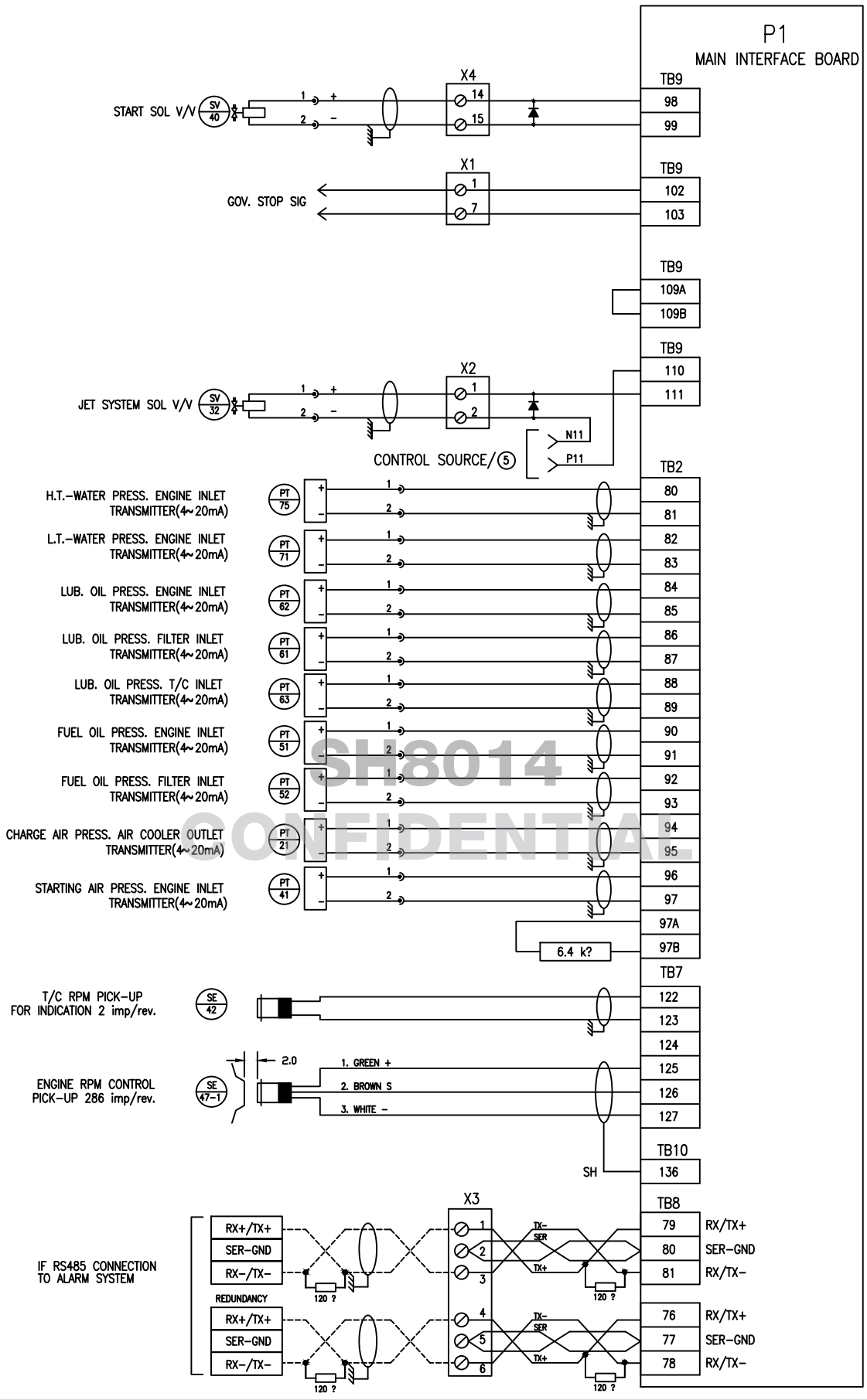
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 25 OF 32		



7

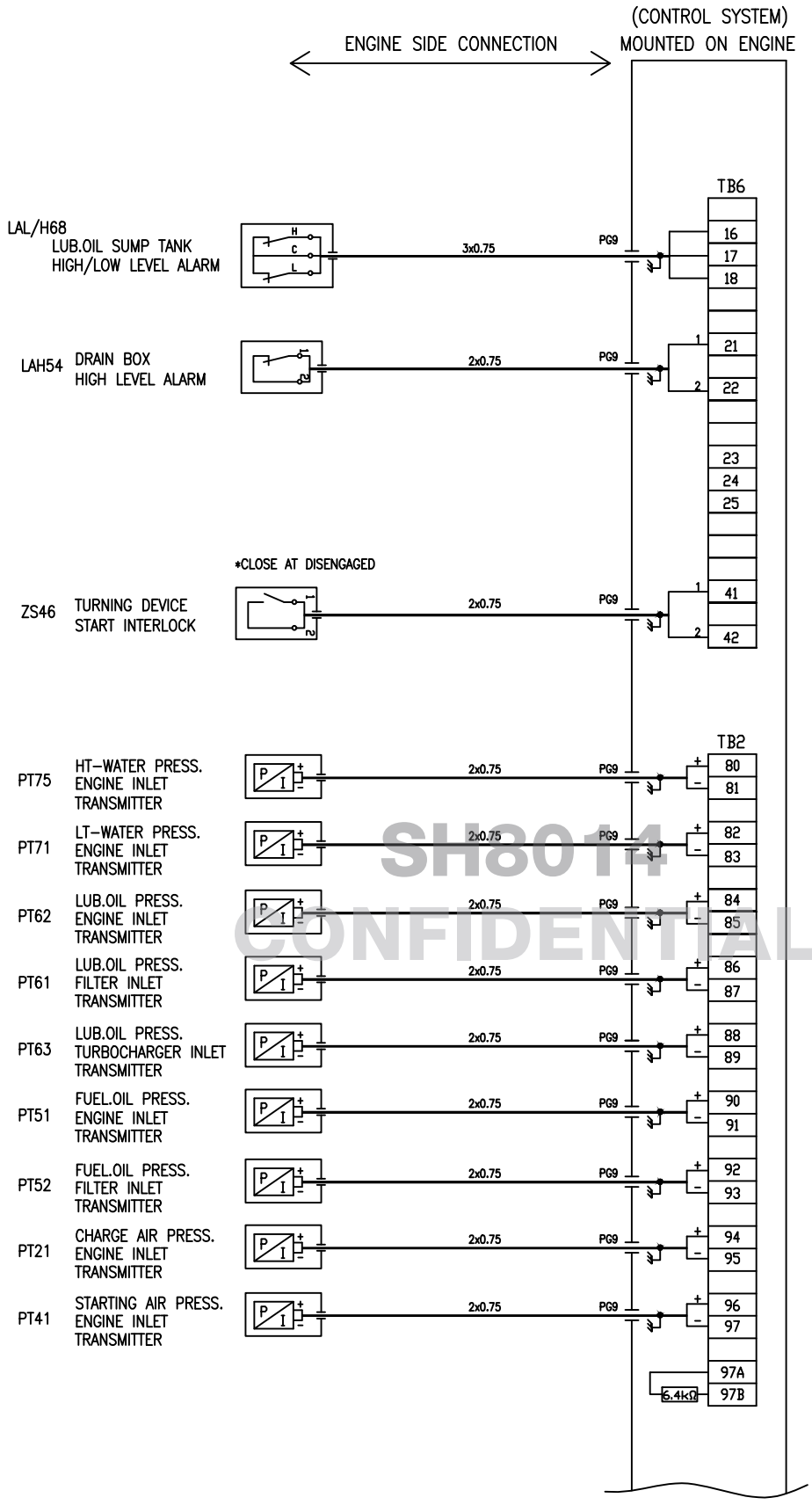
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
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						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 26 OF 32		



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

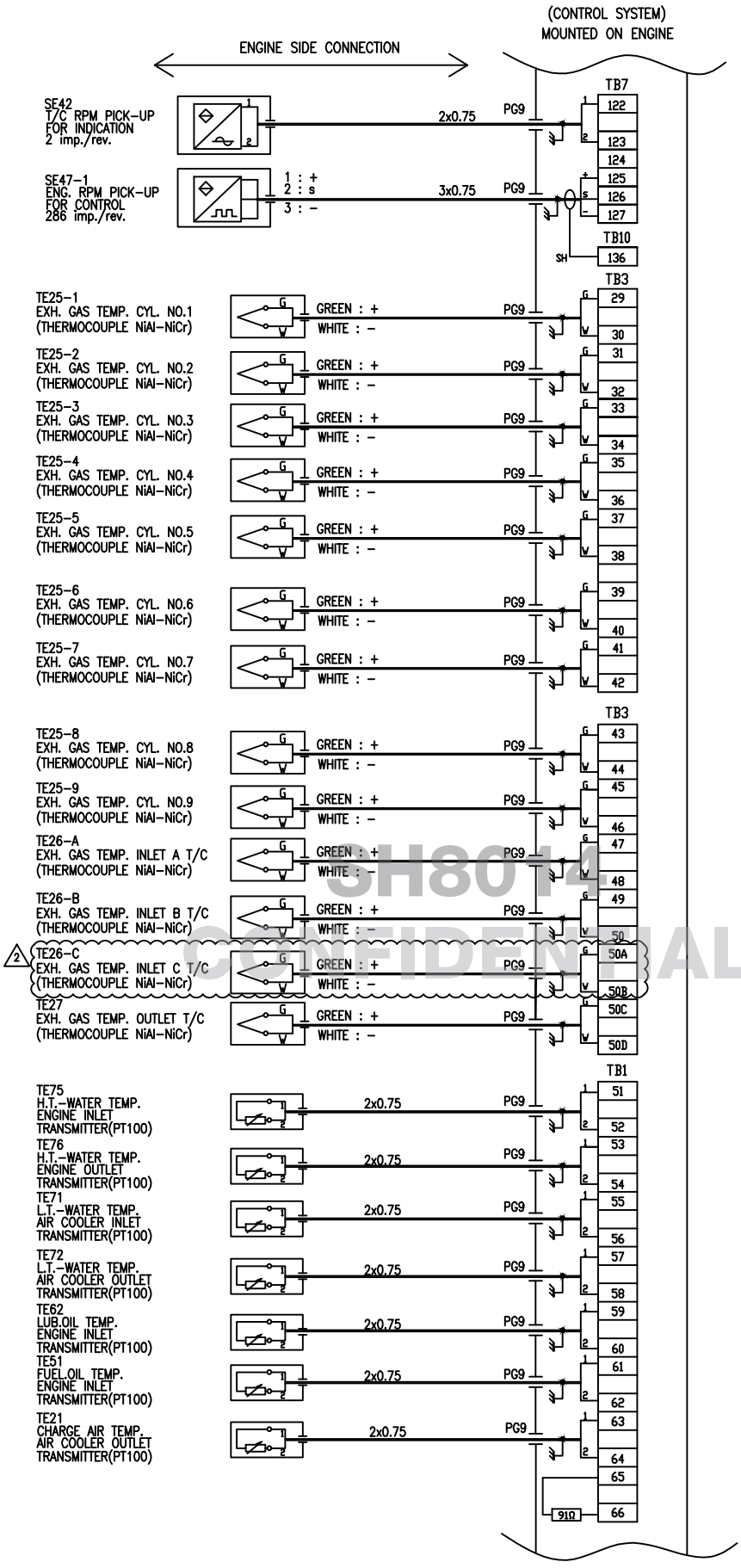
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: CONTROL CIRCUIT	Ident.no.: B94-185596-5
Page.no.: 27 OF 32		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

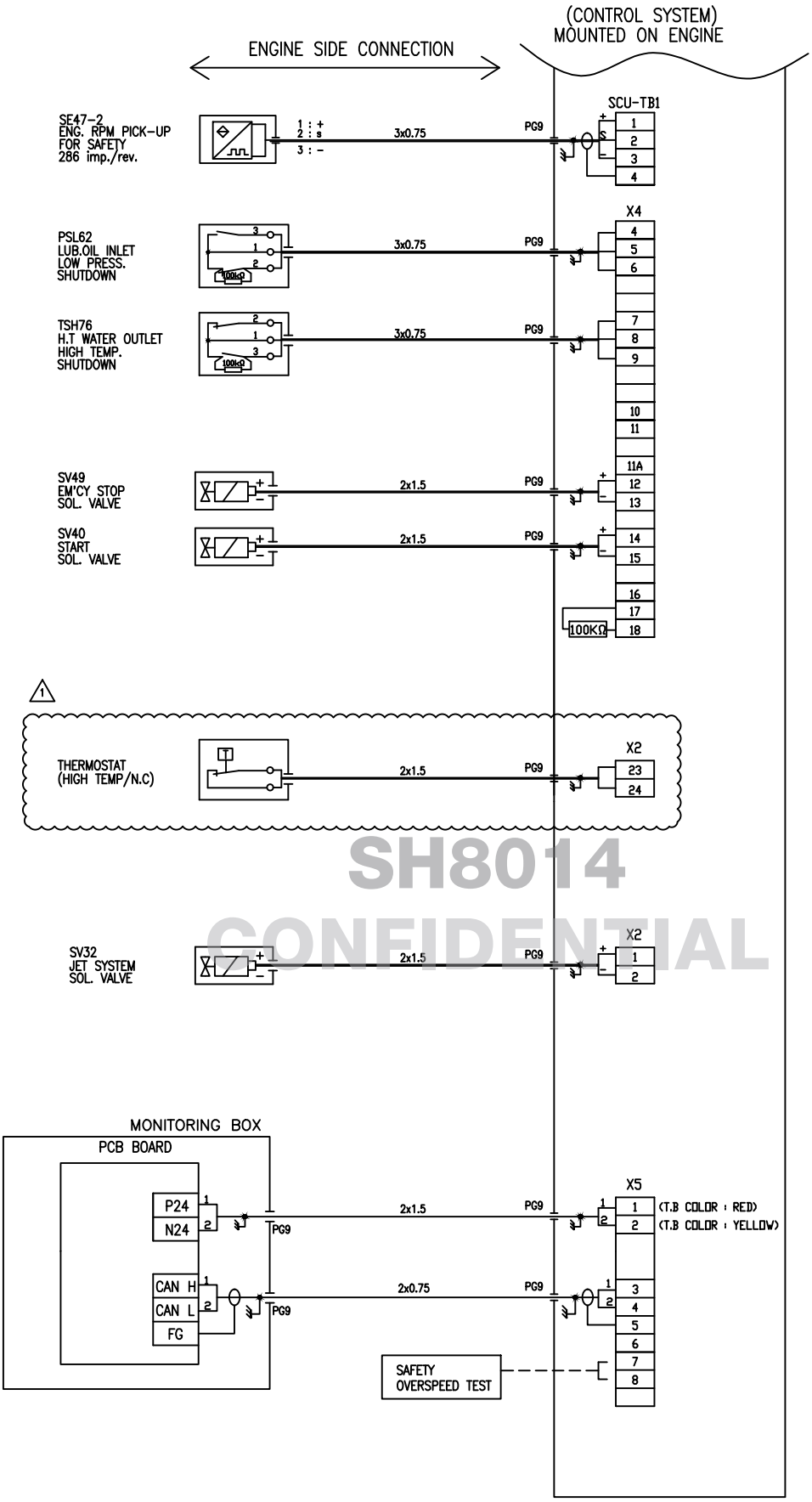
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: TERMINAL ARR'T 1 (FOR ENGINE SIDE)	Ident.no.: B94-185596-5
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

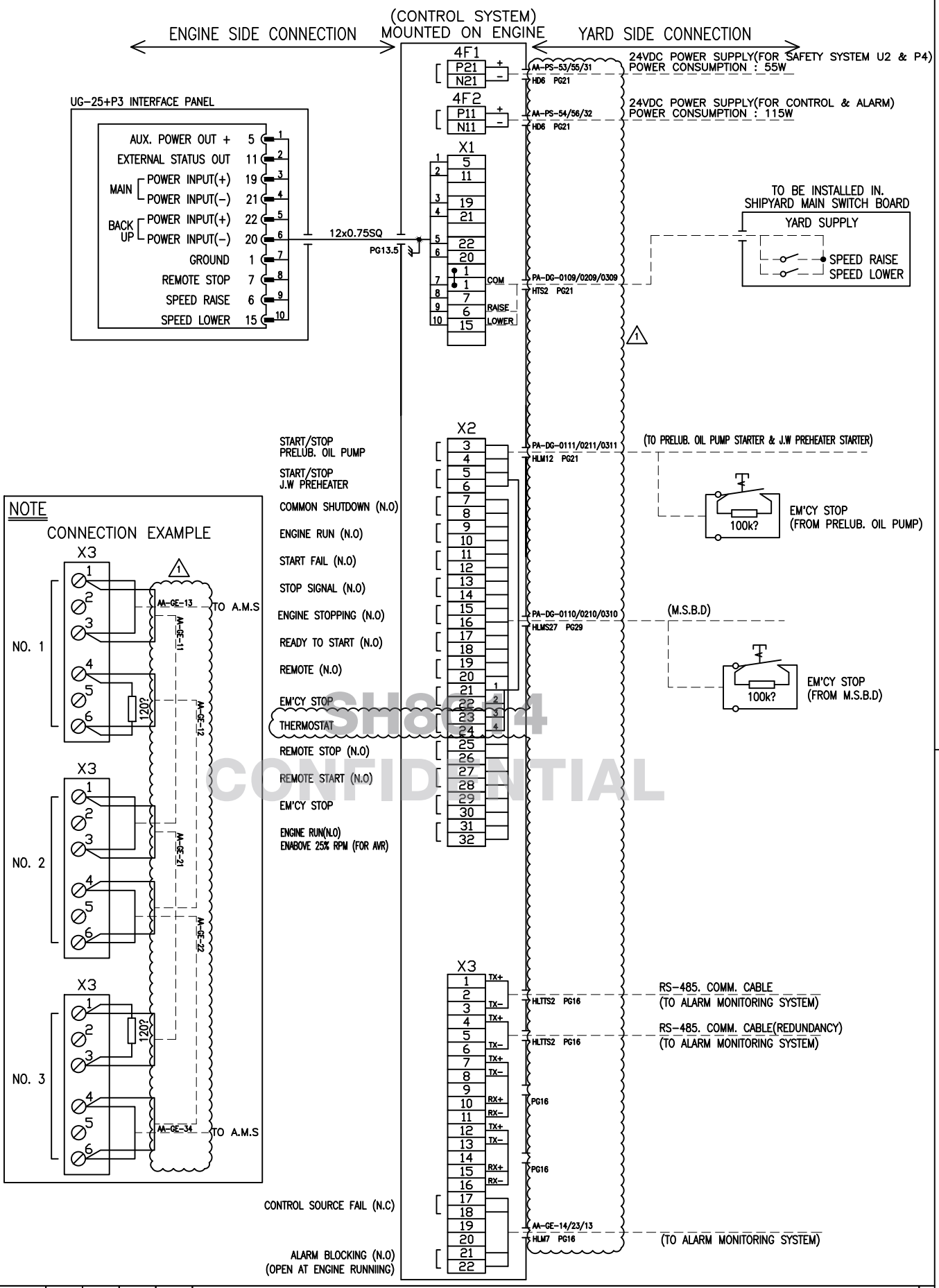
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: TERMINAL ARR'T 2 (FOR ENGINE SIDE)	Ident.no.: B94-185596-5
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

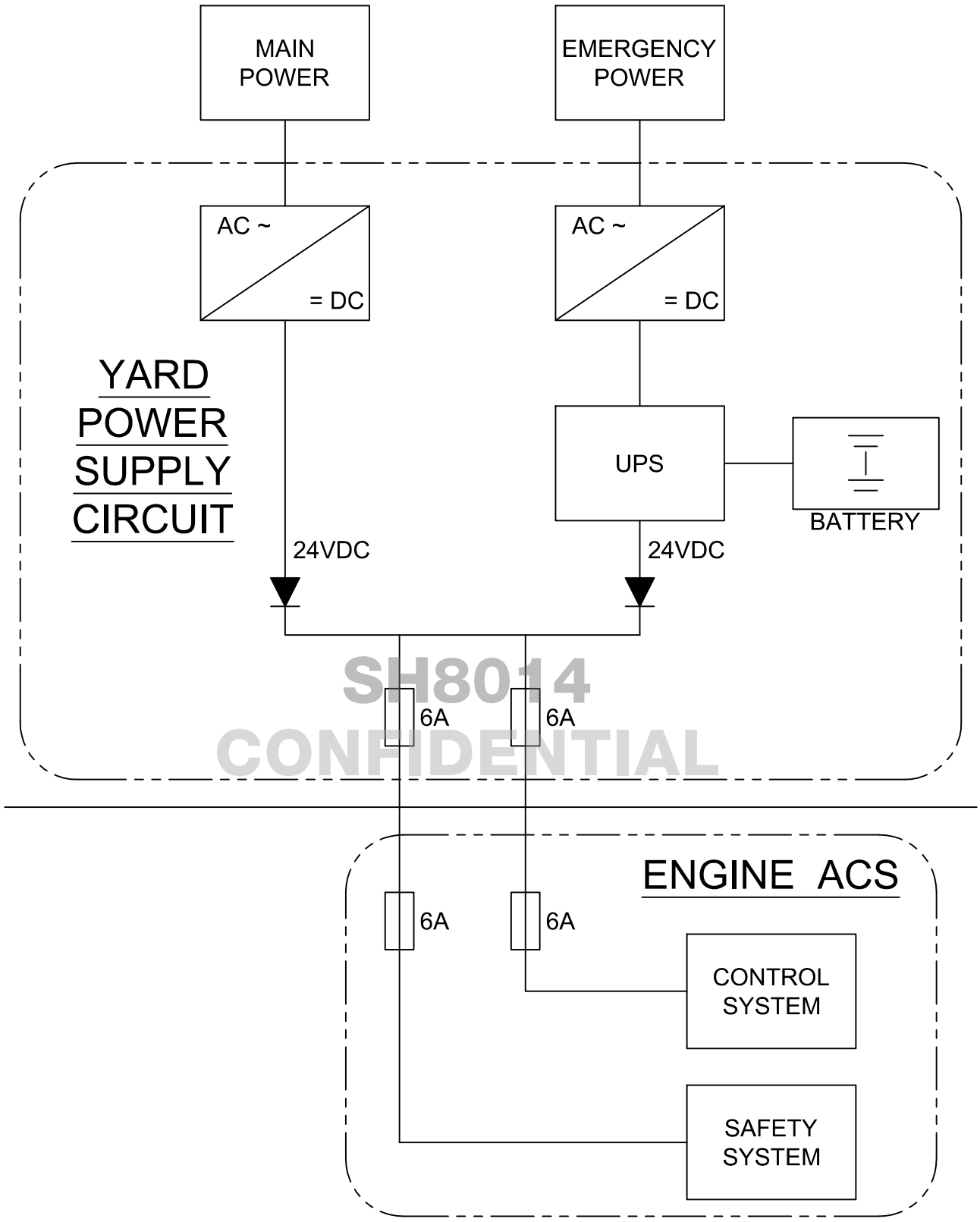
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Info.no.:	Description: TERMINAL ARR'T 3 (FOR ENGINE SIDE)	Ident.no.: B94-185596-5
Page.no.: 30 OF 32		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: TERMINAL ARR'T 4 (FOR YARD SIDE)	Ident.no.: B94-185596-5
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200319	GML	HJL	PJH	*	Chg. T/C set point (page:7), Add. TE26-C (page:8,10,26,29)	2
200218	GML	HJL	PJH	*	Chg. Gland (page:12,31), Add Thermostat (page:30,31), Chg. paint color (page:2,11,12)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: POWER SOURCE DIAGRAM	Ident.no.: B94-185596-5
Page.no.: 32 OF 32		

PLAN HISTORY	ENGINE TYPE	HYUNDAI - HiMSEN 3 x 9H21/23 - 900rpm
	MESSRS.	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
Page.no.: 01 OF 16		

Communication from the GenSet

System Layout

Fig 1 shows the system layout. The modules Base module, OPU, TPM, ETM and Safety system are all placed on the engine.
More detailed information on each module and sensors can be read in the Project drawing.

Communication

Communication from the Base module to the ship's alarm & monitoring system can be done in two ways:

1) In the Base-module there is a MODBUS ASCII or RTU interface communication.

If the alarm system can communicate with MODBUS ASCII or RTU, there is no need for the AMS.

All signals can be communicated by the MODBUS.

2) A LAP(Local alarm panel) with 24LED channels can be installed in the local control site.
This solution only serves digital alarms.

If the alarm system can communicate with CAN communication interlink there is no need for the AMS.

All signals can be communicated by the CAN communication interlink.

In the following please find a description of the MODBUS protocol and addressing of the signals.

MODBUS Protocol(Base module)

The Base module has a standard MODBUS ASCII and RTU interface which may be selected, by means of a DIP switch on the Base module, to be either.

-RS422 5 wire(Rx+, Rx-, Tx+, Tx-, GND) or
-RS485 3 wire(Rx+/Tx+, Rx-/Tx-, GND)

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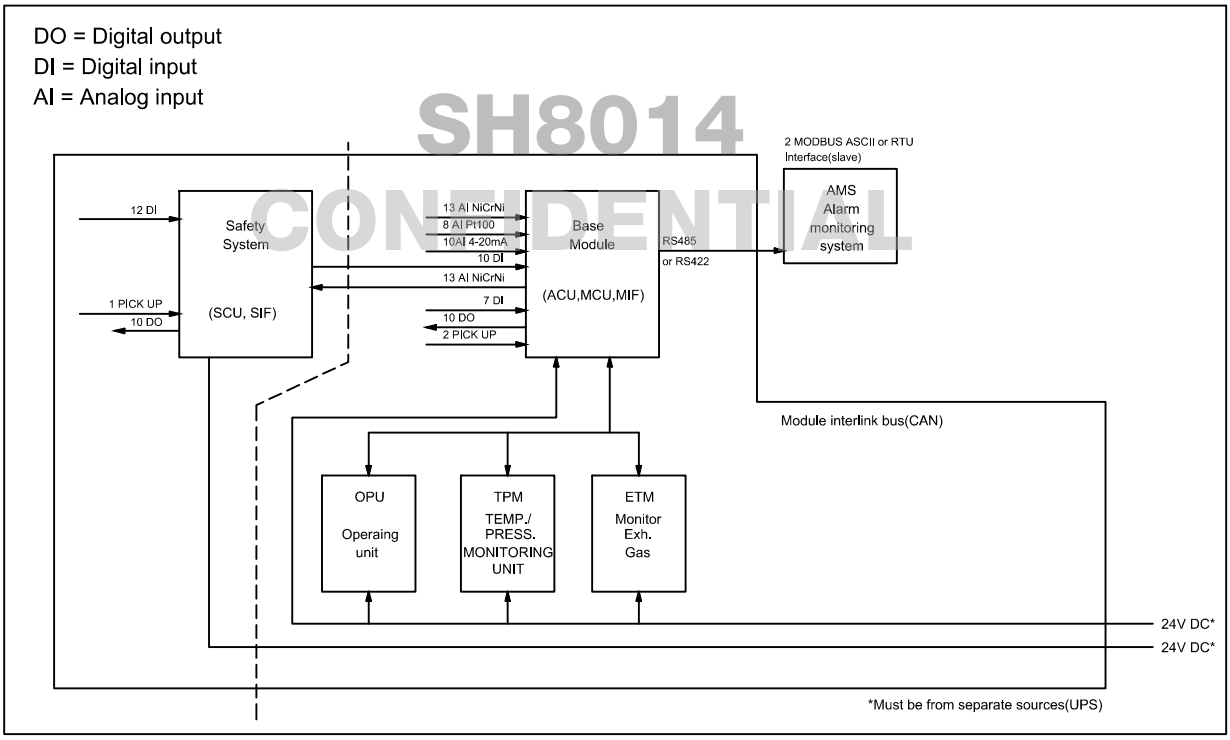


Fig 1 System overview : "monitor system & safety system"

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
Page.no.: 02 OF 16		

Communication from the GenSet

The communication setup is : 9600 baud, 8 date-bits, 1 start bit, 1 stop bit, no parity.

The Base module MODBUS protocol accept one command(Function Code 03) for reading analog and digital input values.

The following chapter describes the commands in the MODBUS protocol, which and implement-ated and how they work.

Protocol Description

The ASCII and RTU version of the MODBUS pro-tocol is used, where the Base module works as MODBUS slave.

◎ RTU mode

When Base module communicate on a MODBUS serial line using the RTU (Remote Terminal Unit) mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters.
The main advantage of this mode is that its greater character density allows better data throughput than ASCII mode for the same baud rate.
Each message must be transmitted in a continuous stream of characters.

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The general "message frame format" has the fol-lowing outlook:

[S] [SLAVE] [FCT] [DATA] [CRC Low] [CRC Hi] [E]

-[S]	A silent interval of at least 3.5 char. times (start bit)
-[SLAVE]	2char. Modbus slave address
-[FCT]	2char. Function code
-[DATA]	nX2 chars data.
-[CRC Low]	2 char. checksum
-[CRC Hi]	2 char. checksum
-[E]	A silent interval of at least 3.5 char. time (stop bit)

Note : The MODBUS address [SLAVE] should be Allowed addresses are 1..99(address 0 is not allowed). Broadcast packages will not be accepted (to be ignored).

The following function code(FCT) is accepted:

- 03H: Read n words at specific address.

In response to the message frame, the slave(Base module) must answer with appropriate data.

The master transmits an inquiry to the slave(Base Module) to read a number(n) of data from a given address. The slave(Base module) replies with the required number(n) of datawords.

The num.(n) of each table's data is fixed as follow.
*Table 3 : 0020(HEX)
Table 4 : 0020(HEX)
Table 5 : 0019(HEX)
Table 6 : 0018(HEX,option for BTM)

The start address of each table is fixed as follow.
*Table 3 : 4002(HEX)
Table 4 : 4042(HEX)
Table 5 : 40C2(HEX)
Table 6 : 40F0(HEX,option for BTM)

Request(master):
[DATA] = [ADR][n]

[ADR] = 2char. The starting address of table.(HEX)
ex) 40 02
: The starting address of table 3

[n] = 2char. The number of data.(HEX)
ex) 00 20
: The number of data.(Table 3)

Answer(slave-MCU)
[DATA] = [bb][1.word][2.word]...[n.word]

[bb] = 2char.The number of data.(HEX)
ex) 40
: The number of dataword.

[1.word] = 1. dataword
ex) FFFF (ON)

[2.word] = 2. dataword
ex) 0000 (OFF)

[n.word] = No n. dataword
ex) 0FFF (100% of range)

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
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◎ ASCII mode

When Base module communicate on a MODBUS serial line using ASCII (American Standard Code for Information Interchange) mode, each 8-bit byte in a message is sent as two ASCII characters.
This mode is used when the physical communication link or the capabilities of the device does not allow the conformance with RTU mode requirements regarding timers management.

Remark : this mode is less efficient than RTU since each byte needs two characters.

* Example
The byte 0x5B is encoded as two characters :
Ox35 and 0x42 (0x35 ="5", and 0x42 ="B" in ASCII)

The general "message frame format" has the following outlook:
[:][SLAVE][FCT][DATA][CHECKSUM][CR][LF]
-[:] 1 char. Start of frame
-[SLAVE] 2 char. Modbus slave address
-[FCT] 2 char. Function code
-[DATA] n X 2 chars data.
-[LRC]2 char. checksum
-[CR] 1 char. CR
-[LF] 1 char. LF (End of frame)

Notice : The MODBUS address [SLAVE] should be
Allowed address are 1..99(address 0 is not allowed).
Broadcast packages will not be ignored).

The following function code(FCT) is accepted:
- 03H: Read n words at specific address.

In response to the message frame, the slave(Base module) must answer with appropriate data.
The master transmits an inquiry to the slave(Base Module) to read a number(n) of dataword from given first start address or second start address.

The slave(Base module) replies with the required number(n) of datawords.

The number(n) of dataword is fixed as follow.
* Table 3
  - The number of dataword(4002~4011) : 0010
  - The number of remaining dataword : 0010
* Table 4
  - The number of dataword(4042~4051) : 0010
  - The number of remaining dataword : 0010
* Table 5
  - The number of dataword(40C2~40D1) : 0010
  - The number of remaining dataword : 0009
* Table 6(option for BTM)
  - The number of dataword(40F0~40FF) : 0010
  - The number of remaining dataword : 000B

The start address is fixed as follow.
* Table 3
  - 1st start address : 4002
  - 2st start address : 4012
* Table 4
  - 1st start address : 4042
  - 2st start address : 4052
* Table 5
  - 1st start address : 40C2
  - 2st start address : 40D2
* Table 6(option for BTM)
  - 1st start address : 40F0
  - 2st start address : 4100

Message Framing

A MODBUS message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows devices that receive a new frame to begin at the start of the message, and to know when the message is completed. Partial messages must be detected and errors must be set as a result.

◎ RTU mode
In RTU mode, message frames are separated by a silent interval of at least 3.5 character times. In the following sections, this time interval is called t3,5.

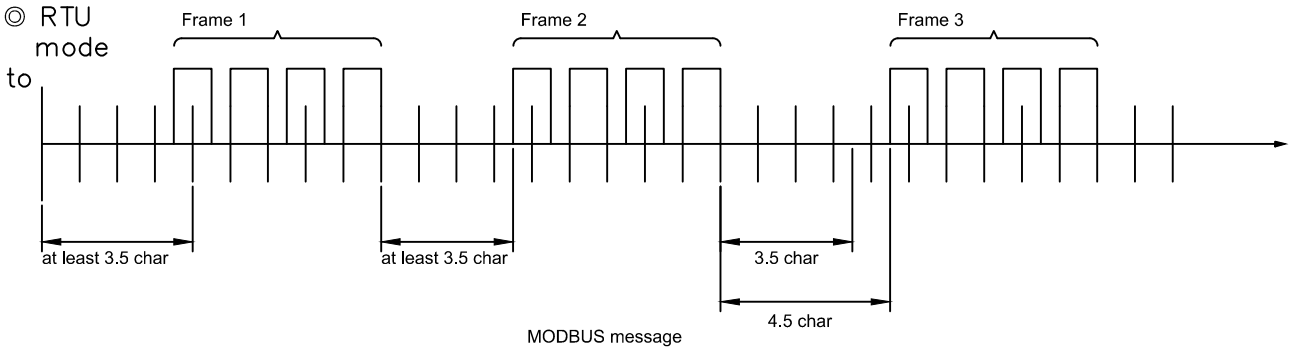
◎ ASCII mode
In ASCII mode, a message is delimited by specific characters as Start-of-frames and End-of-frames, A message must start with a 'colon'(:) character (ASCII 3A hex), and end with a 'carriage return-line feed'(CRLF) pair (ASCII 0D and 0A hex).

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
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191113	GML	HJL	PJH	*	For approval	0

Communication from the GenSet

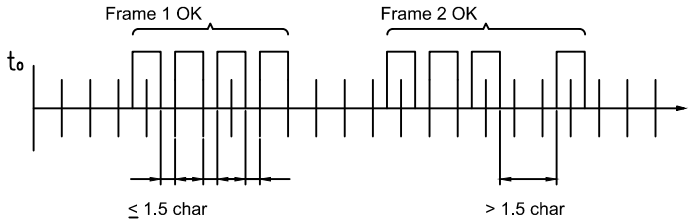
◎ RTU mode



MODBUS message

Start	Address	Function	Data	CRC check	End
≥ 3.5 char	2 char	2 char	n x 2 char	4 char	≥ 3.5 char

The entire message frame must be transmitted as a continuous stream of characters.
If a silent interval of more than 1.5 character times occurs between two characters, the message frame is declared incomplete and should be discarded by the receiver.



◎ ASCII mode

MODBUS message

Start	Address	Function	Data	LRC check	End
1 char :	2 char	2 char	n x 2 char	2 char	2 char CR. LF

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MODBUS addressing

In oredr to be able to read from the different I/O and data areas, they have to be supplied with an "address".

In the MODBUS protocol each address refers to a word or "register". For the GenSet there are following I/O registers:

◎ RTU mode
-Block(multiple) I/O registers occupying up to 32 word of registers.
-Maximum Number of data on a single MODBUS command is 32

◎ ASCII mode
-Block(multiple) I/O registers occupying up to 16 word of registers.
-Maximum Number of data on a single MODBUS command is 16

Data Format

The following type of data format have been chosen:

Digital : Consists of 1 word(register):
1 word: [0000H]=OFF
[FFFFH]=ON

Integer : Consists of 1 word(register):
1 word: 12 bit signed data
(second complement):
[0000H]=0
[OFFFH]=100% of range
but Sensor open is 16bit data
(Engine RPM pickup, TC RPM pickup exclusion)
*[1FFFH]=Sensor OPEN

Notice : 12 bit data format must be used no matter what dissolution a signal is sampled with. All measuring
values will be scaled to 12 bit signed.
* Example 1:
PI10, range 0-6 bar
The value 2.3 bar will be represented as 38.33% of 6 bar = 0621H

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
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MODBUS Timeout

To prevent lock up of the protocol, ie. a breakdown on the connection, a number of timeout are to be built in, as specified in the MODBUS protocol specification:

MODBUS specification max. time between characters in a frame : 10 ms

MODBUS specification max. time between receipt of frame and answer : 1 second

However the implementation of the protocol in the GenSet Base Module is able to handle much smaller timeout(response times), which may be required in order to obtain an acceptable worst-case I/O scan time:

Base Module, max. time between characters in a frame : 5ms

Base Module, max. time between receipt of frame and answer: 150 ms

Communication Example

◎ RTU mode

Request(master):
01 03 40 02 00 20 F0 12

01 : Slave address (Base module address)

03 : Function code

40 02 : Start address of Table 3

00 20 : Number of Table 3 date
*Number of Table 3 data = 32 (Decimal)
Conversion to HEX = 20 (HEX)

F0 12 : CRC code

Answer(slave-Base module):

01 03 40 FF FF FF FF 00 00 00 00 00 00 00 00 FF
FF FF FF 00 00 00 00 FF FF 00 00 00 00 00 00 00
00 FF FF 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 C3 4E

01 : Slave address (Base module address)

03 : Function code

04 : Number of data
*Number od data = 64 (Decimal)
Conversion to HEX = 40 (HEX)

FF FF ~ 00 00: Data of Table 3
(Data of address 4002 ~ 4021)

C3 4E : CRC code

◎ ASCII mode

Request(master):
01 03 40 02 00 10 AA [CR] [LF]

: : Start of frame
01 : Slave address (Base module address)

03 : Function code

40 02 : 1st start address of Table 3

00 10 : The number of dataword(4002~4011)
*The number of dataword(4002~4011)
=16 (Decimal)
Conversion to HEX = 10 (HEX)

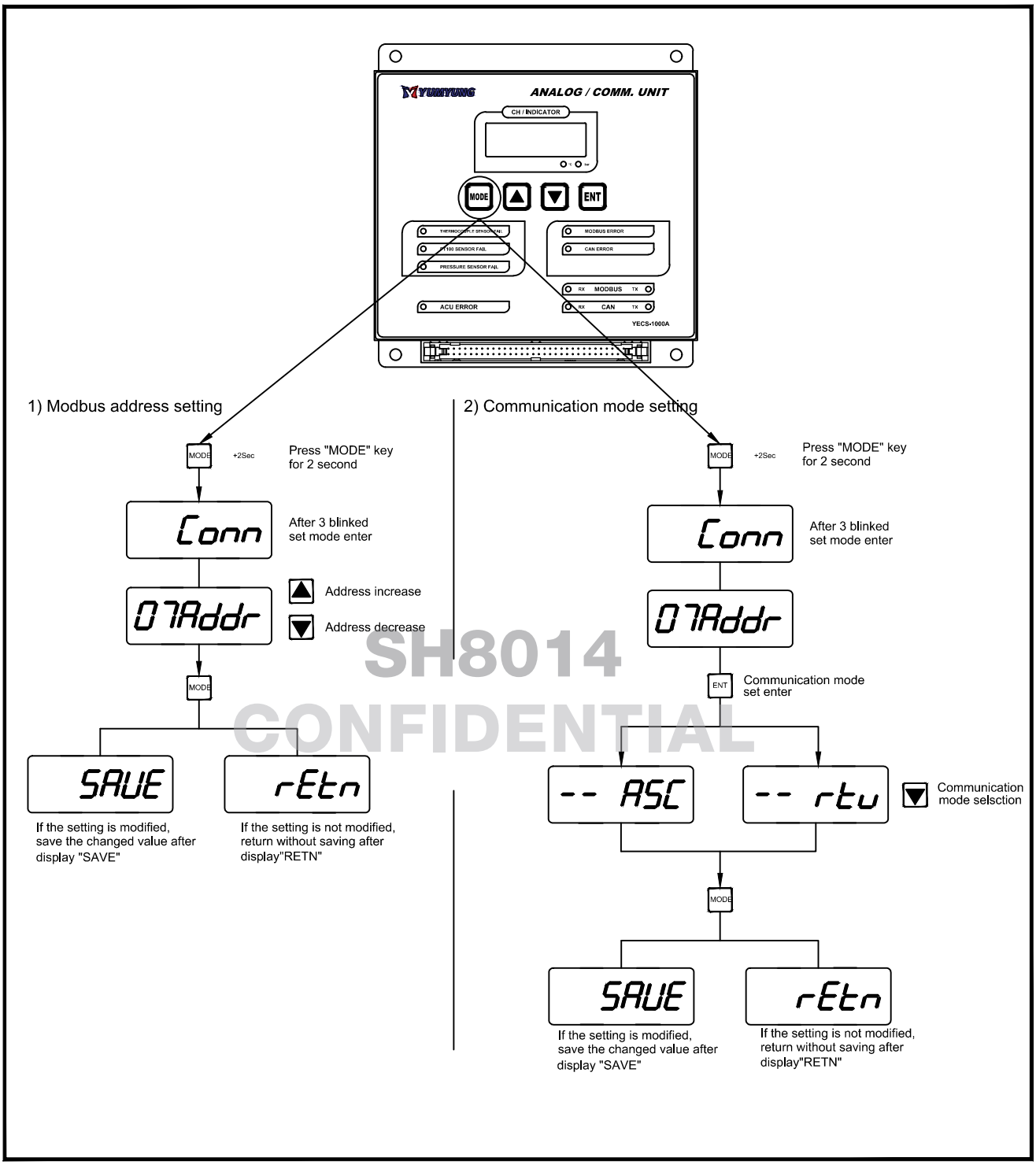
AA : LRC code
[CR] : carriage return
[LF] : line feed

Answer(slave-Base module):

01 03 20 0000 0000 0000 0000 0000 0000
FFFF FFFF 0000 0000 FFFF 0000 0000 0000
0000 FFFF E4 [CR] [LF]

: : Start of frame
01 : Slave address (Base module address)
03 : Function code
20 : Number of data
*Number of data = 32(Decimal)
Conversion to HEX = 20 (HEX)
0000 ~ FFFF : Data of Table 3
(Data of address 4002 ~ 4021)
E4 : LRC code
[CR] : carriage return
[LF] : line feed

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Fig 2 MODBUS address setting

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
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Communication from the GenSet

In the tables below each signal has a importance statement with following meaning:

"Required" : required by the classification society or HHI.
"Recommended" : recommended by HHI.
"Nice to have"

In the tables below some signals have a remark with following meaning:

a) Required by American Bureau of Shipping, ABS
b) Required by Bureau Veritas, BV.
c) Required by juaoslavenski Register & DNV.
d) Required by Reqistro Instano, Navale & RINA.
e) Required by Nippon Kail Kyokai, NKK & DNV.
f) Bureau Veritas, Lloyds Register of shipping and ABS demand alarm point for low/high heavy fuel oil temp. Normally this is placed at yard side as an common alarm for aux. engines. The signal can also be generated from iTI51.
g) "Common shutdown" consists of following signals: iPSL62, iTSH76, iSAH47-1, oSSH47-2, iSE47-2, iZS82 and iLSH92(option), oTSH69(option) Furthermore it consist also of the redundant shutdowns performed in the Base module.
h) "Safety system failure" consists of following signals: Power supply failure and internal watch dog alarm and O.M.D system failure.
i) "Trip circuit failure" means cable failure on or more of following sensors: lub. oil press -ostate PSL62, cool. water ther-mostate TSH76, LSH92, emergency stop switchZS82
j) "Shutdown from safety system" only consists of the shutdowns(PSL62, TSH76, SSH47-2, LSH92 and ZS82) in the safety system.
k) The signal ZS82 is Emergency shutdown.
l) Oil mist(LAH92, LSH92) is available for option.
m) Required by Det Norske Veritas, DNV.
n) TC rpm range is 0 - 80000.
o) Not accepted by all classification societies.
p) For GenSets with high voltage alternators.

General) All alarm signals are already performed with necessary time delay. F.ex. lub. oil sump tank level alarm(LAL/LAH68) includes 30 sec. alarm delay. Start air alarm (PAL41) includes 10sec. alarm delay. No further delay are needed.

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Table 3(Block scanning)

Signal	Name/description	Address	Data format	Importance	Remark	Meas.range
oLAH54	F.O Leakage tank high level	4002	Digital	Required		
oPAL65	Prelub. oil low press	4003	Digital	Required		
oUX95-2	Safety system failure	4005	Digital	Required	h)	
oSS86	Common shutdown	4006	Digital	Required	g)	
oTAH51	Fuel oil temp. High	4007	Digital	Required		
oPAL75	HT water press. Inlet low	4008	Digital	Required		
oPAL41	Starting air press low	4009	Digital	Required		
oPDAH61-62	Diff. press switch for L.O filter	400A	Digital	Required		
oPAL62	LUB. oil press. inlet low	400B	Digital	Required		
oPAL51	Fuel press. low	400C	Digital	Required		
oTAH76	HT water temp. high	400D	Digital	Required		
oTAH62	Lub. oil temp. inlet high	400E	Digital	Required		
oLAL68	Lub. oil sump tank low level	400F	Digital	Recommended	b)	
oLAH68	Lub. oil sump tank high level	4010	Digital	Recommended		
iZS46	Microswitch, turning gear engaged	4011	Digital	Recommended	b)	
oSSH47-1	Overspeed trip(from control sys.)	4012	Digital	Recommended		
oTAD25	Exh. gas temp. Deviation	4013	Digital	Recommended	m)	
oTAH27	TC temp. outlet, high	4014	Digital	Recommended		

Cont. of table 3

Signal	Name/description	Address	Data format	Importance	Remark	Meas.range
oTAH26-A	TC temp. Inlet A. high	4015	Digital	Recommended	m)	
iTI75	HT water temp. Inlet	4016	Integer 12Bit	Recommended	m)	0-200°C
iTI62	Lub. oil temp. Inlet	4017	Integer 12Bit	Recommended	a)+m)	0-200°C
iTI51	Fuel oil temp. Inlet	4018	Integer 12Bit	Recommended	f)	0-200°C
iTI28	Exh. Gas sensor compensation temp.	4019	Integer 12Bit	Recommended		0-200°C
iTI76	HT water temp. outlet	401A	Integer 12Bit	Recommended	a)	0-200°C
iTI72	LT water temp. outlet	401B	Integer 12Bit	Recommended	a)	0-200°C
iPI75	HT water press. Inlet	401C	Integer 12Bit	Recommended	a)+m)	0-6bar
iPI62	Lub. oil press. engine Inlet	401D	Integer 12Bit	Recommended	a)+m)	0-10bar
iPI51	Fuel oil press. engine Inlet	401E	Integer 12Bit	Recommended		0-16bar
iPI41	Starting air press. engine Inlet	401F	Integer 12Bit	Recommended	a)	0-40bar
oSX86-2	Trip circuit failure	4020	Digital	Recommended	i)	
oSX83	Start failure	4021	Digital	Recommended		

Table 3 MODBUS block 1(multiple I/O) register addressing

Table 4(Block scanning)

Signal	Name/description	Address	Data format	Importance	Remark	Meas.range
iPSL62-2	L.o inlet low press trip from safety	4042	Digital	Nice to have		
iTSH76-2	HT water outlet high temp trip from safety	4043	Digital	Nice to have		
iZS82	Emergency stop	4044	Digital	Nice to have	k) + l)	
iSSH47-2	Overspeed stop(from safety sys.)	4045	Digital	Nice to have		
oZS96	Local indication	4046	Digital	Nice to have		
oZS97	Remote indication	4047	Digital	Nice to have		
oPDAH51-52	Diff. press switch for F.O filter	4048	Digital			
oSS47-A	Engine running	4049	Digital	Nice to have		
iTE25-1	Exh. gas temp. cylinder 1	404A	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-2	Exh. gas temp. cylinder 2	404B	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-3	Exh. gas temp. cylinder 3	404C	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-4	Exh. gas temp. cylinder 4	404D	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-5	Exh. gas temp. cylinder 5	404E	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-6	Exh. gas temp. cylinder 6	404F	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-7	Exh. gas temp. cylinder 7	4050	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-8	Exh. gas temp. cylinder 8	4051	Integer 12Bit	Nice to have	c)	0-800°C
iTE25-9	Exh. gas temp. cylinder 9	4052	Integer 12Bit	Nice to have	c)	0-800°C
iTE27	Exh. gas temp. outlet TC	4053	Integer 12Bit	Nice to have	d)	0-800°C
iTE26-A	Exh. gas temp. intlet A, TC	4054	Integer 12Bit	Nice to have	e)	0-800°C
iTI71	LT water temp. inlet	4055	Integer 12Bit	Nice to have		0-200°C
iTI21	Charge air temp.	4056	Integer 12Bit	Nice to have		0-200°C
iPI71	LT water press. inlet	4057	Integer 12Bit	Nice to have		0-6bar
iPI61	Lub. oil press. filter inlet	4058	Integer 12Bit	Nice to have		0-10bar
iPI63	Lub. oil TC press.	4059	Integer 12Bit	Nice to have		0-6bar
iPI21	Charge air press.	405A	Integer 12Bit	Nice to have		0-6bar
iSE47	Engine RPM pickup	405B	Integer 12Bit	Nice to have		0-1200rpm
iSE42	TC RPM pickup	405C	Integer 12Bit	Nice to have	n)	0-80000rpm
oTAH71	LT water temp. high	405D	Digital			
oSX84	Stop failure	405E	Digital	Nice to have		
iSS86-3	Shutdown from safety system	405F	Digital	Nice to have	j)	
oPAL71	LT water press. Inlet low	4060	Digital	Nice to have		
oPAL63	Lub. oil press. TC, low	4061	Digital	Nice to have		

Table 4 MODBUS block 2(multiple I/O) register addressing

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Communication from the GenSet

Table 5(Block scanning)

	Signal	Name/description	Address	Data format	Importance	Remark	Meas.range
	oSAH42	High TC rpm	40C2	Digital	Nice to have	m)	
	oTAH26-B	TC temp. inlet B, high	40C3	Digital	Nice to have	m)	
	oTAH76-2	HT water. high(only DNV class)	40C4	Digital	Nice to have	m)	
	oTAH25-1	High exh. gas temp cyl.1	40C5	Digital	Nice to have	m)	
	oTAH25-2	High exh. gas temp cyl.2	40C6	Digital	Nice to have	m)	
	oTAH25-3	High exh. gas temp cyl.3	40C7	Digital	Nice to have	m)	
	oTAH25-4	High exh. gas temp cyl.4	40C8	Digital	Nice to have	m)	
	oTAH25-5	High exh. gas temp cyl.5	40C9	Digital	Nice to have	m)	
	oTAH25-6	High exh. gas temp cyl.6	40CA	Digital	Nice to have	m)	
	oTAH25-7	High exh. gas temp cyl.7	40CB	Digital	Nice to have	m)	
	oTAH25-8	High exh. gas temp cyl.8	40CC	Digital	Nice to have	m)	
	oTAH25-9	High exh. gas temp cyl.9	40CD	Digital	Nice to have	m)	
	oUX95-1	monitoring system failure	40CE	Digital	Recommended		
	oSE42	Turbocharger tacho failure	40CF	Digital	Recommended		
	iTE26-B	Exh. gas temp. inlet B TC	40D1	Integer 12Bit	Nice to have		0-800°C
1	iTE26-C	Exh. gas temp. inlet C TC	40D2	Integer 12Bit	Nice to have		0-800°C
	iPI52	Fuel oil press. Filter inlet	40D3	Integer 12Bit	Nice to have		0-16bar
1	oTAH26-C	TC temp. inlet C, high	40D5	Digital	Nice to have	m)	
	oUG25	Gov. fault(UG25)	40D6	Digital			
	oSE47-2	Safety system Tacho failure	40D7	Digital			
	oSE47-1	Control system Tacho failure	40D9	Digital			
	iPSL62-1	L.O low press trip from control	40DC	Digital			
	iTSH76-1	H.T water high temp trip from control	40DD	Digital			
	oSE47-3	Both Tacho failure trip	40DF	Digital			

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

In fig 3 and fig 4 some example of wiring are illustrated.

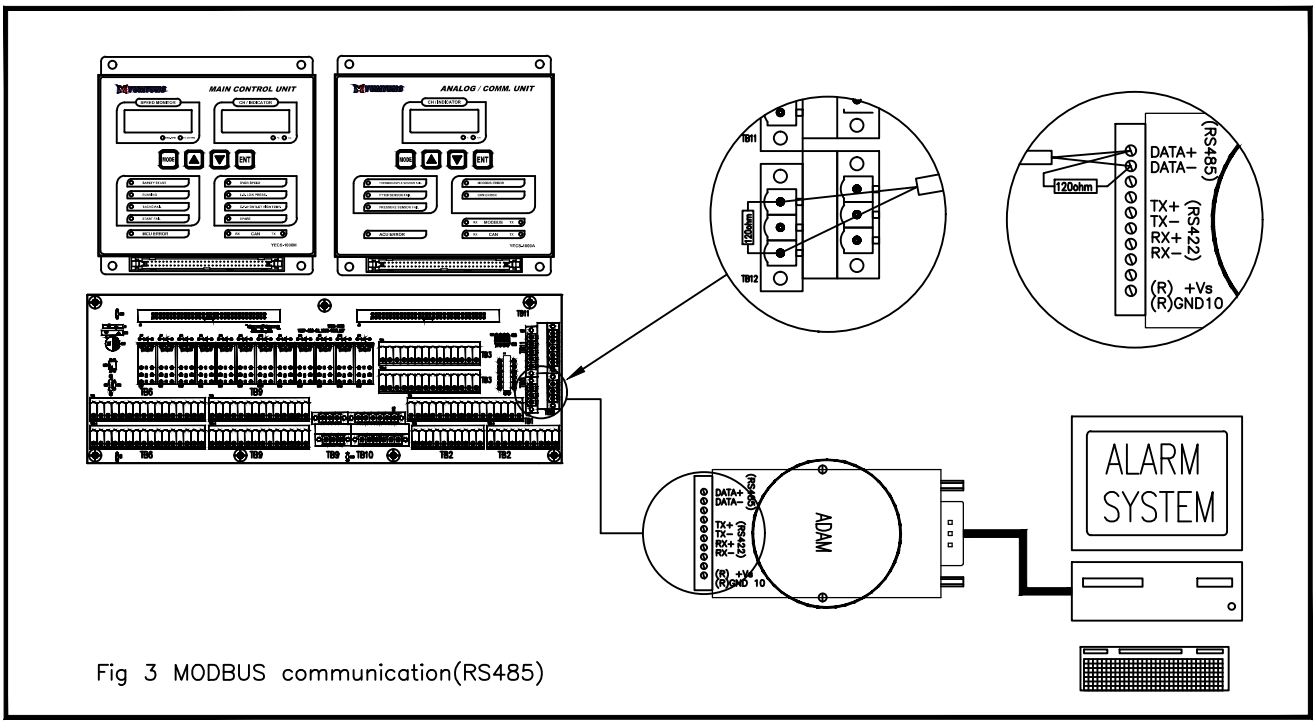


Fig 3 MODBUS communication(RS485)

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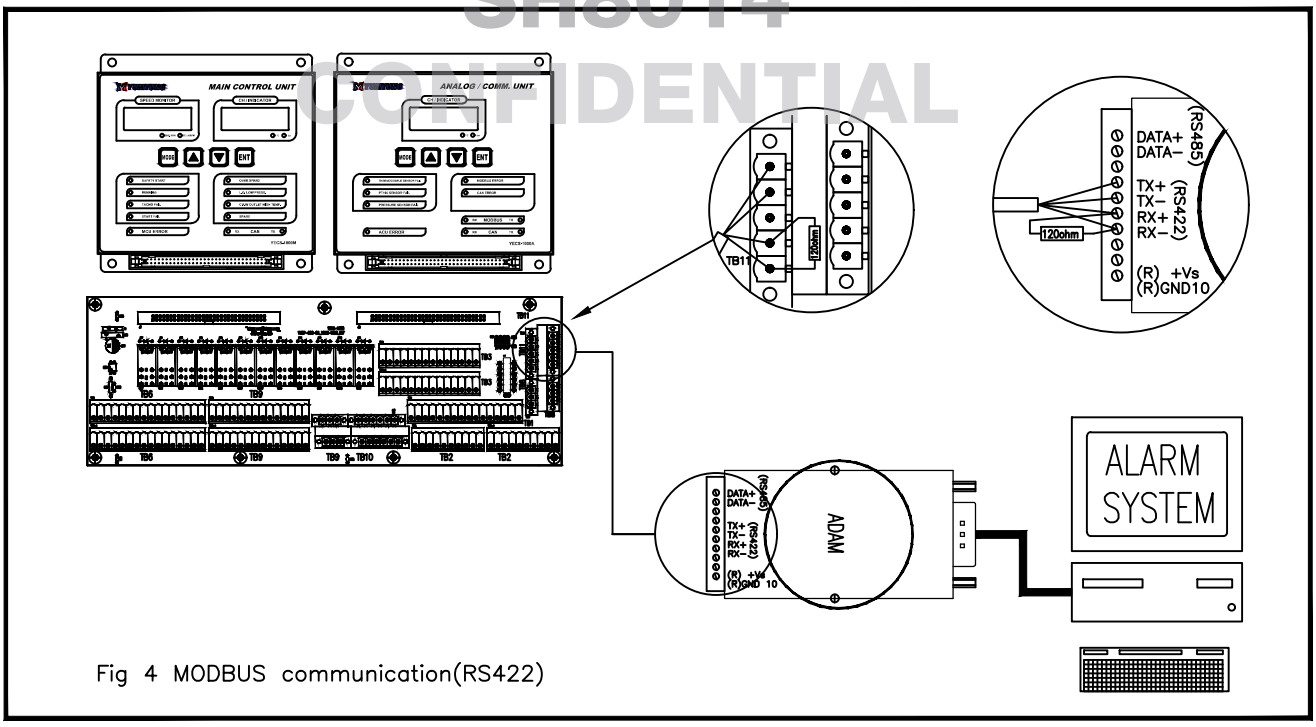
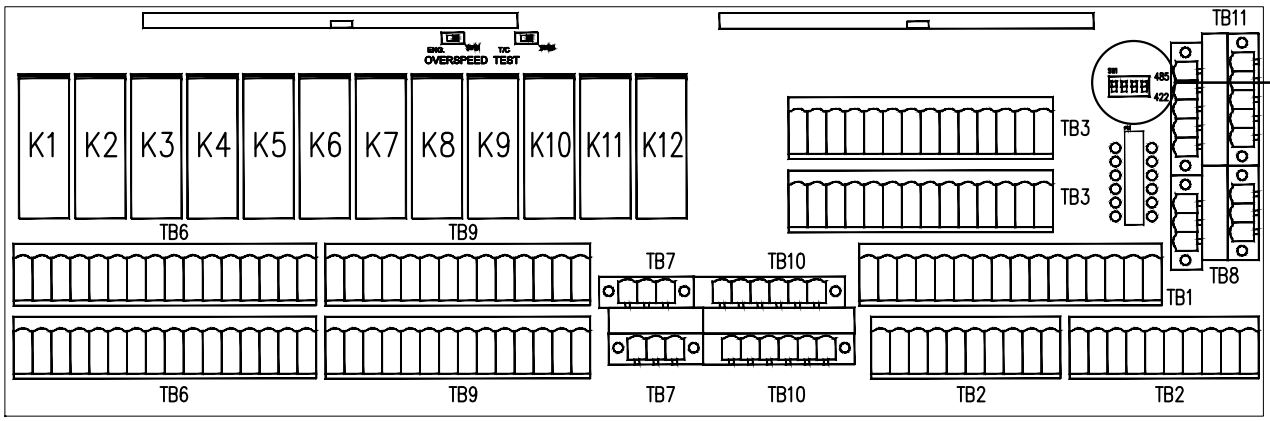


Fig 4 MODBUS communication(RS422)

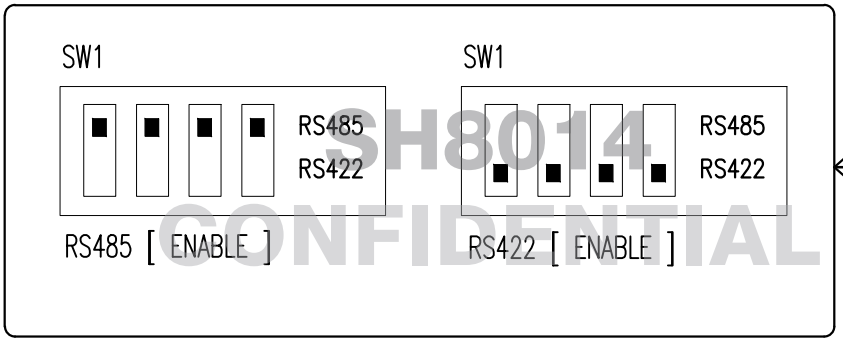
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
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1. MODBUS ALARM/INDICATION

CODE	NAME	ALARM CONDITION or SET POINT	TIME DELAY	SENSOR TYPE
oLAH54	F.O Leakage tank high level	F.O Leakage tank high level (Open contact) IN	5s	N.C CONTACT
oPAL65	Pre lub. oil low press	PT62 : 0.08(kgf/㎠ or bar) + 60sec delay * Set value : it can set up at MCU unit(U3)	0s	4~20mA
oUX95-2	Safety system failure	Safety system power failure. O.M.D system failure signal (Open contect) IN	5s	N.C CONTACT
oSS86	Common shutdown	Overspeed, EM'CY stop, Shutdowns (L.O low press., H.T high temp. OMD, Stop Failure, Both tacho fail) Main bearing high temp (Option)	0s	N.C CONTACT
oTAH51	Fuel oil temp. High	TE51 : Set point H17/28, H17/28U(E), H21/32, H25/33, H32/40 : 155°C (HFO)	3s	Pt100
oPAL75	HT water press. inlet low	PT75 : Engine Running + 20 sec delay + 0.4 + Static (kgf/㎠ or bar) + Alarm blocking OFF * Set value : it can set up at MCU unit(U3)	3s	4~20mA
oPAL41	Starting air press. low	PT41 : Set point H17/28 : 4.5kgf/㎠ or bar H17/28U(E) : 7.5kgf/㎠ or bar H21/32 : 4.5kgf/㎠ or bar (5~7 cyl.) H21/32 : 7.5kgf/㎠ or bar (8~9 cyl.) H25/33 : 9.5kgf/㎠ or bar H32/40 : 15kgf/㎠ or bar Landbase project : Set point	10s	4~20mA
oPDAH61-62	Diff. press high for L.O filter	PT61-PT62 : 2 kgf/㎠ or bar	10s	4~20mA
oPAL62	Lub. oil press. inlet low	PT62 : 3.5 kgf/㎠ or bar + Alarm blocking OFF	3s	4~20mA
oPAL51	Fuel oil press. low	PT51 : Continuous HFO operation [6 kgf/㎠ or bar (HFO)] or [1 kgf/㎠ or bar (MDO)] Continuous MDO operation 6 kgf/㎠ or bar	5s	4~20mA
oTAH76	HT water temp. high	TE76 : 90 °C	3s	Pt100
oTAH62	Lub. oil temp inlet high	TE62 : 80 °C	3s	Pt100
oLAL68	Lub. oil sump tank low level	Lub. oil sump tank low level signal (Open contact) IN	30s	N.C CONTACT
oLAH68	Lub. oil sump tank high level	Lub. oil sump tank high level signal (Open contact) IN	30s	N.C CONTACT
iZS46	Microswitch, turning gear engaged	Turning gear engaged	0s	-
oSSH47-1	Overspeed trip(From control system)	SE47-1 : Set point Rated speed : Over speed 720RPM : 828 RPM 750RPM : 862 RPM 900RPM : 1035 RPM 1000RPM : 1150 RPM		0~10KHz
oTAD25	Exh. gas temp. Deviation	Engine running + 300sec delay, Cylinder Average temp. ±70 °C	60s	THERMOCOUPLE
oTAH27	TC temp. outlet, high	TE27 : Set point H17/28, H17/28U(E) : 430 °C H21/32, H25/33, H32/40 : 450 °C	3s	THERMOCOUPE
oTAH26-A	TC temp. Inlet A. high	TE26-A : 620 °C	10s	THERMOCOUPE

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

CODE	NAME	ALARM CONDITION or SET POINT	TIME DELAY	SENSOR TYPE
iTI75	HT water temp. Inlet	TE75 : INDICATION (0~200 °C) Sensor OPEN (1FFF)		Pt100
iTI62	Lub. oil temp. Inlet	TE62 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	Pt100
iTI51	Fuel oil temp. Inlet	TE51 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	Pt100
iTI28	Exh. Gas sensor compensation temp.	TE28 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	Pt100
iTI76	HT water temp. Outlet	TE76 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	Pt100
iTI72	LT water temp. Outlet	TE72 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	Pt100
iPI75	HT water press. Inlet	PT75 : INDICATION (0~6kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI62	Lub. oil press. engine Inlet	PT62 : INDICATION (0~10kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI51	Fuel oil press. engine Inlet	PT51 : INDICATION (0~16kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI41	Starting air press. engine Inlet	PT41 : INDICATION (0~16kgf/㎠ or 0~40kgf/㎠) Sensor OPEN (1FFF)	-	4~20mA
oSX86-2	Trip circuit failure(Sayfety system)	* PRESS. SWITCH FOR LO INLET CABLE OPEN OR BREAK * TEMP. SMITH FOR H.T WATER OUTLET CABLE OPEN OR BREAK * REMOTE EM'CY SWITCH CABLE OPEN OR BREAK * LOCAL EM'CY SWITCH CABLE OPEN OR BREAK * O.M.D TRIP SWITCH CABLE OPEN OR BREAK(option) * EM'CY SOL V/V CABLE OPEN OR BREAK * FROM MAIN CONTROL SHUTDOWN OPEN OR BREAK	5s	N.O CONTACT
oSX83	Start failure	1. Remote start at Local mode 2. Remote start at Blocking mode 3. Below 50 RPM after Engine start + 5sec delay 4. Not Running state after Engine start + 20sec delay (time adjustable at MCU unit)	0s	-
iPSL62-2	Lub. oil inlet low press, trip from safety	Safety : PSL62 3.0(kgf/㎠ or bar) + Alarm blocking off	0s	N.O CONTACT
iTSH76-2	HT water outlet high temp. trip from safety	Safety : H.T water high temp. shutdown IN 95 °C	0s	N.O CONTACT
iZS82	Emergency stop	Emergency stop signal IN(Local or Remote)	0s	N.O CONTACT
iSSH47-2	Oversepeed trip(From safety system)	SE47-2 : SET POINT Rated speed : Over speed 720RPM : 813 RPM 750RPM : 847 RPM 900RPM : 1017 RPM 1000RPM : 1130 RPM	0s	0~10KHz
oZS96	Local indication	INDICATION	-	-
oZS97	Remote indication	INDICATION	-	-
oPDAH51-52	Diff. press. high for F.O fiter	PT52-PT51 : 1.5 kgf/㎠ or bar	10s	4~20mA
oSS47A	Engine running	200 RPM + 10sec or run RPM	-	-

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
Page.no.: 14 OF 16		

CODE	NAME	ALARM CONDITION or SET POINT	TIME DELAY	SENSOR TYPE
iTE25-1	Exh. gas temp. cylinder 1	TE25-1 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-2	Exh. gas temp. cylinder 2	TE25-2 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-3	Exh. gas temp. cylinder 3	TE25-3 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-4	Exh. gas temp. cylinder 4	TE25-4 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-5	Exh. gas temp. cylinder 5	TE25-5 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-6	Exh. gas temp. cylinder 6	TE25-6 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-7	Exh. gas temp. cylinder 7	TE25-7 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-8	Exh. gas temp. cylinder 8	TE25-8 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE25-9	Exh. gas temp. cylinder 9	TE25-9 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE27	Exh. gas temp. outlet TC	TE27 : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTE26-A	Exh. gas temp. outlet A, TC	TE26-A : INDICATION (0~800 °C) Sensor OPEN (1FFF)	-	THERMOCOUPLE
iTI71	LT water temp. inlet	TE71 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	PT100
iTI21	Charge air temp.	TE21 : INDICATION (0~200 °C) Sensor OPEN (1FFF)	-	PT100
iPI71	LT water press. inlet	PT71 : INDICATION (0~6 kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI61	Lub. oil press. filter inlet	PT61 : INDICATION (0~10 kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI63	Lub. oil TC press.	PT63 : INDICATION (0~6 kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iPI21	Charge air press.	PT21 : INDICATION (0~6 kgf/㎠ or bar) Sensor OPEN (1FFF)	-	4~20mA
iSE47	Engine RPM pickup	SE47 : INDICATION (0~1200RPM)	-	0~10KHz
iSE42	TC RPM pickup	SE42 : INDICATION (0~80000RPM)	-	0~3KHz
iSS86-3	Shutdown from safety system (from Safety system)	- L.O Low press. - H.T Water high temp. - Over speed - Local or Remote EM'CY stop - Oil mist high density (option)	0s	N.O CONTACT
oTAH71	LT water temp. high	TE71 : Engine Running +60 sec delay+45 °C + Alarm blocking OFF	3s	PT100
oSX84	Stop failure	Not Safety stop state after Engine stop + 40sec delay (Safety stop state : 0 RPM + 5 sec)	0s	0~10KHz

* It can set up at MCU unit(U3)

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
Page.no.: 15 OF 16		

CODE	NAME	ALARM CONDITION or SET POINT	TIME DELAY	SENSOR TYPE
oPAL71	LT water press. Inlet low	PT71 : Engine Running +20 sec delay + 0.4 + Static (kgf/㎠ or bar) +Alarm blocking OFF * Set value : it can set up at MCU unit (U3)	3s	4~20mA
oPAL63	Lub. oil press. TC, low	PT63 : Set point + Alarm blocking OFF T/C MAKER / T/C TYPE / ALARM KBB / ST-SERIES / 1.5 bar ABB / TPS-SERIES / 1.5 bar ABB / A130-145 / 3.0 bar ABB / A150-155 / 1.3 bar ABB / TPL-SERIES / 1.3 bar NAPEIRE / NA-SERIES / 1.3 bar MET / 30SRC / 0.6 bar	3s	4~20mA
oSAH42	High TC rpm	SE42 : set point It can be set up at MCU unit (U3)	10s	0~3KHz
oTAH26-B	TC temp. inlet B, high	TE26-B : 620 °C	10s	THERMOCOUPLE
oTAH76-2	HT water. temp. high	TE76 : 93 °C	3s	Pt100
oTAH25-1	High exh. gas temp cyl.1	TE25-1 : 580 °C	60s	THERMOCOUPLE
oTAH25-2	High exh. gas temp cyl.2	TE25-2 : 580 °C	60s	THERMOCOUPLE
oTAH25-3	High exh. gas temp cyl.3	TE25-3 : 580 °C	60s	THERMOCOUPLE
oTAH25-4	High exh. gas temp cyl.4	TE25-4 : 580 °C	60s	THERMOCOUPLE
oTAH25-5	High exh. gas temp cyl.5	TE25-5 : 580 °C	60s	THERMOCOUPLE
oTAH25-6	High exh. gas temp cyl.6	TE25-6 : 580 °C	60s	THERMOCOUPLE
oTAH25-7	High exh. gas temp cyl.7	TE25-7 : 580 °C	60s	THERMOCOUPLE
oTAH25-8	High exh. gas temp cyl.8	TE25-8 : 580 °C	60s	THERMOCOUPLE
oTAH25-9	High exh. gas temp cyl.9	TE25-9 : 580 °C	60s	THERMOCOUPLE
oUX95-1	Monitoring system failure (Control system)	Internal CAN communication. error (Test method : MCU unit (U3) flat cable open)	5s	
oSE42	Tubocharger tacho failure	PT61 : 3(kgf/㎠ or bar) + 10sec delay Turbocharger RPM < 1000RPM + 5sec delay	5s	0~3kHz
iTE26-B	Exh. gas temp. inlet B TC	TE26-B : INDICATION (0~800 °C) Sensor OPEN (1FFF)		THERMOCOUPLE
⚠1 iTE26-C	Exh. gas temp. inlet C TC	TE26-C : INDICATION (0~800 °C) Sensor OPEN (1FFF)		THERMOCOUPLE
iPI52	Fuel oil press. Fliter inlet	PT52 : INDICATION (0~16 kgf/㎠ or bar)	-	4~20mA
⚠1 oTAH26-C	TC temp. inlet C, high	TE26-C : 620 °C	10s	THERMOCOUPLE
oUG25	Gov. fault (Only "UG25+" governor)	Gov. fault signal IN (from Governor)	0s	N.C CONTACT
oSE47-2	Safety system Tacho failure	SE47-2 OPEN or Break	0s	0~10kHz
oSE47-1	Control system Tacho failure	SE47-1 OPEN or Break	0s	0~10kHz
iPSL62-1	Lub. oil inlet low press, trip from control	Control : PT62 2.5(kgf/㎠ or bar) + Alarm blocking off	0s	4~20mA
iTSH76-1	HT water outlet high temp. trip from control	Control : TE76 100°C + Alarm blocking off	0s	Pt100
oSE47-3	Both Tacho failure trip	PT61 : SE47-1 & SE47-2 OPEN or Break + Alarm blocking OFF	0s	0~10kHz

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200414	GML	HJL	PJH	*	Add. TE26-C (page:10,16)	1
191113	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: RS/485,422 COMMUNICATION & COMMUNICATION ALARM TABLE	Ident.no.: B94-185597-7
Page.no.: 16 OF 16		

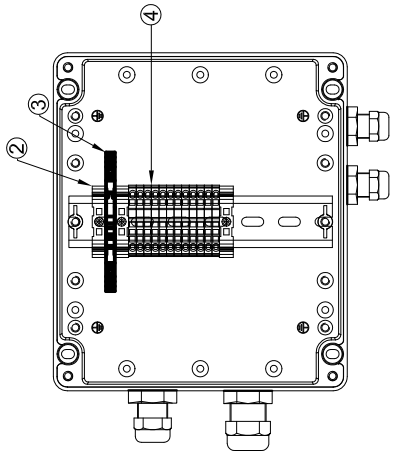
PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN 3 x 9H21/32-900rpm
	MESSRS.	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : AWG VALVE JUNCTION BOX

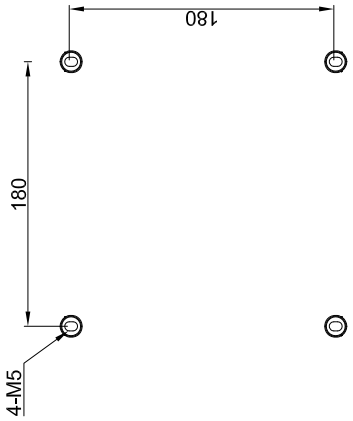
SH8014
CONFIDENTIAL

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 03)	1
191121	GML	HJL	PJH	*	For approval	0

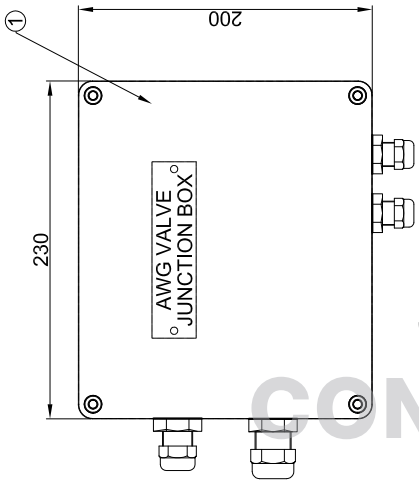
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: COVER	Ident.no.: B94-168018-8
Page.no.: 01 OF 03		



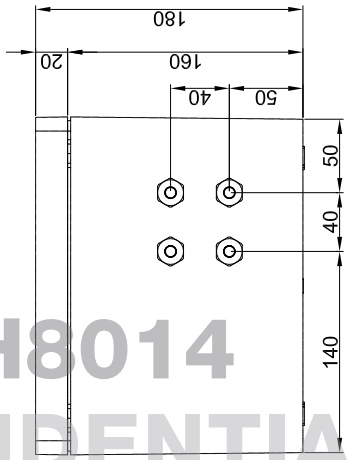
INNER VIEW



FITTING HOLE

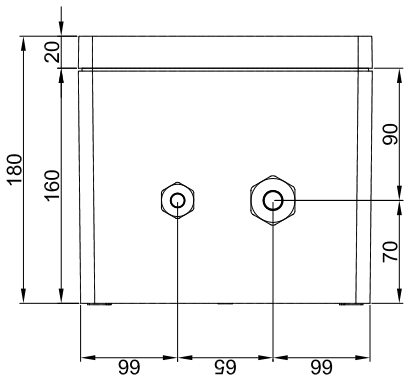


FRONT VIEW



BOTTOM VIEW

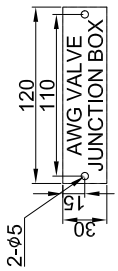
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LEFT SIDE VIEW

NAME PLATE

1. MATERIAL : PHENOL
2. GROUND : WHITE
3. LETTER : BLACK
4. FONT SIZE : 10
5. FONT STYLE : ARIAL



NOTE

1. ENCLOSURE PROTECTION : IP44
2. PAINT COLOR : RAL 7001
3. MASS : abt. 6kg
4. CABLE GLAND - MS-SC TYPE
   - LEFT SIDE : PG16 x 1, PG21 x 1
   - BOTTOM : PG9 x 4
5. Q'TY : 3 EA/SHIP

No.	NAME	SPEC. & MODEL TYPE	Q'TY	REMARK
1	JUNCTION BOX	AL BOX (200x230x180)	1	
2	SIGNAL CONDITIONERS	857-810	1	WAGO
3	END CLAMP	E/NS 35 N(0800886)	3	PHOENIX CONTACT
4	TERMINAL BLOCK	ST 2.5(3031212)	16	PHOENIX CONTACT

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 03)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: AWG VALVE JUNCTION BOX	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: LAYOUT DIAGRAM	Ident.no.: B94-168018-8
Page.no.: 02 OF 03		

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 03)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: AWG VALVE JUNCTION BOX	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: TERMINAL ARRANGEMENT	Ident.no.: B94-168018-8
Page.no.: 03 OF 03		

PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN 3 x 9H21/32-900rpm
	MESSRS.	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : AIR WASTE GATE VALVE CONTROL PANEL

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: COVER	Ident.no.: B94-168019-0
Page.no.: 01 OF 13		

GENERAL SPECIFICATION

1. CLASS & RULE : LR

2. OPERATING TEMP. : 0~60°C

3. CONSTRUCTION OF ENCLOSURE
   - MOUNTING METHOD : WALL MOUNTING TYPE
   - MATERIAL : SHEET STEEL 2.3t
   - PAINT COLOR : RAL 7032
   - PROTECTION DEGREE OF PANEL : IP44

4. NAME PLATE
   - LETTER : ENGLISH
   - MATERIAL : PEHNOLIC

5. ELECTRIC SOURCE / ENGINE
   - AC220V 1PH 60Hz x 1 FEEDER

6. CABLE (INTERNAL)
   - POWER CIRCUIT : 0.6/1kV, SKHF-XPSW, 1.5~2.5 (BLACK)
   - CONTROL CIRCUIT : 0.6/1kV, SKHF-XPSW, 0.75~1.0Sq(GRAY)
     FLAME RETARDENT & HALOGEN FREE TYPE

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7. DISTINGUISH BETWEEN COLOR OF CABLE LUG CAP
   - A.C POWER CIRCUIT : L1-R (RED), L2-S (WHITE), L3-T (BLACK)
   - D.C POWER CIRCUIT : P (WHITE), N (BLACK)
   - CONTROL CIRCUIT : WHITE WITH NUMBERING

8. SCOPE OF SUPPLY
   - AWG CONTROL PANEL : 3 SETS / SHIP

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: GENERAL SPECIFICATION	Ident.no.: B94-168019-0
Page.no.: 02 OF 13		

R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2						
1	200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)
0	191121	GML	HJL	PJH	*	For approval

License Ident.no.:

Info.no.:

Page.no.: 03 OF 13

Type: 9H21/32

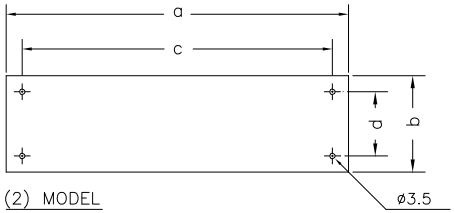
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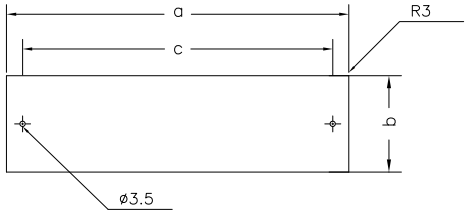
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ident.no.: B94-168019-0

CONFIDENTIAL Sht 01

(1) SIZE





(2) MODEL

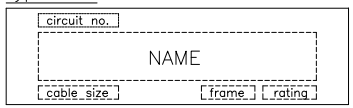
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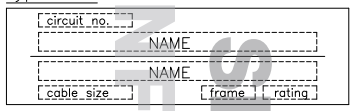
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Type : C



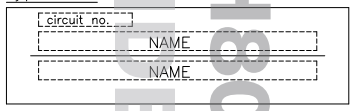
Type : D



Type : L



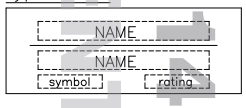
Type : M



Type : GH



Type : 5JH



(3) LETTERS EXAMPLE

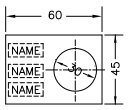
Circuit no.: G1, M19A, GCP2
Cable size : H-TPYC-80
Frame : 60, 100, 225, 250, 400, 1600
Rating : 15A, 400A, INST1000A

1. MATERIAL : PHENOLIC
2. GROUND : WHITE
3. LETTER : BLACK (Rating : RED)
4. "AH", "B", "JH" Type : adhesive Type
5. t : DEPTH (THICKESS)

Type	a	b	c	d	t
0	315	63	302	50	3
01	400	63	387	50	3
1	46	10	38	–	2
2	50	12.5	43	–	2
3	50	20	43	–	2
4	63	16	53	–	2
5	63	25	53	–	2

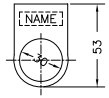
Type	a	b	c	d	t
6	90	25	80	–	2
7	100	31.5	90	–	2
8	150	40	140	–	2
9	200	40	190	30	3
10	40	12.5	–	–	2
11	33	16	–	–	2
12	50	30	43	–	2

Type : SQ



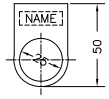
Type : CL

1. material : PHENOLIC
2. letter : black

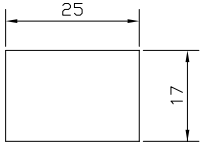


Type : CL1

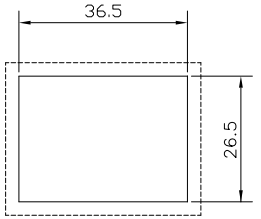
1. material : STS-304
2. letter : black



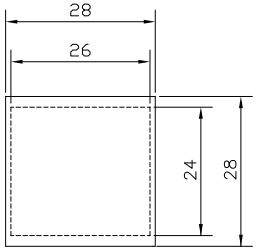
NAME PLATE FOR SQUARE LAMP



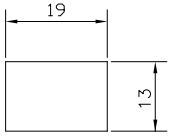
TYPE : RLC
MATERIAL : MAKER SUPPLY
LETTER : BLACK
(EAO LAMP TYPE 02 SERIES)



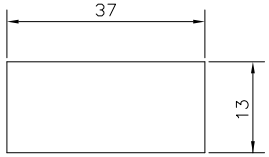
TYPE : RLA
MATERIAL : METHACRYLATE
THICKNESS : 1.0mm
LETTER : BLACK
GROUND : WHITE
(YONG SUNG LAMP TYPE YSNRL34)



TYPE : LN2
MATERIAL : METHACRYLATE
THICKNESS : 1.5mm
GROUND : WHITE
(KUN HUNG LAMP TYPE KH500TL)



TYPE : RLD
MATERIAL : FILM
LETTER : BLACK
(EAO LAMP TYPE 31 SERIES)



TYPE : RLE
(EAO LAMP TYPE 03 SERIES)

NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
1	Q1	MCB	iC60N,2P	63AF/6A	A9F74206	1	SCHNEIDER
2	Q2,3	MCB	iC60N,2P	63AF/2A	A9F74202	2	SCHNEIDER
3	F1,2	MCB	iC60N,2P	63AF/4A	A9F74204	2	SCHNEIDER
4		COMB. BUSBAR	A9XPH257	2P, 57 MODULE		1	SCHNEIDER
5		END PIECE	A9XPE210	2P, C60N		4	SCHNEIDER
6		CONNECTORS	A9XPCM04			4	SCHNEIDER
7							
8	K11~16	RELAY W/BASE	SZR-MY4-X1 SZX-SMF-14N	DC24V, 4c		6	HONEYWELL
9	KA0	RELAY W/BASE	SZR-MY4-N1 SZX-SMF-14N	AC220V, 4c		1	HONEYWELL
10							
11	1P1	CPU	6ES7 215-1AG40-0XB0			1	SIEMENS
12	2P1	8 ANALOG INPUT	6ES7 231-4HF32-0XB0			1	SIEMENS
13	3P1	4 ANALOG OUTPUT	6ES7 232-4HD32-0XB0			1	SIEMENS
14	HP1	HMI PANEL	6AV2 124-0JC01-0AX0			1	SIEMENS
15	HP1	MEMORY CARD	6AV2 181-8XP00-0AX0			1	SIEMENS
16		ETHERNET PLUG	6GK1 901-1BB10-2AA0			2	SIEMENS
17		ETHERNET CABLE	6XV1 840-4AH10			2	SIEMENS
18							
19							
20	G1	POWER SUPPLY	PRO MAX 180W 24V 7.5A		1478120000	1	WEIDMULLER
21	U11	SIGNAL ISOLATOR	ACT20M-AI-AO-S		1176000000	1	WEIDMULLER
22	X0	TERMINAL BLOCK	ZDU 4/3AN	800V, 4Sq		4	WEIDMULLER
23	X0	TERMINAL BLOCK	ZPE 4/3AN	800V, 4Sq		2	WEIDMULLER
24	X1,2	TERMINAL BLOCK	ZDU 2.5/3AN	800V, 2.5Sq		50	WEIDMULLER
25							
26	H1	IND. LAMP	YSPL22-DL-24RFW			1	YONGSUNG
27		POWER OUTLET	04285	AC220V,15A		1	LEGRAND
28							

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:

Type: 9H21/32

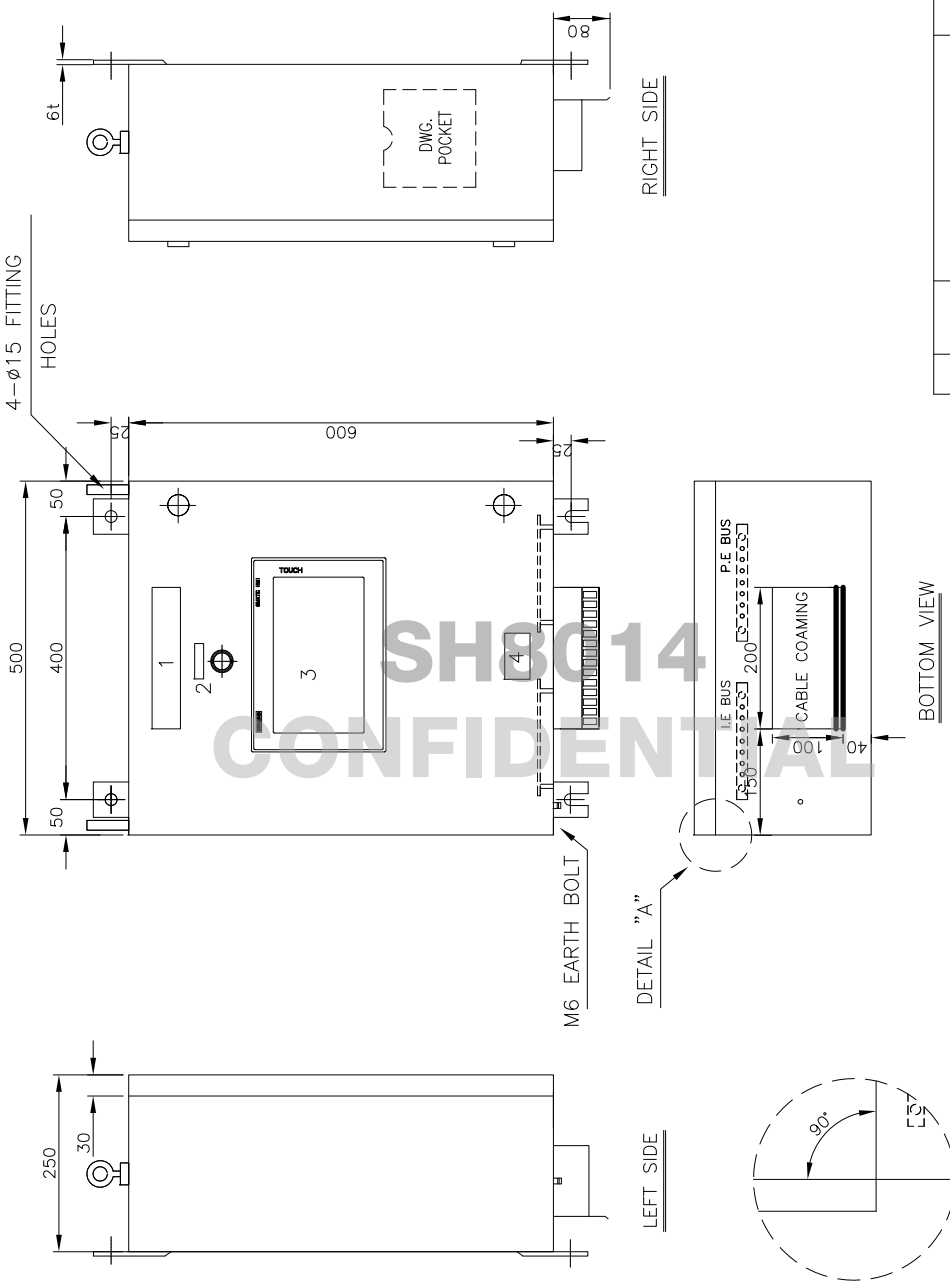
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Info.no.:

Description: PARTS LIST/ENG.

Ident.no.: B94-168019-0

Page.no.: 04 OF 13



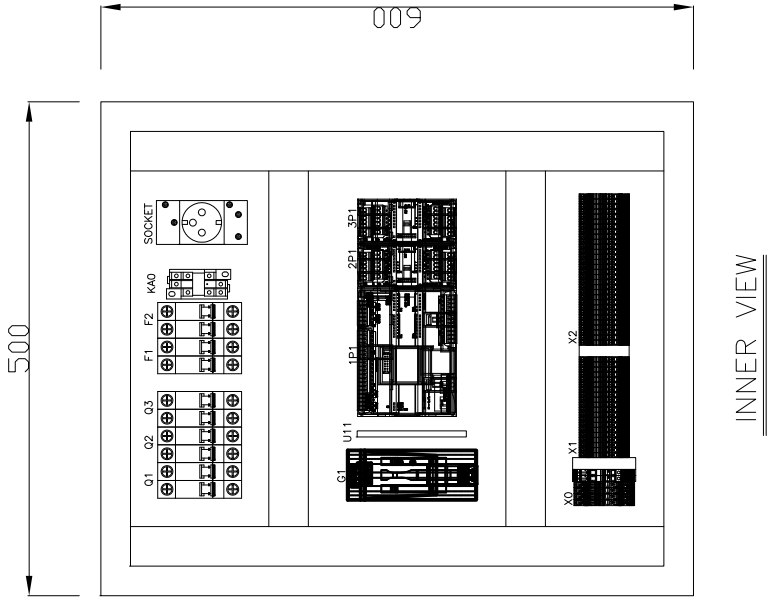
NO.	SYMBOL	DESCRIPTION	NAME PLATE MARK	NAME PLATE TYPE	Q'TY
1		NAME PLATE	NO.1(2,3) AIR WASTE GATE VALVE CONTROL PANEL	8B	3
2	H1	IND. LAMP(WHITE)	SYSTEM ON	2A	3
3	HP1	HMI PANEL			3
4		NAME PLATE	MAKER NAME		3

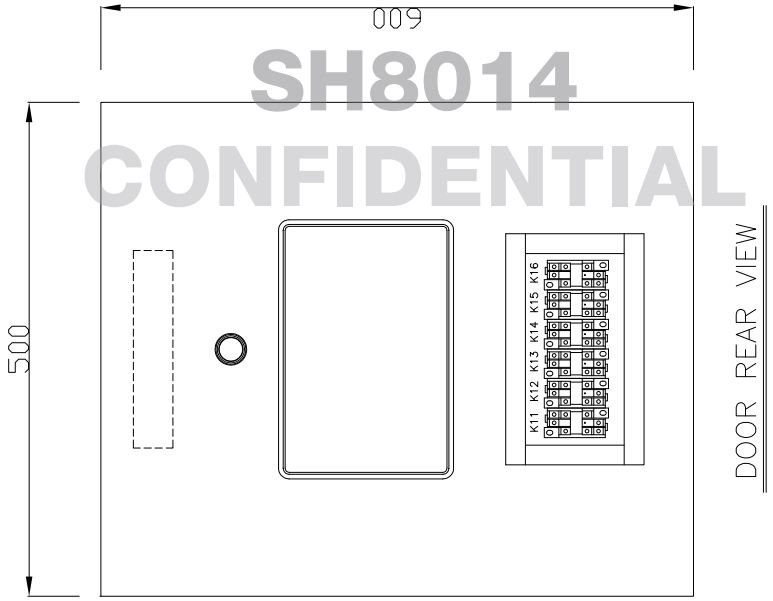
NOTE
1. MATERIAL : SHEET STEEL, 2.3t
2. PAINT COLOR : RAL 7032
3. ENCLOSURE PROTECTION : IP44
4. WEIGHT : ABT. 60kg
5. Q'TY : 3 SET / SHIP

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: OUTLINE VIEW	Ident.no.: B94-168019-0
Page.no.: 05 OF 13		

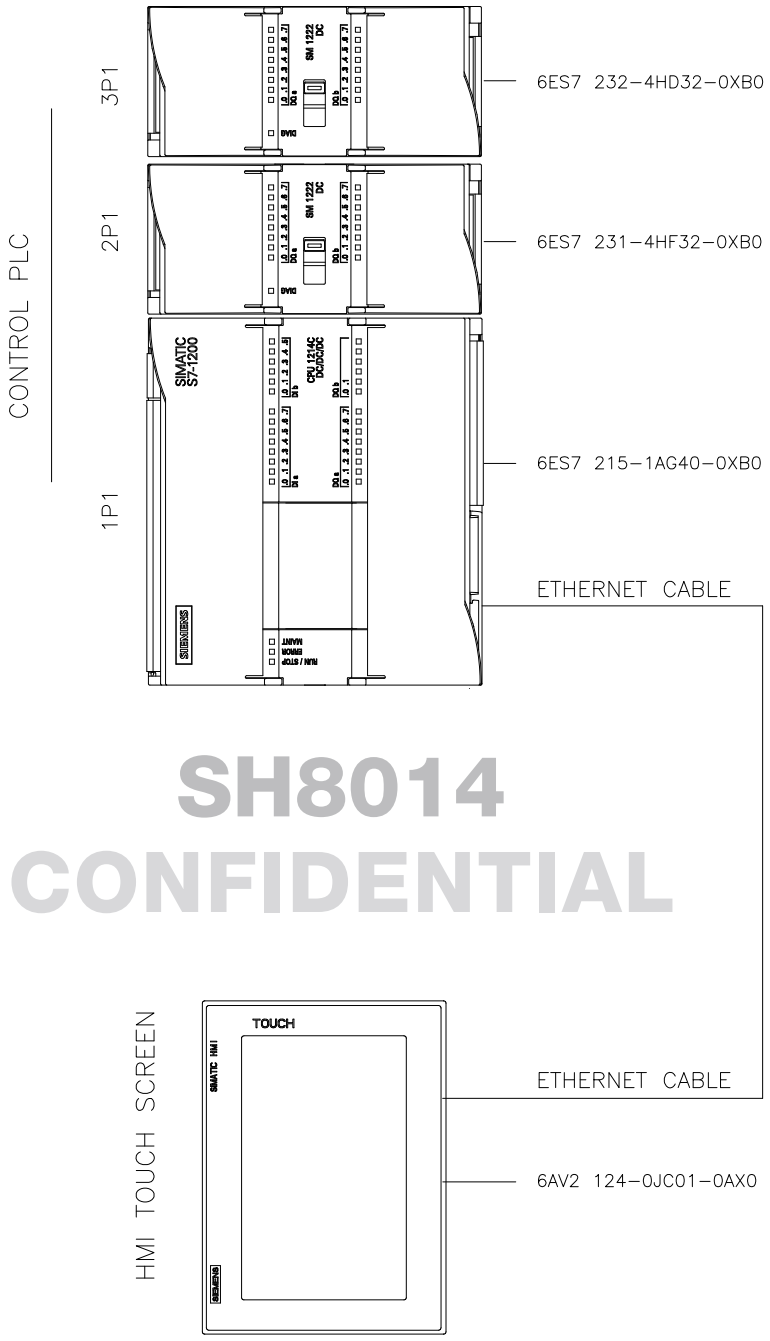




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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

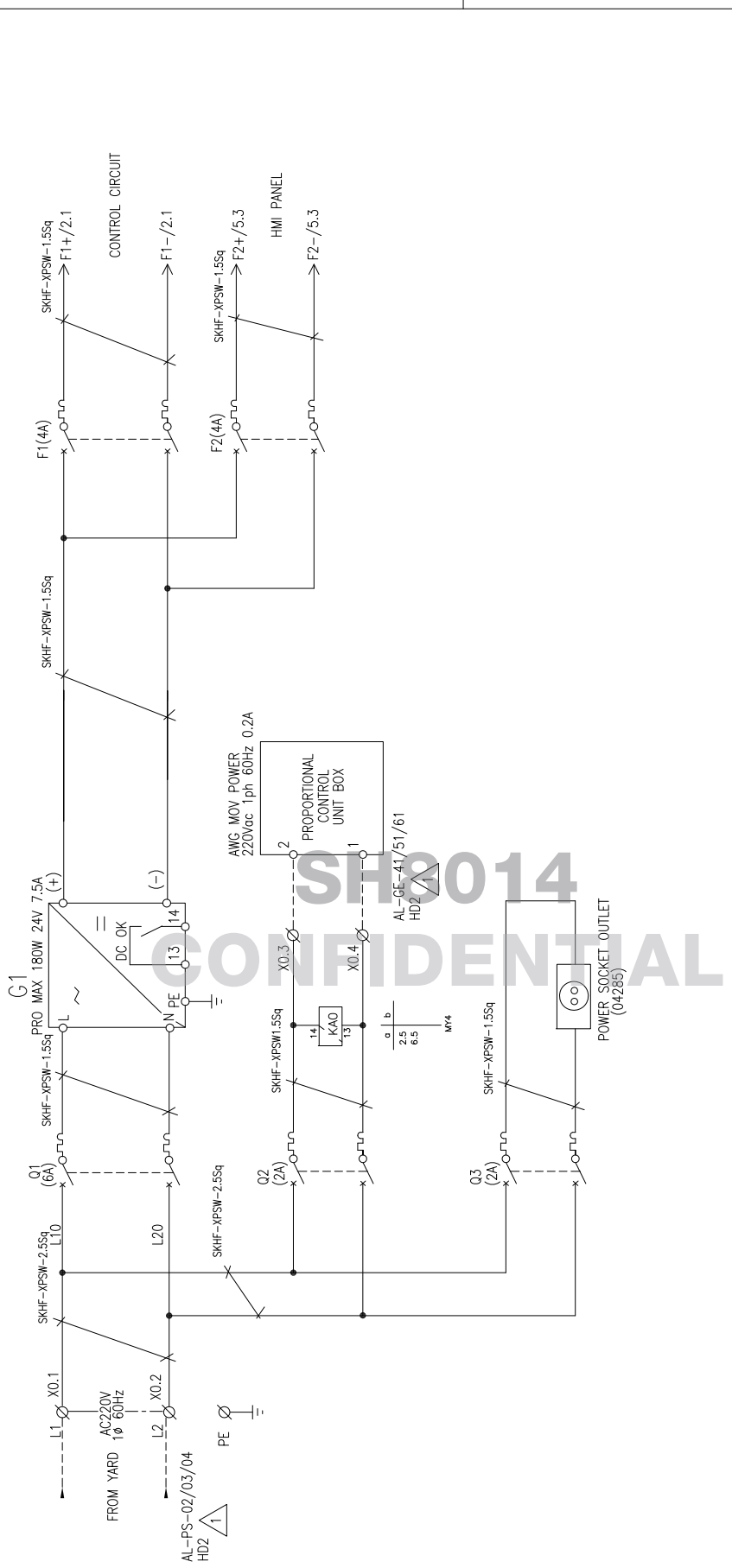
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: INTERNAL ARRANGEMENT	Ident.no.: B94-168019-0
Page.no.: 06 OF 13		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

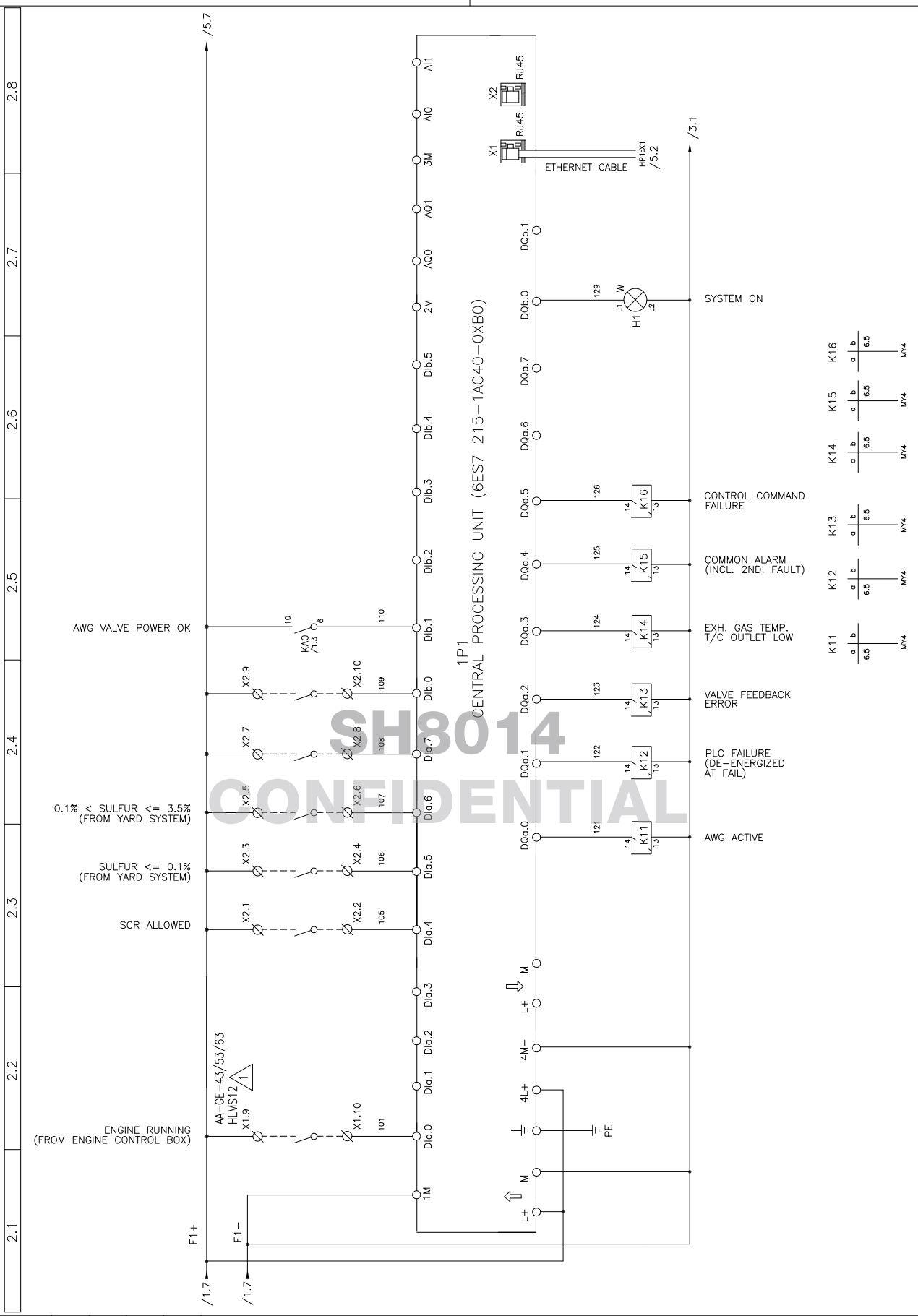
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: PLC CONFIGURATION	Ident.no.: B94-168019-0
Page.no.: 07 OF 13		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

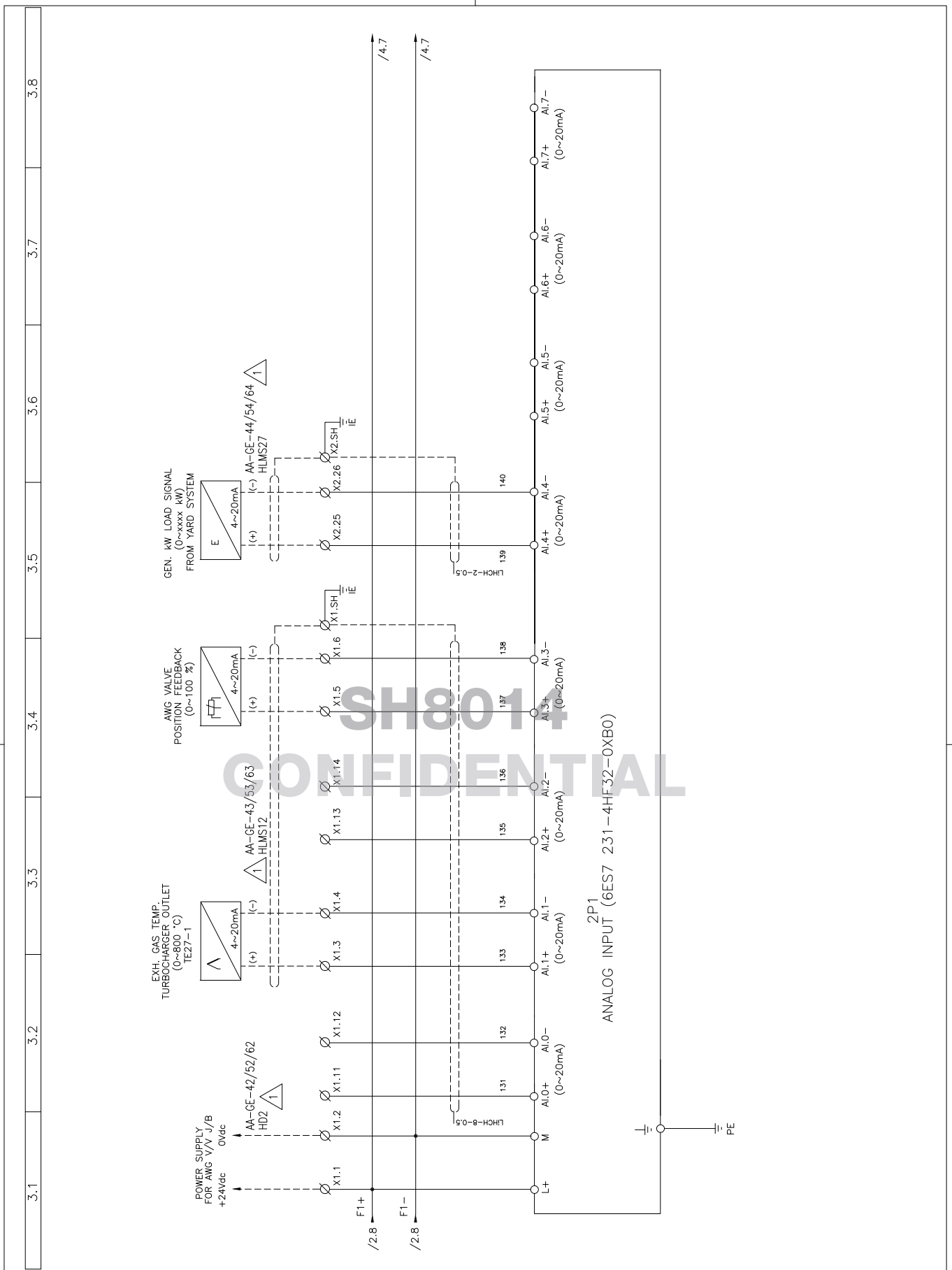
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CIRCUIT DIAGRAM	Ident.no.: B94-168019-0
Page.no.: 08 OF 13		



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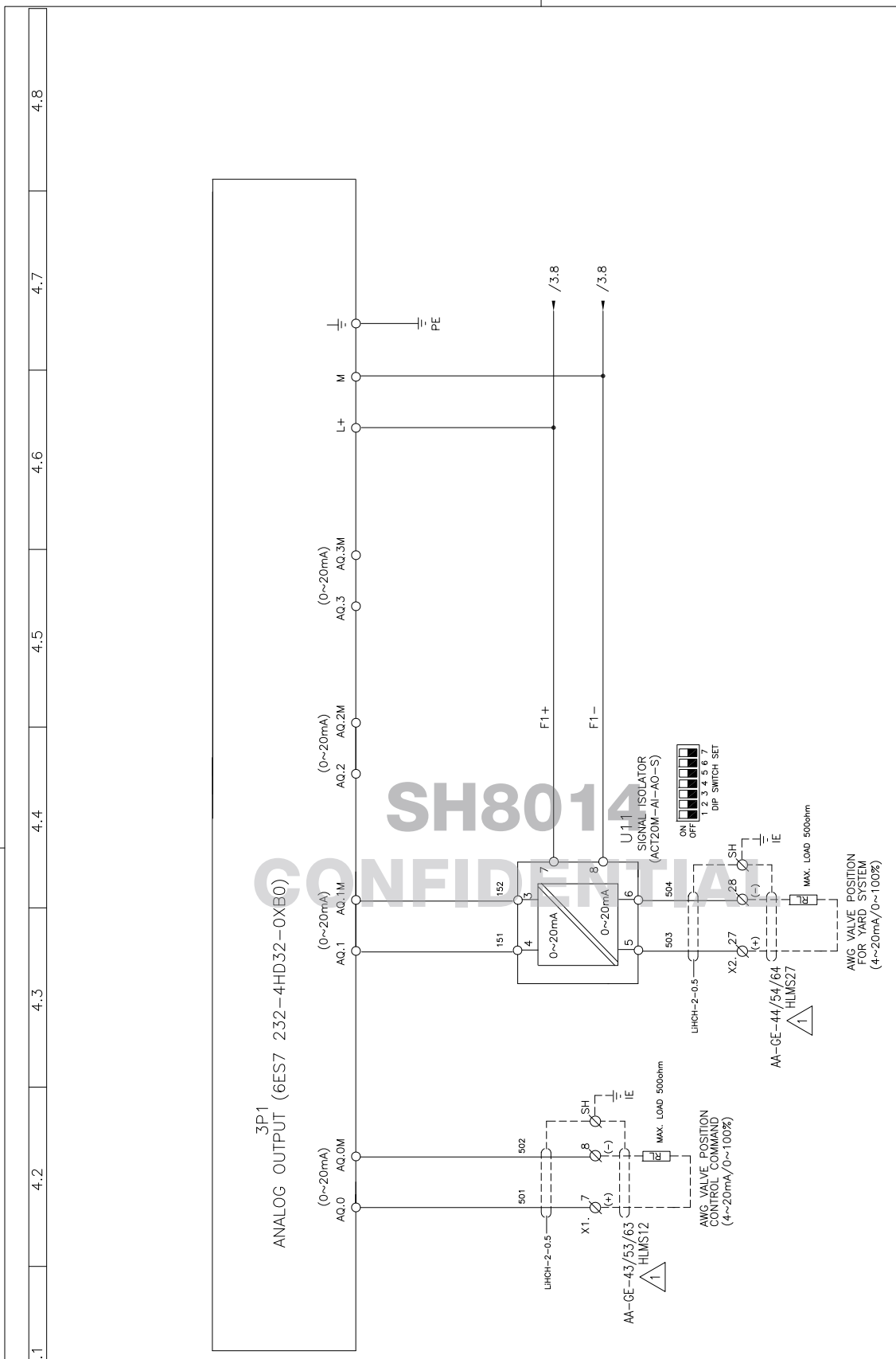
Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CIRCUIT DIAGRAM	Ident.no.: B94-168019-0
Page.no.: 09 OF 13		



Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

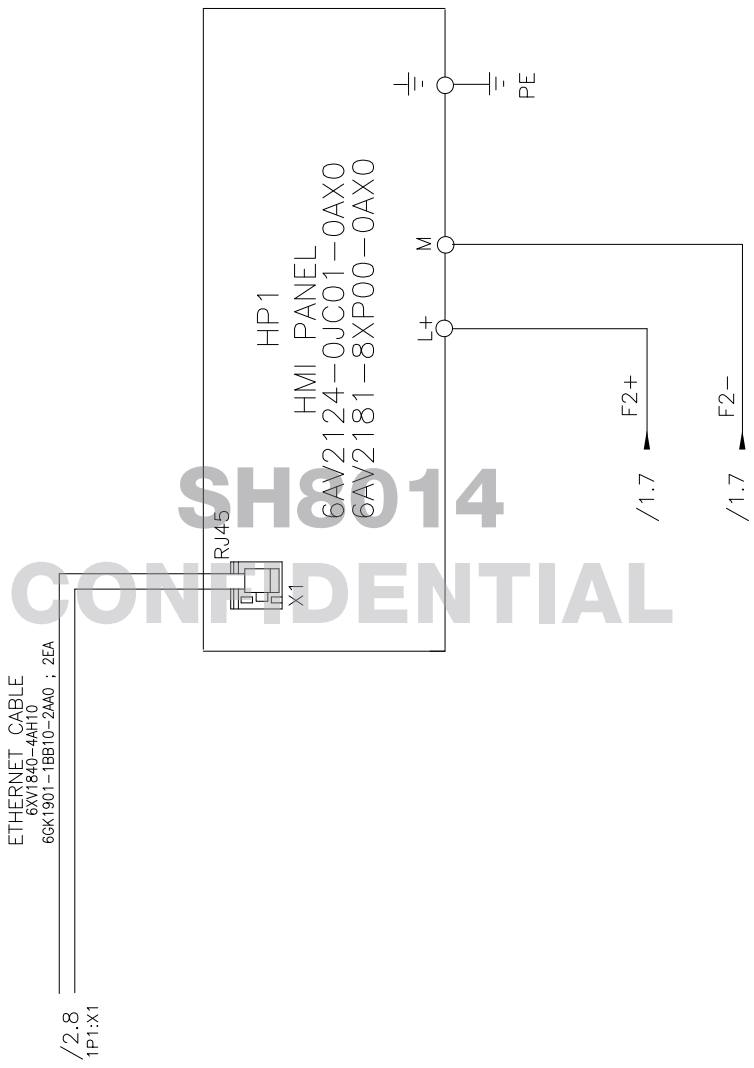
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CIRCUIT DIAGRAM	Ident.no.: B94-168019-0
Page.no.: 10 OF 13		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

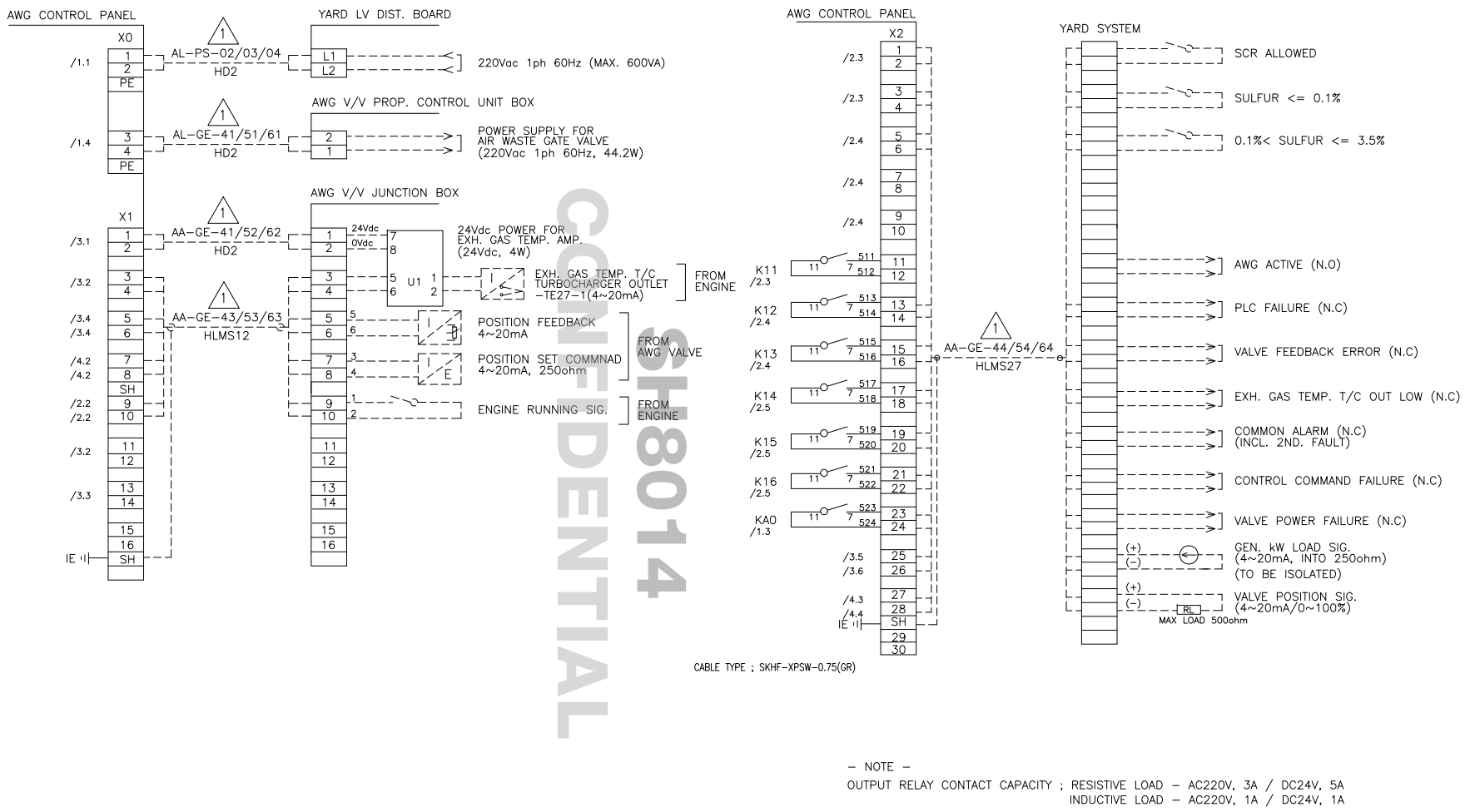
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CIRCUIT DIAGRAM	Ident.no.: B94-168019-0
Page.no.: 11 OF 13		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
						2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: CIRCUIT DIAGRAM	Ident.no.: B94-168019-0
Page.no.: 12 OF 13		



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– NOTE –

OUTPUT RELAY CONTACT CAPACITY ; RESISTIVE LOAD – AC220V, 3A / DC24V, 5A
INDUCTIVE LOAD – AC220V, 1A / DC24V, 1A

R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5						
4						
3						
2						
1	200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 08, 09, 10, 11, 13)
0	191121	GML	HJL	PJH	*	For approval

License Ident.no.:

Info.no.:

Page.no.: 13 OF 13

Type: 9H21/32

Description: TERMINAL ARRANGEMENT

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Ident.no.: B94-168019-0

PLAN HISTORY	ENGINE TYPE	HYUNDAI-HiMSEN 3 x 9H21/32-900rpm
	MESSRS.	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : POWER SUPPLY UNIT FOR D/G ENGINE

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: COVER	Ident.no.: B94-168016-4
Page.no.: 01 OF 07		

GENERAL SPECIFICATION

1. CLASS & RULE : LR

2. AMBIENT TEMP. : 45°C

3. CONSTRUCTION OF ENCLOSURE
   - MOUNTING METHOD : WALL MOUNTING
   - MATERIAL : SHEET STEEL, 2.3t
   - PAINT COLOR : RAL 7032
   - PROTECTION DEGREE OF ENCLOSURE : IP44

4. LETTER OF DOCUMENT & DRAWING : ENGLISH

5. NAME PLATE
   - LETTER : ENGLISH
   - MATERIAL : PHENOLIC

6. ELECTRIC SOURCE
   - AC220V, 1PH, 60Hz FROM MAIN - 1FEEDER
   - AC220V, 1PH, 60Hz FROM EM'CY - 1FEEDER

7. CABLE (INTERNAL)
   - POWER CIRCUIT : 0.6/1kV, SKHF-XPSW-2.5mm² △2
   - CONTROL CIRCUIT : 0.6/1kV, SKHF-XPSW-0.75~1.5mm²
     HALOGEN FREE & FLAME RETARDANT TYPE

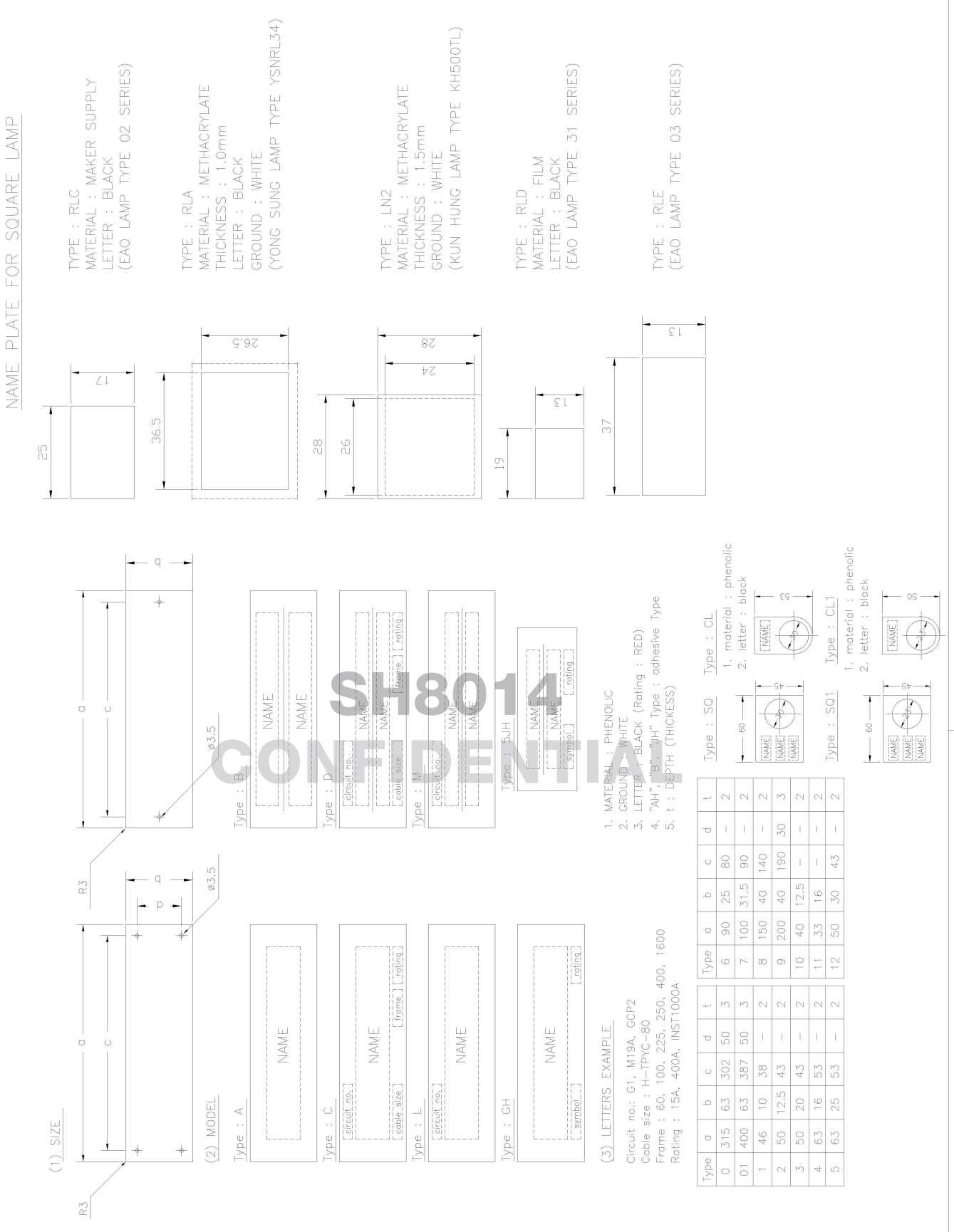
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8. DISTINGUISH BETWEEN COLOR OF CABLE LUG CAP
   - D.C POWER CIRCUIT : P (WHITE), N (BLACK)
   - A.C POWER CIRCUIT : R-U(RED), S-V(WHITE), T-W(BLACK)
   - CONTROL CIRCUIT : WHITE WITH NUMBERING

9. SCOPE OF SUPPLY : 1SET/SHIP

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: GENERAL SPECIFICATION	Ident.no.: B94-168016-4
Page.no.: 02 OF 07		



Type	a	b	c	d	t
0	315	63	302	50	3
01	400	63	387	50	3
1	46	10	38	–	2
2	50	12.5	43	–	2
3	50	20	43	–	2
4	63	16	53	–	2
5	63	25	53	–	2

Type	a	b	c	d	t
6	90	25	80	–	2
7	100	31.5	90	–	2
8	150	40	140	–	2
9	200	40	190	30	3
10	40	12.5	–	–	2
11	33	16	–	–	2
12	50	30	43	–	2

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NAME PLATE MODEL	Ident.no.: B94-168016-4
Page.no.: 03 OF 07		

NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
1	Q1,2	M.C.B	IC60N	10A, 2P		2	SCHNEIDER
2	Q3,4	M.C.B	IC60N	6A, 2P		2	SCHNEIDER
3	G1,G2	POWER SUPPLY	QUINT-PS/1AC/24DC/10			2	PHOENIX
4	U1	UPS	QUINT-UPS/24DC/24DC/10			1	PHOENIX
5	B1	BATTERY	UPS-BAT/VRLA/24DC/7.2AH			1	PHOENIX
6	K1,2	RELAY W/BASE	G2R-2-SND P2RF-08	DC24V, 2c		2	OMRON
7	H1,2	PILOT LAMP	YSAPL22-DL24RHW	24V,22ø	WHITE	2	YONGSUNG
8	V1	DIODE MODULE	KD55F160	55A,1600V		1	SANREX
9	IRM	INSULATION MONTOR	ISD24L	DC24V		1	LUXCO
10		TERMINAL BLOCK	ZDU 2.5-2/3AN	800V,2.5Sq	X2	15	WEIDMULLER
11		FILTER	NSYCAG125LPF			4	SCHNEIDER
12							
13							
14							
15							

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:

Info.no.:

Page.no.: 04 OF 07

Type: 9H21/32

Description: PARTS LIST FOR G/E POWER SUPPLY UNIT

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ident.no.: B94-168016-4

NOTE

1. MATERIAL : SHEET STEEL, 2.3t
2. PAINT COLOR : RAL 7032
3. PROTECTION DEGREE : IP44
4. SPECIFICATIONS : – INPUT : AC220V, 1ø, 60Hz
   – OUTPUT : DC24V 7A
   – BACK UP : DC24V 7A, 30min.
5. WEIGHT : abt 75kg
6. Q'TY : 1 SET / SHIP

NO.	SYMBOL	DESCRIPTION	NAME PLATE LETTERS	TYPE	Q'TY	REMARK
1		NAME PLATE	NO.3 G/E POWER SUPPLY YNIT	8A	1	
2	H1	IND.LAMP	MAIN AC SOURCE	2A	1	WHITE
3	H2	IND.LAMP	EM'CY AC SOURCE	2A	1	WHITE
4		NAME PLATE	MAKER NAME		1	



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:

Info.no.:

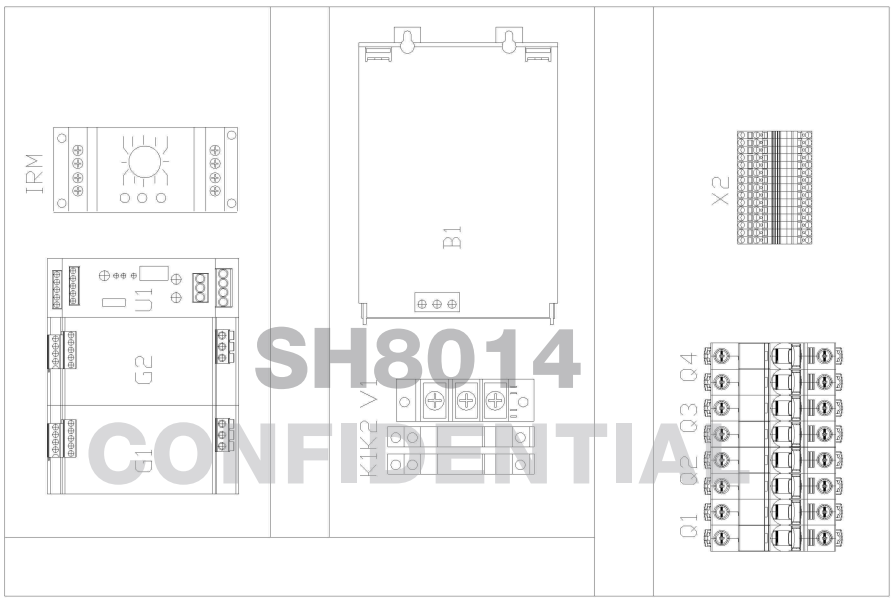
Page.no.: 05 OF 07

Type: 9H21/32

Description: OUTLINE FOR G/E POWER SUPPLY UNIT

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

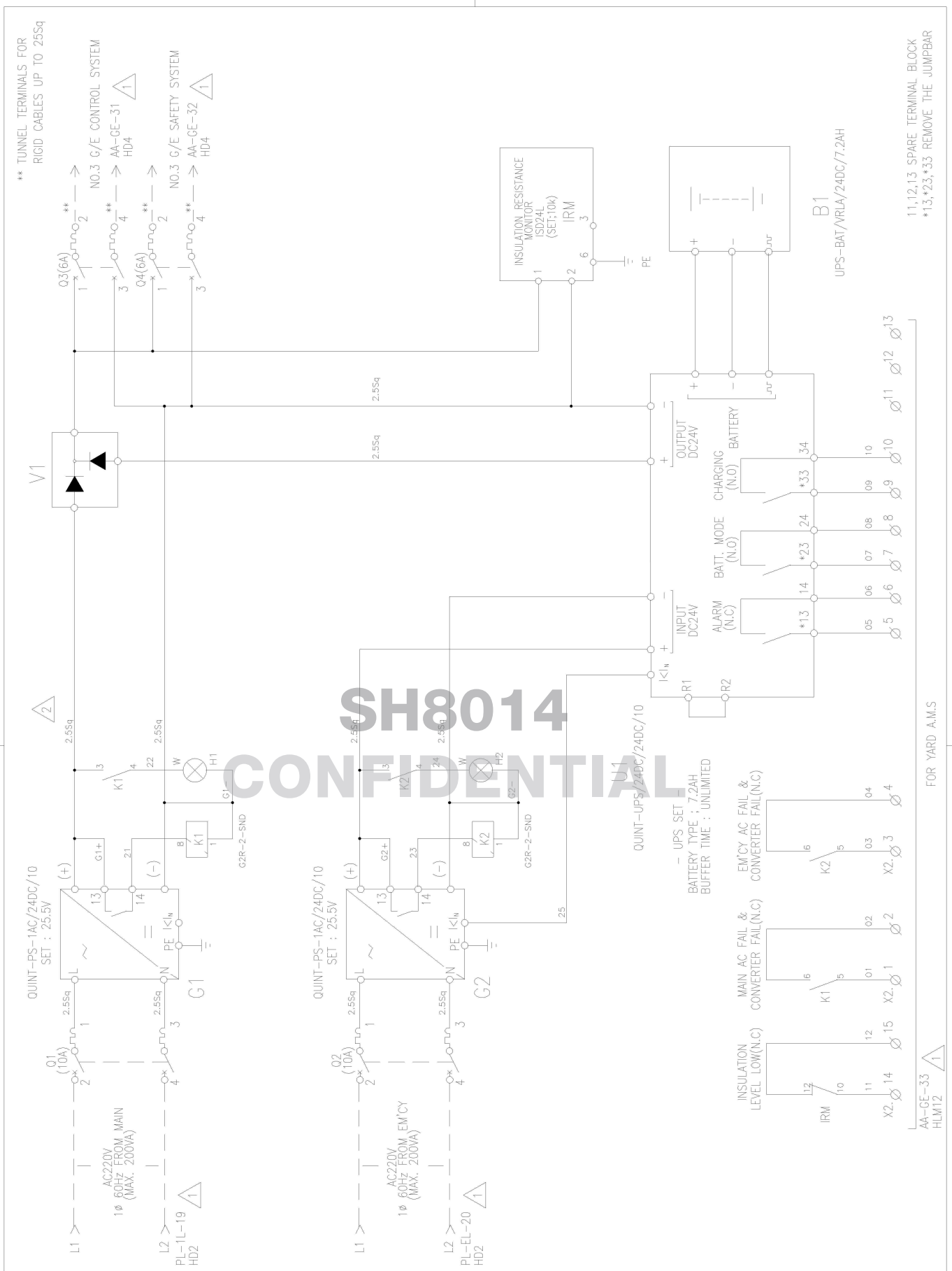
Ident.no.: B94-168016-4



SH8014
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: INTERNAL ARRANGEMENT G/E POWER SUPPLY UNIT	Ident.no.: B94-168016-4
Page.no.: 06 OF 07		



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
						5
						4
						3
200331	GML	HJL	PJH	*	Chg. internal cable size(Revised sht. no.: 02, 07)	2
200225	GML	HJL	PJH	*	Add. Yard cable spec.(Revised sht. no.: 05, 07)	1
191121	GML	HJL	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: CONNECTION DIAGRAM G/E POWER SUPPLY UNIT	Ident.no.: B94-168016-4
Page.no.: 07 OF 07		

PLAN HISTORY	ENGINE TYPE	HYUNDAI - HiMSEN 3 x 9H21/32 - 900rpm
	MESSRS.	HYUNDAI SAMHO HEAVY INDUSTRIES
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : PRE-LUB. OIL PUMP STARTER AND J.W PREHEATER STARTER

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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info.no.:	Description: COVER	Ident.no.: B94-185601-1
Page.no.: 01 OF 12		

GENERAL SPECIFICATION

1. CLASS. & RULE : LR

2. AMBIENT TEMP. : 45°C

3. CONSTRUCTION OF PANEL
- MOUNTING METHOD : WALL MOUNTING
- MATERIAL : SPHC 2.3t
- PAINT COLOR : RAL 7032
- PROTECTION DEGREE OF PANEL : IP44
- MAINTENANCE SPACE : FRONT SIDE
- CABLE ENTRANCE : COAMING TYPE

4. NAME PLATE
- LETTER : ENGLISH
- MATERIAL : SUS-316

5. ELECTRIC SOURCE/ SHIP
- AC440V, 3PH, 60Hz x 3FEEDERS (MAIN SOURCE)

(FOR AC440V, THE MINIMUM ONE FEEDER MUST BE CONNECTED FROM EM'CY SOURCE)

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6. CABLE (INTERNAL)
- POWER CIRCUIT : 660V, 2.0mm^2~6.0mm^2 (BLACK)
- CONTROL CIRCUIT : 500V, 1.25mm^2 (GRAY)

7. DISTINGUISH BETWEEN COLOR OF CABLE LUG CAP
- A.C POWER CIRCUIT : R(U) : RED, S(V) : WHITE, T(W) : BLACK
- D.C POWER CIRCUIT : P(+) : WHITE, N(-) : BLACK
- CONTROL CIRCUIT : WHITE WITH NUMBERING

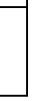
8. SCOPE OF SUPPLY : 1SET/SHIP

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: GENERAL SPECIFICATION	Ident.no.: B94-185601-1
Page.no.: 02 OF 12		

GRAPHICAL SYMBOLS

SYMBOL	NAME
	RESISTOR
	THERMO COUPLE
	FUSE
	EARTH(GROUND) CONNECTION
	AMPERE METER
	VOLT METER
	WATT METER
	SURGE ABSORB
	CONVERTER, TRANSMITTER
	3 PHASE MOTOR
	PILOT LAMP INDICATING LAMP
	DIODE
	CAPICIATOR
	OPEN CONTACT
	CLOSE CONTACT

SYMBOL	NAME
	MAKE CONTACT (NORMAL OPEN)
	BREAK CONTACT (NORMAL CLOSE)
	MOMENTARY SWITCH MANUAL OPERATED WITH 1 NO
	MOMENTARY SWITCH MANUAL OPERATED WITH 1 NC
	MAINTAIN SWITCHS MANUAL OPERATED WITH 1 NO
	MAINTAIN SWITCHS MANUAL OPERATED WITH 1 NC
	CAM SWITCH MANUAL OPERATED WITH 1 NO
	CAM SWITCH MANUAL OPERATED WITH 1 NC
	LEVEL S/W
	PRESSURE S/W
	DELAY OPEN CONTACT
	DELAY CLOSE CONTACT
	THERMAL CONTACT
	MCB, MCCB
	PLUG & SOCKET

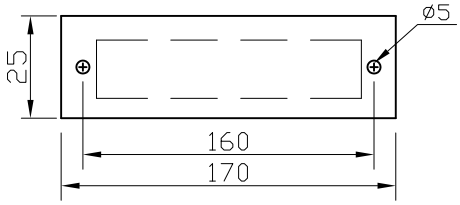
SYMBOL	NAME
	VALVE
	TRANSFORMER
	RECTIFIER
	TERMINAL BLOCK
	BELL
	BUZZER
	BATTERY
	CONTACTOR RELAY
	TIMER (ON DELAY)
	TIMER (OFF DELAY)

SHEET 4
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

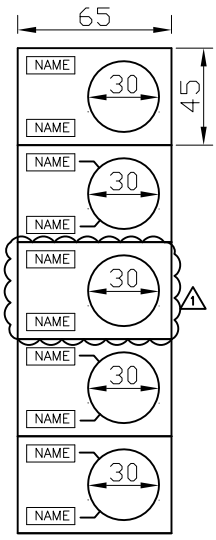
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: SYMBOL LIST	Ident.no.: B94-185601-1
Page.no.: 03 OF 12		

-MATERIAL : SUS-316
-GROUND : WHITE
-LETTER : BLACK



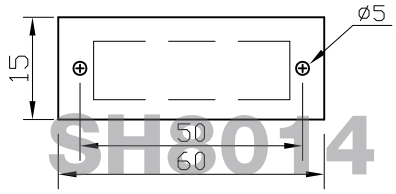
DESCRIPTION	Q'TY
NO.1 G/E PRELUB. OIL PUMP STARTER	1
NO.2 G/E PRELUB. OIL PUMP STARTER	1
NO.3 G/E PRELUB. OIL PUMP STARTER	1
NO.1 G/E JACKET WATER PREHEATER STARTER	1
NO.2 G/E JACKET WATER PREHEATER STARTER	1
NO.3 G/E JACKET WATER PREHEATER STARTER	1

-MATERIAL : SUS-316
-GROUND : WHITE
-LINE : BLACK
-LETTER : BLACK



DESCRIPTION	Q'TY
SOURCE	6
RUNNING / START	
⚠1 FAILURE	
STOP	
MANUAL – AUTO	

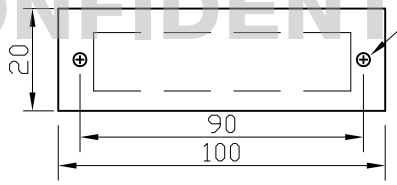
-MATERIAL : SUS-316
-GROUND : WHITE
-LETTER : BLACK



DESCRIPTION	Q'TY
SOURCE(AC440V)	6
LAMP TEST	3

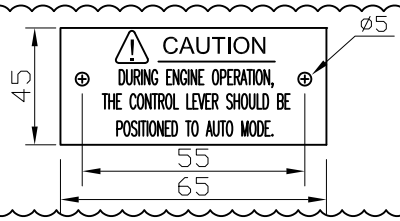
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-MATERIAL : SUS-316
-GROUND : WHITE
-LETTER : RED



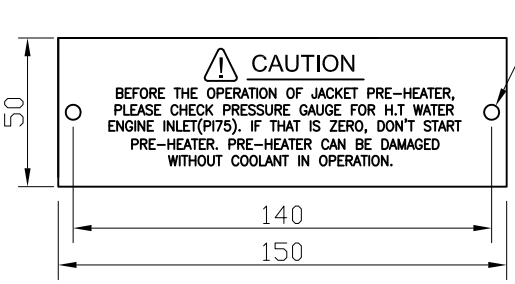
DESCRIPTION	Q'TY
NO.1 G/E EM'CY STOP	1
NO.2 G/E EM'CY STOP	1
NO.3 G/E EM'CY STOP	1

⚠1
-MATERIAL : SUS-316
-GROUND : WHITE
-LETTER : RED
-SYMBOL : RED



DESCRIPTION	Q'TY
CAUTION PLATE	3

-MATERIAL : SUS-316
-GROUND : WHITE
-LETTER : RED
-SYMBOL : RED



DESCRIPTION	Q'TY
CAUTION PLATE	1

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

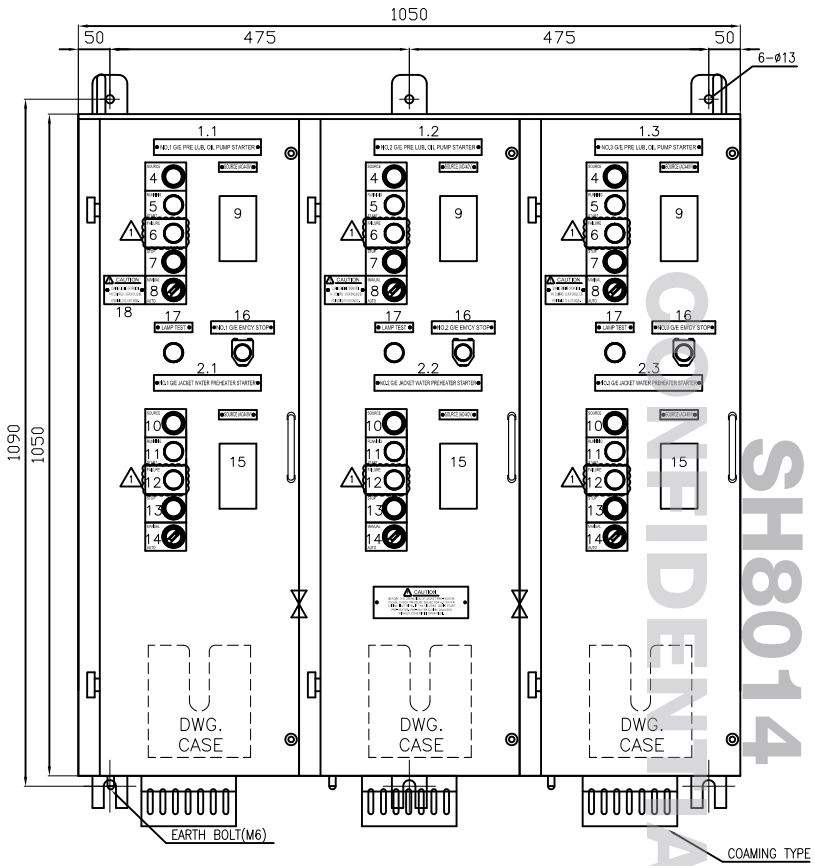
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NAME PLATE MODEL	Ident.no.: B94-185601-1
Page.no.: 04 OF 12		

NO.	SYMBOL	NAME	TYPE	SPEC.	REMARK	Q'TY	MAKER
1	1~3Q1	MCCB	HGM30E	3P 16A		3	HYUNDAI
2	1~3K11	MAGNETIC CONTACTOR	HGC12 22NR	AC220V		3	HYUNDAI
		AUX. CONTACT	HGC TB20NS	2a		3	HYUNDAI
3	1~3F11	E.O.C.R	DSP30-SS-NY	AC220V	3~30A	3	SAMHWA DSP
4	1~3TR1	TRANSFORMER	HCW-96,100VA	440/20/220V		3	H.K.T
5	1~3K12	RELAY W/BASE	DRM570730L	AC220V, 4c		3	WEIDMULLER
6	1~3H10	PILOT LAMP	YSPL3-024AW	AC24V	WHITE	3	YONG SUNG
7	1~3H11 1~3S1	P.B with LAMP	YSNPBL3-024AG	AC24V	GREEN	3	YONG SUNG
1 8	1~3H12	PILOT LAMP	YSPL3-024AR	AC24V	RED	3	YONG SUNG
9	1~3S2	PUSH BUTTON	YSAP13-11R	1a1b	RED	3	YONG SUNG
10	1~3CS1	SELECTOR S.W	YSAR3-222K	2a2b		3	YONG SUNG
11	1~3F1,2,3,4,5	FUSE	FR10GG50V1 1A	WITH HOLDER(CMS101)		15	FERRAZ
12	1~3Q2	MCCB	HGM30E	3P 32A		3	HYUNDAI
13	1~3K21	MAGNETIC CONTACTOR	HGC32 22NR	AC220V		3	HYUNDAI
14		AUX. CONTACT	HGC TB20NS	2a		3	HYUNDAI
15	1~3F12	E.O.C.R	DSP30-ES2-NY	AC220V	3~30A	3	SAMHWA DSP
16	1~3TR2	TRANSFORMER	HCW-96,100VA	440/20/220V		3	H.K.T
17	1~3K22 1~3K23	RELAY W/BASE	DRM570730L	AC220V, 4c		6	WEIDMULLER
18	1~3H20	PILOT LAMP	YSPL3-024AW	AC24V	WHITE	3	
19	1~3H21 1~3S3	P.B with LAMP	YSNPBL3-024AG	AC24V	GREEN	3	YONG SUNG
1 20	1~3H22	PILOT LAMP	YSPL3-024AR	AC24V	RED	3	YONG SUNG
21	1~3S4	PUSH BUTTON	YSAP13-11R	1a1b	RED	3	YONG SUNG
22	1~3CS2	SELECTOR S.W	YSAR3-211K	1a1b		3	YONG SUNG
23	1~3F6,7,8,9,10	FUSE	FR10GG50V1 1A	WITH HOLDER(CMC101)		15	FERRAZ
24	1~3K13 (14) 1~3K24 2	RELAY W/BASE	DRM570524L	AC24V, 4c	2	(9)	WEIDMULLER
25	1~3ES	P.B with LAMP	A204L-A1E20Q7R-B	2a	24V,50mA	3	DECA
26		PROTECTION COVER	S50-011-03			3	DECA
27		REGISTER	100kΩ			3	
28		TERMINAL BLOCK	600V 60A			9	DONG SEO
29		TERMINAL BLOCK	600V 35A			18	DONG SEO
30		TERMINAL BLOCK	600V 15A			54	DONG SEO
31	1~3LT1	PUSH BUTTON	YSAP13-40B	4a	BLACK	3	YONG SUNG

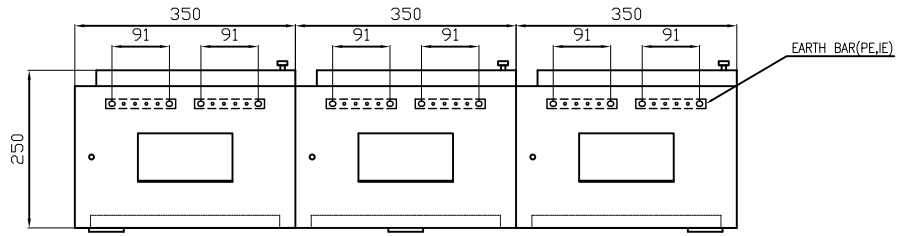
SH8014
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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

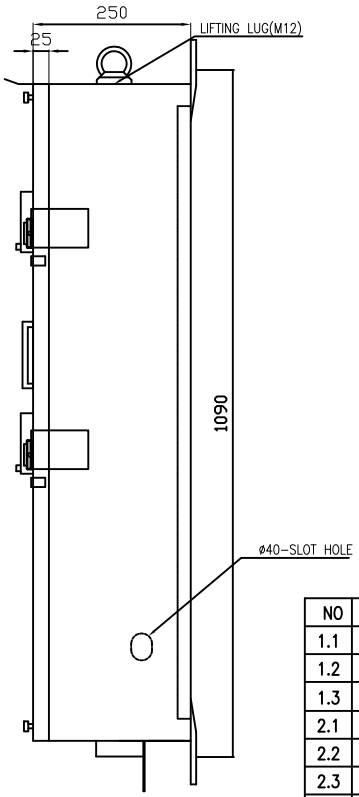
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: PARTS LIST / SHIP	Ident.no.: B94-185601-1
Page.no.: 05 OF 12		



FRONT VIEW



BOTTOM VIEW



SIDE VIEW

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NOTE

1. PAINT COLOR : RAL 7032
2. ENCLOSURE PROTECTION : IP44
3. MATERIAL : SPHC 2.3t
4. MOUNTING METHOD : WALL MOUNTING TYPE
5. WEIGHT : about 140kg / ONE GROUP
6. CABLE ENTRANCE : COAMING TYPE

NO	SYMBOL	NAME PLATE	DESCRIPTION	Q'TY
1.1	NP	NO.1 G/E PRELUB. OIL PUMP STARTER		1
1.2	NP	NO.2 G/E PRELUB. OIL PUMP STARTER		1
1.3	NP	NO.3 G/E PRELUB. OIL PUMP STARTER		1
2.1	NP	NO.1 G/E JACKET WATER PREHEATER STARTER		1
2.2	NP	NO.2 G/E JACKET WATER PREHEATER STARTER		1
2.3	NP	NO.3 G/E JACKET WATER PREHEATER STARTER		1
3	NP	CAUTION		1
4	1~3H10	SOURCE	LAMP (WHITE)	3
5	1~3H11 1~3S1	RUNNING/START	P/B WITH LAMP (GREEN)	3
6	1~3H12	FAILURE	LAMP (RED)	3
7	1~3S2	STOP	P/B S.W (RED)	3
8	1~3CS1	MANUAL – AUTO	SELECTOR S/W	3
9	1~3Q1	SOURCE	MCCB	3
10	1~3H20	FAILURE	LAMP (RED)	3
11	1~3H21 1~3S3	RUNNING/START	P/B WITH LAMP (GREEN)	3
12	1~3H22	FAILURE	LAMP (RED)	3
13	1~3S4	STOP	P/B S.W (RED)	3
14	1~3CS2	MANUAL – AUTO	SELECTOR S/W	3
15	1~3Q2	SOURCE	MCCB	3
16	1~3ES	NO.1~3 G/E EM'CY STOP	P/B S.W WITH COVER (RED)	3
17	1~3LT1	LAMP TEST	P/B S.W (BLACK)	3
18	NP	CAUTION		3

R	Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:
5					*	
4					*	
3	200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)
2	200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)
1	200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)
0	191121	GML	LJH	PJH	*	For approval

Licenser Ident.no.:

Type: 9H21/32

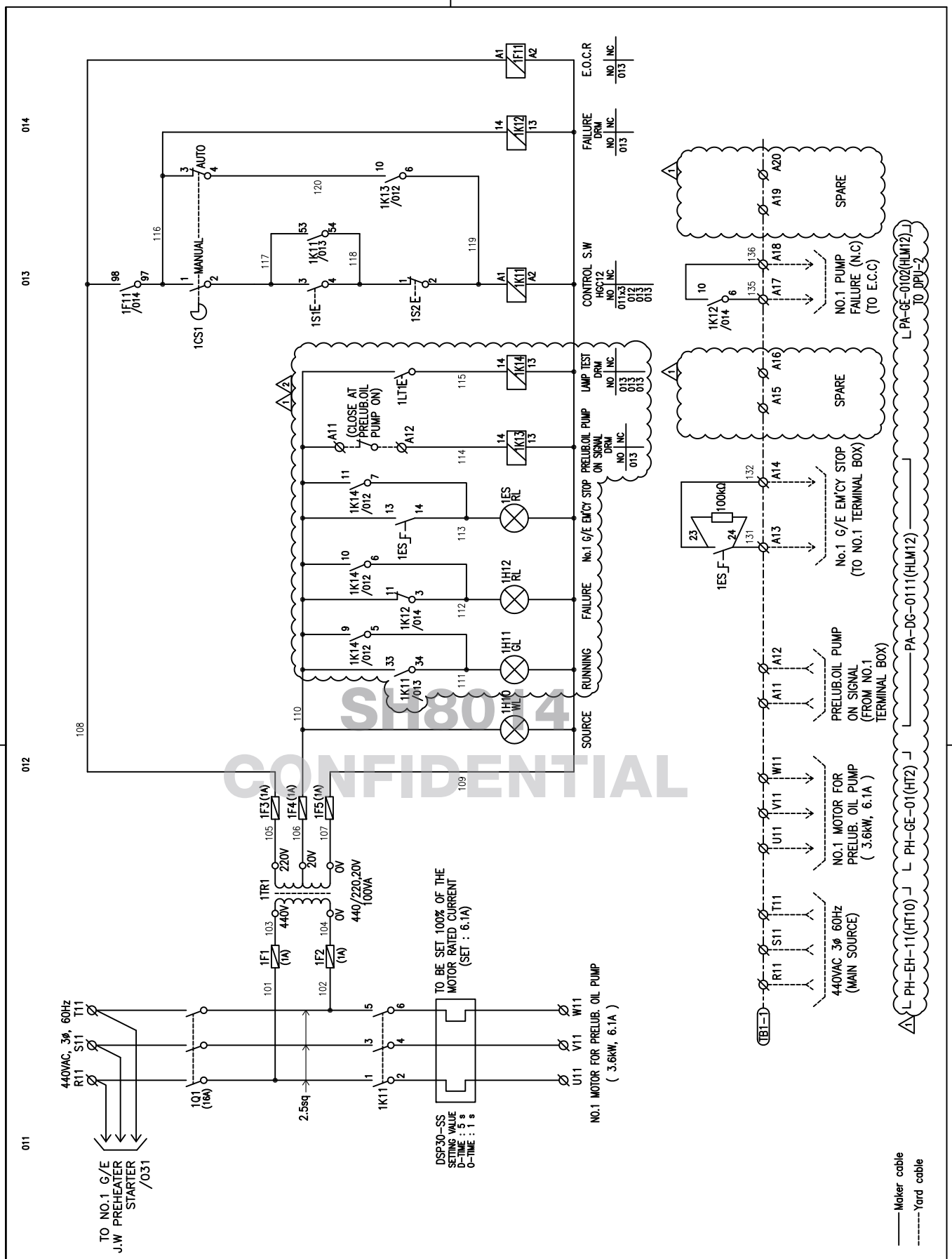
Description: OUTLINE VIEW OF PRE-LUB. OIL PUMP STARTER AND J.W PREHEATER STARTER

Info.no.:

Page.no.: 06 OF 12

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

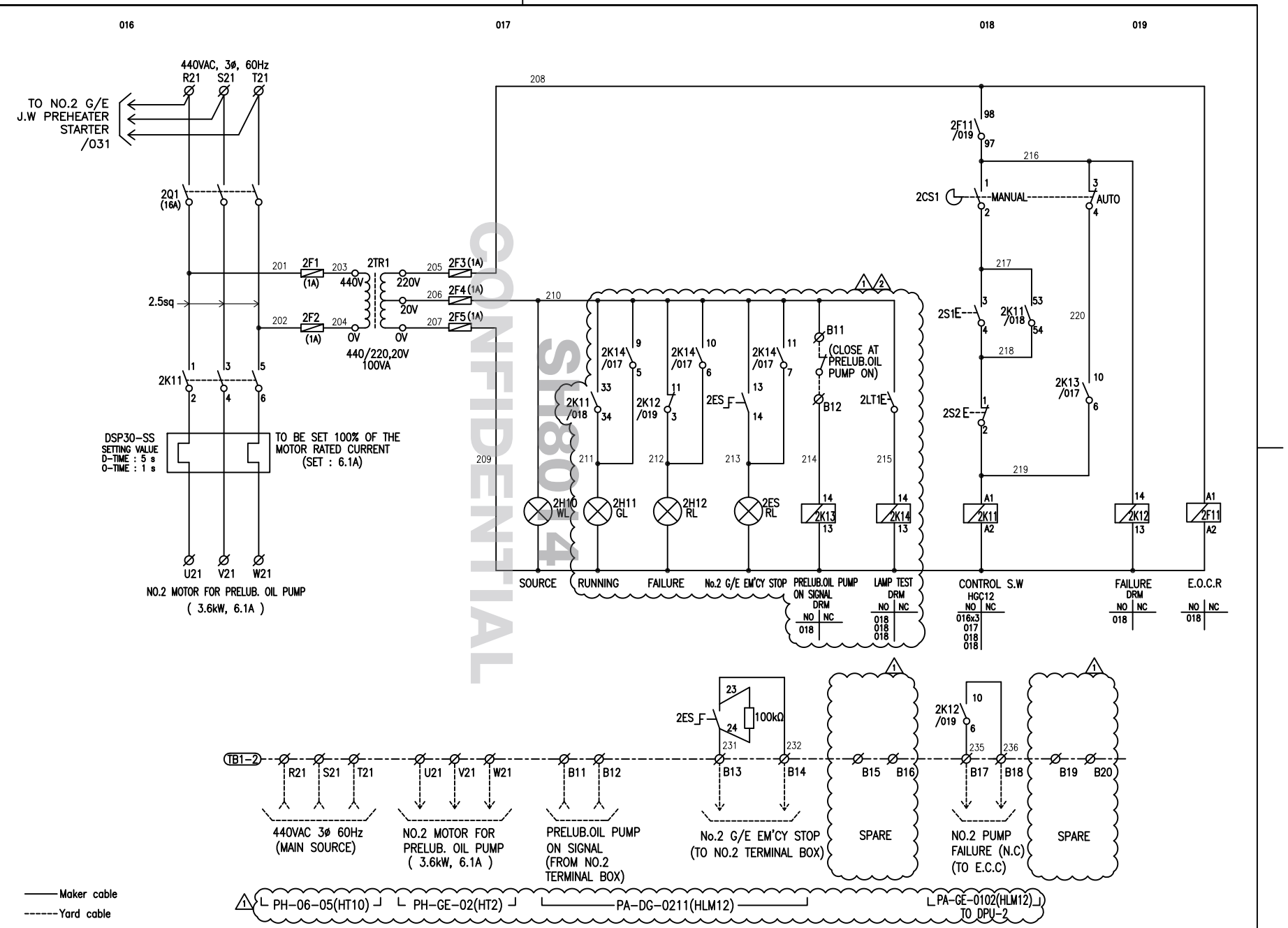
Ident.no.: B94-185601-1



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Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NO.1 G/E PRE-LUB. OIL PUMP STARTER	Ident.no.: B94-185601-1
Page.no.: 07 OF 12		



R	A/C	Appd.	Chk.	Des.	Date
5	*				
4	*				
3	*	PJH	LJH	GML	200615
2	*	PJH	LJH	GML	200511
1	*	PJH	LJH	GML	200226
0	*	PJH	LJH	GML	191121

Chg.Signal(page:10~12)
Add.Signal(page:05,07~09)
Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)
For approval

Licenser Ident.no.:

Info.no.:

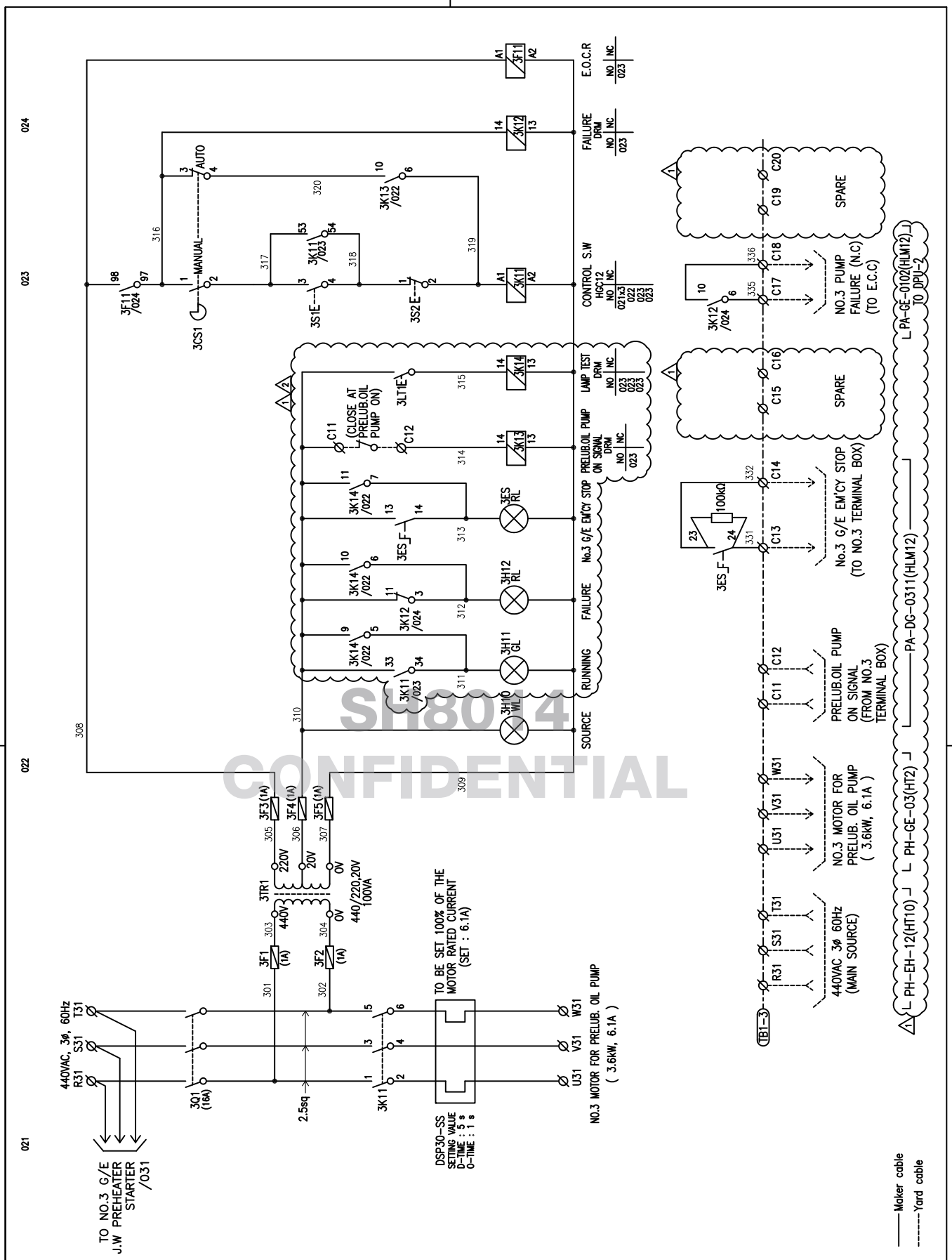
Page.no.: 08 OF 12

Type: 9H21/32

Description: NO.2 G/E PRE-LUB. OIL PUMP STARTER

Ident.no.: B94-185601-1

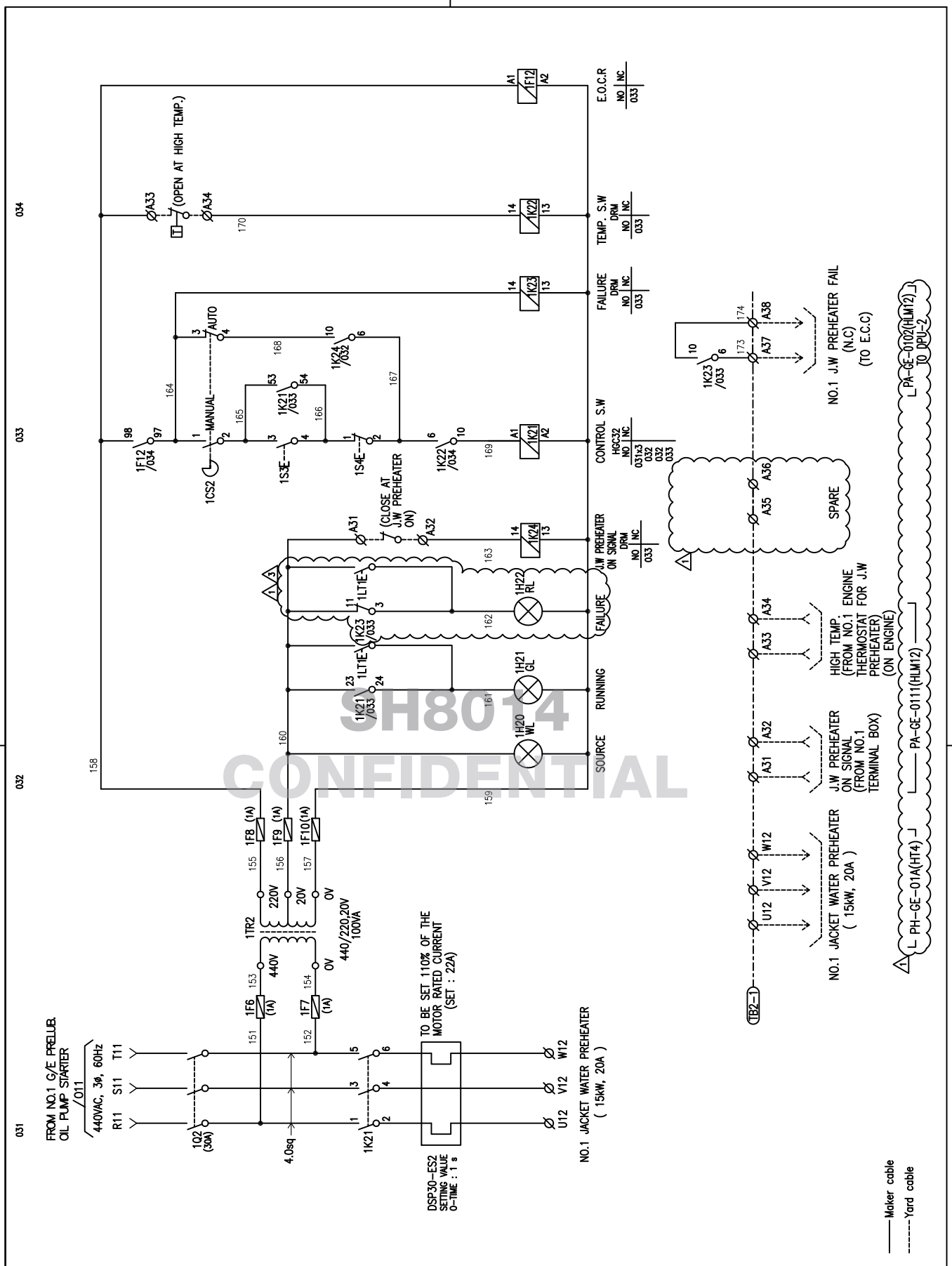
HYUNDAI HEAVY INDUSTRIES CO.,LTD.



SH8014
CONFIDENTIAL

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

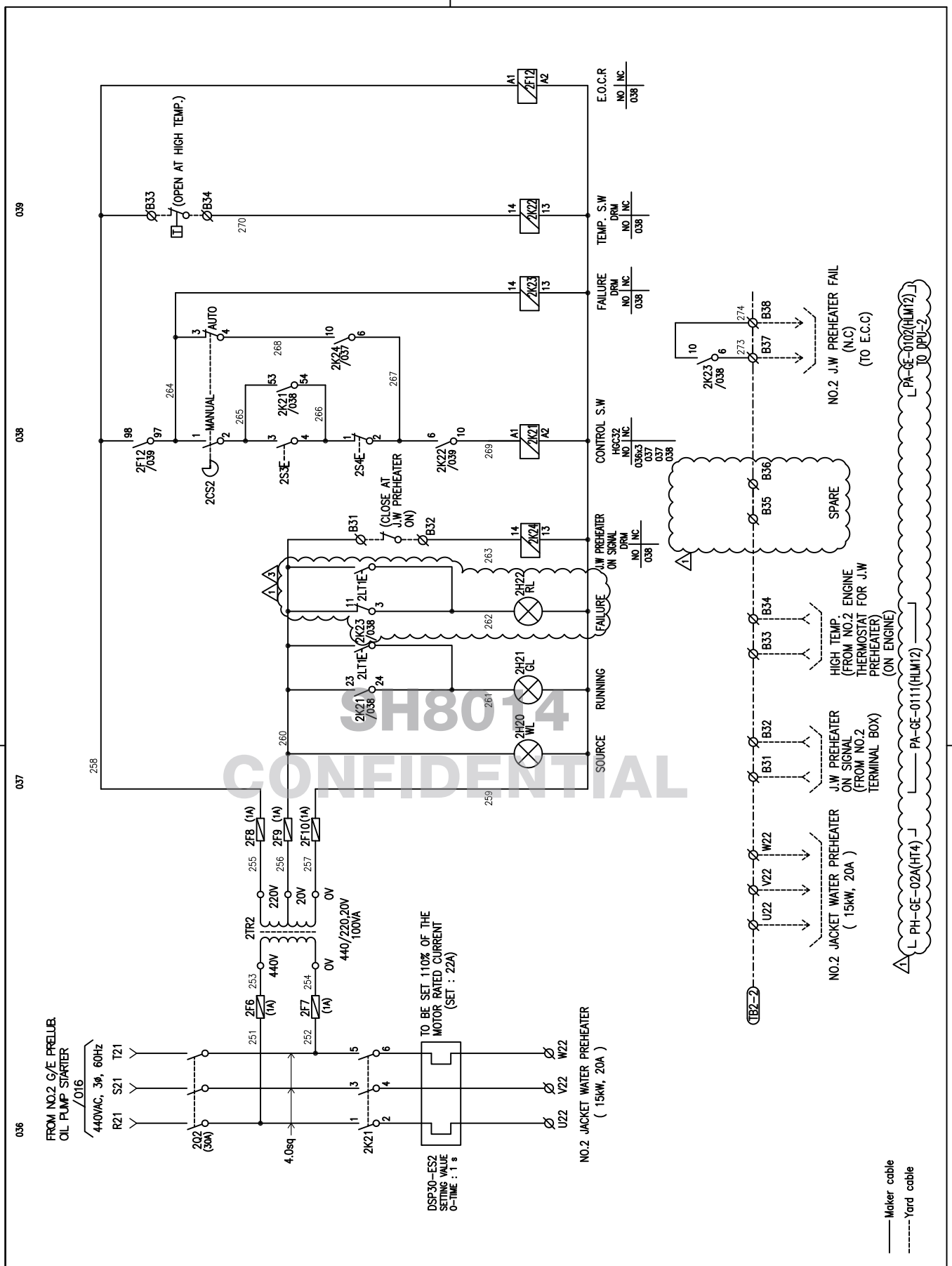
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NO.3 G/E PRE-LUB. OIL PUMP STARTER	Ident.no.: B94-185601-1
Page.no.: 09 OF 12		



SH8014
CONFIDENTIAL

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

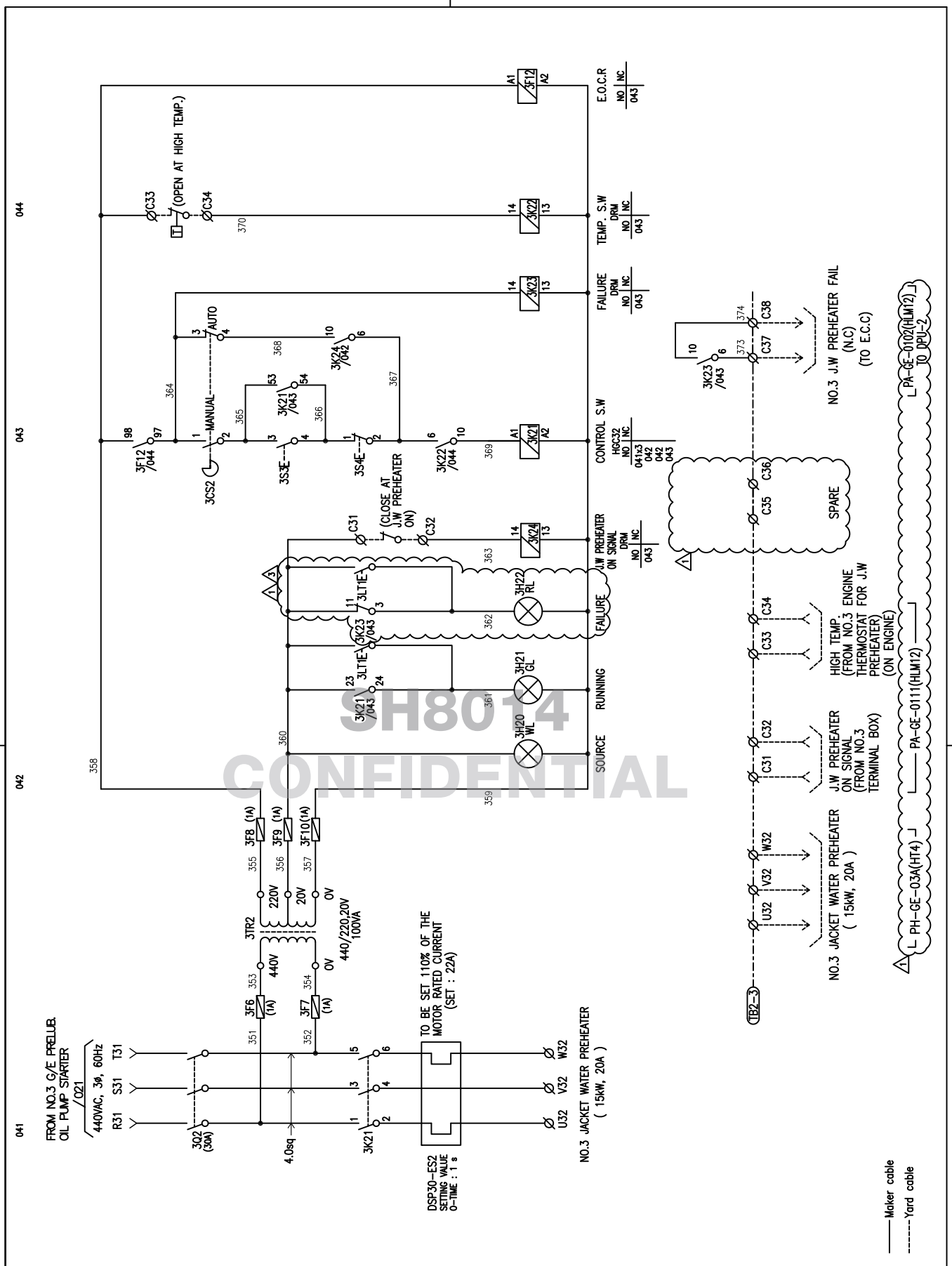
Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NO.1 G/E J.W PREHEATER STARTER	Ident.no.: B94-185601-1
Page.no.: 10 OF 12		



SH8014
CONFIDENTIAL

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NO.2 G/E J.W PREHEATER STARTER	Ident.no.: B94-185601-1
Page.no.: 11 OF 12		



SH8014
CONFIDENTIAL

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
200615	GML	LJH	PJH	*	Chg.Signal(page:10~12)	3
200511	GML	LJH	PJH	*	Add.Signal(page:05,07~09)	2
200226	GML	LJH	PJH	*	Add.Name Plate(page:04)&Add.Failure Lamp(page:04~12)&Add.Cable Spec.(page:07~12)&Del.Signal(page:07~12)	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info.no.:	Description: NO.3 G/E J.W PREHEATER STARTER	Ident.no.: B94-185601-1
Page.no.: 12 OF 12		

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PLAN HISTORY	ENGINE	HYUNDAI-HiMSEN
	TYPE	3 x 9H21/32 - 900rpm(HR)
	MESSRS	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : LIST OF SPARE PARTS FOR D/G ENGINE

1. STANDARD SPARE PARTS ---------- B94-166700-2.0
(SC-8-1~SC-8-8)

⚠1 2. STANDARD SPARE PARTS ---------- B94-314495-0.0
(SP-1-1~SP-1-2)

⚠2 3. SPARE PARTS FOR L.O PUMP & J.W PREHEATER STARTER -- B94-185602-3.2
(SE1-1)

4. SPARE PARTS FOR PWER SUPPLY UNIT ---------- B94-168017-6.0
(SE-1-1)

5. SPARE PARTS FOR YARD WORKING ---------- B94-157519-6.2
(SC-1-1)

6. SPARE PARTS FOR YARD WORKING ---------- B94-158816-8.1
(SC-1-1)

7. 4,000HRS WEARING SPARE PARTS ---------- B94-307124-4.0
(WC-2-1~WC-2-2)

SH8014
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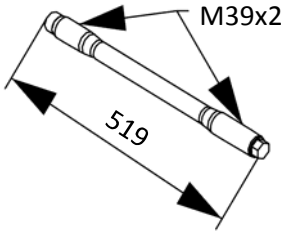
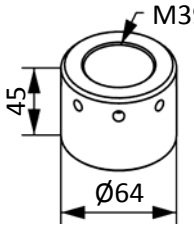
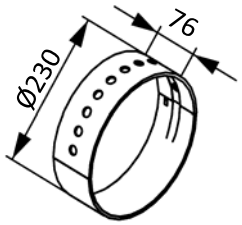
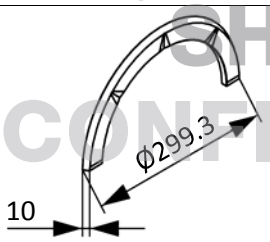
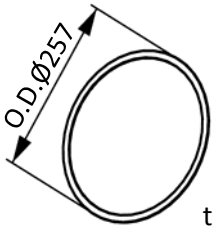
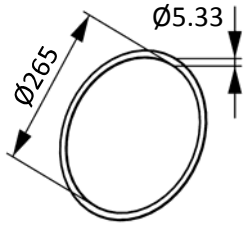
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				*		4
				*		3
20200713	HMC	GJH	DYJ	*	Chg. Item no.3	2
20200417	HMC	GJH	DYJ	*	For working	1
20191114	HMC	GJH	KHS	*	For approval	0

Similar drawing No.:	Replacement for Ident. No.:

Licensor Ident. No.:	Type:	Page. No.:	Confidential :	HYUNDAI HEAVY INDUSTRIES CO., LTD.
	9H21/32(HR)	01 (17)	B	

Info. No.:	Description:	Ident.no.:
	LIST OF SPARE PARTS	B94-307120-7

SC-8-1

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC01	STUD		3.7	(2/cyl.+4)/eng.	2	A13000 -231	for main bearing	S011/DS01
SC02	NUT		0.7	(2/cyl.+4)/eng.	2	A13000 -232	for main bearing stud	S011/DS01
SC03	MAIN BEARING		1.8	(1/cyl.+2)1eng.	1	A13250 -251		S011/DS01
SC04	THRUST WASHER		0.28	2/eng.	2	A13250 -252		S011/DS01
SC05	METAL GASKET		0.13	1/cyl.	1	A15000 -191	for cylinder liner	S011/DS01
SC06	O-RING		0.02	1/cyl.	1	A15000 -192	for cylinder liner	S011/DS01

SH8014
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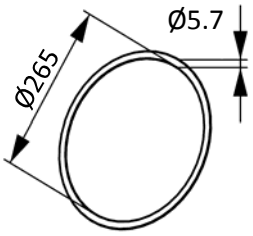
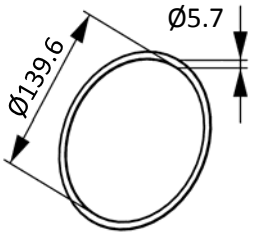
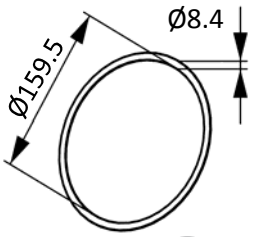
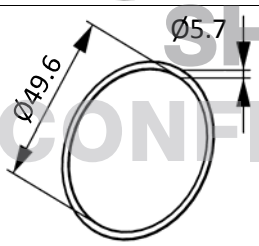
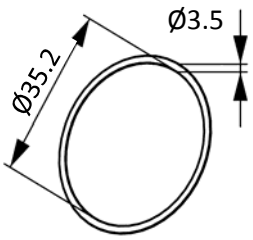
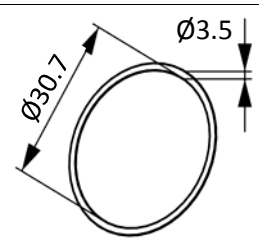
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
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						5
						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

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SC-8-2

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC07	O-RING		0.02	1/cyl.	1	A15000 -193	for cylinder liner	S011/DS01
SC08	O-RING		0.01	1/cyl.	1	A15000 -901	for cooling water jacket	S011/DS01
SC09	O-RING		0.03	1/cyl.	1	A15000 -902	for cooling water jacket	S011/DS01
SC10	O-RING		-	2/cyl.	2	A15000 -903	for cooling water jacket	S011/DS01
SC11	O-RING		-	1/cyl.	1	A15000 -922	for cooling water connection	S011/DS01
SC12	O-RING		-	1/cyl.	1	A15000 -923	for cooling water connection	S011/DS01

3H8014
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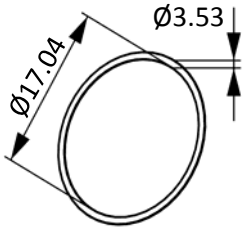
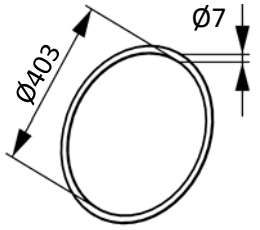
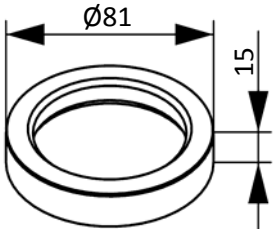
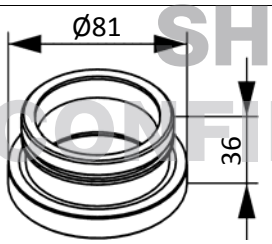
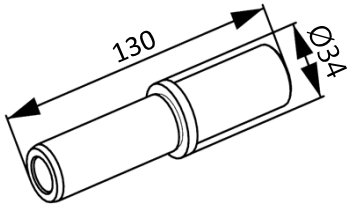
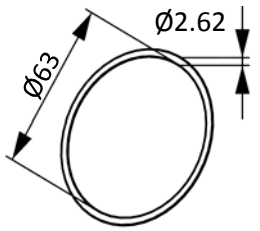
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
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						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD SPARE PARTS	Ident. No. : B94-166700-2

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SC-8-3

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC13	O-RING		-	2/cyl.	2	A15000 -932		S011/DS01
SC14	SEALING RING		0.07	2/cyl.	1	A19300 -384	for cam /crankcase cover	S011/DS01
SC15	INTAKE VALVE SEAT RING		0.23	2/cyl.	2	A21100 -111		S011/DS01
SC16	EXHAUST VALVE SEAT RING		0.4	2/cyl.	4	A21100 -112		S011/DS01
SC17	VALVE GUIDE		0.35	4/cyl.	6	A21100 -113		S011/DS01
SC18	O-RING		-	2/cyl.	4	A21100 -118		S011/DS01

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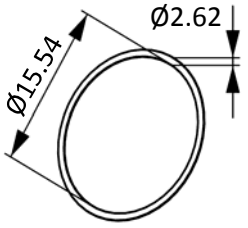
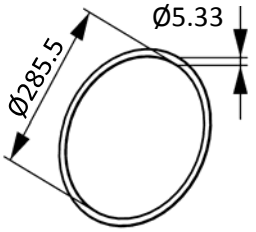
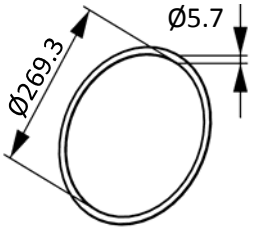
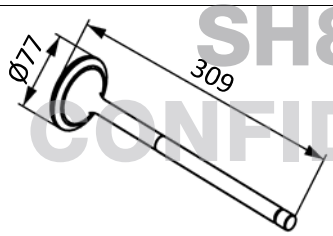
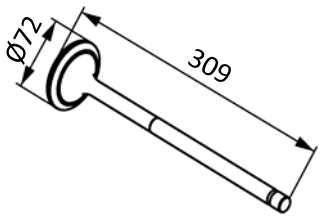
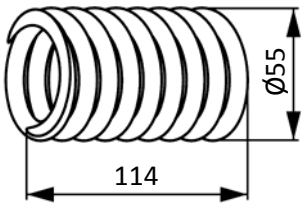
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
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						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

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SC-8-4

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC19	O-RING		-	4/cyl.	6	A21100 -291		S011/DS01
SC20	SEALING RING		0.02	1/cyl.	1	A21100 -805	for cylinder head cover	S011/DS01
SC21	O-RING		0.03	1/cyl.	2	A21100 -903	for cylinder head	S011/DS01
SC22	INLET VALVE SPINDLE		0.93	2/cyl.	2	A21200 -201		S011/DS02
SC23	EXHAUST VALVE SPINDLE		0.85	2/cyl.	4	A21200 -202		S011/DS02
SC24	VALVE SPRING (IN. / EXH.)		0.5	4/cyl.	6	A21200 -203		S011/DS01

SH8014
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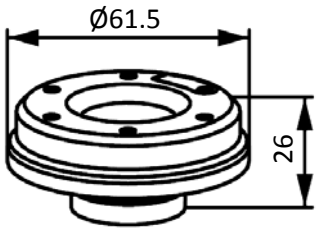
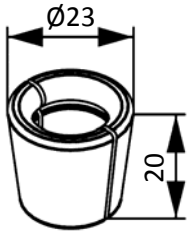
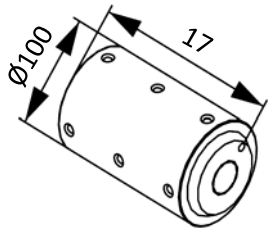
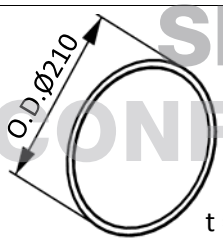
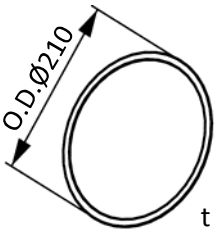
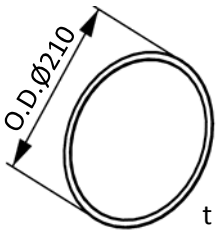
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
						R
						5
						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD SPARE PARTS	Ident. No. : B94-166700-2

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SC-8-5

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC25	ROTO CAP		0.3	4/cyl.	6	A21200 -204		S011/DS01
SC26	CONICAL CLAMPING PIECE		0.2	4/cyl.	6	A21200 -206		S011/DS01
SC27	PISTON PIN COMPLETE		9.5	1/cyl.	1	A31100 -120		S011/DS01
SC28	PISTON RING -TOP		0.21	1/cyl.	1	A31100 -151		S011/DS01
SC29	PISTON RING -2ND		0.17	1/cyl.	1	A31100 -152		S011/DS01
SC30	OIL SCRAPER RING		0.11	1/cyl.	1	A31100 -153		S011/DS01

SH8014
CONFIDENTIAL

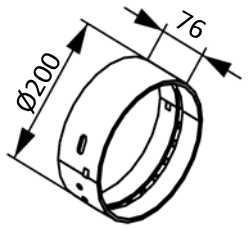
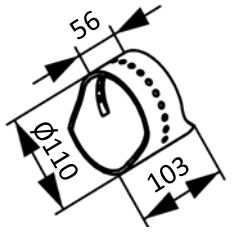
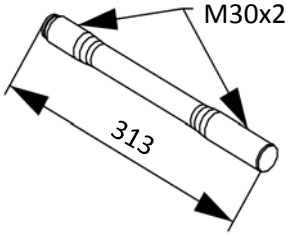
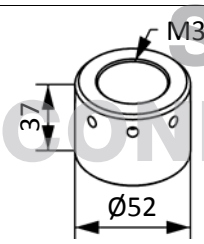
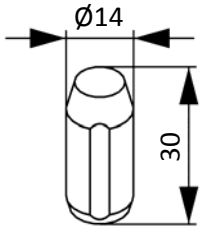
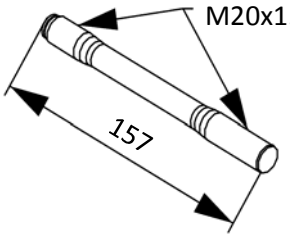
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
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						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

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SC-8-6

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC31	BIG END BEARING		1.8	1/cyl.	1	A32000 -120		S011/DS01
SC32	SMALL END BUSH		0.9	1/cyl.	1	A32000 -130		S011/DS01
SC33	STUD		1.31	2/cyl.	2	A32000 -191	for con-rod big end	S011/DS01
SC34	NUT		0.41	2/cyl.	2	A32000 -192	for con-rod main bearing cap	S011/DS01
SC35	CYLINDRICAL PIN		0.04	4/cyl.	4	A32000 -193		S011/DS01
SC36	STUD		0.31	4/cyl.	4	A32000 -194	for con-rod shaft	S011/DS01

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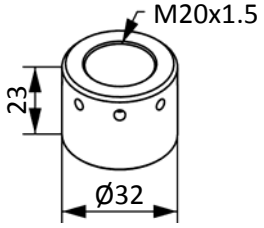
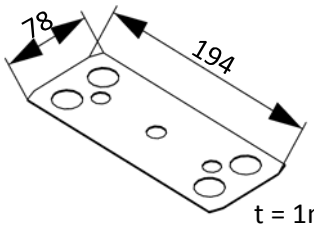
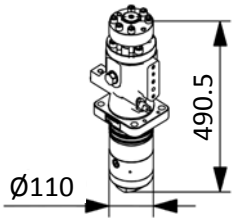
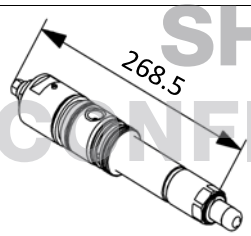
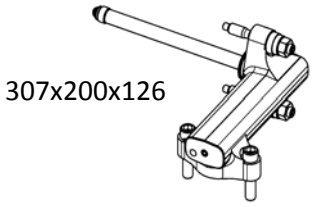
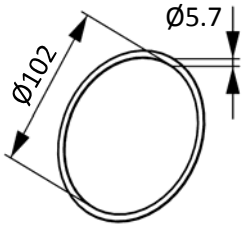
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
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						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

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SC-8-7

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC37	NUT		0.09	4/cyl.	4	A32000 -195	for con-rod shaft	S011/DS01
SC38	SHIM PLATE		0.1	1/cyl.	1	A32000 -196	for con-rod	S011/DS01
SC39	FUEL INJECTION PUMP		32	1/cyl.	1	A51000 -100		S011/DS02
SC40	FUEL INJECTION VALVE		2.4	1/cyl.	5H 3 6H 3 7H 4 8H 4 9H 5	A52000 -100		S011/DS01
SC41	FUEL HIGH PRESSURE BLOCK		4.8	1/cyl.	1	A52300 -100		S011/DS01
SC42	O-RING		0.02	-	4	A78000 -712	for cooling water connection	S011/DS01

SH8014
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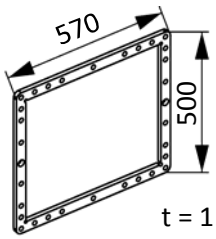
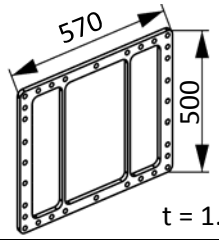
Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
						R
						5
						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

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SC-8-8

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC43	GASKET		0.31	1/eng.	1	A84000 -111	for air cooler cover	S011
SC44	GASKET		0.4	1/eng.	1	A84000 -122	for air cooler cover	S011
SC45	AIR COOLER SPARE KIT	AIR COOLER SPARE KIT	0.3	-	1 Set	-	Maker standard	S011

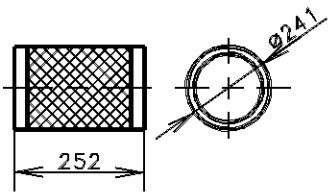
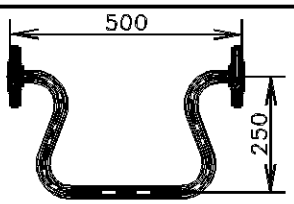
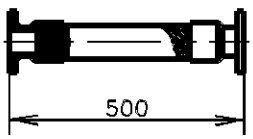
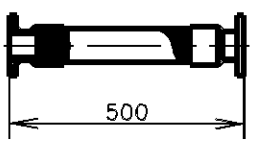
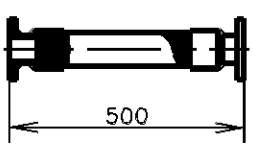
SH8014
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Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
						R
						5
						4
						3
						2
						1
190926	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : –	Confidential : B	Description : STANDARD SPARE PARTS
		Ident. No. : B94-166700-2

ITEM NO.	NAME	SKETCH	Weight (kg)	WORKING	STAN-DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SP01	1'ST FILTER (CARTRIDGE)		2.6	4/eng.	4	A63000-702	for lub. oil	S011
SP02	LOOP EXPAN-SION JOINT Fuel oil in/outlet		3.2	2/eng.	1	A98370-201	16K-25	S011
SP03	METALLIC FLEXIBLE HOSE Waste oil outlet		1.42	1/eng.	1	A98370-206	5K-15	S011
SP04	METALLIC FLEXIBLE HOSE L.O. separator in/outlet		2.12	2/eng.	1	A98370-207	5K-25	S011
OP05	METALLIC FLEXIBLE HOSE Oil vapor discharge		6.07	1/eng.	1	A98370-211	5K-65	S011
SP06	METALLIC FLEXIBLE HOSE Starting air inlet		8.48	1/eng.	1	A98370-213	30K-40	S011

SH8014
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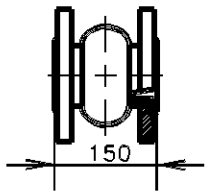
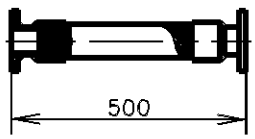
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Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	
				*		5
				*		4
				*		3
				*		2
				*		1
200416	KKC	JCL	DYJ	*	Replacement for Ident.no.: B94-314437-0	0

KYJ

SPARES	Type: H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.	
Info. no.: -	Confidential: B	Description: STANDARD SPARE PARTS	Ident.no.: B94-314495-0

ITEM NO.	NAME	SKETCH	Weight (kg)	WORKING	STAN-DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SP07	COMPENSATOR L.T water in/outlet		4.52	2/eng.	1	A98370-204	5K-100	S011
SP08	METALLIC FLEXIBLE HOSE Venting to expansion tank		2.32	1/eng.	1	A98370-208	5K-25	S011
SP09	PAPER INSERT (CENTRIFUGAL FILTER)		0.75	1/Eng.	1Set (25EA) /Ship	A67000-701	For lub. oil	S011

SH8014
CONFIDENTIAL

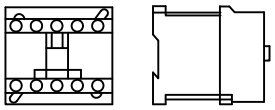
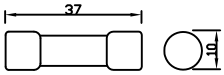
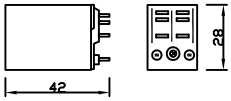
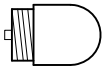
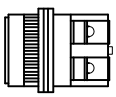
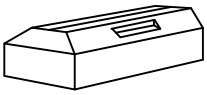
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Similar no.:	Ship no.:	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	
				*		5
				*		4
				*		3
				*		2
				*		1
200416	KKC	JCL	DYJ	*	Replacement for Ident.no.: B94-314437-0	0

KYJ

SPARES	Type: H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.	
Info. no.: -	Confidential: B	Description: STANDARD SPARE PARTS	Ident.no.: B94-314495-0

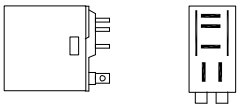
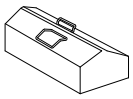
ITEM NO.	NAME	SKETCH (WEIGHT) kg	MAT'L	WORKING	STAND-ARD SPARE (Q'TY /SHIP)	PART NO.	REMARK	BOX NO.
SE01	MAGNETIC CONTACTOR			3	1		HGC12 AC220V	DS04/S011
				3	1		HGC32 AC220V	
SE02	FUSE			30	15		FR10GG50V1 1A	DS04/S011
SE03	RELAY			9	1		DRM570730L (AC220V)	DS04/S011
				2 9	1		DRM570524L (AC24V)	
SE04	GLOVE FOR PILOT LAMP			6	1		WHITE	DS04/S011
				6	1		GREEN	
				6	1		RED	
SE05	BULB FOR PILOT LAMP			18	9 1		E-10 24V 1W	DS04/S011
SE06	PUSH BUTTON			6	1		YSAP13-11R	DS04/S011
SE07	BOX				1			DS04/S011

SH8014
CONFIDENTIAL

Similar no. :	Ship no. : SH8014	Scale :	Mass.(kg) : about 2kg

Date	Des.	Chk.	Appd.	A.C	Replace by Ident.no.:	R
				*		5
				*		4
				*		3
200511	GML	LJH	PJH	*	Add.Relay	2
200227	GML	LJH	PJH	*	Add.Lamp	1
191121	GML	LJH	PJH	*	For approval	0

Licenser Ident.no.:	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
SPARE	Description: SPARE PARTS FOR PRE-LUB. OIL PUMP STARTER & J.W PREHEATER STARTER	Ident.no.: B94-185602-3
Page.no.: -		

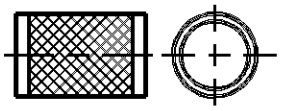
ITEM NO.	NAME	SKETCH (WEIGHT)kg	MAT'L	WORKING	STAN-DARD SPARE (Q'TY /SHIP)	PART NO.	REMARKS	BOX NO.
SE01	RELAY			2	1	EA	G2R-2-SND DC24V, 2c	DS02/S011
SE02	L.E.D			2	1	EA	24VDC,WHITE	DS02/S011
SE03	LAMP GLOBE			2	1	EA	WHITE	DS02/S011
SE04	SPARE PART BOX WITH SUITABLE LOCKING DEVICE				1	EA		DS02/S011
SE05								DS02/S011
SE06								DS02/S011
SE07								DS02/S011
SE08								DS02/S011
SE09								DS02/S011
SE10								DS02/S011
SE11								DS02/S011

SH8014
CONFIDENTIAL

Similar no.:	PROJECT : SH8014	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
				*		2
				*		1
191121	GML	HJL	PJH	*	For approval	0

SPARES	Type: 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. no.: -	Description: SPARE PARTS FOR POWER SUPPLY UNIT	Ident.no.: B94-168017-6

ITEM NO.	NAME	SKETCH	Weight (kg)	WORKING	YARD WORKING SPARE (Q'TY /SHIP)	PART.NO.	REMARKS	BOX NO.
SC71	1'ST FILTER (CARTRIDGE)		2.6	4/Eng.	1eng/ship 4 2eng/ship 8 3eng/ship 12 4eng/ship 16 5eng/ship 20	(A63000-702) 2	For lub. oil	S011

SH8014
CONFIDENTIAL

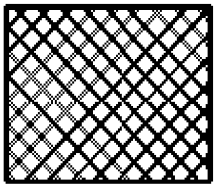
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Similar no.:	Ship no.:	Scale: N.S	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident.no.:	R
				*		5
				*		4
				*		3
170712	JJO	SWS	RYS	*	Chg. PART No.	2
170508	JJO	SWS	RYS	*	Add.Type(H21C)	1
160216	SYH	KJC	RYS	*	Replacement for Ident.no.:	0

SPARES	Type: H21/32, H21C	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. no.: 278713 / Confidential: B	Description: SPARE PARTS FOR YARD WORKING	Ident.no.: B94-157519-6

SC-1-1

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
SC91	AIR FILTER		0.1	1/eng.	1/eng.	ABB 81265	For Turbo charger	S011

SH8014
CONFIDENTIAL

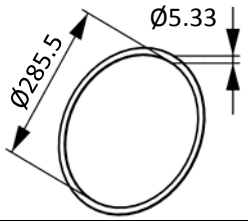
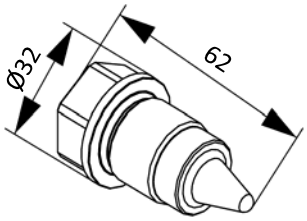
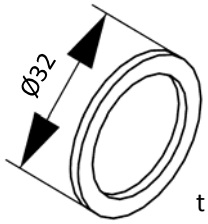
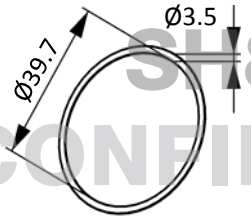
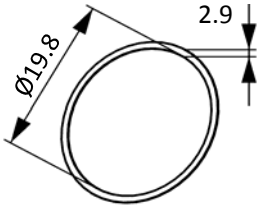
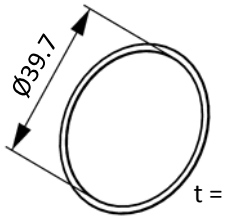
Similar no.:	Ship no.:	Scale: N.S	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
						4
						3
						2
161024	HJY	PJK	RYS		Chg.Text (T/C -> TURBOCHARGER) & PART NO.	1
160216	CBK	PJK	RYS	*	Replacement for Ident_no. :	0

SPARES	Type : ALL	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : SPARE PARTS FOR YARD WORKING (ABB)	Ident. No. : B94-158816-8

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WC-2-1

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
WC01	SEALING RING		0.02	1/cyl.	14	A21100 -805	for cylinder head cover	
WC02	DEFLECTOR		0.18	2/cyl.	54	A51000 -129	for fuel injection pump	
WC03	GASKET		0.03	2/cyl.	54	A51000 -130	for fuel injection pump	
WC04	O-RING		0.02	4/cyl.	216	A52000 -004	for fuel injection valve	
WC05	SEAL RING		0.02	1/cyl.	54	A52000 -013	for fuel injection nozzle	
WC06	O-RING		0.02	1/cyl.	54	A52300 -116	for fuel high pressure block	

SH8014
CONFIDENTIAL

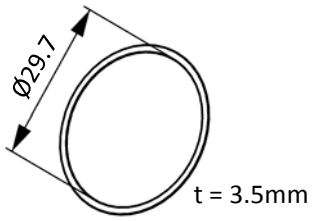
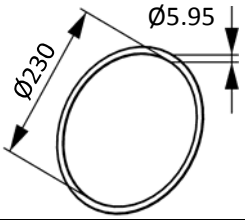
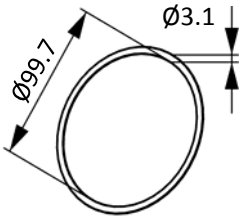
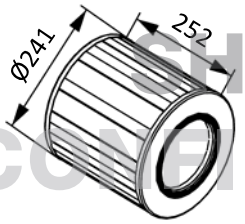
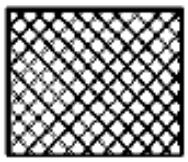
Similar no.:	Ship no.: SH8023/8024	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
						R
						5
						4
						3
						2
						1
191119	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : 3 x 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. No. : – / Confidential : B	Description : 4,000HRS WEARING SPARE PARTS	Ident. No. : B94-307124-4

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WC-2-2

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	WORKING	Q'TY /SHIP	PART NO.	REMARKS	BOX NO.
WC07	O-RING		0.02	2/cyl.	108	A52300 -117	for fuel high pressure block	
WC08	O-RING		0.02	2/eng.	6	A63000 -465	for lub. oil filter	
WC09	O-RING		0.01	2/eng.	6	A63000 -466	for lub. oil filter	
WC10	L.O. FILTER CARTRIDGE		2.6	4/eng.	24	A63000 -702		
WC11	AIR FILTER MAT		0.1	1/eng.	6	MAKER	for turbocharger	

SH8014
CONFIDENTIAL

Similar no.:	Ship no.: SH8023/8024	Scale:	Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	
						R
						5
						4
						3
						2
						1
191119	HMC	GJH	KHS	*	Replacement for Ident_no. :	0

SPARES	Type : 3 x 9H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. No. : – / Confidential : B	Description : 4,000HRS WEARING SPARE PARTS	Ident. No. : B94-307124-4

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PLAN HISTORY	ENGINE	HYUNDAI-HiMSEN
	TYPE	3 x 9H21/32 - 900rpm(HR)
	MESSRS	HSHI
	RULE	LR
	PROJECT	SH8014
	ENG. NO.	KBA007104

TITLE : LIST OF TOOL PARTS FOR D/G ENGINE

1. STANDARD TOOL PARTS ---------- B94-155994-1.4
(ST-10-1~ST-10-10)
2. STANDARD TOOL PARTS ---------- B94-155996-5.1
(ST-10-10-1)

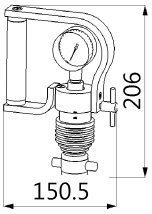
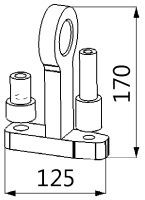
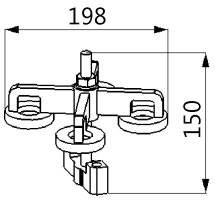
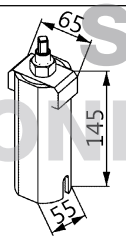
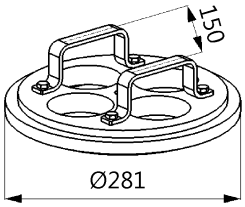
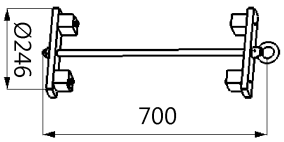
SH8014
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Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No.:	R
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				*		4
				*		3
				*		2
				*		1
20191114	SJJ	GJH	KHS	*	For approval	0

Similar drawing No.:	Replacement for Ident. No.:		
Licensor Ident. No.:	Type: 9H21/32(HR)	Page. No.: 01 (12)	Confidential : B
Info. No.:	Description: LIST OF TOOL PARTS		Ident.no.: B94-307121-9

HYUNDAI HEAVY INDUSTRIES CO., LTD.

ST-10-1

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST01	MAX.PRESSURE INDICATOR		3.8	1	91.100		S011/DT01
ST02	LIFTING TOOL		1.6	1	91.110	for cylinder head	S011/DT01
⚠4 ST03	FIT / REMOVAL DEVICE		3.9	1	91.120	for valve conical clamping piece	S011/DT01
ST04	REMOVAL DEVICE		1.7	1	91.130	for fuel injection valve	S011/DT01
ST05	GRINDING TOOL		30	1	91.140	for cylinder head / liner / block	S011/DT02
ST06	EXTRACT/ SUSPENSION DEVICE		1.9	1	91.150	for cylinder liner	S011/DT01

SH8014
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Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS

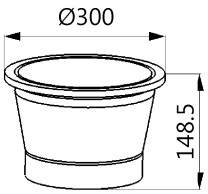
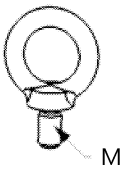
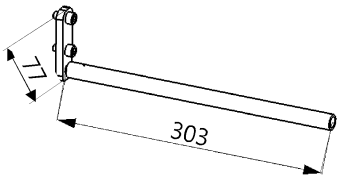
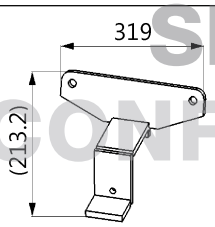
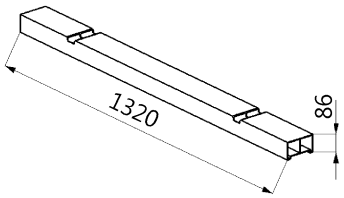
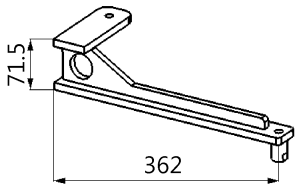
Type : **H21/32**

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Info. No. :	Confidential :	Description :	Ident. No. :
–	B	**STANDARD TOOL PARTS**	**B94-155994-1**

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ST-10-2

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST07	GUIDE BUSH		7	1	91.160	for piston	S011/DT02
ST08	LIFTING TOOL (EYE BOLT M10)		0.1	1	91.170	For piston	S011/DT01
ST09	HOLDING PIECE		0.1	1	91.180	for crank pin bearing	S011/DT01
ST10	SUSPENSION DEVICE		2.4	1	91.190	for connecting rod	S011/DT01
ST11	GUIDE SUPPORT		0.1	1	91.200	for connecting rod	S011
ST12	TURNING BRACKET		2.1	1	91.210	for connecting rod	S011/DT01

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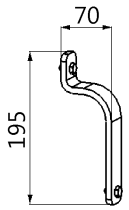
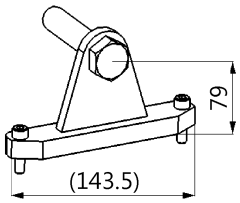
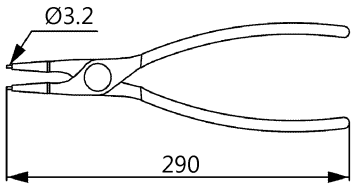
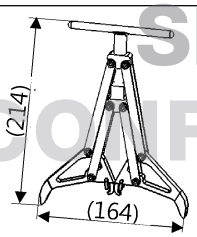
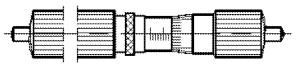
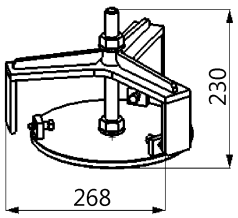
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-3

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST13	CLAMPING SUPPORT		0.5	2	91.220	for connecting rod	S011/DT01
④ ST14	SUPPORT		0.7	1	91.230	for connecting rod & piston	S011/DT01
ST15	PLIER 85		1.5	1	91.240	for piston pin locking ring	S011/DT01
④ ST16	PLIER		0.5	1	91.250	for piston ring opener	S011/DT01
ST17	CYLINDER BORE GAUGE		0.2	1	91.260		S011/DT01
④ ST18	REMOVAL DEVICE		5.3	1	91.270	for flame ring	S011/DT01

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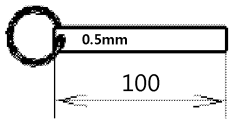
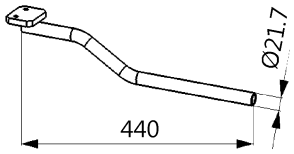
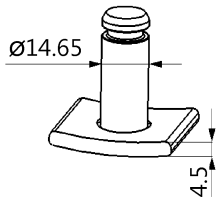
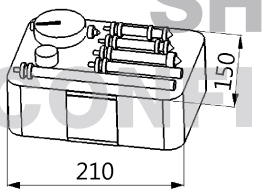
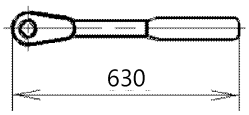
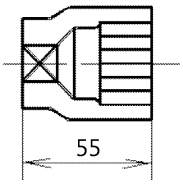
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-4

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST19	FEELER GAUGE		0.1	1	91.280	for intake /exhaust valve	S011/DT01
ST20	LIFTING DEVICE		0.9	4	91.290	for main bearing cap	S011/DT01
ST21	FITTING DEVICE		0.9	1	91.300	for main bearing	S011/DT01
ST22	DEFLECTION GAUGE		1.5	1	91.310	for crankshaft	S011/DT01
ST23	SPANNER 3/4		1	1	91.320	for turning gear	S011/DT01
ST24	EXTENSION BAR 24		0.1	1	91.330	for turning gear	S011/DT01

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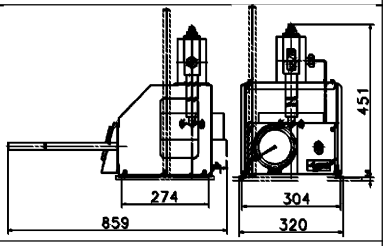
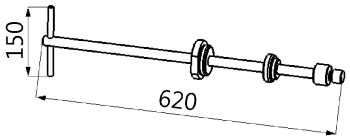
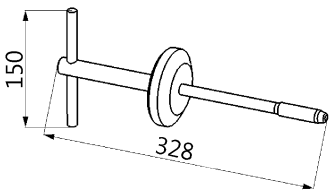
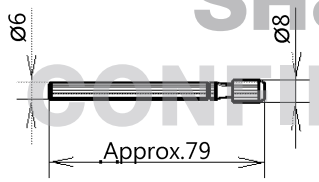
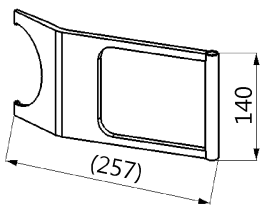
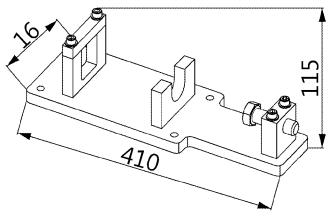
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-5

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST25	TEST TOOL		20	1	91.340	for fuel valve nozzle	S011
ST26	LAPPING DEVICE		2.2	1	91.350	for injection valve bush	S011/DT01
ST27	LAPPING DEVICE		1.5	1	91.360	for inake /exhaust valve seat	S011/DT01
ST28	CLEANING TOOL		0.7	1	91.370	for fuel injection valve nozzle	S011/DT01
ST29	REMOVAL DEVICE		1	1	91.380	for cooling water connection	S011/DT01
ST30	REMOVAL TOOL		7.8	1	91.390	for atomizer nut	S011/DT01

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Similar no.:	Ship no.:		Mass.(kg):

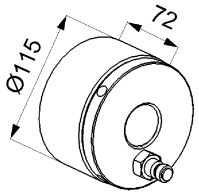
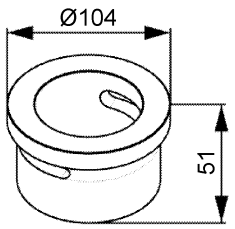
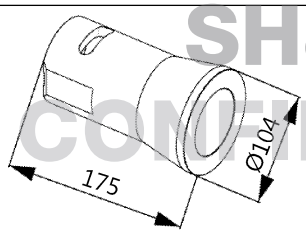
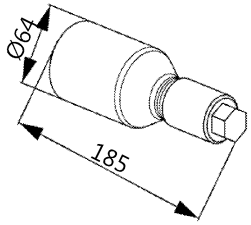
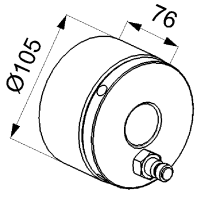
Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS | Type : **H21/32** | HYUNDAI HEAVY INDUSTRIES CO., LTD.

Info. No. :	Confidential :	Description :	Ident. No. :
–	B	**STANDARD TOOL PARTS**	**B94-155994-1**

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ST-10-6

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST31	HYDRAULIC JACK (M39x2)		4.9	4	91.400 *UNIT TOOL.NO. 91.430 91.460 91.490 91.510	for cylinder head / main bearing cap	S011/DT02
	SET OF SPARE PARTS	O-RING : 2 BACK-UP PIRNG :2 QUICK COUPLING	0.6	1	91.430	for hydrulic jack M39	
	SUPPORT (HYD. JACK M39)		1	2	91.460	for main bearing cap	
	LONG SUPPORT (HYD. JACK M39)		4	4	91.490	for cylinder head	
	EXTENSION SCREW (HYD. JACK M39)		2.5	4	91.510	for cylinder head	
ST32	HYDRAULIC JACK (M30x2)		4.4	2	91.410 *UNIT TOOL.NO. 91.440 91.470 91.480 91.520	for side stud / Con- rod big end / counter weight flywheel	S011/DT02

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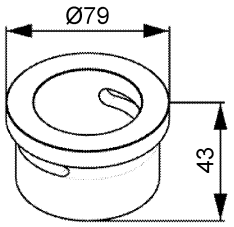
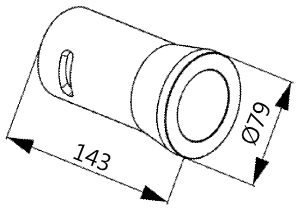
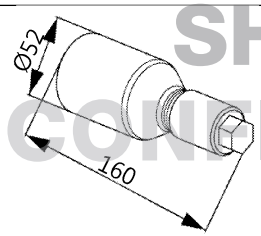
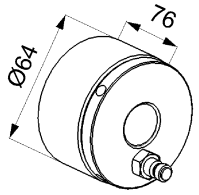
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
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180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-7

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST32	SET OF SPARE PARTS	O-RING : 2 BACK-UP PIRNG :2 QUICK COUPLING	0.6	1	91.440	for hydrulic jack M30	S011/DT02
	SUPPORT (HYD. JACK M30)		0.5	2	91.470	for side stud / con-rod big end	
	LONG SUPPORT (HYD. JACK M30)		1.3	2	91.480	for counter weight / flywheel	
	EXTENSION SCREW (HYD. JACK M30)		1.5	2	91.520	for flywheel / counter weight	
ST33	HYDRAULIC JACK (M20x1.5)		1.7	2	91.420 *UNIT TOOL.NO. 91.450 91.500 91.530	for con-rod shaft	S011/DT02
	SET OF SPARE PARTS	O-RING : 2 BACK-UP PIRNG :2 QUICK COUPLING	0.6	1	91.450	for hydrulic jack M20	

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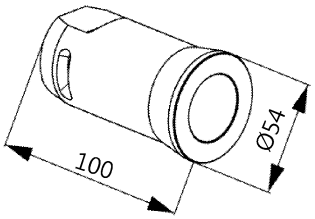
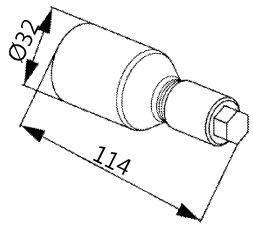
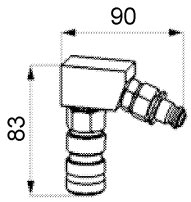
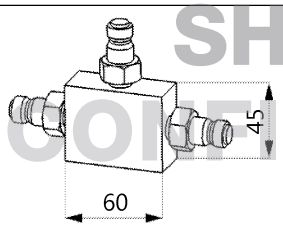
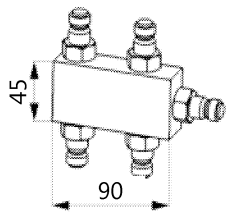
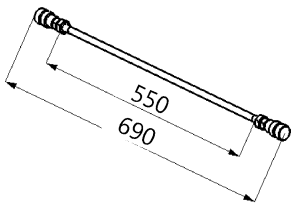
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-8

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST33	LONG SUPPORT (HYD. JACK M20)		0.6	2	91.500	for con-rod shaft	S011/DT02
	EXTENSION SCREW (HYD. JACK M20)		0.4	2	91.530	for con-rod shaft	
ST34	ANGLE PIECE		0.46	2	91.421		S011/DT02
ST35	DISTRIBUTING PIECE (2-PORT)		0.68	1	91.541		S011/DT01
ST36	DISTRIBUTING PIECE (4-PORT)		1	1	91.542		S011/DT01
ST37	HIGH PRESSURE HOSE L=550		1.7	4	91.551		S011/DT02

SH8014
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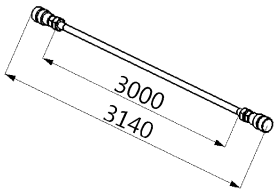
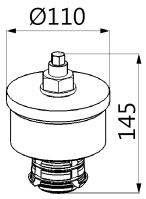
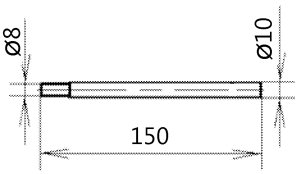
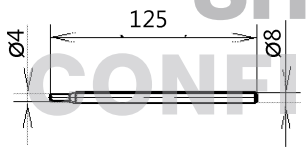
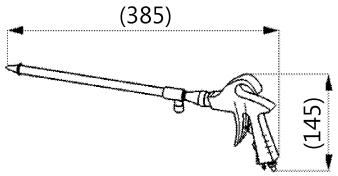
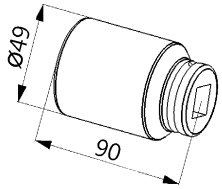
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-9

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST38	HIGH PRESSURE HOSE L=3000		8	2	91.552		S011/DT02
ST39	REMOVAL DEVICE		2.5	1	91.580	for exhaust valve seat	S011/DT01
ST40 ④	TURNING PIN (Φ10)		0.1	2	91.600		S011/DT01
ST41 ④	TURNING PIN (Φ8)		0.05	2	91.610		S011/DT01
ST42	AIR GUN		0.46	1	91.620		S011/DT01
ST43	LONG SOCKET		0.1	1	91.630	for nozzle nut	S011/DT01

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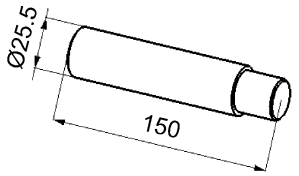
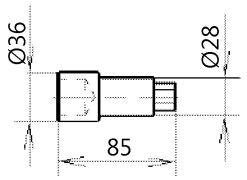
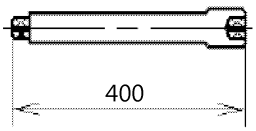
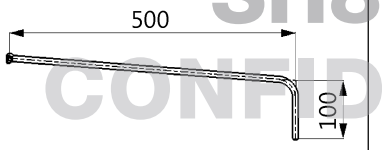
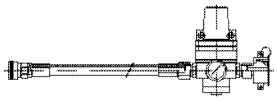
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO., LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-10

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST44	REMOVAL DEVICE		1	1	91.720	for fuel valve bush	S011/DT01
ST45	T.V DAMPER TOOL		0.1	1	91.930		S011/DT01
ST46	EXTENSION BAR 20		0.5	1	91.931		S011/DT01
ST47	PLIER		0.3	1	91.940	for locking ring	S011/DT01
ST48	CLEANING HOSE		5.26	1	98.100	for turbocharger	S011/DT02

SH8014
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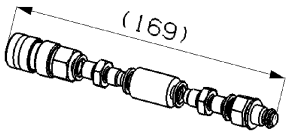
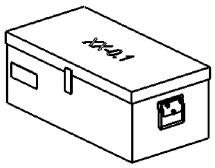
Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
180105	SJJ	YJH	RYS	*	Chg. Sketch No. ST03, ST16, ST18, Weight No. ST14, ST40, ST41, Part no.->Tool no.	4
170403	SJJ	YJH	RYS	*	Chg. Sketch No. ST15	3
170310	SJJ	YJH	RYS	*	Chg. Sketch No. ST04, 30, 31, 32, Weight No. ST38	2
160328	XHJ	YJH	RYS	*	Chg, ST44 Part No (91.750->91.720)	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155994-1

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ST-10-10-1

ITEM NO.	NAME	SKETCH	WEIGHT (kg)	Q'TY /SHIP	TOOL NO.	REMARKS	BOX NO.
ST49	ADAPTER		0.7	1	91.590	for hydraulic pump	S011/DT01
ST50	SPARE & TOOL BOX	 (800x400x300)	22.3	4	91.640		S011
ST51	AIR COOLER TOOL KIT	AIR COOLER TOOL KIT	4	1 SET	-	Maker standard	S011/DT01

SH8014
CONFIDENTIAL

Similar no.:	Ship no.:		Mass.(kg):

Date	Des.	Chk.	Appd.	A.C	Replaced by Ident. No. :	R
						5
						4
						3
						2
180718	SJJ	YJH	KHS	*	Chg. Part No.->Tool No., Type	1
160215	XHJ	YJH	RYS	*	Replacement for Ident_no. :	0

TOOLS	Type : H21/32	HYUNDAI HEAVY INDUSTRIES CO.,LTD.
Info. No. : – / Confidential : B	Description : STANDARD TOOL PARTS	Ident. No. : B94-155996-5

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Hyundai Heavy Industries
Engine & Machinery

1000 Bangeojinsunhwan-doro, Dong-Gu, Ulsan, Korea
www.hyundai-engine.com
www.hhi.co.kr

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