INTERNATIONAL MARITIME ORGANIZATION

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SUB-COMMITTEE ON HUMAN ELEMENT, TRAINING AND WATCHKEEPING
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Agenda item 3

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VALIDATION OF MODEL TRAINING COURSES

Model course – Engine-Room Simulator

Note by the Secretariat

SUMMARY

Executive summary:	This document provides the draft of a revised model course on Engine Room Simulator
Strategic direction:	5.2
High-level action:	5.2.2
Planned output:	5.2.2.5
Action to be taken:	Paragraph 3
Related document:	STW 40/14

1 Attached in the annex is a revised draft model course on Engine Room Simulator.

2 The preliminary draft of this revised model course was forwarded to members of the validation panel for their comments. Owing to time constraints, any comments received on the draft course from the validation panel will be provided directly to the Sub-Committee.

Action requested of the Sub-Committee

3 The Sub-Committee is invited to consider the above information and take action, as appropriate.

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ANNEX

DRAFT IMO MODEL COURSE ON ENGINE-ROOM SIMULATOR

Model Course 2.07

ENGINE-ROOM SIMULATOR

FOREWORD

XXX

Text for the Acknowledgement
IMO expresses sincere appreciation to Piri Reis University, Istanbul, Turkey for its cooperation to update this model course, and the National Institute for Sea Training, Independent Administrative Institution, Yokohama, Japan and the Graduate School of Maritime Sciences, Kobe University, Japan for their support by providing the materials to update this model course pursuant to the 2010 Manila Amendments.

Contents

Introduction

■ Purpose of the model courses

The purpose of the IMO model courses is to assist maritime training institutes and their teaching staff in organizing and introducing new training courses or in enhancing, updating or supplementing existing training materials, where the quality and effectiveness of the training courses may thereby be improved. This model course is particularly intended to assist trainers who utilize a simulator as a teaching aid for conducting training related to engine room simulation described in the STCW Code.

It is not the intention of the model course programme to present instructors with a rigid "teaching package", which they are expected to "follow blindly". Nor is it the intention to substitute audiovisual or "programmed" material for the instructor's presence. Rather, this document should be used as a guide with the course duration given as indicative of the expected time required to cover the required outcomes. The parties may modify this course to suit their respective training schemes.

As in all training, the knowledge, skills and dedication of the instructor are key components in the transfer of knowledge and skills to those being trained through IMO model course material.

The educational systems and the cultural backgrounds of trainees in maritime subjects vary considerably from country to country. Hence, the model course material has been designed to identify the basic entry requirements and trainee target group for each course in universally applicable terms, and to specify clearly the technical content and levels of knowledge and skill necessary to meet the technical intent of IMO conventions and related recommendations.

In order to keep the training programme up to date in future, it is essential that users provide feedback. New information will provide better training in safety at sea and protection of the marine environment. Information, comments and suggestions should be sent to the Head of Maritime Training and Human Element in the Maritime Safety Division of IMO.

■ Use of the model course

The instructor should review the course plan and detailed teaching syllabus, taking into account the information provided under the entry standards specified in the course framework. The actual level of knowledge and skills and prior technical education of the trainee should be kept in mind during this review, and any areas within the detailed teaching syllabus which may cause difficulties because of differences between the actual trainee entry level and that assumed by the course designer should be identified. To compensate for such differences, the instructor is expected to delete from the course, or to reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. The instructor should also identify any academic knowledge, skills or technical training which may not have acquired.

By analyzing the detailed teaching syllabus and academic knowledge required to allow training in the technical area to commence, using their professional judgment, instructors can design an appropriate pre-entry course or alternatively, insert the elements of academic knowledge required to support the technical training elements concerned at appropriate points within the technical course.

Within the course plan the course designers have indicated assessment of the time which should be allotted to each area of learning. However, it must be appreciated that these allocations are arbitrary and assume that the trainees have fully met all entry requirements of the course. The instructor should, therefore, review these assessments and may need to reallocate the time required to achieve each specific learning objective or training outcome.

■ Aims

This model course aims to address the requirements of Section A-I/12, paragraphs 6 and 7, related to engine room simulator training to address the competences in tables A-III/2 and A-III/3.

■ Lesson plans

Instructors should develop lesson plans based on the detailed teaching syllabus and specifications of simulators. Instructors should pay due attention to the trainee's background and previous knowledge when adjusting the course content to suit the student intake and any revision of the course objectives. The detailed teaching syllabus describes required performances which together with the exercise scenarios in the appendices to be used to deliver the course.

■ Presentation

The presentation will be made in briefing and debriefing sessions, and the concepts and methodologies must be repeated in various ways until the instructor is satisfied that the trainee has attained the required proficiency to meet each specific learning objective. The detailed teaching syllabus is laid out in learning objective format, and each objective specifies the knowledge, understanding and proficiency the student shall have acquired after the exercise to meet the knowledge, understanding and proficiency specified in the appropriate tables of the STCW Code

■ Evaluation or assessment of a trainee's progress

The nature of this course will involve all the trainees and instructors in an ongoing process of individual and group evaluation. However; formal evaluation is a very important aspect of all simulator training because it provides the means to determine whether or not the trainee has achieved the prescribed standard of competence. This competence is needed during normal watchkeeping and operation and can be vital in emergency situations. Formal evaluation should, therefore, be emphasized and conducted as soon as the trainee is ready and always at the end of the simulator exercise.

■ Implementation

For the course to run smoothly and to be effective, considerable attention must be paid to thorough planning and preparation prior to each exercise concerning

- teaching facility
- equipment
- exercises/training scenarios
- assignments and technical papers; and
- other reference material

Properly qualified and trained instructors, support staff, observers and assessors are absolutely vital in order to achieve good end results.

■ Training and the STCW Code

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended, defines the minimum standards of competence that have to be met by seafarers, which are provided in Part A of the STCW Code. This IMO model course has been revised and updated pursuant to the 2010 Manila Amendments to address the minimum standards of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room, and minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more (refer to STCW Code, Table A-III/1 and A-III/2).

Each minimum standard of competence has eight functions as follows:

Function:	Marine engineering at the operational level/management level
Function:	Electrical, electronic and control engineering at the operational level/management level
Function:	Maintenance and repair at the operational level/management level
Function:	Controlling the operation of the ship and care for the persons on board at the operational level/management level

This model course covers four functions from among the abovementioned, namely: "Marine engineering at the operational level/management level"; and "Electrical, electronic and control engineering at the operational level/management level".

Mandatory provisions concerning qualifications of instructors, supervisors and assessors; in-service training; assessment of competence; and training and assessment within an institution are given in Section A-I/6 of the STCW Code. The corresponding Part B of the STCW Code contains guidance on training and assessment.

■ Structure of the course

This model course consists of the following:

Part A - Course framework:

This provides the framework for the course with its aims and objectives and notes on the suggested teaching facilities and equipment.

Part B - Course outline:
This provides an outline of exercises for the course. No detailed timetable is suggested. From the aspect of teaching and learning, it is more important that the trainee achieves the minimum standard of competence defined in the STCW Code than that a strict timetable being followed.

Part C - Detailed teaching syllabus:

This provides the detailed teaching syllabus. This is based on the theoretical and practical knowledge specified in the STCW Code and is written as a series of learning objectives. Each of the objectives is expanded to define a required performance of knowledge, understanding and proficiency.

Part D - Instructor manual:

This provides necessary key information for the instructor to design and conduct the course.

Part E - Evaluation:

This provides prevalent notions of the evaluation for exercises. Each sample exercise in the appendices explains specific methods for demonstrating competence, and criteria for evaluating competence, as tabulated in the STCW Code. A separate IMO Model course 3.12 also addresses Examination and Assessment of Competence of Seafarers.

Part A: Course Framework

■ Scope

Column 3 of the Table A-III/1 and A-III/2 states "approved simulator training" as one of the "Methods for demonstrating competence", where approved simulator training means training utilizing simulators or indicates that competences acquired from some practical training or classroom lectures can be demonstrated by simulator training. Furthermore, simulators are construed as various types of simulators with various functions including Engine-room simulators available for simulator training.

At the same time, various simulators available for learning construction of machinery, operation principles, control engineering and etc. have been recently developed and some of them can be utilized in the field of marine engineering.

In this context, in this model course simulators which have been developed or may be developed to learn machinery and control systems are deemed as engine-room simulators, which are available for plant operation training by simulating dynamic characteristics of plant machinery and indicating running parameters of the machinery.

This model course describes guidelines for simulator training specified as one method of demonstrating competence in the Column 3 of tables A-III/1 and A-III/2 except the functions "Maintenance and repair at the operational level/management level" and "Controlling the operation of the ship and care for the persons on board at the operational level/management level" and one exception.

The one exception means that sample exercises as simulator trainings for the KUP "Basic construction and operation principles of machinery systems including ・・・" were developed due to the following reasons although no simulator training was described in the Column 3 of A-III/1

1. "Approved laboratory equipment training" for the KUP is described in the Column 3 and educational aids in which simulation software for learning machinery, control engineering and the like are incorporated may be included in the laboratory facilities.
2. Large-scale display and/or mimic panel used for an engine room simulator can be largely utilized for the KUP "Fluid flow and characteristics of lubricating oil, fuel oil and cooling systems" of A-III/1.

3. Simulator training is described in the Column 3 of table A-III/2 where similar KUP "Design features and operative mechanism of the following machinery and associated auxiliaries" is specified.

This is essentially a practical model course, consisting of a series of exercises structured around the construction, operation principles and the operation of a ship machinery installation, and carried out in conjunction with an engine room simulator.

The exercises are supervised by an instructor and will initially allow the trainee to become familiar with the machinery and controls used in the engine rooms of modern merchant ships. Furthermore, the trainee shall become skilled in the scanning of instrument displays when assessing the normal operational conditions of a propulsion plant.

Each exercise should be preceded by a briefing session and followed up by a group debrief, which will analyze the actions and decisions of the trainee.

Note: It should be emphasized that this course does not provide the equivalent of the experience acquired from actual watchkeeping service in the engine room on board a ship.

■ Objective

To provide knowledge and skills related to: construction and operation principles of machinery; and operate, supervise and monitor the safe operation and control of a ship's machinery in accordance with provisions of the STCW Code.

In particular, the trainee will be able to have:
- An understanding of construction, design feature and operational principles of a ship's machinery
- familiarization with the use of instrumentation and controls used in the engine rooms of modern merchant ships
- an awareness of the need for proper pre-planning, the use of checklists and of the timescale involved in starting up propulsion plant machinery
- an understanding and awareness of correct watchkeeping procedures
- experience in identifying operational problems and trouble-shooting them
- the ability of decision makings which promote the safety

■ Entry standards

Entry to the course is open to trainees with basic background and knowledge and to marine engineers who wish to improve their knowledge and understanding of the operation of the machinery of a modern merchant ship.

■ Course intake limitations

The course intake limitation depends on number and/or scale of facilities and the target activity will regulate the number of trainees who can use the simulator at any given time. Training activity using ERS I allows one or two trainees, ERS II allows three to five trainees and ERS III allows six to ten trainees to be directly involved in a simulator exercise simultaneously. Trainees must therefore be sub-divided into groups and activities should be phased so that all trainees can receive the same period of training on the simulator.

The briefing and debriefing sessions can be carried out as main group or sub-group activities, according to circumstances.

■ Staff requirements

Both the assessor and the instructor in charge should be qualified according to Section A-I/6 of the STCW Code, and at least one additional instructor is desirable to deliver the course effectively, preferably with qualifications and experience similar to those of the instructor in charge. An observer, who can provide support as directed by the instructor in charge is also a desirable addition to the staff. The observer's main task is to observe the trainees in action and gather information about their activities and attitudes shown for later presentation during the debriefing session. The observer shall not actively intervene in course delivery.

■ Teaching aids

Instructor manual of this model course and Appendixes.

■ IMO references

Chapter III, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, (STCW) 1978 as amended).

Chapter III, Part A and Chapter VIII, Part A and B, of the Seafarers Training, Certification and Watchkeeping (STCW) Code.

■ Textbooks

No specific texts and books have been used in developing this course.

■ Bibliography

No material has been specifically identified for supplementary reading. However, a large number of texts and books on propulsion plant machinery are available and provide reference material.

For such books, reference can be made to the bibliography of IMO model course 7.02 (Officer in charge of an engineering watch) and 7.04 (Chief engineer officer and second engineer officer).

■ Teaching facilities and equipment

In general, an engine room simulator is a training aid which is able to represent static and dynamical characteristics of ship's propulsion plant machinery, illustrating its machinery installations and indicating running parameters and changes in the running parameters responding to the machinery characteristics and inputs entered by the trainees.

Simulators available for performing simulations to learn construction and operation principles of machinery showing various picture and animation videos are, however, deemed as an engine room simulator to be utilized in this model course, taking into account that the requirements "construction and operation principles of machinery" and "design feature of machinery" are clearly described in the STCW Code, Tables A-III/1 and A-III/2.

In addition, since this model course has been revised based on the concept "what functions of a simulator are necessary to acquire knowledge and skills which meet the knowledge, understanding and proficiency (KUP) requirements described in the tables", new developments for some simulator functions may be expected.

From this aspect, we may utilize simulation tools which are widely used in various engineering fields.

In this model course, the following three types of simulators are suggested as teaching facilities and equipment.

ERS I: This type of simulator allows one or two trainees to learn mainly construction/ configuration and operation principles of machinery and additionally gives prior knowledge and skills concerning machinery and plant operation.

ERS II: This type of simulator allows three to five trainees in a group to learn mainly construction/ configuration and operation principles/mechanism providing the trainees with larger display than ERS I, which is able to display system diagrams/configurations in an effective manner.

ERS III: This type of simulator allows six to ten trainees in a group to learn mainly knowledge and skills on watchkeeping, Engine-room Resource Management (ERM) and propulsion plant operation. Furthermore, its mimic panel allows the trainees to figure out simultaneously the entire system of the machinery plant.

Note: In the following tables, columns of "Competence" and "Knowledge, understanding and proficiency" are excerpts from the STCW Code Table A-III/1 and A-III/2, and the numbers in the each column of ERS I, II and III indicate indexes which lead operational overviews of these types of simulator and the detailed teaching syllabus. For example, the number "1" in column of ERS III means the training item "ERS III - 1" which is the first training item conducted by ERS III.

Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty in a periodically unmanned engine-room

Function: Marine engineering at the operational level

Competence	Knowledge, understanding and proficiency	Index		
		ERS I	ERS II	ERS III
Maintain a safe engineering watch	Thorough knowledge of principles to be observed in keeping an engineering watch, including: .1 duties associated with taking over and accepting a watch			1
	.2 routine duties undertaken during a watch			
	.3 maintenance of the machinery space logs and the significance of the readings taken			
	.4 duties associated with handing over a watch			
	Safety and emergency procedures; change-over of remote/automatic to local control of all systems			2
	Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems			3
	Engine-room resource management Knowledge of engine-room resource management principles including: .1 allocation, assignment, and prioritization of resources			4
	.2 effective communication			
	.3 assertiveness and leadership			
	.4 obtaining and maintaining situational Awareness			
	.5 consideration of team experience			
Use English in written and oral form	Adequate knowledge of the English language to enable the officer to use engineering publications and to perform engineering duties			(*1)
Use internal communication Systems	Operation of all internal communication systems on board			(*2)
Operate main and auxiliary machinery and associated control systems	Basic construction and operation principles of machinery systems including: .1 marine diesel engine	1		
	.2 marine steam turbine	2		
	.3 marine gas turbine	-----	----	----
	.4 marine boiler	3		
	.5 shafting installations including propeller	4		

	.6 other auxiliaries including various pumps, air compressor, purifier, fresh water generator, heat exchanger, refrigeration, air-conditioning and ventilation systems	5 (*3)	1 (*4)	
	.7 steering gear	6		
	.8 automatic control systems		2	
	.9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems		3(*5)	5(*6)
	.10 deck machinery	7		
	Safety and emergency procedures for operation of propulsion plant machinery including control systems			(*7)
	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems: .1 main engine and associated auxiliaries			6
	.2 steam boiler and associated auxiliaries and steam systems			
	.3 auxiliary prime movers and associated systems			
	.4 other auxiliaries including refrigeration, air- conditioning and ventilation systems		4 (*8)	
Operate fuel, lubrication, ballast and other pumping systems and associated control systems	Operational characteristics of pumps and piping systems including control systems		5(*9)	7 (*10)
	Operation of pumping systems: .1 routine pumping operations			
	.2 operation of bilge, ballast and cargo pumping systems		6 (*11)	
	Oily water separators (or similar equipment) requirements and operation	8(*12)		

*1: Effects for this competence can be expected through trainings ERS III - 1, 2, 3 and 4 if the trainings are carried out in English.
*2: Effects for this competence can be expected through trainings ERS III - 1, 2, 3 and 4 by using communication equipment.
*3: Pumps, Air compressor Purifier, FWG, Heat Exchanger
*4: Refrigerator, Air-conditioner and ventilation systems
*5: Main steam turbine
*6: Main diesel engine
*7: Effects for this requirement can be expected through trainings ERS III-2, 3 and 4
*8: Refrigerator, Air conditioner and Ventilation systems
*9: Operational characteristics of pumps is applied and effects for the requirements "piping system" can be expected through trainings ERS II - 3, ERS III - 5 and 7
*10: Routine pumping operations, bilge operation and oily water separator (or similar equipment) operation
*11: Ballast and cargo pumping systems
*12: Oily water separators (or similar equipment) requirements

Function: Electrical, electronic and control engineering at the operational level

Competence	Knowledge, understanding and proficiency	Index		
		ERS I	ERS II	ERS III
Operate electrical, electronic and control systems	Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment .a generator and distribution systems		7	
	.b preparing, starting, paralleling and changing over generators			8
	.c electrical motors including starting methodologies	9(*13)	8(*14)	
	.d high-voltage installations	10		
	.e sequential control circuits and associated system devices	11(*15)	9 (*16)	
	.2 electronic equipment .a characteristics of basic electronic circuit elements	12		
	.b flowchart for automatic and control system			
	.c functions, characteristics and features of control systems for machinery items including main propulsion plant operation control and steam boiler automatic controls		10	
	.3 control systems .a various automatic control methodologies and characteristics		11	
	.b Proportional-Integral-Derivative (PID) control characteristics and associated system devices for process control		12	
Maintenance and repair of electrical and electronic equipment	(All KUPs for the competence)	-----	-----	-----

*13: Electrical motors
*14: Starting methodologies
*15: Associated system devices
*16: Sequential control circuits

Function: Maintenance and repair at the operational level
No "approved simulator training, where appropriate" is provided in Colum 3.

Function: Controlling the operation of the ship and care for persons on board at the operational level

To be excluded from this model course

Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power and more

Function: Marine engineering at the management level

Competence	Knowledge, understanding and proficiency	Index		
		ERS I	ERS II	ERS III
Manage the operation of propulsion plant machinery	Design features, and operative mechanism of the following machinery and associated auxiliaries .1 marine diesel engine	13		
	.2 marine steam turbine	14		
	.3 marine gas turbine	-----	-----	-----
	.4 marine steam boiler	15		
Plan and schedule operations	*Theoretical knowledge* Thermodynamics and heat transmission	-----	-----	-----
	Mechanics and hydromechanics			
	Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption			9(*17)
	Heat cycle, thermal efficiency and heat balance of the following .1 marine diesel engine			10
	.2 marine steam turbine		13	
	.3 marine gas turbine	-----	-----	-----
	.4 marine steam boiler		13	
	Refrigerators and refrigeration cycle		4	
	Physical and chemical properties of fuels and lubricants	-----	-----	-----
	Technology of materials			
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	Naval architecture and ship construction, including damage control			
	Practical knowledge Start up and shut down main propulsion and auxiliary machinery, including associated systems			11
	Operating limits of propulsion plant		14(*18)	
	The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery			12
	Functions and mechanism of automatic control for main engine		10	
	Functions and mechanism of automatic control for auxiliary machinery including but not limited to: .1 generator distribution systems			

	.2 steam boilers			
	.3 oil purifier			
	.4 refrigeration system		10	
	.5 pumping and piping systems			
	.6 steering gear system			
	.7 cargo handling equipment and deck machinery			
Manage fuel, lubrication and ballast operations	Operation and maintenance of machinery, including pumps and piping systems		(*19)	

*17: Main diesel engine

*18: Main diesel engine and steam turbine

*19: Effects can be expected through relevant trainings of ERS II and III.

Function: Electrical, electronic and control engineering at the management level

Competence	Knowledge, understanding and proficiency	Index		
		ERS I	ERS II	ERS III
Manage operation of electrical and electronic control equipment	*Theoretical knowledge* Marine electrotechnology,	-----	-----	-----
	Electronics,			
	Power electronics			
	Automatic control engineering and safety devices			
	Design features and system configurations of automatic control equipment and safety devices for the followings : .1 main engine		10	
	.2 generator and distribution system			
	.3 steam boiler			
	Design features and system configurations of operational control equipment for electrical motors		8 & 9	
	Design features of high voltage installations	10		
	Features of hydraulic and pneumatic control equipment		10	
Manage troubleshooting restoration of electrical and electronic control equipment to operating condition	*Practical knowledge* Troubleshooting of electrical and electronic control equipment	-----	-----	-----
	Function test of electrical, electronic control equipment and safety devices			
	Troubleshooting of monitoring systems			
	Software version control			

Function: Maintenance and repair at the management level

Competence	Knowledge, understanding and proficiency	Index		
		ERS I	ERS II	ERS III
Manage safe and effective maintenance and repair procedures	(All KUPs for the competence)	-----	-----	-----
Detect and identify the cause of machinery malfunctions and correct faults	Practical knowledge Detection of machinery malfunction, location of faults and action to prevent damage			3 & 12
	Inspection and adjustment of equipment	-----	-----	-----
	Non-destructive examination	-----	-----	-----
Ensure safe working practice	(All KUPs for the competence)	-----	-----	-----

Function: Controlling the operation of the ship and care for persons on board at the management level

To be excluded from this model course

Concept of ERS I

Nature of the training using ERS I is Computer Based Training (CBT) and available for one or two trainees to perform simulator training, watching simulation videos and pictorial images selected by the trainee/trainees from its menu display. An instructor gives the trainees instructions with assignment paper/scenario paper or materials which say training items and/or tasks to be tackled by the trainee/trainees. The instructor should note that CBT performed by two trainees is sometimes more effective than single trainee's performance, it is therefore important to allocate CBT units to the trainees in accordance with the objectives of the training considering the limitation of the facility.

The number of CBT units to be installed should be at least six out of ten of all the trainees in a class.

Functional overview of ERS I

Ind.	Machinery	Function of simulation
ERS I-1	Marine Diesel Engine A (Uniflow scavenging, Exhaust gas turbocharged, Two-stroke, Crosshead type diesel engine) Marine diesel engine B (Exhaust gas turbocharged 4 stroke trunk Piston type diesel engine)	① Construction/Structure a. Sequentially labels components/parts of the engine displaying cross-sectional view of the engine assembly. b. Sequentially labels components/parts of the main structural components of the engine displaying their 3-D cross-sectional/full view - Cylinder head - Cylinder liner - Piston - Stuffing box (2 stroke) - Crosshead (2 stroke) - Connecting rod - Crankshaft - Main bearing. c. Sequentially labels components/parts of the valves fitted to the cylinder head displaying their cross-section/full view (Exhaust valve, Fuel injection valve, Starting valve, Indicator valve, Safety valve). d. Sequentially labels main parts of the turbocharger displaying their 3-D cross-sectional view. e. Sequentially labels parts of the fuel oil injection pump displaying its 3-D cross-sectional view. f. Sequentially labels components/parts of valve operation mechanism/system displaying the system ② Operation principle a. Displays animation video which shows fuel injection, fuel combustion, movements of piston, exhaust valve and crankshaft, movable combustion gas flow, movable scavenging air flow (suction valve) and indicator diagram utilizing the cross-sectional view of the engine assembly. b. Displays animation video which shows movable lubricating oil flow utilizing the cross-sectional view of the engine assembly. c. Displays animation video which shows movable cooling fresh water flow utilizing the cross-sectional view of the engine assembly. ③ Selective function as follow Diesel engine → 2-stroke → Construction → a → Operation principle → b → 4-stroke → Construction → c → Operation principle → d a(c): → Engine assembly → Main components → Cylind er head → Cylinder liner → Piston → · ·

		→Valves on cylinder head → Exhaust valve → Suction valve (4-stroke) → Fuel injection valve → Starting valve → Indicator valve → Safety valve → Turbocharger → Air cooler → Fuel oil injection pump → Valve operation mechanism/system b(d): → Movement of piston and others with fuel oil injection and indicator diagram → Lubricating oil flow → Cooling fresh water flow
ERS I-2	Marine steam turbine (Two cylinder cross compound impulse turbine)	① Construction a. Sequentially labels components/parts of the turbine assembly displaying its 3-D full view. b. Sequentially labels parts of the main structural components of the turbines displaying their cross-sectional views/3-D full views (Casing, Turbine rotor, Nozzle, Moving blade, Labyrinth packing, Flexible coupling, Bearing and Reduction gear). ② Operation principle a. Displays animation video which shows movable steam flow inside the high and low pressure turbine and astern turbine with rotor rotation utilizing its cross-sectional view. b. Displays animation video which shows movable packing steam flow utilizing the cross-sectional view and system diagram. c. Displays animation video which shows movable lubricating oil flow unitizing cross-sectional view of the turbines. ③ Selective function as follow Steam turbine → Construction → a → Operation principle → b a. → Turbine assembly → Main condenser → Main components → Cylinder/Casing → Turbine rotor → HP T → LP & AST T → Nozzle → Moving blade → Labyrinth packing → Flexible coupling → Bearing → Reduction gear b.

		→ Superheated steam flow → Ahead → Astern → Gland steam flow → Lubricating oil flow
ERS I-3	Marine boiler	① Construction a. Sequentially labels main components/parts of several typed of boilers displaying their cross-sectional view/3-D full view. b. Sequentially labels parts of the main structural components of the boilers displaying their 3-D full view for each type of boilers c. Sequentially labels components/parts of Air resister assembly, Pressure atomizing burner, Steam atomizing burner and Rotary burner displaying its cross-sectional view/3-D full view. d. Sequentially labels components of heat medium boiler system displaying its simple system diagram. ② Operation principle a. Displays animation video which shows movable process of generating steam from boiler water and combustion gas flow inside the boilers utilizing their cross-sectional view/3-D full view. b. Displays animation video which shows steam flow from the steam drum to the superheater, desuperheater and/or attemperator, and main steam stop valve utilizing cross-sectional view/3-D full view of two drums water tube boiler. c. Displays animation video which shows movable heat medium flow utilizing its simple system diagram. ③ Selective function as follow Marine boiler → Construction → a → Operation principle → b a → Two drums water tube boiler assembly, → Vertical cylindrical boiler, → Small flow-through boiler, → Exhaust gas economizer → Thermal fluid boiler → Main components → Steam drum → Water drum → Water tube → Furnace → → → → Air resister assembly → Burners → Pressure atomizing burner → Steam atomizing burner → Rotary burner b → Process of generating steam

		→ Two drums water tube boiler → Vertical cylindrical boiler, → Small flow-through boiler, → Combustion gas flow → Soot blower → Boiler flow → Thermal fluid/Heat medium flow
ERS I-4	Shafting installations	① Construction a. Sequentially labels equipment of shafting system such as Thrust bearing, Intermediate shaft and bearing, Propeller shaft, Stern tube and bearing, Shaft sealing equipment, Shaft earthing device Rope guard, and Propeller displaying shafting arrangement. b. Sequentially labels components/parts of shafting system equipment aforementioned including conventional propeller and controllable pitch propeller, displaying their cross-sectional view/3-D full view) c. Sequentially labels components/parts of a propelling unit without shafting system displaying their 3-D full views. ② Operation principle a. Displays animation video which shows how Michel type thrust bearing works utilizing its cross-sectional view and/or 3-D full view. b. Displays animation video which shows how shaft sealing equipment works utilizing its cross-sectional view and/or 3-D full view. c. Displays animation video which shows how the propeller blades of controllable pitch propeller are rotated around their long axis to change their pitch. ③ Selective function as follow Shaft installation → Construction → a → Operation principle → b a → Shafting arrangement → Thrust bearing → Intermediate shaft and bearing → Propeller shaft → Stern tube and bearing → Shaft sealing equipment → Shaft earthing device → Rope guard → Propeller → Conventional propeller → Controllable pitch propeller → Propelling unit without shafting b. → Thrust bearing

		→ Shaft sealing equipment → Controllable pitch propeller ④ Arbitrary setting in blade angle of the controllable pitch propeller
ERS I-5	Pump	① Construction a. Sequentially labels components/parts of the following pumps displaying their cross-sectional view and/or 3-D full views. - Centrifugal pump - Gear pump - Screw pump - Reciprocating pump - Vane pump - Axial-flow pump b. Sequentially labels components/parts of mechanical seal used for a pump displaying its cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation videos which show how the aforementioned pumps discharge the fluid utilizing their cross-sectional views ③ Selective function as follow Pump → Construction → Centrifugal pump → Gear pump → Screw pump → Reciprocating pump → Vane pump → Axial-flow pump → Mechanical seal → Operation principle → Centrifugal pump → Gear pump → Screw pump →Reciprocating pump → Vane pump → Axial-flow pump
	Air compressor	① Construction a. Sequentially labels components/parts of air compressor displaying its cross-sectional view and/or 3-D full views. - One cylinder stage compression type - Three-cylinder there stage compression type b. Sequentially labels components/parts of a plate valve used for air compressor displaying its cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation video which shows how the compressor works with air flow, discharge pressure and actuation of drain valves utilizing their cross-sectional views and/or 3-D full views.

		③ Selective function as follow Air compressor → Construction → a → Operation principles → b a. → One cylinder stage compression type → Three-cylinder there stage compression type b. → One cylinder stage compression type → Three-cylinder there stage compression type
	Purifier	① Construction a. Sequentially labels components/parts of Delaval type and Sharples type of oil purifiers displaying their cross-sectional view and/or 3-D full views. b. Sequentially labels components/parts of the bowl assembly of Delaval type of oil purifier displaying its cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation video which shows how Delaval type and Sharples type oil purifier work with oil flow, and sludge separation and discharge utilizing their cross-sectional views and/or 3-D full views. b. Displays animation video which shows sludge discharge procedures/mechanism of the Delaval type oil purifier unitizing its cross-sectional view and/or 3-D full views of the bowl assembly. ③ Selective function as follow Purifier → Construction → Delaval type → a → b → Sharples type → Operation principle → Delaval type → c → d → Sharples a: Overall b: Bowl assembly c: Working mechanism d: Sludge separation
	Fresh Water Generator	① Construction a. Sequentially labels components/parts of the several type of fresh water generators displaying their cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation videos which show process of generating distilled water in the fresh water generators utilizing their cross-sectional views and/or 3-D full views. ③ Selective function as follow FWG → Construction → Operation principle

	Heat exchanger	① Construction a. Sequentially labels components/parts and their functions of the following heat exchangers displaying their cross-sectional view and/or 3-D full views. - Shell and tube type - Plate type - Pin type - Fin type ② Operation principle a. Displays animation videos which show heating/cooling process in the heat exchangers aforementioned utilizing their cross-sectional views and/or 3-D full views. ③ Selective function as follow Heat exchanger → Construction → a → Operation principle → b a (b) → Shell and tube type → Plate type → Pin type → Fin type
ERS I-6	Steering gear	① Construction a. Sequentially labels components of Rapson slide type and Rotary vane type oil hydraulic steering systems displaying their system structures. b. Sequentially labels components/parts of the following equipment displaying their cross-sectional views and/or 3-D full views. - Ram, ram cylinder and crosshead unit - Vane unit - Oil hydraulic pump - Hunting gear ② Operation principle a. Displays animation video which shows mechanism of changing rudder angle with oil flow and movement of hunting gear for two types of the steering system aforementioned utilizing their cross-sectional views and/or 3-D full views. b. Displays animation videos which show how the oil hydraulic pumps work utilizing their cross-sectional views and/or 3-D full views. ③ Selective function as follow Steering gear → Construction → a → Operation principle → b a → Overall structure → Rapson slide → Rotary vane → Ram, ram cylinder and crosshead unit

		→ Vane unit → Hunting gear →Oil hydraulic pump b → Rapson slide → Rotary vane → Oil hydraulic pump
ERS I-7	Deck machinery	① Construction a. Sequentially labels main components of the following deck machinery displaying their entire structure of the machinery. - Electric driven mooring windlass - Oil hydraulic driven mooring windlass - Electric driven mooring winch - Oil hydraulic driven mooring winch - Electric driven cargo winch - Oil hydraulic driven cargo winch b. Sequentially labels parts of the main components used for the deck machinery aforementioned displaying their cross-sectional views and/or 3-D full views. ② Operation principle a. Displays animation videos which show how the aforementioned deck machinery works utilizing their cross-sectional views and/or 3-D full views. b. Displays animation videos which show how the oil hydraulic motors work utilizing their cross-sectional views and/or 3-D full views. ③ Selective function as follow Deck machinery → Construction → a → Operation principle → b a → Electric driven mooring windlass → Oil hydraulic driven mooring windlass → Electric driven mooring winch → Oil hydraulic driven mooring winch → Electric driven cargo winch → Oil hydraulic driven cargo winch → Main components → Driving gear assembly → Lifting gear assembly → Warping gear assembly → Braking gear assembly → Oil hydraulic pump b → Electric driven mooring windlass → Oil hydraulic driven mooring windlass → Electric driven mooring winch → Oil hydraulic driven mooring winch → Electric driven cargo winch

		→ Oil hydraulic driven cargo winch → Oil hydraulic pump
ERS I-8	Oily water Separator (or similar equipment)	① Construction a. Sequentially labels components/parts of oily water separator (or similar equipment) displaying its cross-sectional view and/or 3-D full views. b. Sequentially labels component/parts of oil content monitor displaying its system configuration. ② Operation principle a. Displays animation video which shows how the oily water separator (or similar equipment) works in service with oil separation and discharging process utilizing their cross-sectional views and/or 3-D full views. b. Displays animation video which shows principle of detecting oil and actuation of the monitor unitizing its system configuration and others. ③ Selective function as follow Oily water separator (or similar equipment) → Construction → a → Operation principle → b a → Overall structure → Oil content monitor b → Oil separation → Oil content monitor
ERS I-9	Electrical motor	① Configuration a. Sequentially labels components/parts of an electric motor generally used for machinery displaying their internal wiring diagram, cross-sectional view and 3-D full views. ② Operation principle a. Displays animation video which shows how the electric motors rotate including electrical mechanism in service with running parameters utilizing their internal wiring diagram, cross-sectional views and 3-D full views. ③ Selective function as follow Electric motor → Configuration → a → Operation → b a → Single phase AC motor → Three phase AC motor → DC motor b → Single-phase AC motor → Three-phase AC motor

		→ DC motor
ERS I-10	High-voltage installations	① Configuration a. Sequentially labels components/parts of Main Switch Board (MSB) used for high-voltage distribution system displaying its cross-sectional view and/or 3-D full views including design features compared to low voltage installations. b. Sequentially labels components/parts of Vacuum Circuit Breaker (VCB) and Earthing device displaying their cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation video which shows how the main switch board is operated utilizing its remote control system configuration. b. Displays animation video which shows how the following systems work utilizing their system configuration, cross-sectional view and/or 3-D full views. - VCB - Earthing device - Interlocking device ③ Selective function as follow Main Switch Board → Configuration → a → Operation principle → b a → Main Switch Board → Vacuum Circuit Breaker (VCB) → Earthing device b → Vacuum Circuit Breaker (VCB) → Earthing device → Interlocking device ④ Selective malfunctions to the system equipment are to be available for simulated actuations of VCB, Earthing device and Interlocking devices.
ERS I-11	Sequential control circuit devices	① Configuration a. Sequentially labels devices used for sequential control circuits displaying their symbols and pictorial images. - MCCB - Electromagnetic relays - Switches - Indication lamps - Mechanical switches - Ampere meter - Fuses - Transformers ② Operation principle a. Displays animation videos which show how the aforementioned devices work utilizing their internal wiring diagram,

		cross-sectional views and 3-D full views. ③ Selective function as follow Sequential control circuit devices → Configuration → a → Operation principle → b a (b) → MCCB → Electromagnetic relays → Switches → Indication lamps → Mechanical switches → Ampere meter → Fuses → Transformers
ERS I-12	Electronic circuit element	① Configuration a. Sequentially labels the following electronic elements typically used for electronic circuit displaying their symbols and pictorial images. - Resisters - Capacitors - Inductors - Diodes - Transistors - Thyristors - Series regulator - IGBT - MOSFET - Various LSI ② Operation principle a. Displays animation video which shows how the aforementioned electronic circuit elements work utilizing simple circuit diagram and symbolic illustrations. ③ Selective function as follow Electronic circuit element → Configuration → a → Operation principle → b a (b) → Resisters → Capacitors → Inductors → Diodes → Transistors → Thyristors → Series regulator → IGBT → MOSFET → Various LSI
ERS	Marine diesel	① Design features and operative mechanism

I-13	engine	a. Sequentially labels parts/components and briefs their design features reflected on the structure of diesel engine displaying their cross-sectional view and/or 3-D full views b. Sequentially labels parts/components and briefs their design features and operative mechanism of diesel engine reflected on the following displaying their cross-sectional/3-D full views and/or animation video - Operative mechanism - Fuel injection equipment - Combustion chamber components ② Selective function as follow Design features and operative mechanism → Structural components → Operative mechanism → Gear assembly → Crank shaft → Camshaft → Starting mechanism → Reversing mechanism → Exhaust valve drive → a → Fuel injection Cam driving → Common rail system → Combustion chamber a. → Mechanical → Mechanical – Oil hydraulic → Oil hydraulic (common rail system)
ERS I-14	Marine steam turbine	① Design features and operative mechanism a. Sequentially labels parts/components and briefs their design features reflected on the structure of steam turbine displaying their cross-sectional/3-D full views. and/or animation video ② Selective function as follow Design features and operative mechanism → High pressure turbine → Low pressure turbine and astern turbine → Flexible coupling → Gland sealing → Bearing
ERS I-15	Marine steam boiler	① Design features and operative mechanism a. Sequentially labels parts/components and briefs design features reflected on the structure of marine steam boilers displaying their cross-sectional/3-D full views. and/or animation video ② Selective function as follow Design features and operative mechanism → Two drum water tube → Steam drum

			→ Water drum → Superheater → Desuperheater → Tubes → Main bank → Water wall → Screen → Down comer → Riser → Economizer → Gas air heater → Soot blower

Concept of ERS II

Nature of ERS II training is small group training. The trainees watch simulation videos and perform simulations from key boards on their desk. ERS II provides the trainees with a larger display which is able to display various system diagrams and configurations of machinery/machinery system.

These diagrams cannot be displayed effectively on a display of ERS I and ERS II trainings, as they cover topics which are hard to understand through ERS I training, and the training should be conducted, in principle, with instructor's briefing and instructions to make them more effective.

One unit of ERS II comprises the following (and two or three units of ERS II are desirable):

- Approximate 60 inch display
- Instructor's desk with operation key board
- Trainee's desk with operation key boards

Figure 1 gives suggested arrangement of ERS II unit.

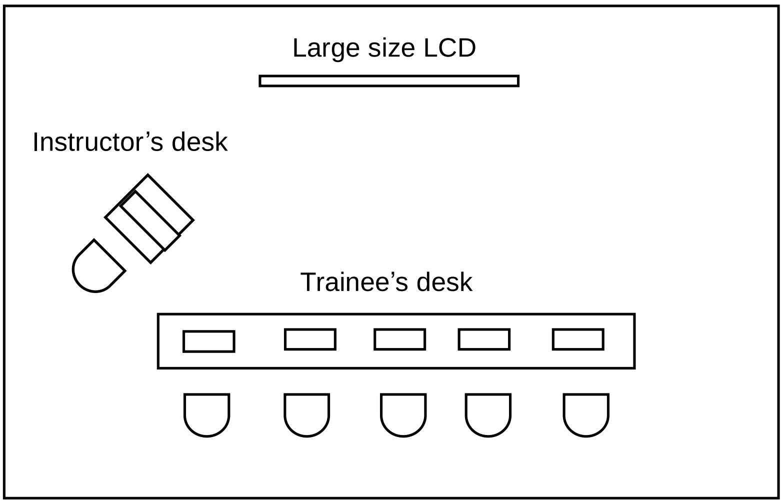


Figure 1

Functional overview of ERS II

Ind.	Machinery	Function of simulation
ERS II-1	Refrigerator	① Construction a. Sequentially labels components of a provision refrigeration system displaying its system illustrative configuration. b. Sequentially labels components/parts of the following compressors displaying their cross-sectional view and/or 3-D full views. - Reciprocating type - Screw type c. Sequentially labels parts of plate type suction and delivery valves, and shaft seal used in the reciprocating type compressor displaying their cross-sectional view and/or 3-D full views. d. Sequentially labels parts of the following components displaying their cross-sectional view and/or 3-D full views. - Condenser - Evaporator - Expansion valve - Oil separator - Dryer ② Operation principle a. Displays animation video which shows how the aforementioned components work utilizing their cross-sectional view and/or 3-D full views. b. Displays animation video which shows how the provision refrigeration system works utilizing its illustrative configuration which contains necessary valves, thermostat, start and stop switches and others available for operation by trainees. ③ Selective function as follow Refrigeration → Construction → a Refrigeration → Operation principle → b a → Provision refrigeration system → Compressor → Reciprocating → Overall structure → Suction & Delivery Valve → Shaft seal → Screw → Other component → Condenser → Evaporator → Expansion valve → Oil separator → Dryer b → Provision refrigeration system → Component → Compressor → Reciprocating type → Screw type → Condenser → Evaporator → Expansion valve

		→ Oil separator → Dryer
	Air conditioner	① Construction a. Sequentially labels components of marine air conditioning system displaying its illustrative system configuration. b. Sequentially labels components/parts of thermo tank unit of marine air conditioning displaying its cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation video which shows how the marine air conditioning system works utilizing its illustrative system configuration which contains necessary valves, dampers, thermostat, start and stop switches and others available for operation by trainees. ③ Selective function as follow Air conditioning → Construction → a → Operation principle → b a (b) → Air conditioning system → Thermo tank unit
	Ventilation	① Construction a. Sequentially labels components/parts of Axial flow fan and Centrifugal fan used for marine air conditioning system and engine room displaying their cross-sectional view and/or 3-D full views. ② Operation principle a. Displays animation video which shows how the ventilation systems work for accommodation and engine room including an event of fire utilizing its illustrative system configuration which contains necessary dampers, start and stop switches and others available for operation by trainees. ③ Selective function as follow Ventilation → Construction → Axial flow fan → Centrifugal fan → Operation principle → Accommodation → Engine room
ERS II-2	Automatic control	① Construction a. Sequentially labels and briefs components used for the following typical process control systems on board displaying their illustrative systems configurations. - Level control - Temperature control - Pressure control b. Sequentially labels and briefs sensor devices, controllers and manipulation equipment used for aforementioned control systems displaying their cross-sectional view and/or 3-D full views and/or

		illustrative configuration. ② Operation principle a. Displays animation video which shows how the sensors devices/units aforementioned detect process values utilizing their illustrative drawings. b. Display animation video which shows how the manipulation equipment aforementioned works utilizing their illustrative drawings. ③ Selective function as follow Automatic control → Construction → Level control → a → Temp. control → b → Press. control → c → Operation principle → d a. (b, c, e, f, g) → Sensor → Controller → Manipulation equipment d. → Level control → e → Temp. control → f → Press. control → g
ERS II-3	Fluid flow and characteristics	① Construction a. Sequentially labels components of the following systems used for steam turbine propulsion plant displaying their illustrative system diagrams. - Superheated stem system - Bleeding steam system - Condensate water system - Feed water system - Gland steam system - Lubricating oil system ② Operation principle a. Displays animation video which introduces how the aforementioned systems work indicating fluid flow with arrowheads or other means utilizing their illustrative system diagrams which contains necessary valves, start and stop switches and others available for operation by trainees and simulated pressure, temperature and level meters. ③ Selective function as follow Fluid flow of steam turbine plant → Construction → Superheated stem system → Bleeding steam system → Condensate water system → Feed water system → Gland steam system → Lubricating oil system

		→ Operation principle → Superheated stem system → Bleeding steam system → Condensate water system → Feed water system → Gland steam system → Lubricating oil system
ERS II-4	Refrigeration Air-conditioning Ventilation	① Preparation, operation, fault detection and damage prevention a. Displays simulated entire system diagram of typical refrigeration system on the screen with necessary valves, and start, stop and changeover switches available for operation by trainees and simulated pressure, temperature and level. b. Selective initial condition of cold and running conditions c. Selective simulation speed d. Displays simulated refrigeration cycle on the p-h diagram (Mollier diagram) and process of refrigeration with necessary running parameters. e. The following training is feasible. - Starting up the system in manual - Manual operation including changeover of compressors, alternation of setting temperature, defrosting, supply of LO and refrigerant. - Putting the system into automatic operation - Response to malfunctions (shortage of cooling water or similar malfunction, short cycle, liquid back, higher compression of compressor, activation of safety devices, etc.) - Shutting down the system
ERS II-5	Pumps	① Operational characteristics a. Displays simulated characteristic performance curves of several types of pumps with necessary running parameters. b. Displays simulated entire system diagram of simple pumping system using centrifugal pump on the screen with necessary valves, and start and stop switches available for operation by trainees and simulated pressure, temperature and level. c. Pump experiment using centrifugal pump is feasible for operational characteristic performance.
ERS II-6	Ballast and cargo pumping systems	① Operation a. Displays simulated entire system diagram of ballast and cargo pumping systems on the screen with necessary valves, and start, stop and changeover switches available for operation by trainees and simulated pressure, temperature and level. b. Displays simulated tank conditions on the screen. c. Selective initial conditions of loading and discharging conditions d. Selective simulation speed
ERS II-7	Generator and distribution system	① Configuration a. Sequentially labels components/parts of Self-excited 3 phase A.C generator displaying its illustrative wiring, cross-sectional view and/or 3-D full views. b. Sequentially labels components/parts of Main Switch Board (MSB) displaying its illustrative power distribution diagram, cross-sectional

		view and/or 3-D full views. c. Sequentially labels components/parts of the following circuit breakers displaying its cross-sectional view and/or 3-D full views. - Air Circuit Breaker (ACB) - Mold Case Circuit Breaker (MCCB) ② Operation principle a. Displays animation video which shows how an alternative current and voltage are generated utilizing its illustrative system diagrams which contains simulated current, voltages, frequency and others. b. Displays animation video which shows opening and closing mechanism of ACB and how ACB works in case of the following utilizing its illustrative diagram, cross-sectional view and/or 3-D full views. - Low voltage - Over current - Reverse power c. Displays animation video which shows opening and closing mechanism of MCCB and how MCCB works its illustrative diagram, cross-sectional view and/or 3-D full views d. Displays animation video which shows how the electric power is distributed to electrical loads. ③ Selective function as follow Generator and Distribution System → Configuration → A.C Generator → MSB → Circuit breaker → a → Operation principle → A.C Generator → Circuit breaker → b → Distribution system a (b) → ACB → MCCB
ERS II-8	Motor starting methodologies	① Configuration a. Sequentially labels devices/circuit elements of motor starting circuit displaying typical motor starter circuit diagrams with symbols and pictures of actual devices as follow. ② Operation principle a. Displays animation video which shows how the following motor starting circuits work utilizing their circuits which contains switches available for operation by trainees to start the motors. - Direct-on-line - Direct-on-line reverse - Star-Delta - Reactor - Inverter - Thyristor/Softstarter ③ Selective function as follow A.C motor starting methodology

		→ Configuration → MCCB → Switches → Relays → Transformer → Fuses → Lamps → Operation principle → Direct-on-line → Direct-on-line reverse → Star-Delta → Reactor → Inverter → Thyristor/Softstarter
ERS II-9	Sequential control circuit and associated system devices	① Configuration a. Sequentially labels and briefs components/devices/circuit elements of the following typical control circuit diagrams displaying their circuit diagrams. - Diesel generator engine remote and automatic starting and stopping circuit - Auxiliary boiler combustion control ② Operation principle a. Displays animation video which shows how the control circuits aforementioned and their components work with necessary running parameters including safety functions utilizing circuit diagrams which contains switches available for operation by trainees. ③ Selective function as follow Sequential control circuit → Diesel generator automatic starting and stopping circuit → Auxiliary boiler combustion control

ERS II-10	Main diesel engine Main steam turbine Diesel generator and distribution system Main steam boiler Oil purifier Refrigeration system Pumping and piping system Steering gear System Cargo handling equipment and deck machinery	① Configuration a. Sequentially labels and briefs components of "A ~ I" remote and automatic control system displaying system configurations, flowcharts, system diagrams and illustrative drawings/images. A: main diesel engine B: main steam turbine C: diesel generator and distribution systems D: main steam boiler E: Oil purifier F: Refrigeration system G: pumping and piping system H: Steering gear system I: cargo handling equipment and deck machinery ② Operation principle a. Displays animation video which introduces operation principle of functions of the each component aforementioned including characteristic and features utilizing its illustrative drawing/images ③ Function and mechanism (Management level) a. Displays animation video which introduces the following functions and mechanism of "A ~ I" automatic control utilizing illustrative images, flowchart and system diagrams which contains necessary indications and switches available for operation by trainees. A: main engine automatic control (1) remote and Automatic start (2) automatic revolution speed control - revolution speed control under standby engine - speed run-up program including blade angle control of CPP (3) crash astern (4) variable injection timing (5) variable exhaust valve timing (6) actuation of safety functions: - automatic shutdown - automatic slow down - start failure - start impossible - wrong way B: main steam turbine (1) automatic revolution speed control (2) crash/emergency astern (3) automatic rollover (4) actuation of safety functions: - automatic shutdown - automatic slow down C: diesel generator and distribution systems (1) full automatic control for generator and distribution system (2) automatic starting and stopping generator engine (3) automatic synchronizing (4) automatic load sharing (5) optimum load sharing (6) large motor start blocking (6) preference trip (8) protective/Safety functions built in ACB and/or VCB (9) automatic voltage (AVR) and frequency control

		(3) automatic synchronizing (4) automatic load sharing (5) optimum load sharing (6) large motor start blocking (6) preference trip (8) protective/Safety functions built in ACB and/or VCB (9) automatic voltage (AVR) and frequency control Steam boiler (1) automatic Combustion Control (ACC), (2) automatic feed water control (3) automatic steam temperature control (4) protective/Safety functions for steam boiler E: oil purifier (1) temperature control (2) automatic start (3) automatic desludging (4) actuation of safety functions Efrigeration system (1) automatic temperature control (2) automatic start and stop of compressor (3) timer control for defrosting (4) capacity control (5) actuation of safety functions G: pumping and piping system (1) automatic changeover (2) automatic start and stop H: Steering gear system (1) auto pilot hydraulic system I: cargo handling equipment and deck machinery (1) remote and automatic speed control
ERS II-11	Various automatic control	① Configuration a. Displays animation video which introduces typical systems and characteristics of the following automatic control methodologies utilizing illustrative drawings/diagrams/images and labeling components of the systems. - ON-OFF control - Sequential control - PID control - Programmable Logic Control (PLC) - Program control. b. Sequentially labels parts of the following sensor devices used for the aforementioned automatic control displaying symbols, their cross-sectional view and/or 3-D full views and/or illustrative configuration. - Limit switches - Pressure switch

		- Level switch - Thermostat - Flow switch - Resistance thermometer bulb - Pressure transmitter c. Sequentially labels components/parts of the following manipulation equipment used for the aforementioned automatic control displaying their symbols, cross-sectional view and/or 3-D full views and/or illustrative configuration. - Diaphragm control valve - Positioner - Motor drive control valve - Solenoid valve d. Sequentially labels components/parts of the following hydraulic and pneumatic devices as manipulation equipment used for the aforementioned automatic control displaying their symbols, cross-sectional view and/or 3-D full views and/or illustrative configuration. - Hydraulic and Pneumatic pumps - Hydraulic and Pneumatic motors - Reservoirs - Directional control valves - Valve actuators - Flow control valves - Cylinders and piston ② Operation principle a. Displays animation video which introduces control actions of aforementioned control methodologies from theoretical aspect utilizing illustrative drawings/diagrams/images. b. Displays animation video which introduces how the control actions are performed utilizing illustrative drawings/diagrams/images which contains adjustable switches and process values for experimental operation of the systems. c. Displays animation video which introduces how the aforementioned sensors detect process values and others utilizing their cross-sectional view and/or 3-D full views and/or illustrative d. Displays animation video which introduces how the aforementioned manipulation equipment work utilizing their cross-sectional view and/or 3-D full views and/or illustrative configuration. e. Displays animation video which introduces how the aforementioned hydraulic and pneumatic devices work as manipulation equipment utilizing their cross-sectional view and/or 3-D full views and/or illustrative configuration. ③ Selective simulation speed ④ Selective function as follow Various automatic control ┌→ ON-OFF control → Sequential control → PID control

		→ Programmable Logic Control → Program control
ERS II-12	PID control	① Configuration a. Sequentially labels components/parts of the following controllers displaying their actual examples and illustrative drawings/images. - Pneumatic PID controller - Electro PID controller - Programmable PID controller ② Operation principle a. Displays animation video which shows P, PI, PD and PID control actions/outputs to step inputs utilizing its illustrative drawing which contains adjustable switches and process values for PID parameters and the inputs available for operation by trainees. b. Displays animation video which shows PID control actions of a feedback control system (level control system and/or temperature control system) to step inputs for experimental step response test, utilizing its illustrative drawing which contains adjustable switches for PID parameters and the inputs. ③ Selective mode of manual and automatic control ④ Selective simulation speed ⑤ Other functions a. Manual input of disturbances as step inputs b. Trend display of present value, setting value and control output ⑥ Selective function as follow PID Controller → Pneumatic PID controller → Electro PID controller → Programmable PID controller
ERS II-13	Marine steam turbine Marine steam boiler	① Heat cycle, thermal efficiency and heat balance a. Displays respectively the following illustrative system diagrams steam turbine propulsion plant with vital valves and start and stop switches available for operation from the key boards by the trainees indicating main running parameters on the screen. - Entire plant - Superheated steam - Bleeding steam - Condensate water - Feed water system - Desuperheated stem - Gland steam - Drain - Lubricating oil - Sea water circulation - Boiler fuel oil b. All running parameters available represent dynamic characteristic performance of steam turbine propulsion plant. c. Running parameters necessary for calculating thermal efficiency of

		steam turbine and boiler can be found on the relevant illustrative system diagram on the screen. d. Selective initial conditions of cold ship, in port, and seagoing e. Selective simulation speed
ERS II-14	Propulsion plant	① Operating limits of propulsion plant a. Displays planned propeller curves (speed – shaft output diagram) of main diesel engine and main steam turbine respectively with typical area of operating limits indicating running points of the engines. b. Displays maneuvering lever of main diesel engine available for operation from the key board by the trainees. c. Displays illustrative main diesel engine with following running parameters on the screen. - Indicator diagram - Shaft revolution speed - Engine torque - Shaft output - Exhaust gas temperature - Turbo revolution speed - Scavenging air pressure - Etc. d. Displays illustrative main steam turbine with the following running parameters on the screen. - Shaft revolution speed - Shaft torque - Shaft output - Temperature and pressure of steam entering the turbine - Main condenser vacuum - Etc. e. All running parameters on the screen represent dynamic characteristic performance of main diesel engine and steam turbine. f. Selective sea and weather conditions and loaded and light load conditions. g. Selective simulation speed. h. Selective function as follow Operating limits → Main diesel engine → Main steam turbine

Concept of ERS III

Nature of ERS III training is group training of 6 to 10 trainees. ERS III provides the trainees with training mainly in operation of diesel engine propulsion plant, and watchkeeping including ERM training. ERS III simulates static and dynamic characteristics of a typical diesel engine propulsion plant, and the simulation is represented by simulated engine room and control room equipped with a mimic panel, control console, main switchboard and others. The propulsion plant machinery to be simulated is suggested in the table "Functional overview of ERS III".

Figure 2 shows suggested arrangement of ERS III

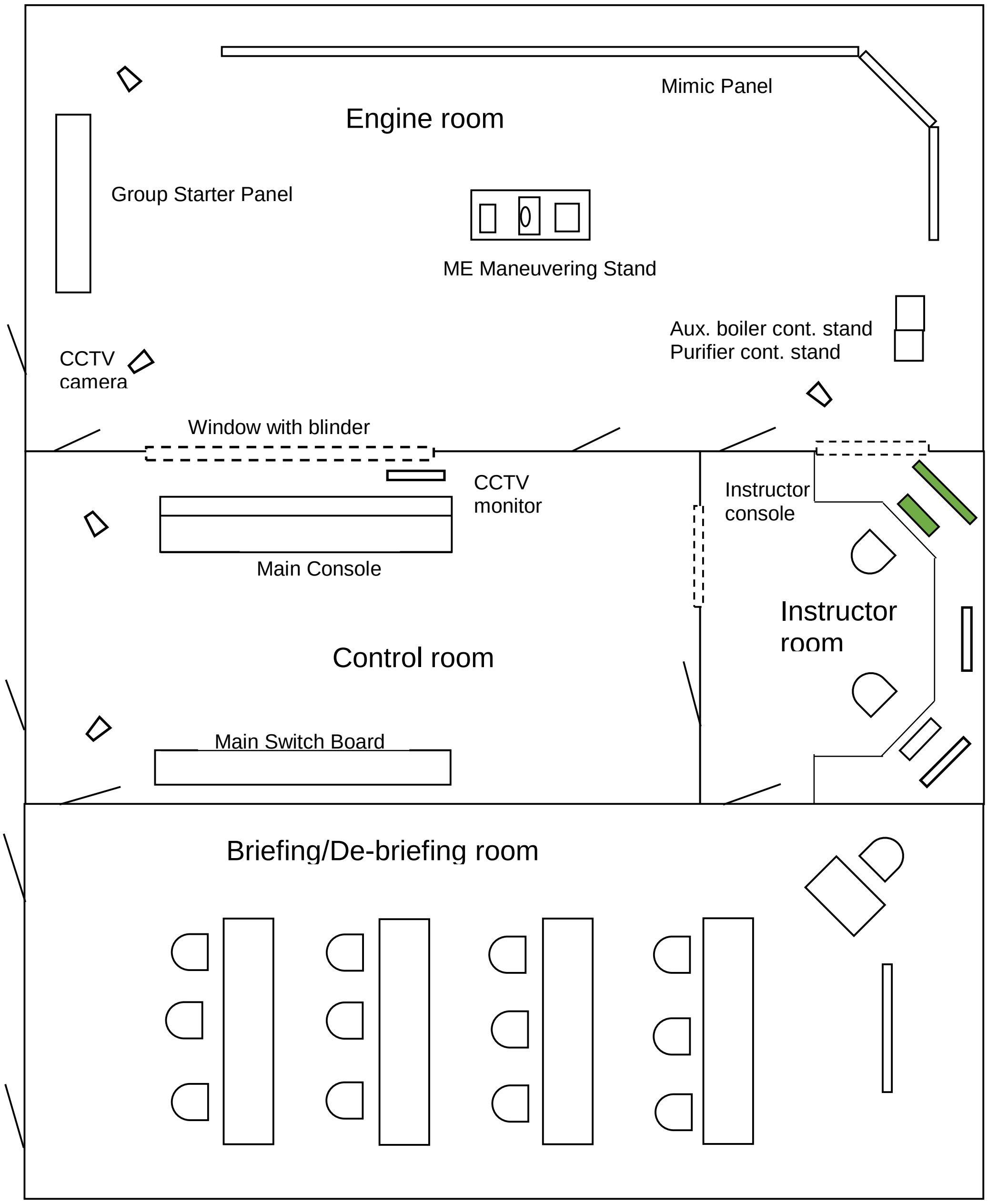


Figure 2

Installations of ERS III

ERS III consists of the following rooms equipped with necessary equipment.

- Engine room
  where all operations necessary for starting up and shutting down the propulsion plant can be performed.
- Control room
  where remote and automatic control of main machinery can be performed and all running parameters can be monitored.
- Instructor room
  where instructors can direct and control simulator trainings.
- Briefing room
  where instructors can give trainees briefing and debriefing and the trainee can observe activities being made by other trainees on the screen

Engine room comprises the following:

- Mimic panel
- Main engine control stand
- Group starter panels (GSPs)
- Auxiliary boiler control stand
- Purifier control stand
- Sound system equipment
- Communication system equipment
- Illumination system equipment
- CCTV system equipment

Control room comprises the following:

- Main console
- Main switch board (MSB)
- Communication system equipment
- Sound system equipment
- Illumination system equipment
- CCTV system equipment

Instructor room comprises the following:

- Instructor console
- Simulator control equipment
- Communication system equipment
- CCTV system equipment

Briefing room comprises the following:

- Instructor desk
- Trainees' desk
- Overhead projector and screen

Outline of Engine room Installations
Mimic panel

- The latest and typical diesel engine propulsion plant is represented on the panel with its constructing machinery, piping diagrams and necessary accessories such as lamps, switches, meters and indicators.

- The panel must be designed based on the following ideas for effective training of plant operation and for better understanding of construction of the plant system:

(1) The panel should be such it would be possible for trainees to:
  - ➢ observe the entire range of the panel from the appropriate position of the engine room and easy to figure out what machinery comprises the propulsion plant;
  - ➢ figure out mutual relationship of the machinery and actual arrangement of boiler, generator and other auxiliaries on board; and
  - ➢ figure out running conditions and status of the propulsion plan.

(2) Accessories on the panel should not be conspicuous to allow trainees easily to figure out system diagrams.

- The following are considered to be precautions to meet the ideas above:

(1) Clear space of 10 to 12 meter width and 1.5 meter height would be suitable to present entire system of the diesel engine propulsion plant in terms of size of illustrated machinery, presentation of piping diagrams and the idea (1) aforementioned.
(2) Machinery systems comprising diesel engine propulsion plant should be illustrated except provision refrigerator and air conditioning systems.
(3) Piping systems representing cooling fresh water, fuel oil, lubricating oil and others should be illustrated in recognizable color, wideness, length and arrangement as much as possible.
(4) Actual relativity between the machinery should be reflected in designing their shapes and sizes, since illustrated machinery is drawn on the common panel surface. (For example, auxiliary boiler and generator should not be drawn bigger than main engine)
(5) The illustrated machinery should be drawn and arranged in an impressive manner as much as possible according to actual arrangement on board. (For example, exhaust gas economizer must be drawn above the main engine in terms of the relativity).

(6) Appropriate size of pressing area and lower height of push button switches from the panel surface should be adopted in terms of the idea (2) aforementioned and to ensure reliable operations on the panel.
(7) Brightness and Higher visibility and appropriate size of indication lamps should be adopted in terms of the idea (2) aforementioned.
(8) Appropriate size and number of indication meters for pressure, temperature, level and control parameters should be fitted on the panel as necessary to allow trainees to observe the running conditions. (An indicator unit with rotary switch should be adopted for indicating temperatures of exhaust gas, cooling water and lubricating oil of diesel engines to deduce the number of temperature indicator in terms of the idea (2) aforementioned.
(9) Mounting models or LCD display available for showing animation videos of steering gear and propeller is desirable.

Main engine control stand

- Main engine control stand is a desk type control stand equipped with main engine maneuvering equipment, engine telegraph and communication system equipment. (If an engine with no engine side control is simulated, the maneuvering equipment is not necessary)
- Enough durability of maneuvering lever is desirable for handling by trainees since frequent use is expected comparing to an actual one.

Group Starter Panel (GSP)

- GSP is a dead front type panel equipped with starter panels of auxiliaries such as pumps and air compressors.
- Simulated functions and devices on the panels are same as actual starter panels on board.

Auxiliary boiler control stand

- Auxiliary boiler control panel is a desk type control stand equipped with manual and automatic control equipment and available to remotely control the auxiliary boiler represented on the mimic panel.
- It is desirable that the arrangement of the equipment can be same as an actual control panel, adopting switches and indications actually used on board.

Purifier control stand

- Purifier control stand is a desk type control stand equipped with manual and automatic control equipment of FO. DO and LO purifiers and available to remotely control the purifiers represented on the mimic panel and available remotely control the purifiers represented on the mimic panel.

- It is desirable that the arrangement of the equipment can be same as an actual control panel, adopting switches and indications actually used on board.

Sound system equipment

- A speaker of the sound system plays simulated engine room sounds according to running conditions of the propulsion plant while simulation is performed.

Communication system equipment

- The communication system equipment on the main engine control stand consists of the following:
  (1) A microphone to communicate to the control and instructor rooms with speaker systems.
  (2) A speaker to sound messages from the control and instructor rooms to all persons in the engine room.
  (3) An interphone to communicate with the control and instructor rooms.

Illumination system equipment

- The illumination system equipment consists of room and emergency lightings.
- The lightings are controlled by simulated conditions of the propulsion plant.

CCTV system equipment

- 2 to 3 Cameras of CCTV system are to be installed at suitable positions so that trainees and instructors in the briefing, control and instructor rooms can observe performances being made by other trainees in the engine room.

Outline of Control room Installations

Main console

- The main console is a desk front type console in size of 5 meter wideness and 1.5 meter height approximately and comprises the following.
  (1) Main engine remote and automatic control equipment
  (2) Monitoring (Data logger) system
  (3) Main auxiliary machinery control panel
  (4) Steering gear control panel
  (5) Communication system equipment
  (6) Trainee's log space

Main Switch Board (MSB)

- The main switch board is dead front type panel equipped with same functions as an actual main switch board used on board.
- The MSB comprises the following
  (1) Generator panel
  (2) Synchronizing panel

(3) Feeder panels.

Communication system equipment

- The communication system equipment consists of the following.
  (1) A microphone to communicate to the engine and instructor rooms with speaker systems
  (2) A speaker system installed in the control room which is available to sound messages from the engine and instructor rooms
  (3) An interphone to communicate with the engine and instructor rooms

Sound system equipment

- A speaker of the sound system plays simulated control room sounds caused by operation of the propulsion plant.

Illumination system equipment

- The illumination system equipment consists of room and emergency lightings.
- The lightings are controlled by simulated conditions of the propulsion plant.

CCTV system equipment

- 2 to 3 Cameras of CCTV system are to be installed at suitable positions so that trainees and instructors in the briefing and instructor rooms can observe performances being made by other trainees in the control room.
- One monitor display is to be installed at the suitable position so that trainees in the control room can observe performances being made by other trainees in the engine room.

Outline of Instructor room Installations

Instructor console

- The instructor console is a desk front type console which incorporates the following.
  (1) Simulator control equipment
  (2) Communication system equipment
  (3) CCTV system equipment

Simulator control equipment

- Simulator control equipment control various functions of the simulator consisting of the dedicated key board, monitor display and control unit

Communication system equipment

- The communication system equipment consists of the following:
  (1) A microphone to communicate to the engine and control rooms with speaker systems

(2) A speaker system installed in the instructor room which is available to sound messages from the engine and control rooms
(3) An interphone to communicate with the engine and control rooms

CCTV system equipment

- Two monitor displays with control unit are to be installed on the instructor console so that instructors in the instructor room can observe performances being made by trainees in the engine and control rooms.

Outline of Briefing room Installations
Instructor desk

- The instructor desk is a desk front console equipped with equipment consisting of monitor display and control unit available to show displays of monitoring (data logger) system of the simulator and video pictures of CCTV system on the screen.

Trainee desk

- The trainee desk should be available for 10 to 15 trainees with enough space of writing.

Overhead projector and screen

- The screen should be large enough for 10 to 15 trainees to clearly watch displays.

Functional overview of ERS III

<table>
<tr><th>Ind.</th><th>Scenario</th><th>Function of simulation</th></tr>
<tr><td>ERS III-1</td><td>Watchkeeping</td><td rowspan="12">
① The following is suggested as diesel engine propulsion plant to be simulated and the plant is represented on the mimic pane.
<table>
<tr><td>Ship type</td><td>General cargo or Container ship</td></tr>
<tr><td>Main engine</td><td>Two stroke, crosshead, low speed marine diesel engine with turbo chargers</td></tr>
<tr><td>Propeller</td><td>Fixed pitch propeller</td></tr>
<tr><td>Thruster</td><td>Bow thruster</td></tr>
<tr><td>Generator</td><td>Diesel generator×2,
Steam turbine generator
Emergency diesel generator</td></tr>
<tr><td>Steam generator</td><td>Cochran type auxiliary boiler and Exhaust gas economizer/boiler</td></tr>
<tr><td>Cooling system</td><td>Central cooling system</td></tr>
<tr><td>Major auxiliary</td><td>Fresh water generator
Main air compressor×2
Control air compressor
FO Purifier×2
DO Purifier
LO Purifier×2
Coolers, Heaters and Tanks</td></tr>
</table>
② Automatic controls applied to the machinery systems are same grade as unmanned machinery systems.

③ Functions of process control systems using PID controllers are to be same as an actual PID controller.

④ Functions of monitoring system are to be same grade as an actual data logger including data display formats.

⑤ Realistic operation sound of the plant machinery according to the status of the machinery is to be simulated and represented through speakers in the engine and control rooms. (The control room is located in the engine room or adjacent to the engine room.

⑥ Realistic lightings of the engine and control rooms according to the status of the machinery are to be simulated and represented through their illumination systems.

⑦ Selective malfunctions of the plant machinery are to be available.

⑧ Selective initial conditions as dead ship, in port, standby engine and seagoing are available.

⑨ Selective weather conditions and loading conditions are available.
</td></tr>
<tr><td>ERS III-2</td><td>Change-over of remote/ automatic to local control</td></tr>
<tr><td>ERS III-3</td><td>Safety precautions to be observed and immediate actions</td></tr>
<tr><td>ERS III-4</td><td>ERM</td></tr>
<tr><td>ERS III-5</td><td>Fluid flow and characteristics</td></tr>
<tr><td>ERS III-6</td><td>Preparation operation fault detection and necessary measures</td></tr>
<tr><td>ERS III-7</td><td>Operation of pumping systems</td></tr>
<tr><td>ERS III-8</td><td>Operation of generators</td></tr>
<tr><td>ERS III-9</td><td>Thermal efficiency and heat balance</td></tr>
<tr><td>ERS III-10</td><td>Automatic control for machinery</td></tr>
<tr><td>ERS III-11</td><td>Start up and shut down machinery</td></tr>
<tr><td>ERS III-12</td><td>Efficient operation, surveillance, performance assessment and maintaining safety</td></tr>
</table>

Part B: Course Outline

■ Course outline

Any simulator training shall consist of briefing, implementation and debriefing including evaluation. This model course provides sample exercises of simulator training in the Appendix. They contain the process of the entire training, essential points of briefing and debriefing, and evaluation. If functions of simulators belonging to training establishments are the same or familiar as the functions specified in this model course, any sample exercise (e.g. ERS I - 1, ERS I - 2, ERS II - 5, ERS III - 8) can be used separately as a training module. If the simulator functions and facilities of the training establishments are different from this model course, the sample exercises can be used as examples and the instructor should develop exercises based on their own simulators in order to suit individual groups of trainees, depending on their experience, ability, equipment and staff available for training.

■ Lectures

As far as possible, briefing and debriefing lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams and photographs, and be related to matter learned during simulator exercises.

As far as simulator training is concerned, it is quite essential not to miss the specific purpose of the exercises, and instructors should allow trainees to perform simulations with awareness on what they are doing. For this reason, the instructors should present their briefing and debriefing in a specific manner of describing tasks to be done during their performance of the simulation.

■ Time table

No formal example of a timetable is included in this model course. Instructors must develop their own timetable depending on:

- the level of skills of trainees;
- the numbers to be trained;
- the number of instructors; and
- simulator facilities available,

and normal practices at the training establishment.

The tables below list the competencies and knowledge, understanding and proficiency, together with the estimated hours required for the exercises of ERS I, II and III.

Table A-III/1: Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty in a periodically unmanned engine-room

Function: Marine engineering at the operational level

Competence	Knowledge, understanding and proficiency	Index	Hour
Maintain a safe engineering watch	Thorough knowledge of principles to be observed in keeping an engineering watch, including: .1 duties associated with taking over and accepting a watch .2 routine duties undertaken during a watch .3 maintenance of the machinery space logs and the significance of the readings taken .4 duties associated with handing over a watch	ERS III - 1	13.5
	Safety and emergency procedures; change-over of remote/automatic to local control of all systems	ERS III - 2	5
	Safety precautions to be observed during a watch and immediate actions to be taken on the event of fire or accident, with particular reference to oil systems	ERS III - 3	3
	Engine-room resource management Knowledge of engine-room resource management principles including: .1 allocation, assignment, and prioritization of resources .2 effective communication .3 assertiveness and leadership .4 obtaining and maintaining situational awareness .5 consideration of team experience	ERS III - 4	6
Use English in written and oral form	Adequate knowledge of the English language to enable the officer to use engineering publications and to perform engineering duties	ERS III - 1, 2, 3 and 4	---

Competence	Knowledge, understanding and proficiency	Index	Hour
Use internal communication systems	Operation of all internal communication systems on board	ERS III - 1, 2, 3 and 4	---
Operate main and auxiliary and associated control systems	Basic construction and operation principles of machinery systems including: .1 marine diesel engine	ERS I – 1	2
	.2 marine steam turbine	ERS I – 2	2
	.3 marine gas turbine	-----	-----
	.4 marine boiler	ERS I – 3	2
	.5 shafting installations including propeller	ERS I – 4	2
	.6 other auxiliaries including various pumps, air compressor, purifier, fresh water generator, heat exchanger, refrigeration, air-conditioning and ventilation systems	ERS I – 5	10
		ERS II – 1	2.5
	.7 steering gear	ERS I – 6	2
	.8 automatic control systems	ERS II – 2	4
	.9 fluid flow and characteristics of lubricating oil, fuel oil and cooling systems	ERS II – 3	3
		ERS III – 5	4
	.10 deck machinery	ERS I – 7	2
	Safety and emergency procedures for operation of propulsion plant machinery including control systems	ERS III - 2, 3 and 4	---
	Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems .1 main engine and associated auxiliaries .2 steam boiler and associated auxiliaries and steam systems .3 auxiliary prime movers and associated systems	ERS III – 6	4
	.4 other auxiliaries including refrigeration, air- conditioning and ventilation systems	ERS II – 4	4
Operate fuel, lubrication, ballast and other pumping	Operational characteristics of pumps and piping systems including control systems	ERS II – 5	3.5
		ERS III – 7	2
	Operation of pumping systems: .1 routine pumping operations	ERS I – 8	2
		ERS II – 6	2

Competence	Knowledge, understanding and proficiency	Index	Hour
systems and associated control systems	.2 operation of bilge, ballast and cargo pumping systems Oily water separators (or similar equipment) requirements and operation	ERS III – 7	(2)

*Hours in ( ) is not counted.

Function: Electrical, electronic and control engineering at the operational level

Competence	Knowledge, understanding and proficiency	Index	Hour
Operate electrical, electronic and control systems	Basic configuration and operation principles of the following electrical, electronic and control equipment: .1 electrical equipment .a generator and distribution systems	ERS II – 7	2
	.b preparing, starting, paralleling and changing over generators	ERS III – 8	2.5
	.c electrical motors including starting methodologies	ERS I – 9	2
		ERS II - 8	4
	.d high-voltage installations	ERS I – 10	1
	.e sequential control circuits and associated system devices	ERS I – 11	2
		ERS II – 9	3.5
	.2 electronic equipment .a characteristics of basic electronic circuit elements	ERS I – 12	2
	.b flowchart for automatic and control system .c functions, characteristics and features of control systems for machinery items including main propulsion plant operation control and steam boiler automatic controls	ERS II – 10	8
	.3 control systems .a various automatic control methodologies and characteristics	ERS II – 11	2.5
	.b Proportional-Integral-Derivative (PID) control characteristics and associated system devices for process control	ERS II – 12	3
Maintenance and repair of electrical and electronic equipment	All KUPs for the competence " Maintenance and repair of electrical and electronic equipment	----	----

<u>Total hours of simulator trainings for the Table A-III/1 113 hours</u>

Table A-III/2: Specification of minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power and more

Function: Marine engineering at the management level

Competence	Knowledge, understanding and proficiency	Index	Hour
Manage the operation of propulsion plant machinery	Design features, and operative mechanism of the following machinery and associated auxiliaries .1 marine diesel engine	ERS I – 13	2
	.2 marine steam turbine	ERS I – 14	2
	.3 marine gas turbine	----	----
	.4 marine steam boiler	ERS I – 15	2
Plan and schedule operations	*Theoretical knowledge* Thermodynamics and heat transmission	----	----
	Mechanics and hydromechanics		
	Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption	ERS III - 9	3.5
	Heat cycle, thermal efficiency and heat balance of the following .1 marine diesel engine	ERS III - 10	6
	.2 marine steam turbine	ERS II - 13	2.5
	.3 marine gas turbine	----	----
	.4 marine steam boiler	ERS II - 13	(2.5)
	Refrigerators and refrigeration cycle	ERS II - 4	(4)
	Physical and chemical properties of fuels and lubricants	----	----
	Technology of materials		
	Naval architecture and ship construction, including damage control		
Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	*Practical knowledge* Start up and shut down main propulsion and auxiliary machinery, including associated systems	ERS III - 11	3
	Operating limits of propulsion plant	ERS II - 14	3
	The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery	ERS III - 12	4

	Functions and mechanism of automatic control for main engine	ERS II - 10	8

*Hours in ( ) is not counted

Competence	Knowledge, understanding and proficiency	Index	Hour
	Functions and mechanism of automatic control for auxiliary machinery including but not limited to: .1 generator distribution systems	ERS II - 10	(8)
	.2 steam boilers		
	.3 oil purifier		
	.4 refrigeration system		
	.5 pumping and piping systems		
	.6 steering gear system		
	.7 cargo handling equipment and deck machinery		
Manage fuel, lubrication and ballast operations	Operation and maintenance of machinery, including pumps and piping systems	----	----

*Hours in ( ) is not counted

Function: Electrical, electronic and control engineering at the management level

Competence	Knowledge, understanding and proficiency	Index	Hour
Manage operation of electrical and electronic control equipment	*Theoretical knowledge* Marine electrotechnology,	----	----
	Electronics,		
	Power electronics		
	Automatic control engineering and safety devices		
	Design features and system configurations of automatic control equipment and safety devices for the followings : .1 main engine	ERS II - 10	(8)
	.2 generator and distribution system		
	.3 steam boiler		
	Design features and system configurations of operational control equipment for electrical motors	ERS II - 8	(4)
	Design features of high voltage installations	ERS I - 11	1

	Features of hydraulic and pneumatic control equipment	ERS II - 10	(8)

*Hours in ( ) is not counted

Competence	Knowledge, understanding and proficiency	Index	Hour
Manage troubleshooting restoration of electrical and electronic control equipment to operating condition	*Practical knowledge* Troubleshooting of electrical and electronic control equipment	----	----
	Function test of electrical, electronic control equipment and safety devices		
	Troubleshooting of monitoring systems		
	Software version control		

Function: Maintenance and repair at the management level

Competence	Knowledge, understanding and proficiency	Index	Hour
Manage safe and effective maintenance and repair procedures	(All KUPs for the competence)	----	----
Detect and identify the cause of machinery malfunctions and correct faults	Practical knowledge Detection of machinery malfunction, location of faults and action to prevent damage	ERS III-3	(3)
		ERS III-12	(4)
	Inspection and adjustment of equipment	----	----
	Non-destructive examination		
Ensure safe working practice	(All KUPs for the competence)		

*Hours in ( ) is not counted

Total hours of simulator trainings for the Table A-III/2 37 hours

Grand Total hours 150 hours

Part C: Detailed teaching syllabus

The detailed teaching syllabus has been written in required performance format. It describes what the student must do to demonstrate that the specified knowledge or skill has been achieved.

All the required performances are prefixed by the words, "The expected learning outcome is that the student should be able to ……………………."

ERS I

Ind.	Required Performance

ERS I-1	A-III/1 (Basic construction and operation principles of 2 stroke crosshead marine diesel engine)
	- Identify components/parts which construct 2 stroke crosshead type marine diesel engine using its cross sectional drawing as follow.
	  - cylinder head
	  - cylinder liner
	  - piston
	  - piston rod
	  - cylinder jacket
	  - stuffing box
	  - crosshead and bearing
	  - crosshead guide and shoes
	  - connecting rod and bottom end bearing
	  - crankshaft
	  - main bearing
	  - engine bed
	  - a turbocharger
	  - the scavenge trunk
	  - an air cooler
	- Describe operation principles of 2 stoke crosshead type marine diesel engine including the following
	  - suction and compression stroke
	  - combustion and exhaust stroke
	  - how fuel oil is injected and its injection timing
	  - how exhaust valve is operated/opened and its opening timing
	- Describes flow of the following in the engine
	  - air and exhaust gas
	  - lubricating oil
	  - cooling fresh water
	  - fuel oil injection valve cooling fluid
	
	A-III/1 (Basic construction and operation principles of 4 stroke trunk piston marine

	diesel engine)
	- Identify components/parts which construct the 4 cycle trunk piston type marine diesel engine using its cross sectional drawing.
	  - bedplate
	  - push rod
	  - rocker arm
	  - camshaft
	  - cylinder block
	  - cylinder jacket
	  - cylinder liner
	  - cylinder head
	  - exhaust gas manifold
	  - air-inlet manifold
	  - air cooler
	  - engine crankcase
	  - the lubrication-oil sump
	  - piston
	  - connecting rod
	  - gudgeon/piston pin
	  - crankshaft
	  - injection valve
	  - air inlet and exhaust valves
	- Describe operation principles of 4 stroke trunk piston type marine diesel engine including the following
	  - suction, compression, combustion and exhaust strokes
	  - how fuel oil is injected and its injection timing
	  - how exhaust valve and suction valve are operated/opened and its opening timing
	- Describe the flow of the following fluid in the engine
	  - air and exhaust gas
	  - lubricating oil
	  - cooling fresh water
	  - fuel oil injection valve cooling fluid

ERS I-2	A-III/1 (Basic construction and operation principles of marine steam turbine)
	- Identify components/parts which construct marine steam turbine used for propulsion machinery
	  - high pressure turbine casing
	  - low pressure turbine casing
	  - astern turbine casing
	  - low pressure turbine exhaust casing

	- high pressure turbine rotor
	- low pressure turbine rotor
	- receiver pipe
	- nozzle
	- blades (moving blade, stationary blade)
	- shroud
	- labyrinth packing
	- flexible coupling
	- bearing
	- reduction gear (wheel and pinion)
	- thrust bearing
	- Describe operation principles of the marine steam turbine including the following
	  - steam flow from nozzle valves to main condenser
	  - how gland sealing is secured
	  - how rotation of turbine rotor is transferred to propeller shaft

ERS I-3	A-III/1 (Basic construction and operation principles of marine boiler)
	- Identify the following marine boilers used as auxiliary or main boiler
	  - two drums water tube boiler
	  - vertical cylindrical boiler
	  - small flow-through boiler
	  - exhaust gas economizer (exhaust boiler)
	  - thermal fluid boiler
	- Identify components/parts which construct the two drums water tube boiler
	  - steam drum
	  - water drum
	  - water tube
	  - superheater
	  - desuperheater
	  - economizer
	  - safety valve
	  - water level gauge
	  - soot blower
	- Identify components/parts which construct the Vertical cylindrical boiler
	  - shell
	  - furnace
	  - water/smoke tube
	  - valves attached
	  - manhole and hand hole
	- Describe operation principles of the marine steam boilers in terms of steam

	generation/heating system and combustion gas flow - two drums water tube boiler - vertical cylindrical boiler - small flow-through boiler - exhaust gas economizer (exhaust boiler) - thermal fluid boiler

ERS I-4	A-III/1 (Basic construction and operation principles of shafting installations including propeller)
	- Identify components/parts of the following shafting installations
	  - thrust bearing
	    - casing
	    - thrust shaft
	    - thrust collar
	    - thrust pad
	  - intermediate shaft
	  - intermediate shaft bearing (plumber block)
	    - bearing metal
	    - collar
	    - oil chamber
	  - aft most shaft bearing
	  - intermediate shaft coupling
	  - shaft sealing equipment
	    - seal ring
	    - liner
	    - casing cover
	  - shaft earthing device
	  - stern tube and stern tube bearing
	  - rope guard
	  - propeller
	    - boss
	    - blade
	    - leading edge
	    - trailing edge
	    - pressure side
	    - suction side
	- Describe operation principles used for thrust bearing including how it works
	- Describe operation principles of shaft sealing equipment including how it works
	-

ERS	A-III/1 (Basic construction and operation principles of pumps)

I-5	- Identify components/parts of the following pumps
	    - centrifugal pump
	    - gear pump
	    - screw pump
	    - positive-displacement pump
	    - vane pump
	- Describe operation principles of the aforementioned pumps including how they work
	
	A-III/1 (Basic construction and operation principles of air compressor)
	- Identify components/parts of air compressor
	    - piston
	    - cylinder
	    - cylinder head
	    - plate valve
	    - intercooler and after cooler
	    - drain separator
	- Describe operation principle of air compressor including its operational mechanism indicating compressed air flow
	
	A-III/1 (Basic construction and operation principles of purifier)
	- Identify components/parts of oil purifier
	    - bowl assembly
	        - separating plate
	        - valve cylinder
	        - gravity disk
	    - vertical shaft
	    - gears
	    - gear pumps
	    - clutch
	- Describes operation principle of oil purifier including its operational mechanism
	
	A-III/1 (Basic construction and operation principles of fresh water generator)
	- Identify components/parts of the following types of fresh water generators
	    - shell and tube type
	    - plate type
	- Describes operation principle of the aforementioned fresh water generators including its operational mechanism
	
	A-III/1 (Basic construction and operation principles of heat exchangers)
	- Identify components/parts of the following types of heat exchangers

	- shell and tube type - plate type - fin type - pin type - Describe operation principle of the aforementioned heat exchangers including its operational mechanism

ERS I-6	A-III/1 (Basic construction and operation principles of steering gear)
	- Identify components which construct the following type of steering gear system
	  - rapson slide type
	  - rotary vane type
	- Identify components/parts of the following variable displacement pump
	  - William Janney Pump
	  - Hele Shaw Pump
	- Describe operation principles of the aforementioned pumps including how they work
	- Describe operation mechanism of steering gear system

ERS I-7	A-III/1 (Basic construction and operation principles of deck machinery)
	- Identify components/parts of the following deck machinery
	  - electric driven mooring windlass
	  - oil hydraulic driven mooring windlass
	  - electric driven mooring winch
	  - electric driven cargo crane
	  - oil hydraulic driven cargo winch
	- Describe operation principles of the aforementioned deck machinery including how they work

ERS I-8	A-III/1 (Oily water separators (or similar equipment) requirements
	- Describes the requirements necessary for oily water separators/similar equipment
	- Describes construction of oily water separators/similar equipment identifying its components
	  - multi-layer parallel plate
	  - coalescer
	  - oil level sensor
	  - solenoid valve
	- States the reasons to use positive-displacement pump for oily water separators/similar equipment
	- Describes separation principles of oily water separator/similar equipment
	- Explains how to prevent oil being mixed into discharging bilge when oil content

	exceeds 15 ppm - States the principles of oil content meter attached to oily water separators/similar equipment

ERS I-9	A-III/1 (Basic configuration and operation principles of electrical motors)
	- Identify components/part of a three phases induction motor
	  - rotor
	  - bearings
	  - fan
	  - stator
	  - field windings
	  - rotor cage
	- Describes operation principles of the induction motor and how the driving torque is produced.

ERS I-10	A-III/1 (Basic configuration and operation principles of high-voltage installations)
	- Identify components/part of main switch board used for high-voltage distribution system
	  - low voltage compartment
	    - protection and control unit
	    - switch panel
	  - VCB compartment
	    - VCB
	    - VCB draw in/out handling port
	    - indicator of VCB position
	    - emergency open mechanism
	    - interlock key for de-excitation
	    - earthing switch operating handle port
	  - BUS bar compartment
	    - pressure relief flap
	    - insulation bushing
	    - main BUS bar
	  - cable compartment
	    - surge arrester
	    - current transformer
	    - load BUS bar
	    - power cable terminal
	    - earthing switch
	    - zero phase current transformer
	    - voltage transformer
	- Identify components/part of vacuum circuit breaker (VCB) used for high-voltage

	distribution system (Design features of high-voltage installations) - Describe the special characteristics and features of main switch board in comparison with less than 1,000 V from the aspect of construction. - Describe the special characteristics and features of vacuum circuit breaker (VCB) used for high-voltage in comparison with air circuit breaker (ACB) from the aspect of construction. - Describe functional, operational and safety requirements for a marine high-voltage system - States that high-voltage systems are normally earthed via a resistor - Explains how the presence of earth faults is indicated in a high-voltage system with an earthed neutral - States safety precautions to be strictly observed to prevent accidents when working on high-voltage electrical equipment

ERS I-11	A-III/1 (Basic configuration and operation principles of sequential control circuit devices)
	- Identify components/parts of the following sequential control circuit devices
	  - MCCB
	  - electromagnetic relays
	  - switches
	  - indication lamps
	  - mechanical switches
	  - ampere meter
	  - fuses
	  - transformers
	- Describe operation principles of an electromagnetic relay and switches

ERS I-12	A-III/1 (Basic configuration and operation principles of basic electronic circuit elements)
	- Identify the following electronic circuit elements
	  - Resisters
	  - Capacitors
	  - Inductors
	  - Diodes
	  - Transistors
	  - Thyristors
	  - Series regulator
	  - IGBT
	  - MOSFET
	  - Operational amplifier
	  - LED
	  - LED/CdS
	- Describe functions of the aforementioned electronic circuit elements using

	illustrative drawings

ERS I-13	A-III/2 (Design features and operative mechanism of marine diesel engine)
	- Describe design features of cylinder liner for the following using sample drawings
	  - construction
	  - cooling jacket
	  - scavenging air inlet
	  - cylinder oil groove.
	- Describe design features of cam shaft driving assembly using sample drawings.
	- Explain effects of variable injection timing (VIT)
	- Describe design features and operative mechanism with cam shaft for the following using sample drawings/diagrams.
	  - FO injection pump and VIT system
	  - starting air valve and control system
	  - reversing system
	- Describe design features and operative mechanism with common rail system (without cam shaft) for the following
	  - FO injection system
	  - exhaust gas valve driving system (VET)

ERS I-14	A-III/2 (Design features and operative mechanism of marine steam turbine) - Describe how turbine casings are supported. - Explain reasons why the astern turbine casing is separated from the low pressure turbine. - Explain impulse and reaction stage of turbine - Describe type of stage for the first and second stages in astern turbine - Describe operation principles of labyrinth packing - Explain why the labyrinth packing is used in steam turbine - Describe purpose and mechanism of the flexible coupling - Describe how the flexible coupling is lubricated

ERS I-15	A-III/2 (Design features and operative mechanism of marine steam boiler)
	- Describe functions of the following components inside the steam drum
	  - steam separator
	  - swash plate
	  - perforated plate
	  - feed water inlet
	  - surface blow pipe
	- Describe design features of steam drum in figure and strength from the aspect of working stress of horizontal and vertical cross sections.

	- Describe functions of the following piping of the boiler water circulation - main bank - water wall tube - water wall header connection - screen tube - Explain briefly how tubes are connected to steam drum and water drum. - Describe how superheated steam and desuperheated steam are generated Describe how the starting valve contributes to start of the boiler. - Describe how temperature of superheated steam is controlled - Describe purposes of the soot blower - Describe what type of soot blower is applied to main boiler - Explain how heat exchange is taken place in gas air heater used for main boiler

ERS II

Ind.	Required Performance
ERS II-1	A-III/1 (Basic construction and operation principles of refrigeration system) - Identify main components of refrigeration system equipment - compressor - screw type compressor - drive gear - driven gear - capacity control/unloader mechanism - reciprocating type compressor - suction and delivery valves - piston and cylinder - cylinder head - unloader mechanism - shaft seal - LO cooler - oil separator - condenser - solenoid vale - expansion valve - unit cooler (evaporator) - Describe operation principle of refrigeration system - Describe how capacity control/unloader system works - Describe how oil separator works - Describe how automatic expansion valve works.

ERS II-2	A-III/1 (Basic construction and operation principles of automatic control systems)
	- Identify components of automatic control system for process control used on board
	  - level
	  - temperature
	  - pressure
	- Describe what control methods are used for process control on board.
	- Explain briefly how level, temperature and pressure are automatically controlled.
	- Describe principles of detecting level, temperature and pressure used for process control on board
	  - level
	  - temperature
	  - pressure
	- Explain how signals of level, temperature and pressure detected are processed for control.
	- Explain how Wax type temperature control valve works to control LO temperature.
	- Explain how three-way control valve works.

ERS II-3	A-III/1 (Basic construction and operation principles: Fluid flow and characteristic of lubricating oil, fuel oil and cooling systems; Steam turbine plant) - Describe steam flow from steam drum of boiler to steam turbine identifying main components of the system - Describe bleeding steam flow from turbines to heaters identifying main components of the system - Describe Gland steam flow from makeup valve to leak off valve - Describe condensate water flow from Main condenser to De-aerate feed water heater identifying main components of the system. - Explain how Main condenser hot well level is kept constant. - Explain how De-aerate feed water heater level is kept in a certain range. - Describe feed water flow from De-aerate feed water heater to the steam drum identifying main components of the system - Explain how condensate water and feed water are heated step by step. - Describe LO flow from LO pump to bearings and reduction gears

ERS II-4	A-III/1 (Operation of refrigeration system)
	- Describe what preparation id necessary before starting up refrigeration system
	- Describe procedures for starting up refrigeration system
	- Explain the flowing operations:
	  - changeover of compressor
	  - change in setting value of temperature

	- defrosting - supply of LO - supply and transfer of refrigerant - Explain how to address the flowing malfunctions: - shortage of cooling water - short cycle - liquid back - higher compression of compressor - activation of safety device - Describe procedures for shutting down refrigeration system - Explain meaning of pumping down A- III/2 (Refrigerators and refrigeration cycle) - Explain "Refrigeration cycle" using Mollier diagram as follow. - compression - condensation - expansion - evaporation - degree of supercool - degree of superheat
ERS II-5	A-III/1 (Operational characteristics of pumps) - Explain characteristic performance of the following pumps: - centrifugal pump - gear pump - axial flow pump - positive-displacement pump - Explain starting and stopping methods of pump with respect to pumps' characteristic performance. - Explain control methods of pump capacity with respect to pumps' characteristic performance. - Explain the following: - suction head - delivery head - total head - water horse power - shaft output
ERS II-6	A-III/1 (Operation of ballast and cargo pumping system) - Explain purposes of ballast pumping system - Explain ballast pumping procedures using sample ballast diagrams

	- Describe piping arrangement and fittings for loading and discharging fluid cargo
	- Explain why specification of oil is necessary when loading fluid cargo
	- Describe precautions necessary when:
	    - loading and discharging fluid cargo
	    - transferring fluid cargo between tanks
	    - loading and discharging ballast water
	- Explain procedures for line air purge
	- Explain procedures for tank cleaning

ERS II-7	A-III/1 (Basic configuration and operation principles of generator and distribution systems)
	- Identify main components/parts of the generator.
	    - rotor core
	    - stator core
	    - stator coil
	    - field coil
	    - armature coil
	    - static exciter
	    - rotating rectifier
	- Explain briefly how electric power is generated using sample diagrams
	- Explain the main power distribution system using sample diagrams
	- Explain the emergency power distribution system using sample diagrams
	- Explains basic purposes of switches, circuit breakers and fuses
	- Explain purposes of the following parts of main switch board
	    - synchronizing panel
	    - generator panel
	    - common 440 V feeder panel
	    - No1 and 2 440 V feeder panel
	- Explain meaning of two feeder panels (No1. and No.2 Feeder panel)
	- Identify main components/parts of the mold circuit breaker using sample drawings/diagrams
	- Identify main components/parts of the air circuit breaker (ACB) using sample drawings/diagrams
	- List functions incorporated in ACB

ERS II-8	A-III/1 (Basic configuration and operation principles: Motor starting methodologies)
	- Explain starting principles of the following starting methodologies.
	    - direct on line
	    - direct on line reverse
	    - direct on line low volt release
	    - star-delta

	- reactor
	- inverter
	- thyrister/softstarter
	- Describe sequence actions of starting and stopping motors in the following starter circuits using sample circuit diagrams
	  - direct on line reverse
	  - direct on line low volt release
	  - star-delta
	- Describe sequence actions of the following circuits using sample starter circuit diagram.
	  - self-holding
	  - automatic changeover
	  - automatic/sequential restart
	
	A-III/2 (Design features and system configurations of operational control equipment for electrical motors)
	- Identify control circuit units used in starter circuits using sample starter circuit diagram.
	- Identify control circuit elements used in control circuit units using sample control unit.
	- Describe sequential actions taken place in control circuit units using sample ladder diagrams which represent the control unit.
	- Describe design features of control circuit units including softstarter unit.

ERS II-9	A-III/1 (Basic configuration and operation principles: Sequential control circuits)
	- Explain that a sequential control circuit exists in almost all machinery control systems.
	- Explain that the sequential control circuit works as manipulator or controller taking generator engine (prime mover) control circuit or boiler combustion control circuit as a typical example of a sequential control circuit.
	- Describe that the circuit consists of main circuits and control circuits, and the control circuits consists of operation control circuits and safety circuits.
	- Explain that some of the control circuits are modularized and functions of these modular units should be understood.
	- Explain that the sequential control circuits should be read for each function of the circuits.
	- Describe sequential actions in case of the following using sample control circuits.
	  - start of generator engine in manual.
	  - emergency stop of generator engine in case of LO low pressure
	  - burner ignition of boiler in manual
	  - emergency stop of boiler in case of lowest water level

ERS II-10	A-III/1 (Basic configuration and operation principles: Flowchart for automatic and control system)
	- Explain that flowcharts are used for representing sequence of control actions and functions.
	- Describe the following symbols used for flowcharts
	    - flow line
	    - beginning and end of process
	    - process
	    - input and output
	    - decision
	    - "and" and "or"
	    - definition processed
	- Describe some control actions using sample flowcharts actually used on board.
	
	A-III/1 (Basic configuration and operation principles: Functions, characteristics and features of control systems for machinery including main propulsion plant operation control and steam boiler automatic controls)
	- List functions of control systems used for the following machinery
	    - main diesel engine
	    - main steam turbine
	    - generator distribution system
	    - steam boiler
	    - steering gear system
	    - oil purifier
	    - pumps
	    - refrigeration system
	    - deck machinery
	- Describe control methodologies used for the control systems listed above
	- Identify main components and system configurations for the control systems listed above using sample system diagrams.
	
	A-III/2 (Functions and mechanism of automatic control for main engine)
	A-III/2 (Functions and mechanism of automatic control for auxiliary machinery including but not limited to (.1) generator and distribution system, (.2) steam boilers, (.3) oil purifier, (.4) refrigeration system, (.5) pumping system, (.6) steering gear system and (.7) cargo handling equipment and deck machinery)
	A-III/2 (Design features and system configurations of automatic control equipment and safety devices for main engine, generator and distribution system, steam boiler)
	A-III/2 (Features of hydraulic and pneumatic control equipment)

	(Main diesel engine)
	- Explain mechanism of the following automatic functions used for main diesel engine control using sample system diagrams/configurations.
	  - changeover from air running to fuel running
	  - revolution speed control
	  - CPP angle load control
	  - emergency shut-down
	  - emergency slow down
	  - VIT and VET
	    - electronic - mechanical
	    - electronic - common rail
	- Explain why air pneumatic control system is used for control main diesel engine
	- Explain design features of electronic governing system
	- Explain design features of oil hydraulic system used for the common rail system applied to fuel injection and exhaust valve
	
	(Main steam turbine)
	- Explain mechanism of the following automatic functions used for main steam turbine control using sample system diagrams/configurations.
	  - revolution speed control
	  - vital valve control
	  - emergency shut-down
	  - emergency slow down
	  - rollover/spinning
	- Describe features of oil hydraulic system used for main steam turbine.
	- Explain mechanism of the following automatic functions used for main gas turbine control using sample diagrams/configurations.
	  - revolution speed control
	  - emergency shut-down
	
	(Generator and distribution system)
	- Explain mechanism of the following automatic functions used for generator and distribution system control using sample diagrams/configurations/flowcharts
	  - generator start and stop
	  - synchronization
	  - optimum load sharing
	  - emergency shut down
	  - over current trip
	  - reverse power trip
	  - preference trip
	
	(Main steam boiler)

	- Explain mechanism of the following automatic functions used for main steam boiler control system using sample diagrams/configurations/flowchart
	  - ACC (Automatic Combustion Control)
	  - STC (Steam Temperature Control)
	  - FWC (Feed Water Control)
	  - emergency shut down
	
	(Steering gear)
	- Explain mechanism of the following automatic functions used for steering gear control system using sample diagrams/configurations
	  - autopilot
	- Explain feature of oil hydraulic system used for steering gear system
	
	(Oil purifier)
	- Explain mechanism of the following automatic functions used for oil purifier control using sample diagrams/configurations
	  - start and stop
	  - de-sludging
	  - emergency stop
	
	(Pumping system)
	- Explain mechanism of the following automatic functions used for pumping systems control using sample diagrams/flowcharts.
	  - start and stop
	  - changeover
	
	(Refrigeration system)
	- Explain mechanism of the following automatic functions used for refrigeration system control using sample diagrams/configurations
	  - compressor start and stop
	  - unload running of compressor
	  - defrosting
	  - start blocking
	
	(Deck machinery)
	- Explain mechanism of the following automatic functions used for deck machinery control using sample diagrams/configurations
	  - self-tensioning of mooring winch
	  - running speed control
	- Explain features of hydraulic motors used for deck machinery.
	- Explain why oil hydraulic system is used for control and operate deck machinery.

ERS II-11	A-III/1 (Basic configuration and operation principles: Various automatic control methodologies and characteristics)
	- Define the following control methodologies
	    - ON-OFF control
	    - Sequential control
	    - PID control
	    - Programmable Logic Control (PLC)
	    - Program control
	- Explain features and characteristic of control methodologies aforementioned.
	- Explain principles of control actions applied to the each control methodology aforementioned.
	- Describe examples of machinery systems which the each control methodology aforementioned is applied.

ERS II-12	A-III/1 (Basic configuration and operation principles: PID control characteristics and associated system devices for process control)
	- Describe types of PID controller.
	- Define P, I and D parameters and their effects
	- Explain how P, I and D parameters are represented in an actual PID controller
	- Explain significance of "Step response test" to process control system
	- Define the following terms in "Step response test"
	    - maximum overshoot
	    - time lag
	    - rise time
	    - settling time
	    - off-set
	- Explain methods of determining optimum PID parameters.

ERS II-13	A-III/2 (Heat cycle, thermal efficiency and heat balance of marine steam turbine and boiler)
	- Explain heat cycle applied to steam turbine plant.
	- Define the following terms and describe how they are represented
	    - total calorific value
	    - total thermal efficiency
	    - boiler efficiency
	    - turbine effective efficiency:
	    - turbine internal efficiency
	- List heat losses of steam turbine propulsion plant:
	- Explain how the work done by steam turbine is represented on the h-s diagram.
	- Explain heat balance diagram using a sample diagram.

	- Explain characteristic performance curve using a sample diagram

ERS II-14	A-III/2 (Operating limits of propulsion plant)
	- Explain meaning of operating limits of main machinery
	- Describe how operating limits are usually represented.
	- Describe running parameters which affect operating limits of the following main machinery
	    - diesel engine
	    - steam turbine
	- Explain adverse effects on main machinery when the machinery runs outside operating range for each specific running factor.
	- Describe meaning of critical speed.
	- Explain why continuous running of engines at the range of critical speed must be avoided.

ERS III

Ind.	Required Performance
ERS III-1	A-III/1 (Thorough knowledge of principles to be observed in keeping an engineering watch) - Explain significance of watchkeeping - Explain responsibilities as watch officers. - Describe precautions and preparations before accepting watch duty. - List duties of watch officers - Describe a code of conduct to be observed during a watch - List information to be noted to duty officers on bridge. - List information to be handed over to relieving watch officers - List information to be reported to Chief engineer.

ERS III-2	A-III/1 (Safety and emergency procedures; change-over of remote/automatic to local control of all systems)
	- Explain meanings of emergency in accordance with machinery.
	- Explain meanings and purposes of change-over of remote/automatic to local control.
	- Describe precautions when changing-over remote/automatic of the following vital machinery to local control underway.
	    - main engine
	    - boiler
	    - generator
	    - power distribution system

	- steering gear system - Describe procedures necessary for changing-over remote/automatic of main engine to local control from bridge control underway. - Describe procedures necessary for changing-over remote/automatic of steering gear system to local control from bridge control underway.

ERS III-3	A-III/1 (Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems)
	- List safety precautions to be observed during a watch
	- List particular safety precautions under heavy weather during a watch
	- Explain how engine-room rounds during a watch contribute to safety.
	- Describe countermeasures to be taken by engineering watch officers in the event of the following.
	  - fire underway
	    - engine-room fire
	    - fire other than engine-room
	  - man overboard underway
	  - flood underway
	    - engine room flood
	    - flood other than engine room
	  - oil spill
	- Explain why urgent standby engine request must be issued when the event of fire or accident occurs.
	- Describe main procedures to urgently bring a propulsion plant to standby condition.

ERS III-4	A-III/1 (*Engine-room resource management:* Knowledge of engine-room resource management principles)
	- Explain meanings of each ERM principle described in STCW Code, Chapter VIII, Section A-VIII/2, Part 3, paragraph 8.
	- Describe resources that engineering watch officers have during a watch
	- Explain significance of ERM in terms of maintaining a safe engineering watch
	- Explain how the following ERM requirements described in STCW Code Ch III Section A-III/1 Table A-III/1 contribute to maintaining safe engineering watch.
	  - allocation, assignment and prioritization of resources
	  - effective communication
	  - assertiveness and leadership
	  - obtaining and maintaining situational awareness
	  - consideration of team experience
	- Explain precautions or ideas necessary to put effective communication into practice.

ERS III-5	A-III/1 (Basic construction and operation principles of machinery: Fluid flow and characteristics of lubricating oil, fuel oil and cooling systems; Main diesel engine) (fuel oil) - Explain flow of fuel oil from FO service tank to main engine injection pump using sample diagrams. - Explain functions of main components fitted to fuel oil service line to main engine using sample diagrams. - Explain why FO viscosity control is necessary. - Describe approximate temperature of fuel oil to be supplied to main engine. - Describe functions of emergency shut off valves fitted to FO tanks. - Explain flow of LO from LO sump tank to main engine using sample diagrams. - Explain how LO temperature is controlled using sample diagrams. - Describe approximate temperature of LO to be supplied to main engine. - Describe purposes of an emergency LO tank using sample diagrams. - Explain flow of HTFW form Jacket CFW pump to the pump using sample diagrams. - Explain flow of LTFW form central CFW pump to the pump using sample diagrams. - Describe functions of FW expansion tank. - Explain how temperatures of HTFW and LTFW are controlled using sample diagrams. - Describe approximate temperature of HTFW to be supplied to main engine. - Explain flow CSW from Low Sea Chest to overboard valve using sample diagrams. - Explain why emergency bilge suction valve is connected to No.1 CSW pump. - Explain functions of sea chests. -
ERS III-6	A-III/1 (Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems) - Explain main sequence to bring diesel engine propulsion plant to navigational condition from cold ship provided that FO, LO and FW are loaded. - Describe precautions to fire up boiler and to raise steam pressure in order to prevent damage. - Explain reasons to warm up main diesel engine before start. - Explain main sequence applied to warming up main diesel engine. - Describe how main engine is warmed up. - Explain reasons to warm up Turbo generator before start. - Explain main sequence applied to warming up Turbo generator - Describe how Turbo generator is warmed up. - Describe that all procedures for plant machinery must be documented and

	authorized and correctly carried out to prevent damage. - Describe all running parameters of machinery must be kept within a range of operation in principle to prevent damage. - Explain precaution necessary for fault detection and damage prevention when starting up machinery. - Describe what is necessary for machinery to detect fault and prevent damage while in service. -
ERS III-7	A-III/1 (Operation of pumping systems: (.1) routine pumping operations (.2) operation of bilge pumping system) - Explain how piping system of transferring fuel oil is constructed. - Explain precautions to transfer fuel oil to FO settling tank from bunker tanks. - Describe approximate temperature of fuel oil to be kept in FO settling tank. - Explain precaution to transfer bilge to bilge tank. - Explain methods to incinerate waste oil and separated oil from oily water separator or similar equipment. - Describe general use of sea water on board and how to supply sea water for general use. (Oily water separators (or similar equipment) operation) - Explain how bilge must be discharged overboard based on MARPOL Convention. - Describe functions of oil content monitor fitted to oily water separator or similar equipment. - Describe methods to clean up inside the oily water separator or similar equipment before and after use.
ERS III-8	A-III/1 (Basic configuration and operation principles: Preparation, starting, paralleling and changing over generators) - Explain system configurations of power distribution systems including generators using sample system diagrams/configurations. - Describe main components of power distribution systems. - Describe functions of the main components which construct power distribution system. - Describe conditions for automatically starting up generators. - Describe meaning of synchronization to make parallel running of generators. - Describe meanings of parallel running of generators. - Describe procedures to make parallel running of generators in manual. - Describe procedures to make single running of generator in manual.
ERS III-9	A-III/2 (Propulsive characteristics of diesel engines, steam turbines and gas turbines including speed, output and fuel consumption)

	- Describe relations between engine/propeller revolution speed and ship's speed. - Describe relations between propeller revolution speed and engine output. - Describe relations between propeller revolution speed and fuel consumption. - Describe relations between fuel consumptions necessary for same distance run by two different propeller revolution speeds. - Describe these relations can be applied in principle to main diesel engine, steam turbine and gas turbine as a propeller characteristic curve. - Describe how engine output can be determined for each main engine. - Describe how outputs of main engines will be changed in accordance with changes in hull resistance.

ERS III-10	A-III/2 (Heat cycle, thermal efficiency and heat balance of marine diesel engine)
	- Explain heat cycle applied to low speed diesel engine.
	- Define the following terms and describe how they are determined.
	  - total calorific value
	  - indicated horse power
	  - mechanical efficiency
	  - shaft output
	  - heat loss
	- List heat loss of diesel engine
	- Explain heat balance diagram using a sample diagram.
	- Explain characteristic performance curve using a sample diagram

ERS III-11	A-III/2 (*Practical knowledge*: Start up and shut down main propulsion and auxiliary machinery, including associated systems) - Explain warming up procedures of main engine using main engine system diagrams. - Describe criteria of completing warming up main diesel engine. - Describe meanings of interlocks for starting up main diesel engine listing their conditions. - Explain preparations just before staring up main engine - Explain significance of air running just before staring up main engine with fuel oil. - Describe precautions when maneuvering main engine during standby engine - Explain methods of bringing propulsion pant into navigational condition. - Explain meanings of variable injection timing (VIT) and variable exhaust valve timing (VET) - Explain cooling down procedures of main engine using main engine system diagrams. - Describe criteria of completing cooling down main diesel engine. - Explain methods of keeping main engine in a hot condition during stay in port using main engine system diagrams.

ERS III-12	A-III/2 (The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery)
	- Explain changes in running parameters of main diesel engine when weather condition becomes heavy.
	- Given engine speed N1 and output L1, determine anticipated engine output (L2) in case that N1 is decreased until engine speed N2 (0.8 N1) by moving maneuvering lever under the same weather condition.
	- Discuss fuel oil consumption Q2 as follow
	  - when the engine speed decreases to N2 from N1 (Q1) naturally due to weather condition.
	  - when the engine speed is decreased until N2 from N1 (Q1) by moving maneuvering lever under the same weather condition.
	- Explain meanings of torque rich/over torque of main engine.
	- Discuss indicator diagrams and draw curves at constant position of maneuvering lever of main engine as follow using sample diagrams
	  - differences between VIT in service and VIT out of service.
	  - differences between earlier injection timing and original timing
	  - differences between later injection timing and original timing.
	- Discuss indicator diagram and draw curves at different output as follow.
	  - differences between 90 % MCR output and 50 % MCR output of the engine
	- List conditions for main engine automatic shutting down
	- List conditions for main engine automatic slowdown
	- Explain impacts on propulsion plant in case of automatic shutting down and slowdown
	- Explain procedures to recover automatic slowdown of main engine.

Part D: Instructor manual

■ General

This manual reflects the views of the course designers on methodology and organization and what they consider relevant and important in the light of their experience as instructors. Although the guidance given should be of value initially, course instructors should work out their own methods and ideas, refine and develop what is successful, and discard ideas and methods which may be considered, in their view, to be unsuitable.

■ Briefing

Practical exercises constitute the main training components in the course, and they are carried out under supervision of the instructors. A briefing on important aspects of the exercise is advisable before each exercise begins. The briefing shall include clear information on the purpose of the exercise and the learning objectives to be achieved. If the briefing precedes an assessment session, the trainee shall be given a clear and concise description of criteria required to pass the evaluation. Provision has been made for this in the course structure.

The instructor should use practical examples involving real shipboard equipment and systems, referring to diagrams, technical drawings, photographs, and the other related technical documents to supplement and reinforce the briefing and training session.

One effective technique is to outline what is to be done during the exercise and then explain in detail those aspects that are considered to be important. Finally, allow the trainee to summarize the exercise using key words and phrases.

There should always be a final discussion to make sure that everyone understands the role they will play, as well as what is to be done and achieved by the exercise.

An overhead projector is a useful teaching aid during the briefing. Copies of the transparencies used can be distributed to the trainees for reference purposes during the exercise.

■ Simulator exercise

Engine room and propulsion plant machinery and systems may differ widely from ship to ship. Trainees with some previous experience may have different and varied knowledge and experience. Therefore, it is important to use the briefing period to explain precisely which particular machinery units and systems are being simulated in the exercise, as well as their functions, how they interact with each other, and the role to be performed by each trainee during the exercise.

Before the exercise, the trainees should be encouraged to work together as a team towards a common goal. They must co-ordinate their activities, show initiative and proper attitude in order to bring the exercise to a successful conclusion.

Safety is a fundamental aspect of machinery operation. Safety should be stressed during the briefing, throughout the exercise and the following debrief session. The use of pre-planning, checklists and safe working procedures should be stressed. Before the students are allowed to start any simulation, they shall have prepared themselves by pre-planning, working out checklists and safe working procedures for the exercise in question.

Often, such as during stand-by, there is more than one engineer on duty. When simulating this situation, one may assume that the chief engineer, a first engineer and an assistant are on duty.

During such an exercise, one trainee should assume the role of engineer in charge, with the responsibility of ensuring that the requirements and activities of the exercise are properly carried out. The other trainees act as his assistants. If the exercise is a lengthy one, each trainee in turn may undertake the role of team leader.

■ Preparing and conducting exercise

Particularly, as far as ERS III training is concerned in this course, when new exercises are developed, or the ones provided in the course are modified, these should not be so complicated that the trainees will have difficulty in carrying out their tasks and duties.

An exercise should start with simple activities, in which trainees can use simple elements such as valves, pumps, fluid systems or tanks. Step by step they should proceed towards more complex activities.

Split a lengthy exercise into two or more separate exercises to ensure that the learning process is effective.

The simulator is designed to provide training for normal, faulty and emergency machinery operation. It is important for the trainees to achieve a satisfactory level of competence under normal conditions before proceeding to exercises in which faults have been introduced or emergency situations are simulated.

The exercises should be made to reflect realistic situations in order to provide the trainees with the impression of actually being in an engine room or control room aboard ship. For this reason, the simulator's sound system should be activated.

■ Exercise scenarios

Simulator exercise scenarios should be designed for the specific simulator that is available for conducting simulator training to address the STCW requirements specified in the tables A-III/1 and A-III/2.

The familiarization scenario should be also designed for ERS III training. This should familiarize the trainees with units and systems being simulated and provide some hands-on experience with the ERS III simulator.

The watchkeeping scenario should be based on the following provisions relating to watchkeeping procedures and duties and responsibilities of the engineer in charge of a watch of the STCW Code.

- Section A-VIII/1, paragraph 10
- Section A-VIII/2 ,Part 4, paragraph 9 to 12,
    - Part 4-2 paragraph 52 to 83,
    - Part 5 paragraph 90 to 97 –
    - Part 5-2 paragraph 103 to 104,
- Section B-VIII/1, paragraph 6 to 9,
- Section B-VIII/2, Part 4-2, paragraph 6 to 8

Further details regarding the content of the scenarios are provided in the Appendices from page 92 onwards.

■ Monitoring of exercise

During an exercise the instructor is responsible for monitoring and taking notes for use during the debriefing session. To assist, a second instructor or an observer which could be an experienced trainee, should be available in some cases of ERS III trainings. The observer's task will vary according to the trainees' abilities and competence. Observers will be involved in the briefing and debriefing activities and will also, when the trainees become more experienced, take part in assisting and guiding them in the use of the equipment. The observer should follow their work closely, but should avoid interrupting them and save observations for the debriefing session. The use of the simulator event log may be of assistance during the whole operation.

■ Debriefing

The time for debriefing session should be occupied by contents of the trainings but it is better to make debriefing sessions as short as possible. The instructor should summarize the training to let the trainees ensure what they have learned through the training.

The instructor should refer to the notes taken during the exercise, raise important points and lead the discussion among the trainees, and they should be encouraged to examine their performance critically. Instructors should not impose their own views, but ensure that the trainees have the right attitude and are encouraged to use correct procedures at all times.

Part E: Evaluation

■ Introduction

Evaluation is an important aspect of simulator training and has to be done for every simulator training course. As long as the evaluation is conducted, it generally provides the means to determine the trainee's achievement through the simulator training as well as making the training effective and useful.

Furthermore, this is to ensure consistency amongst evaluation staff and to ensure an objective summary of a trainee's achievement. It is vital to keep evaluation of performance on a simulator as objective as possible in order to enhance uniformity and rule out subjective judgments. It is desirable that a team of three persons: the instructor running the simulator, an observer and assessor, undertake the final evaluation of the trainees.

With regard to operation training, the main purpose of an evaluation should not be to check if the trainee is able to memorize specific procedures or potentially dangerous situations, but to check if the trainee has acquired the necessary knowledge, understanding and proficiency or skills enabling the trainee to operate a propulsion plant machinery. Indeed, they should also demonstrate, beyond any reasonable doubt, that they are confident about their performance and treat all situations showing a sound and conscious attitude by adhering to procedures and consulting references, if in doubt, about how to handle a situation.

■ Development of evaluation and assignment forms

Various types of evaluation can be considered and instructors should develop effective evaluation forms depending on contents and functions of simulators. It would be most important not to miss key issues or words of the topics when developing evaluation forms.

As far as knowledge is concerned, a written examination is a general method to evaluate trainees' knowledge, and an assignment containing problems to be answered by the trainees is suggested in this model course, which is marked and used for evaluation. With regard to skills on the other hand, evaluation based on demonstrations is appropriate, as knowledge alone does not always mean an ability for practical skills.

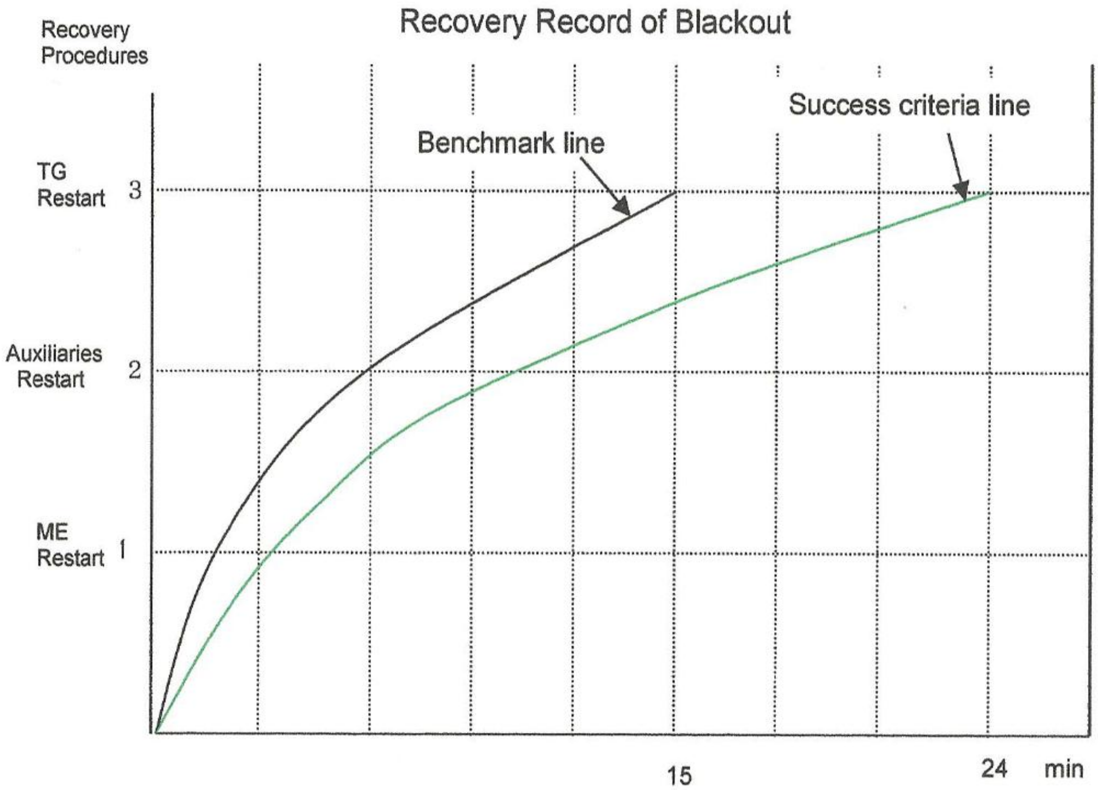
The following can be suggested for the evaluation of skills in simulator training:

■ Evaluation based on facts

It evaluates the ability of demonstrating skills by counting number of errors made during demonstrations, including a method of weighting the errors. This is a simple method of evaluation, however, the trainees can easily obtain perfect score by simply memorizing procedures of operations or regardless time taken to demonstrate and timing of procedures could not be reflected.

■ Evaluation based on time taken and process made

This is an evaluation that takes into account time and process of demonstrating a target task. In the example shown below, the graph shows process of recovering blackout underway (Diesel engine propulsion, Turbo generator and FWG were in service) and the benchmark line was made by records of experienced person's demonstration. The success criteria line means that the demonstration was successful, as records of demonstration stays between the both lines. If the recorded line exists in left side of the bench mark line, it means that demonstrators performed recovering operation neglecting dynamic characteristics of the propulsion plant. There is a case that time records partially came out from the success criteria line even when they completed the recovery within 24 minutes. This means that they took a longer time for the particular task due to some reasons. The reasons should be discussed or followed up later to improve their ability.
The recovery procedures 1, 2, and 3 mean key points of recovery operation and 3 means completion of putting TG into service.



We need to divide the target task into several key procedures in this evaluation method and accurate time recording. From these aspects, this method can be applied to limited number of demonstrations only.

- **Evaluation based on observation**

This is an evaluation method where instructors evaluate trainees' ability by observing their demonstration of practical skills. In this method, evaluation criteria is usually prepared in advance, however, instructors' experience, knowledge and ideas are likely reflected in the evaluation. Accumulation of the evaluation would improve validity of the evaluation and this might be the most practical method. Among others, when the instructors evaluate non-technical skills represented by ability of communication in such ERM training, this evaluation method would be most appropriate.

In this context, sample training scenario suggested in the Appendix contains an Assignment form or Evaluation form according to the proposed simulator training.

Basically, an assignment form is used for evaluation of training other than operation training and consists of questions about construction and operation principles. These questions must be developed by instructors according to functions and contents of simulators.

The assignment form, in principle, should be submitted to instructors at end of the training followed by a debriefing session. The assignment form is basically given to the trainees soon after completion of the training. However, it may be given to trainees in accordance with questions before the training begins, in some cases.

An evaluation form is basically used for evaluation of operation training and consists of items to be evaluated by observation. The evaluation items should be developed based on the contents of the simulator training and should be as objective and specific as possible although the proposed evaluation form includes evaluation of behavior/attitude.

Instructors evaluate trainees using this evaluation form after the training and the trainees must submit a "Report form" to the instructors. The main purpose of the Report form is to let the trainees report what they have done during the training. It is also important to let the trainees submit a report every time they have done something educational in order to summarize events and secure knowledge they have acquired. The trainees fill out the form with the trainees' information, what they have done and their comments.

■ Conduct of evaluation

The assignment form shall be marked based on the instructors' solution to each assignment and graded for specific simulator training. The results of marked assignment forms should be fed back to the trainees for their review. The marking point should be recorded and treated as evidence of grading for the simulator training course.

Further, the instructors should utilize the results of the assignment form as materials for follow-up of the trainees. From the results, weak points of the trainees must be elicited and the instructors should have opportunities to strengthen the points identified.

With regard to evaluation forms, as far as possible, the responsible evaluator should collect comments or evaluations made by other evaluators, and evaluate the trainees' marks on the evaluation form. The marking of the evaluation form should be done in a cautious and dispassionate manner. The results of marking should be processed in the same manner as the assignment form.

APPENDIX

COMMON ITEMS OF ERS I TRAINING

The following is common items to be applied to ERS I trainings.

Training Title/Scenario: written in each exercise

Table A-III/1 Competence: written in each sample exercise
Table A-III/1 KUP: written in each sample exercise
Table A-III/2 Competence: written in each sample exercise
Table A-III/2 KUP: written in each sample exercise

Time allocation: 2 hours
Number of Trainees: 1 - 2 /CBT unit
Number of Instructors: 1 /20 trainees

Outline of the training:

Trainees watch and/or perform simulation on the allocated CBT units. During the performance of the simulation, the trainees follow instructions displayed on the screen and/or assignment paper given by instructors. After the performance of the simulation, the trainees complete the assignment first in the debriefing session and submit it to the instructors. The instructors debrief the training taking into account the contents of the simulation and the results of the assignment.

Prerequisite:

Fundamental knowledge on assigned machinery

Note:

A group of 2 trainees is more effective in some cases to carry out CBT eliminating waste of time and maintaining concentration according to topics although CBT is usually performed solely. Instructors therefore should arrange allocation of CBT units to the trainees taking into account the simulation contents or tasks of the topics.

Specific purpose of the training:

By watching simulation video that shows construction and operation principles of machinery, the trainee identifies components which construct the machinery and understand the operation principles.

Assignment (written in each exercise)

Instructors should prepare an assignment to be used as a report of training and evaluation. The assignment will make training more effective by giving trainees ideas on what should learned and concentration on the training.
The assignment should include the trainee's information and problems concerning specific topics being simulated and the problems should be developed by the instructors in accordance with contents of simulation programs, in order to ensure that the trainees acquire knowledge on construction and operation principles of machinery.

Briefing session (15 min):

Instructor should explain:
- purpose of the simulation
- contents of simulation program
- how to carry on the training
- points of problems contained in the assignment paper giving it to the trainees
- what should be learned

Instructor should also emphasize that:
- this training supplements classroom lectures on the machinery for better understanding
- the trainees should keep in mind the problems described in the assignment paper before starting the simulation, saying that the simulation video must contain keywords to solve the problems

The Instructor allocates CBT units to the trainees and lets them begin the training.

Implementation of the training (60 min):

The trainees start up the allocated CBT units and begin the training selecting the assigned simulation program. The Instructor pays attention to proceedings and gives advice to the trainees accordingly.
The following is examples of the assignment paper containing problems. The assignment paper is used for debriefing and evaluation.

Implementation of the training by CBT with assignment paper (1 hour) (The trainees may answer to some of the problems during their performance of the simulation, where appropriate)

Debriefing session (45 min):

The Instructor lets trainees complete the assignment first and collect them to make sure their achievements.
The instructor should complement their understanding on the topics in light of the purpose of this simulator training and the results of the assignment.
After the debriefing session, the instructor marks the assignment for evaluation.

ERS I – 1

Training Title/Scenario: Basic construction and operation principles of marine diesel engine

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems
Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .1) marine diesel engine
.2 marine steam turbine .3 marine gas turbine .4 marine boiler .5 shafting installations including propeller .6 pumps, air compressor, purifier, fresh water generator and heat exchanger .7 steering gear .10 deck machinery

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Two Stroke Crosshead

1) Label the components shown by arrowheads in Figure 1, 2 and 3
2) Describe names of the valves fitted to Cylinder head
3) Describe which components/parts are cooled by fresh water
4) Describe which components are lubricated
5) Describe how the piston is cooled
6) Describe scavenging air and exhaust gas flow
7) Describe functions of stuffing box
8) Describe functions of tie rod
9) Identify mechanisms for fuel injection and exhaust valve

2. Turbocharger

1) Label the components shown by arrowheads in Figure 4

3. Four Stroke

1) Label the components shown with arrow marks in Figure 5, 6, 7 and 8
2) Identify differences between two stroke and four stroke diesel engine in construction
3) Describe how the piston is cooled in the engine shown in Figure 5
4) Identify driving mechanisms for exhaust valve
5) Describe valve timing applied to a four stroke engine

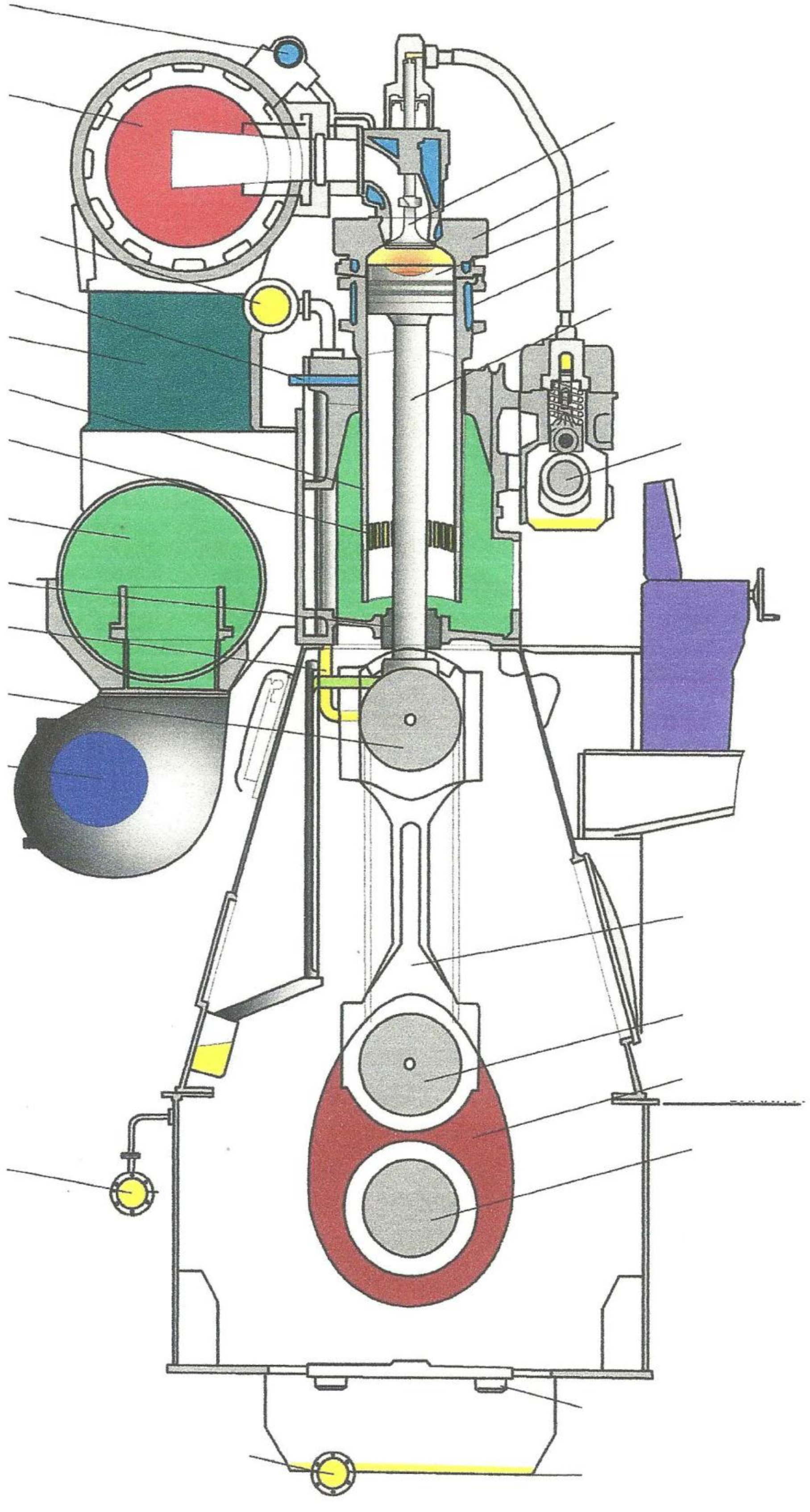


Figure 1

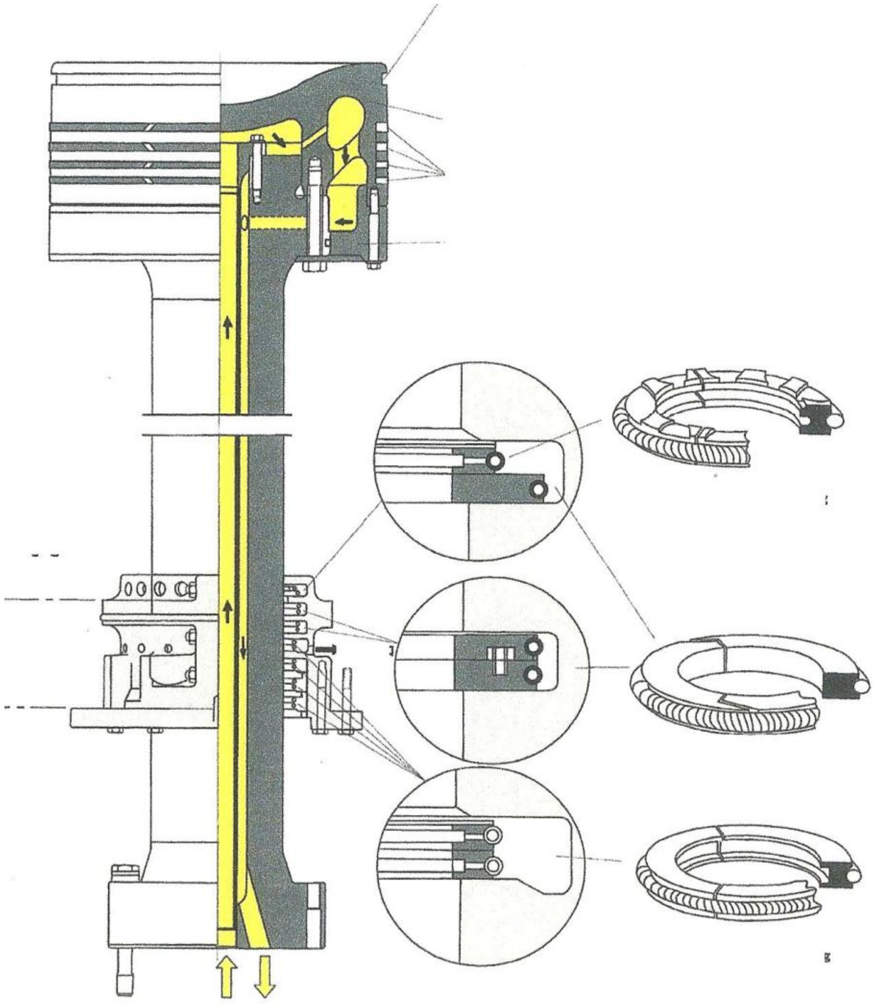


Figure 2

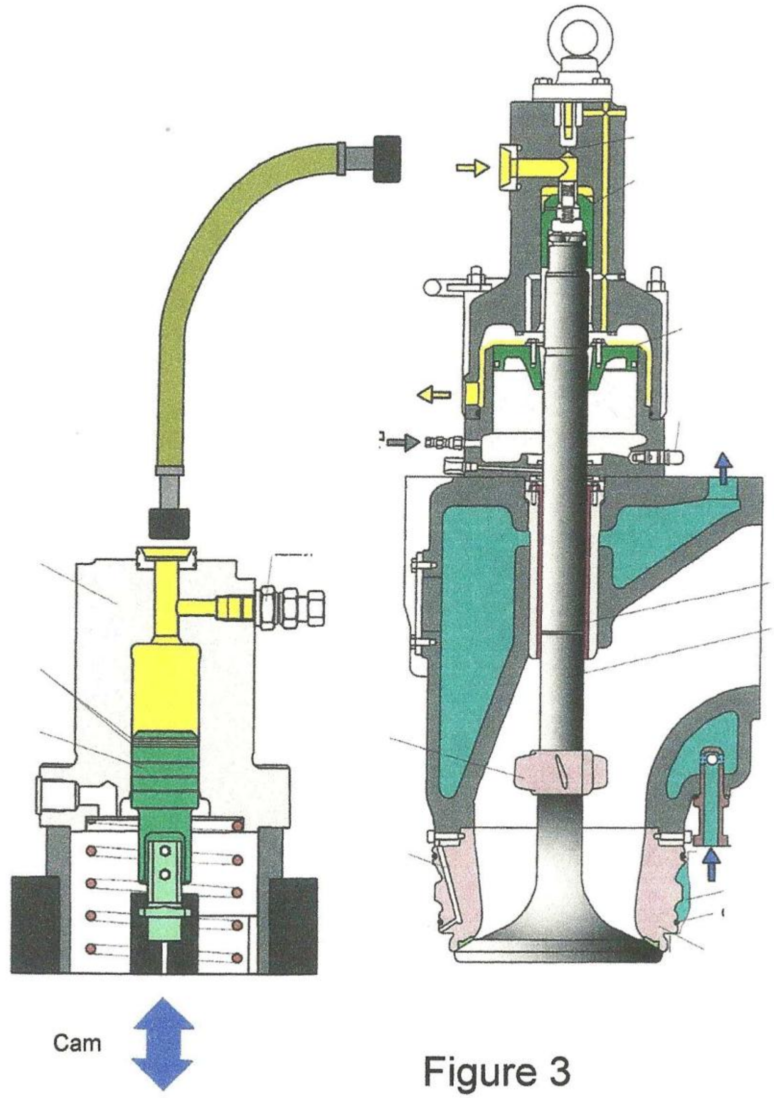
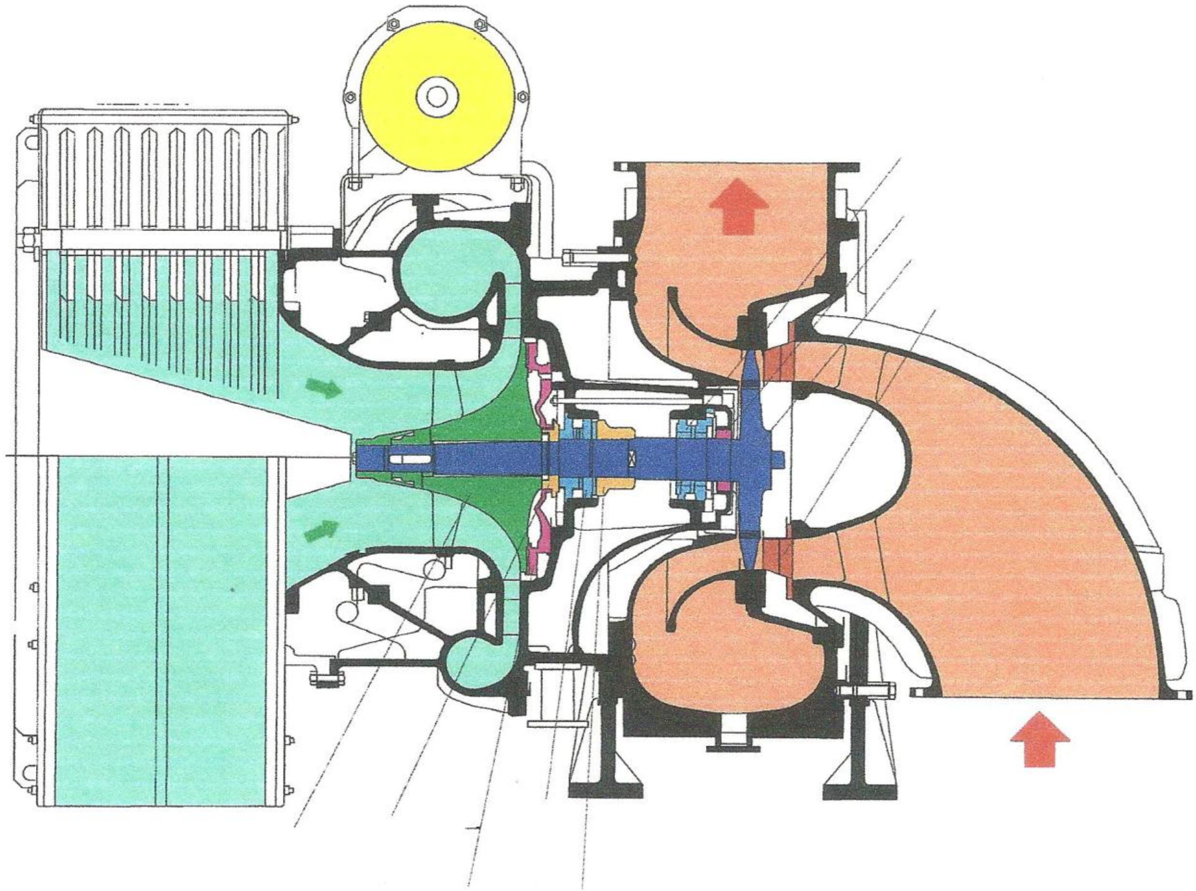


Figure 3



Turbocharger

Figure 4

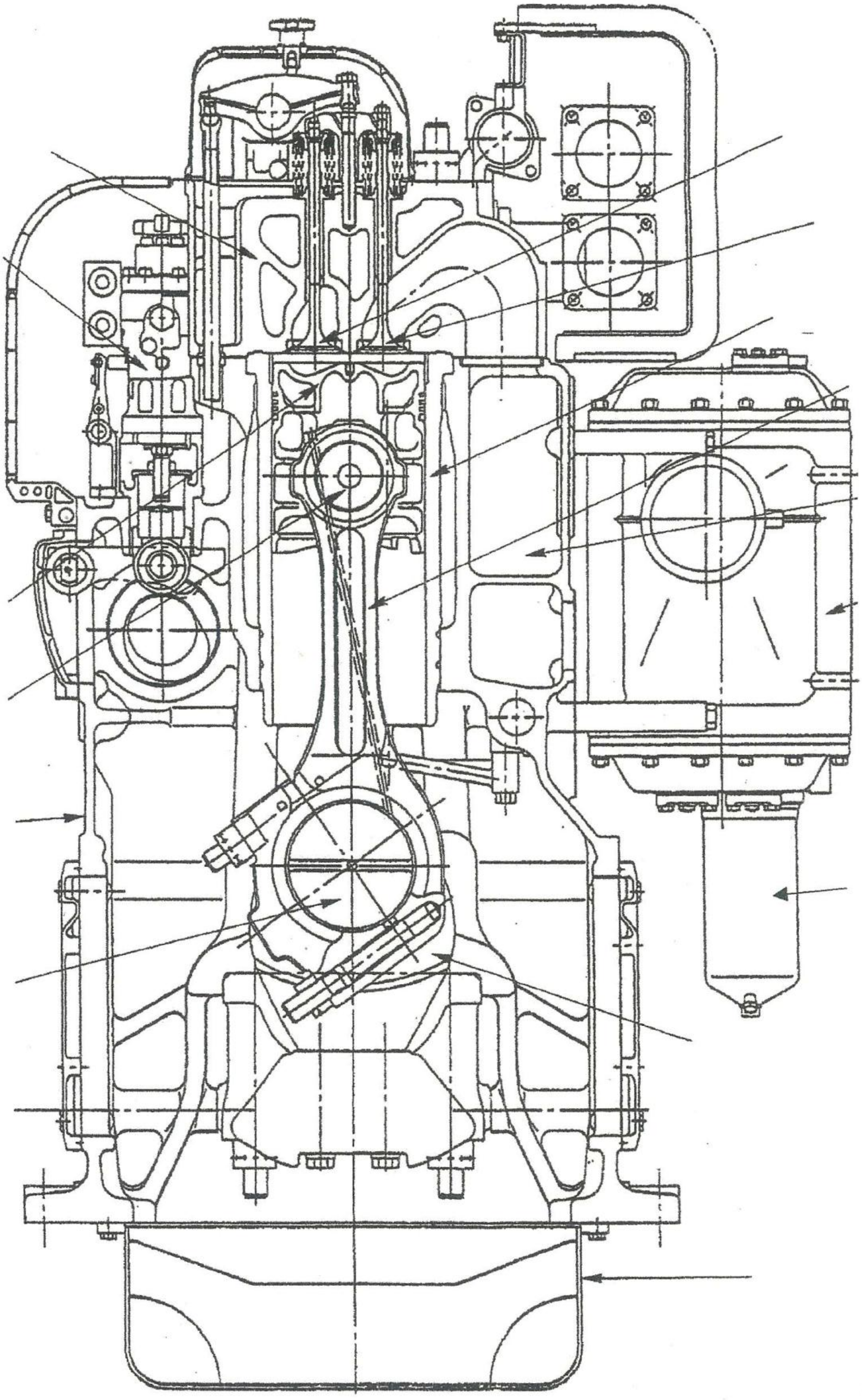


Figure 5

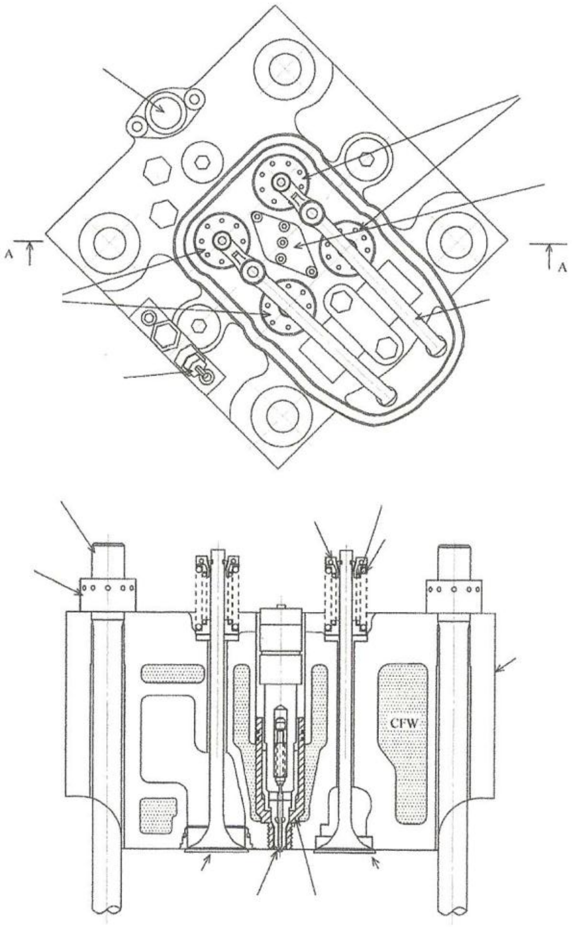


Figure 6

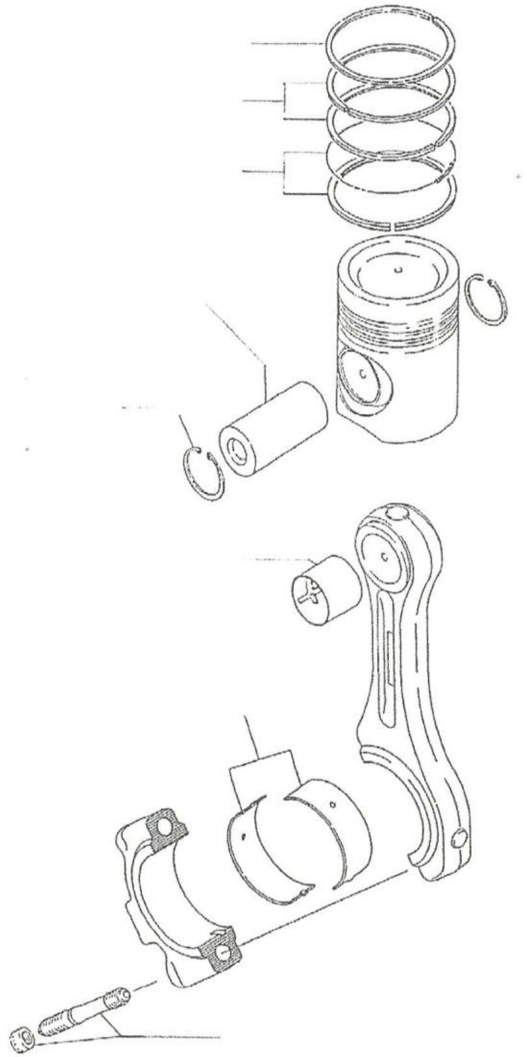


Figure 7

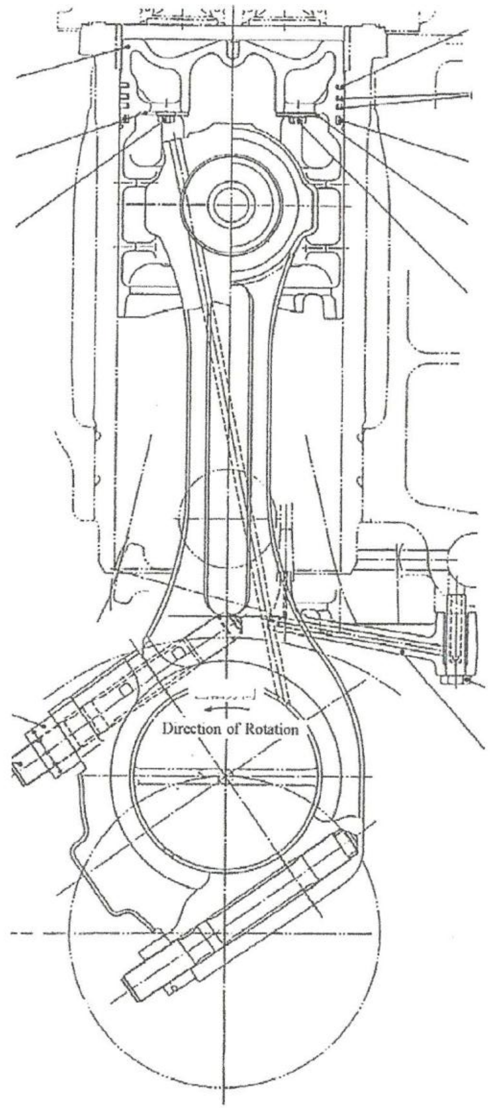


Figure 8

ERS I - 2

Training Title/Scenario: Basic construction and operation principles of marine steam turbine

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .2) marine steam turbine
.3 marine gas turbine .4 marine boiler .5 shafting installations including propeller .6 pumps, air compressor, purifier, fresh water generator and heat exchanger .7 steering gear .10 deck machinery

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the components shown by arrowheads in Figure 1, 2, 3 and 4

2. Explain why we need reduction gear in steam turbine propulsion

3. Explain briefly meaning of high pressure turbine and low pressure turbine

4. Explain why we need high pressure turbine and low pressure turbine

5. Describe functions of the nozzle valves shown in Figure 2

6. Describe what sealing is applied to avoid steam leak between the stages (diaphragms and rotor discs) shown in Figure 3

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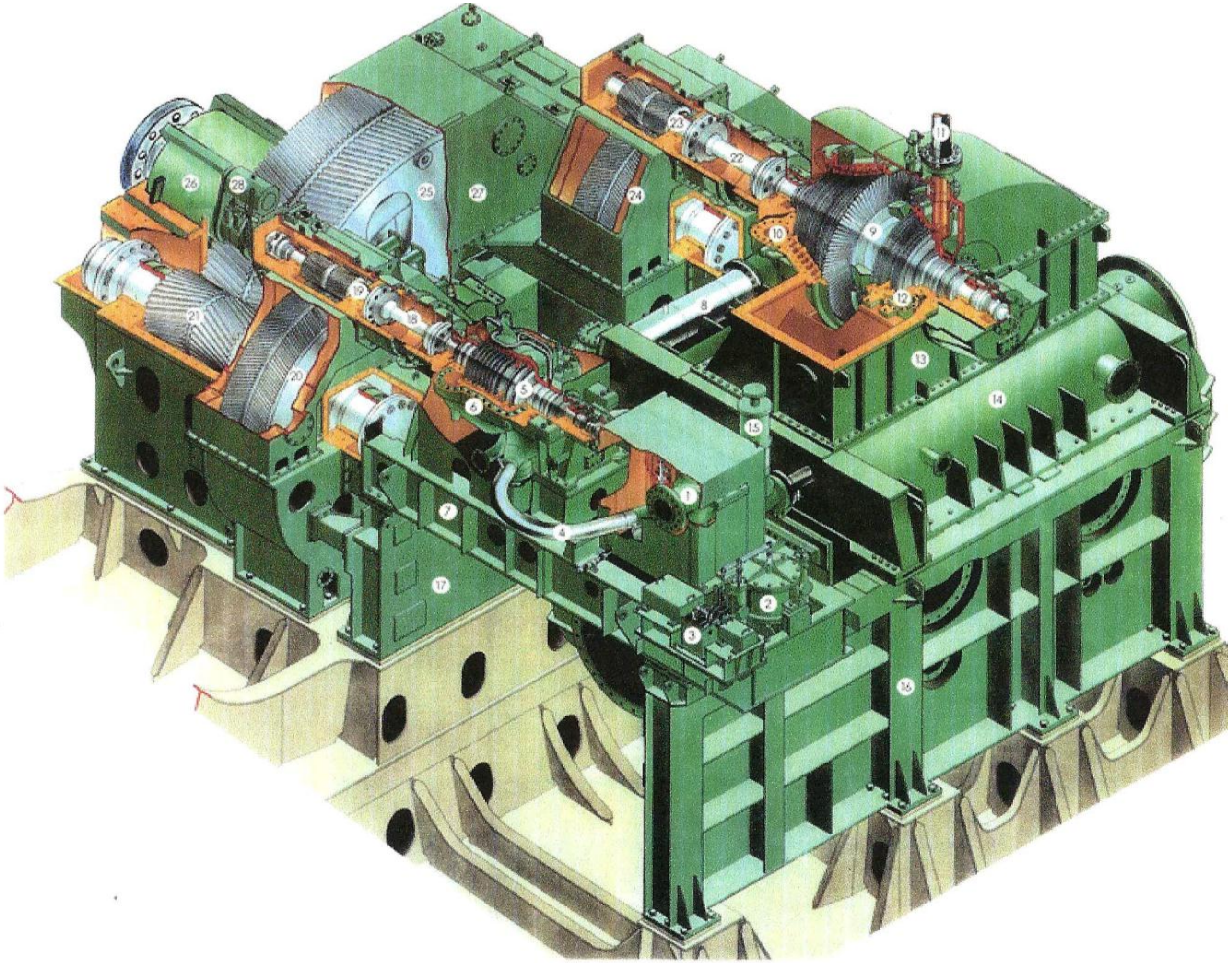


Figure 1

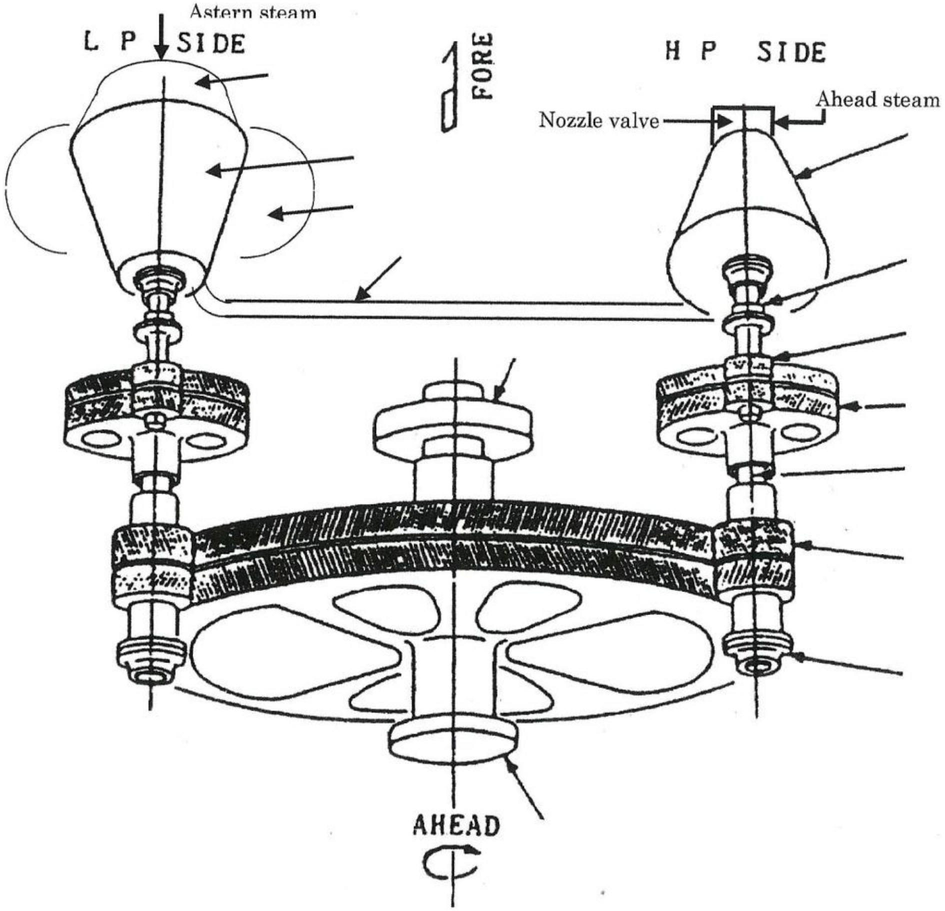
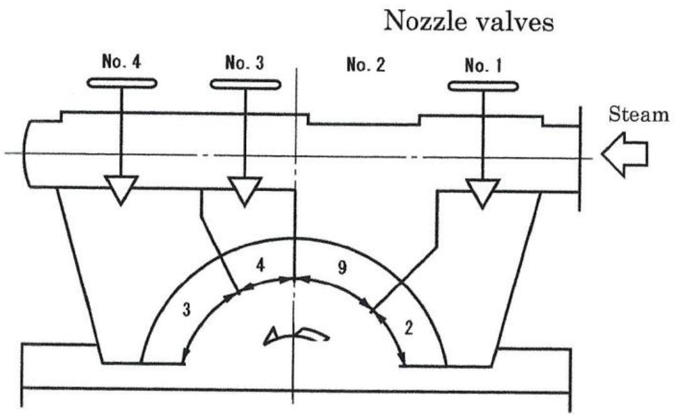

Astern steam
L P SIDE
FORE
H P SIDE
Nozzle valve
Ahead steam
AHEAD

Figure 2


Nozzle valves
No. 4
No. 3
No. 2
No. 1
Steam
4
9
3
2

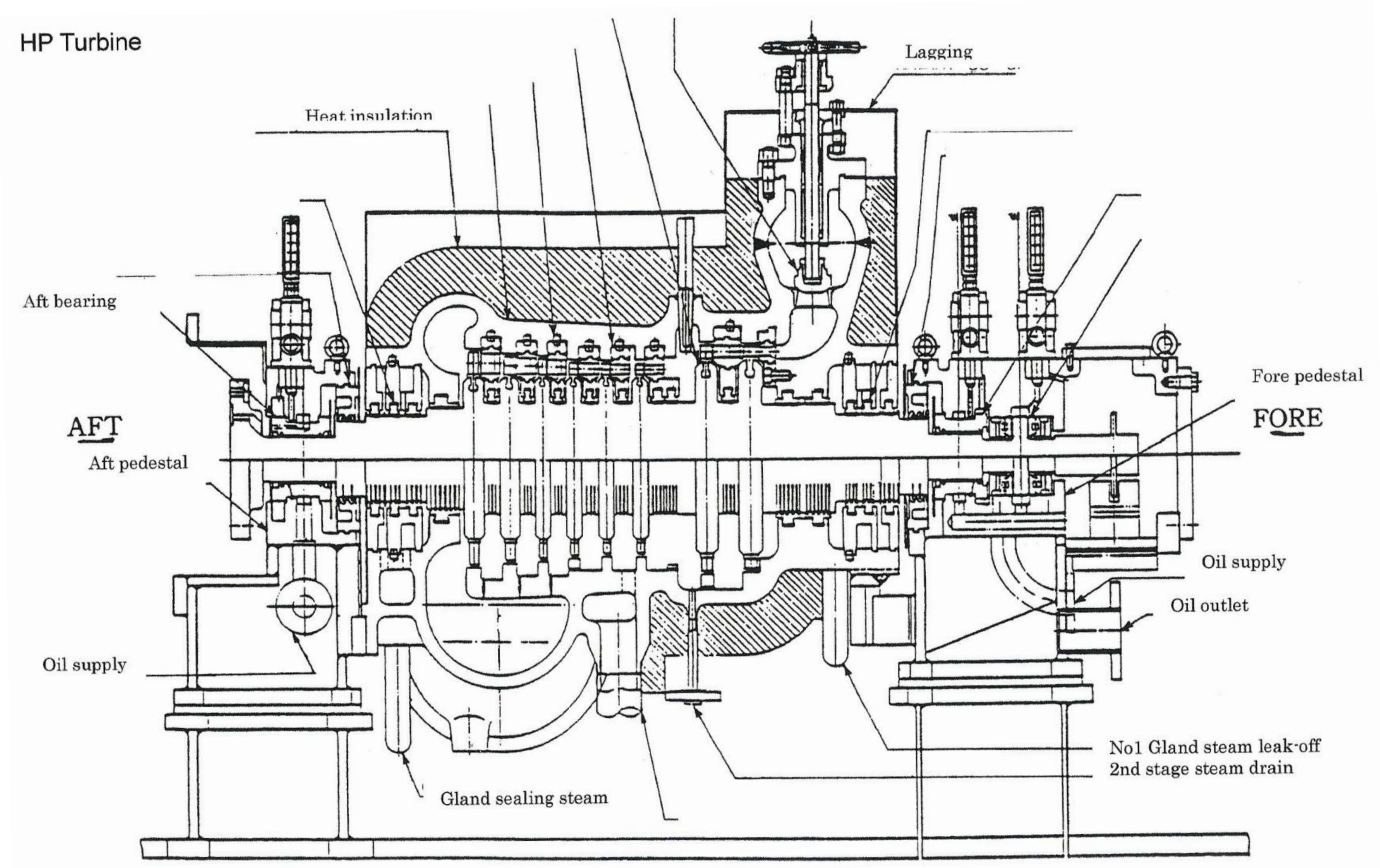

HP Turbine
Lagging
Heat insulation
Aft bearing
AFT
Aft pedestal
Fore pedestal
FORE
Oil supply
Oil outlet
Oil supply
No1 Gland steam leak-off
2nd stage steam drain
Gland sealing steam

Figure 3

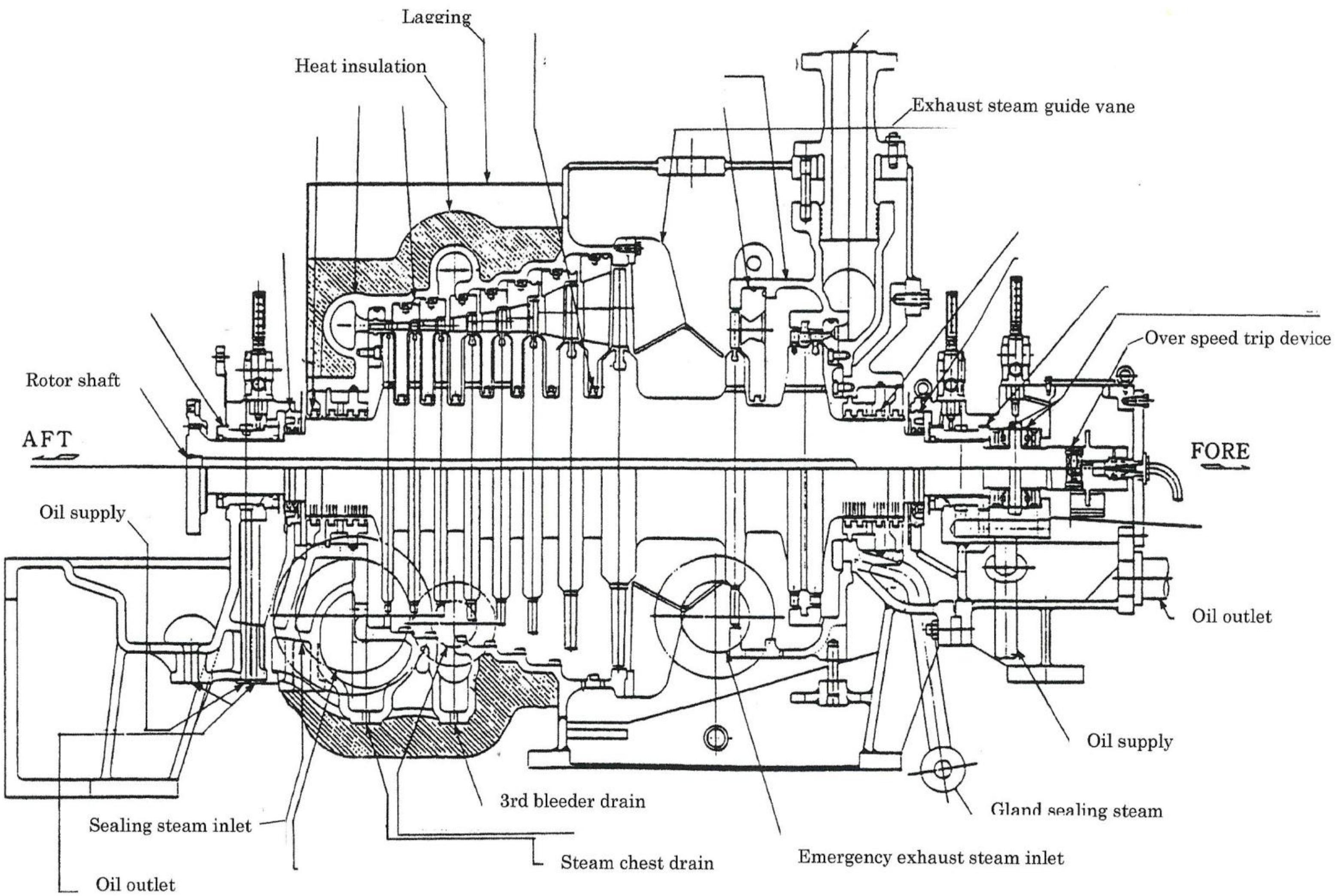

Lagging
Heat insulation
Exhaust steam guide vane
Over speed trip device
Rotor shaft
AFT
FORE
Oil supply
Oil outlet
Oil supply
Gland sealing steam
3rd bleeder drain
Sealing steam inlet
Steam chest drain
Emergency exhaust steam inlet
Oil outlet

Figure 4

ERS I - 3

Training Title/Scenario: Basic construction and operation principles of marine boiler

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

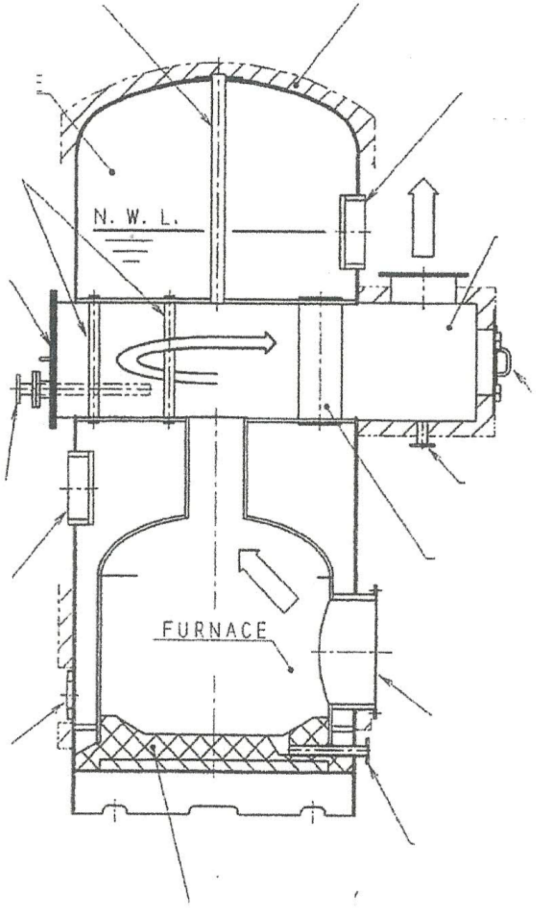
Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .4) marine boiler
.5 shafting installations including propeller .6 pumps, air compressor, purifier, fresh water generator and heat exchanger .7 steering gear .10 deck machinery

ASSIGNMENT

(The following problems are based on the sample drawings)

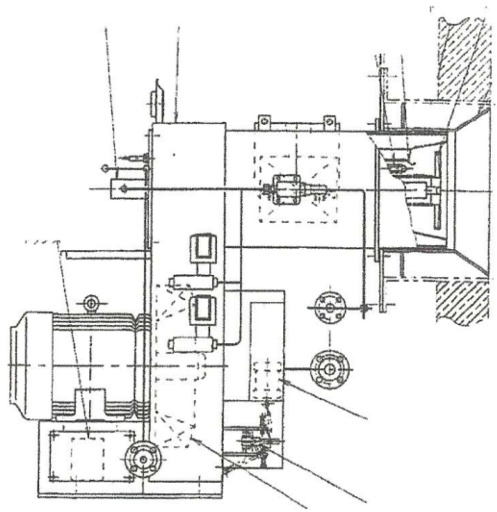
Name		Class	
Reg. No		Date	

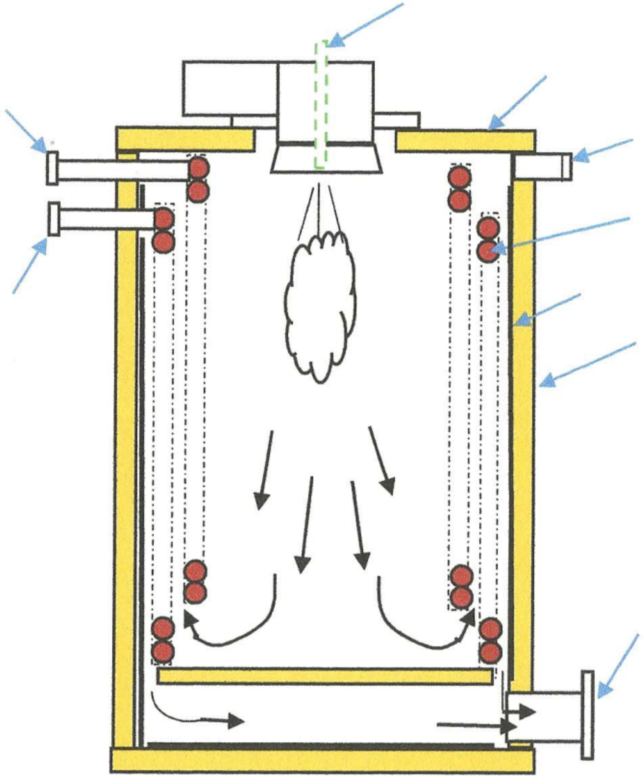
1. Label the components shown by arrowheads in Figure 1, 2, 3 and 4
2. Explain main purposes of auxiliary boiler and main boiler respectively
3. Identify differences between Cochran boiler and Thermal fluid boiler
4. Describe ranges of steam pressure generally used for auxiliary boiler and main boiler respectively
5. Explain briefly purpose of soot blower
6. Explain briefly differences between saturated steam and superheated steam generated in the superheater shown in Figure 4
7. Describe purposes of economizer and water wall shown in Figure 4



Cochran Boiler

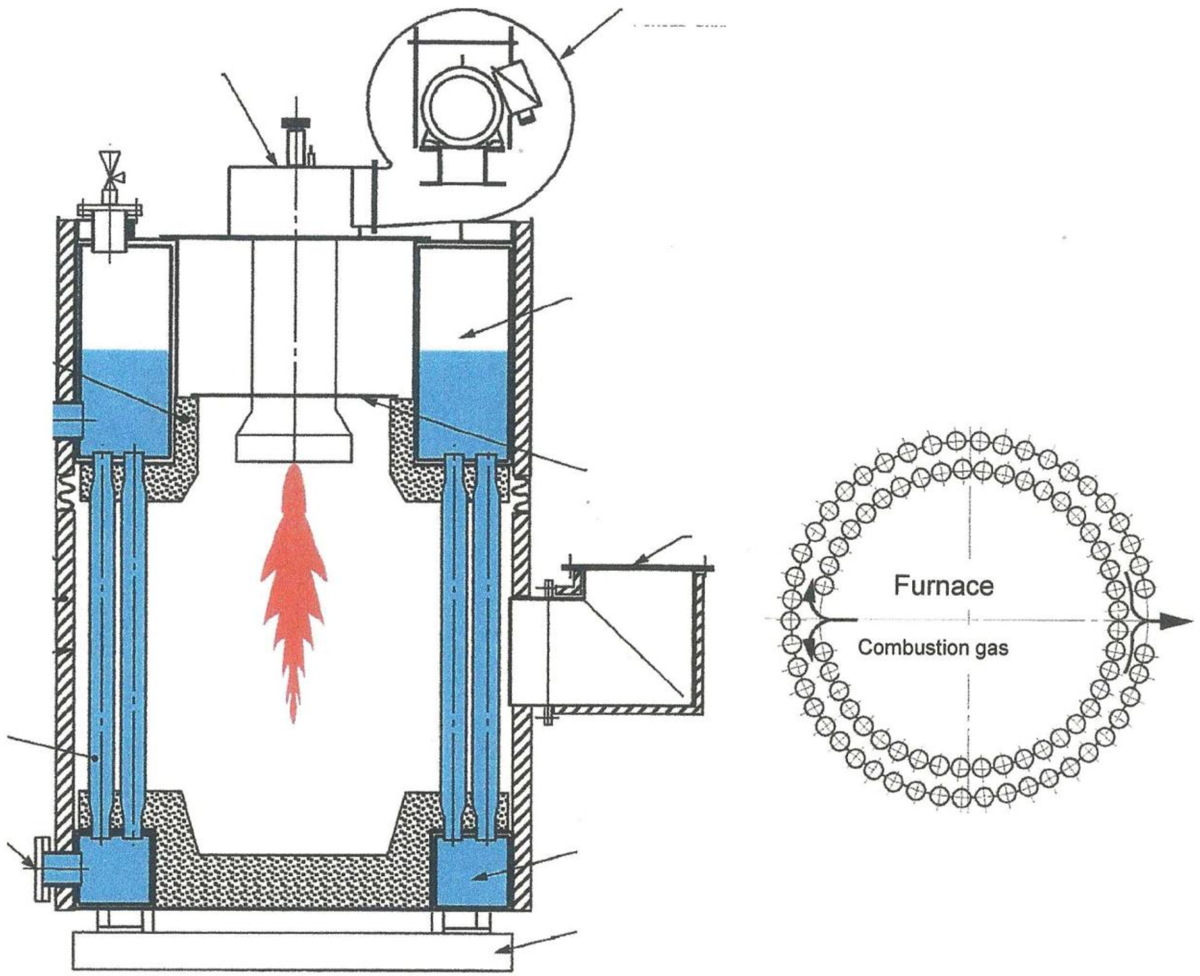
Figure 1





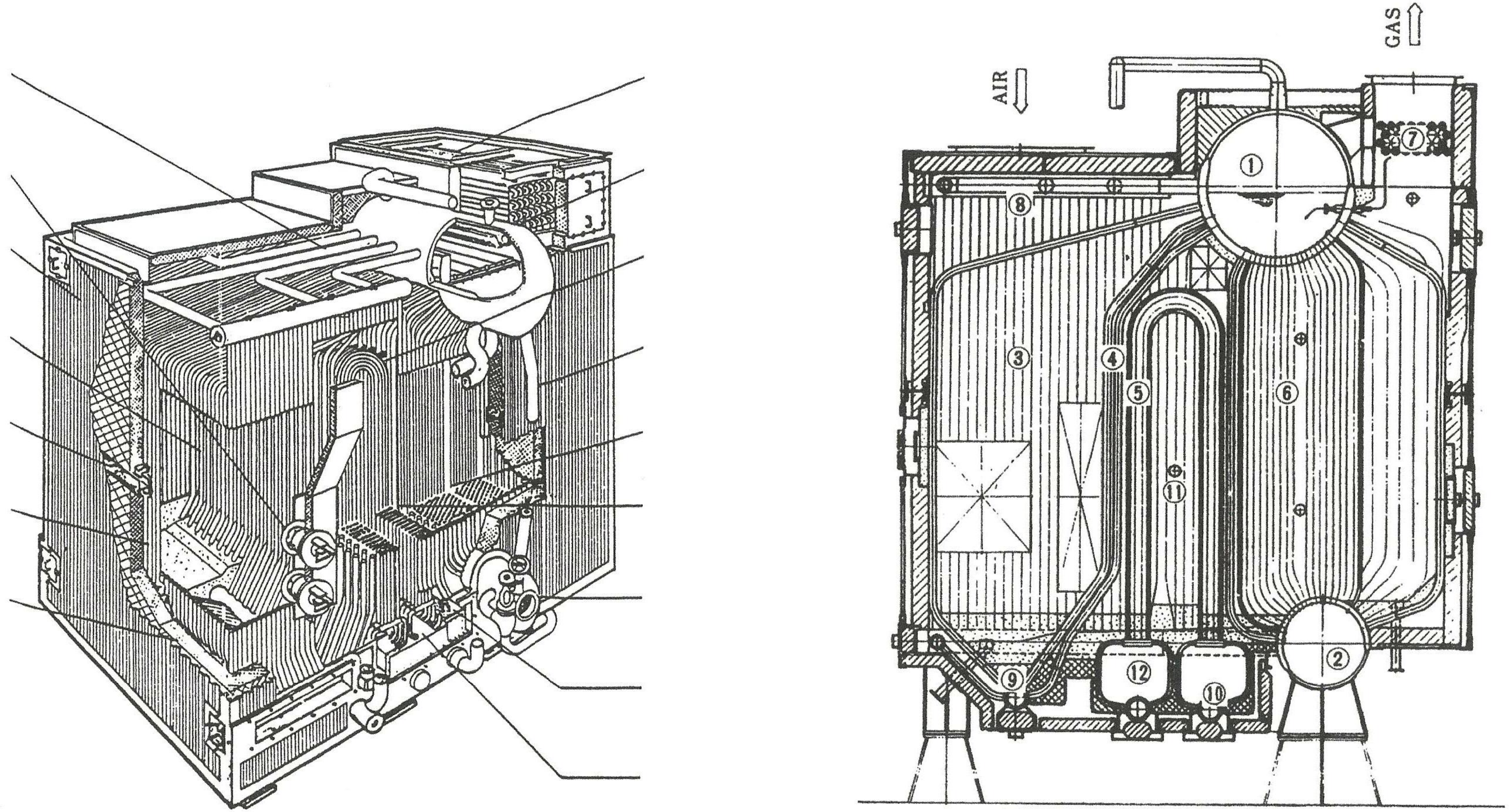
Thermal Fluid (Heat Medium) Boiler

Figure 2



Vertical Water Tube Boiler

Figure 3



Two Drums Water Tube Boiler

Figure 4

ERS I - 4

Training Title/Scenario: Basic construction and operation principles of shafting installations

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

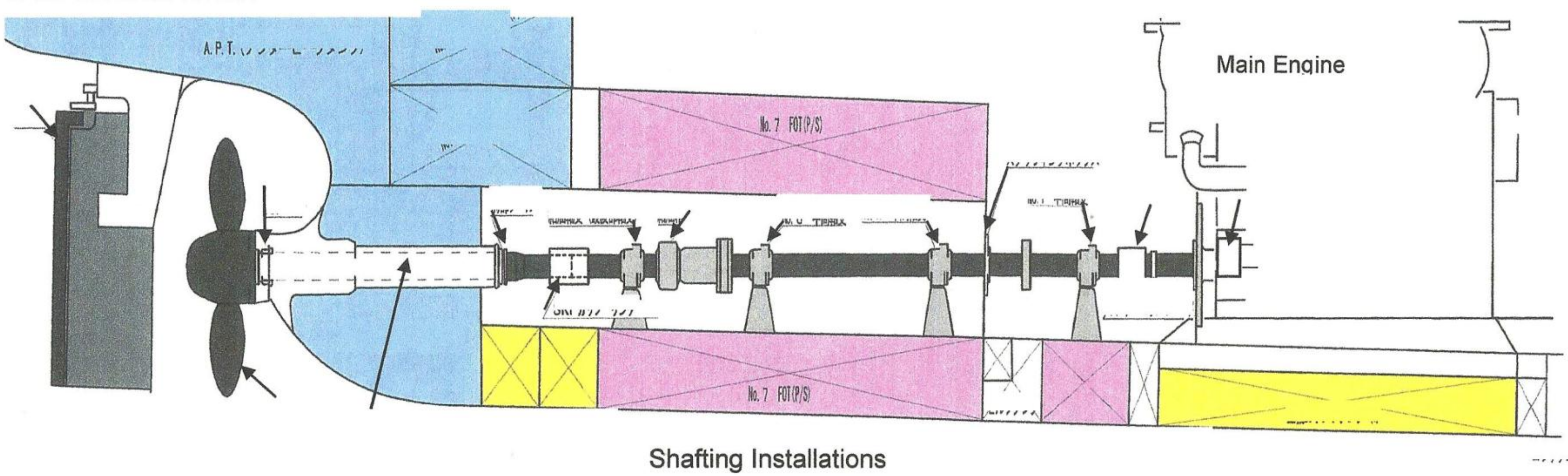
Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .5) shafting installations including propeller
.6 pumps, air compressor, purifier, fresh water generator and heat exchanger .7 steering gear .10 deck machinery

ASSIGNMENT

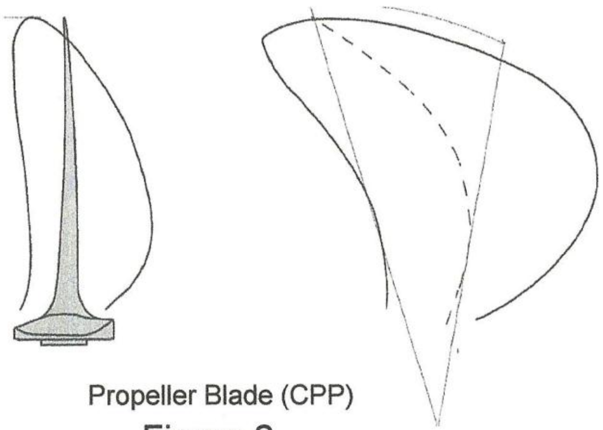
(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

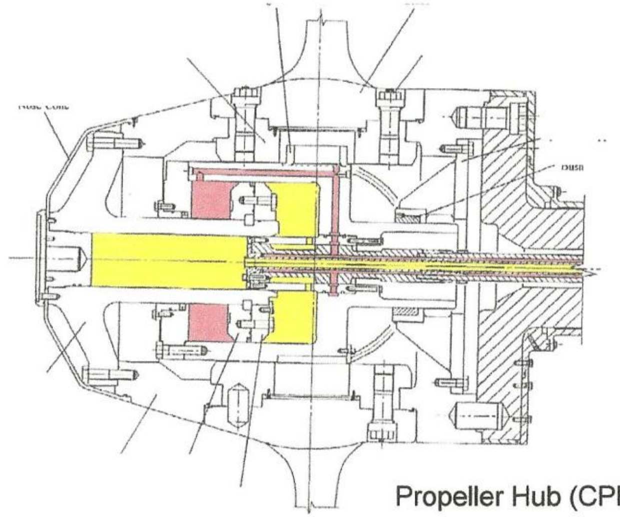
1. Label the components of the shafting system shown by arrowheads in Figure 1.
2. Explain briefly controllable pitch propeller shown in Figure 2, comparing to fixed pitch propeller.
3. Explain briefly how blade angle of the propeller is changed adding necessary terms shown in Figure 3.
4. Explain briefly functions of stern tube adding necessary terms shown in Figure 4.
5. Explain briefly function of rope guard located between stern frame and propeller hub.
6. Explain briefly how stern tube sealing seals the gap between propeller shaft and stern tube adding necessary terms shown in Figure 5.
7. Explain briefly differences between sleeve type coupling and flange type coupling referring to Figure 6
8. Explain briefly functions of aft most bearing and intermediate shaft/plumber block and how they are lubricated, adding necessary terms shown in Figure 7.
9. Explain briefly functions of thrust bearing.
10. Explain briefly how the thrust bearing receives thrust force adding necessary terms shown in Figure 8.



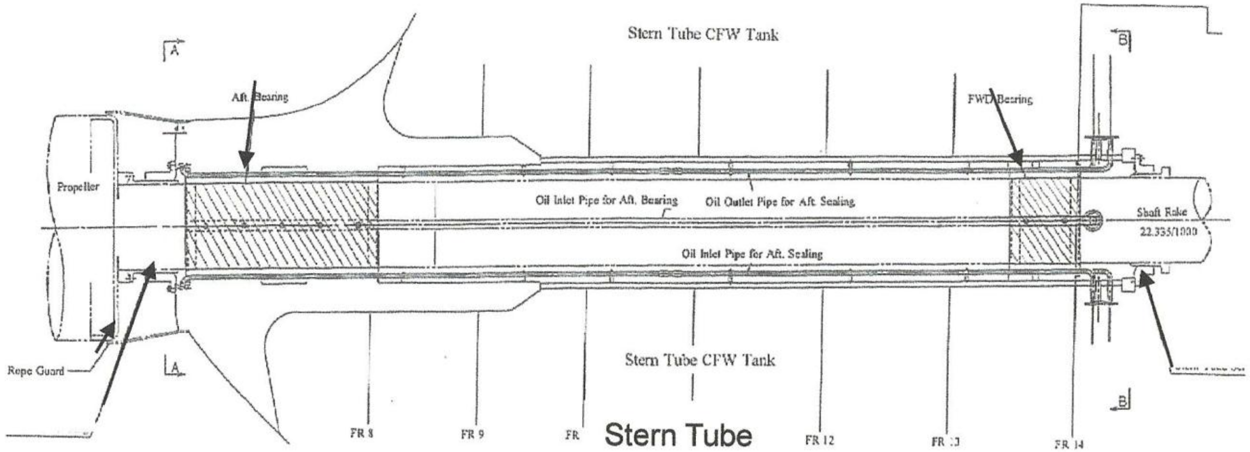
Shafting Installations
Figure 1



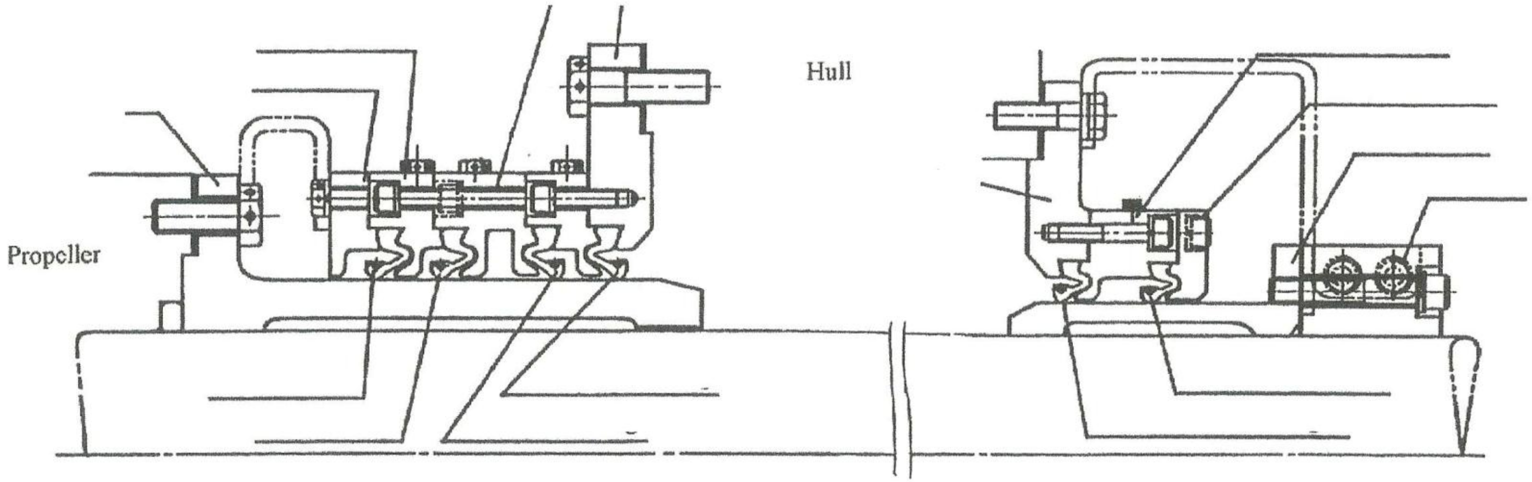
Propeller Blade (CPP)
Figure 2



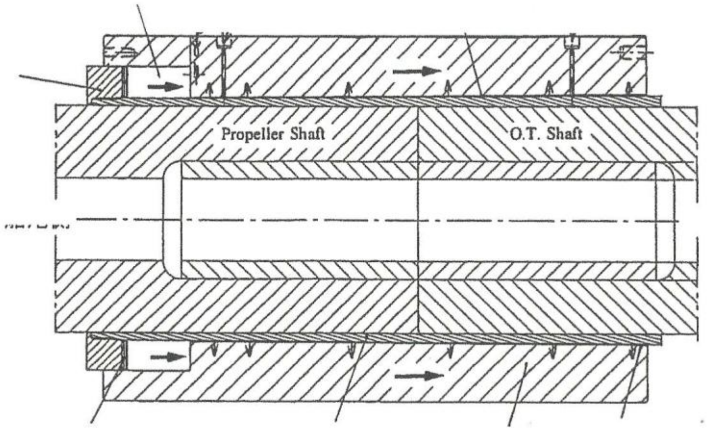
Propeller Hub (CPP)
Figure 3



Stern Tube
Figure 4

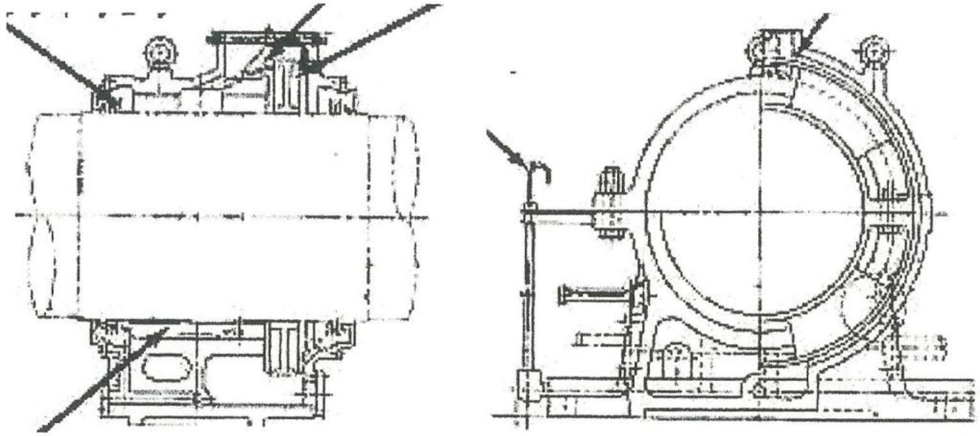


Stern Tube Sealing
Figure 5



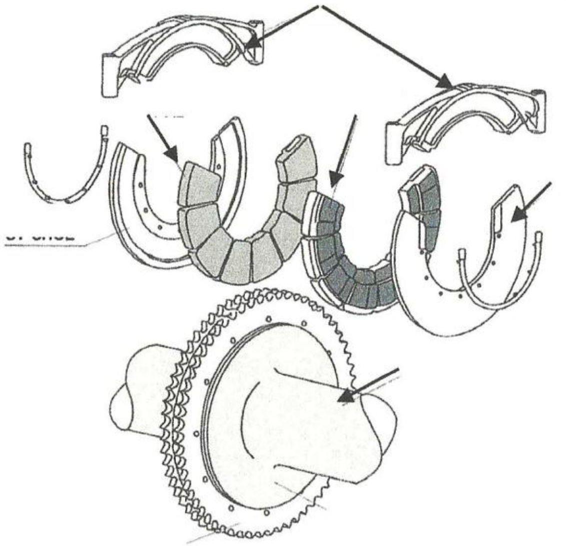
Sleeve Type Shaft Coupling

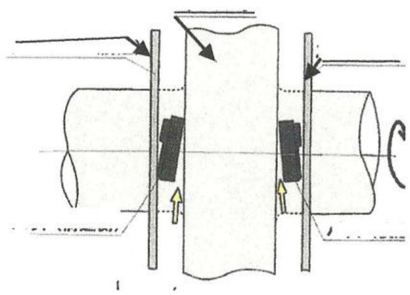
Figure 6



Aft Most Bearing/Intermediate Shaft Bearing

Figure 7





Thrust Bearing

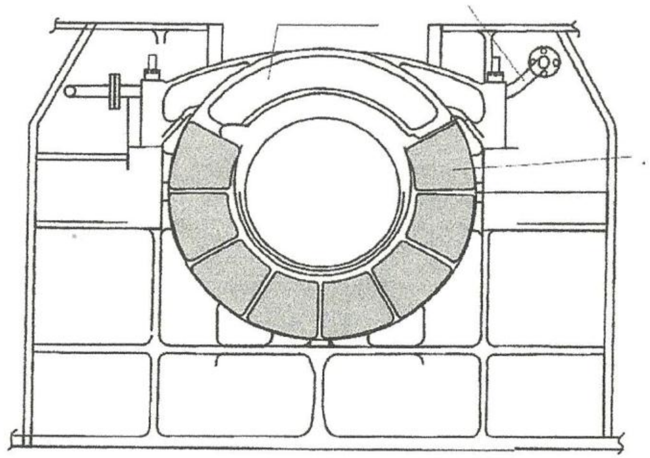


Figure 8

ERS I - 5

Training Title/Scenario: Basic construction and operation principles of pumps, air compressor, purifier, fresh water generator and heat exchanger

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .6) pumps, air compressor, purifier, fresh water generator and heat exchanger

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

(Pumps)

1. Label the components of the centrifugal pump shown by arrowheads in Figure 1 (1/2).
2. Explain briefly functions of impeller and mouth ring respectively.
3. Label the components of the gear pump shown by arrowheads in Figure 2.
4. Label the components of the screw pump shown by arrowheads in Figure 3
5. Label the components of the vane pump shown by arrowheads in Figure 4.
6. Label the components of the reciprocating pump shown by arrowheads in Figure 5

(Air compressor)

7. Label the components of the air compressor shown by arrowheads in Figure 6 (1/2)
8. Identify where second stage compression is taken place in Figure 6 (2/2).

(Oil purifier)

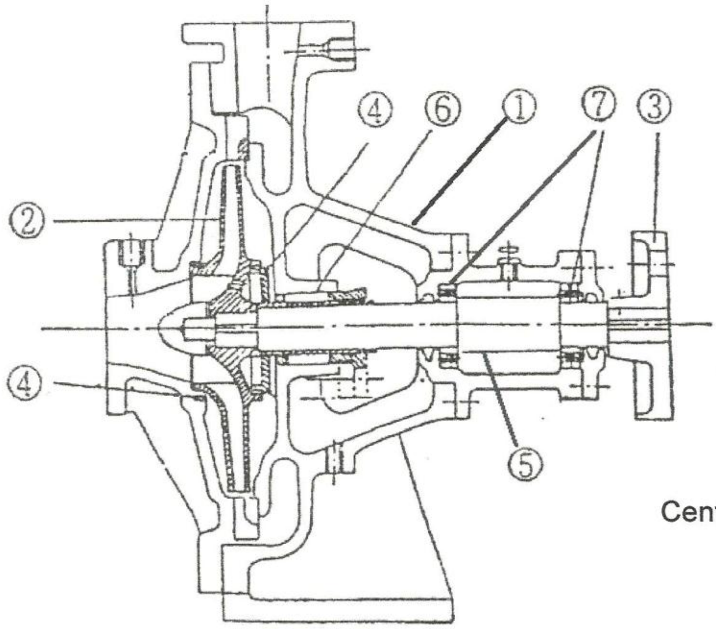
9. Label the components of the oil purifier shown by arrowheads in Figure 7.
10. Explain briefly why we need the friction clutch and safety joint respectively.
11. Explain briefly mechanism of discharging sludge.

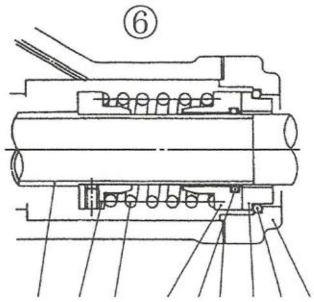
(Fresh Water Generator)

12. Label the components of the fresh water generator shown by arrowheads in Figure 8 (1/3).
13. Describe functions of the ejector

(Heat exchanger)

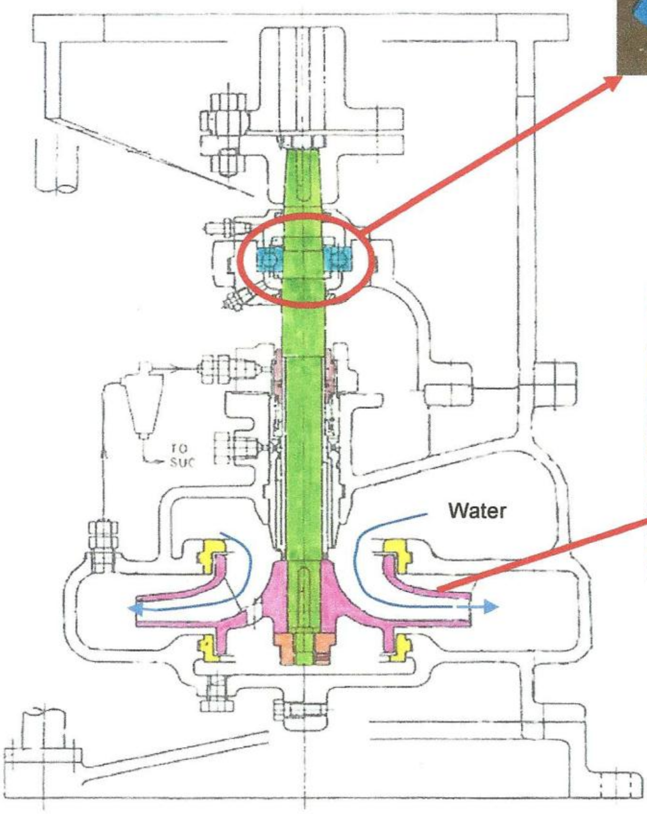
14. Label the components of the heat exchangers shown by arrowheads in Figure 9.
15. Explain briefly functions of corrugated pattern on the surface of cooling plates used for plate type heat exchanger.

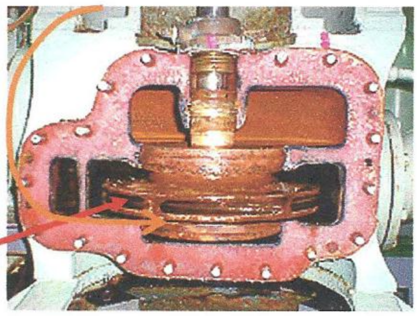




Centrifugal pump (Horizontal Type)

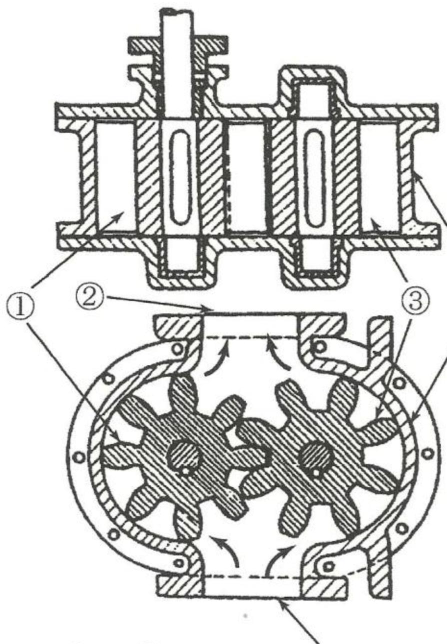
Figure 1 (1/2)



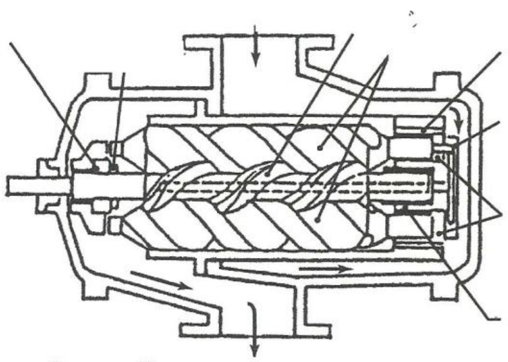


Centrifugal Pump (Vertical Type)

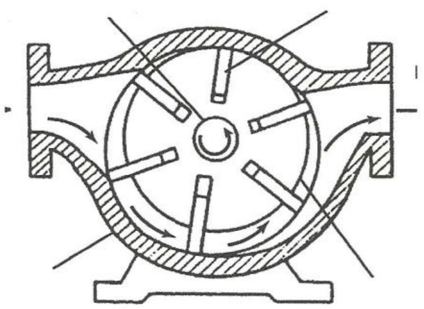
Figure 1 (1/2)



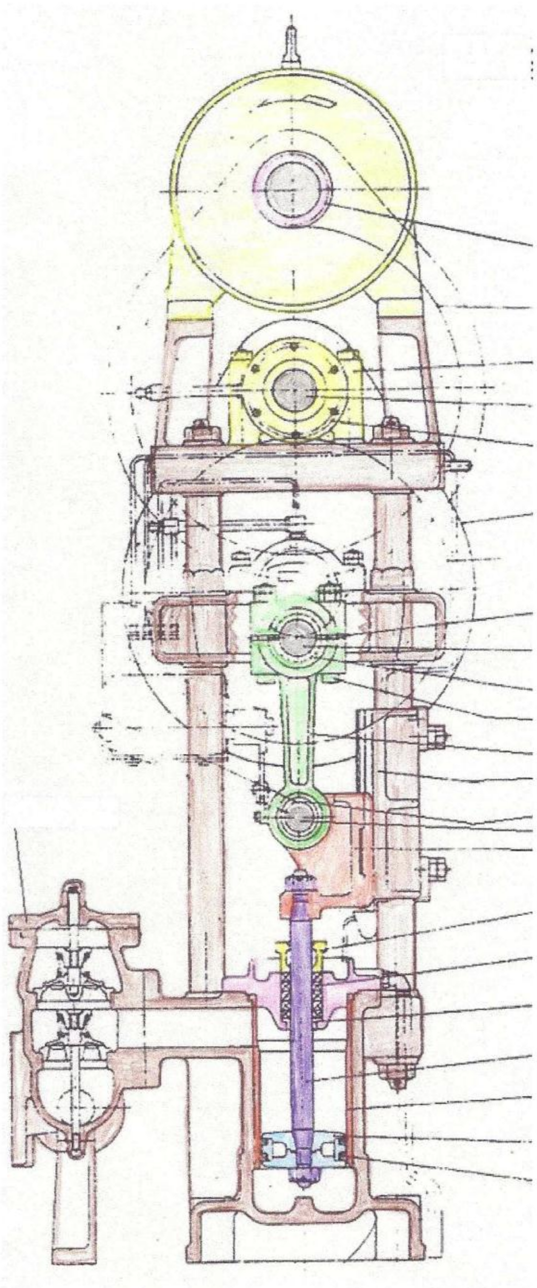
Gear Pump
Figure 2



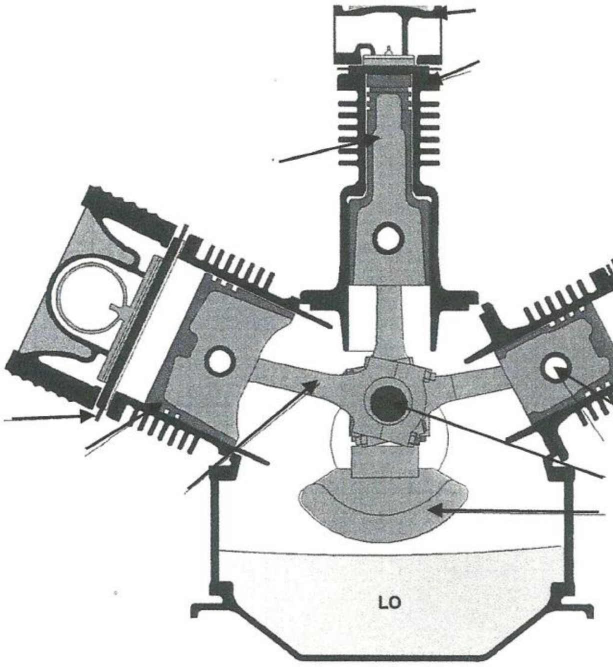
Screw Pump
Figure 3

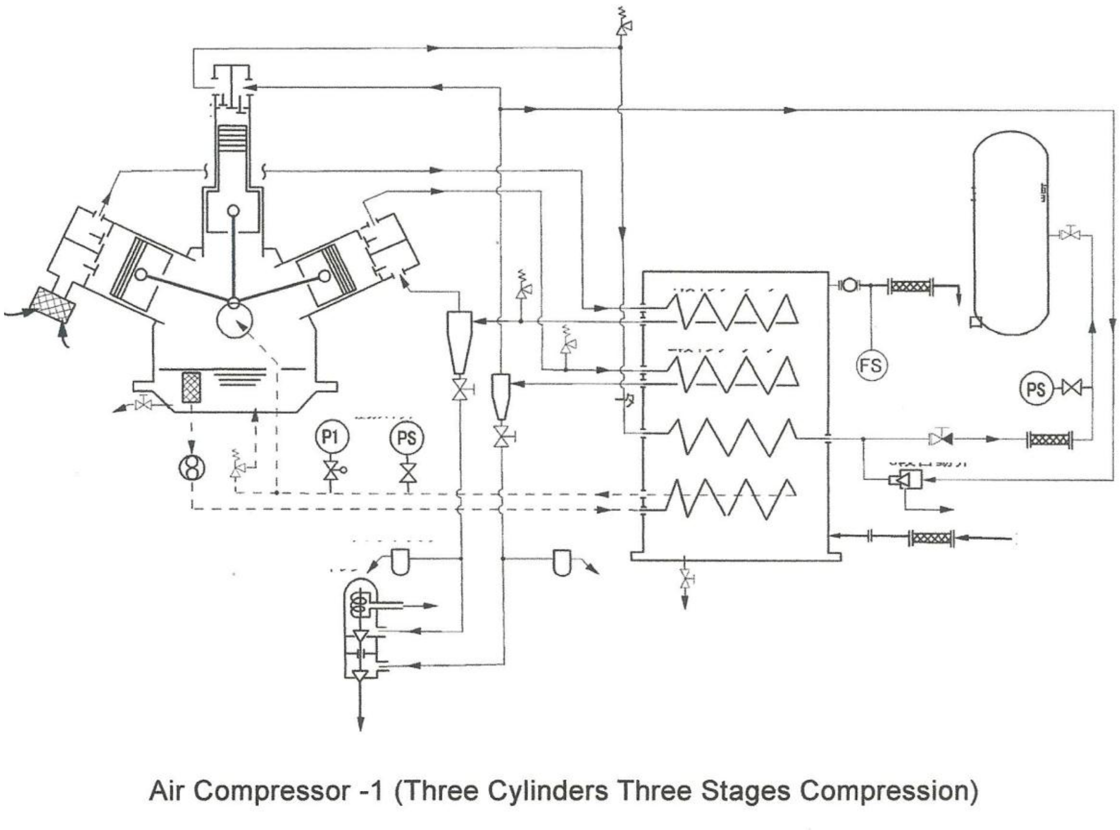


Vane Pump
Figure 4



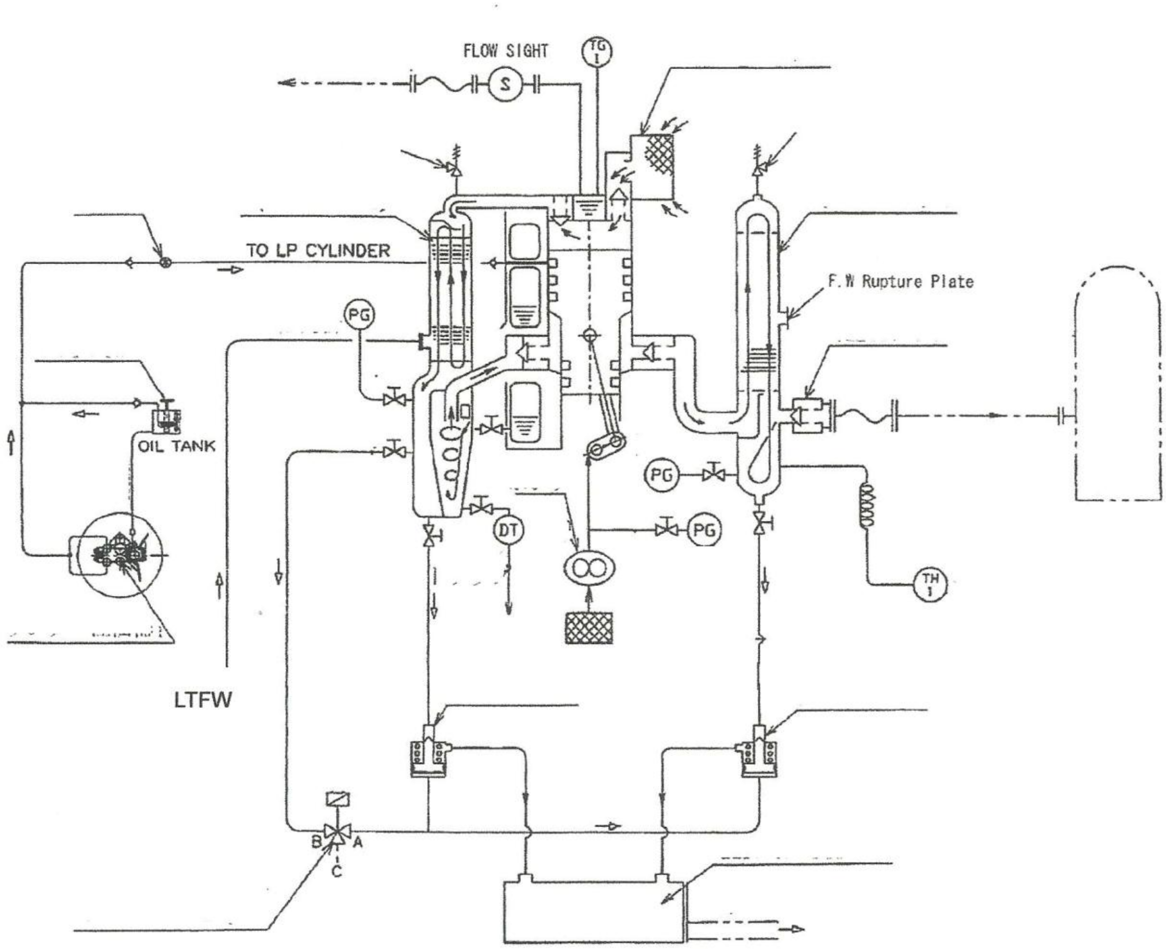
Reciprocating Pump
Figure 5





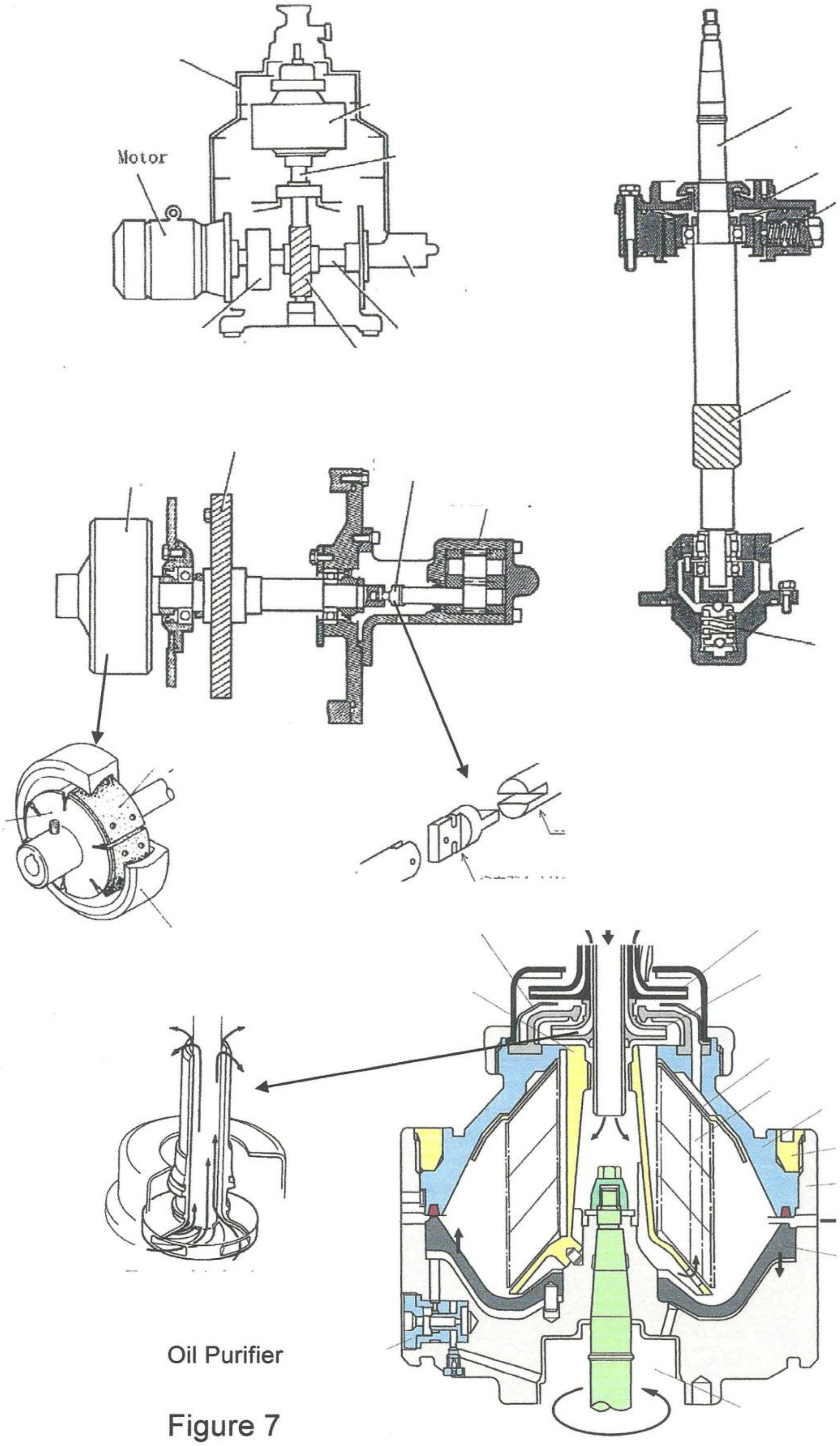
Air Compressor -1 (Three Cylinders Three Stages Compression)

Figure 6 (1/2)



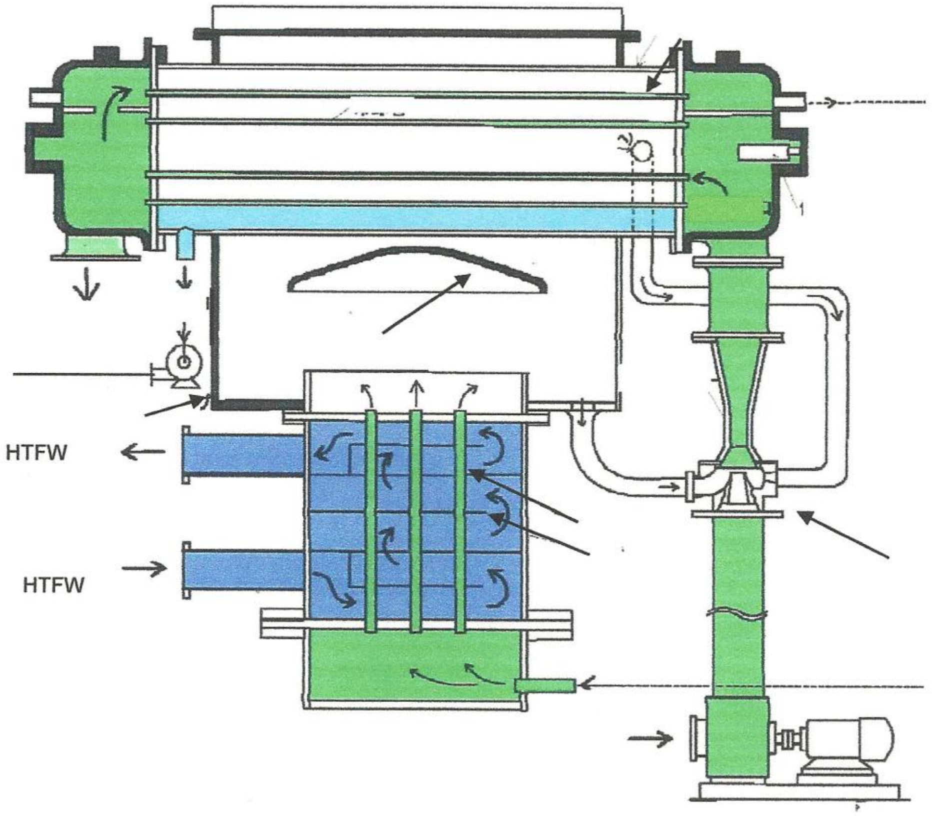
Air compressor - 2 (One Cylinder Two Stage Compression)

Figure 6 (2/2)



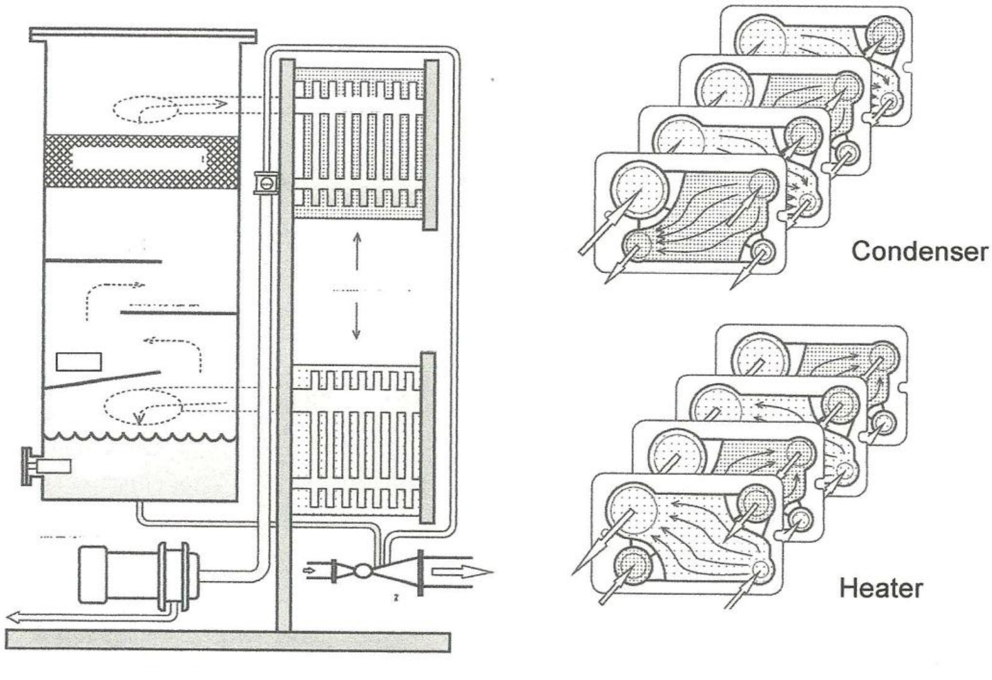
Oil Purifier

Figure 7



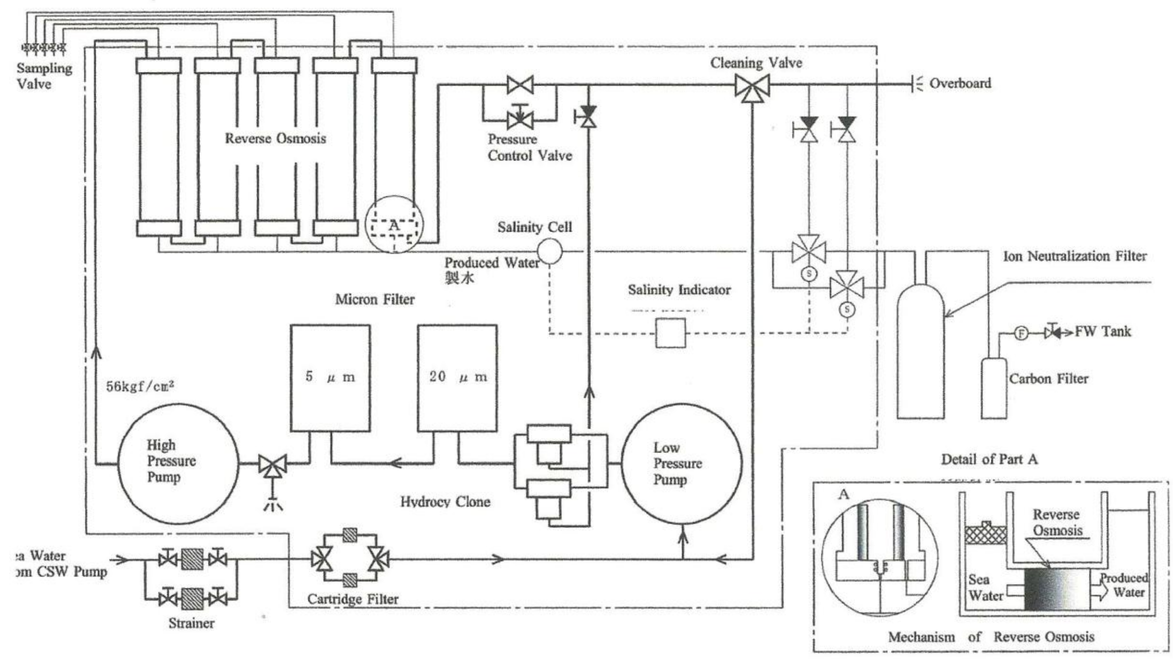
Fresh Water Generator - 1

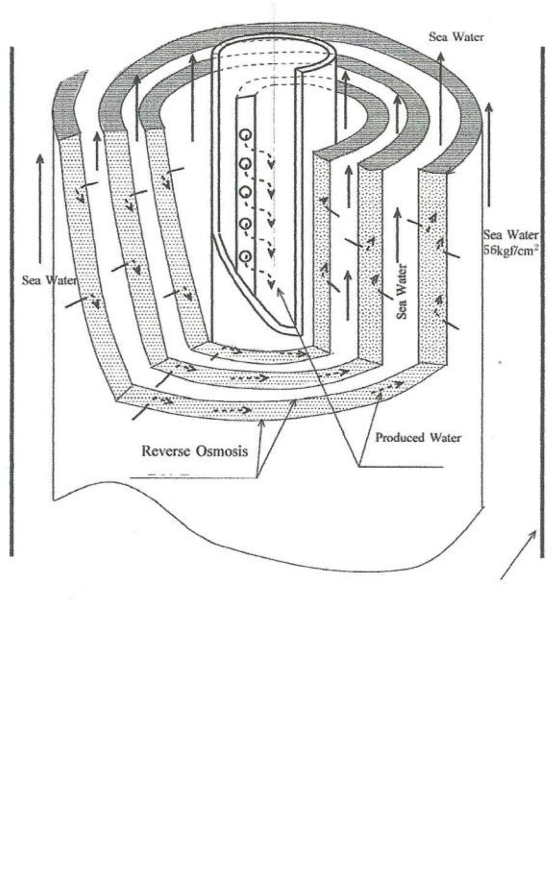
Figure 8 (1/3)



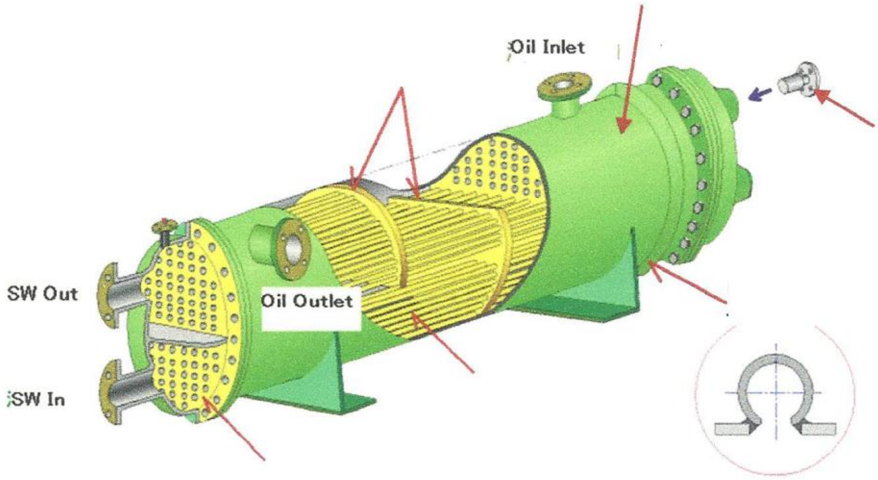
Fresh Water Generator - 1

Figure 8 (2/3)



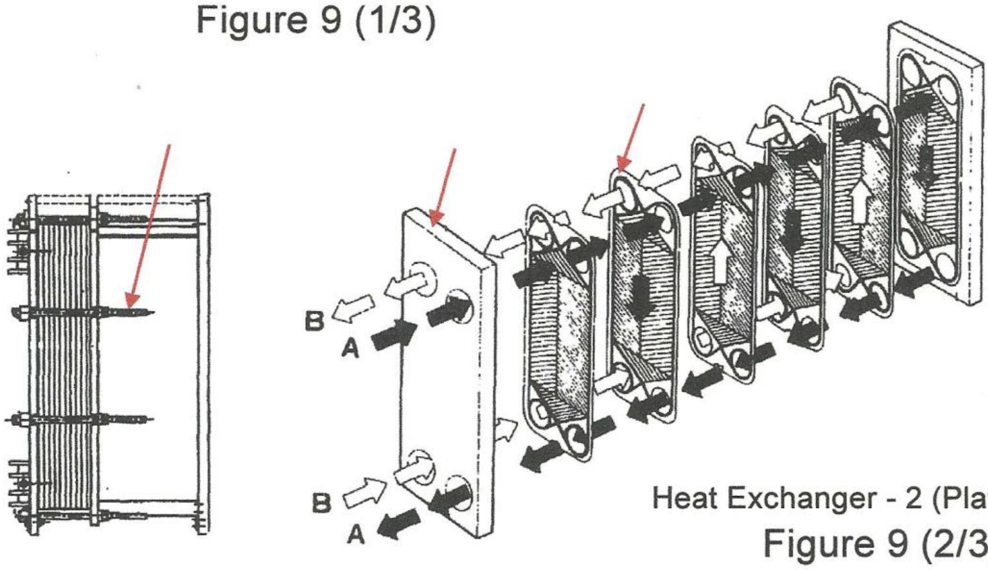


Fresh Water Generator - 3
(Reverse Osmosis Type)
Figure 8 (3/3)



Heat Exchanger - 1 (Shell and Tube Type)

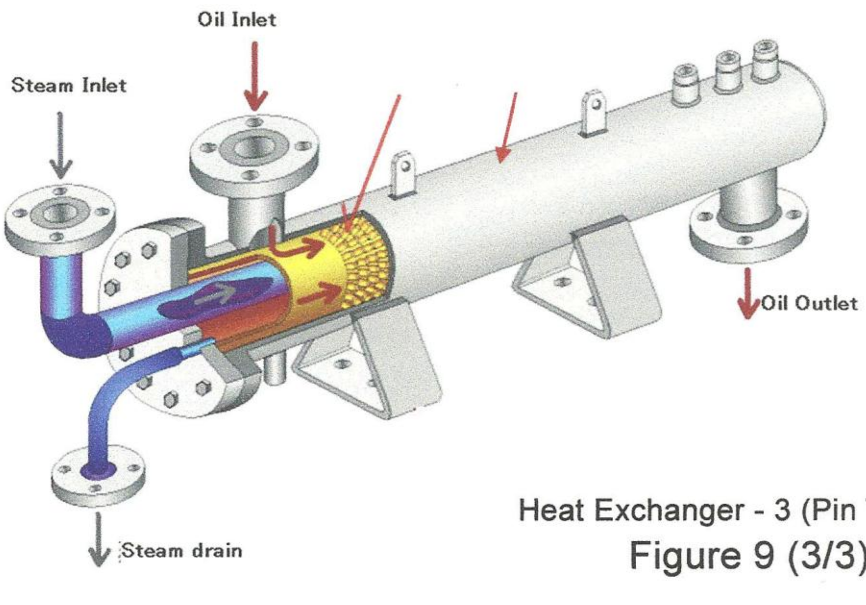
Figure 9 (1/3)



Heat Exchanger - 2 (Plate Type)

Figure 9 (2/3)

FO Heater



Heat Exchanger - 3 (Pin Type)

Figure 9 (3/3)

ERS I - 6

Training Title/Scenario: Basic construction and operation principles of steering gear

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .7) steering gear.

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the components of the Rapson slide type steering gear shown by arrowheads in Figure 1.

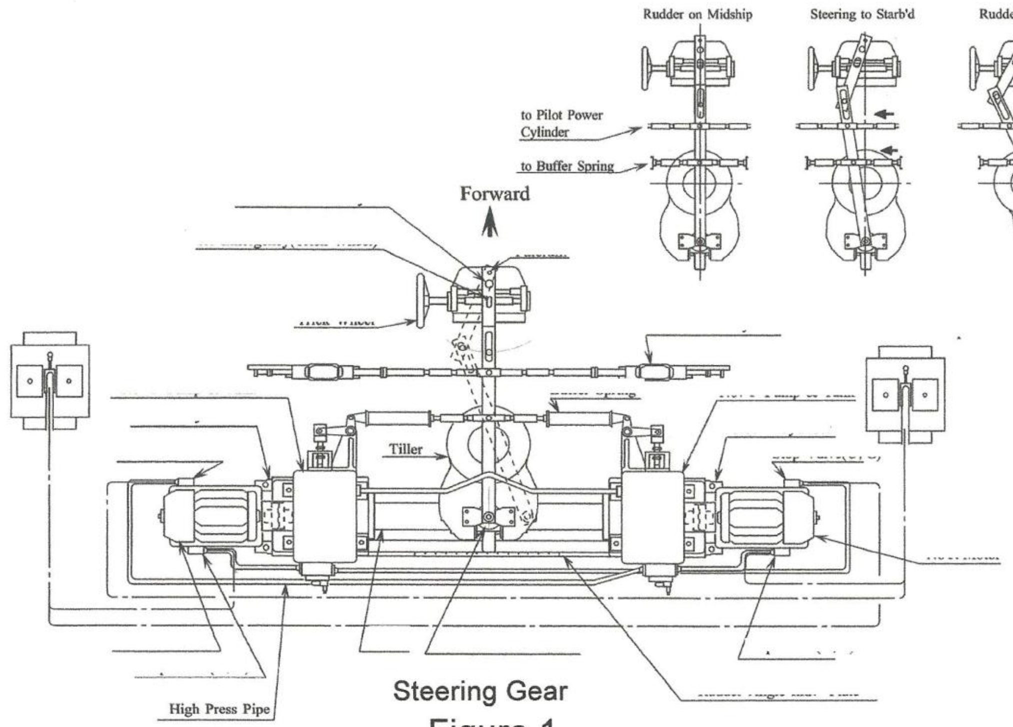
2. Explain briefly operation principles of the Rapson slide type steering gear.

3. Label the components of the hydraulic pump shown by arrowheads in Figure 2 (1/3) and 2 (3/3).

4. Explain briefly how the hydraulic pump of the steering gear works using Figure 2 (2/3).

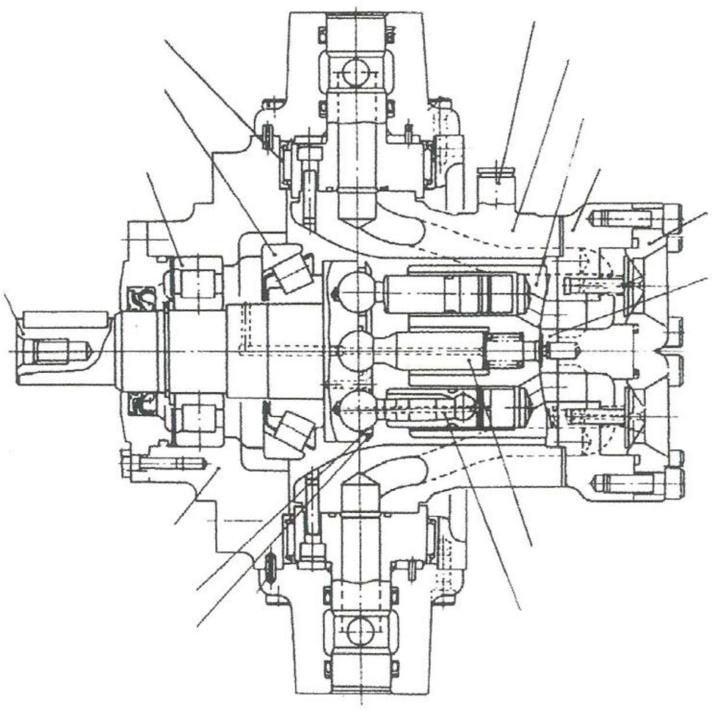
5. Label the components of the vane type steering gear shown by arrowheads in Figure 6 (1/2).

6. Explain briefly how the rudder of the vane type steering gear is moved to Port and Starboard using Figure 3.



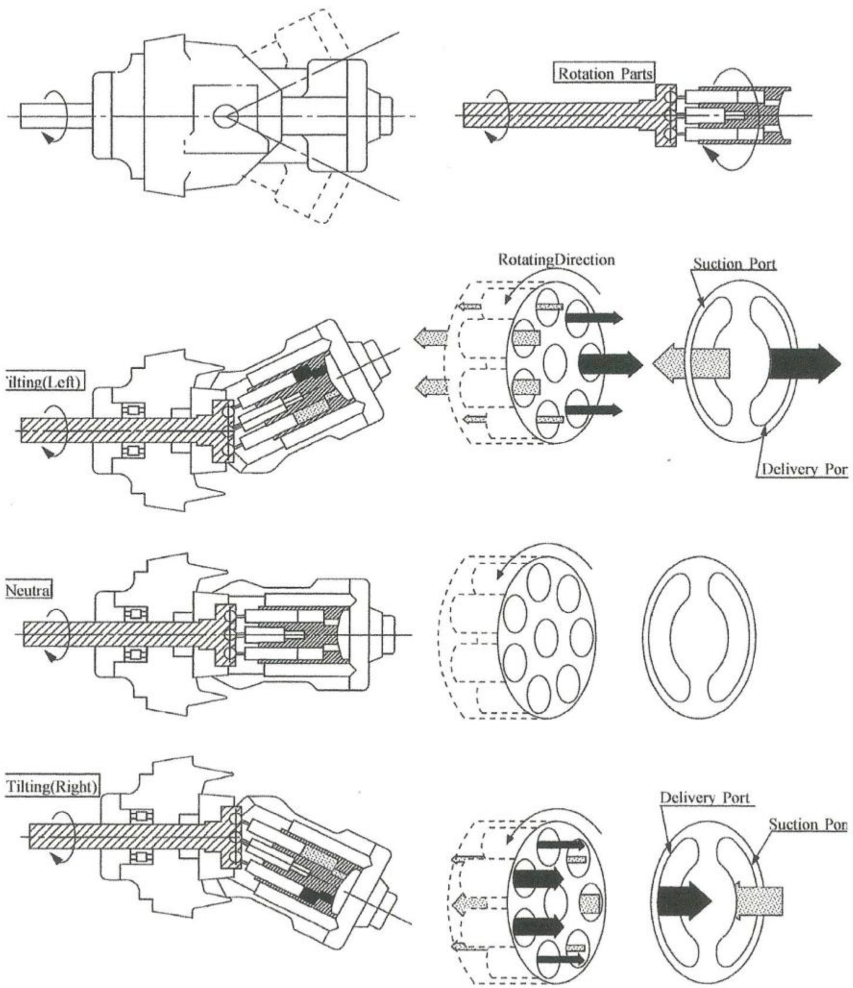
Steering Gear

Figure 1



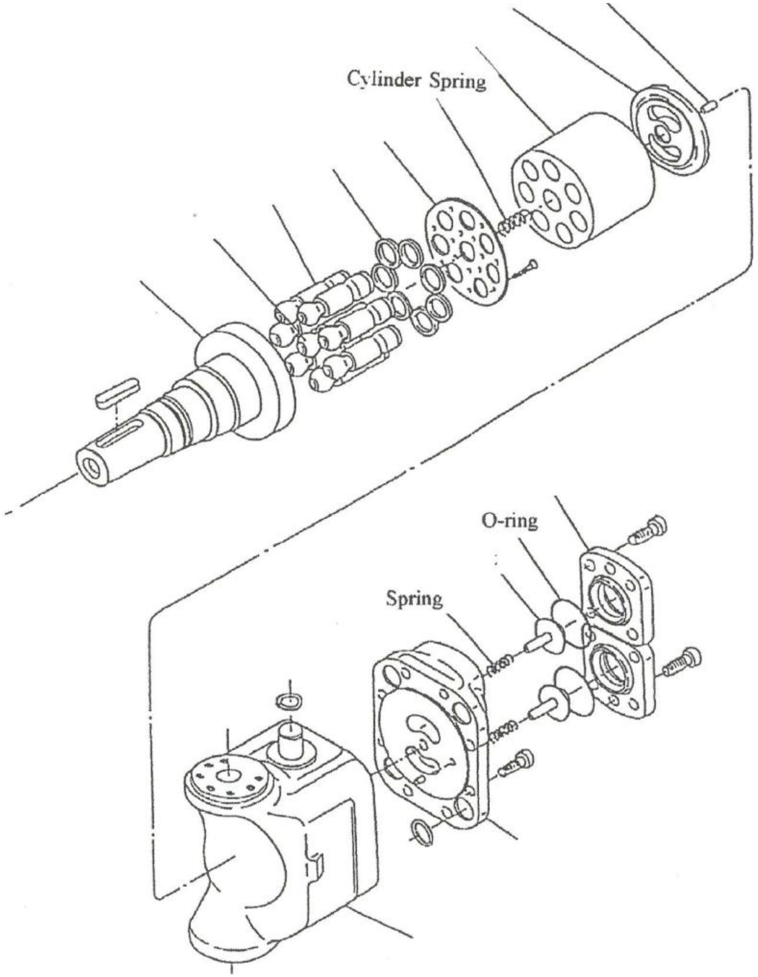
Hydraulic Pump (William Janney Pump)

Figure 2 (1/3)



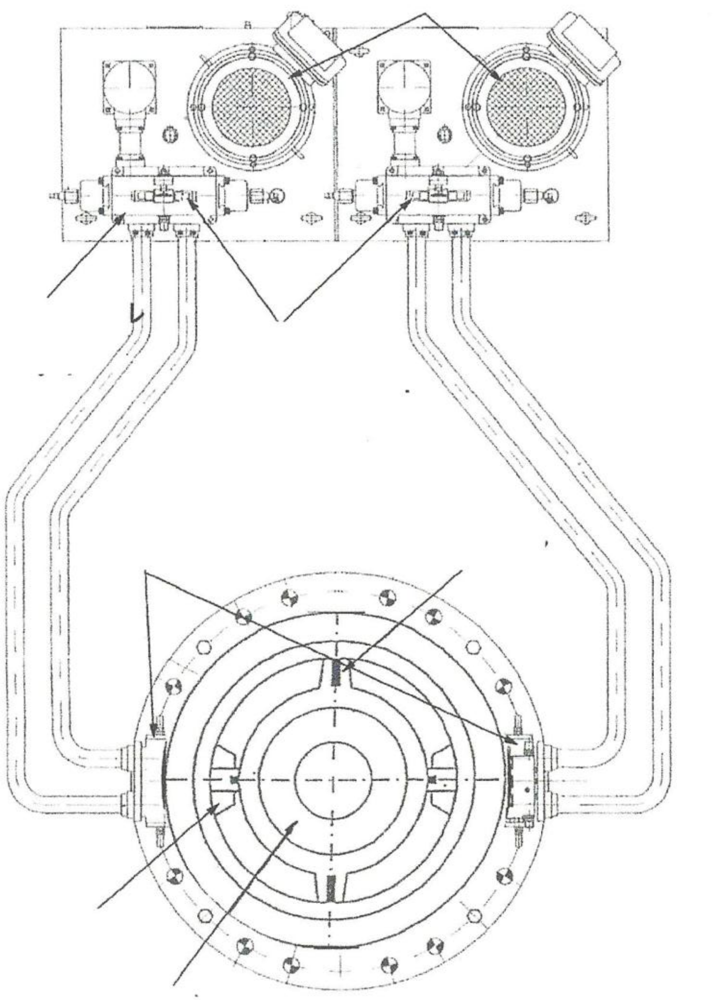
Hydraulic Pump (Janney Pump)

Figure 2 (2/3)

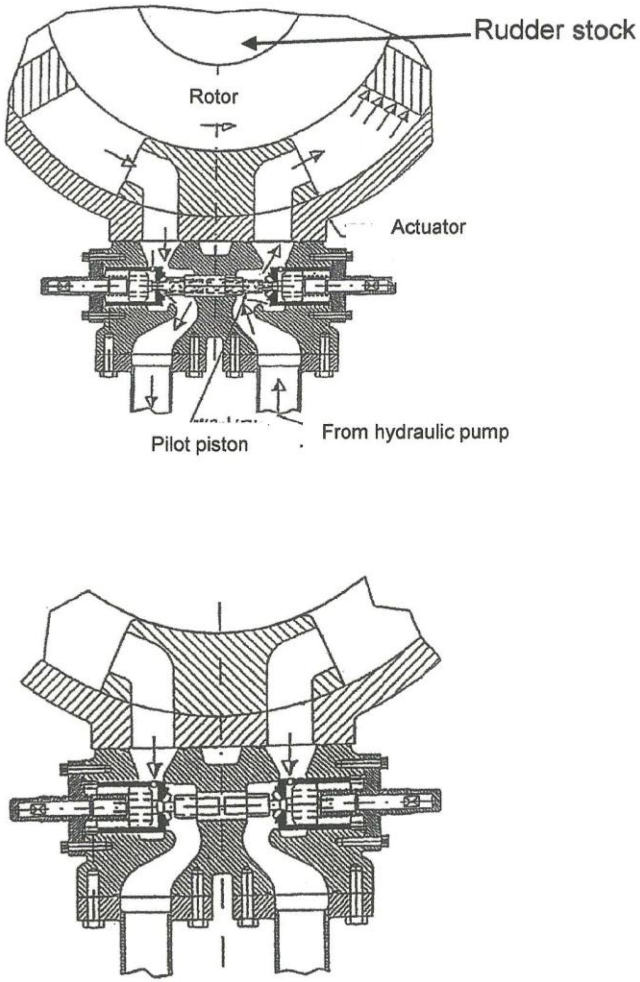


Hydraulic Pump (Janney Pump)

Figure 2 (3/3)



Steering Gear (Rotary Vane Type)
Figure 3 (1/2)



Rock Valve
Figure 3 (2/2)

ERS I - 7

<u>**Training Title/Scenario:** Basic construction and operation principles of deck machinery</u>

Table A-III/1 Competence: Operate main and auxiliary machinery and associated systems

Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; .10) deck machinery

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the components of the Windlass and Mooring winch shown by arrowheads in Figure 1 and 2 and describe their functions.

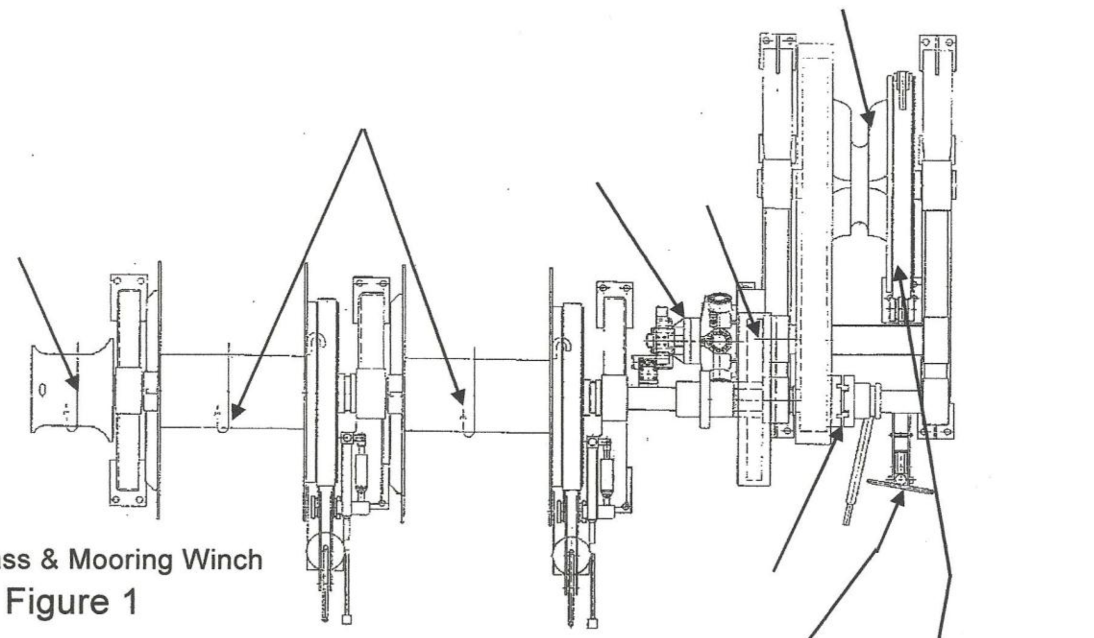
2. Describe operation principle of the Windlass and Mooring winch with reference to Figure 1 and 2.

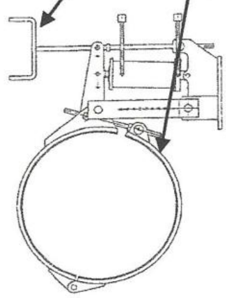
3. Describe types of Oil hydraulic pump and Motor shown in Figure 3 and 4.

4. Explain how the oil hydraulic pump works with reference to Figure 3

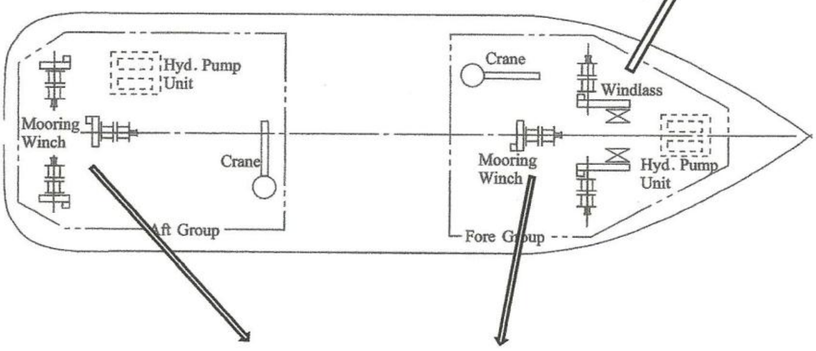
5. Explain how the oil hydraulic pump works with reference to Figure 4 (2/3)

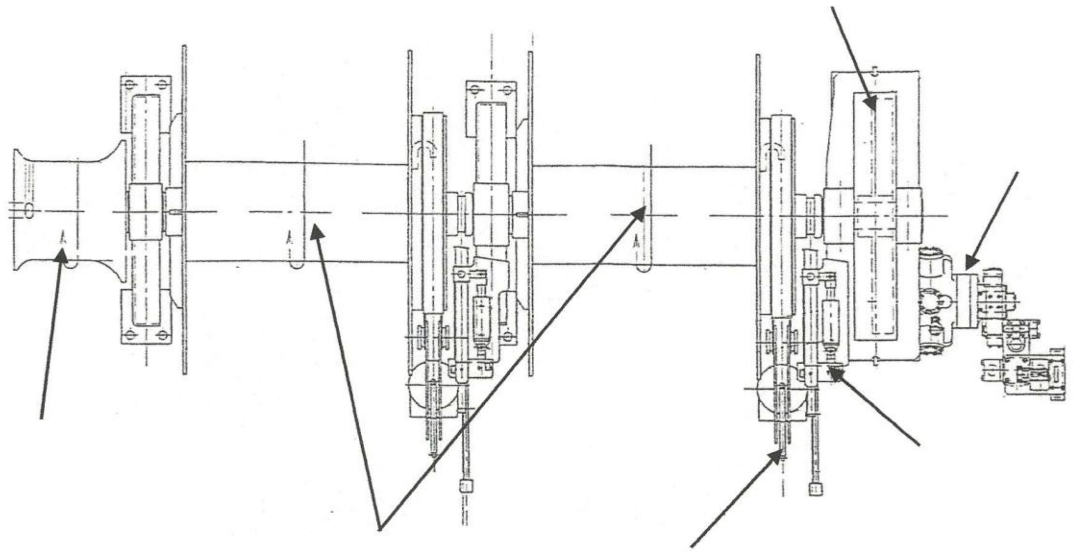
6. Describe how Capacity control works with reference to figure 4 (3/3) and 5.



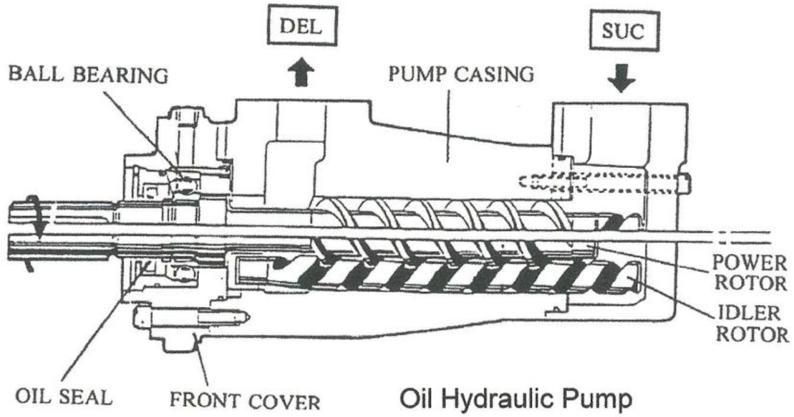


Windlass & Mooring Winch
Figure 1

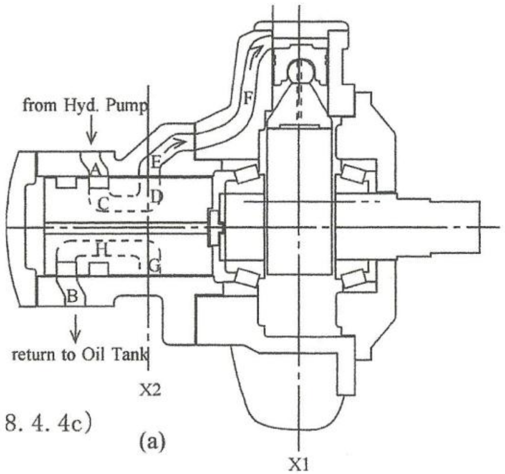




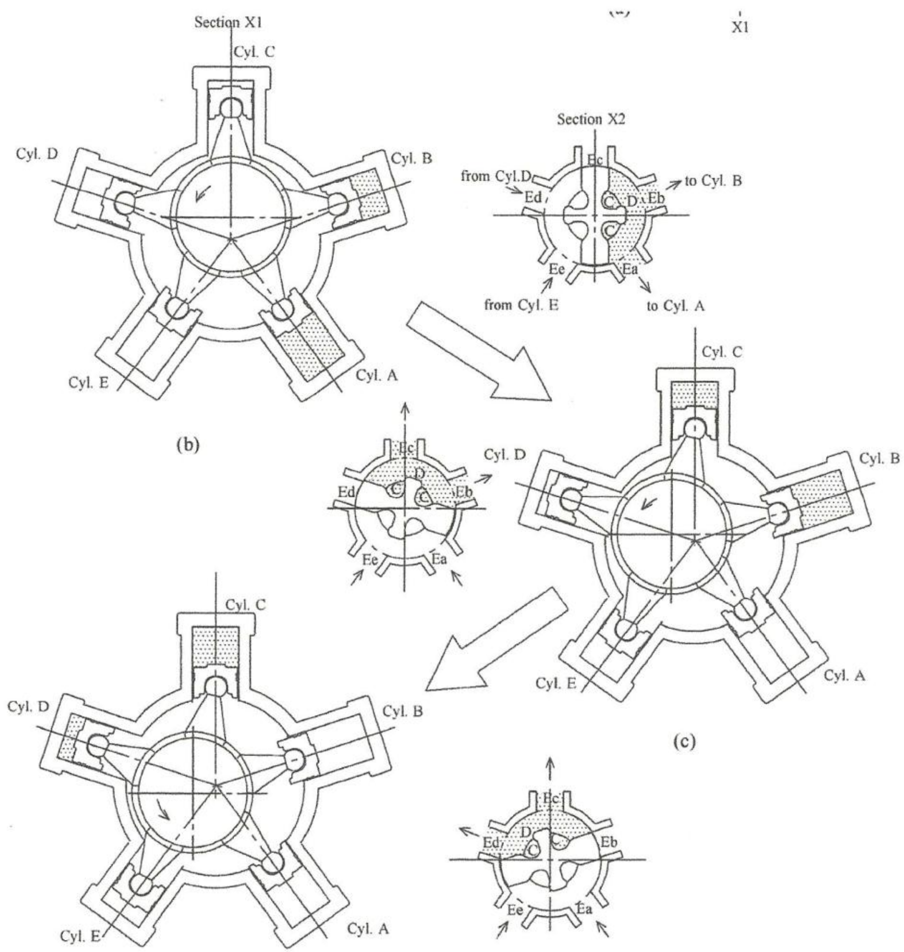
Mooring Winch
Figure 2



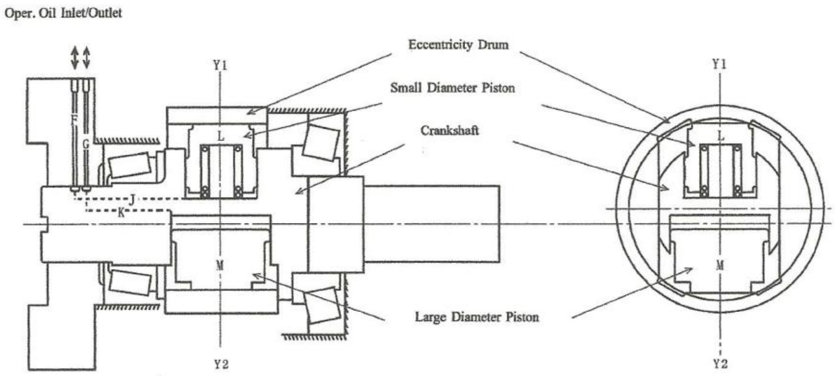
Oil Hydraulic Pump
Figure 3



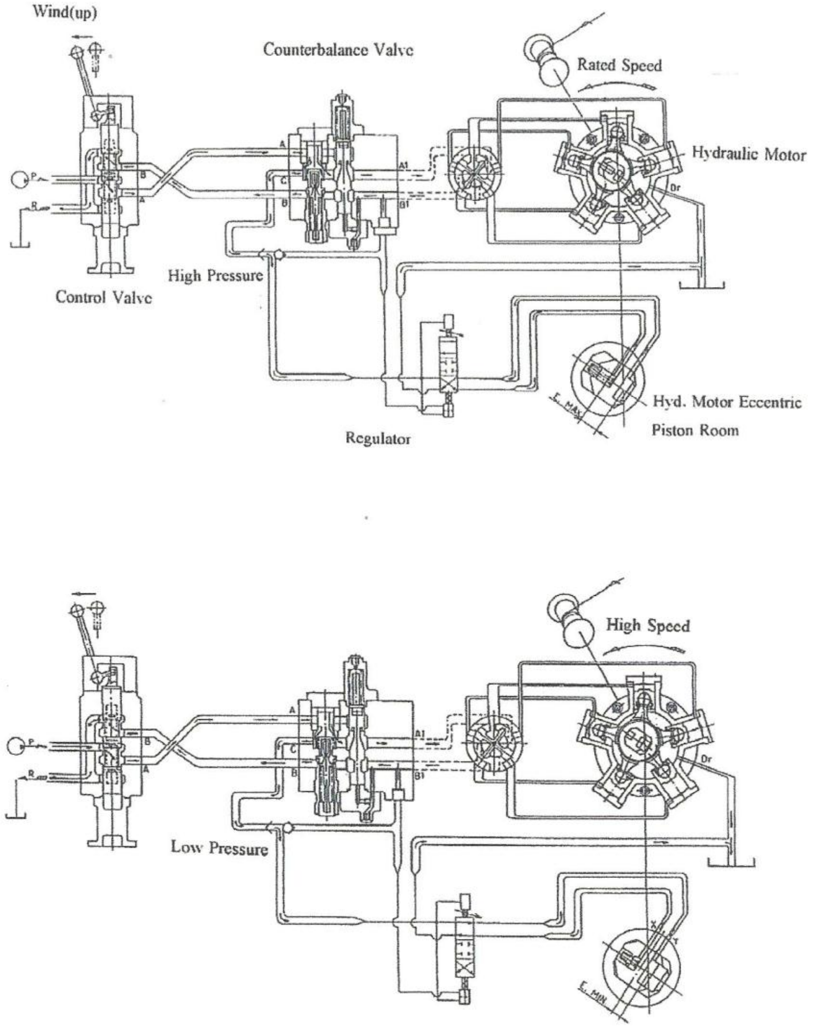
Oil Hydraulic Motor
Figure 4 (1/3)



Operation Principle of Oil Hydraulic Pump
Figure 4 (2/3)



Capacity Control of Oil Hydraulic Pump
Figure 4 (3/3)



Operation Principle of Windlass
Figure 5

ERS I - 8

Training Title/Scenario: Oily water separator or similar equipment requirements

Table A-III/1 Competence: Operate fuel, lubrication, ballast and other pumping systems and associated control systems

Table A-III/1 KUP: Oily water separator (or similar equipment) requirements

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

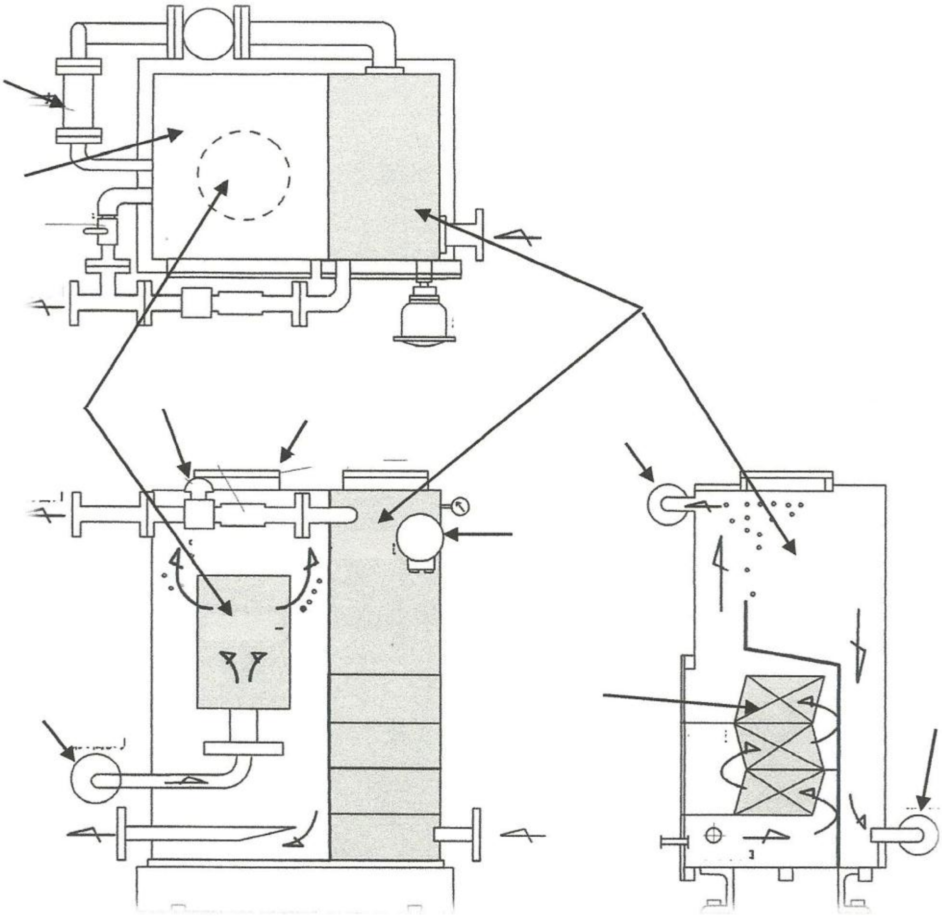
1. Label the components of the oily water separator shown by arrowheads in Figure

2. Describe flow of oily water inside the separator.

3. Explain functions of the following
   1) Separating plates
   2) Coalescer
   3) Electrodes

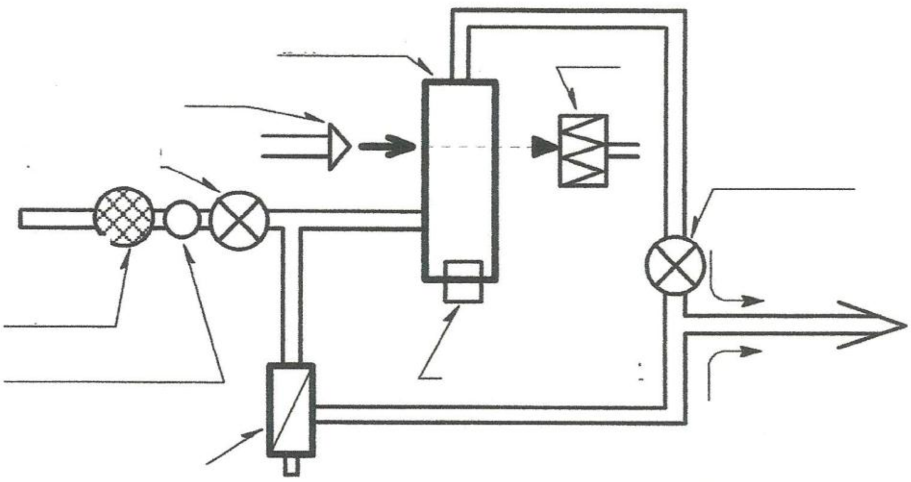
4. Label the components of detecting oil content shown by arrowheads in Figure 2.

5. Explain briefly detecting principle of oil content.



Oily Water Separator

Figure 1



Principle of Detecting Oil Content

Figure 2

ERS I - 9

Training Title/Scenario: Basic configuration and operation principles of electrical motors

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment;

.1 electrical equipment

.c electrical motors including starting methodologies

ASSIGNMENT

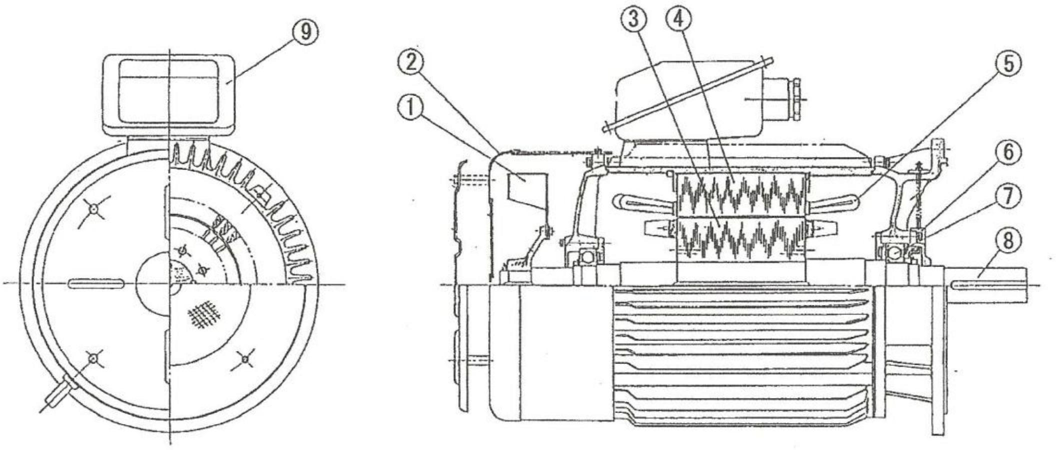
(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the components of the three phase induction motor shown by arrowheads in Figure 1.

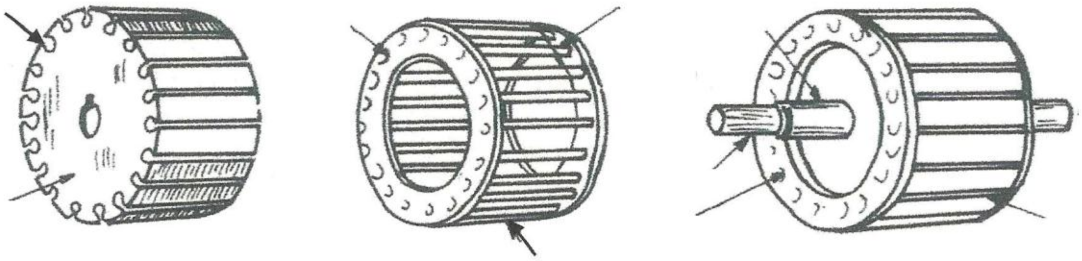
2. Explain briefly operation principle of three phase induction motor.

3. Label the components of the squirrel cage rotor shown by arrowheads in Figure 2.



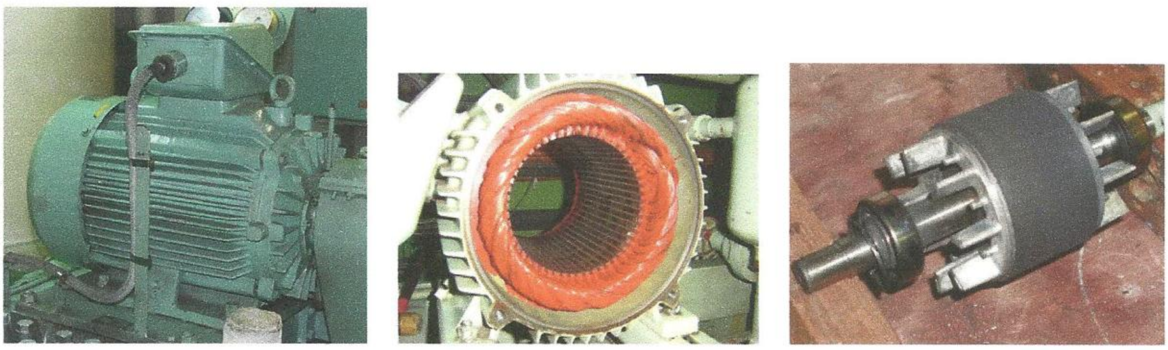
Three Phase Induction Motor

Figure 1



Construction of Squirrel Cage Rotor

Figure 2



Example of Three Phase Induction Motor

Figure 3

ERS I - 10

Training Title/Scenario: Basic configuration, operation principles and design features of high-voltage installations

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment;
.1 electrical equipment
.d high-voltage installations

Table A-III/2 Competence: Manage operation of electrical and electronic control equipment

Table A-III/1 KUP: Design features of high voltage installations

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the components of the high voltage main switch board shown by arrowheads in Figure 1.

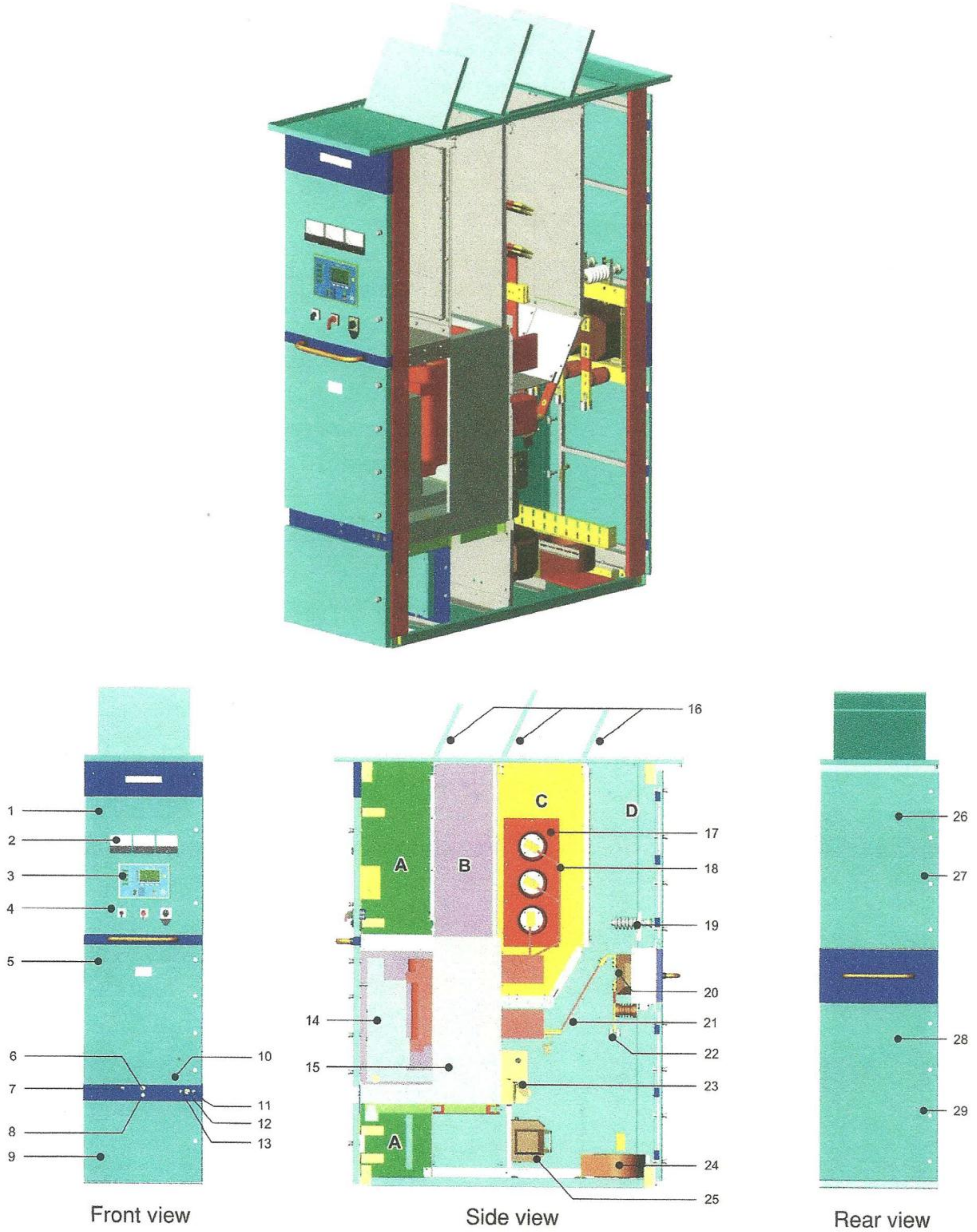
2. Describe features of high voltage main switch board comparing to low voltage main switch board.(Management level)

3. Describe differences between high and low voltage installations in handling them.

4. Label the components of the vacuum circuit breaker shown by arrowheads in Figure 2.

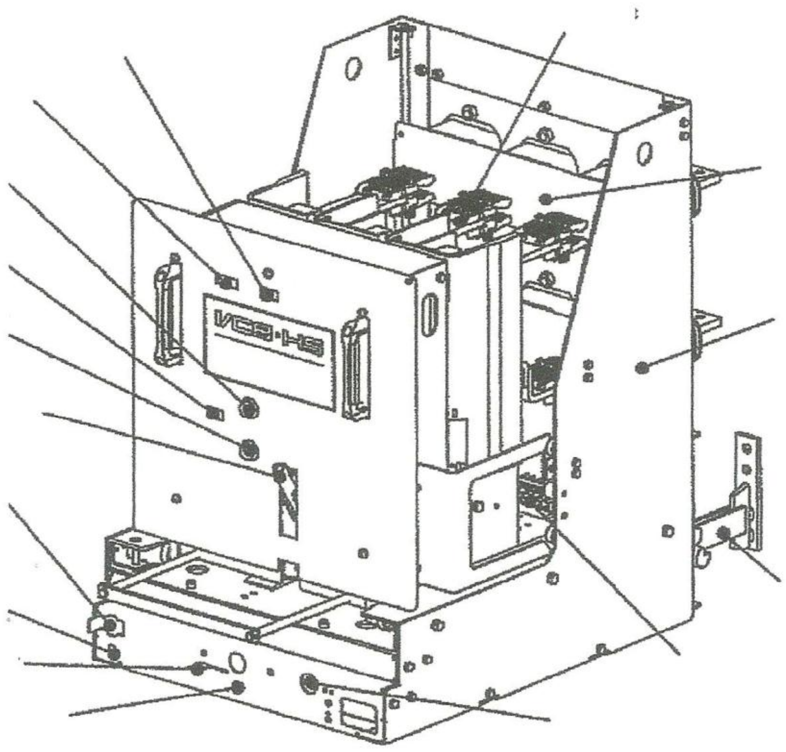
5. Describe features of vacuum circuit breaker (VCB) comparing to air circuit breaker (ACB). (Management level)

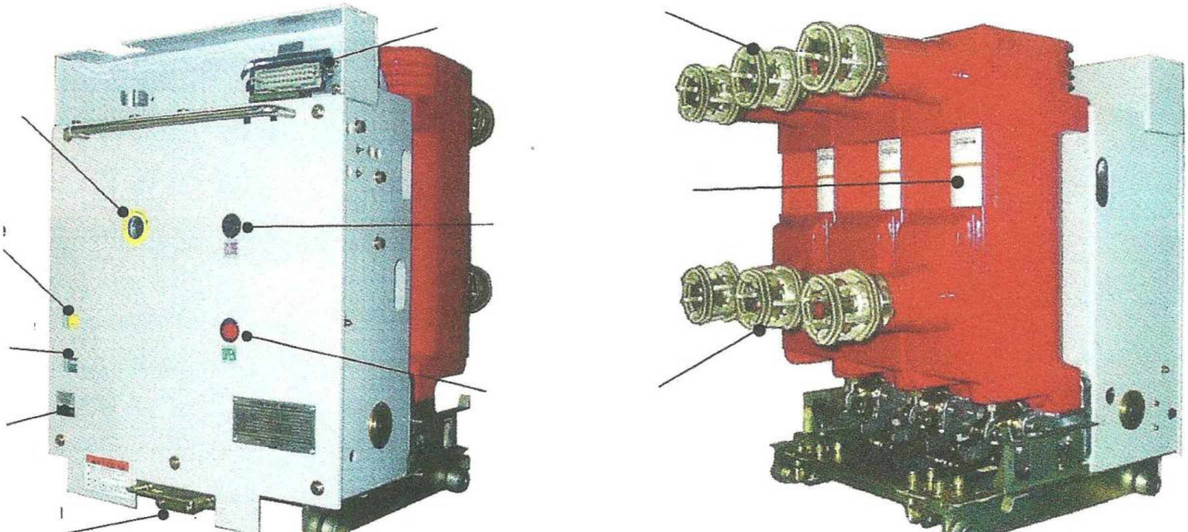
6. Describe advantages in adopting high voltage systems. (Management level)



High Voltage Main Switch Board

Figure 1





Vacuum Circuit Breaker (VCB)

Figure 2

ERS I - 11

Training Title/Scenario: Basic configuration and operation principles of associated system devices for sequential control circuits

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment;

.1 electrical equipment

.e sequential control circuits and associated system devices (ERS II)

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the symbols ① ~ ⑳ shown in Figure 1 & 2 and explain briefly how they work.

①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯
⑰
⑱
⑲
⑳

2. List sorts of mechanical contact to send an electrical ON- OFF signal.

Symbols of Electrical and Mechanical Contact

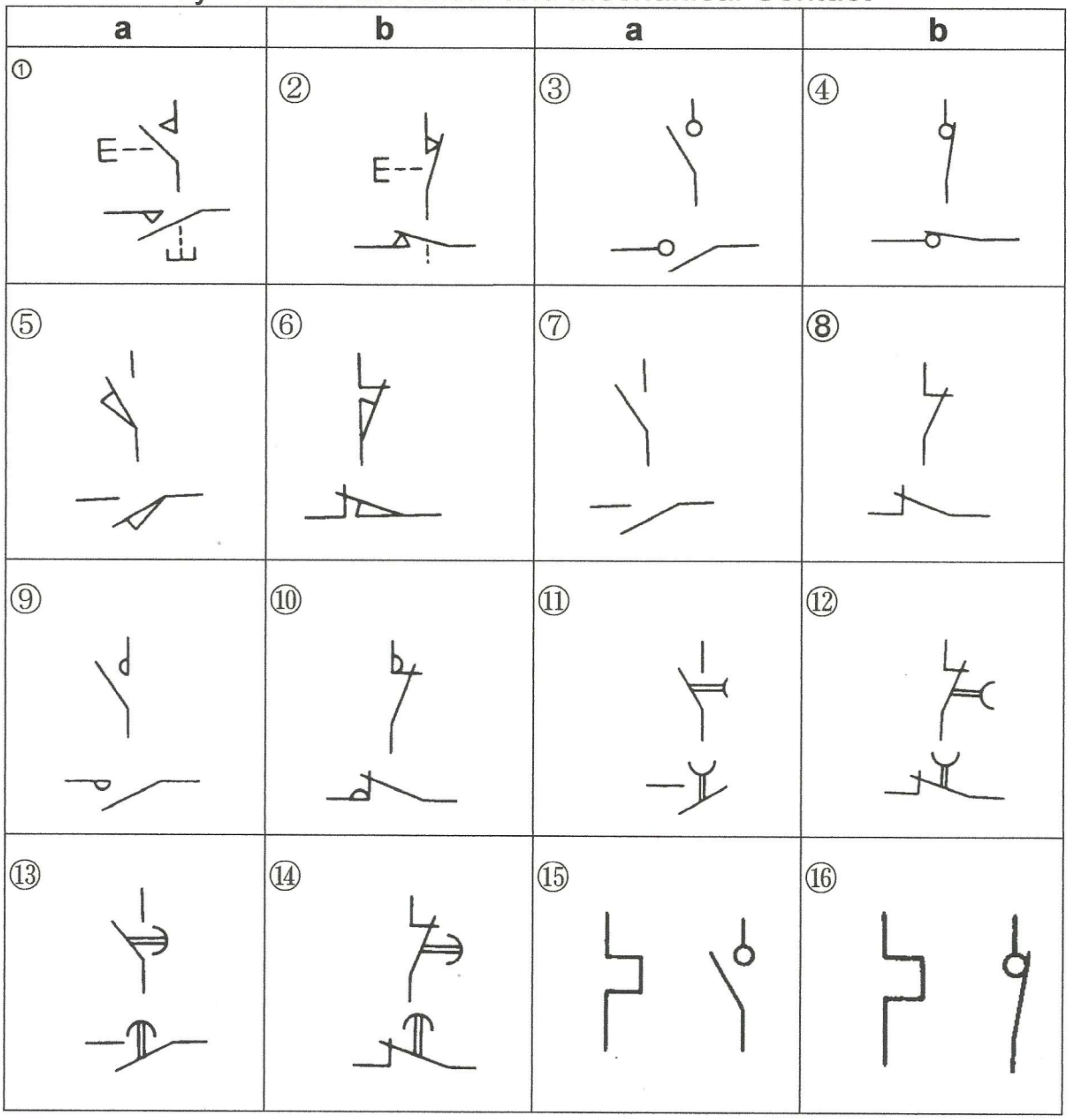


Figure 1

Other Electrical Circuit Elements

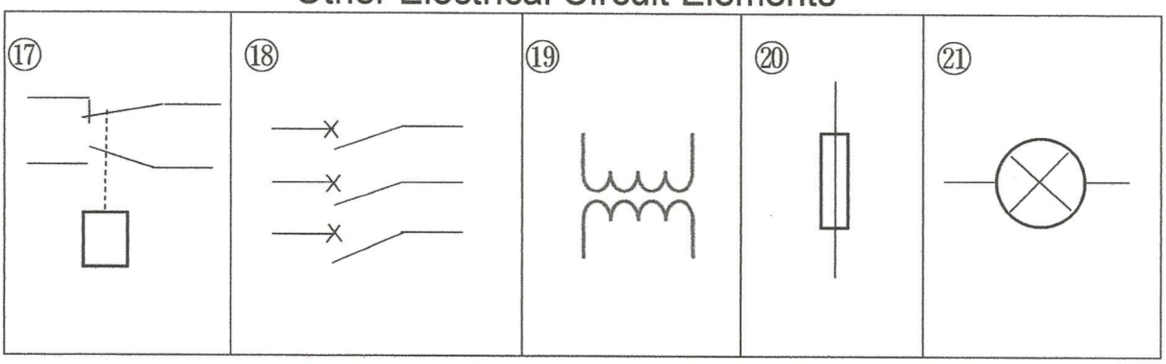


Figure 2

ERS I – 12

Training Title/Scenario: Basic configuration and operation principles; characteristics of basic electronic circuit elements

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment;

.2 electronic equipment

.a characteristics of basic electronic circuit elements

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Label the symbols ① ~ ㉑ shown in Figure 1 and explain briefly their functions.

①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯
⑰
⑱
⑲
⑳
㉑

2. List sorts of mechanical contact to send an electrical ON- OFF signal.

Symbols of electronic circuit elements

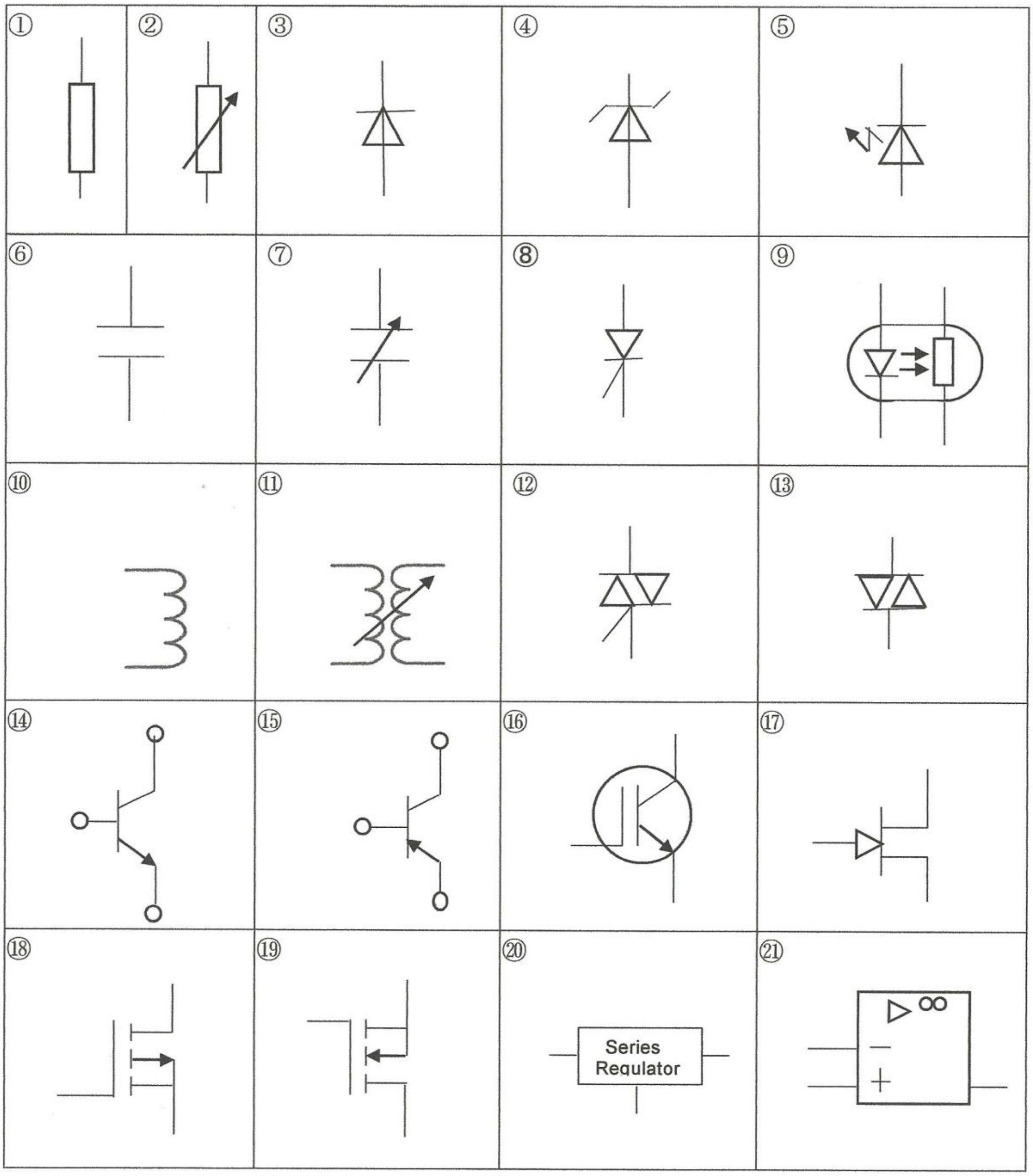


Figure 1

ERS I – 13

Training Title/Scenario: Design features and operative mechanism of marine diesel engine

Table A-III/2 Competence: Manage the operation of propulsion plant machinery

Table A-III/1 KUP: Design features, and operative mechanism of the following machinery and associated auxiliaries

.1 marine diesel engine

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Describe design features of cylinder liner shown in Figure 1 for the following.
   1) construction
   2) cooling jacket
   3) scavenging air inlet
   4) cylinder oil groove

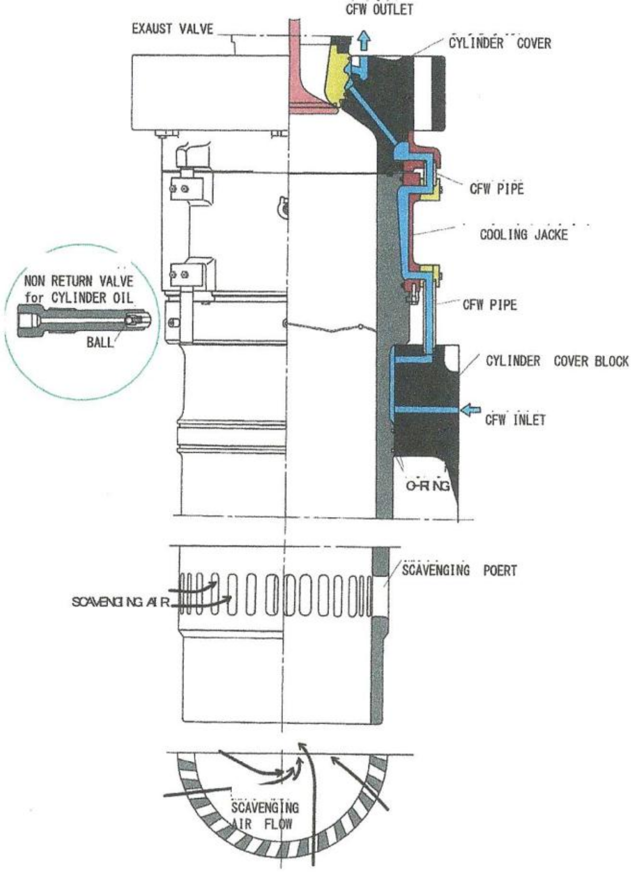
2. Describe design features of cam shaft driving assembly with reference to Figure 2 and 3

3. Explain effects of variable injection timing (VIT)

4. Describe design features of operative mechanism of FO injection pump and VIT system shown in Figure 4.

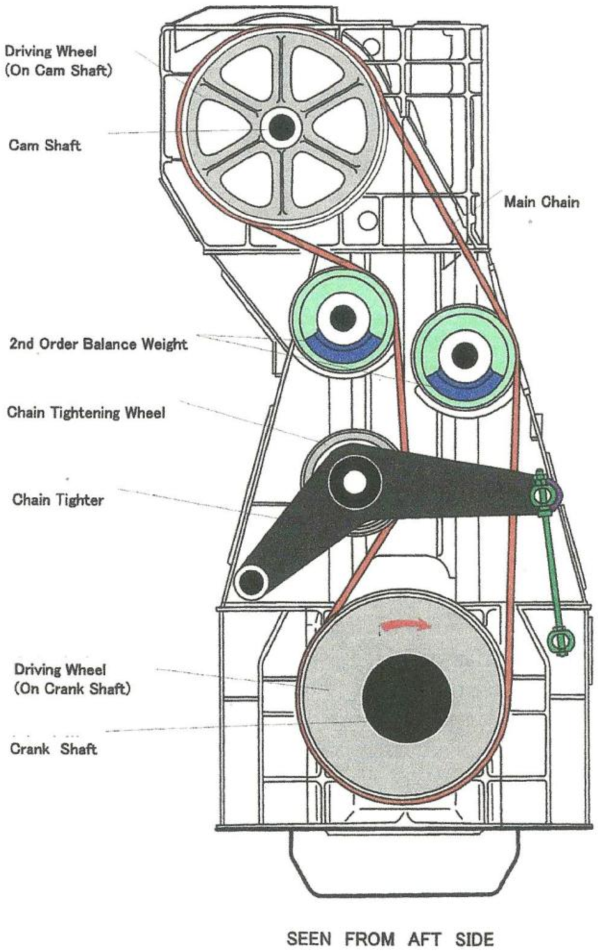
5. Describe design features and operative mechanism of starting air valve and control system shown in Figure 5.

6. Describe design features and operative mechanism of reversing system shown in Figure 6.



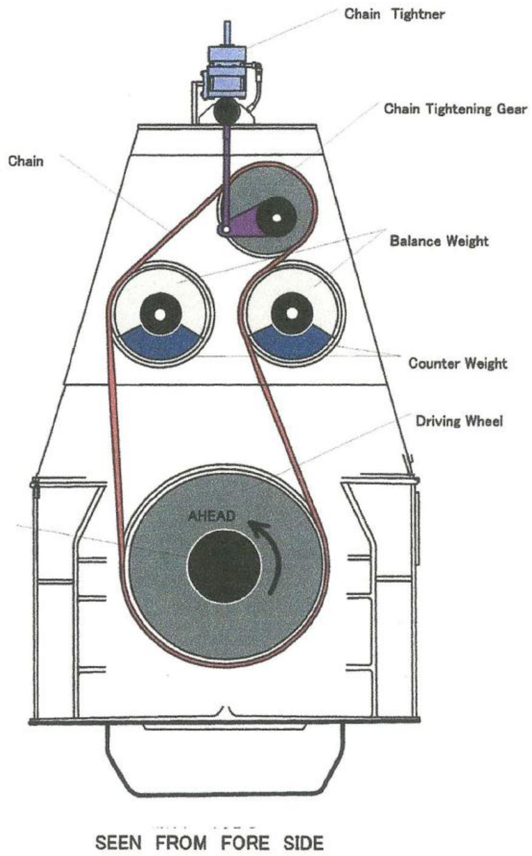
Cutaway of Cylinder Liner

Figure 1



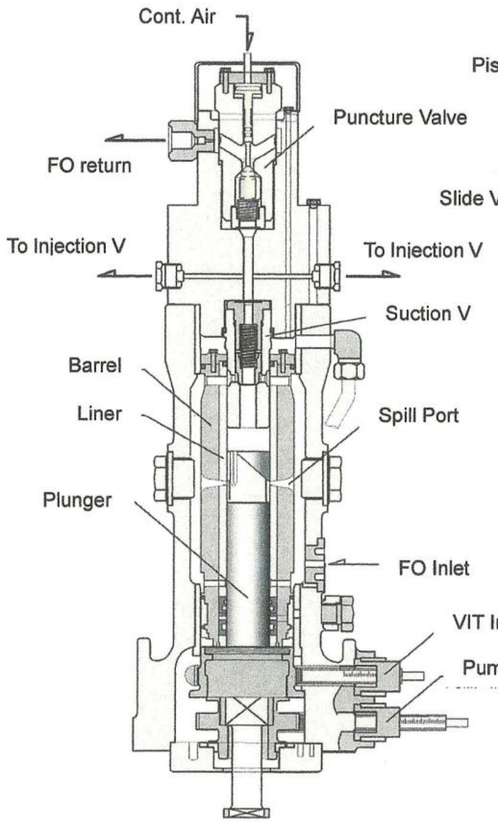
Cam Shaft Driving Assembly

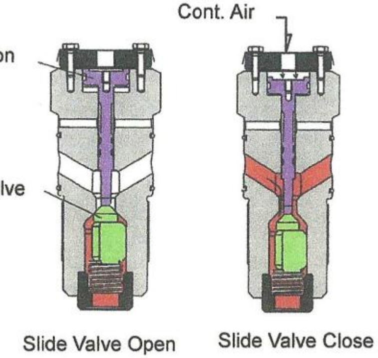
Figure 2

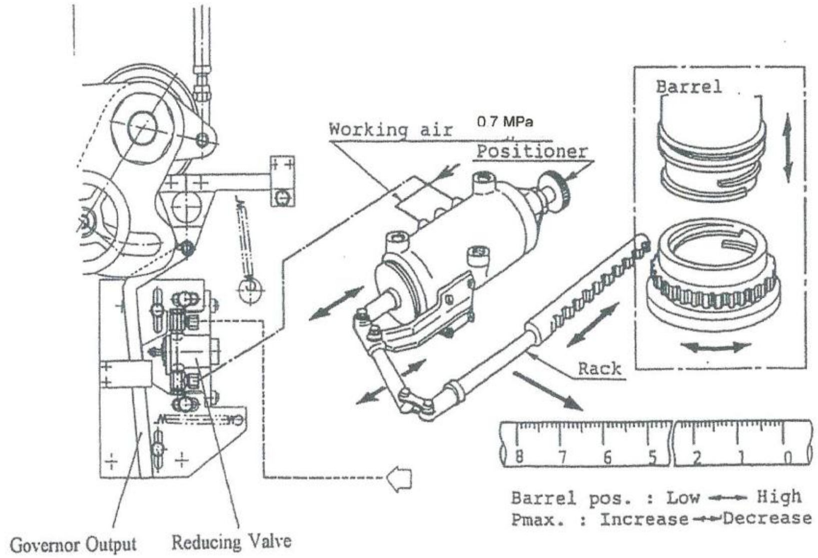


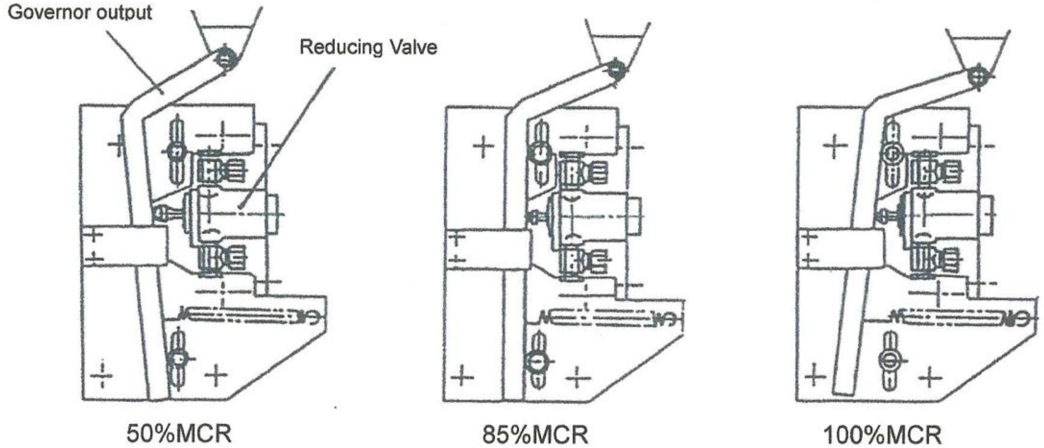
Secondary Moment Compensator
(Fore side)

Figure 3



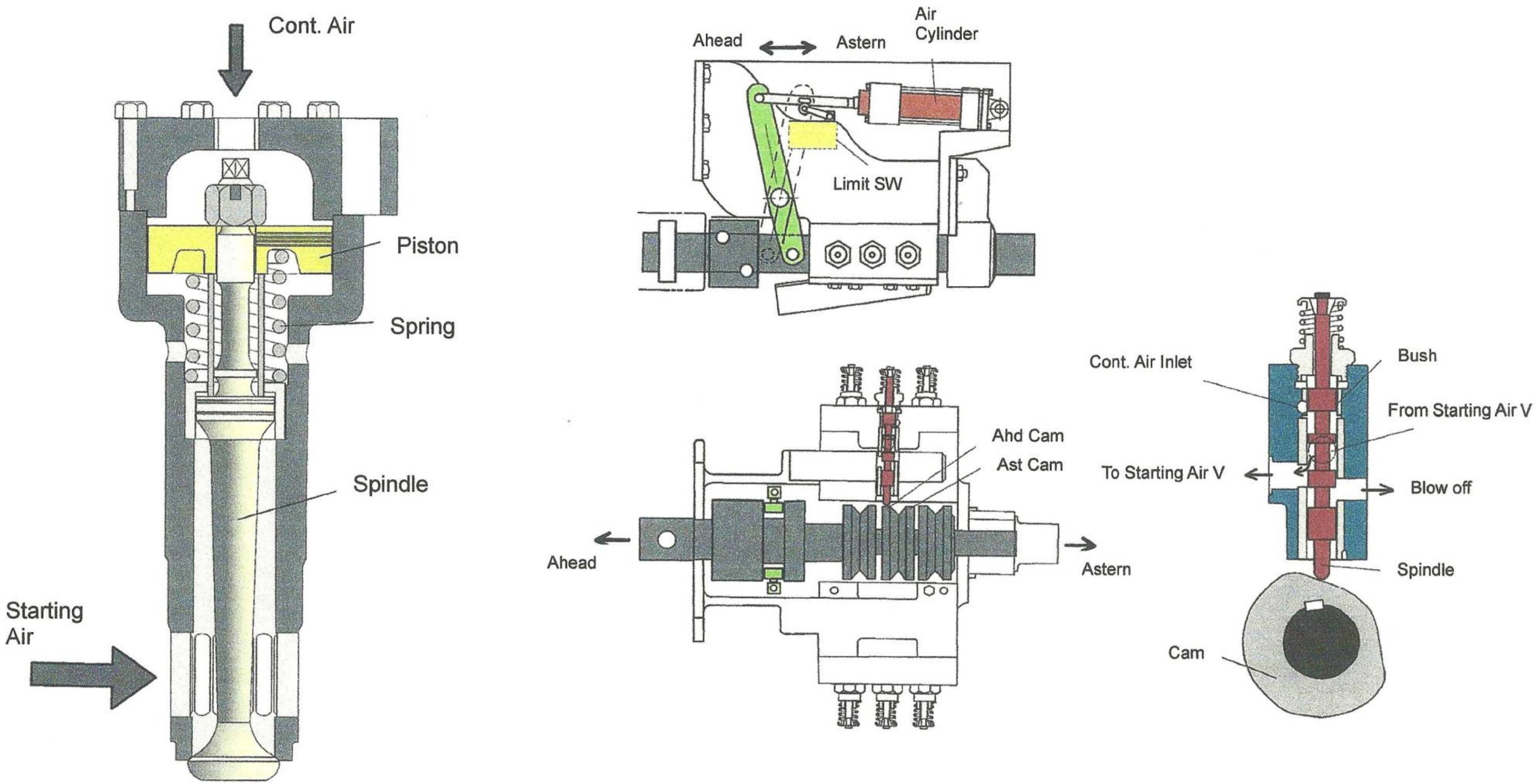






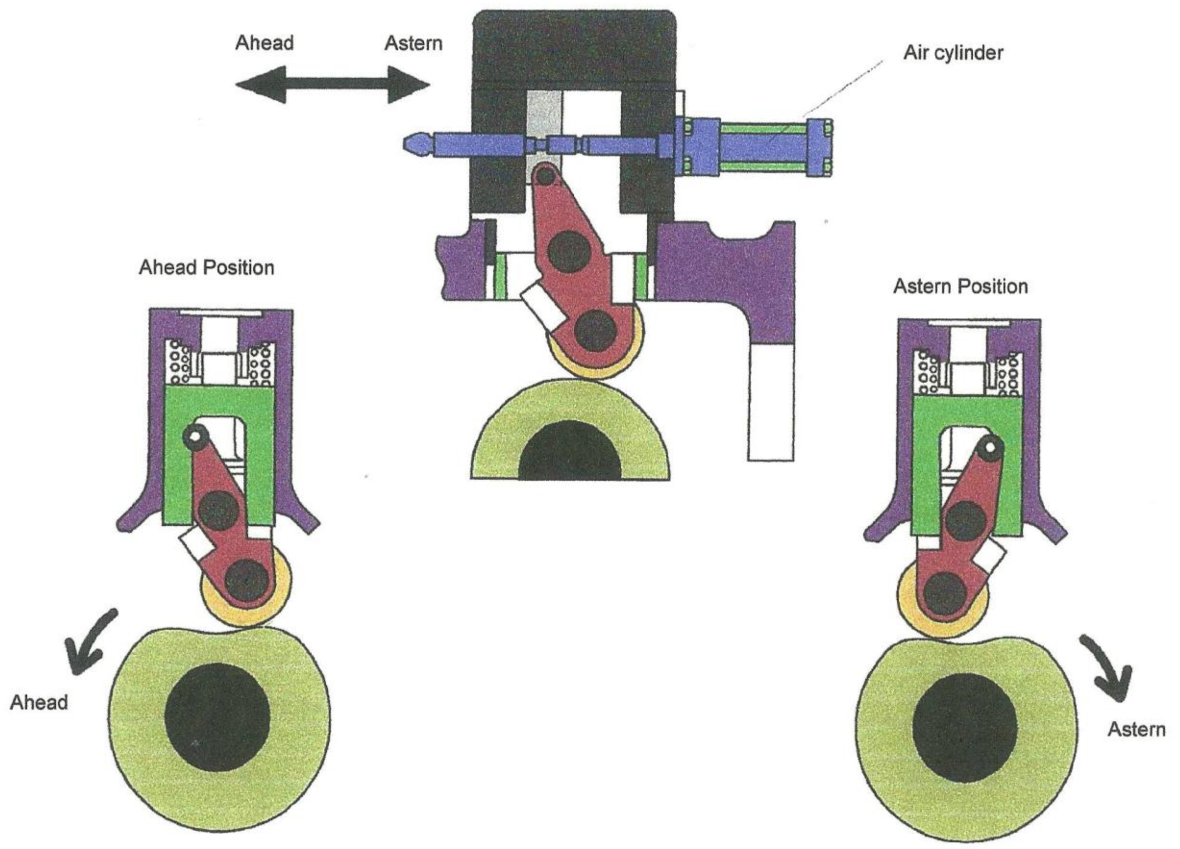
FO Injection Pump and VIT Mechanism

Figure 4



Starting Mechanism

Figure 5



Reversing Mechanism

Figure 6

ERS I – 14

Training Title/Scenario: Design features and operative mechanism of marine steam turbine

Table A-III/2 Competence: Manage the operation of propulsion plant machinery

Table A-III/1 KUP: Design features, and operative mechanism of the following machinery and associated auxiliaries

.2 marine steam turbine

ASSIGNMENT

(The following problems are based on the sample drawings)

Name		Class	
Reg. No		Date	

1. Describe how the casings of high pressure and low pressure turbines are supported in Figure 1 and 2.

2. Describe operation principles of labyrinth packing used for sealing.

3. Explain briefly why labyrinth packing is used for steam turbine in Figure 3 and 4.

4. Explain briefly reasons for adopting partial inflow of steam in the high pressure turbine shown in Figure 3.

5. Explain briefly reasons why length of moving blades become longer as the steam passes through inside the low pressure turbine shown in Figure 4.

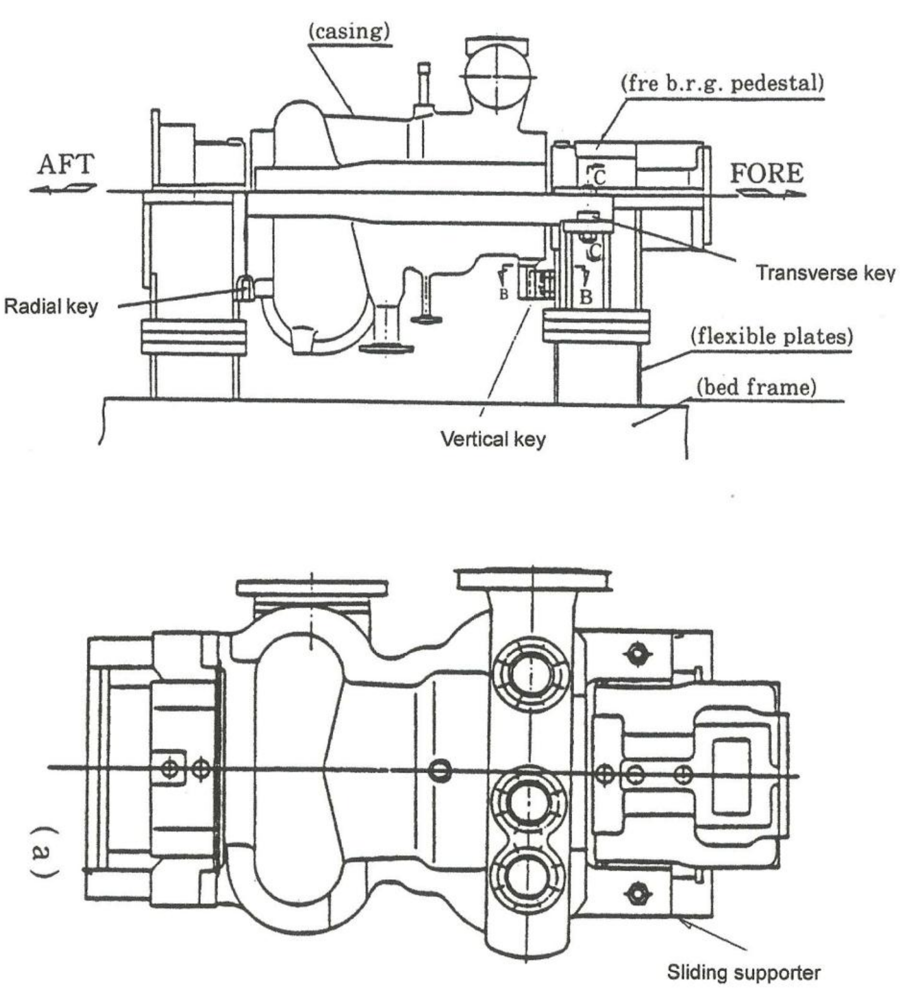
6. Describe type of stage for the first and second stages in the astern turbine shown in Figure 4 and effects of this type of stage.

7. Explain briefly reasons why the astern turbine casing is separated from the low pressure turbine.

8. Describe an impulse and reaction stages of steam turbine.

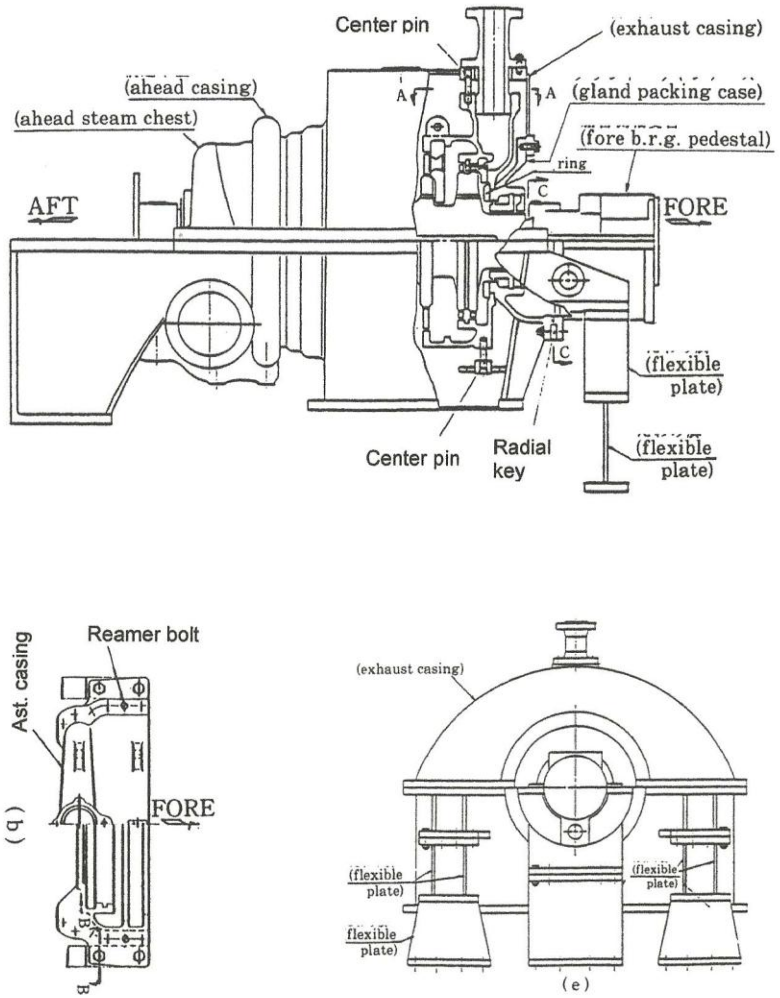
9. Explain briefly purposes and mechanism of the flexible couplings shown in Figure 5 and 6, adding necessary terms.

10. Describe how the flexible couplings are lubricated.



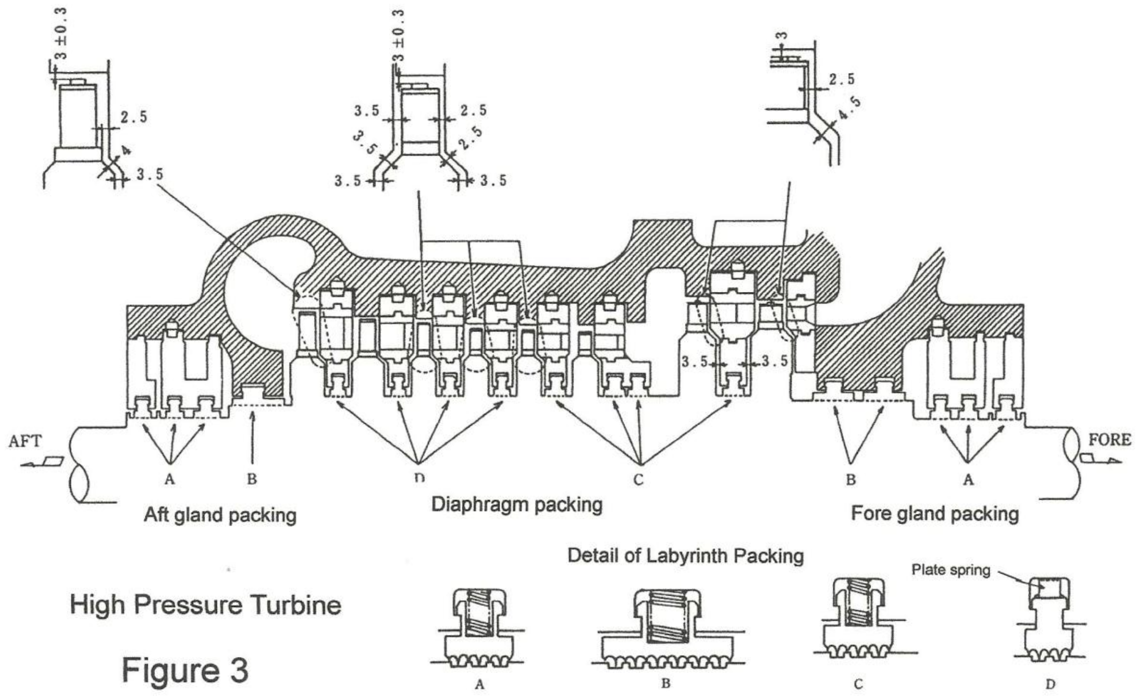
Fitting of High Pressure Casing

Figure 1



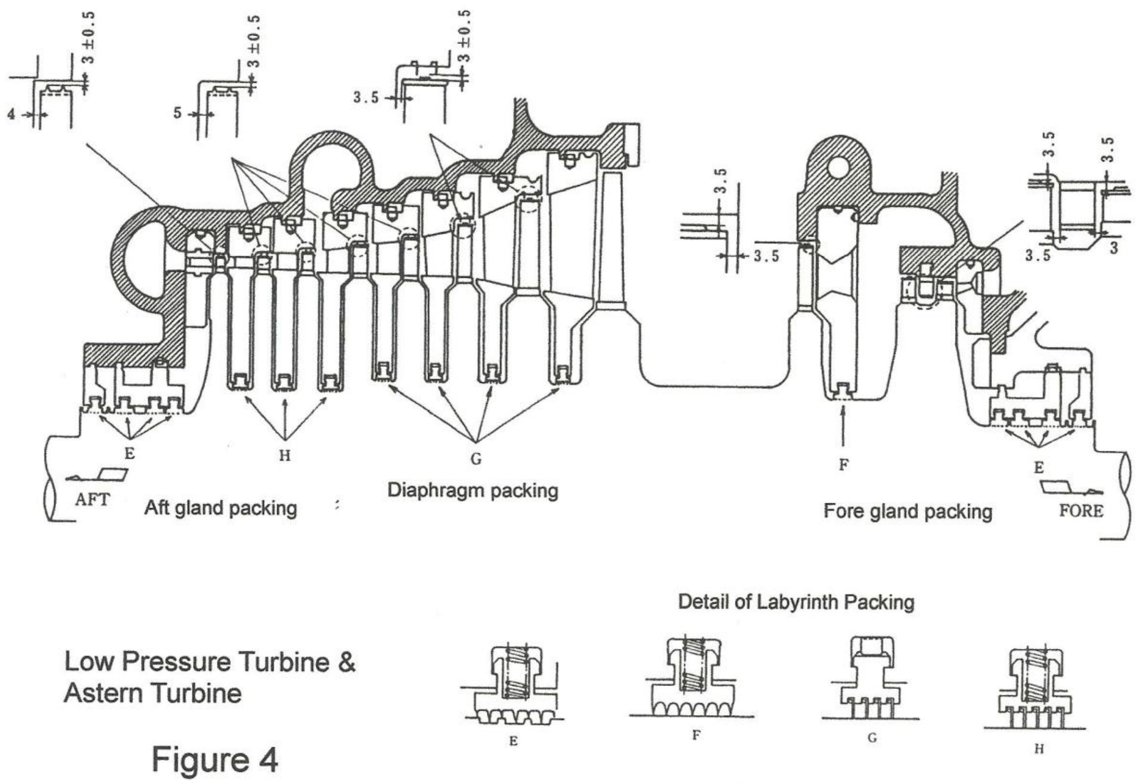
Fitting of Low Pressure and Astern Turbine Casing

Figure 2



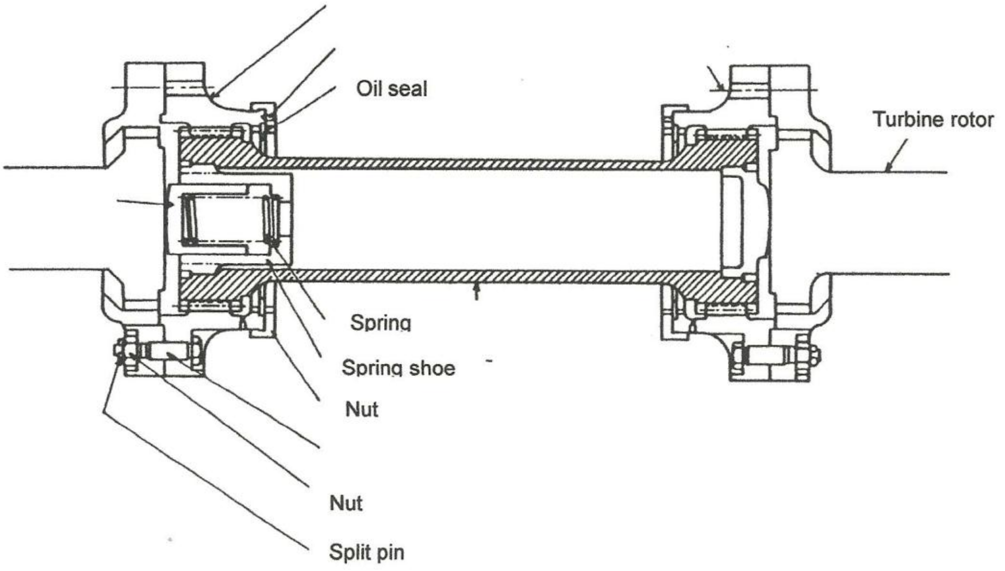
High Pressure Turbine

Figure 3



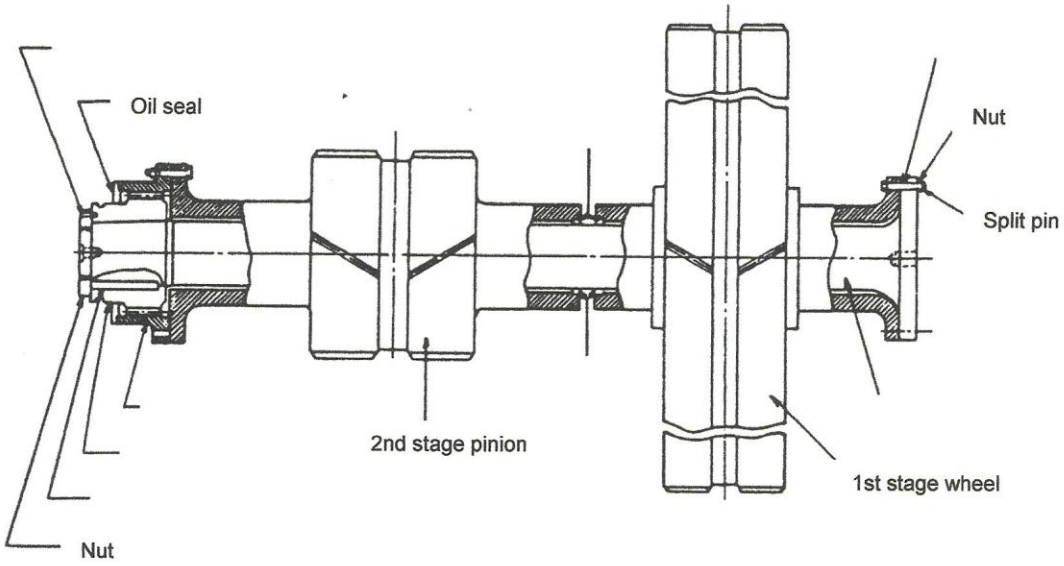
Low Pressure Turbine &
Astern Turbine

Figure 4



1st Stage Flexible Coupling

Figure 5



2nd Stage Flexible Coupling

Figure 6

ERS I – 15

Training Title/Scenario: Design features and operative mechanism of marine steam boiler

Table A-III/2 Competence: Manage the operation of propulsion plant machinery

Table A-III/1 KUP: Design features, and operative mechanism of the following machinery and associated auxiliaries

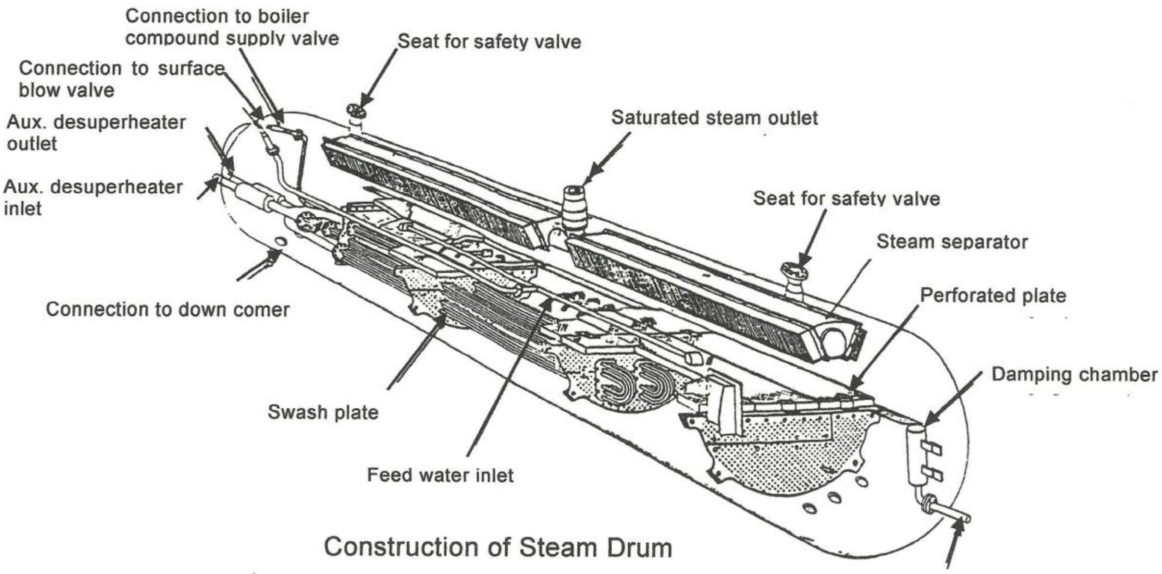
.4 marine steam boiler

ASSIGNMENT

(The following problems are based on the sample drawings)

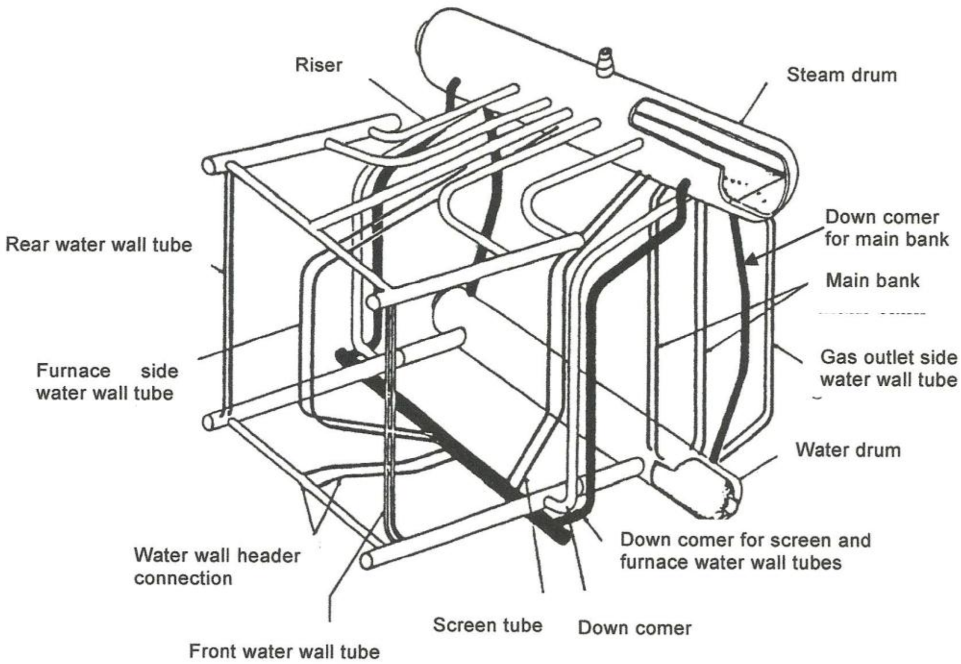
Name		Class	
Reg. No		Date	

1. Describe functions of the following components inside the steam drum shown in Figure 1.
   1) Steam separator
   2) Swash plate
   3) Perforated plate
   4) Feed water inlet
   5) Surface blow pipe
2. Describe design features of steam drum in figure and strength from the aspect of working stress of horizontal and vertical cross sections.
3. Describe functions of the following piping of the boiler water circulation shown in Figure 2.
   1) Main bank
   2) Water wall tube
   3) Water wall header connection
   4) Screen tube
4. Explain briefly how tubes are connected to steam drum and water drum.
5. Describe how superheated steam and desuperheated steam are generated shown in Figure 3.
6. Describe how the starting valve contributes to start of the boiler in Figure 3.
7. Describe how temperature of superheated steam is controlled in Figure 3.
8. Describe purposes of the soot blower shown in Figure 4.
9. Describe what type of soot blower is applied to soot blowers ①~④ respectively in Figure 4.
10. Explain briefly how the heat exchange is taken place in Figure 5.
11. Describe purpose of air bypass damper in Figure 5.



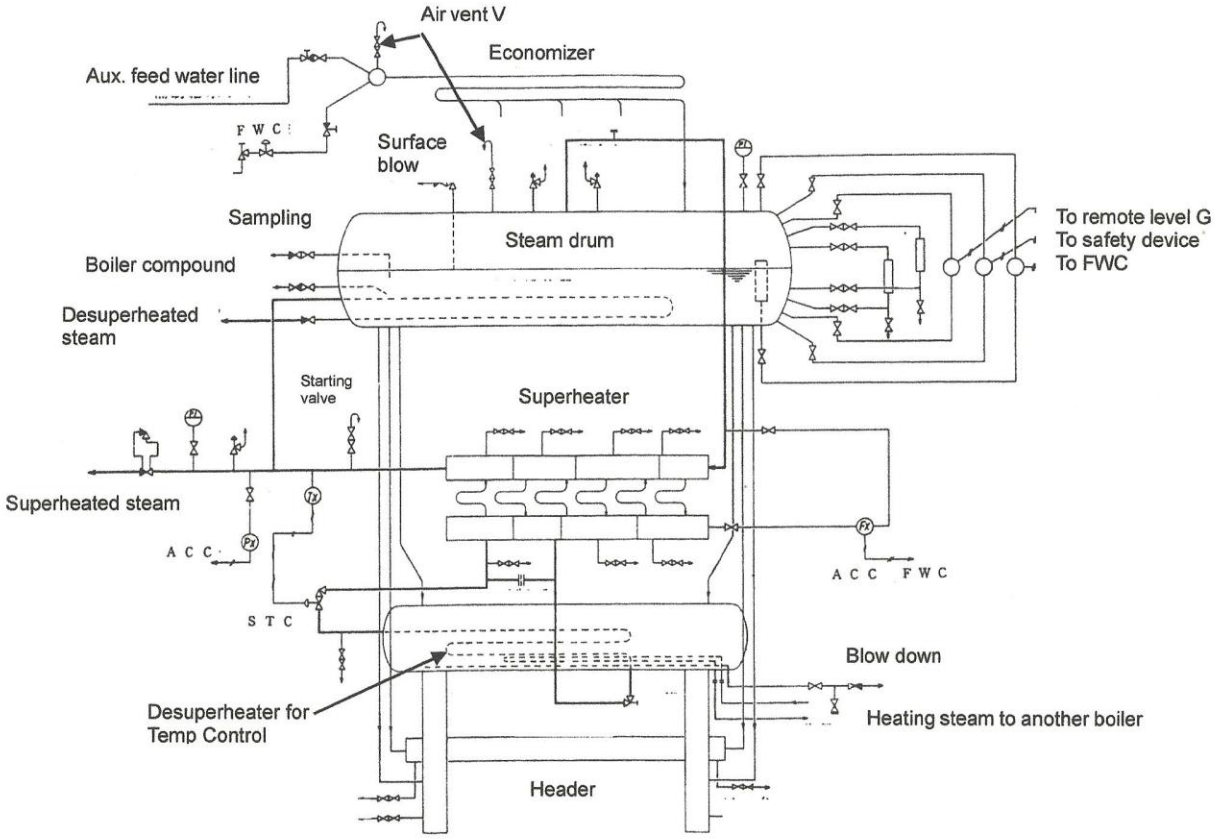
Construction of Steam Drum

Figure 1



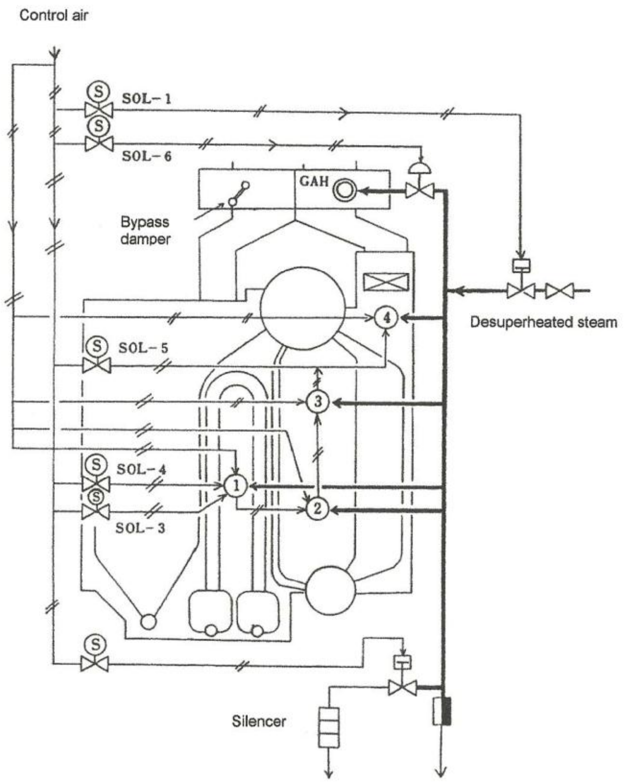
Arrangement of Boiler Water Circulation

Figure 2



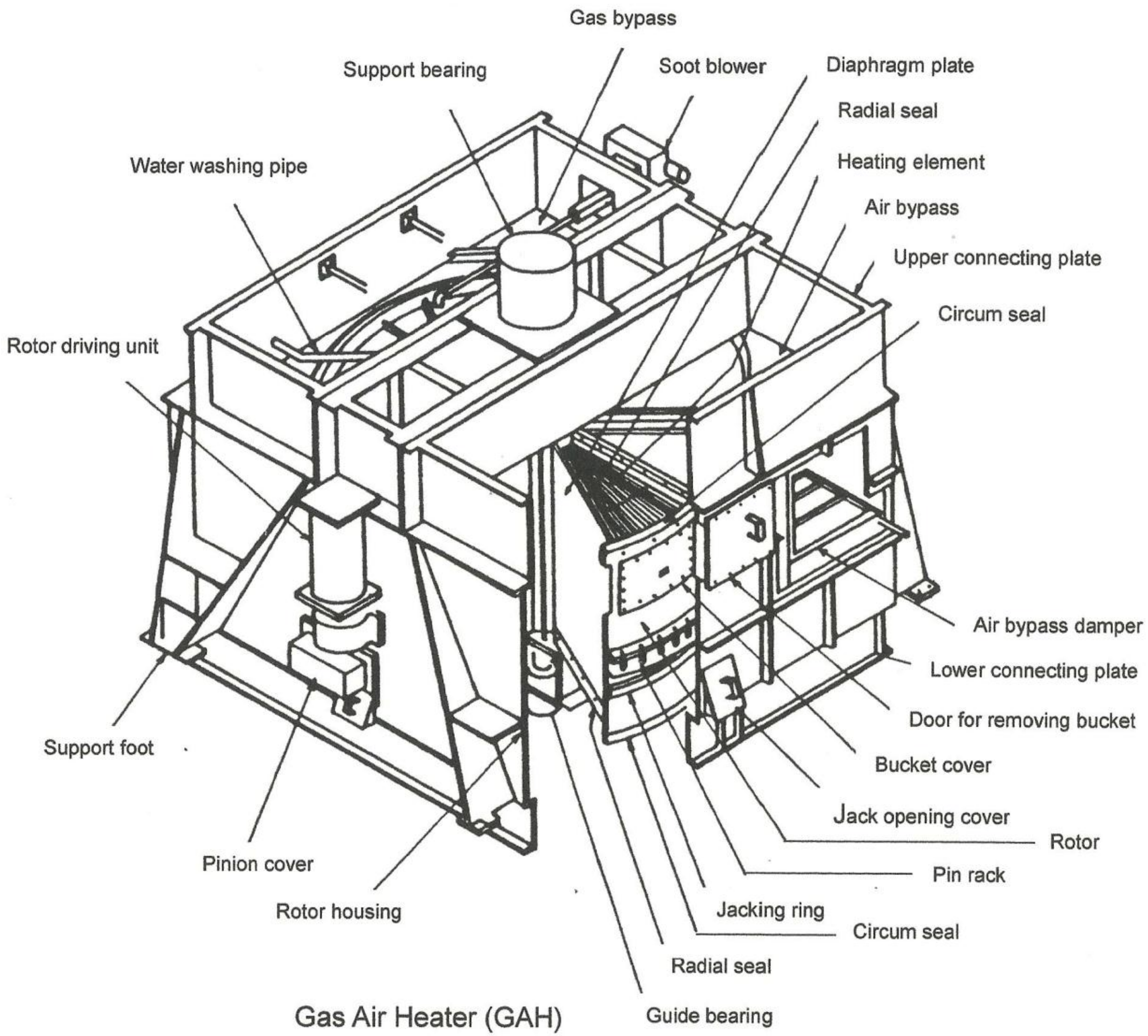
Superheated Steam and Desuperheated Steam Generation System

Figure 3



Arrangement of Soot Blower

Figure 4



Gas Air Heater (GAH)

Figure 5

COMMON ITEMS OF ERS II TRAINING

The following is common items to be applied to ERS II trainings.

Training Title/Scenario: written in each sample exercise

Table A-III/1 Competence: written in each sample exercise
Table A-III/1 KUP: written in each sample exercise

Time allocation: written in each sample exercise
Number of Trainees: 3 to 5
Number of Instructors: 1

Outline of the training : written in each sample exercise

Prerequisite: written in each sample exercise

Note: written in each sample exercise

Specific purpose of the training: written in each sample exercise

Briefing session (15 min)

The Instructors should emphasize that this training supplements classroom lectures on the machinery for better understanding and explain:

- purpose of the simulation
- contents of simulation program
- how to carry on the training
- what should be learned

Implementation of the training: written in each sample exercise

The trainees complete "Assignment" for each ERS II training given by the instructor after the implementation of the training. (Some of ERS II trainings don't include the "Assignment" and the trainees must submit "Report form" in such a case instead of "Assignment" after the debriefing session. Sample "Report form" is shown in the following page and can be commonly used for ERS II trainings when necessary)

Debriefing session (15 min)

The instructor collects the assignment paper and briefs the results.
(The results of the assignment paper is used for evaluating the trainees. If no assignment was given, a specific evaluation form is suggested in the each ERS II training for evaluation)

TRAINEE'S REPORT FOR ERS II & III TRAINING

(Common for all the ERS II and III training)

Each trainee must fill out the blanks in the table below when the debriefing session is over and submit this form to the instructor as a training report.

Trainee's information

Name	
Reg. No	
Class	
Course Name	
Remarks	

Report of Training

Date of Training	
Time of Start & Finish	Start: ～Finish:
Training Course/Scenario	
Objective of Training	
What you performed during the training	
Comments	

Trainee's signature ____

Instructor's signature and date ____________________________________

ERS II - 1

Training Title/Scenario: Construction and operation principle of Refrigeration and Air-conditioning systems

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems
Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; other auxiliaries including various pumps, air compressor, purifier, fresh water generator, heat exchanger, refrigeration, air-conditioning and ventilation systems

Time allocation: 2.5 hours

Outline of the training :
The trainees watch simulation video that introduces construction of refrigeration and air conditioning systems and perform operations concerning operation principles of components constructing the refrigeration system. After the simulation, the trainees complete an assignment answering to the questions about what they have learned through the simulation.

Prerequisite:
Fundamental knowledge on refrigeration system

Note:
This topic is applied to both Refrigeration and Air conditioning systems.

Specific purpose of the training
The trainee acquire knowledge on:
- what components construct the refrigeration system;
- construction of the components
- operation principles, mechanism and design features of the system; and
- functions and operation mechanism of the components.

Implementation of the training

T in min	Training process
0 ~ 20	The instructor shows the trainees the simulation video that introduces construction of refrigeration system and functions of the components. (Refer to Figure 1 ~ 6)
20 ~ 40	The instructor indicates the simulated system diagrams following the simulation program and the trainees label the components of the refrigeration system with reference to the simulation video. (The instructor lets the trainees enter their solutions from their key boards, or answer orally, naming the trainee by turns and lets the trainee describe their functions)
40 ~ 60	The instructor shows the trainees the simulation video that introduces how the each component of the refrigeration system works, labeling main parts and constructing components.
60 ~ 90	The instructor indicates the simulated drawings of the components following the simulation program and the trainees label the main parts of the components with reference to the simulation video. (The instructor lets the trainees enter their solutions from their key boards, or answer orally, naming the trainee by turns and lets the trainee describe how they work)
90 ~120	(The instructor stops the simulation and lets the trainees complete the assignment giving assignment paper and another 30 minute)

ASSIGNMENT

(The following questions are based on the sample drawings)

Name		Date	
Reg. No		Scenario: Construction and operation principle of Refrigeration and Air-conditioning systems	
Class			

1. Label the main components of refrigeration system with reference to Figure 1 on the screen and describe briefly their functions below.

2. Label the main components of the compressor with reference to Figure 2 on the screen and describe briefly how it works.

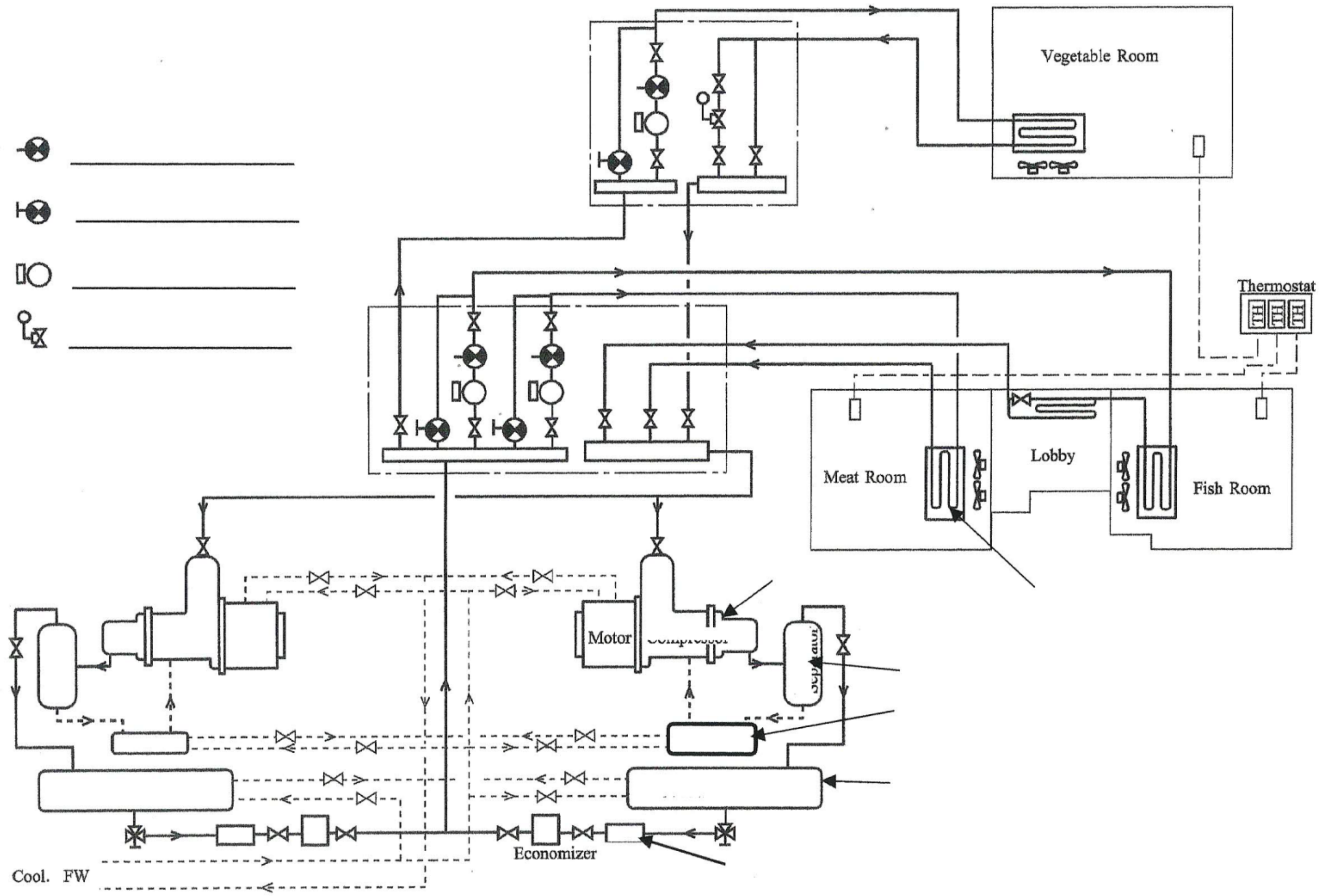
3. Label the main components of "Capacity Control System" with reference to Figure 3 on the screen and describe briefly how it works.

4. Label the main components of unloader mechanism with reference to Figure 4 on the screen and describe briefly the mechanism/principle.

5. Explain briefly how the unloader works adding necessary terms with reference to Figure 5 on the screen.

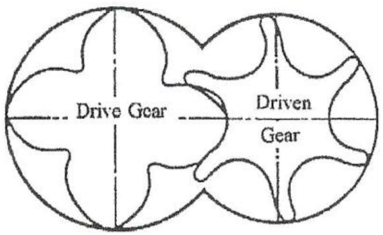
6. Explain how the oil separator works adding necessary terms with reference to Figure 6 on the screen.

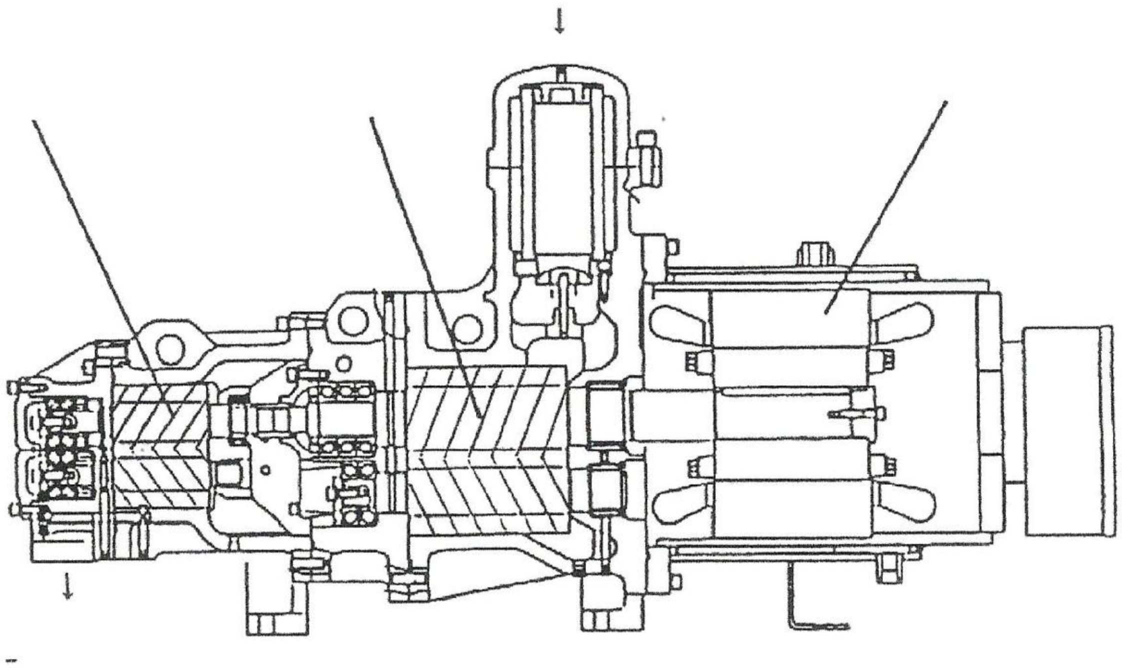
7. Explain how the automatic expansion valve works adding necessary term with reference to Figure 7 on the screen

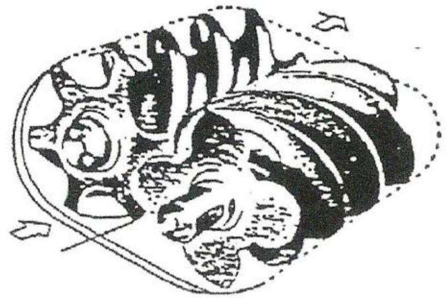


Provision Refrigeration System

Figure 1

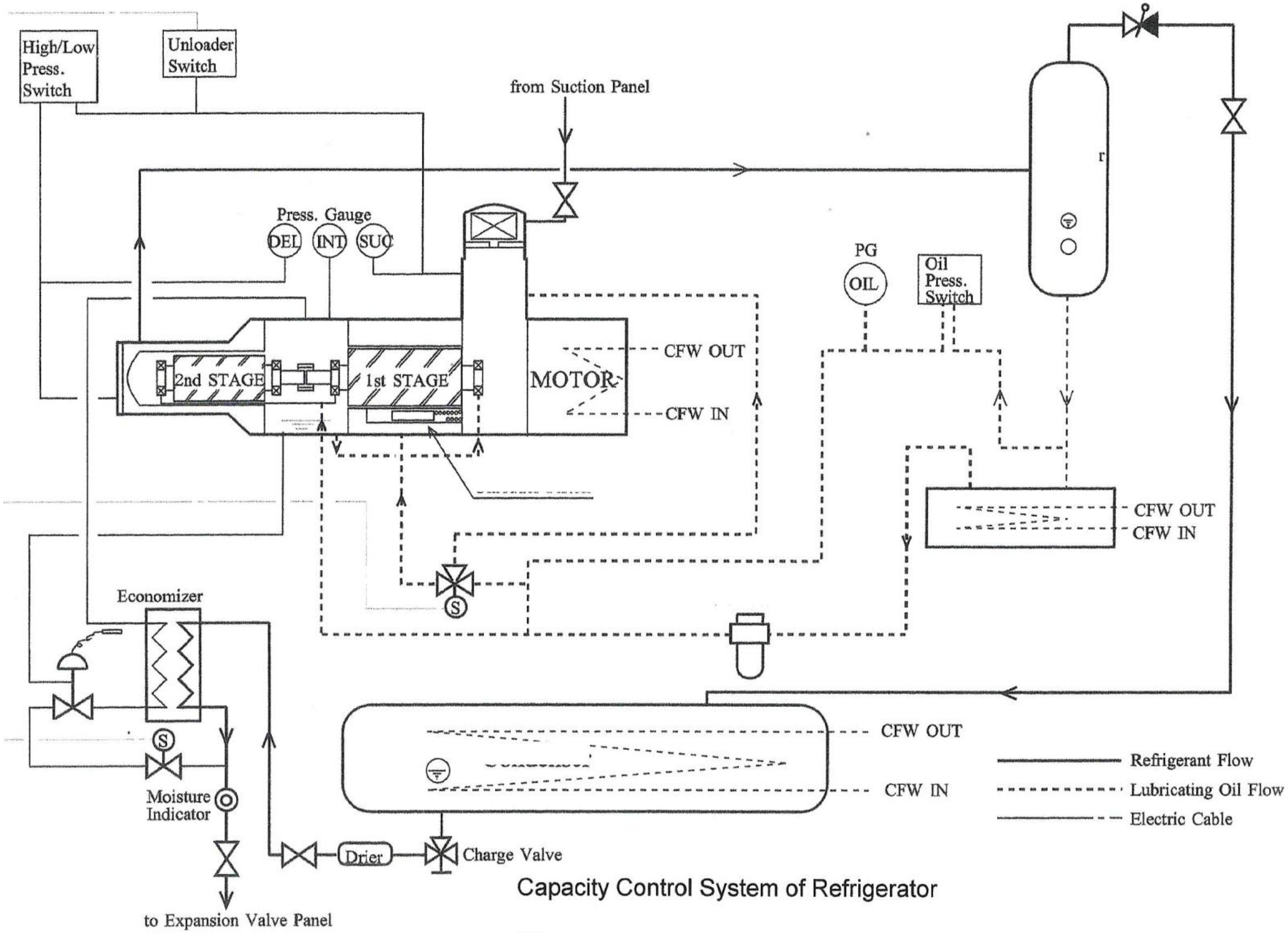






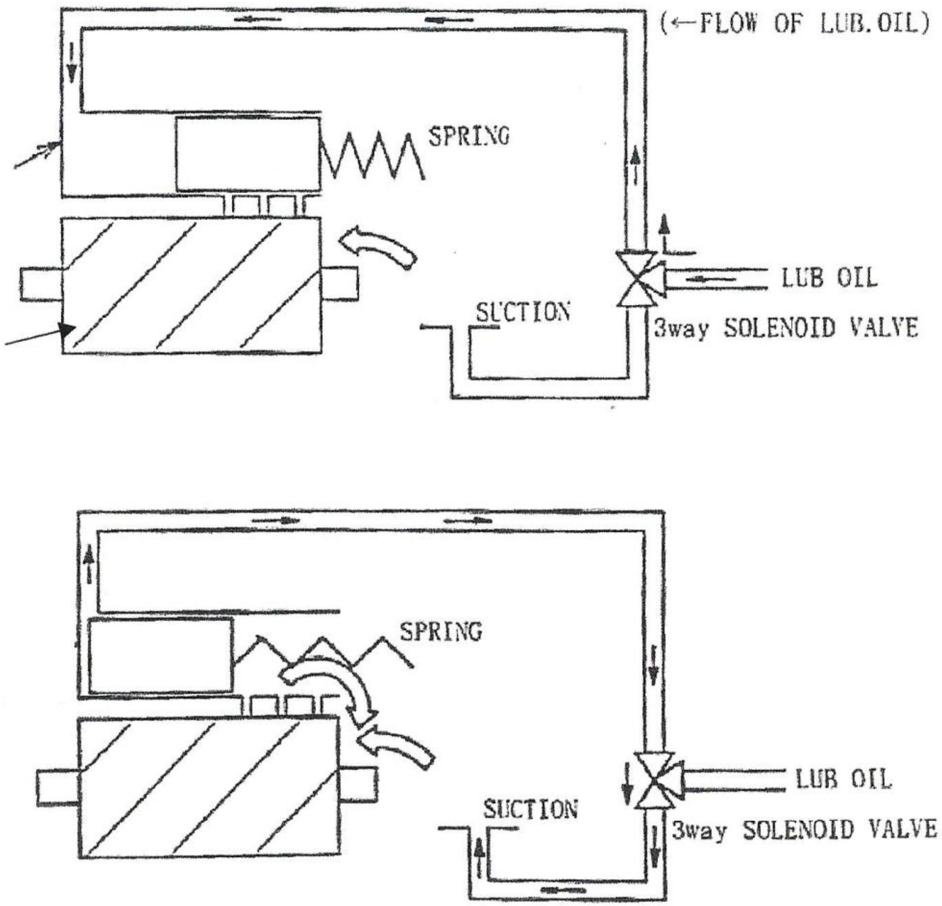
Screw Type Compressor

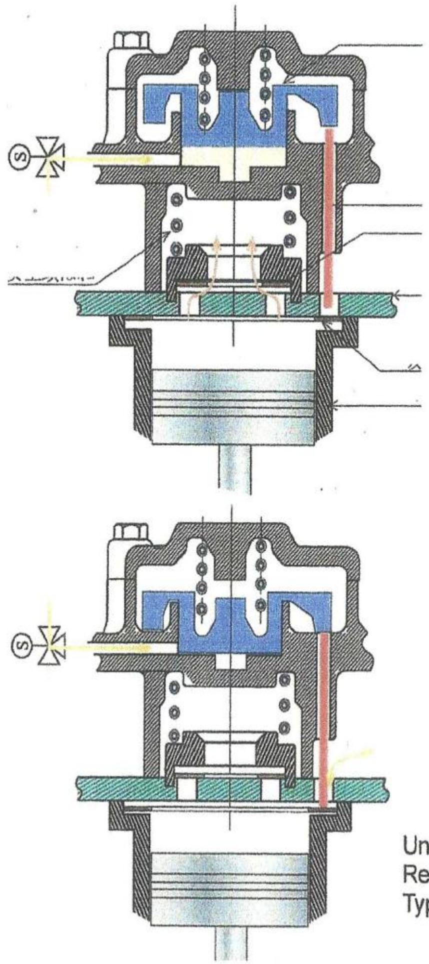
Figure 2



Capacity Control System of Refrigerator

Figure 3





Unloader of
Reciprocating
Type Compressor

Operation principle of Unloader
Figure 4

Figure 5

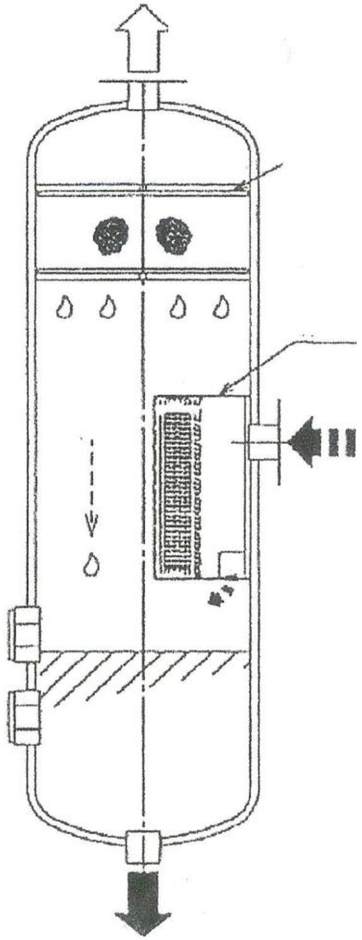


Figure 6

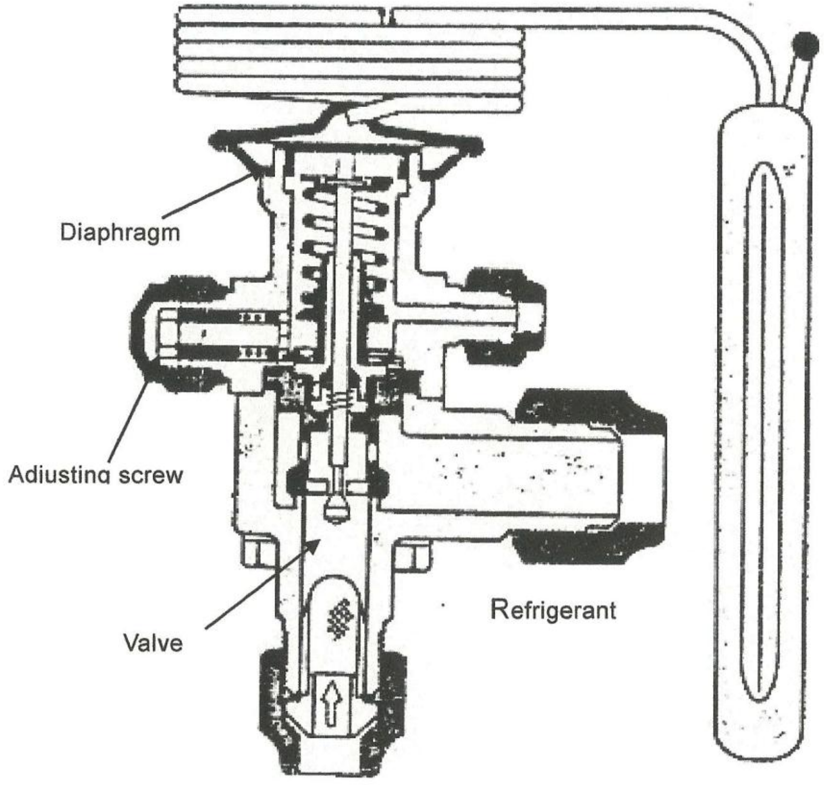


Figure 7

ERS II – 2

Training Title/Scenario: Basic construction and operation principle of automatic control systems

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems

Table A-III/1 KUP: Basic construction and operation principles of machinery systems including; Automatic control systems

Time allocation: 4 hours

Outline of the training :
The trainees watch the simulation video that introduces level, temperature and pressure controls commonly used on board to understand constructions of the control systems and perform operations to execute the simulated controls in order to understand operation principles of the components of the systems.

Prerequisite:
Fundamental knowledge on automatic control.

Note:
There are several categories of automatic control and the trainees should learn only basic control systems commonly used for level, temperature and pressure controls on board, since details or more theoretical issues and more advanced type of control systems will be learned in other topics.

Specific purpose of the training
The trainee understands constructions and components of basic automatic control systems commonly used on board as follow:
- Level control
- Temperature control
- Pressure control

Implementation of the training

<table>
<tr><th>T in min</th><th>Training process</th></tr>
<tr><td>0 ~ 30</td><td>The instructor shows the trainees the simulation video that introduces level, temperature and pressure control systems commonly used on board and how they work including operation principles of sensors, control valves and relays. The instructor should brief the simulation as necessary. (Refer to Figure 1 ~ 7 as examples)</td></tr>
<tr><td>30 ~ 60</td><td>The instructor indicates simulated control systems on the screen and the trainees perform operations from the key boards following the instructor's instructions in turn as follow.
- manual operations of level, temperature and pressure control systems
    - start and stop pumps
    - control of control valves
    - alternation of setting value
    - changeover of operation mode to automatic from manual and vice versa
- automatic operations of level, temperature and pressure control systems including alternation of setting value and control parameters of controllers</td></tr>
<tr><td>60 ~ 90</td><td>The instructor shows the trainees the simulation video that introduces components used in the control systems such as level switch, transmitter, control valve and etc. and how they work (operation principles) including outline of PID/PLC controller. The instructor should brief the simulation as necessary.</td></tr>
<tr><td>90 ~ 120</td><td>(The instructor stops the simulation and lets the trainees complete the assignment giving assignment paper and another 30 minute)</td></tr>
</table>

ASSIGNMENT

(The following questions are based on the sample drawings)

Name		Date	
Reg. No		Scenario: Construction and operation principle of automatic control systems	
Class			

1. Label components used for level, temperature and pressure control system
1.1 level
1.2 temperature
1.3 pressure

2. Describe what control methods are used in the simulated control systems.

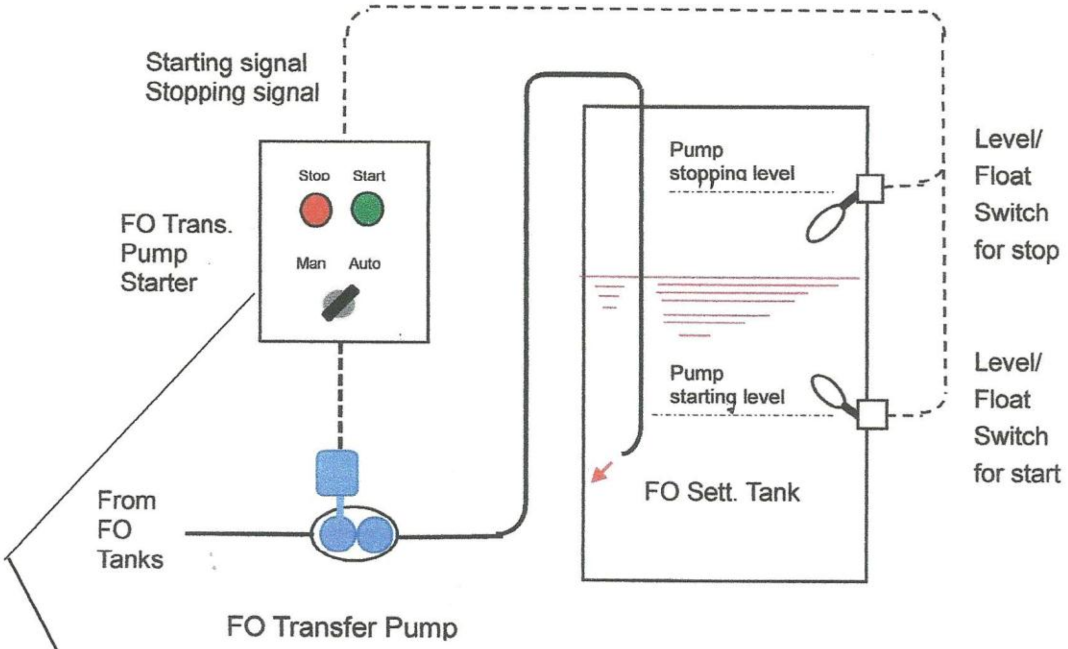
3. Explain briefly how level, temperature and pressure are controlled.

4. Describe principles of detecting level, temperature and pressure used in simulated control systems.
4.1 level
float switch
level condenser and transmitter
4.2 temperature
thermo resistance bulb
wax element
4.3 pressure
pressure transmitter
pressure switch

5. Explain how signals of level, temperature and pressure detected are processed.

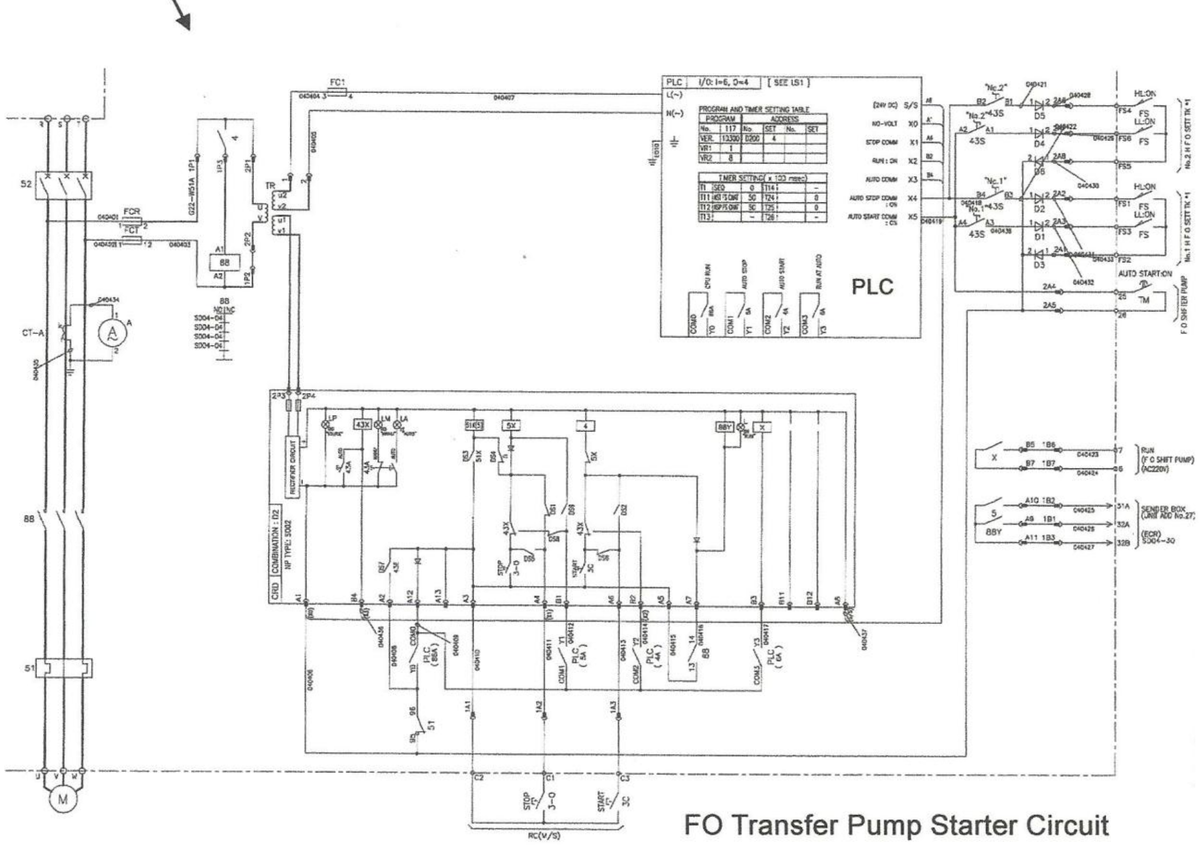
6. Explain how Wax type temperature control valve works to control LO temperature.

7. Explain how three-way control valve works.

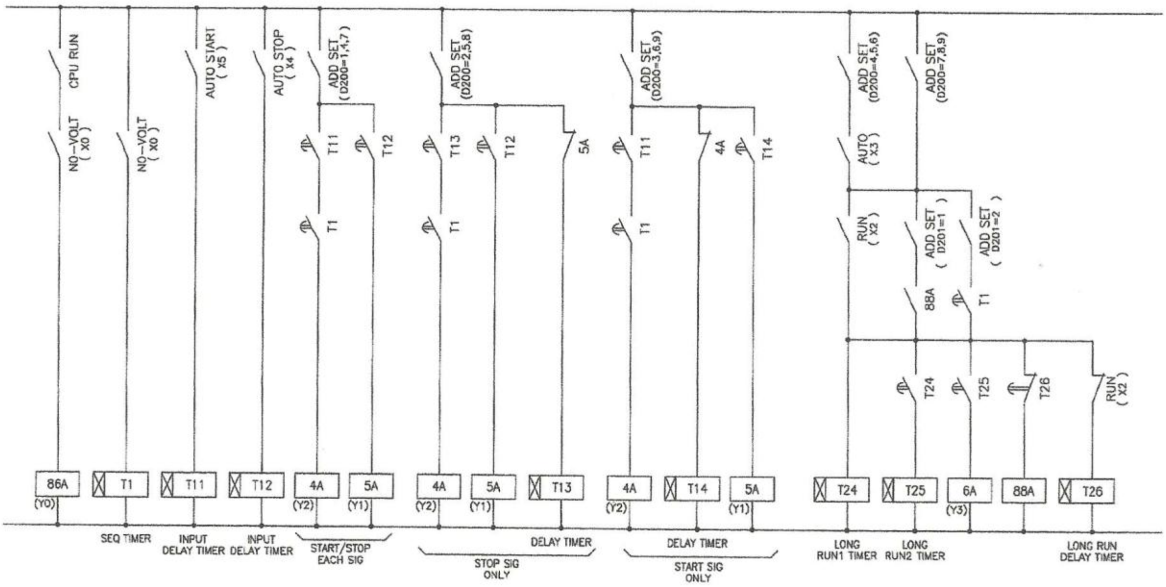


Level Control-1 (ON-OFF Control)

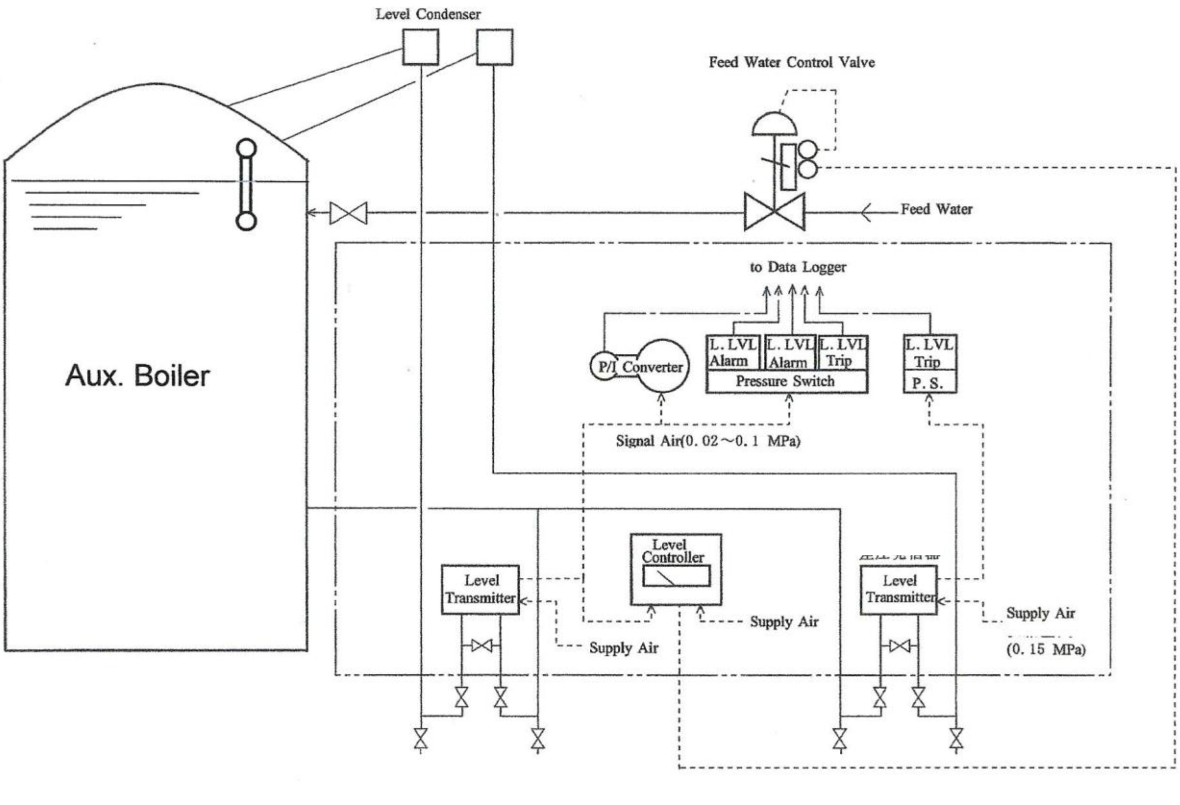
Figure 1



FO Transfer Pump Starter Circuit

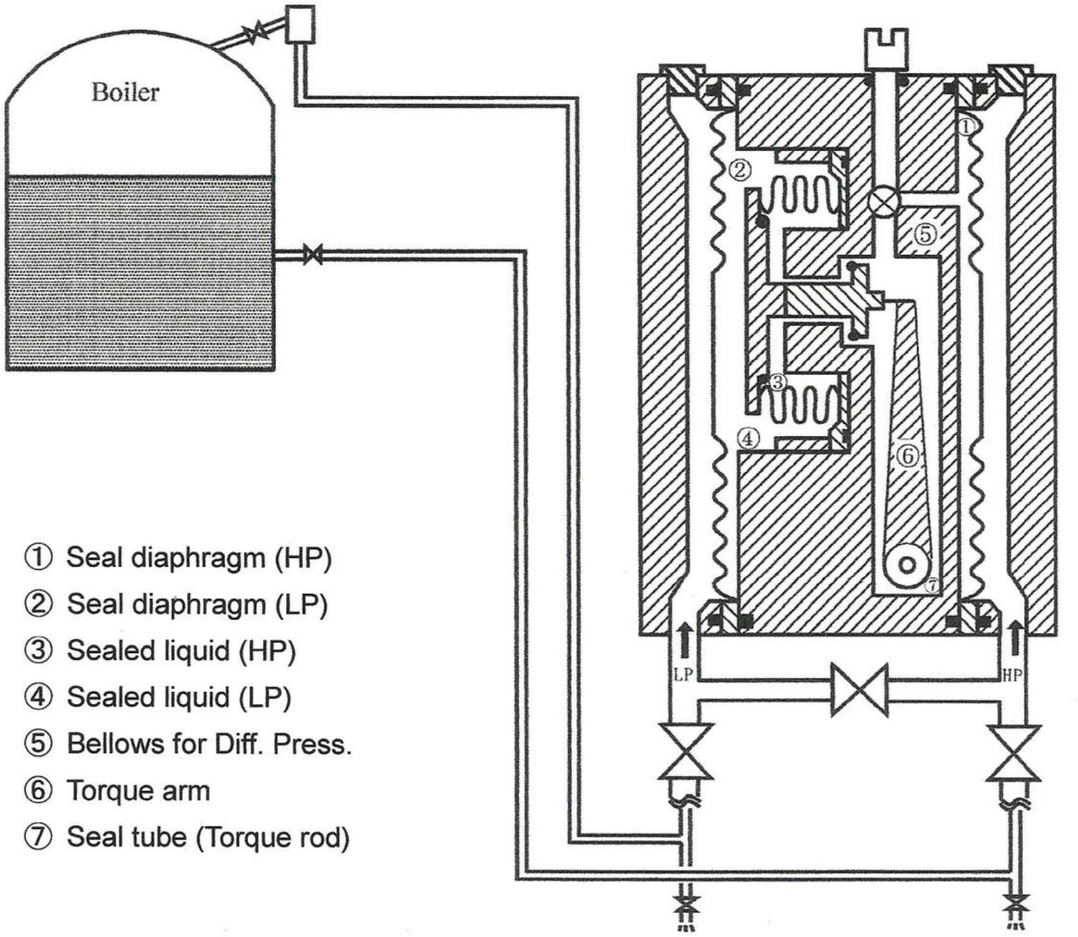


PLC (Ladder Diagram)



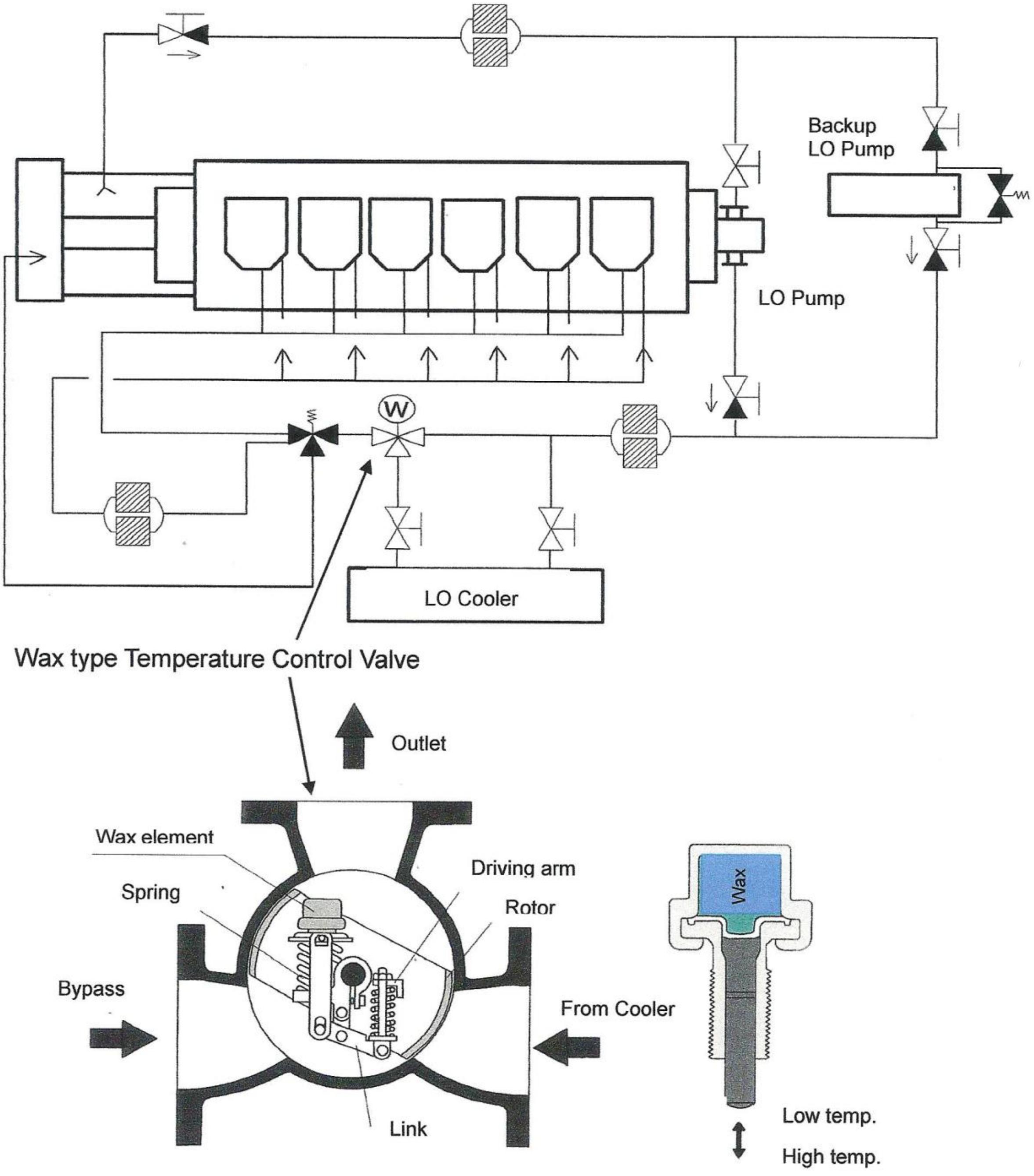
Level Control 2 (PID Control)

Figure 2



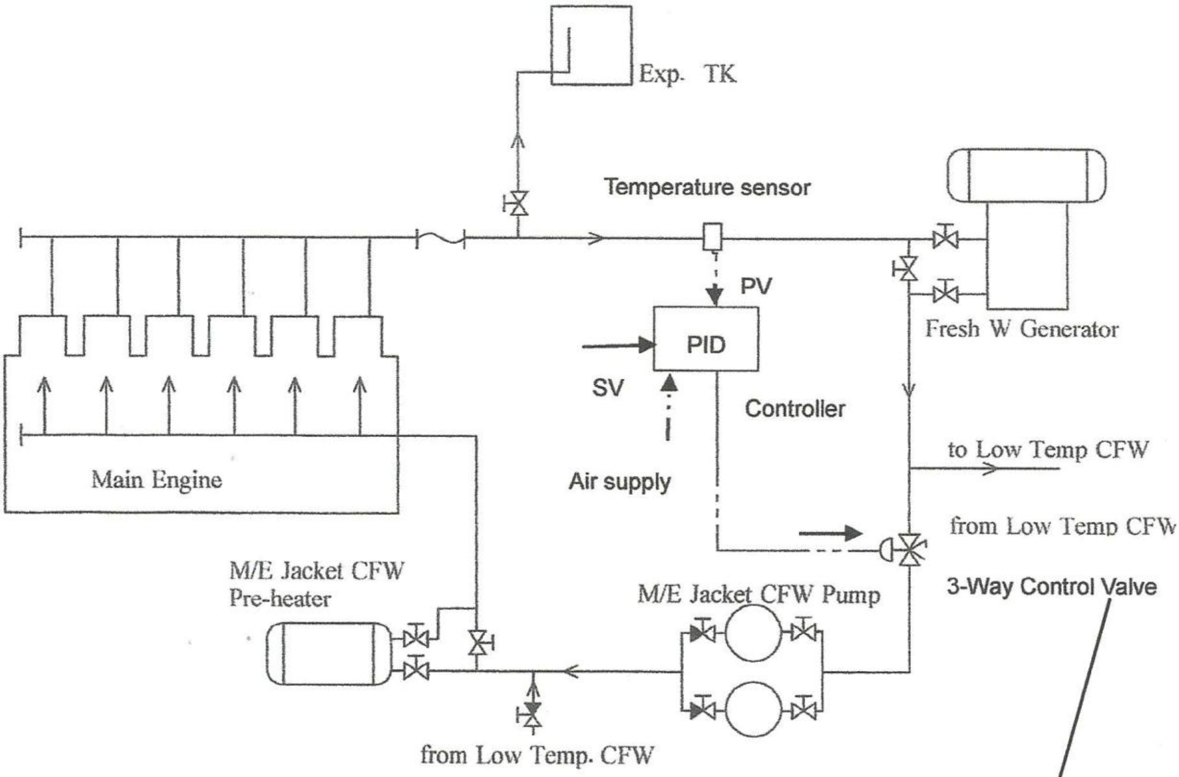
Differential Pressure Transmitter

Figure 3



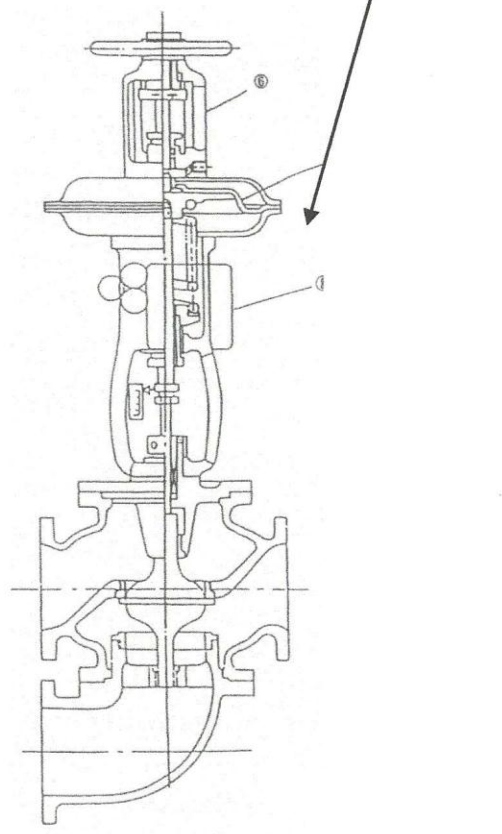
Temperature Control-1 (LO Temp)

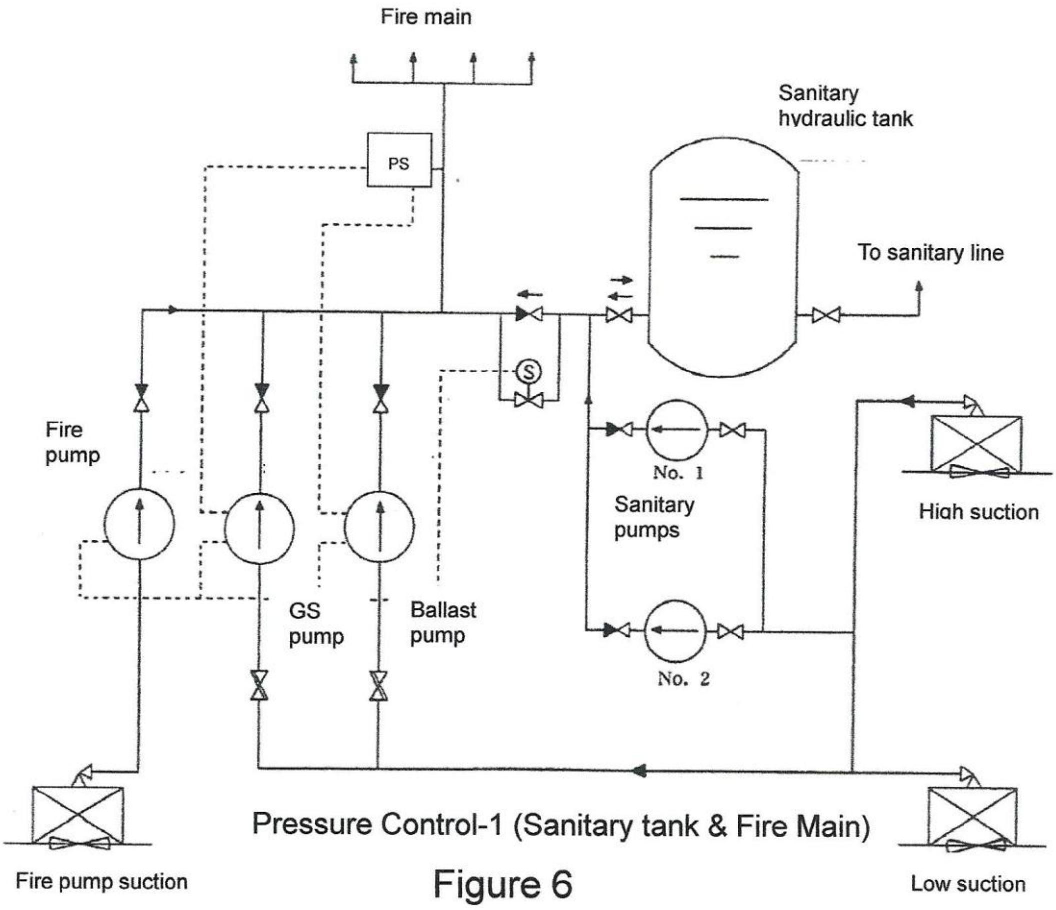
Figure 4



Temperature Control-2 (ME CFW Temp. PID Control)

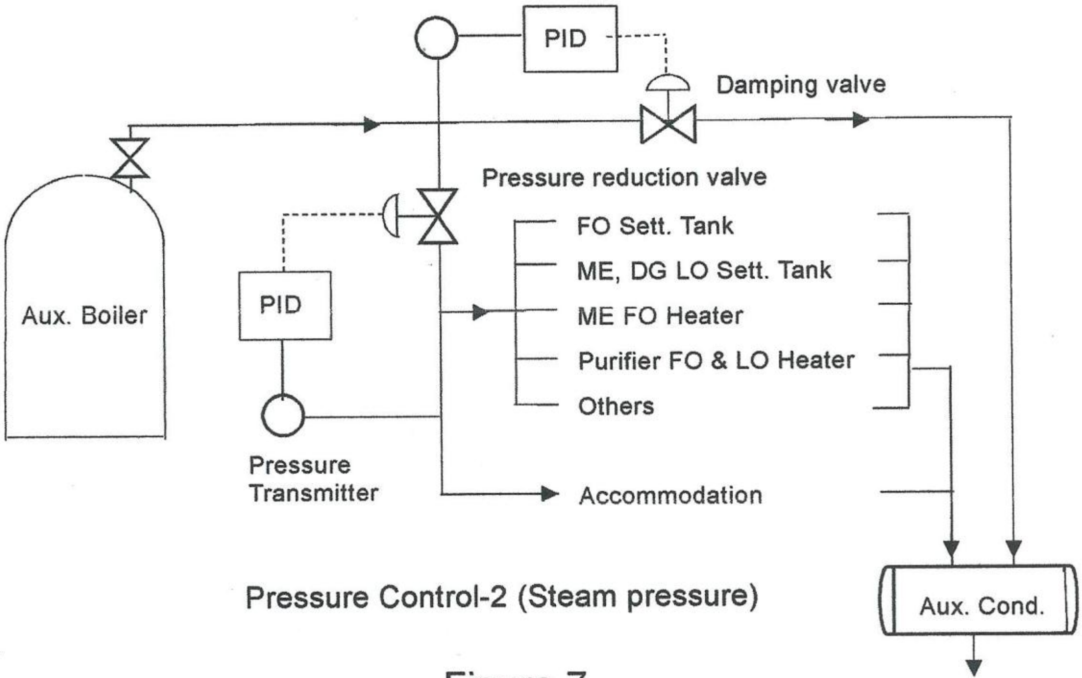
Figure 5





Pressure Control-1 (Sanitary tank & Fire Main)

Figure 6



Pressure Control-2 (Steam pressure)

Figure 7

ERS II - 3

Training Title/Scenario: Basic construction and operation principles of; fluid flow and characteristics of lubricating oil, fuel oil and cooling systems for steam turbine plant

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems
Table A-III/1 KUP: Basic construction and operation principles of; fluid flow and characteristics of lubricating oil, fuel oil and cooling systems

Time allocation: 3 hours

Outline of the training:

The trainees watch the simulation video that introduces system configuration of steam turbine propulsion plant and fluid flow of superheated steam, condensate water, feed water, gland steam, lubricating oil and boiler fuel oil systems. The trainees perform operations to confirm fluid flow of the each system.

Prerequisite:

Fundamental knowledge on steam turbine propulsion machinery systems.

Note:

Through the simulation that shows the fluid flows by opening valves and starting pumps on the screen, the trainees should understand the fluid flows.

In the briefing session, the instructor should emphasize features of steam propulsion plant comparing to diesel engine propulsion plant and that fluid flows of the steam turbine plant are more complicated than diesel engine including ideas reflected in the fluid flows.

Specific purpose of the training:

The trainees will be able to understand construction of steam turbine plant, main fluid flows of the systems and functions of each system as follow.

- Superheated steam
- Condensate water
- Feed water
- Gland steam
- Lubricating oil

Implementation of the training

T in min	Training process
0 ~ 40	The instructor shows the trainees the simulation video that introduces system configuration of steam turbine propulsion plant and fluid flow of superheated steam, condensate water, feed water, gland steam, lubricating oil and boiler fuel oil systems by opening valves and starting pumps on the screen. The instructor should brief the simulation as necessary. (Refer to Figure 1 ~ 7 as examples)

40 ~ 120	The instructor displays system diagrams one by one on the screen and the trainees perform operations from the key boards following the instructor's instructions in turn as follow.
	(Figure 1: System configuration)
	- Open and close the maneuvering valve confirming rotation of the propeller, main flows of superheated steam, condensate water, feed water and lubricating oil
	(Figure 2: Superheated stem and bleeding steam)
	- Open and close the bleeding valves and others available confirming flow of bleeding steam
	(Figure 3: Condensate water)
	- Open and close the condensate recirculation valve and others available confirming levels of Main condenser and Deaerate feed water heater
	(Figure 4: Feed water)
	- Open and close the feed water control valve and others available confirming levels of Steam drum, Deaerate feed water heater and Dist. water tank
	(Figure 5: Gland steam)
	- Open and close the maneuvering valve and others available confirming pressures of Gland steam leak off reservoir and Gland steam reservoir, and flow of gland steam
	(Figure 6: Lubricating oil)
	- Start and stop LO pump confirming which parts of the turbine and the reduction gears are lubricated as follow
	  - HP and LO turbine rotor bearings
	  - Flexible couplings
	  - Reduction gear bearings
	  - Reduction gears

120 ~150	(The instructor stops the simulation and lets the trainees complete the assignment giving assignment paper and another 30 minute)

ASSIGNMENT

(The following questions are based on the sample drawings)

Name		Date	
Reg. No		Scenario: Basic construction and operation principle of; Fluid flow and characteristics of lubricating oil, fuel oil and cooling systems; Steam turbine plant	
Class			

1. Describe steam flow from the steam drum of the boiler to main steam turbine and generator turbine

2. Describe bleeding steam flow from turbines to heaters

3. Describe Gland steam flow from makeup valve to leak off valve

4. Describe condensate water flow from Main condenser to Deaerate feed water heater

5. Explain how Main condenser hot well level is kept constant.

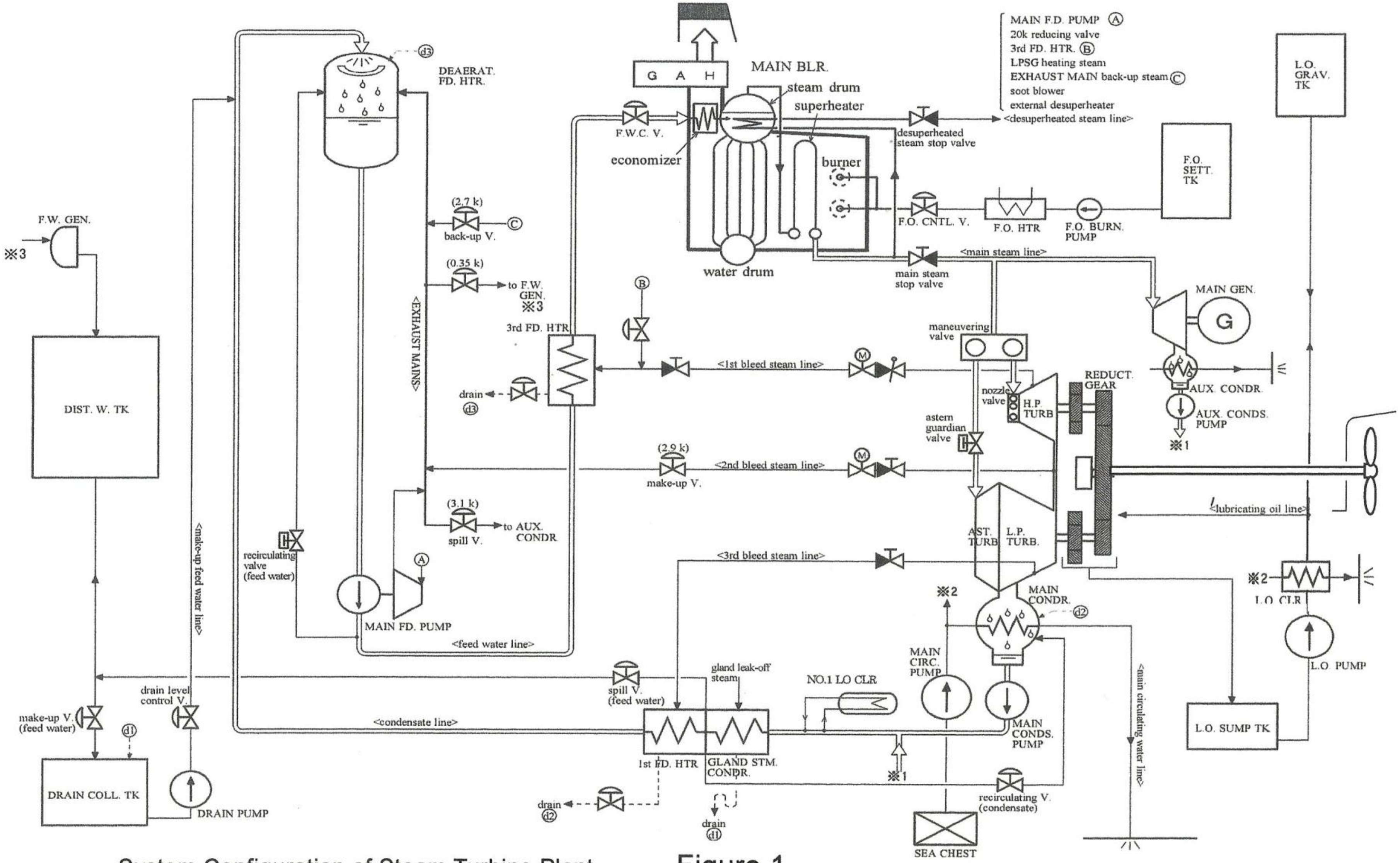
6. Explain how Deaerate feed water heater level is kept in a certain range.

7. Describe feed water flow from Deaerate feed water heater to the steam drum

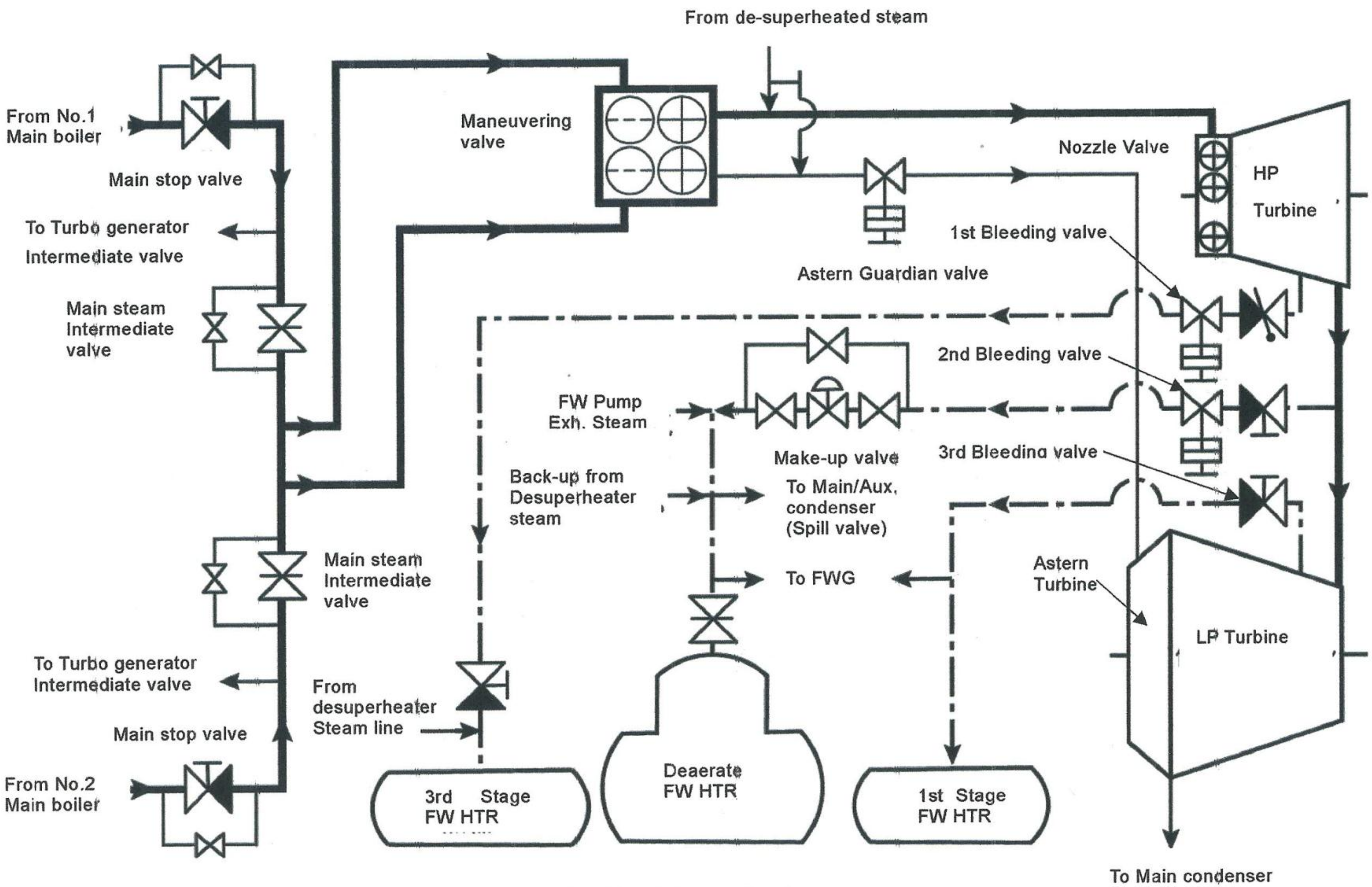
8. Explain how condensate water and feed water are heated step by step.

9. Describe LO flow from LO pump to bearings and reduction gears

10. Explain functions of LO gravity tank

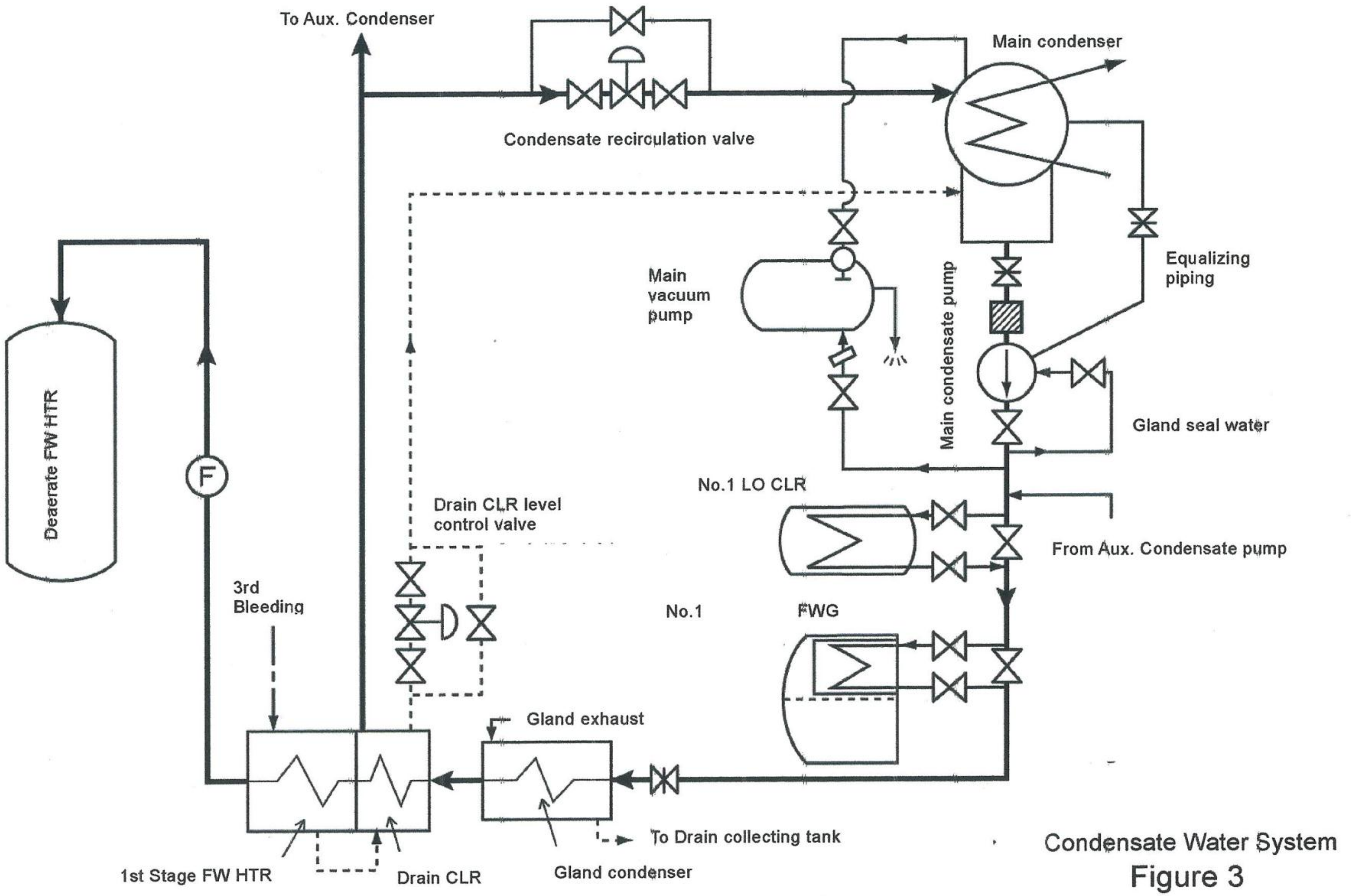


System Configuration of Steam Turbine Plant **Figure 1**

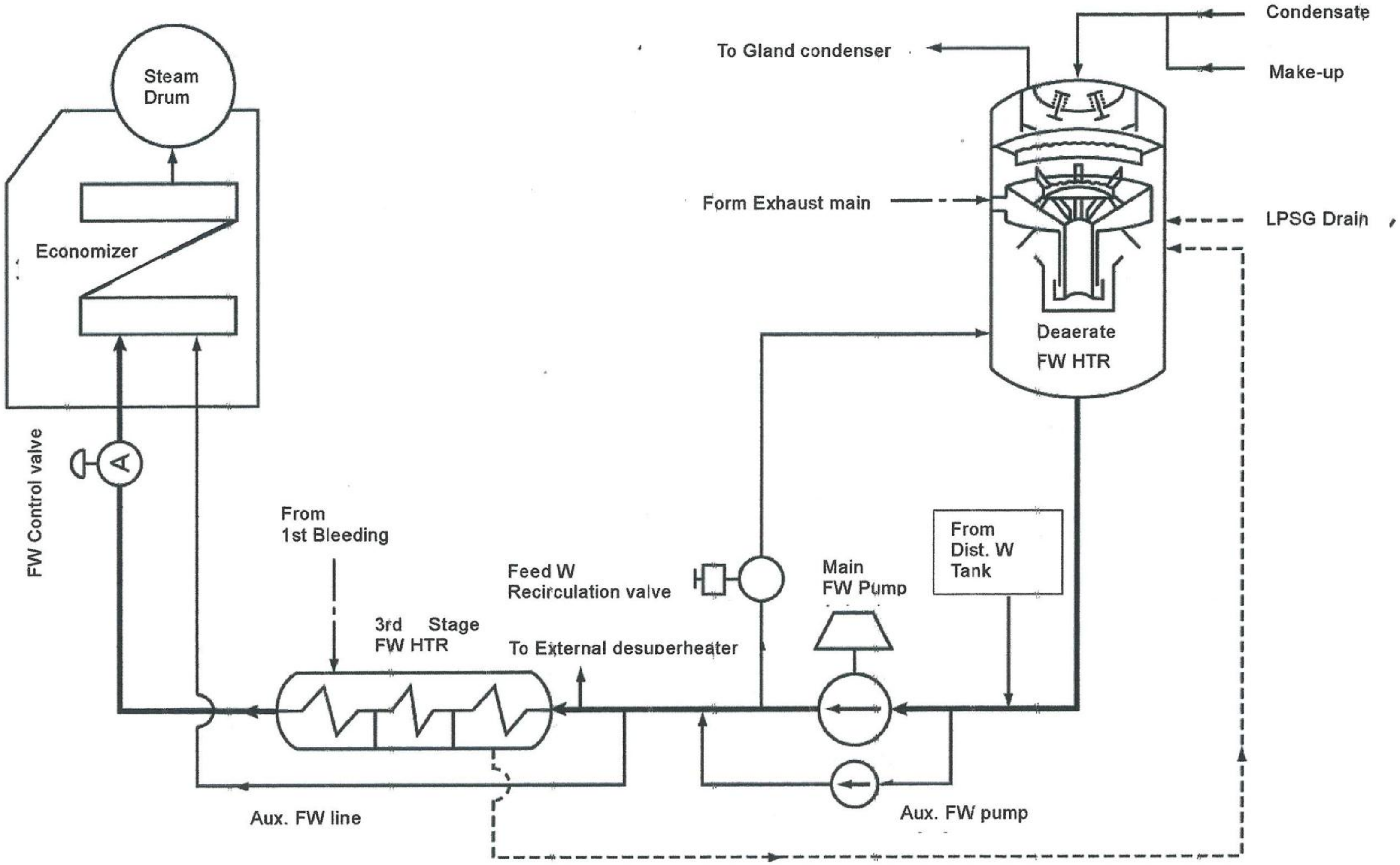


Main and Bleeding Steam Systems

Figure 2



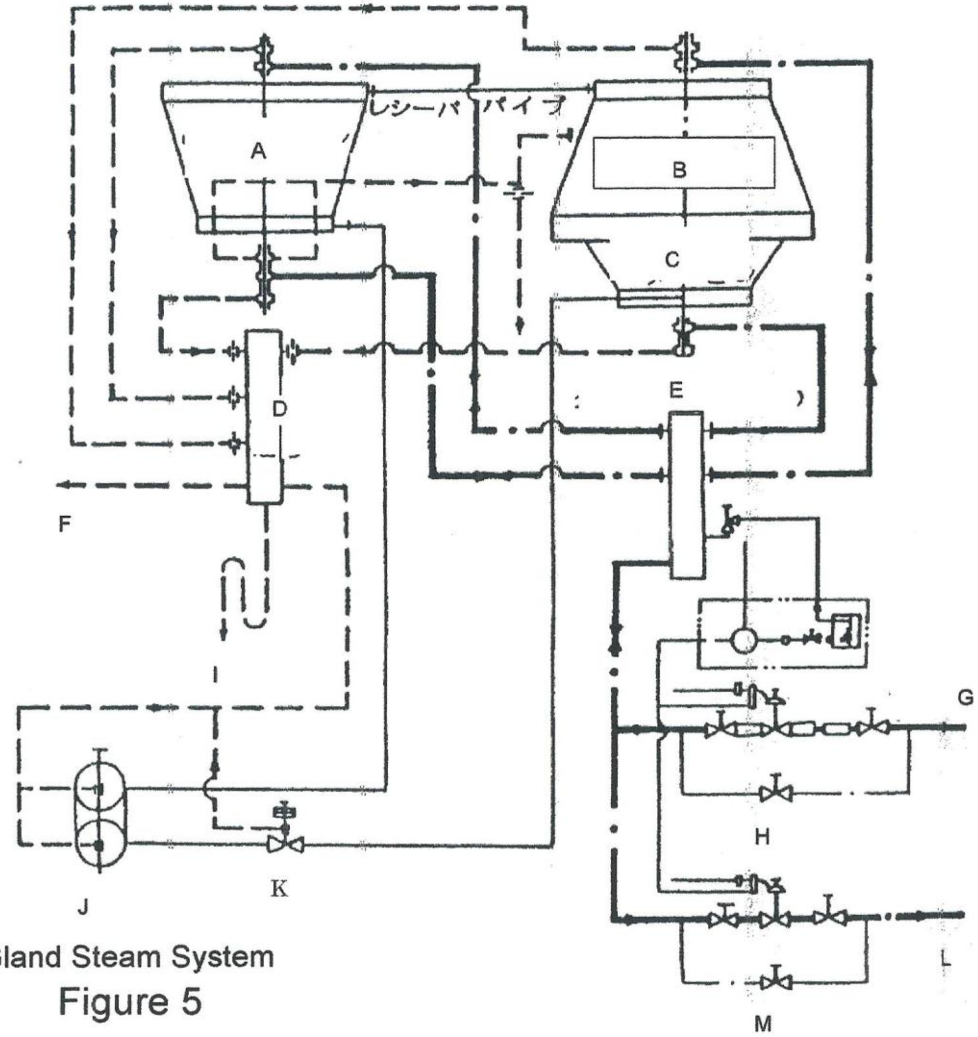
Condensate Water System
Figure 3



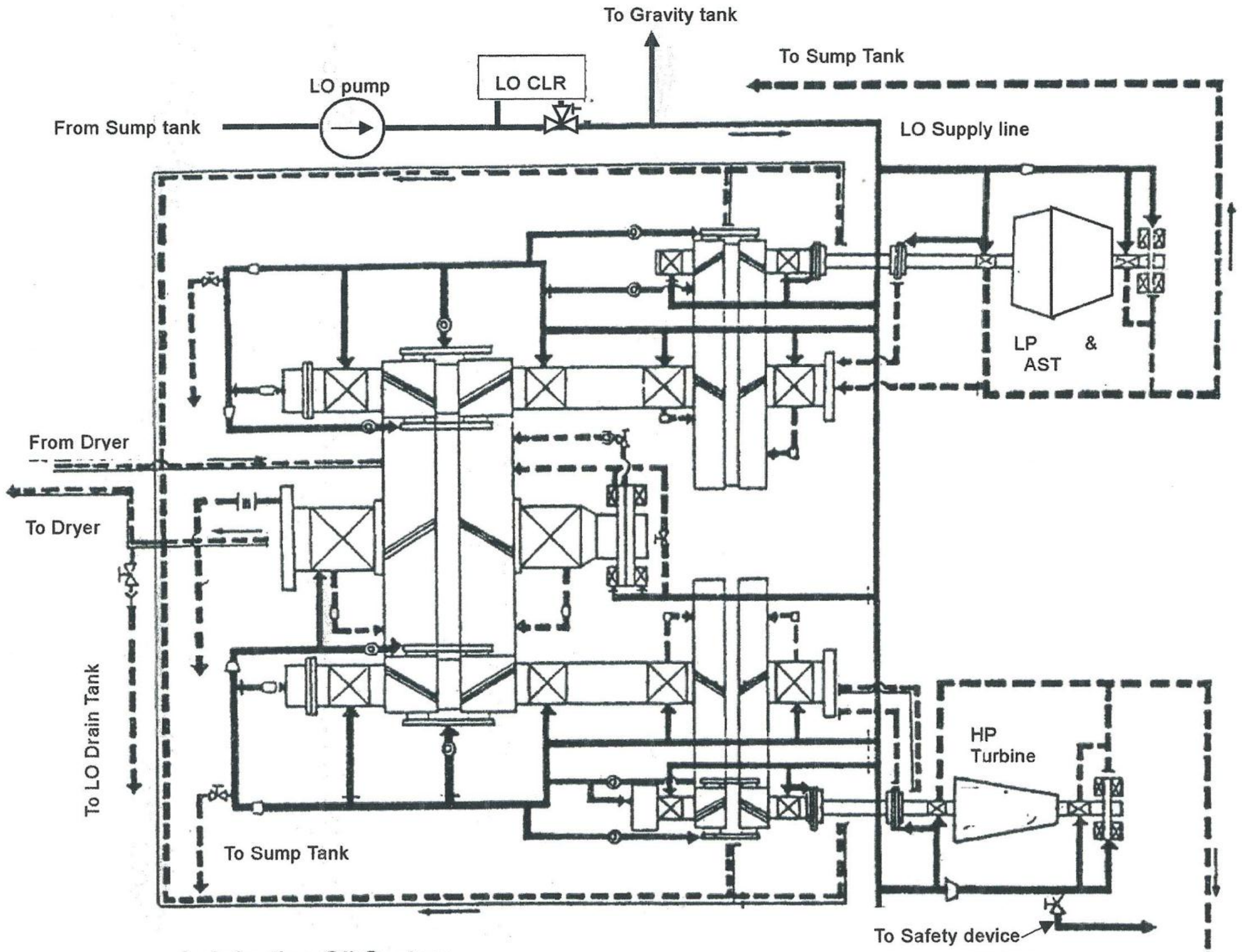
Feed Water System

Figure 4

A	High pressure turbine
B	Low pressure turbine
C	Astern turbine
D	Gland steam leak off receiver
E	Gland steam reservoir
F	To Gland condenser
G	From desuperheater line
H	Gland steam make up line
I	To bilge
J	Maneuvering valve
K	Astern guardian valve
L	To main condenser
M	Gland steam spill line



Gland Steam System
Figure 5



Lubricating Oil System
Figure 6

ERS II – 4

Training Title/Scenario: Operation of refrigeration, air conditioner and ventilation systems

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems

Table A-III/1 KUP: Preparation, operation, fault detection and necessary measures to prevent damage for refrigeration and control system

Time allocation: 4 hours

Outline of the training:

The instructor uses either provision refrigeration system or air conditioning system. The trainees make various operation procedures for operating the refrigeration system from the key boards in turn, watching the display on the screen.

In this training, the trainees perform the following operations.
1. Starting up the system in manual
2. Manual operation including changeover of compressors, alternation of setting temperature, defrosting, supply of LO and refrigerant.
3. Putting the system into automatic operation
4. Response to malfunctions (shortage of cooling water or similar malfunction, short cycle, liquid back, higher compression of compressor, activation of safety devices, etc.)
5. Shutting down the system

These operations are carried out in turn one by one as follow (Each period takes 60 min)

Trainee / Tasks		A	B	C	D	E
1st period	1	○				
	2		○			
	3			○		
	4				○	
	5					○
	1			○		

2nd period	2				○	
	3					○
	4		○			
	5	○				
3rd period	1				○	
	2					○
	3	○				
	4			○		
	5		○			

The instructor should arrange the combination of tasks 1 ~ 5 and the trainees in accordance with the number of trainees.

After completion of the operations, the trainees develop "Refrigeration cycle" on the Mollier diagram" and determine some running factors.
The instructor gives the trainees necessary running parameters and the diagram showing an example on the screen. (Refer to Figure 3)

Prerequisite:

- Theoretical fundamental knowledge on refrigeration
- Completion of ERS II-1

Note:

The instructor should note that all the trainees don't need to perform all the operations since all the trainees can perform similar operations and observe all performance being made by other trainees. However, according to the number of trainees and arrangement of the operations, it would become possible that all the trainees could experience all the operations.

With regard to development of refrigeration cycle, the instructor needs to prepare the running data based on the specification of the refrigerator and decide what running factors of the refrigerator should be determined. The instructor does not need to allocate a long time for this topic since theoretical issues are largely studied in their classroom lecture.

The instructor should explain specifications of the refrigeration system simulated
The instructor should prepare "Procedure Manual" for the system and explain main procedures.
The instructor should emphasize additionally in the briefing session:

- knowledge obtained from the training can be applied to actual tasks concerned in refrigerator
- although all the trainees may not perform all the tasks, observe carefully other trainee's performance
- The trainees may refer to the Procedure Manual accordingly

Specific purpose of the training:

The trainees acquire knowledge and skills on operations concerned in **refrigeration**.

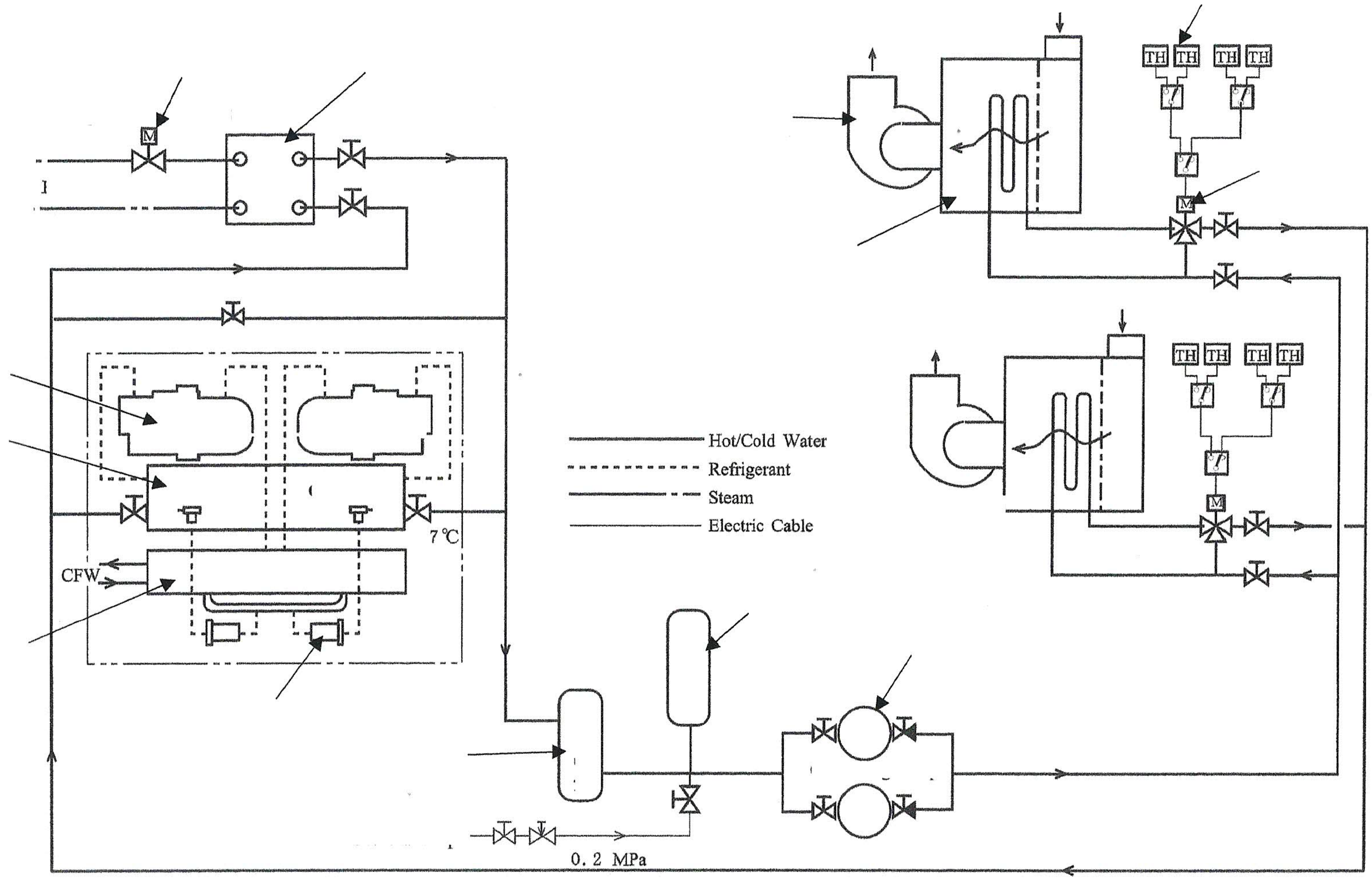
Implementation of the training

T in min	Training process

0 ~ 60
(1st period)
	(The instructor creates the initial condition as shutting down condition displaying system diagram on the and starts the training)
	1. Starting up the system in manual
	- Preparation
	    - Check the compressor for LO level (if the level is lower than its standard, supply LO following the procedure)
	    - Check the condenser for refrigerant level
	    - Establish cooling water line and begin supply of water
	    - Establish refrigerant line for No.1 compressor
	    - Check magnetic valves for operation
	    - Check setting value of temperature
	- Start of refrigerator
	    - Start fans of unit coolers in provision stores
	    - Open refrigerant valves to expansion valves
	    - Start No.1 compressor and stop the compressor accordingly as necessary
	(When condition of the system becomes stable, the instructor stops the simulation confirming the temperature goes down and creates the system in service as an initial condition to proceed with the next performance)
	
	2. Manual operation including changeover of compressors, alternation of setting temperature, defrosting, supply of LO and refrigerant.
	The instructor lets the trainee perform the following operations one by one:
	- Changeover of compressors
	- Alternation of setting temperature
	- Defrosting
	- Supply of LO

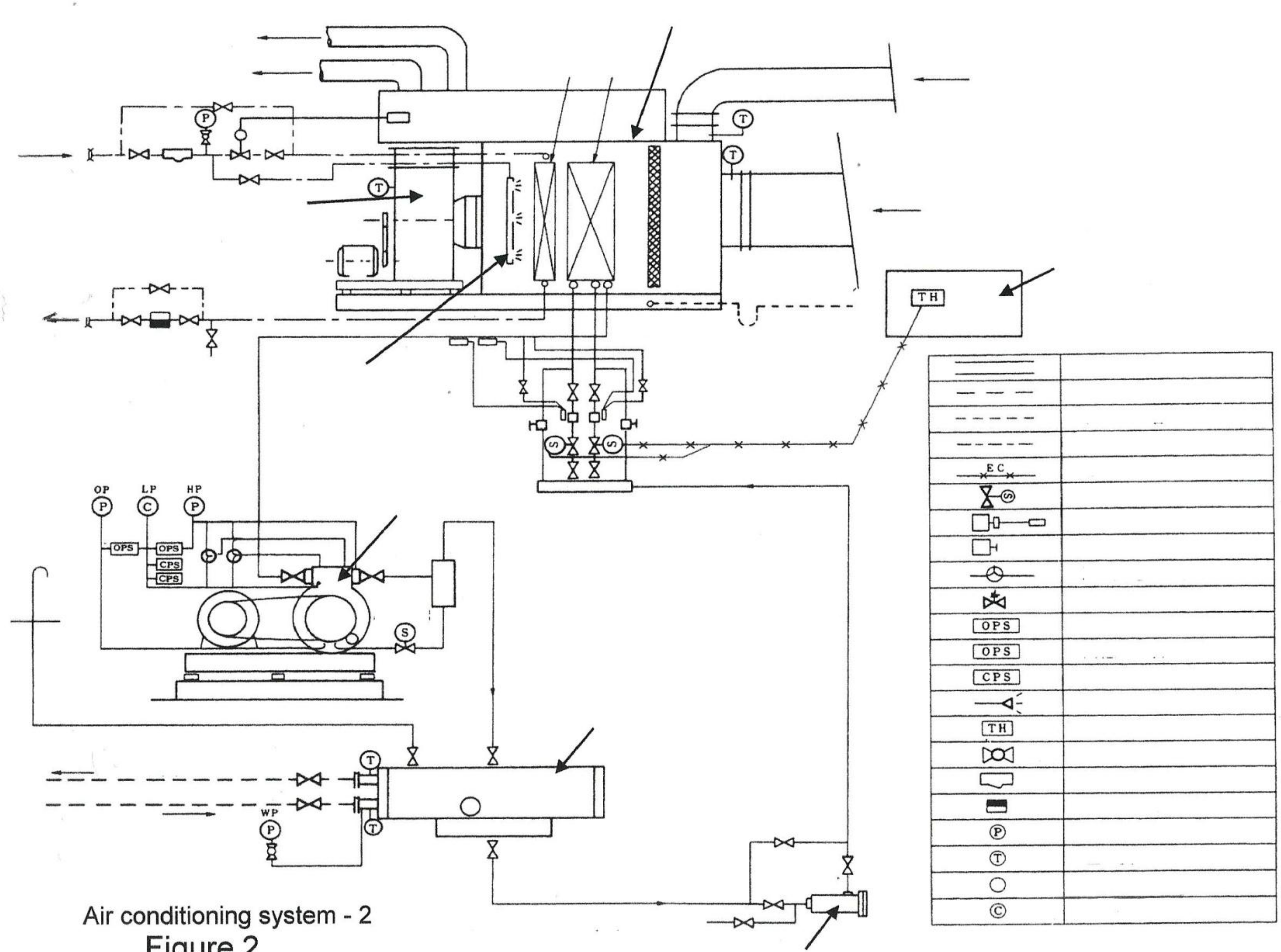
	- Supply of refrigerant.
	
	3. Putting the system into automatic operation
	After the operation 2, the instructor lets the trainee perform the task to the system into automatic operation.
	
	4. Response to malfunctions (shortage of cooling water or similar malfunction, short cycle, liquid back, higher compression of compressor, activation of safety devices, etc.)
	The instructor makes malfunctions and lets the trainee respond them. (Before inputting a malfunction, the instructor may brief meaning of the malfunction and how to address it)
	
	5. Shutting down the system
	After the operation 3, the instructor lets the trainee perform the operation to shut down the system changing over the system to manual operation.
	- Changeover of operation from auto to manual
	- Shutting down the system
	  - Close refrigerant valves to the expansion valves and condenser outlet valve.
	  - Start and stop the compressor according to the inlet pressure of the refrigerant in order to collect all the refrigerant.
	  - Close all the refrigerant valves concerned.
	  - Stop supply of cooling water
	Close all valves concerned in cooling water.
	(This is completion of 1st period and the instructor creates the initial condition for starting up the system)

60 ~ 120 (2nd period)	(The second period is repeated in same manner as the first period)
120 ~ 180 (3rd period)	(The third period is repeated in same manner as the first period and the instructor stops simulation)
180 ~ 210	The instructor gives "Mollier diagram" showing it on the screen and lets the trainees develop "Refrigeration cycle" giving necessary running parameters. (Refer to Figure 3) The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out. The instructor collects "Mollier diagram" and the report form after debriefing session.

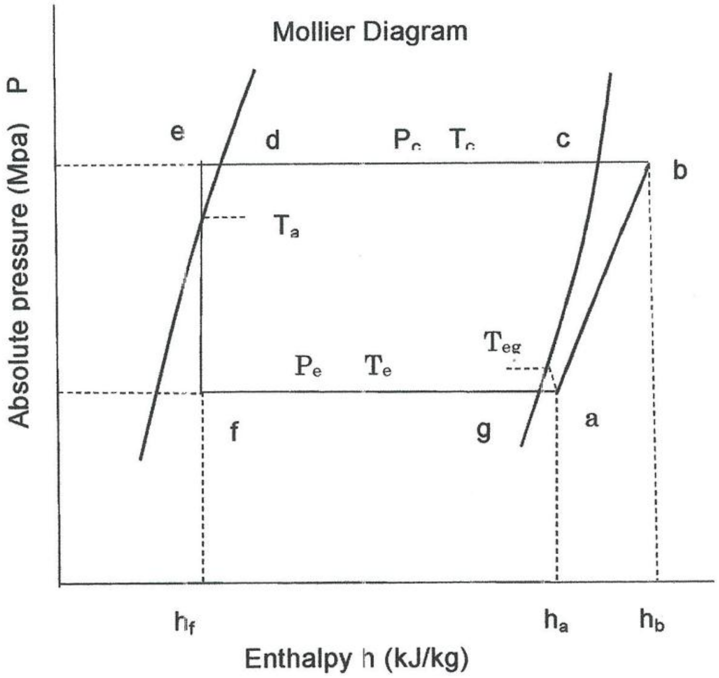


Air conditioning system - 1

Figure 1



Air conditioning system - 2
Figure 2



Refrigeration Cycle

Figure 3

P_c: Condensation pressure
P_e: Evaporating pressure
T_c: Condensation temperature
T_e: Evaporating temperature
h_a: Compressor inlet enthalpy
h_b: Compressor outlet enthalpy
h_e: Condenser outlet enthalpy
(Expansion valve inlet enthalpy)
h_f : Expansion valve outlet enthalpy = h_e

Degree of undercooling: $t_c = T_c - T_a$
Degree of superheat: $t_e = T_{eg} - T_e$
Refrigerating effect: $q_1 = h_a - h_f = h_a - h_e$
Compressor indicated output $L = h_b - h_a$
Condenser radiation amount $q_2 = h_b - h_e$
Coefficient of performance:
$\varepsilon = q_1 / L = (h_a - h_f) / (h_b - h_a)$

TRAINEE'S EVALUATION FORM FOR ERS II-4

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Operation of refrigeration, air conditioner and ventilation systems
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Operation of refrigeration system (If operation procedures for starting up and shutting down the system were based on correct understanding of refrigeration principles)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Associate work on refrigeration system (If associate work such as changeover of compressors, alternation of setting temperature, defrosting, supply of LO, supply of refrigerant)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Response to malfunctions (If there were no incorrect procedures and the operation was done in smooth, effective and confident manner)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Refrigeration cycle (This is evaluated by the results of their development of refrigeration cycle in terms of accuracy)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Cooperativeness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ________________________________

ERS II – 5

Training Title/Scenario: Operation Characteristics of Pumps

Table A-III/1 Competence: Operate fuel, lubrication, ballast and other pumping systems and associated control systems
Table A-III/1 KUP: Operational characteristic of pumps and piping systems including control systems

Time allocation: 3.5 hours

Outline of the training:
The trainees watch simulation video that introduces operation characteristics of various pumps and perform operations to understand pumps' operation characteristics staring pumps and watching running parameters.
After the simulation, the trainees perform an experiment for operation characteristics of centrifugal pump on the simulated experimental pumping system.

Prerequisite:
Fundamental theoretical knowledge on pumps

Note:
The trainees should clearly understand pump characteristics, developing characteristic performance curve of centrifugal pump mainly used on board ships.

Specific purpose of the training:
The trainees will be able to understand pumps' operation characteristics.
The trainees will be able to calculate total head, shaft power and water power of pump, and pump efficiency.

Implementation of the training

T in min	Training process
0 ~ 20	The trainees watch the simulation video that introduces operation characteristics of various pumps such as centrifugal pump, gear pump, axial flow pump and positive displacement pump.
20 ~ 60	The instructor indicates simulated pumping system diagram on the screen and the trainees perform operations watching running parameters in turn. (Centrifugal pump) - Open No.1 pump suction valve - Start No.1 pump - Open No.1 pump delivery valve step by step until full open

	- Adjust the pump's rotation speed in a certain range - Open No. 2 pump suction valve - Start No,2 pump - Connect No. 2 pump to No.1 pump in parallel. - Open No.2 pump delivery valve step by step until full open - Change over the connection of pumps to series running. - Close No.2 pump delivery valve - Stop No.2 pump and close its suction valve - Close no.1 pump delivery valve - Stop No. 1 pump and close its suction valve (Gear pump) (Reciprocating pump)
60 ~ 120	The instructor displays the simulated experimental system diagram of centrifugal pump on the screen and briefs measurement table, calculation table and calculation methods. The trainees start the pump and record running parameters changing quantity of discharge as follow. - Open the pump suction valve and start the pump - Open the pump delivery valve step by step keeping same increasing rate of discharge and recording running parameters at each opening of the valve. (The trainees record the running parameters at least ten times) After collecting the running parameters, the trainees calculate total head, shaft power, water power and pump efficiency flowing the calculation methods, and develop characteristic curve.
120 ~ 150	The instructor stops the simulation and explain briefly how to develop characteristic curve and instructs the trainee to submit the developed performance curve and calculation table by the deadline as a report. (The report must be used for evaluation) The instructor finally gives "Report form" and lets the trainees fill out to dismiss the trainees.

Calculation Method

1. Total head: H (m)

Total head = Actual head + Loss

$$H = \frac{(P1 - P2)}{\rho g} + (h1 - h2)$$

P_1: Discharge pressure (Pa)

P_2: $G_2 \times g \times \rho$ (Pa) G_2: Suction pressure (mAq)

g: Acceleration of gravity (9.80665 m/s^2)

h_1: Distance between center of the pump and pressure gauge of discharge side

h_2: Distance between center of the pump and detecting point of suction pressure

ρ: Density of water (1000 kg/m^3)

2. Shaft power (L_b)

$L_b = \sqrt{3}$ EI $\times$ cos$\Phi \times \eta_m$/1000 (kW)

E: Voltage

I: Current value

cosΦ: Power factor

η_m: Motor efficiency (This can be obtained from the current value and the motor characteristic performance curve provided)

3. Water power

$$Lw = \frac{\rho \times Q \times g \times H}{1000} \text{ (kW)}$$

Q: Pumping discharge (m^3/sec)

4. Pump efficiency

η_p = (Lw/Lb) $\times$ 100 (%)

5. Correction to specified speed

When measured value of revolution speed of the pump does not meet its specified speed, correction to the specified speed is necessary as follow.

$Q = Q1\,(N/N1)$, $H = H1\,(N/N1)^2$, $L = L1\,(N/N1)^3$

N: Specified speed (min^{-1})

Q: Quantity of discharge (m^3/sec)

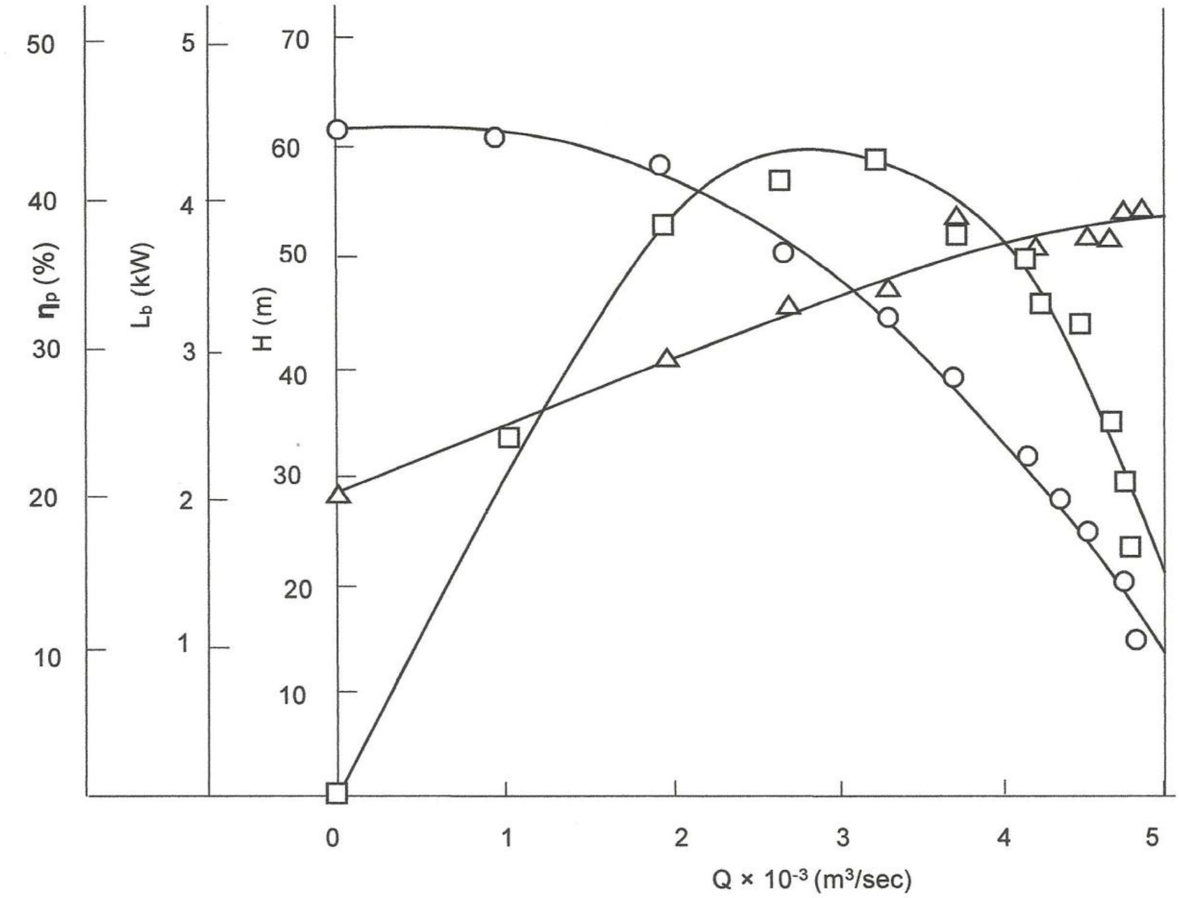
H: Total head (m)

L: Shaft power (kW)

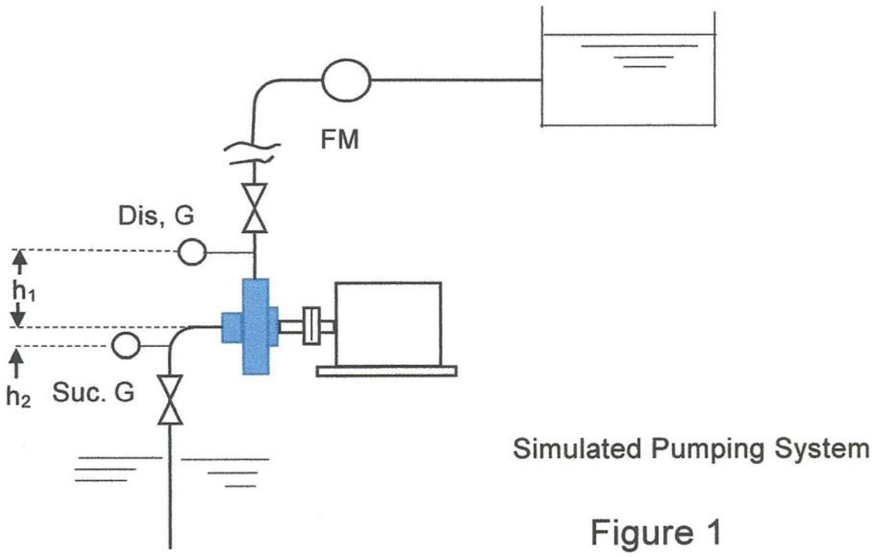
N1, Q1, H, L1: Measured value

Measurement and Calculation Table (Name:)

No. of Measurement	Revolution Speed (min^{-1})	Quantity of Discharge: Measured Disch. Flow meter: Q (l)	Quantity of Discharge: Time (sec)	Quantity of Discharge: Quantity Disch. (m^3/s) $\times 10^{-3}$	Quantity of Discharge: Corrected value (m^3/s) $\times 10^{-3}$	Total Head: Discharge Press. (Mpa)	Total Head: Suction Press. (mAQ)	Total Head: Total Head (m)	Total Head: Corrected value (m)	Water Power (kW)	Motor: Voltage (V)	Motor: Current value (A)	Motor: Power Factor	Motor: Motor Efficiency (%)	Motor: Output (kW)	Motor: Corrected value	Pump Efficiency
	1715		22.17	4.51	4.73	0.11	-6.0	17.19	18.93	0.88	191	13.1	93.5	87.6	3.55	4.10	21
	1740		51.33	1.95	2.02	5.2	-2.5	53.69	57.46	1.14	193	10.5	91.5	88.2	2.83	3.14	36.2



Characteristic Performance Curve of Centrifugal Pump



Simulated Pumping System

Figure 1

ERS II – 6

Training Title/Scenario: Operation of ballast and cargo pumping systems

Table A-III/1 Competence: Operate fuel, lubrication, ballast and other pumping systems and associated control systems

Table A-III/1 KUP: Operation of pumping systems
.2 operation of bilge, ballast and cargo pumping systems

Time allocation: 2 hours

Outline of the training:

The trainees perform operations concerning cargo loading and cargo discharging based on the functions and specification of the ship by turns following instructions from the instructor.

Prerequisite:

Knowledge on significance of cargo operations

Note:

All the trainees don't need to perform all the tasks since all the trainees can perform similar tasks and observe all performances being made by other trainees. However, according to the number of trainees and arrangement of the tasks, it would become possible that all the trainees could experience all the tasks.

The trainees may refer to the Procedure Manual accordingly.

Specific purpose of the training:

The trainees will be able to become familiar with cargo operations and to understand pumping systems concerned.

Implementation of the training:

T in min	Training process
0 ~ 20	The instructor shows the trainees the simulation video that introduces ballast and cargo piping systems. The instructor should brief the piping systems and fittings as necessary. (Refer to Figure 1 ~ 2 as examples)
20 ~ 90	The instructor indicates simulated ballast and cargo piping systems on the screen and the trainees perform operations/tasks from the key boards following the instructor's instructions in turn as follow. 1. Oil cargo loading The instructor gives several conditions to load oil cargo according to the specifications of the simulated systems such as oil specification, quantity of oil, draft, trim and heel. 2. Transferring oil cargo between tanks The instructor gives the instructions concerning trim and heel of the hull. 3. Ballast water loading and discharging The instructor gives the instructions concerning trim and heel of the hull. 4. Line air purge The instructor lets the trainee carry out air purge of the piping line. 5. Cargo discharging The instructor gives instructions concerning quantity of oil and kind of oil. 6. Tank cleaning The instructor lets the trainee carry out tank cleaning. After completion of the operations, The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

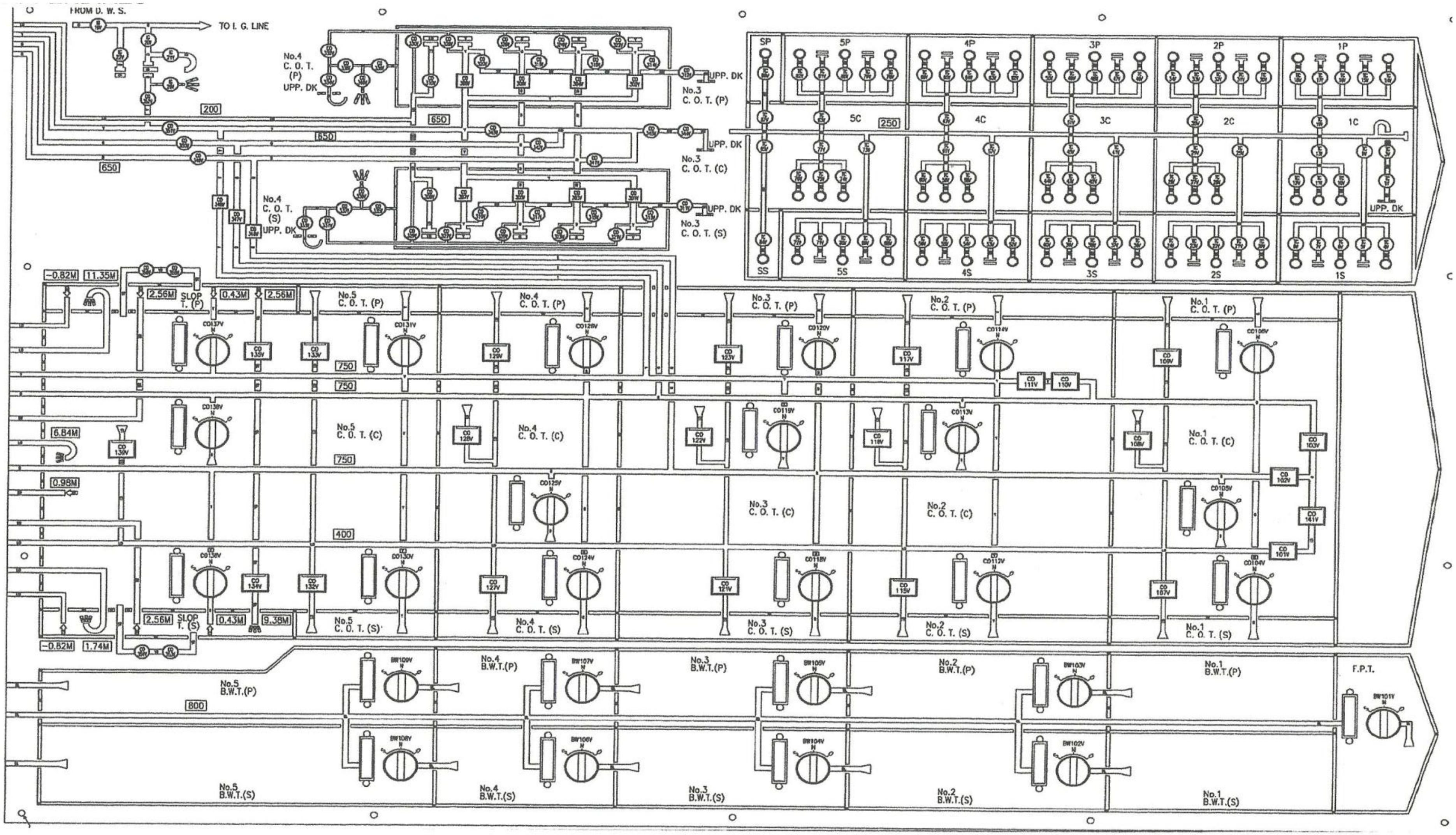
TRAINEE'S EVALUATION FORM FOR ERS II - 6

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Operation of ballast and cargo pumping systems
Date of Training	

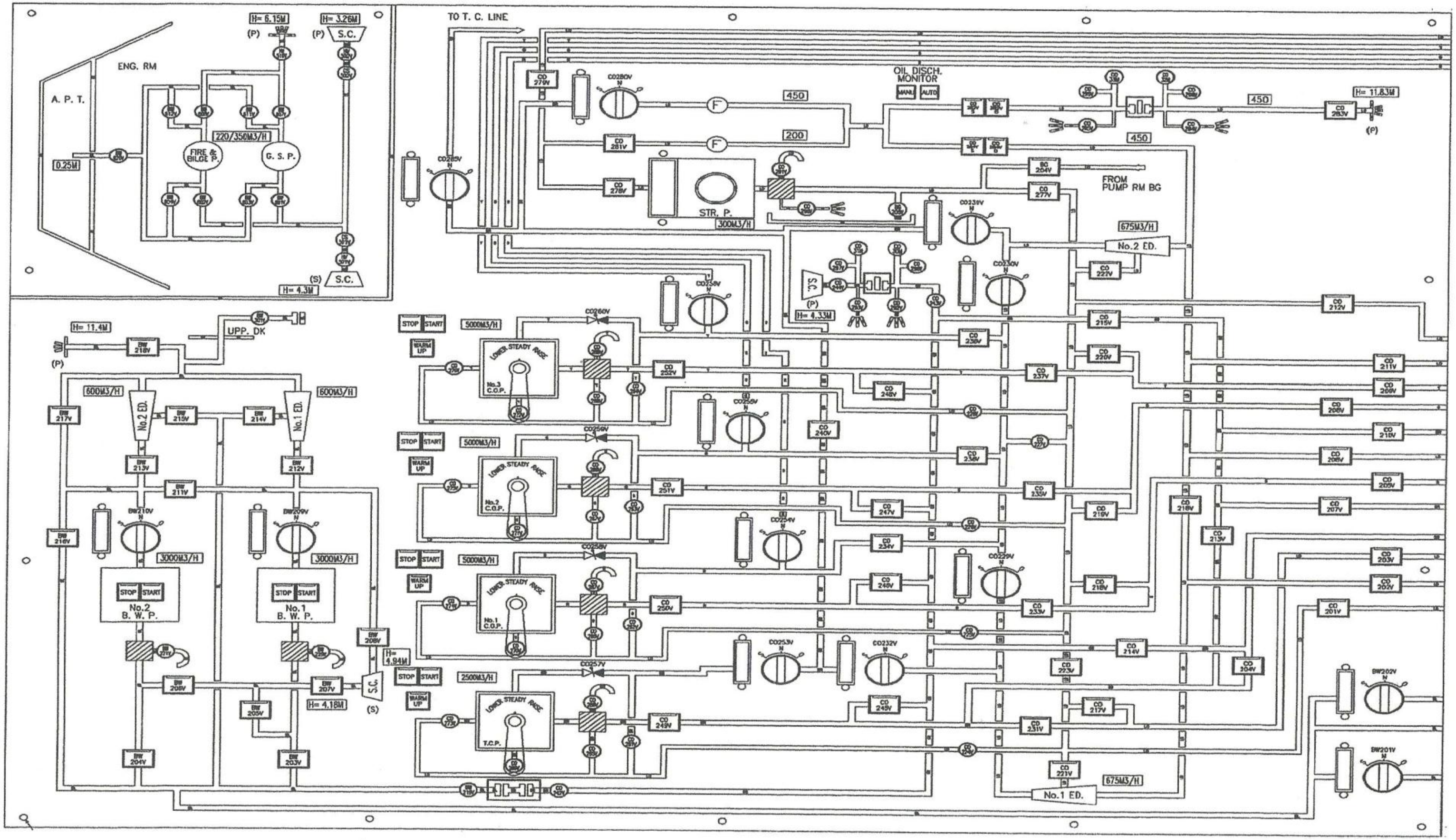
Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Understanding of the pumping systems (If the trainee understood piping arrangements and fittings necessary for loading and discharging cargo)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Functions of system components (If the trainee understood functions of system components and fittings)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Operation of the pumping systems (If there were no incorrect procedures and the operation was done in smooth, effective and confident manner)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ______________________________



Cargo Tank Piping
Figure 1



Cargo Pump Room Piping
Figure 2

ERS II – 7

Training Title/Scenario: Basic configuration and operation principles of generator and distribution systems

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment
.1 electrical equipment
   .a generator and distribution systems

Time allocation: 2 hours

Outline of the training:

The trainees watch simulation video that introduces configuration of a generator and distribution systems and perform simulations concerning operation principles of components constructing the generator and the distribution systems. After the simulations, the trainees complete an assignment answering to questions about what they learned through the simulation.

Prerequisite:

Fundamental knowledge on the generator and the distribution systems

Note:

Specific purpose of the training
The trainee acquire knowledge on:
- what components construct the generator and distribution systems;
- construction of the generator and distribution systems
- operation principles, mechanism and design features of the system; and
- functions and operation mechanism of the components.

Implementation of the training

T in min	Training process
0 ~ 20	The instructor shows the trainees the simulation video that introduces construction of generator and distribution systems, functions of the components and how they work. (Refer to Figure 1 ~ 5)
20 ~ 40	The instructor indicates drawings/diagrams of the generator and distribution systems on the screen and the trainees label their components with reference to the simulation video. (The instructor lets the trainees enter their solutions from their key boards, or answer orally, naming the trainee by turns.)
40 ~ 60	The instructor shows the trainees the simulation video that introduces construction of the main components constructing the generator and distribution systems and how they work. The trainees label the main parts of components with reference to the simulation video. (The instructor lets the trainees enter their solutions from their key boards, or answer orally, naming the trainee by turns and lets the trainee describe their functions)
60 ~ 90	(The instructor stops the simulation and lets the trainees complete the assignment giving assignment paper and another 30 minutes)

ASSIGNMENT

(The following questions are based on the sample drawings)

Name		Date	
Reg. No		Scenario: Basic configuration and operation principles of Generator and Distribution systems	
Class			

1. Identify main components/parts of the generator in Figure 1

2. Explain briefly how electric power is generated with reference to Figure 1 and 2.

3. Explain the main power distribution system with reference to Figure 3

4. Explain the emergency power distribution system with reference to Figure 3

5. Explains basic purposes of switches, circuit breakers and fuses

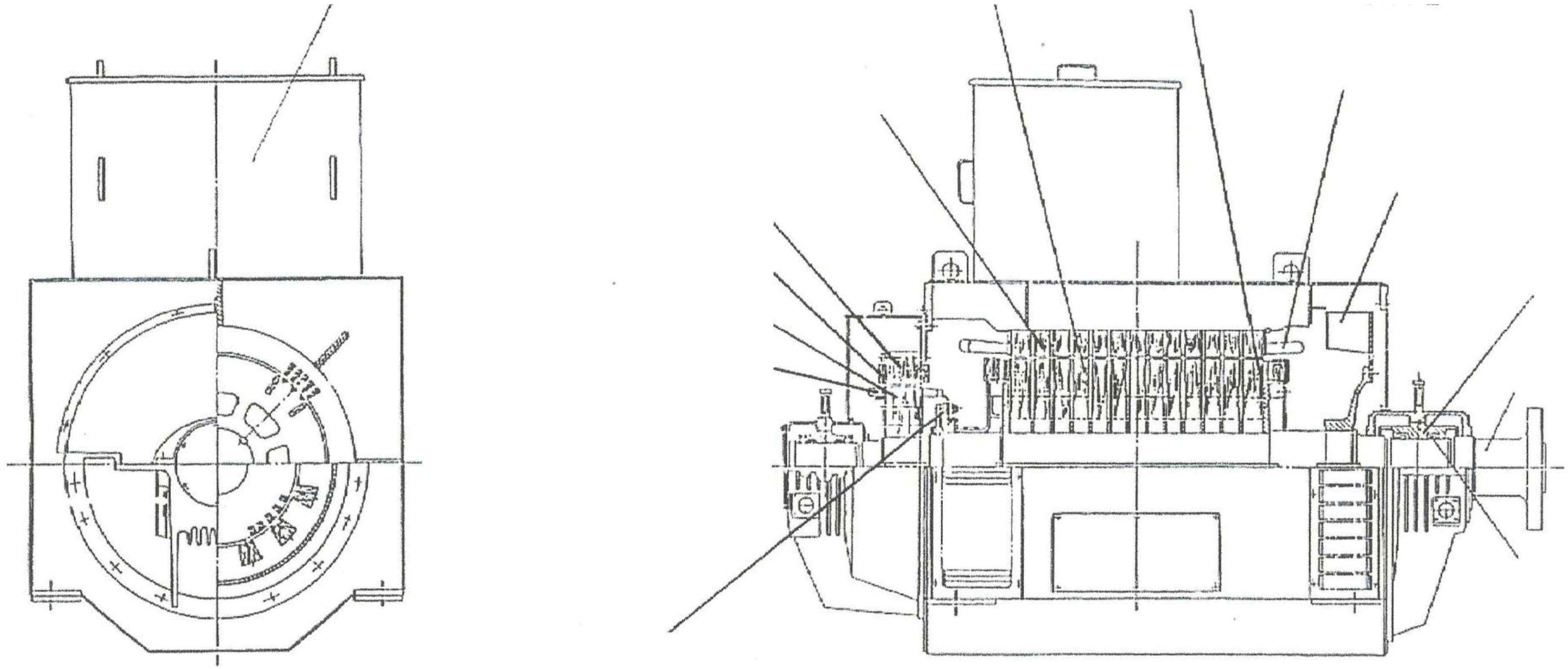
6. Explain purposes of the following parts of main switch board in Figure 4
- synchronizing panel
- generator panel
- common 440 V feeder panel
- No1 and 2 440 V feeder panel

7. Explain meaning of two feeder panels (No1. and No.2 Feeder panel)

8. Identify main components/parts of the mold circuit breaker in Figure 5

9. Identify main components/parts of the air circuit breaker (ACB).

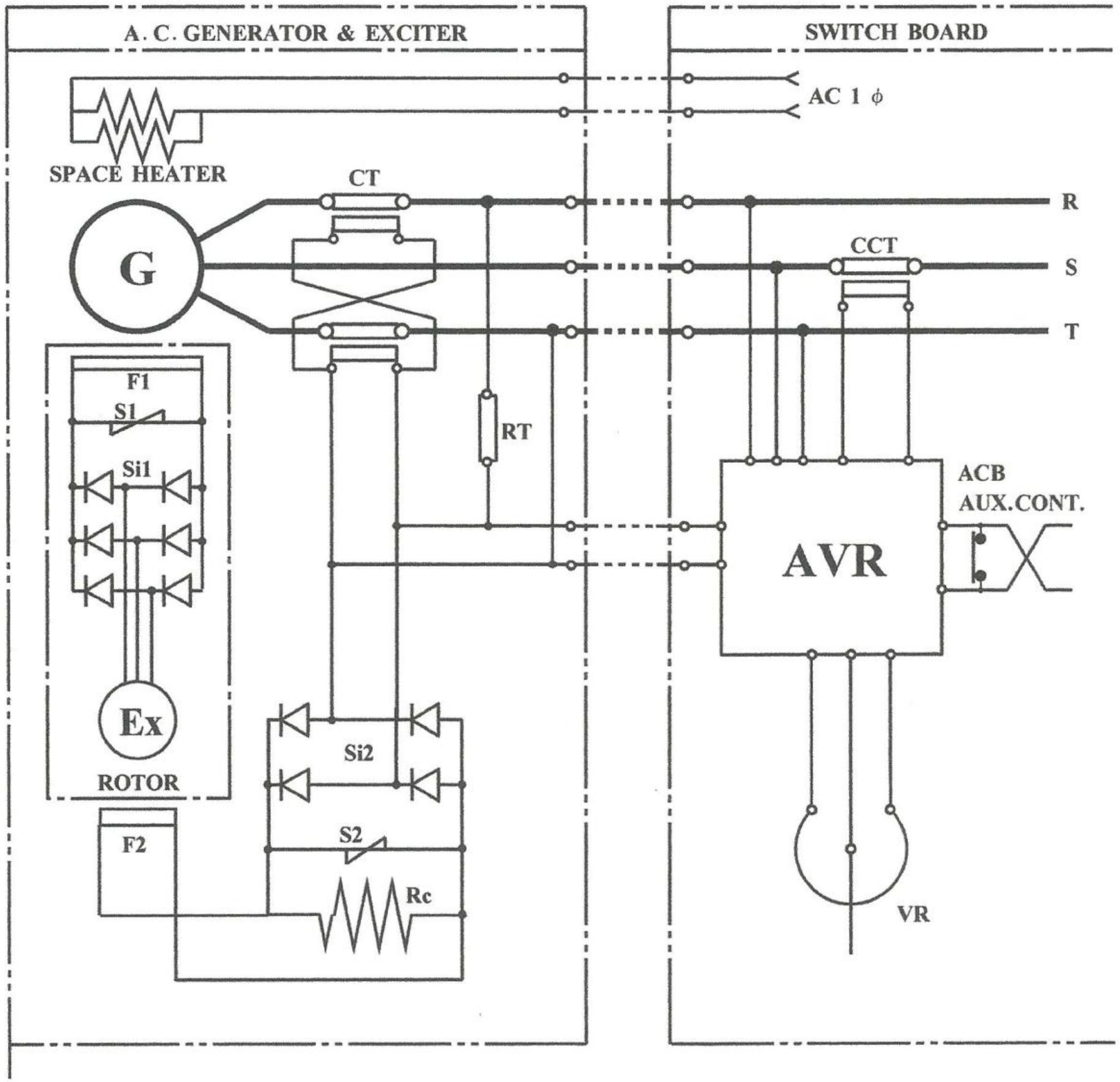
10. List functions incorporated in ACB



Construction of Generator

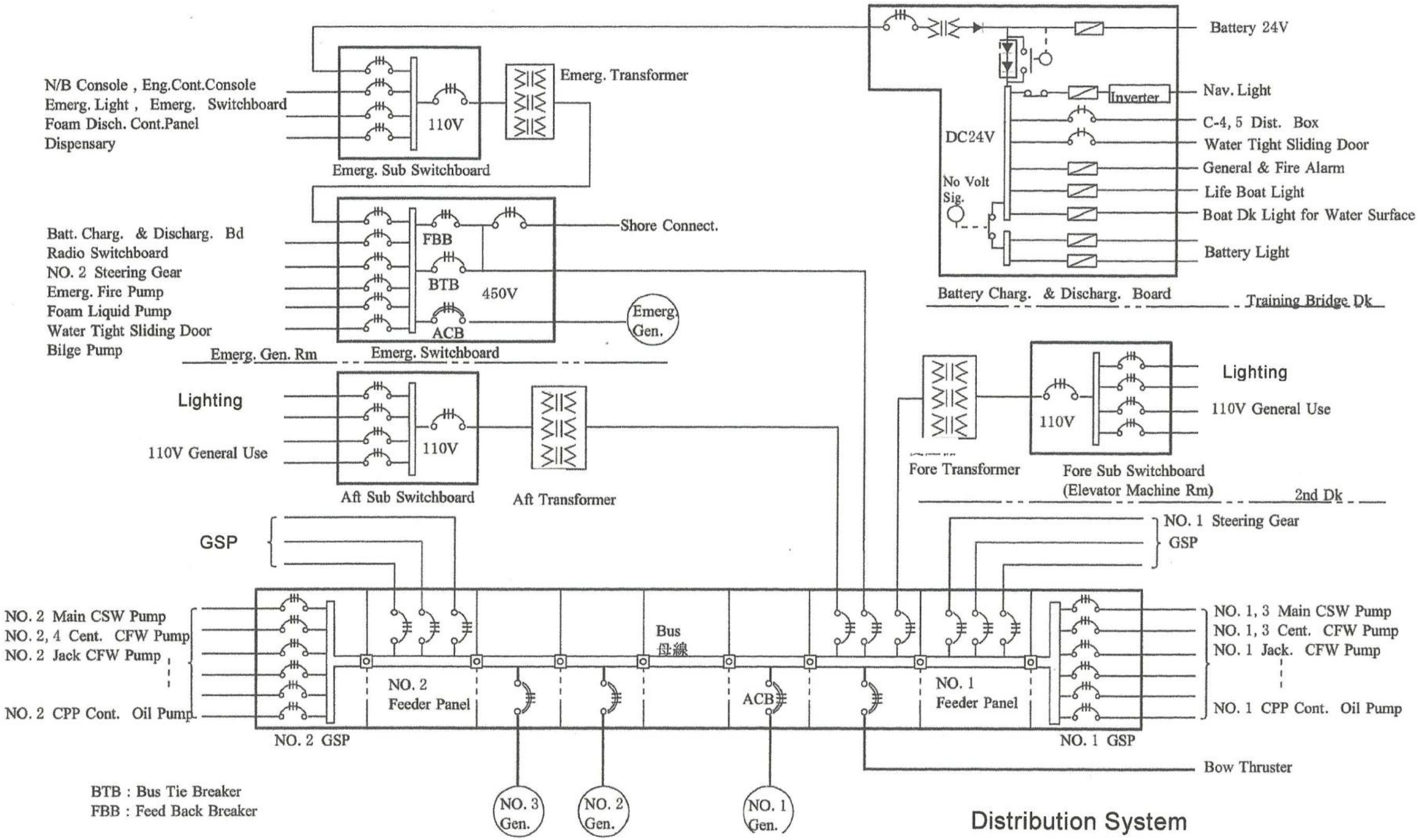
Figure 1

G	
F1	
S1, 2	
Si1, 2	
Ex	
F2	
Rc	
CT	
RT	
CCT	
AVR	
VR	



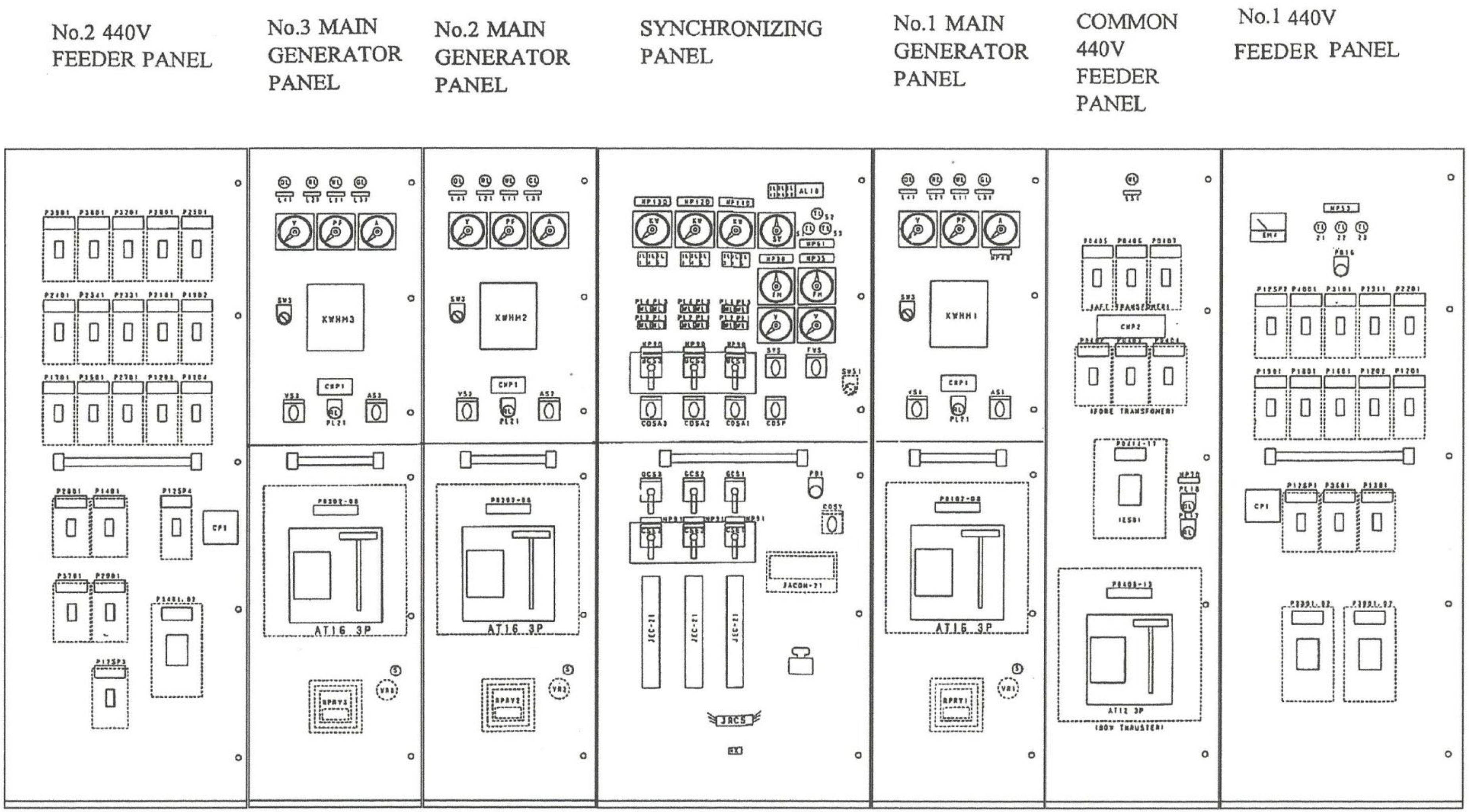
Configuration of Generator

Figure 2



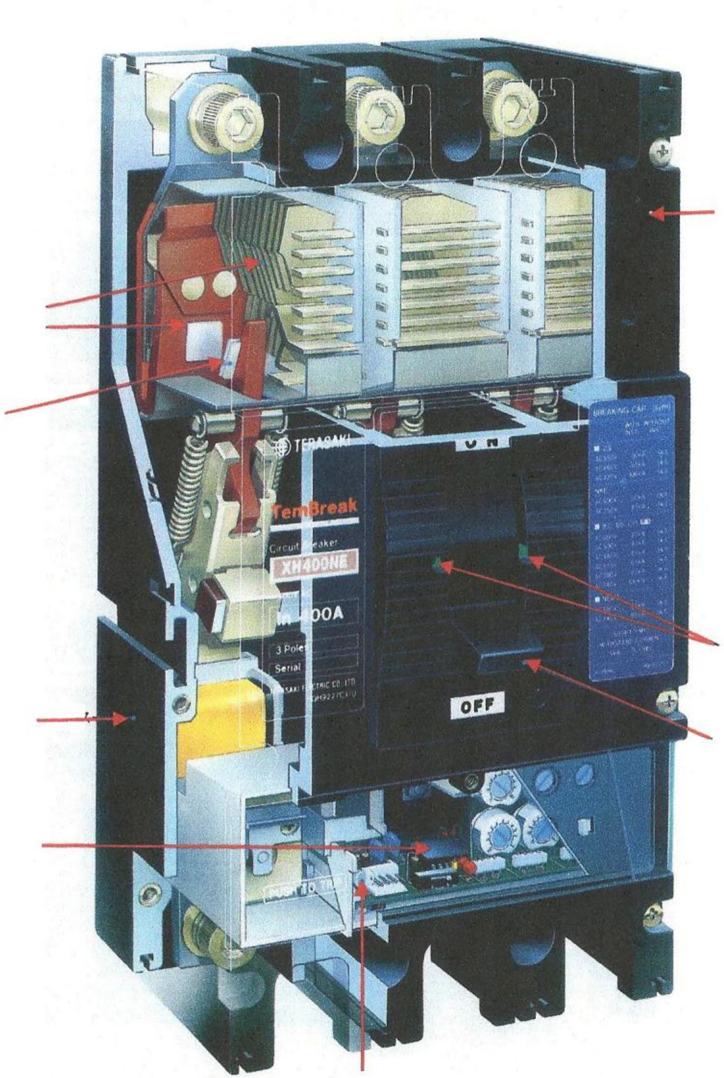
Distribution System

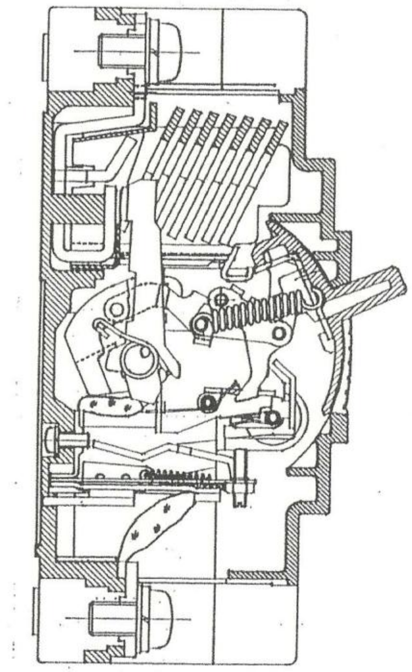
Figure 3



Main Switch Board (MSB)

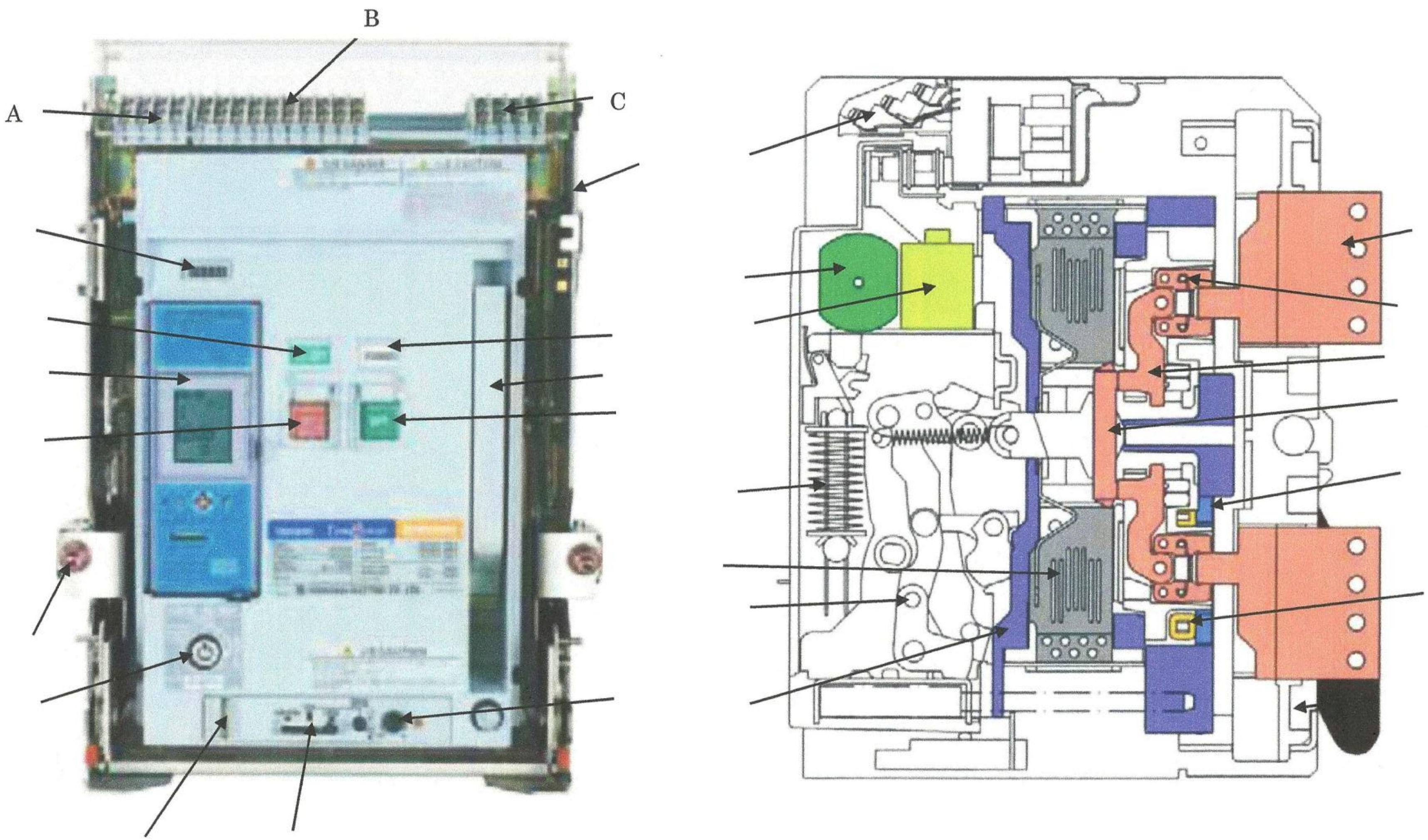
Figure 4





MCCB
(Mold Case Circuit Breaker)

Figure 5



ACB (Air Circuit Breaker)

Figure 6

ERS II – 8

Training Title/Scenario: Starting methodologies of an electric motor

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment
.1 electrical equipment
.c electric motors including starting methodologies

Time allocation: 4 hours

Outline of the training:

The trainees watch simulation video that introduces various sequential actions taken place in starter circuits for starting an electric motor. The trainees perform operations to start and stop the motors and to address malfunctions from the key boards in turn. The instructor gives advice to the trainees accordingly.

In this training, the trainees watch simulated actions of the following starter and motor control circuits and perform the operation on these diagrams.
1. Direct-on-line
2. Direct-on-line reverse
3. Star-Delta
4. Reactor
5. Inverter
6. Thyrister (Softstarter)

These operations are carried out in turn one by one as follow (Each period takes 60 min)

Tasks \ Trainee		A	B	C	D	E
1st period	1	○				
	2		○			
	3			○		
	4				○	
	5					○
	6	○				
2nd period	1			○		
	2				○	
	3					○
	4		○			
	5	○				
	6			○		
3rd period	1				○	
	2					○
	3	○				
	4			○		
	5		○			
	6				○	

The instructor should arrange the combination of operations 1 ~ 6 and the trainees in accordance with the number of trainees.

Prerequisite:

- Theoretical fundamental knowledge on electric motor starting methodologies
- Completion of ERS I-12 training

Note:

The instructor should note that all the trainees don't need to perform all the operations since all the trainees can perform similar operations and observe all performance being made by other trainees. However, according to the number of trainees and arrangement of the operations, it would become possible that all the trainees could experience all the operations.

The instructor should emphasize that there are approximately a hundred motors and their various starter circuits on board according to capacities and features of the motors.
The engineer officers need to be able to read these starter circuit diagrams.

Specific purpose of the training:

The trainees will be able to read motor starter circuit diagrams and acquire knowledge and skills on motor starting methodologies.
The trainees understand functions incorporated in starter circuits such as manual start and stop, automatic start and stop, automatic changeover, automatic restart (sequential restart).

Implementation of the training

T in min	Training process
0 ~ 30	The instructor shows the trainees the simulation video that introduces sequential actions taken place in starter circuits for starting and stopping motors as follow. (Refer to Figure 1 ~ 6 as examples) - Direct-on-line - Direct-on-line reverse - Star-Delta - Reactor - Inverter - Thyrister (Softstarter) (The instructor should brief meaning of manual start and stop, automatic start and stop, automatic changeover, sequential restart and starting principles in accordance with motor capacities and features.) The trainees should make sure the following control circuits other than staring methodologies used for main circuits: - self-keeping/holding circuit - reverse direction circuit - sequential restarting circuit - automatic changeover circuit - automatic starting and stopping circuit

30 ~ 90 1st period	(The instructor lets the trainees perform operations for 1 ~ 6 staring methodologies as assigned for the 1st period indicating relevant starter circuit diagrams on the screen. The instructor names the trainees by turns) The trainees should perform operations on the simulated starter circuits confirming the functions and features incorporated in the circuits as follow 1. manual start of the motors in various methods used for main circuits 2. start of the motor in reverse direction 3. automatic changeover 4. sequential restart 5. automatic start and stop
90 ~ 150 2nd period	(The instructor lets the trainees perform operations for 1 ~ 6 staring methodologies as assigned for the 2nd period indicating relevant starter circuit diagrams on the screen. The instructor names the trainees by turns) The trainees perform operations on different starter circuit diagrams.
150 ~ 210	(The instructor lets the trainees perform operations for 1 ~ 6 staring methodologies as assigned for the 3rd period indicating relevant starter circuit diagrams on the screen. The instructor names the trainees by turns) The trainees perform operations on different starter circuit diagrams. (After the debriefing, the instructor gives the report form and lets them fill out)

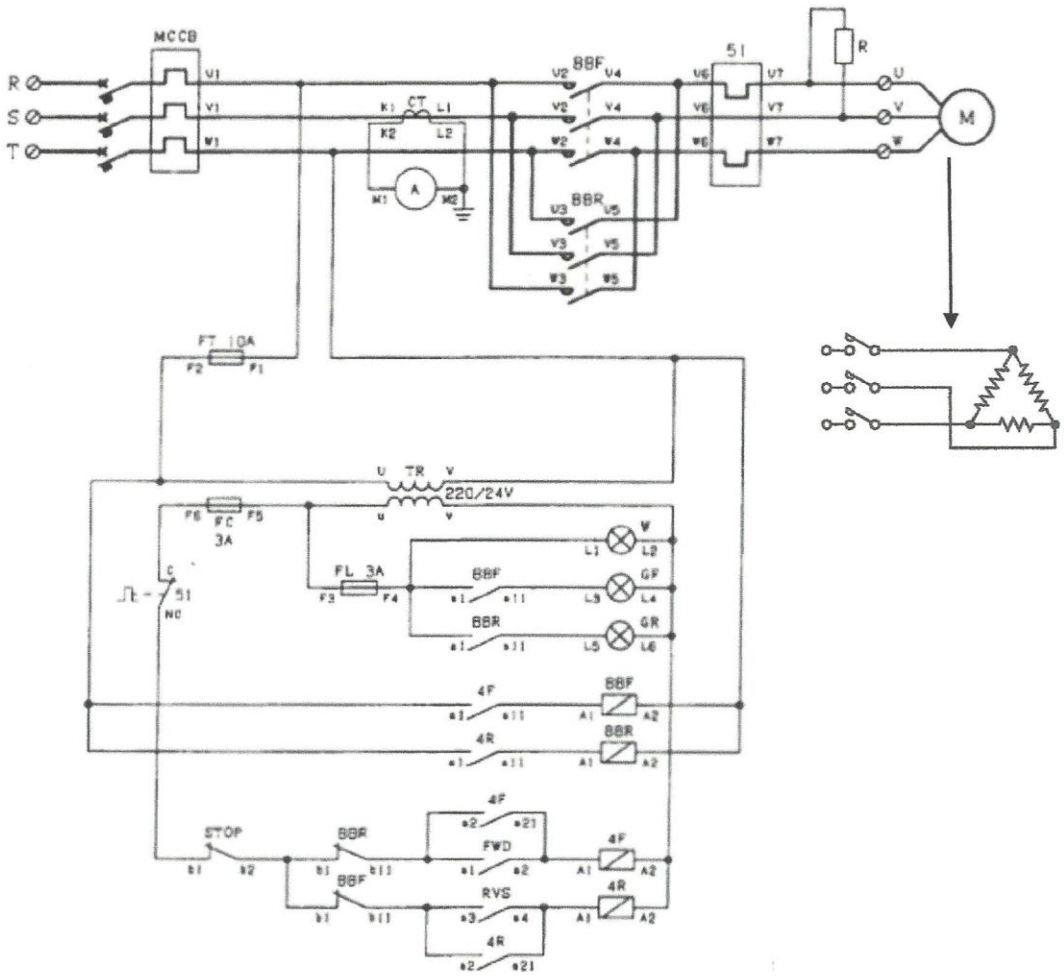
TRAINEE'S EVALUATION FORM FOR ERS II- 8

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Starting methodologies of an electric motor
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

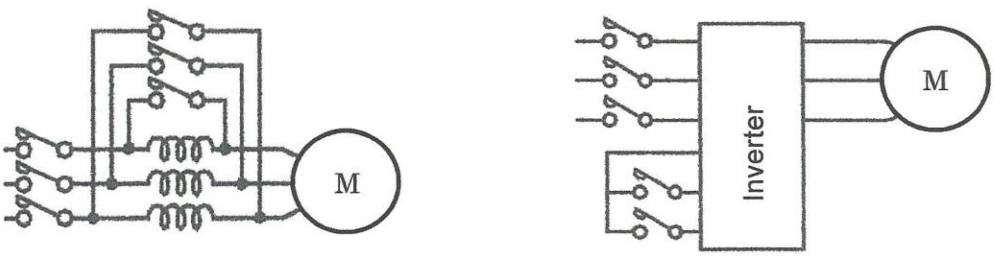
Item	T	Mark
1. Understanding of starter circuits (If the trainee understood operation principles and purposes of starter circuits)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Functions of starter circuits (If the trainee understood starting methodologies and their functions)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Comprehension to control/sequential circuits (If the trainee could read/follow the starter circuit diagrams)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Functions of control units (If the trainee understood functions and characteristics of integrated/molded control circuit units like PLC used for starter circuits)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Attentiveness, Cooperativeness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ______________________



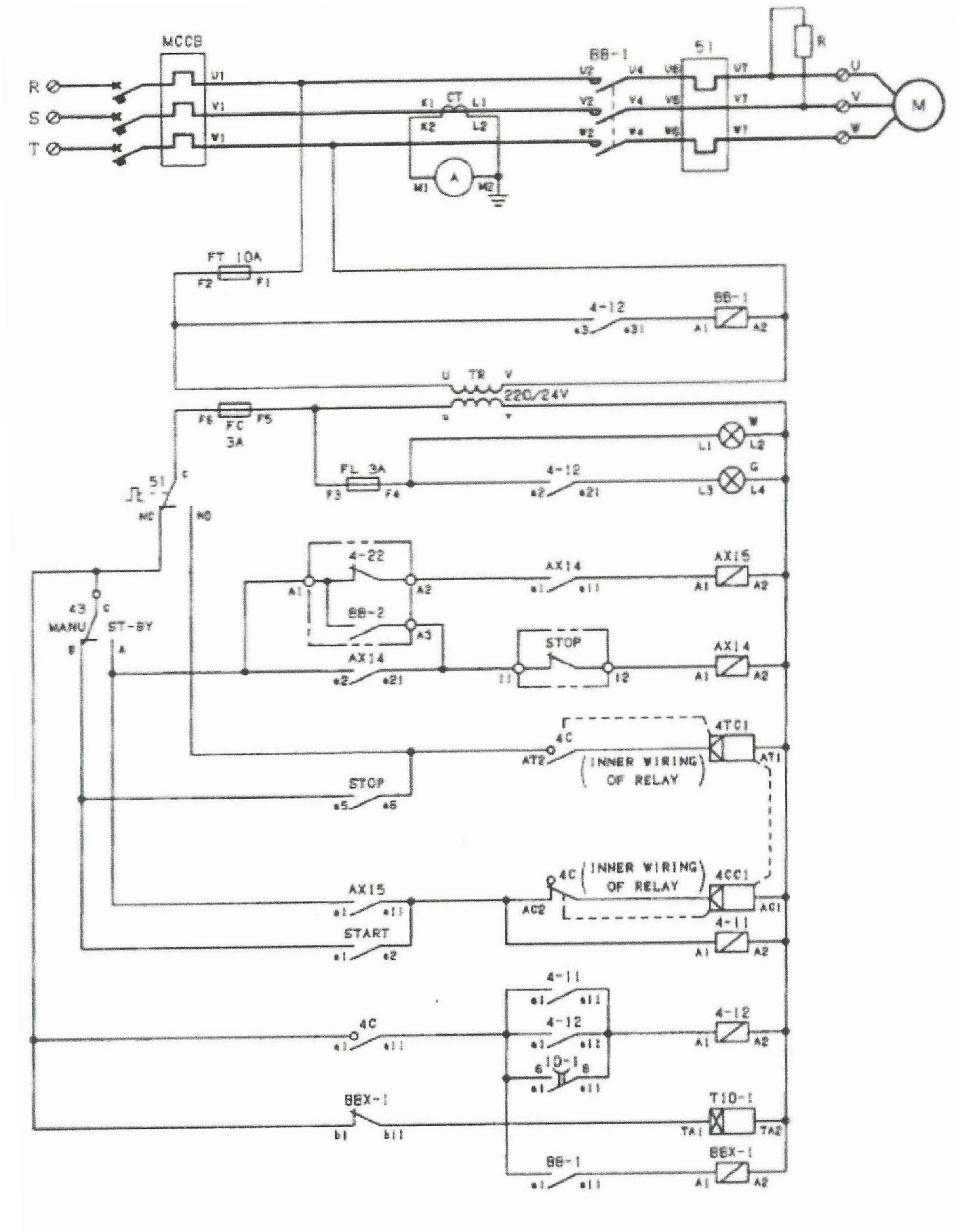
Direct-on-line Reverse

Figure 1



Main Circuit of Reactor and Inverter Start

Figure 2



Direct-on line Low Volt Release

Figure 3

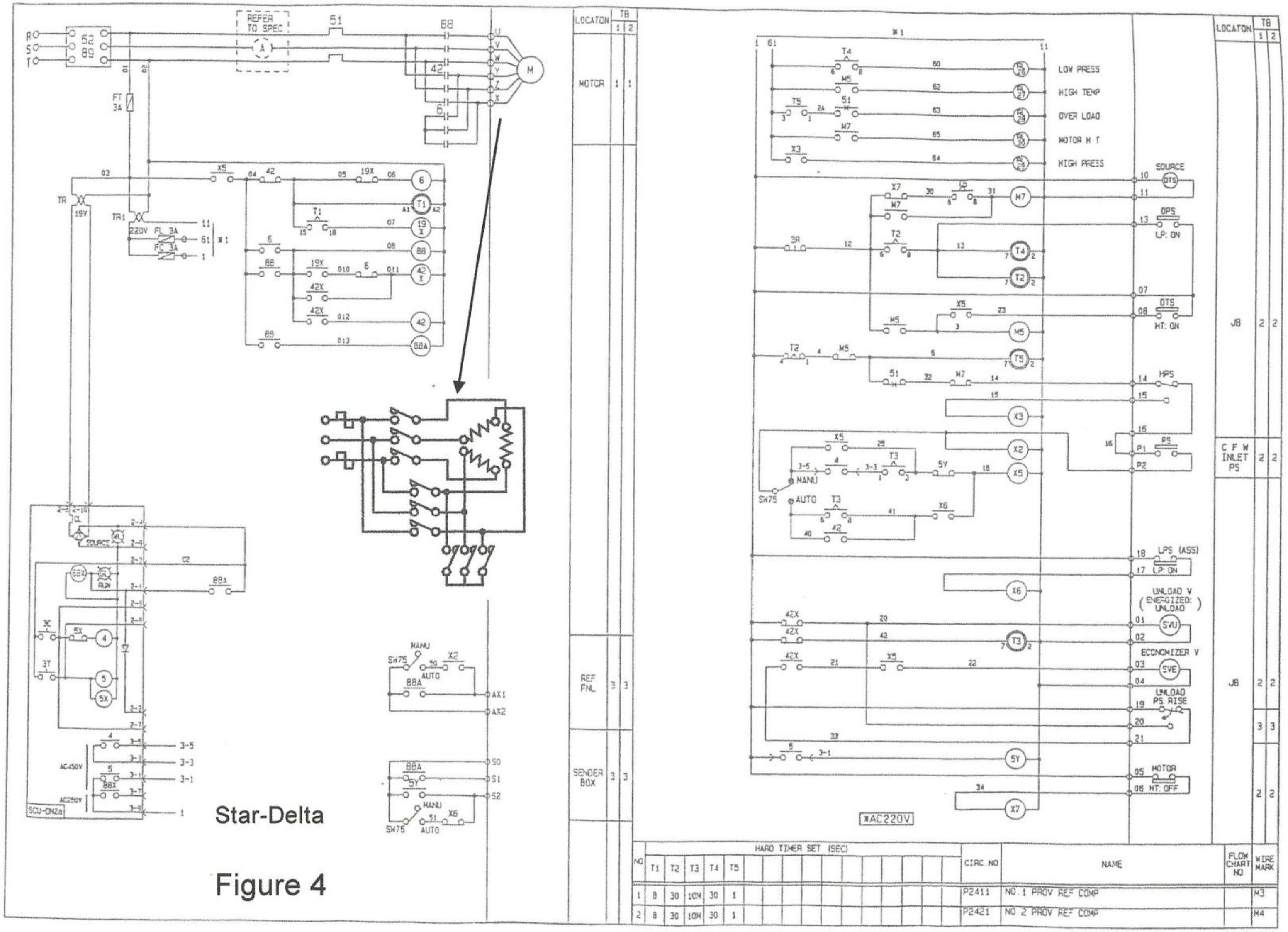
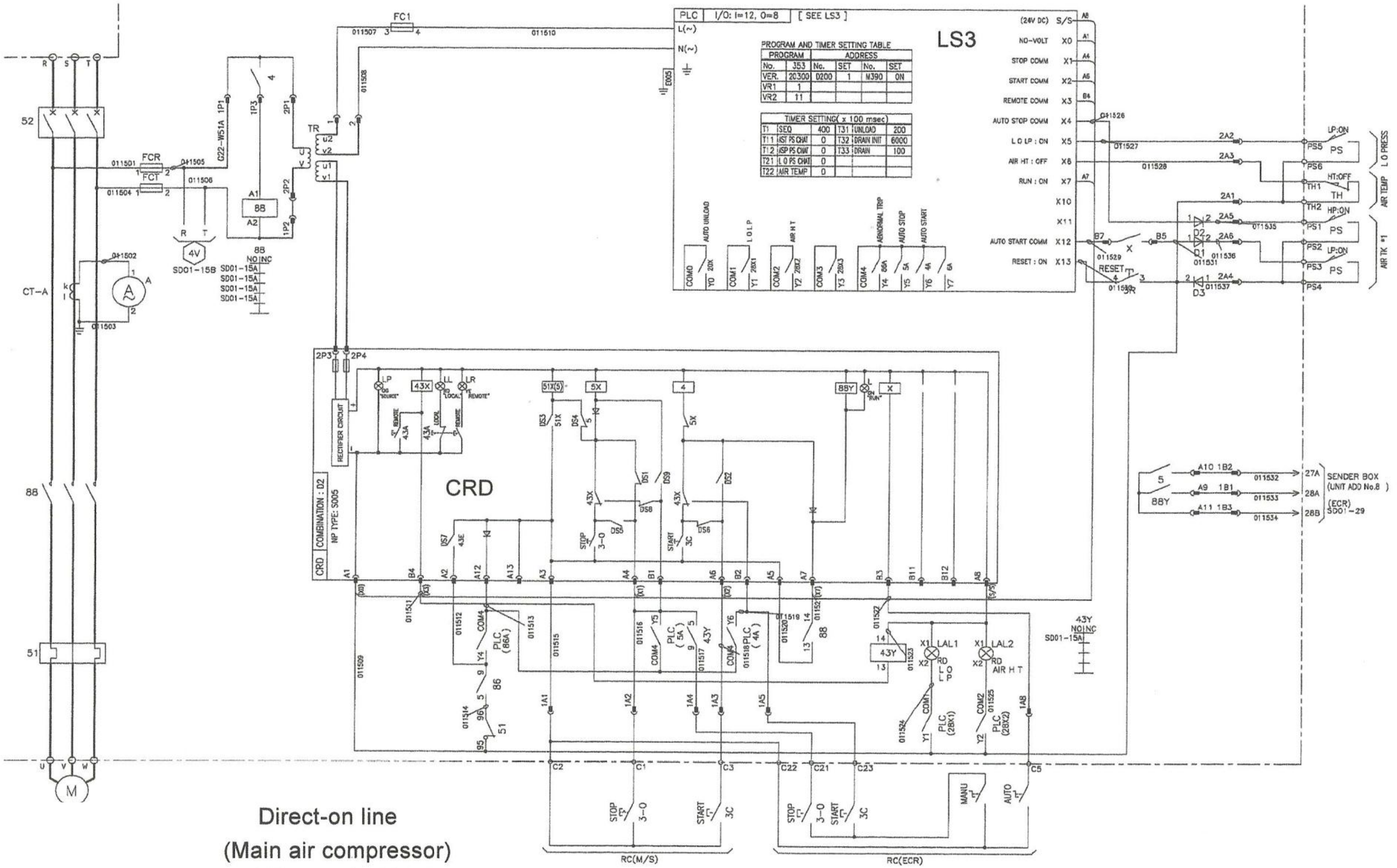
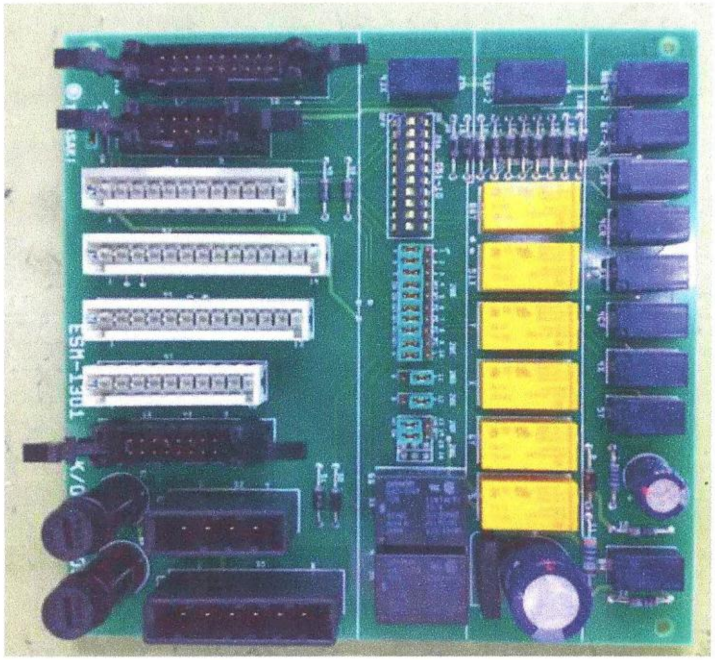

Star-Delta
LOCATON
TB
MOTOR
REF PNL
SENDER BOX
LOW PRESS
HIGH TEMP
OVER LOAD
MOTOR H T
HIGH PRESS
SOURCE
C F W INLET PS
UNLOAD V (ENERGIZED: UNLOAD)
ECONOMIZER V
MOTOR HT: OFF
※AC220V
HARD TIMER SET (SEC)
CIRC. NO
NAME
FLOW CHART NO
WIRE MARK
P2411
NO. 1 PROV REF COMP
P2421
NO. 2 PROV REF COMP

Figure 4

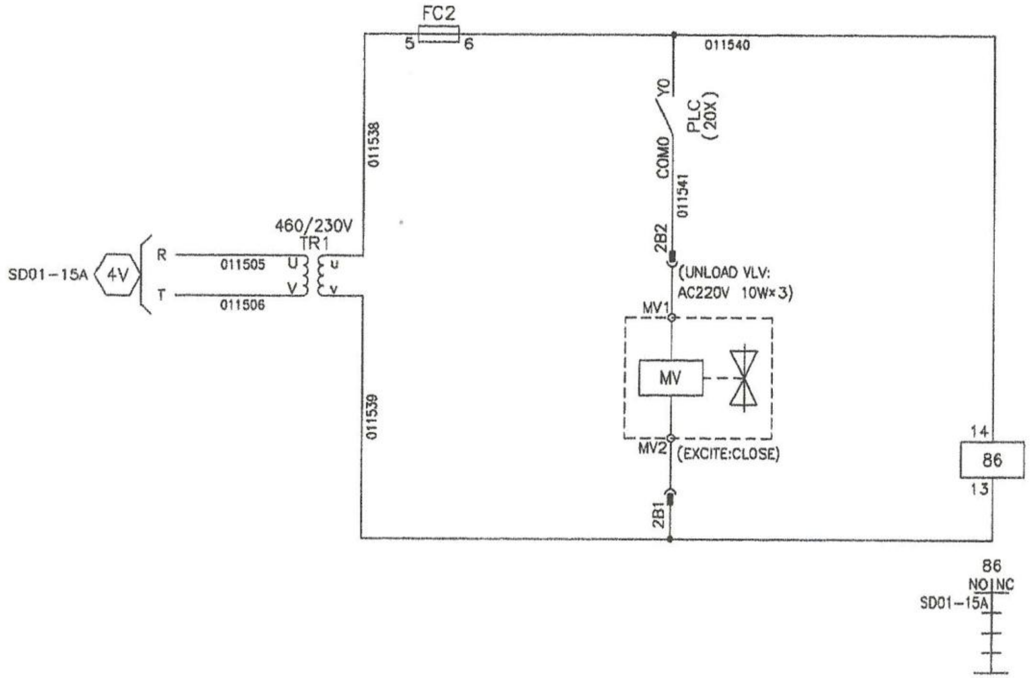


Direct-on line
(Main air compressor)
Figure 5 (1/5)

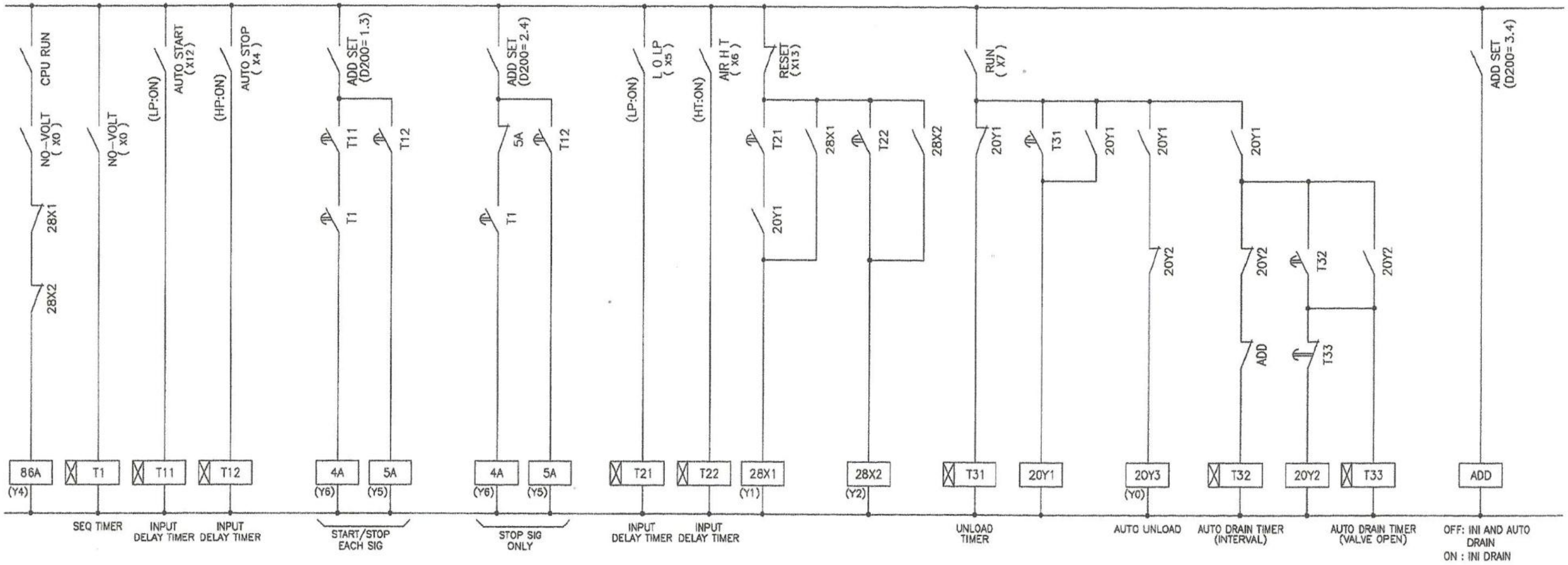


Molded Circuit Board used for CRD (Control circuit)
Shown in Figure 5 (1/5)

Figure 5 (2/5)

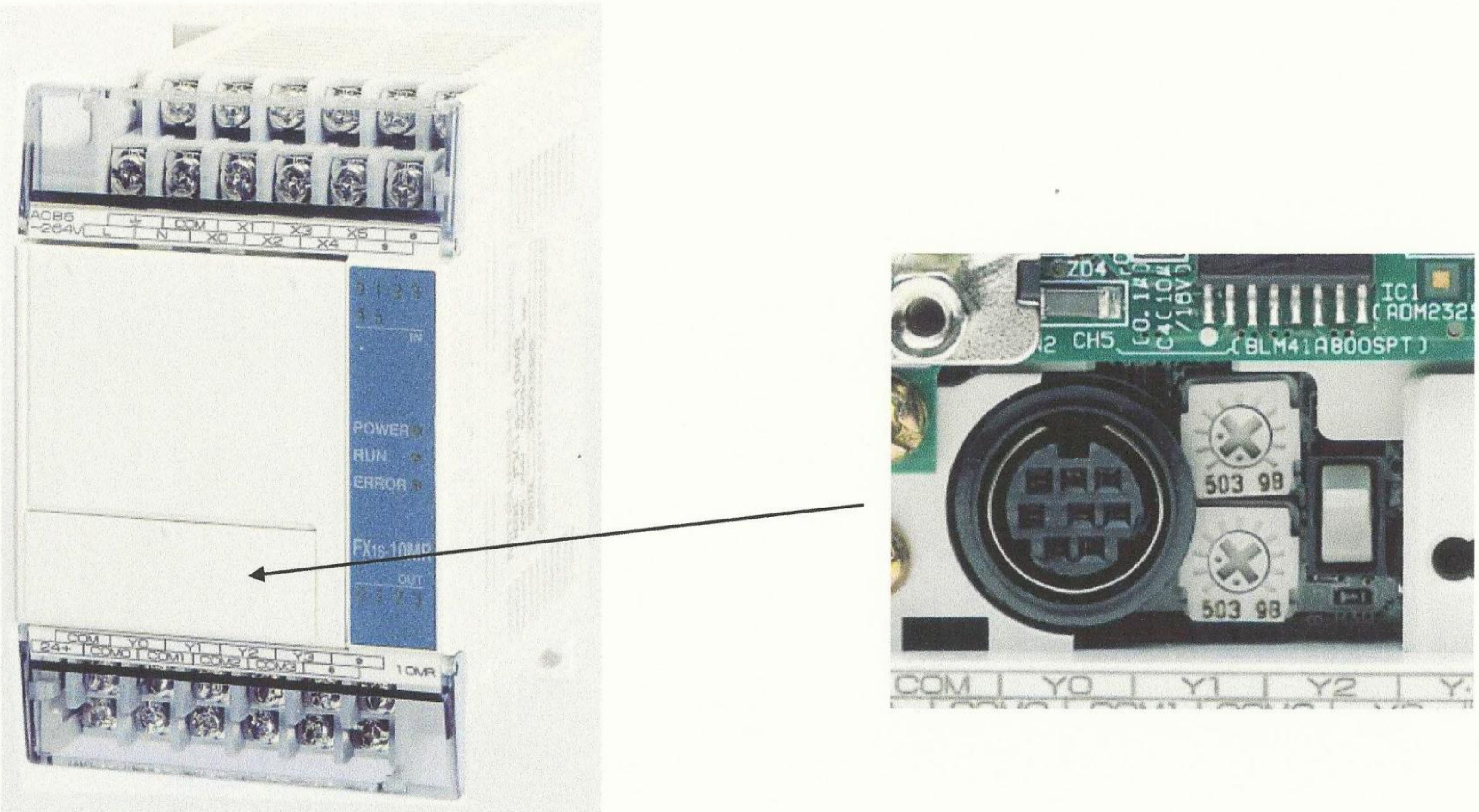


Direct-on line
(MV driving circuit for Main air compressor)
Figure 5 (3/5)



Direct-on line
(PLC "LS3" used for controlling Main air compressor)

Figure 5 (4/5)



Unit of PLC (LS 3)

Figure 5 (5/5)

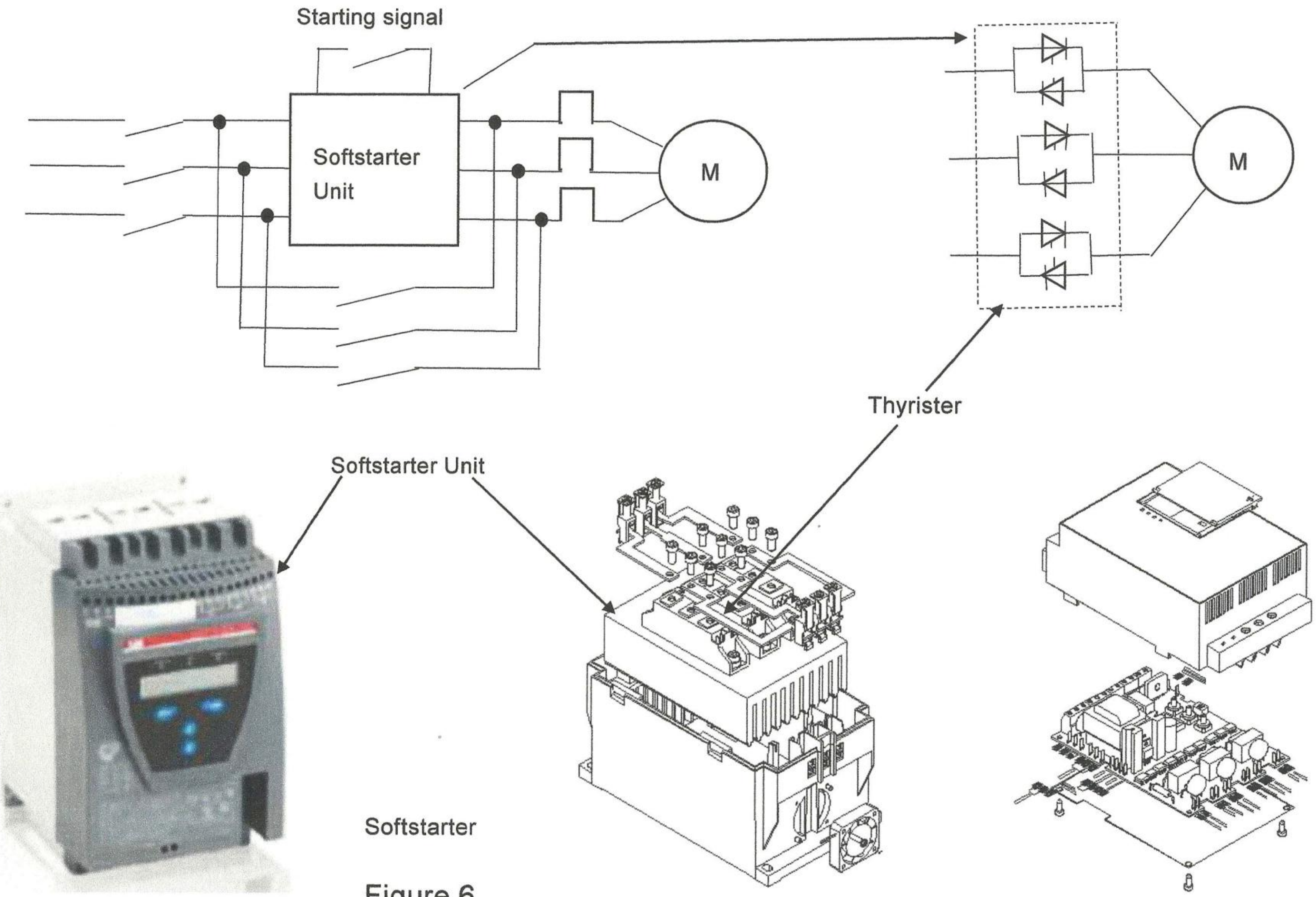

Starting signal
Softstarter Unit
M
M
Thyrister
Softstarter Unit
Softstarter

Figure 6

ERS II – 9

Training Title/Scenario: Sequential control circuits and associated system devices

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment
.1 electrical equipment
.e sequential control circuits and associated system devices

Time allocation: 3.5 hours

Outline of the training:

The trainees watch simulation video that introduces typical sequential control circuits used for controlling generator engine, boiler combustion, oil purifier, and refrigerator. The trainees read the sequential diagrams displayed on the screen and perform operations to control machinery using the diagrams.

The following is suggested as examples of the operations in case of generator engine and auxiliary boiler combustion controls. (Refer to Figure 1 and 2)
(Generator engine)
1. Manual and automatic start and stop
2. Actuation of safety functions (Emergency stop)
(Auxiliary boiler)
3. Manual and automatic ignition of burner
4. Actuation of safety functions

Prerequisite:

- Basic knowledge on sequential control
- Completion of ERS I-12 training

Note:

Sequential control circuits using relays are used for controlling almost all the machinery and generator engine and auxiliary boiler combustion control are taken up as the most general sequential control circuits in this training. Processes of automation are demonstrated by the simulation and the trainees should learn how to read the sequential diagrams for control rather than functions of the diagrams.

The instructor should also emphasize that sequential control using relays are still surely exists between control unit and machinery in an advanced and sophisticated automation systems although almost controllers are built up by electronic devices/units.

Specific purpose of the training:

The trainees will be able to read sequential control circuit diagrams.

Implementation of the training

T in min	Training process
0 ~ 30	The instructor shows the trainees the simulation video that introduces sequential control circuits and associated system devices used for controlling generator engine. (The instructor should brief functions of the sequential control for the generator engine referring to the simulated diagram. The trainees should carefully watch processes of controlling the generator engine/sequential actions)
30 ~ 90	(The instructor lets the trainees perform operations for starting, stopping the generator and etc. indicating relevant sequential control circuit diagrams on the screen. The instructor names the trainees by turns) The trainees perform operations on the simulated sequential control circuit diagrams confirming the functions and features incorporated in the circuits and watching carefully processes of sequential control/actions as follow 1. manual/local start of the generator 2. manual/local stop of the generator 3. automatic start and stop 4. emergency stop

90 ~ 120	The instructor shows the trainees the simulation video that introduces sequential control circuits used for auxiliary boiler combustion control and associated system devices. (The instructor should brief functions of the sequential control for the combustion control referring to the simulated diagram. The trainees should carefully watch control processes/sequential actions)
120 ~ 180	(The instructor lets the trainees perform operations for controlling the combustion and etc. indicating relevant starter circuit diagrams on the screen. The instructor names the trainees by turns) The trainees perform operations on the simulated sequential control circuit diagrams confirming the functions and features incorporated in the circuits and watching carefully processes of sequential control/actions as follow 1. manual/local ignition of the burner 2. manual/local stop of the combustion 3. automatic combustion 4. actuation of safety devices (After the debriefing, the instructor gives the report form and lets them fill out)

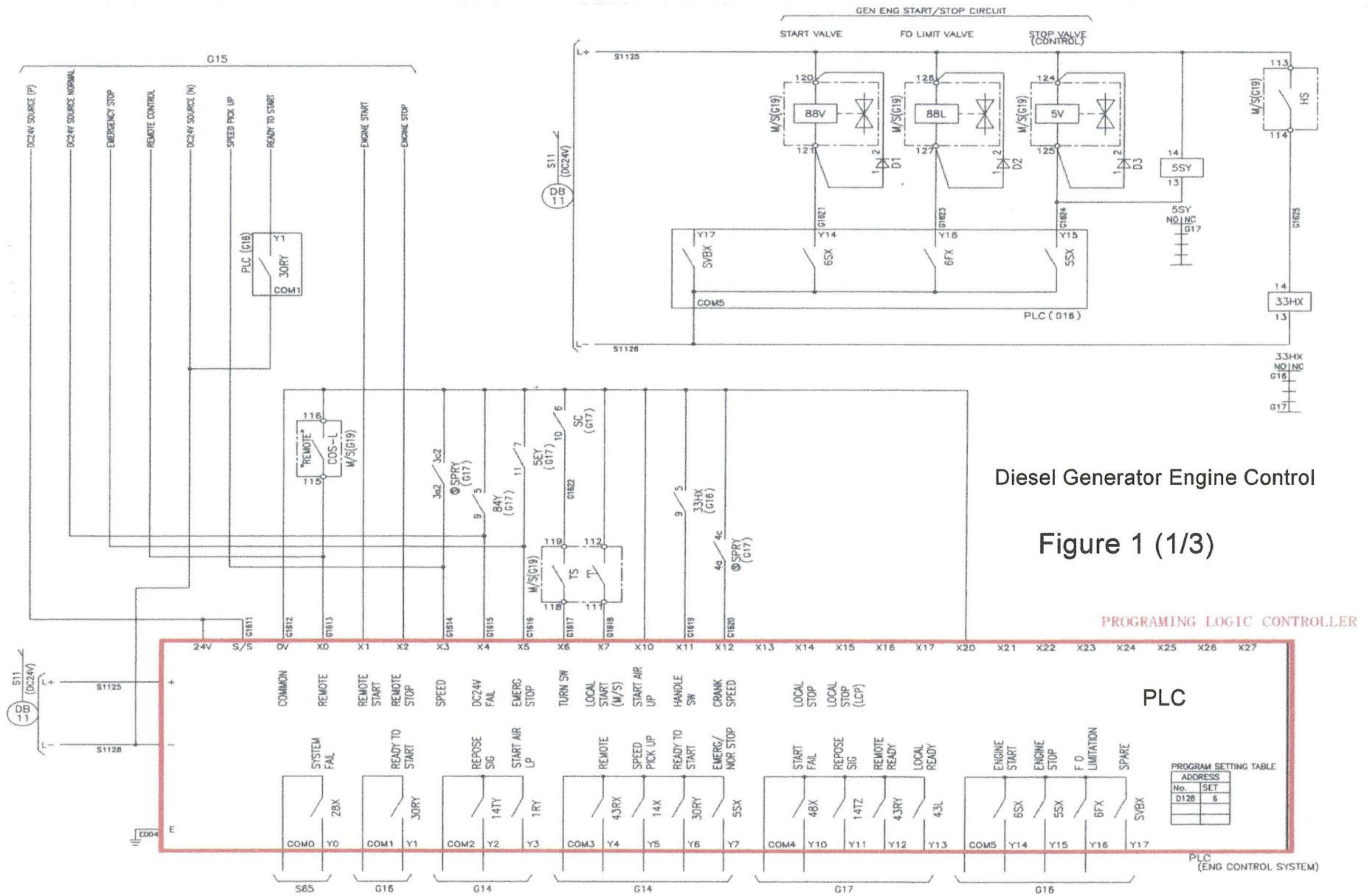
TRAINEE'S EVALUATION FORM FOR ERS II- 9

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Sequential control circuits and associated system devices
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
6. Understanding of relay circuits (If the trainee understood functions and operation principles of magnetic relays)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
7. Functions of control/sequential circuits (If the trainee understood functions and purposes of the circuits)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
8. Comprehension to control/sequential circuits (If the trainee could read/follow the control/sequential diagrams)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
9. Functions of control units (If the trainee understood functions and characteristics of integrated/molded control units like PLC)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
10. Incentive, Attentiveness, Cooperativeness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ______________________



Diesel Generator Engine Control

Figure 1 (1/3)

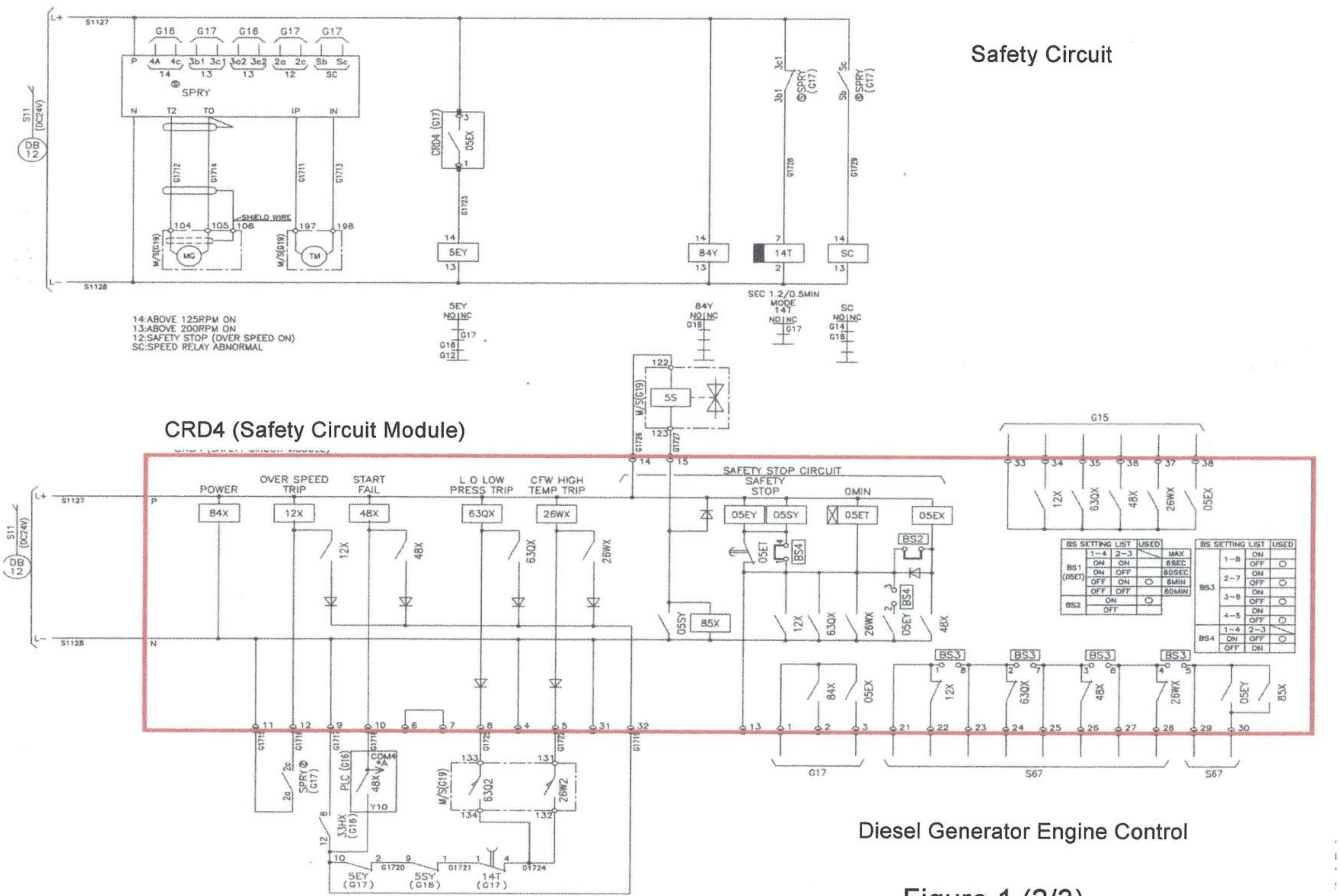
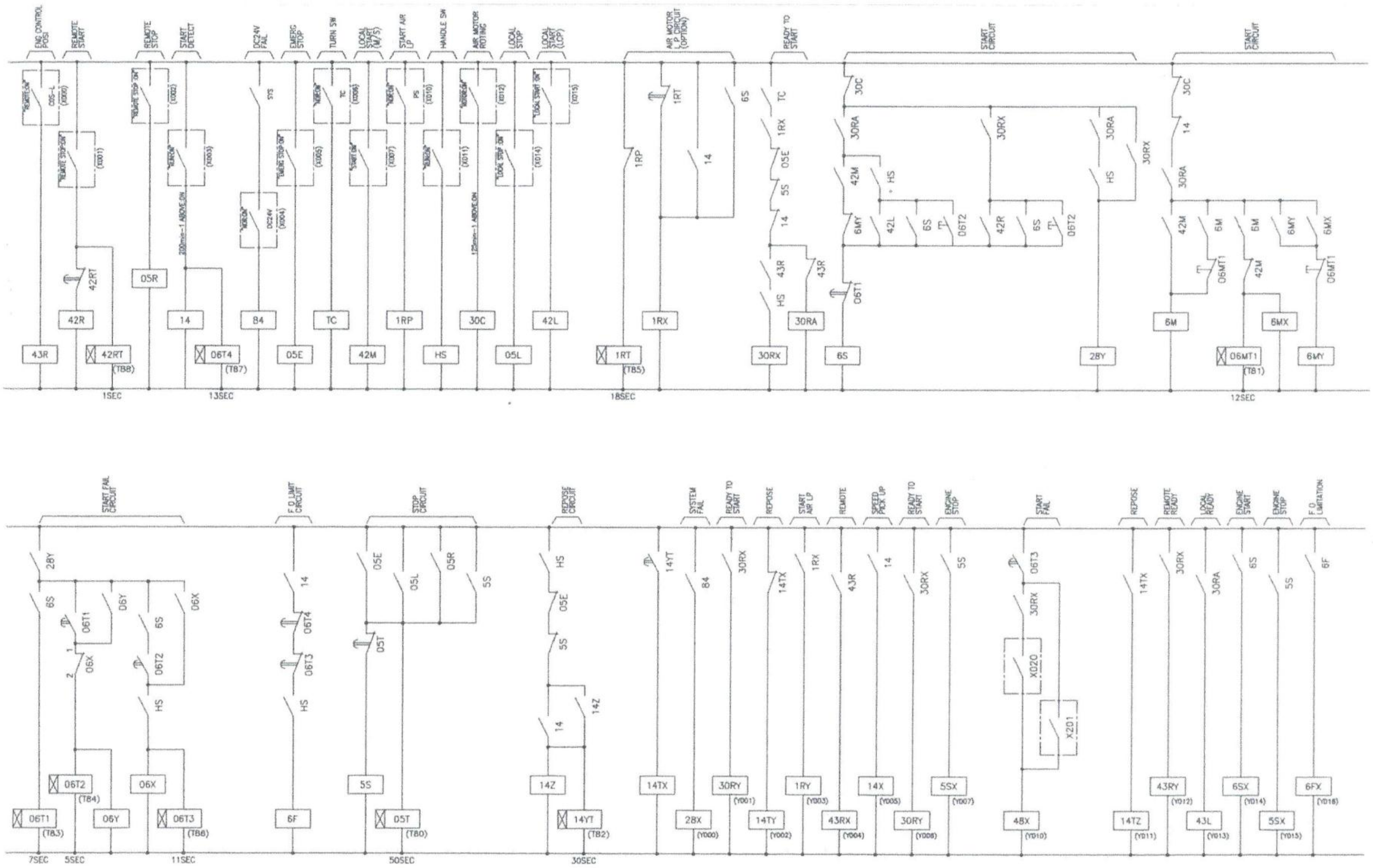
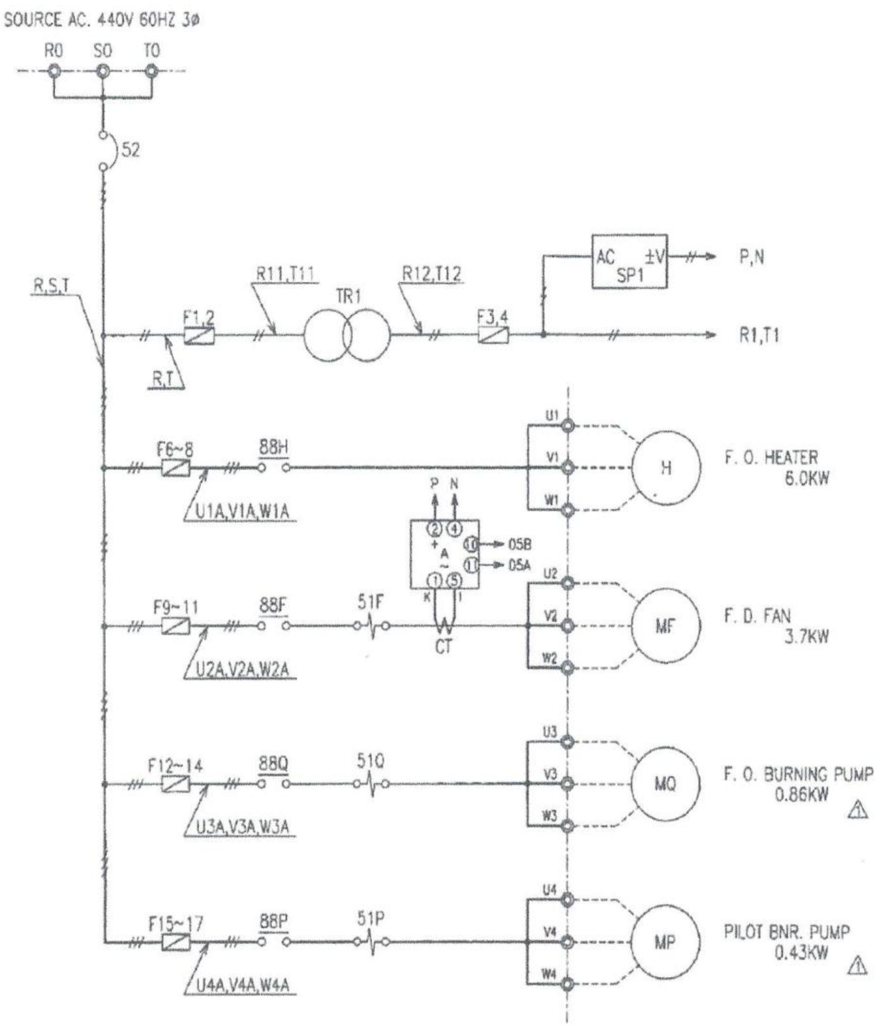
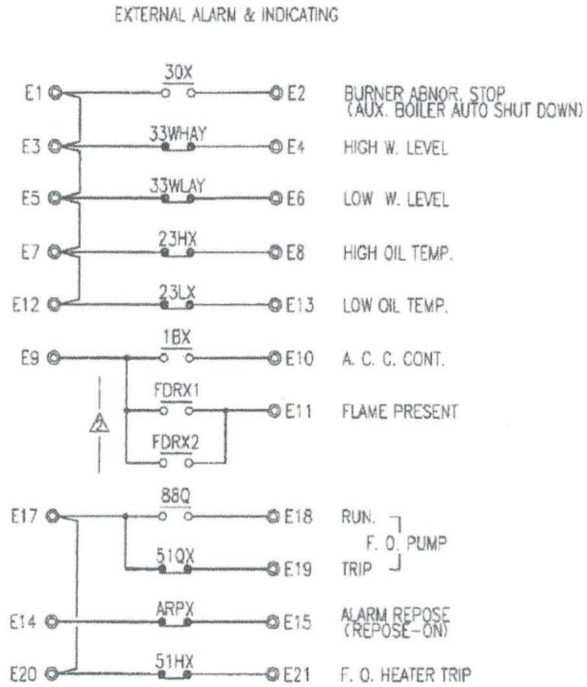

Safety Circuit
14:ABOVE 125RPM ON
13:ABOVE 200RPM ON
12:SAFETY STOP (OVER SPEED ON)
SC:SPEED RELAY ABNORMAL
CRD4 (Safety Circuit Module)
POWER
OVER SPEED TRIP
START FAIL
L O LOW PRESS TRIP
CFW HIGH TEMP TRIP
SAFETY STOP CIRCUIT
SAFETY STOP
0MIN
Diesel Generator Engine Control

Figure 1 (2/3)



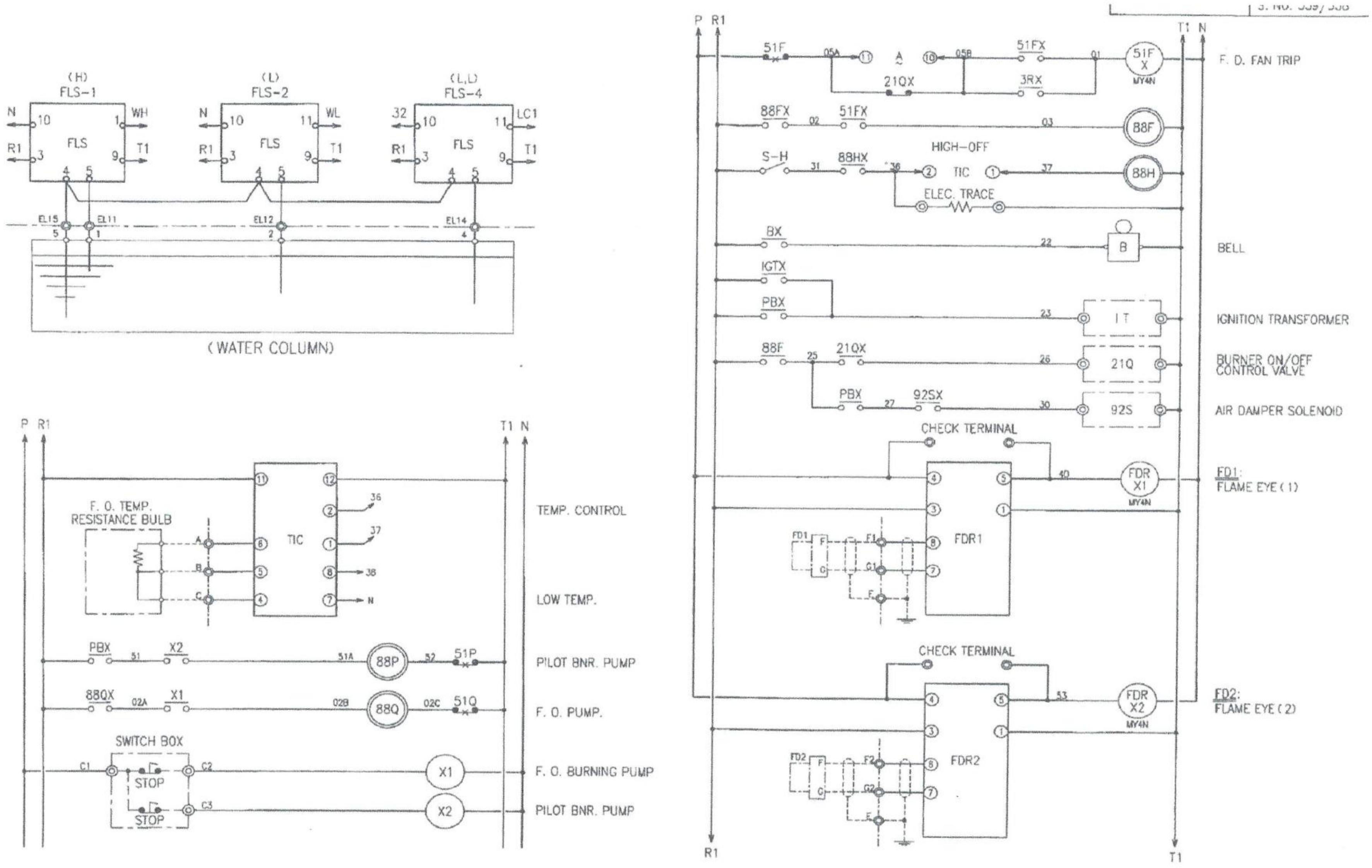
PLC (Ladder circuit diagram) Diesel Generator Engine Control Figure 1 (3/3)



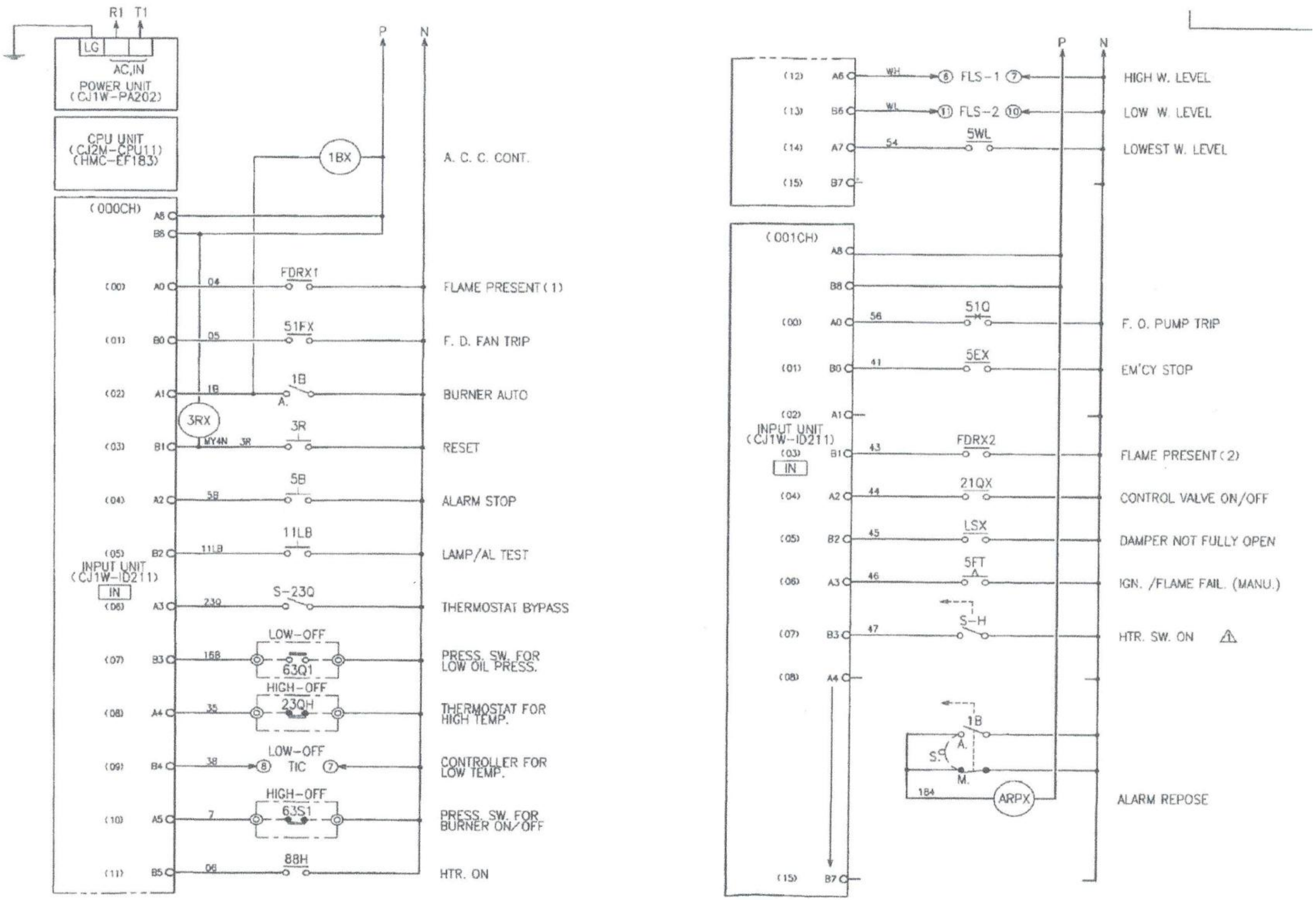


Auxiliary Boiler Combustion Control

Figure 2 (1/5)

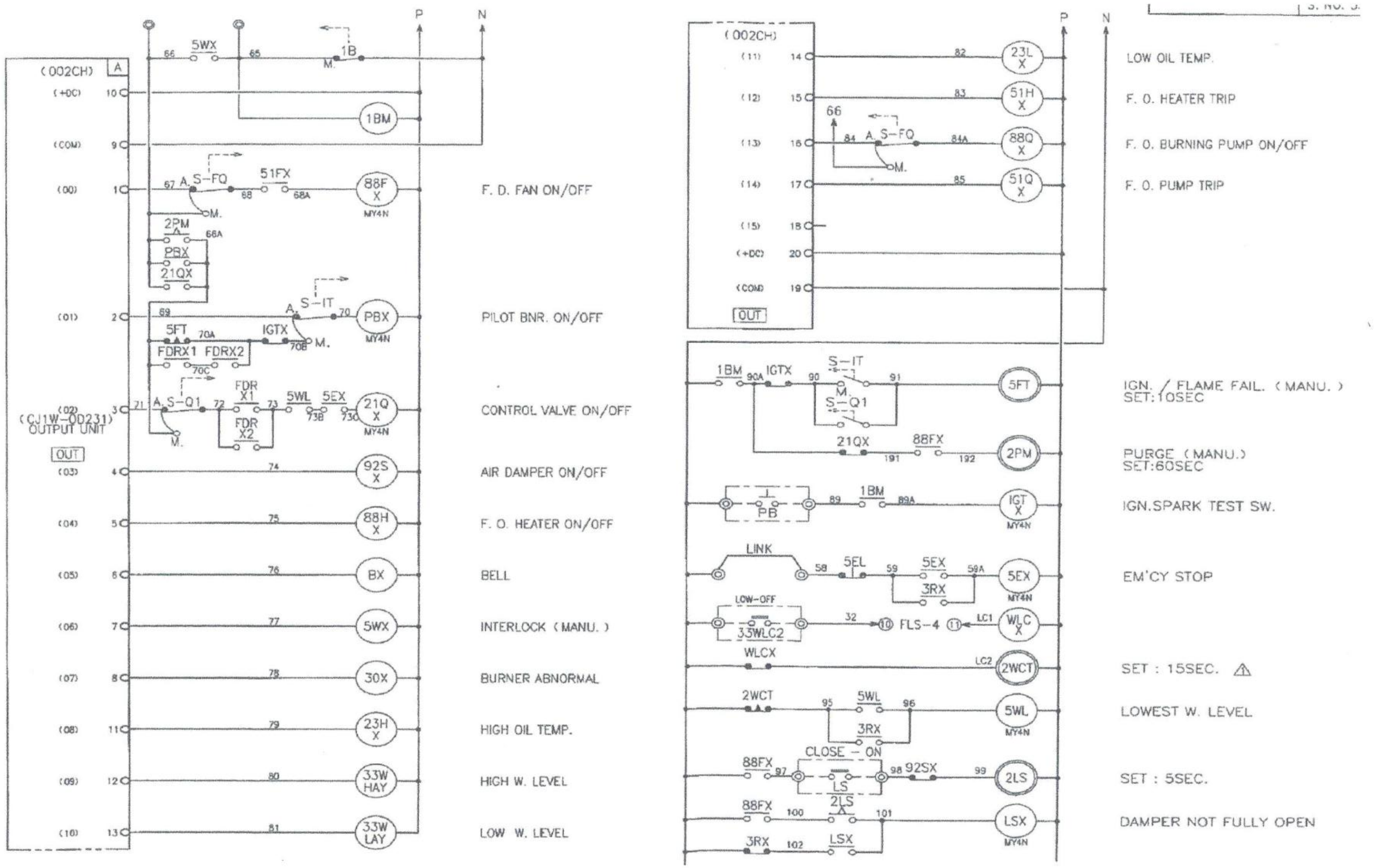


Auxiliary Boiler Combustion Control Figure 2 (2/5)

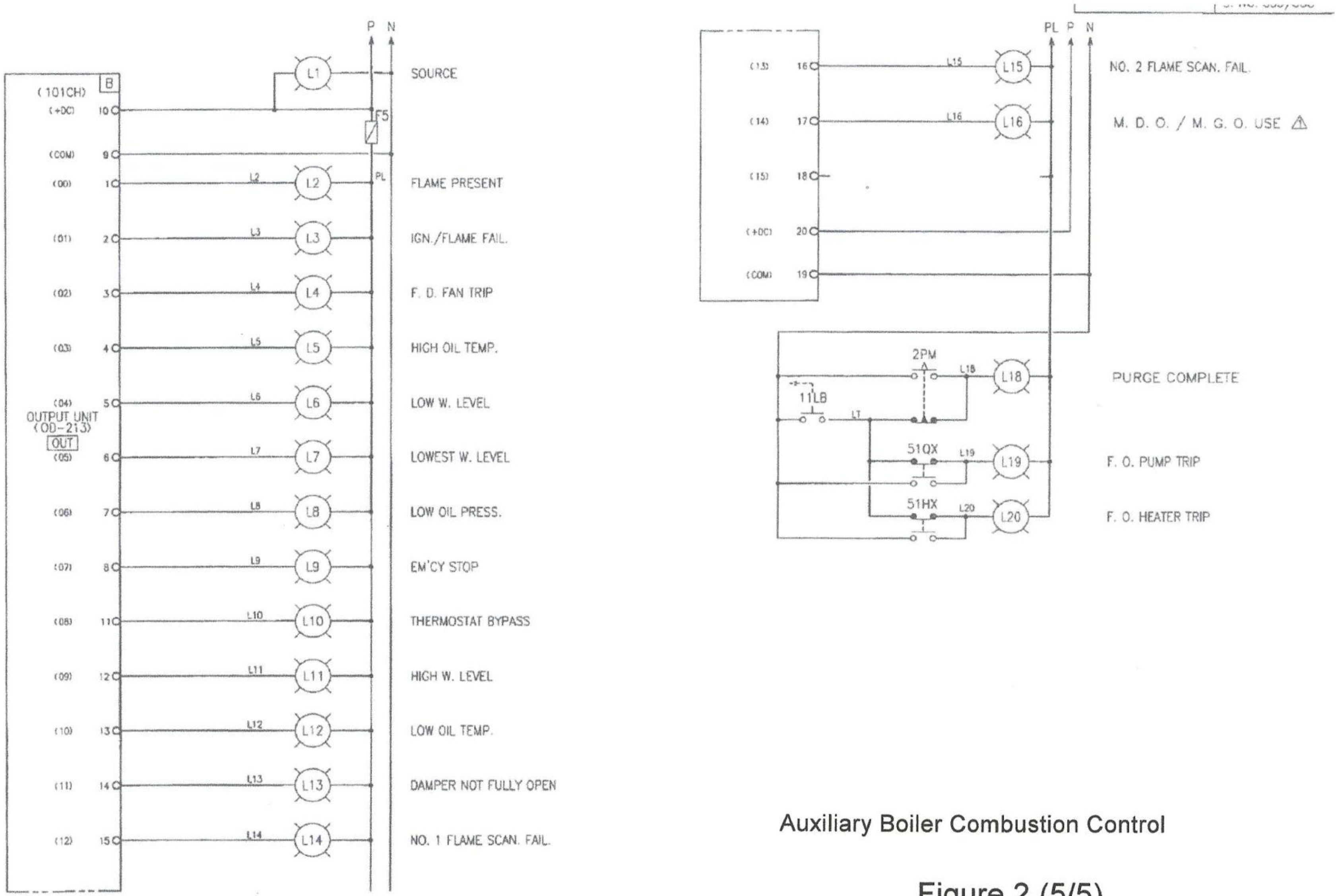


Auxiliary Boiler Combustion Control

Figure 2 (3/5)



Auxiliary Boiler Combustion Control Figure 2 (4/5)



Auxiliary Boiler Combustion Control

Figure 2 (5/5)

ERS II – 10

Training Title/Scenario: Automatic control for machinery systems

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment

.2 electronic equipment

.b flowchart for automatic and control system

.c functions, characteristics and feature of control systems for machinery items including main propulsion plant control and steam boiler automatic controls

Table A-III/2 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Table A-III/2 KUP:

- Functions and mechanism of automatic control for main engine
- Functions and mechanism of automatic control for auxiliary machinery including but not limited to;
  .1 generator distribution systems
  .2 steam boiler
  .3 oil purifier
  .4 refrigeration system
  .5 pumping and piping systems
  .6 steering gear system
  .7 cargo handling equipment and deck machinery

Table A-III/2 Competence: Manage operation of electrical and electronic control equipment;

Table A-III/2 KUP: Design features and system configurations of automatic control equipment and safety devices for the followings;

.1 main engine
.2 generator and distribution system
.3 steam boiler

Time allocation: 16 hours

Outline of the training :
The trainees watch simulation video that introduces functions, characteristics and

features of typical automatic control systems used for machinery items. The trainees perform operations to control machinery using system diagrams displayed on the screen.

The following is suggested as examples of the operations.
(Main diesel engine) (3 hours)
1. Automatic start
2. Automatic revolution speed control
   - revolution speed control under standby engine
   - speed run-up program by revolution, load and/or combination control
3. Crash astern
4. Variable injection timing
5. Variable exhaust valve timing
6. Actuation of safety functions:
   - automatic shutdown
   - automatic slow down
   - start failure
   - start impossible
   - wrong way

(Main steam turbine) (2 hours)
1. Automatic revolution speed control
2. Crash/Emergency astern
3. Automatic rollover
4. Actuation of safety functions:
   - automatic shutdown
   - automatic slow down

(Diesel generator and distribution systems) (2 hours)
1. Full automatic control for generator and distribution system
2. Automatic starting and stopping generator engine
3. Automatic synchronizing
4. Automatic load sharing
5. Optimum load sharing
6. Large motor start blocking
7. Preference trip
8. Protective/Safety functions built in ACB and/or VCB
9. Automatic voltage (AVR) and frequency control

(Main steam boiler) (2 hours)
1. Automatic Combustion Control (ACC),

2. Automatic feed water control
3. Automatic steam temperature control
4. Protective/Safety functions for steam boiler

(Oil purifier) (1.5 hours)
1. Temperature control
2. Automatic start
3. Automatic desludging
4. Actuation of safety functions

(Refrigeration system) (1.5)
1. Automatic temperature control
2. Automatic start and stop of compressor
3. Timer control for defrosting
4. Capacity control
5. Actuation of safety functions

(Pumping and piping systems) (1.5 hours)

Pump	Automatic changeover	Automatic		Function
		ST	SP	
Cooling sea water pump		○		CSW low pressure
LTFW pump		○		LTFW low pressure
HTFW pump	○			
Feed water pump	○			
Boiler water circulating pump	○		○	At 12 hours after ME stops
Distilled water transfer pump		○	○	
ME LO pump	○			
ME FO supply pump	○			
ME FO Circ. Pump	○			
Stern tube LO pump	○			
Gen. engine LO priming pump		○	○	Gen. engine start/stop
FO transfer pump		○	○	FO Sett. Tank level
Diesel oil transfer pump		○	○	DO Sett. Tank level
Fire pump		○		Fire main low pressure
General service pump		○		Fire main low pressure
Waste oil transfer pump			○	Waste oil tank High level
Sanitary pump		○	○	Hydraulic tank pressure
FW pump		○	○	Hydraulic tank pressure

(Steering gear system) (1.5 hours)
1. Auto pilot hydraulic system

(Cargo handling equipment and deck machinery) (1 hour)
1. Remote and automatic speed control

Prerequisite:

Basic knowledge on automatic control systems used for machinery

Note:

In this training, processes of automatic control are demonstrated by the simulation and the trainees should learn functions of components constructing the system and how the automatic functions are executed.
The training of each topic and simulations cover both the requirements (KUP) of the operational and the management level.

Specific purpose of the training:

The trainees will be able to understand the following:
- what components construct automatic control systems
- functions of the components
- mechanism of controlling machinery.
- flowchart representing control systems

Implementation of the training (Main diesel engine)

T in min	Training process
0 ~ 30	The instructor shows the trainees the simulation video that introduces typical main engine automatic control system and associated system devices.(Refer to an example of main engine control system shown in Figures 1) (The instructor should brief functions of the components referring to the simulation) The trainees should carefully watch processes of controlling the main diesel engine.

30 ~ 150	(The instructor lets the trainees perform operations for starting, stopping the main engine and etc. indicating relevant system diagrams on the screen. The instructor names the trainees by turns) The trainees perform operations on the simulated control system confirming the functions and features incorporated in the system and watching carefully processes of controlling the engine as follow. 1. Automatic start (Automatic changeover to fuel running) 2. Automatic revolution speed control - Revolution control under standby condition - Speed run-up program by revolution, load and/or combination control 3. Crash astern 4. Variable injection timing 5. Variable exhaust valve timing 6. Actuation of safety functions: - automatic shutdown - automatic slow down - start failure - start impossible - wrong way (The trainings for other machinery are to be conducted in the same manner. The instructor gives a break time accordingly or the instructor may conduct the trainings of other machinery in a different day)
150 ~ 690	- Main steam turbine (Refer to Figure 2 as sample drawings/illustrations) - Diesel generator and distribution systems (Refer to Figure 3 as sample drawings/illustrations) - Main steam boiler (Refer to Figure 4 as sample drawings/illustrations) - Oil purifier (Refer to Figure 5 as sample drawings/illustrations) - Refrigeration system (Refer to Figure 6 as sample drawings/illustrations) - Pumping and piping systems (Refer to Figure 7 and motor starter circuits as sample drawings) - Steering gear system (Refer to Figure 8 as sample drawings/illustrations) - Cargo handling equipment and deck machinery (Refer to Figure 9 as sample drawings/illustrations) (After the debriefing, the instructor gives the report form and lets them fill out)

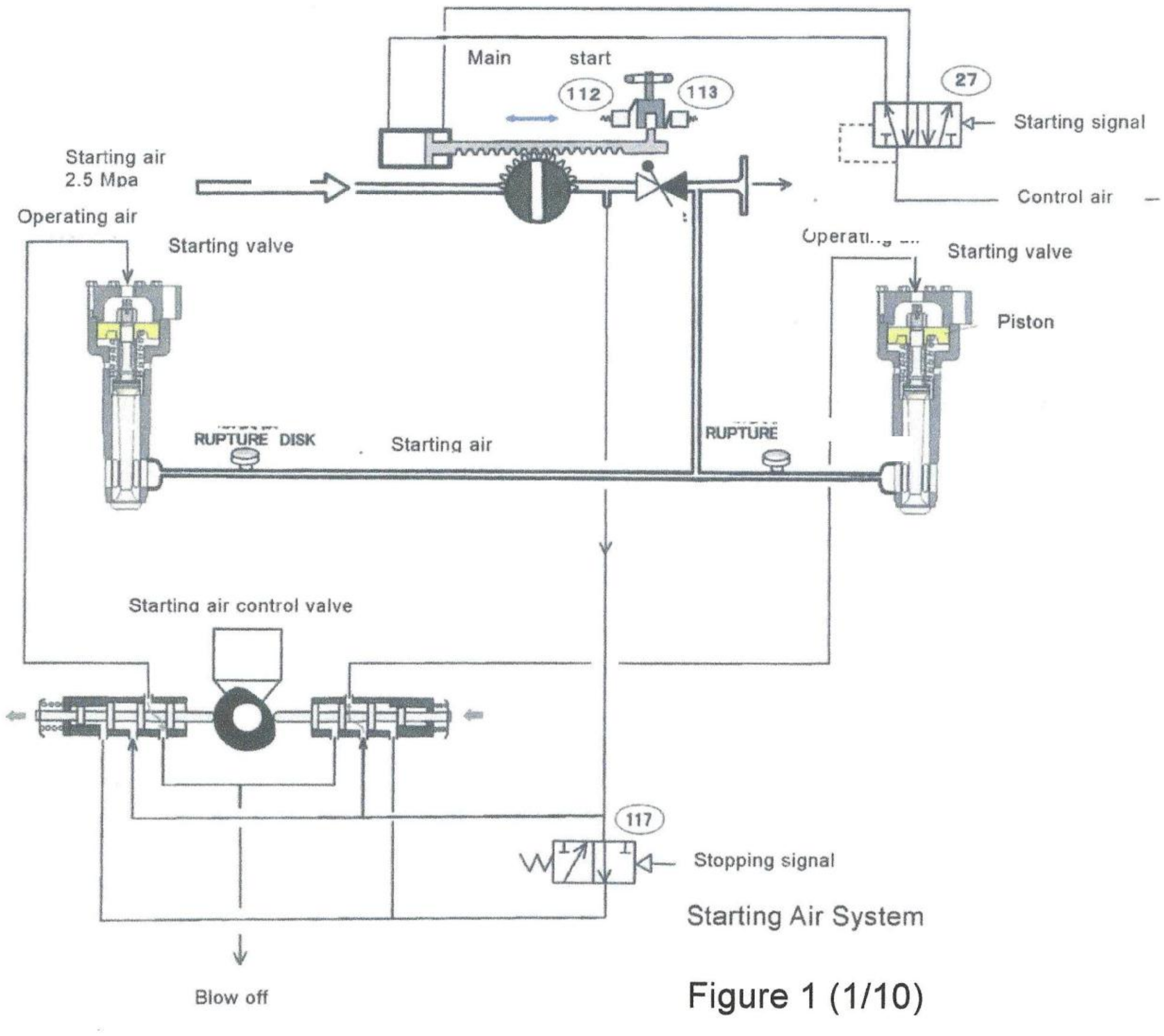
TRAINEE'S EVALUATION FORM FOR ERS II - 10

Trainee's Class	
Instructor attended	
Training Title/Scenario	Automatic control for machinery systems
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

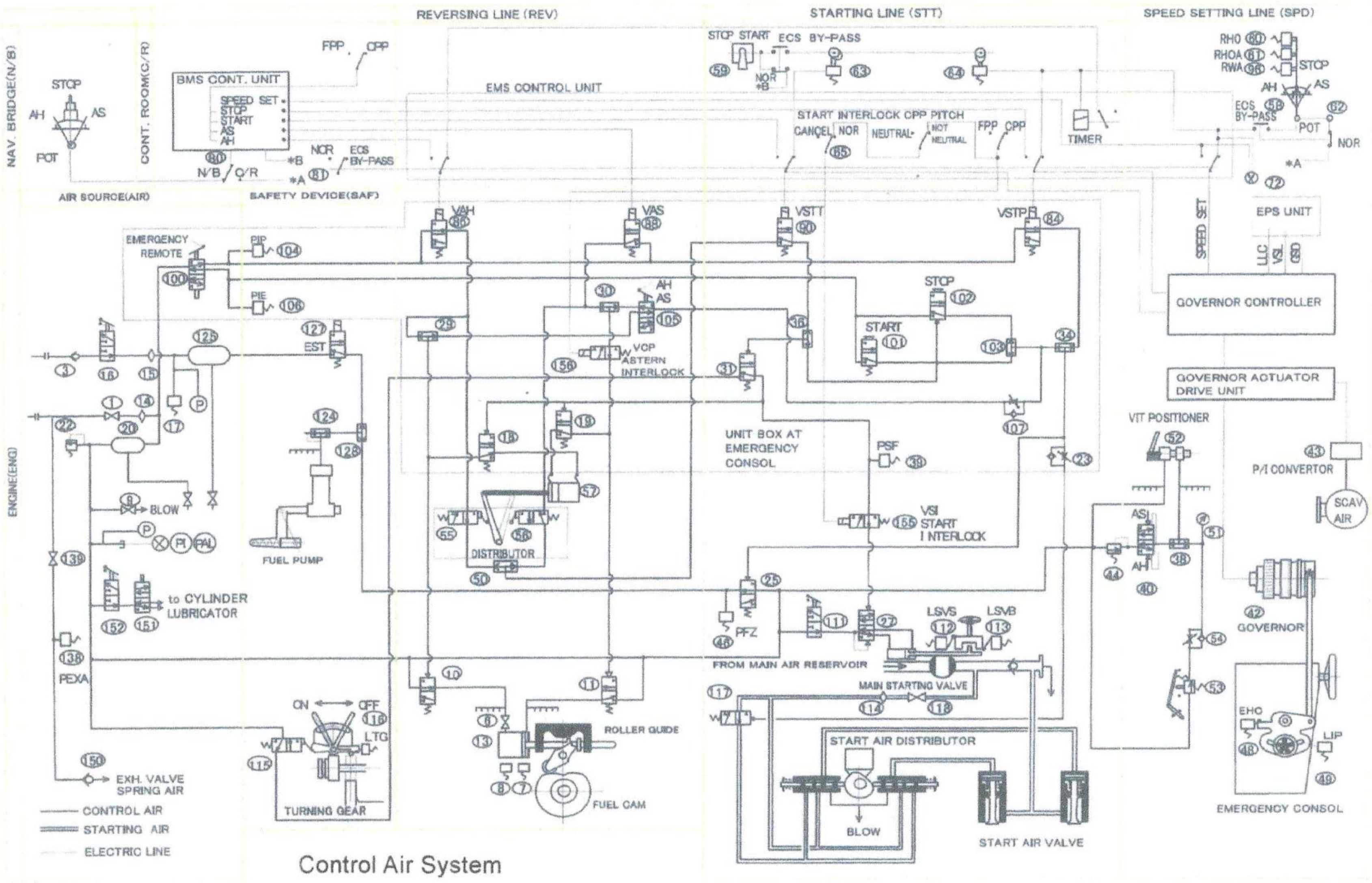
Item	T	Mark
1. Understanding of functions (If the trainee understood what functions of automatic control systems for the machinery)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Understanding of mechanism/flowchart (If the trainee understood mechanism/flow for automatically controlling the machinery)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Understanding of components (If the trainee understood what components are used for controlling the machinery)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Operation of control systems (If the operations were based on correct understanding on functions and specifications of the machinery)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Attentiveness, Cooperativeness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ______________________



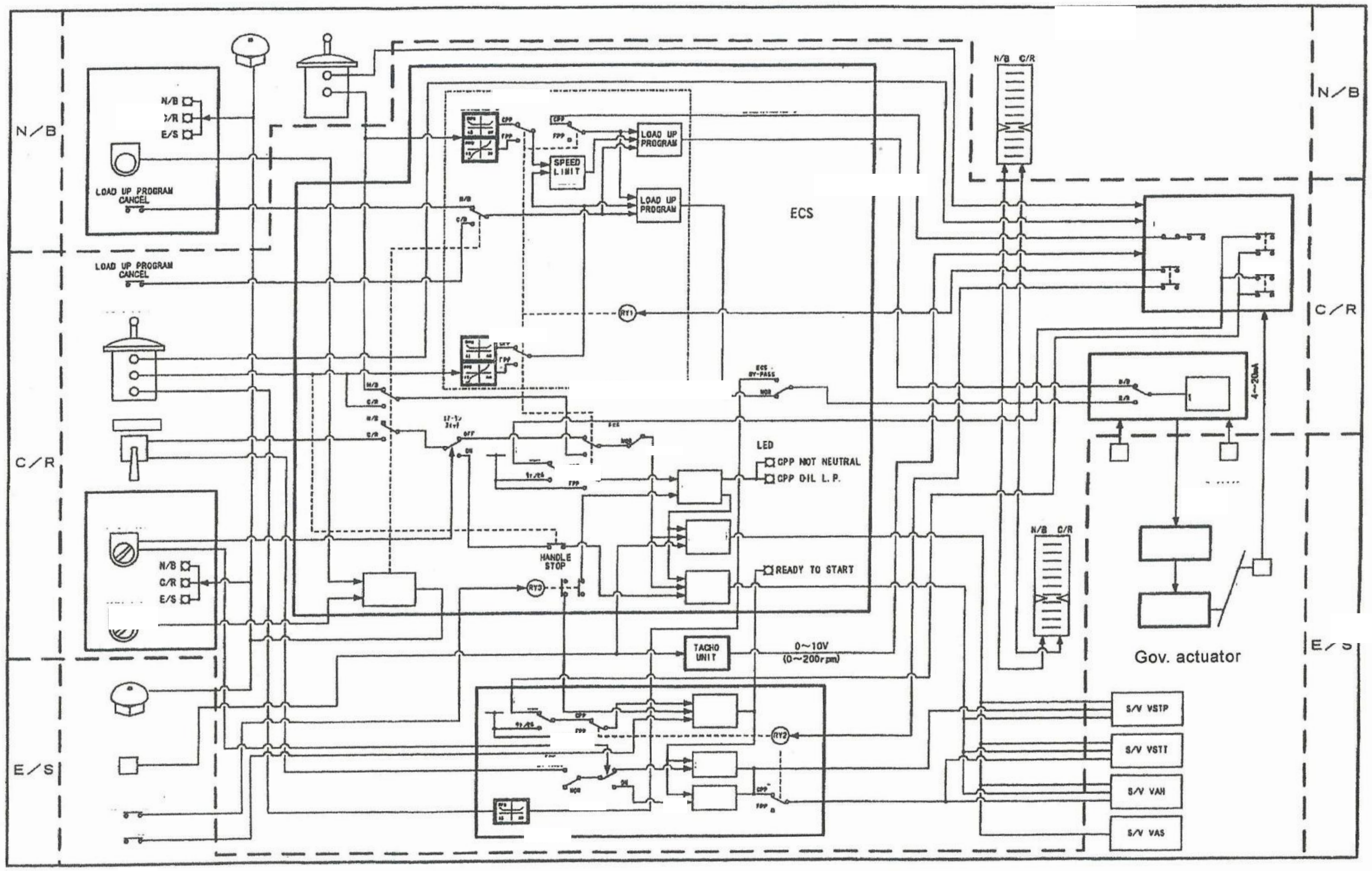
Starting Air System

Figure 1 (1/10)



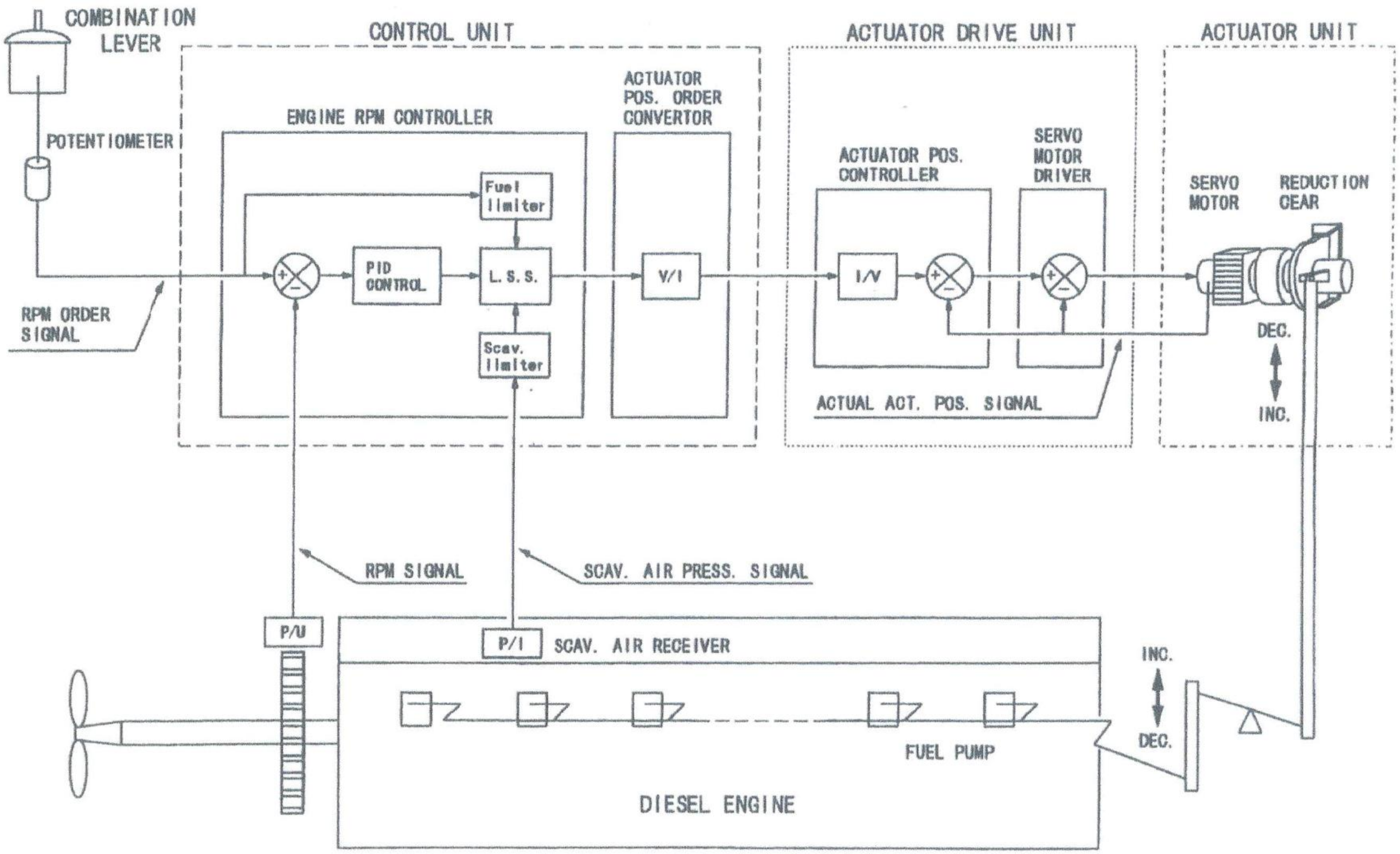
Control Air System

Figure 1 (2/10)



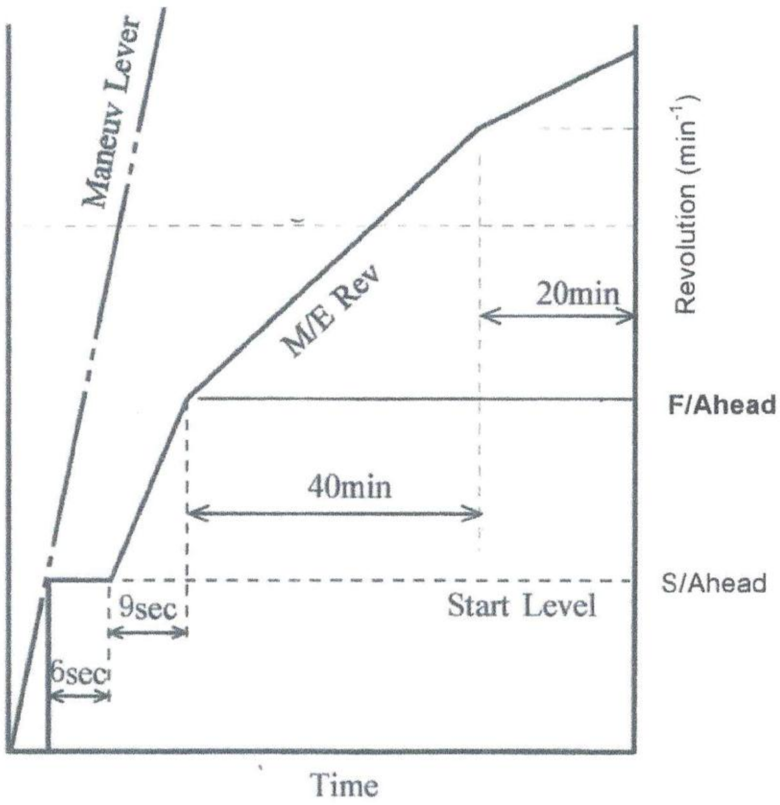
System Configuration of Remote and Automatic Control

Figure 1 (3/10)



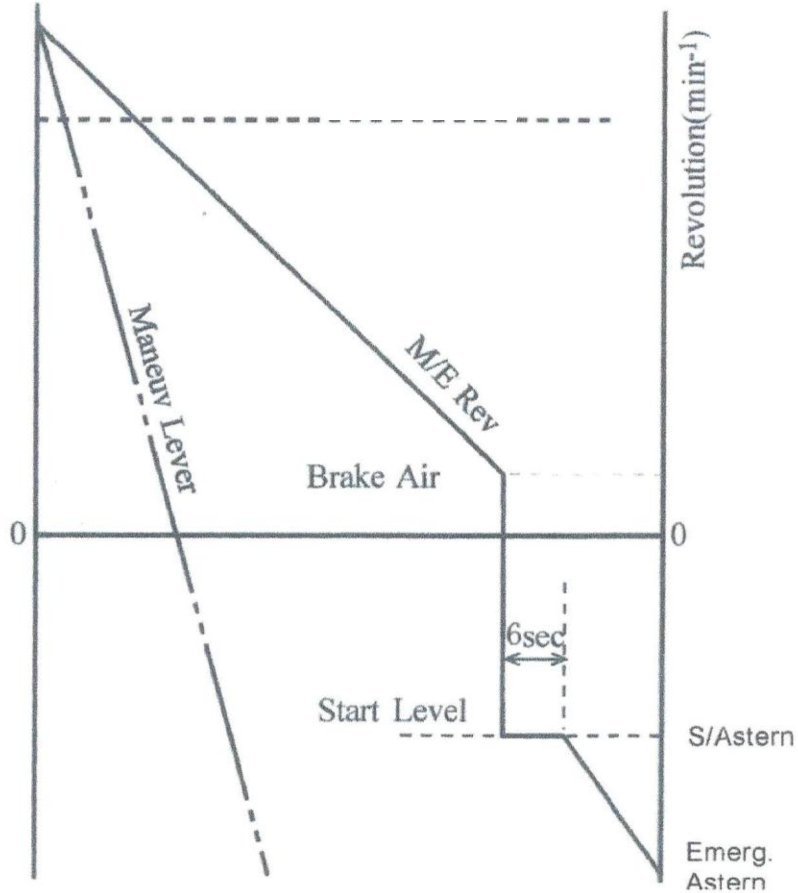
System Configuration of Electronic Governor

Figure 1 (4/10)



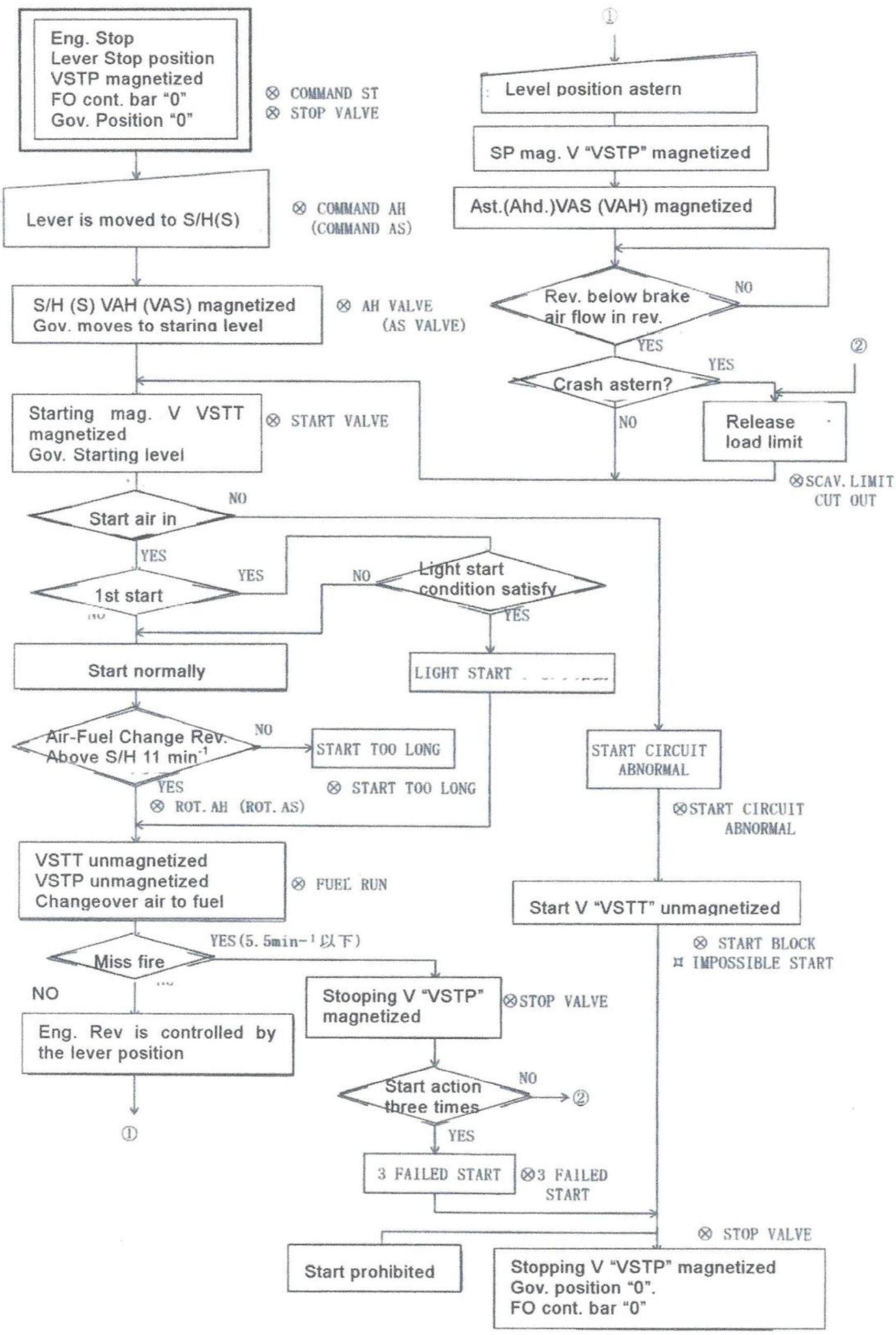
Speed Run-up Program

Figure 1 (5/10)



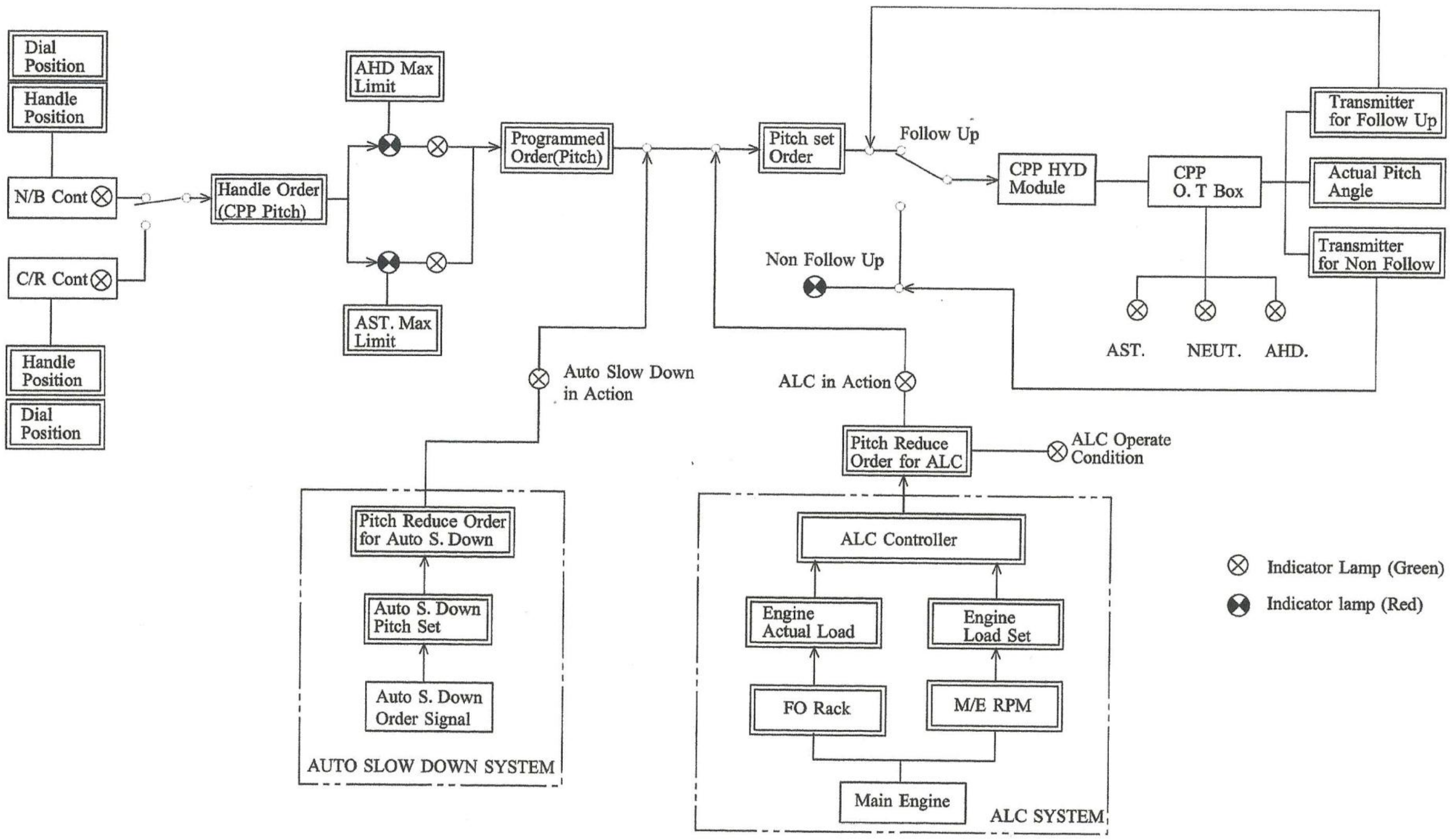
Crash Astern Program

Figure 1 (6/10)



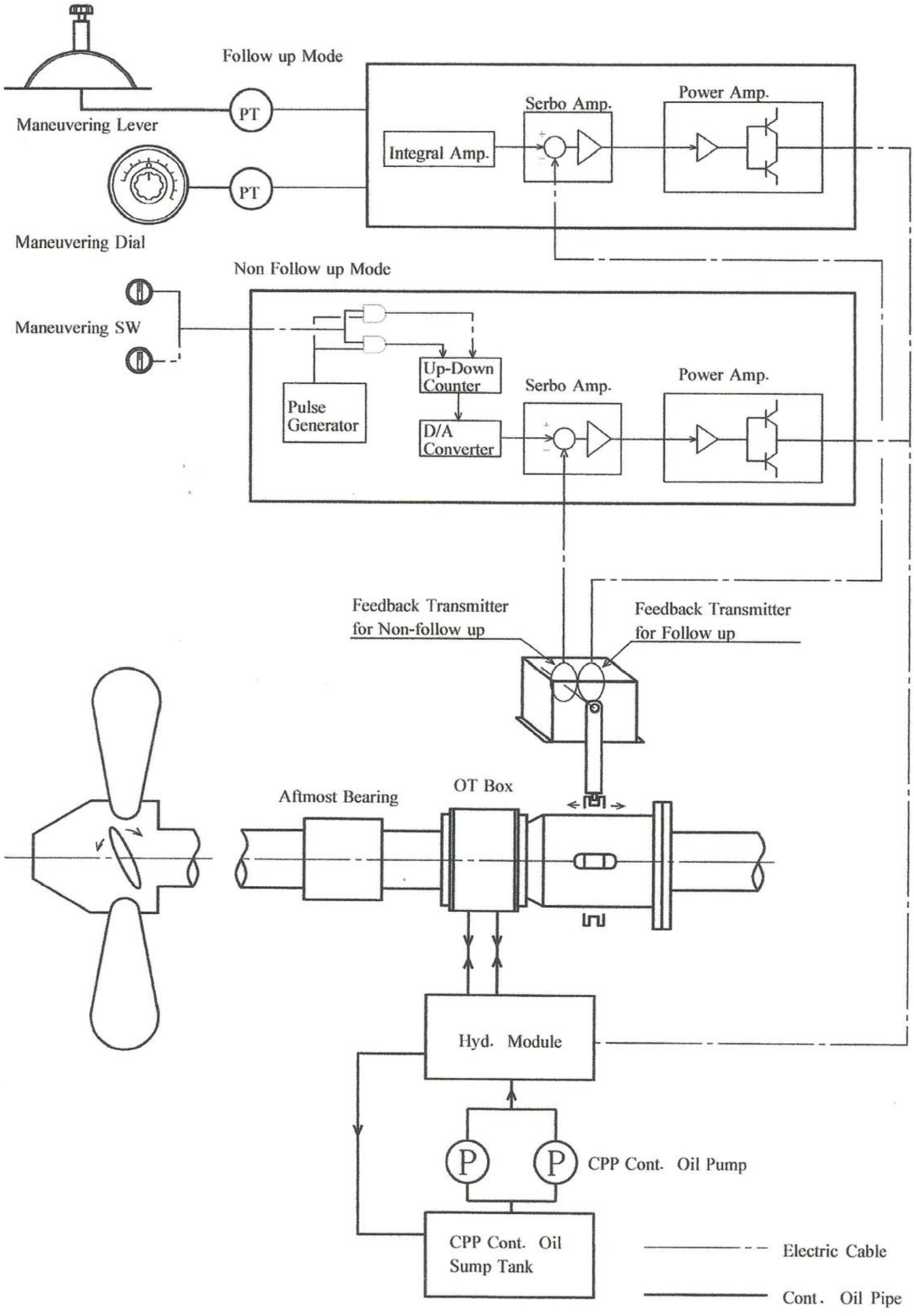
Flowchart of Starting Main Engine from Control Room

Figure 1 (7/10)



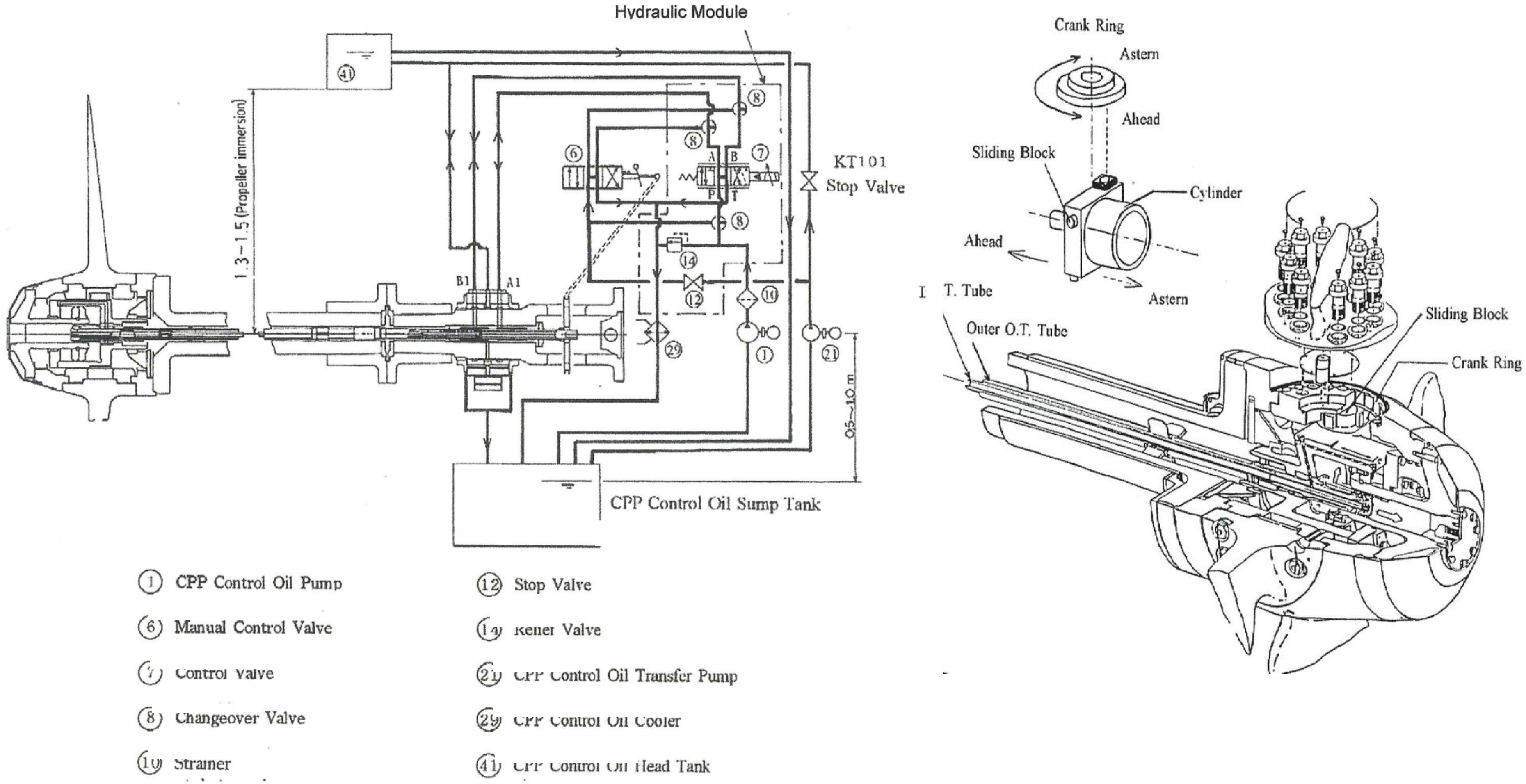
Schematic CPP Control System

Figure 1 (8/10)



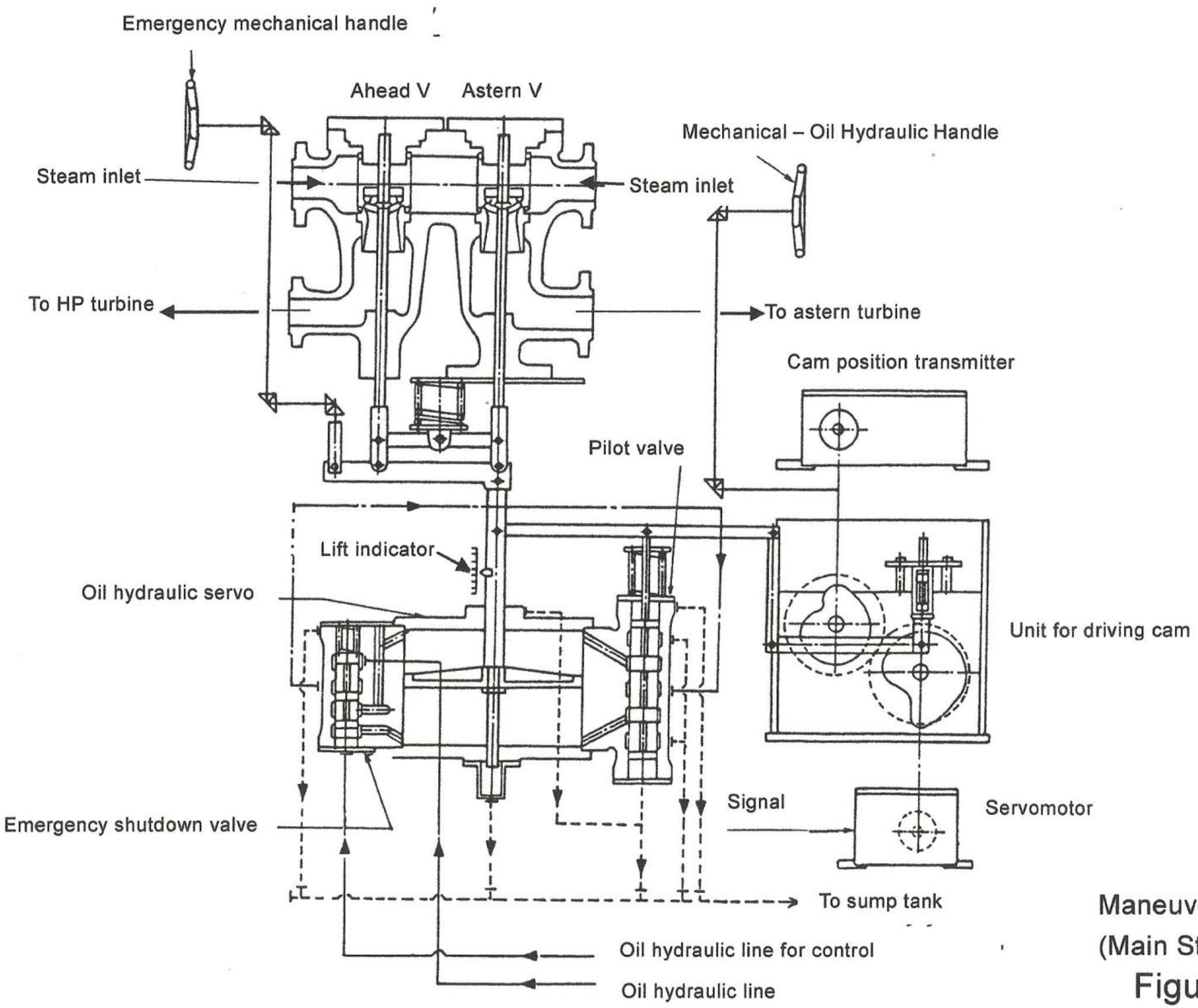
CPP Maneuvering Circuit

Figure 1 (9/10)

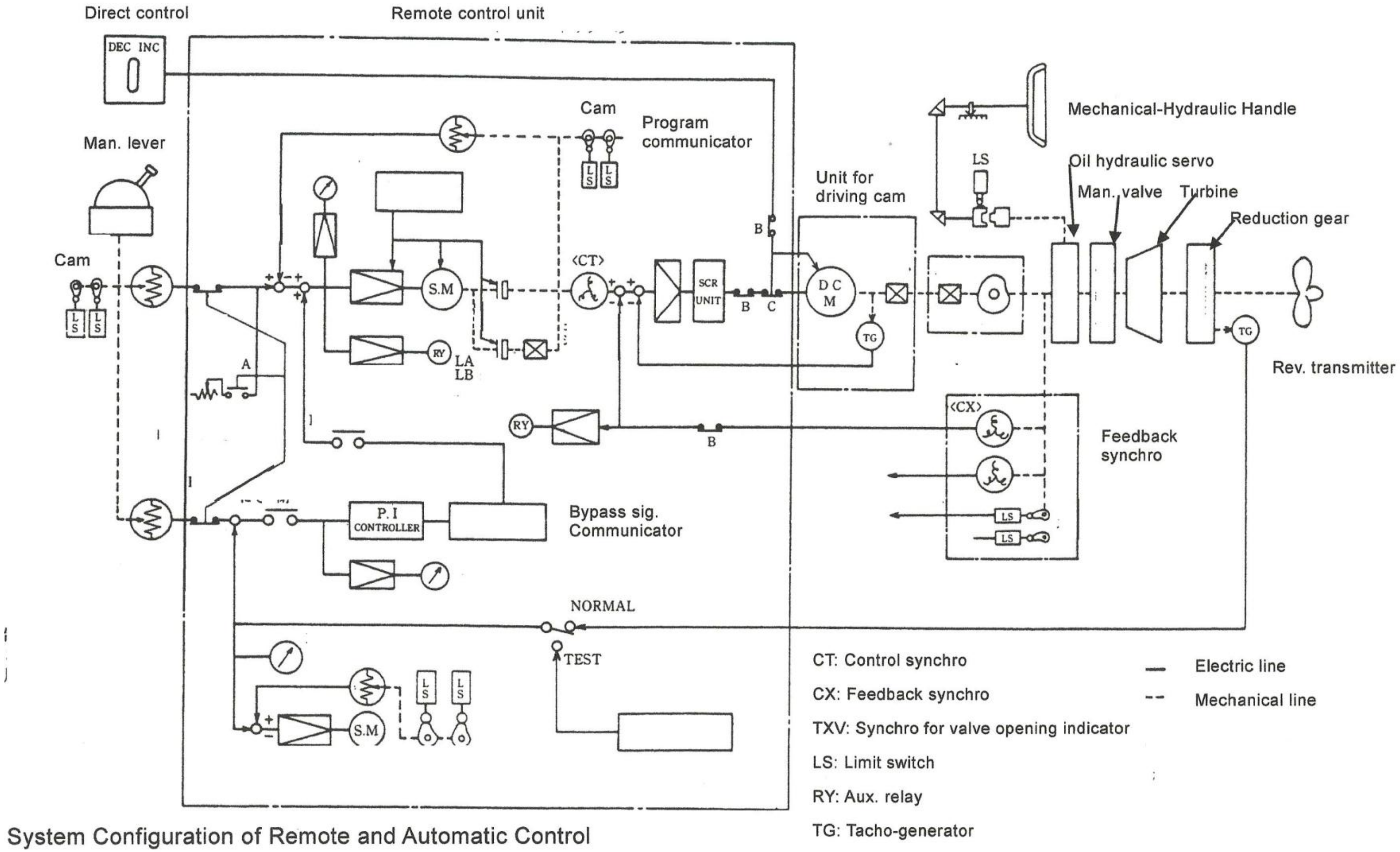


CPP Hydraulic System Diagram

Figure 1 (10/10)

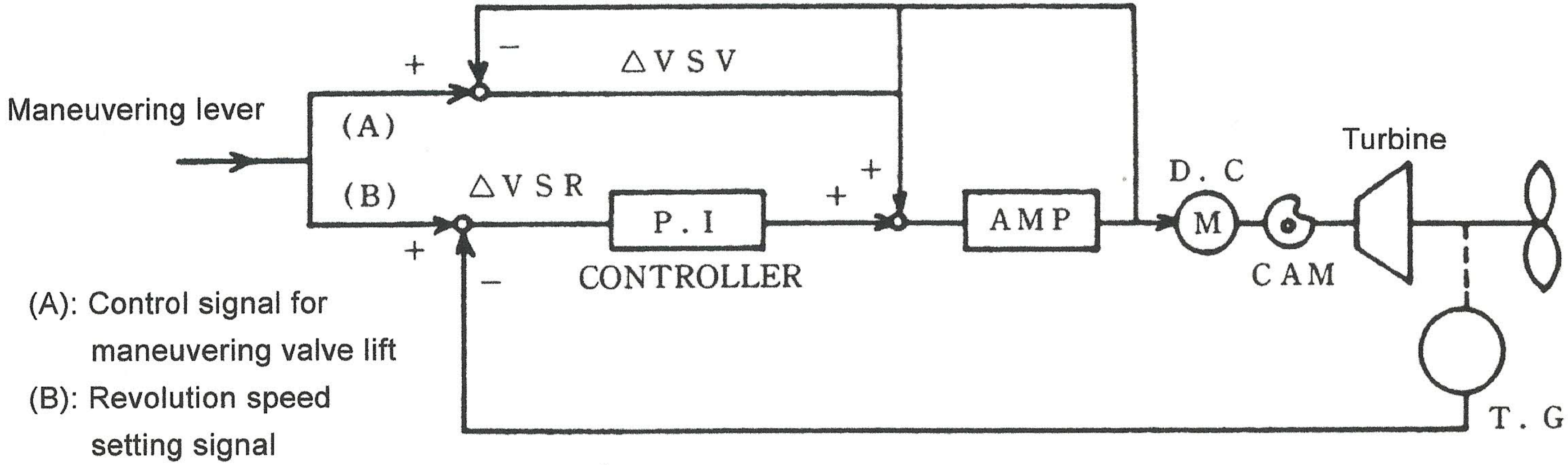


Maneuvering Valve
(Main Steam Turbine)
Figure 2 (1/5)

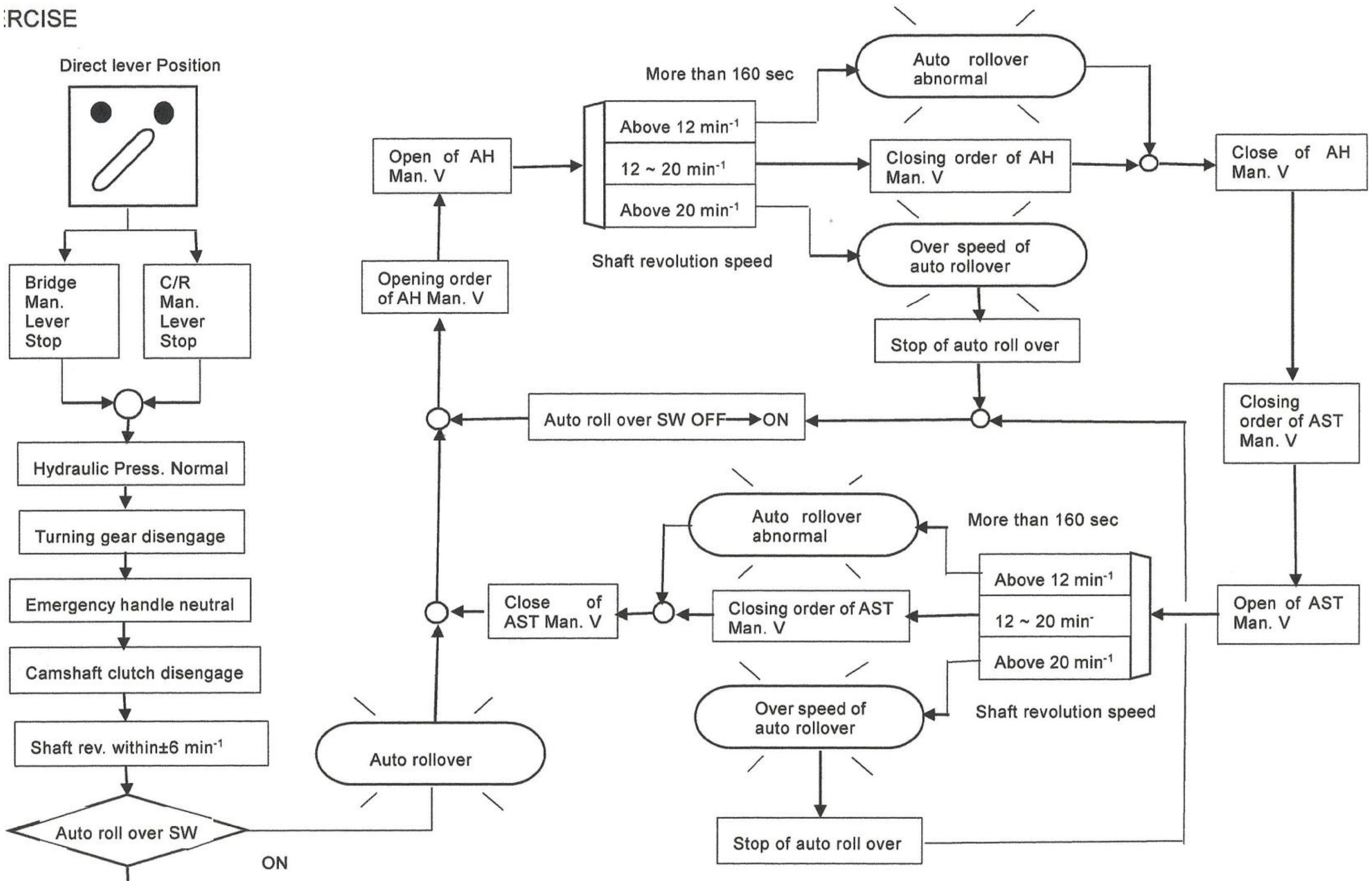


System Configuration of Remote and Automatic Control
(Main Steam Turbine)

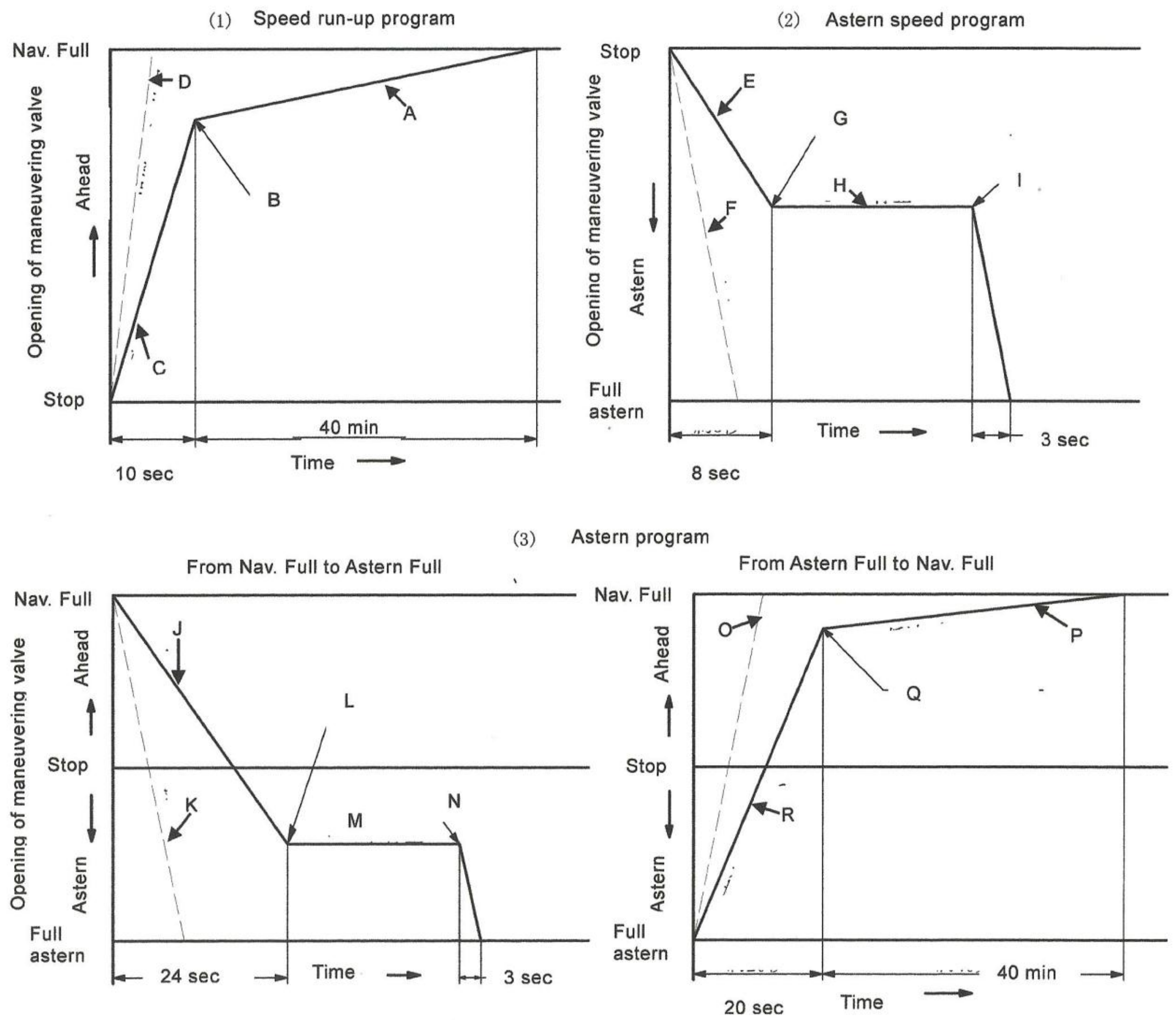
Figure 2 (2/5)



Block Diagram of Revolution Speed Control
(Main Steam Turbine)
Figure 2 (3/5)



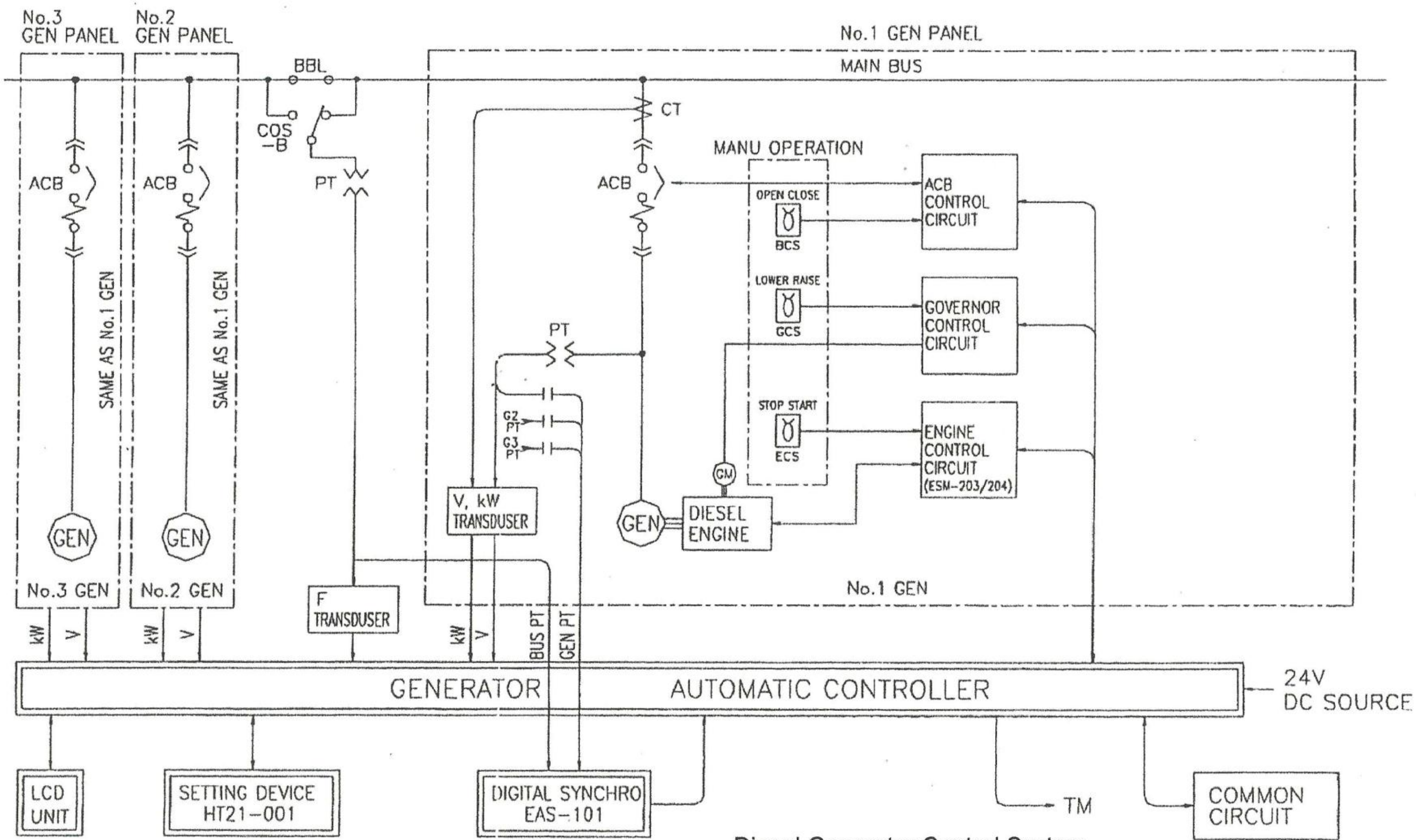
Automatic Rollover/Spinning
(Main Steam Turbine)
Figure 2 (4/5)



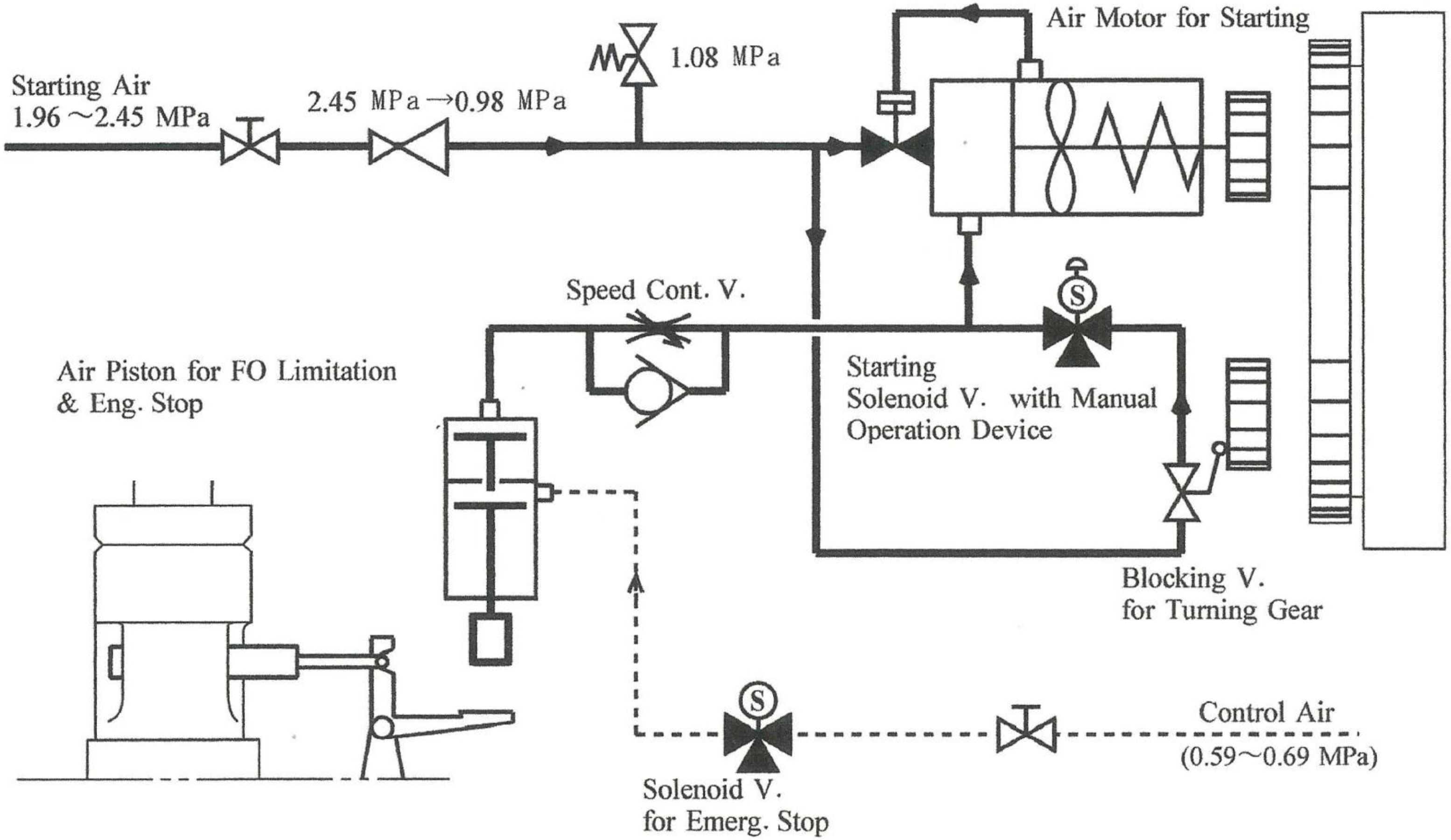
A: Low speed program
B: 80 % of Nav. Full
C: High speed program
D: Maneuvering lever position
E: High speed program
F: Maneuvering lever position
G: Astern steam pressure 1.7 Mpa
H: Motor stop
I: 45 % of Astern Full

J: High speed program
K: Maneuvering lever position
L: Astern steam pressure 1.7 Mpa
M: Motor stop
N: 45 % of Astern Full
O: Maneuvering lever position
P: Low speed program
Q: 80 % of Nav. Full
R: High speed program

Program Control
(Main Steam Turbine)
Figure 2 (5/5)

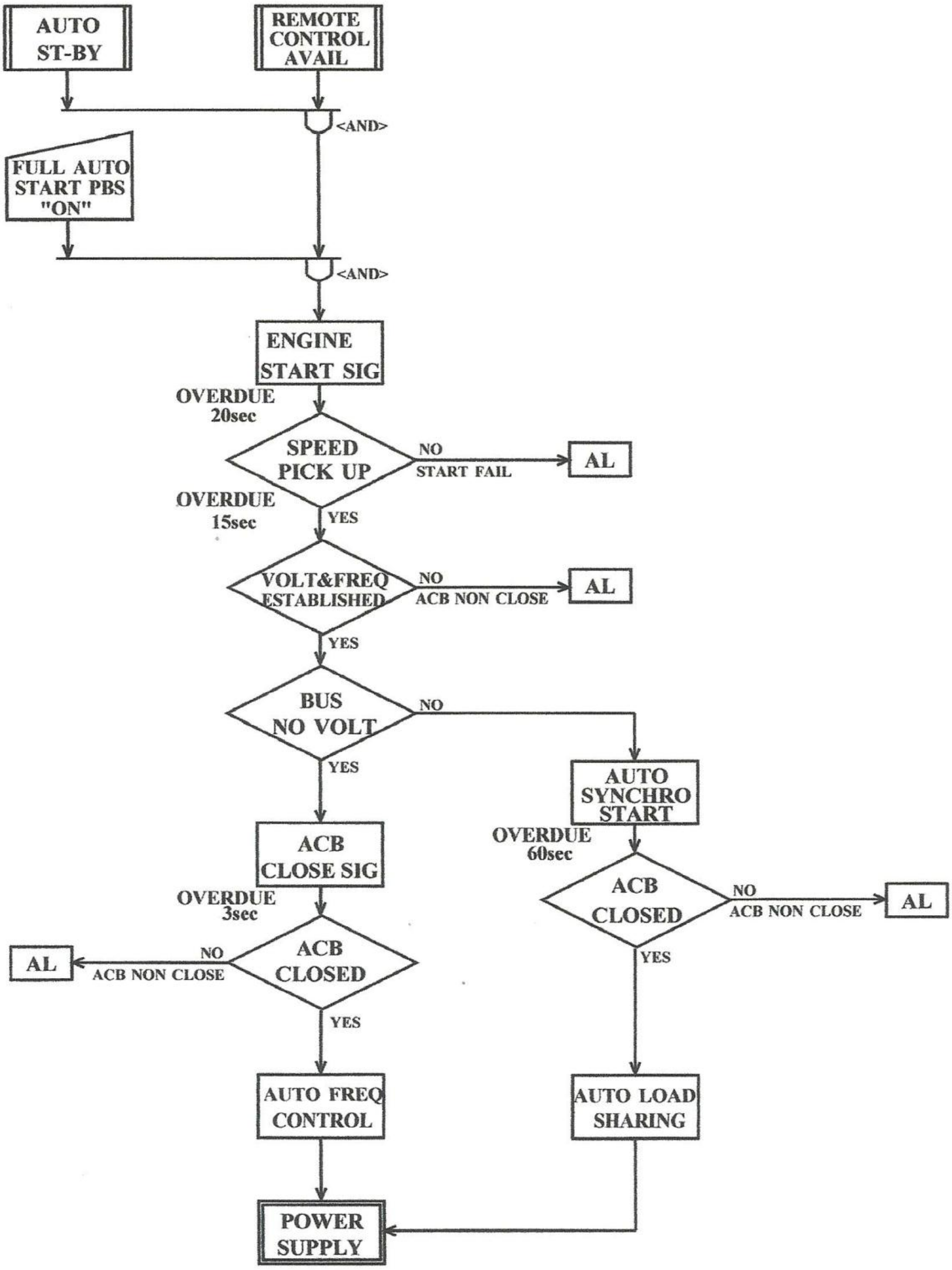


Diesel Generator Control System
(Diesel Generator and Distribution System)
Figure 3 (1/8)

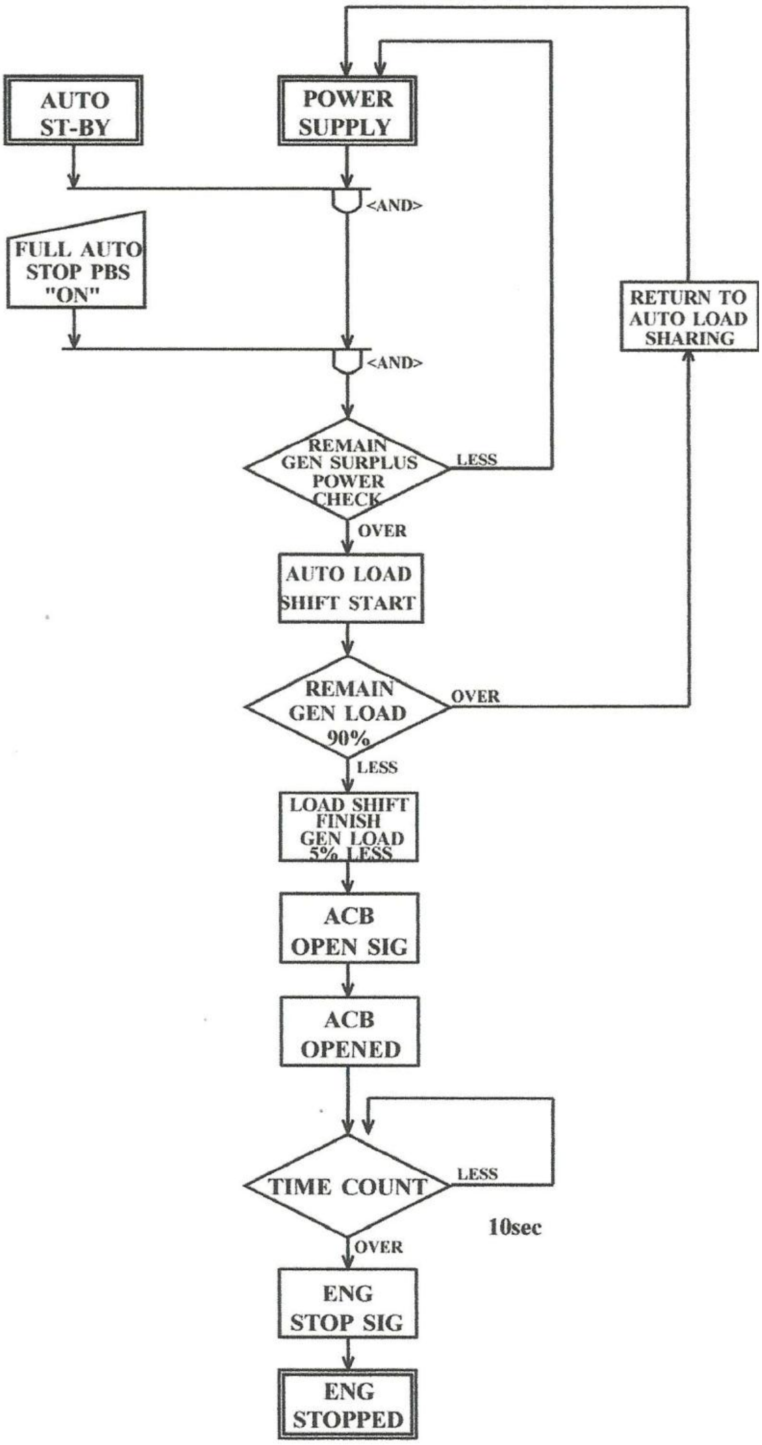


Starting and Control air System

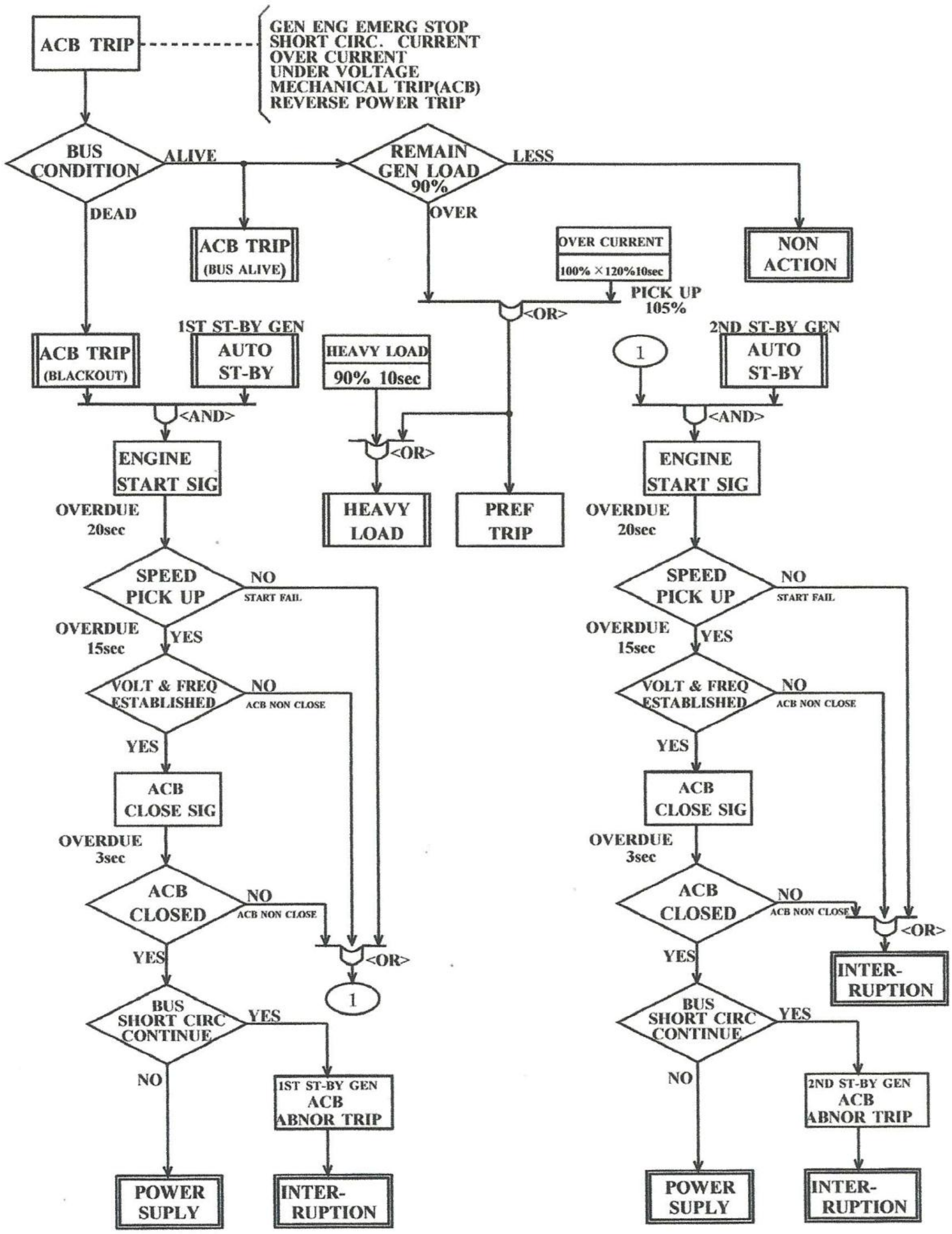
Figure 3 (2/8)



Diesel Generator Control System Flowchart – 1
(Generator Engine automatic start and synchronization)
(Diesel Generator and Distribution System)
Figure 3 (3/8)



Diesel Generator Control System Flowchart – 2
(Automatic load shift and ACB disconnection)
(Diesel Generator and Distribution System)
Figure 3 (4/8)

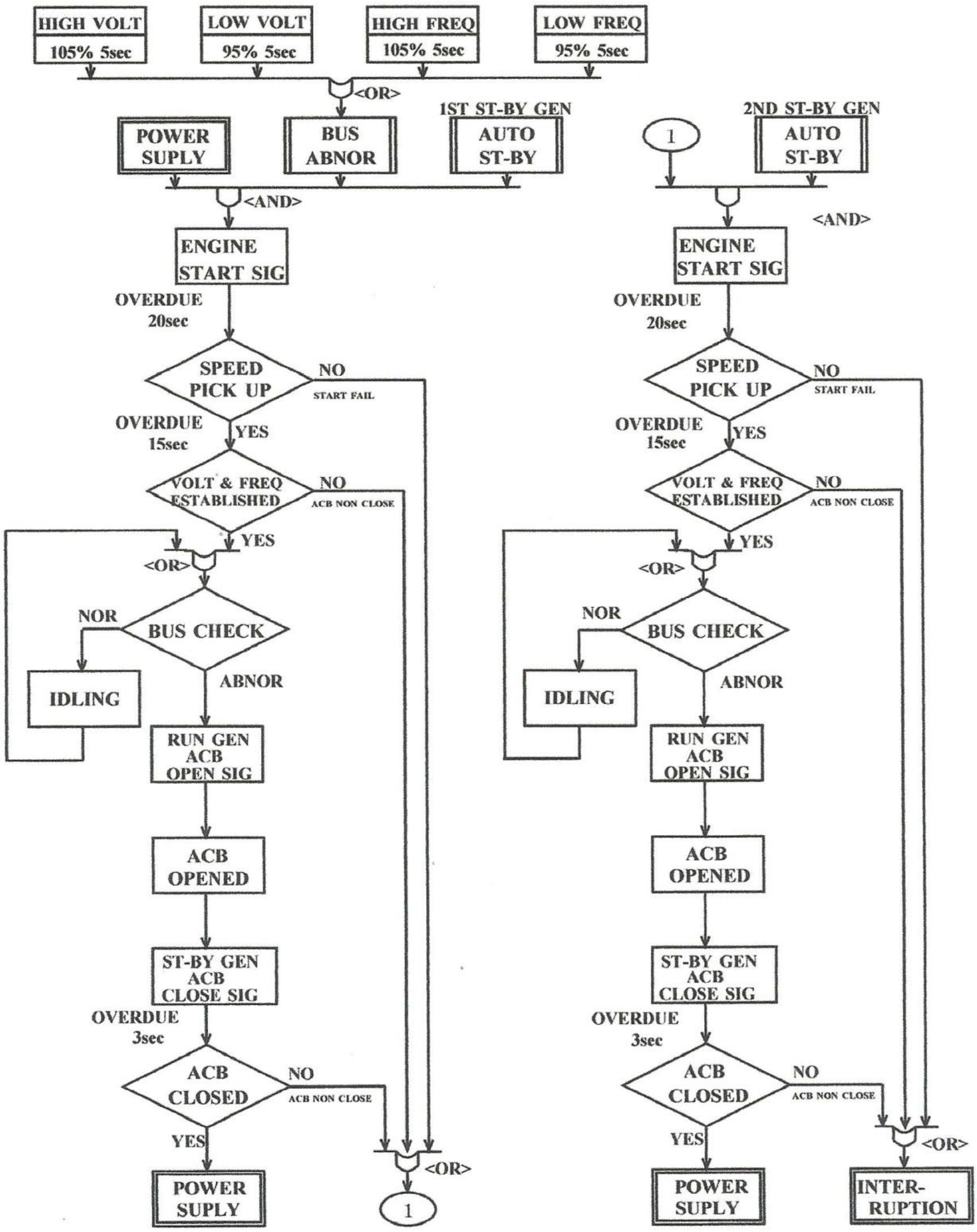


Diesel Generator Control System Flowchart – 3

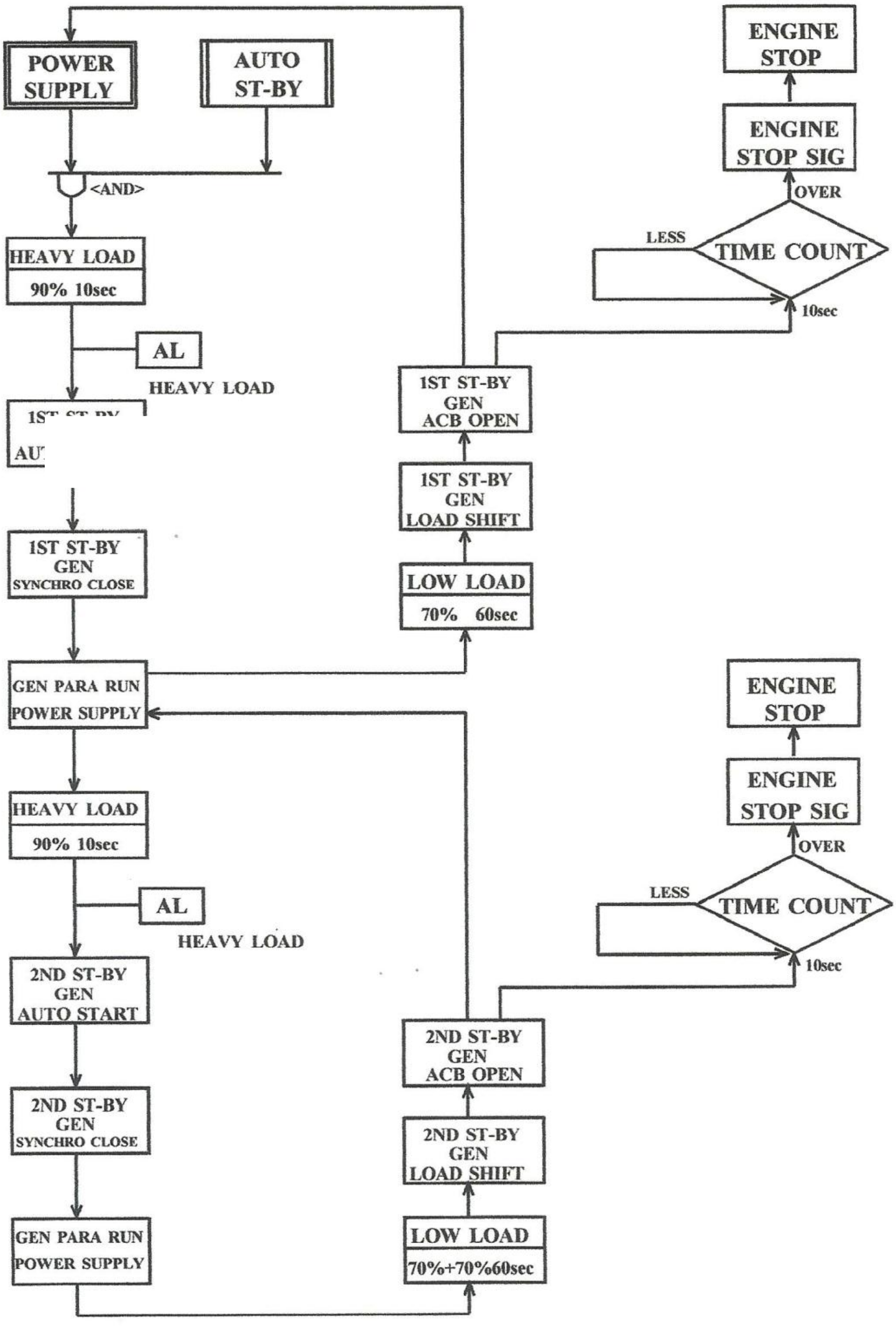
(Generator Engine automatic start when blackout)

(Diesel Generator and Distribution System)

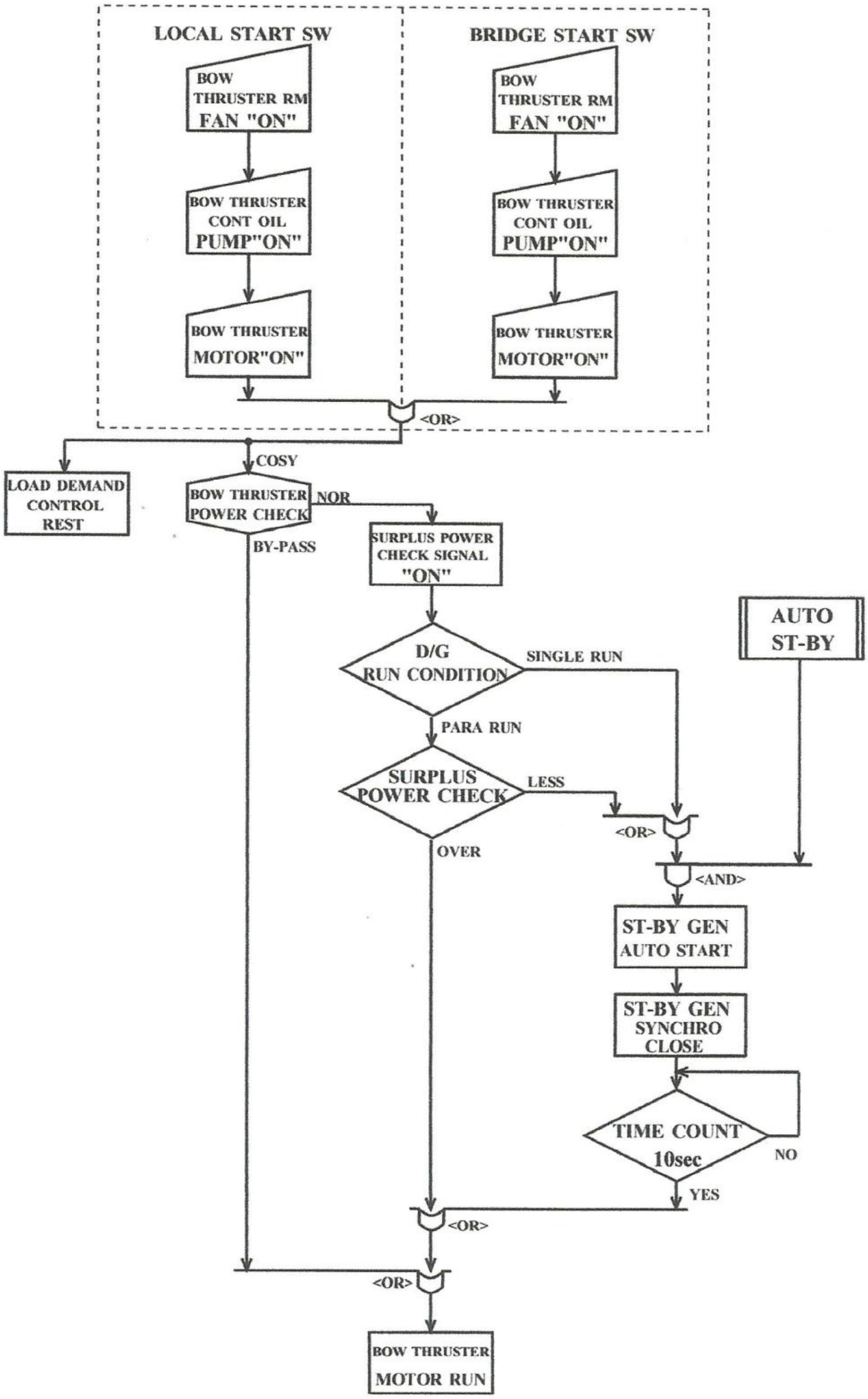
Figure 3 (5/8)



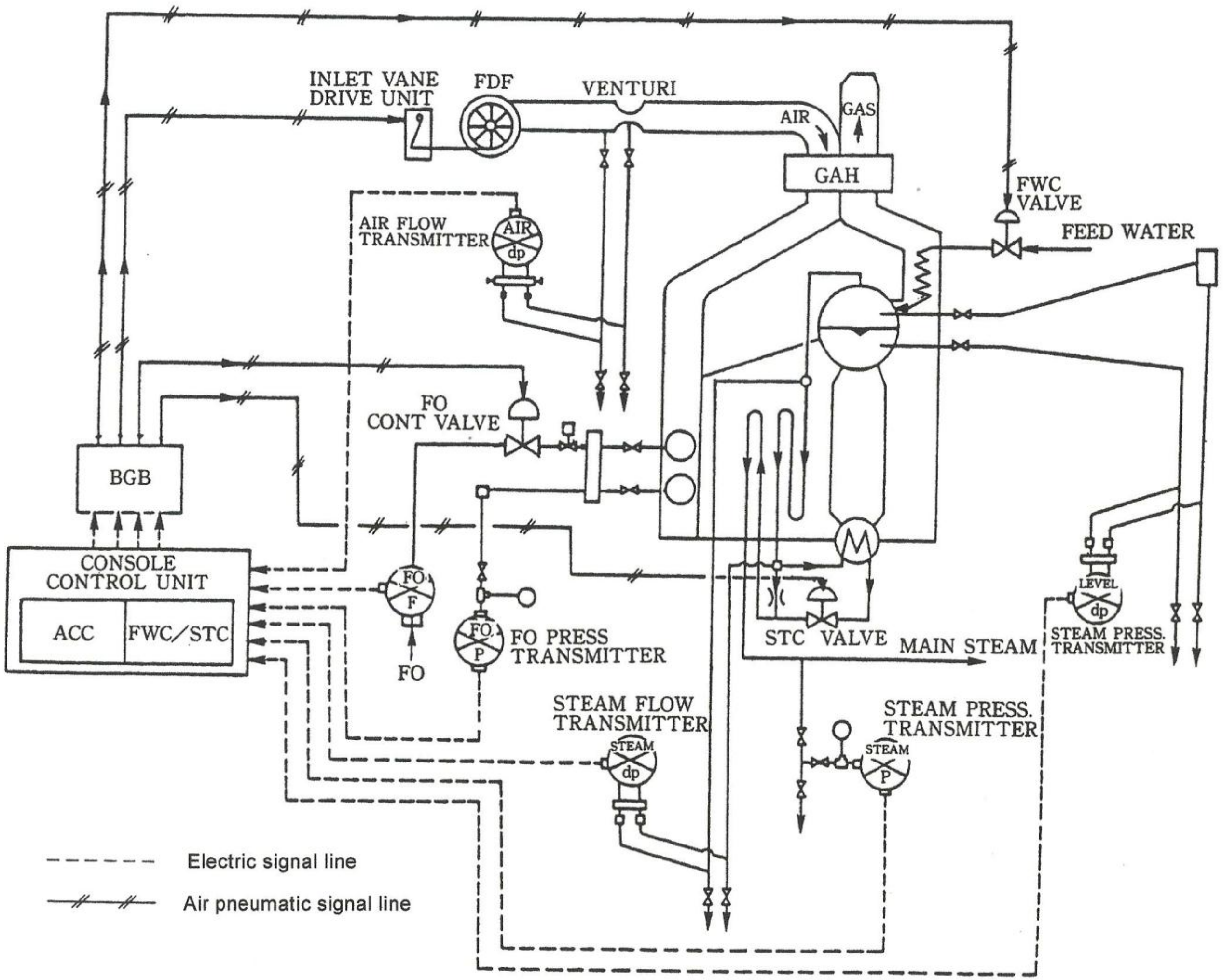
Diesel Generator Control System Flowchart – 4
(Generator Engine automatic start when BUS abnormal)
(Diesel Generator and Distribution System)
Figure 3 (6/8)



Diesel Generator Control System Flowchart – 5
(Load Demand Control)
(Diesel Generator and Distribution System)
Figure 3 (7/8)

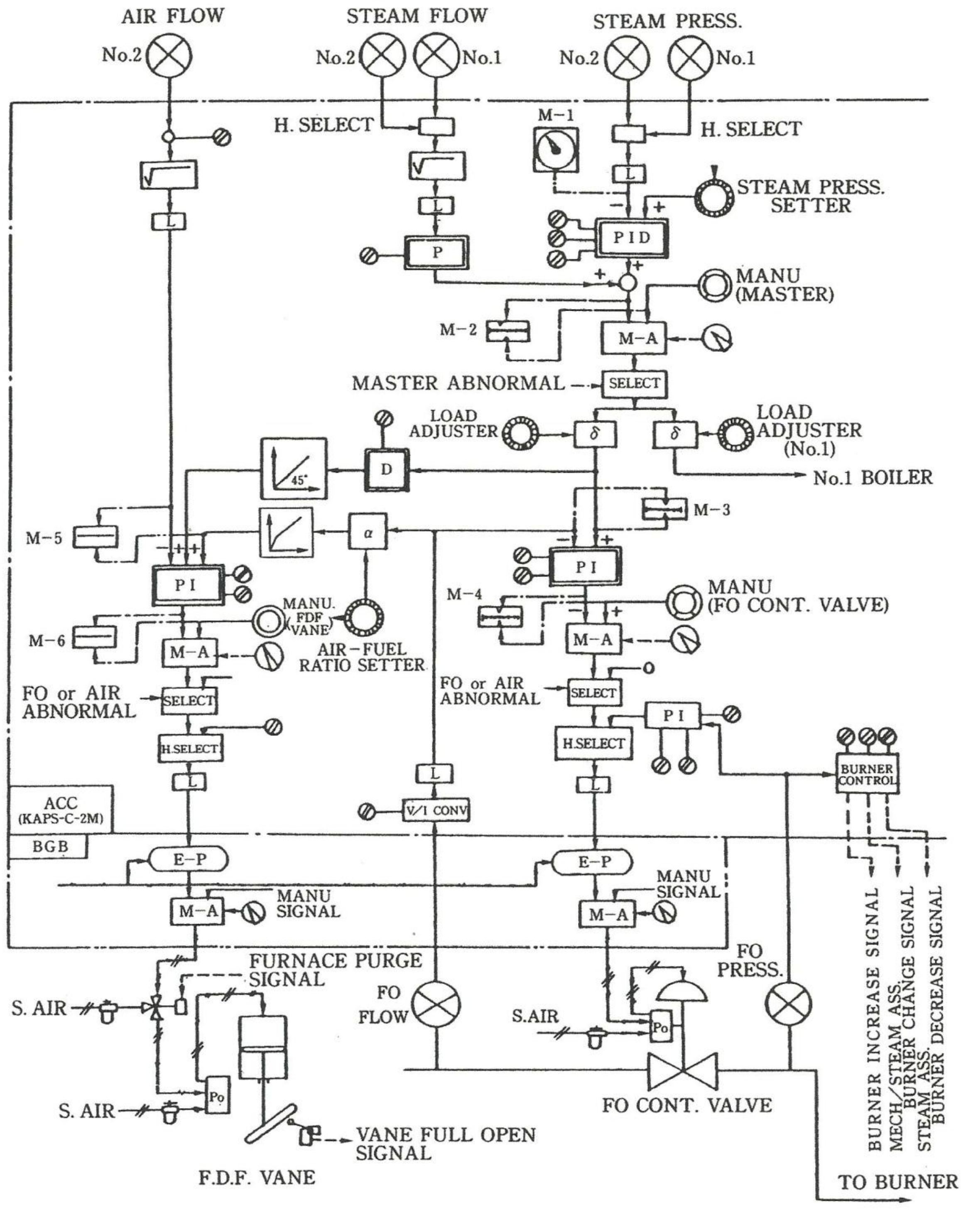


Diesel Generator Control System Flowchart – 6
(Large motor start blocking)
(Diesel Generator and Distribution System)
Figure 3 (8/8)

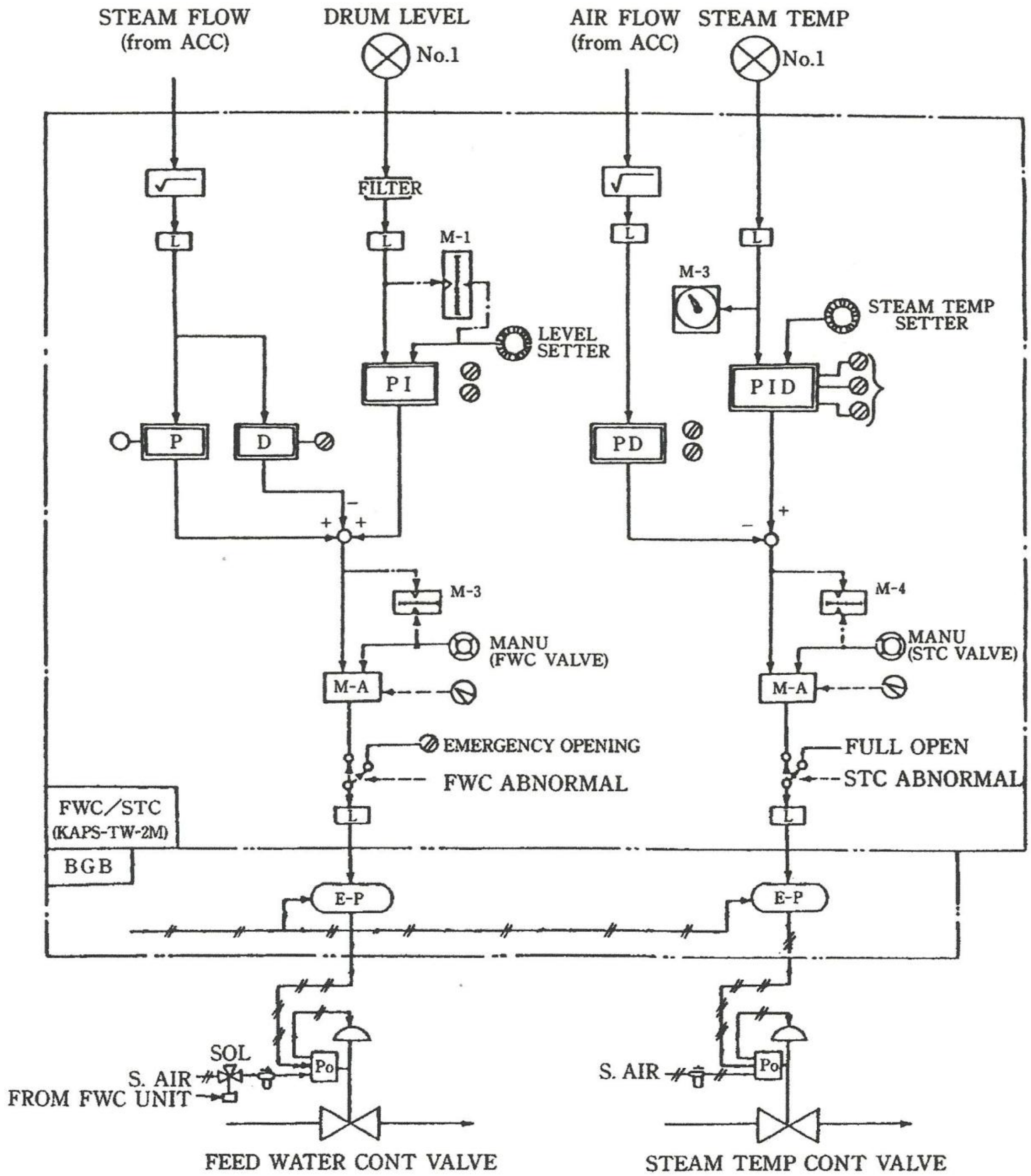


System Configuration of Main Boiler Automatic Control (Main Steam Boiler)

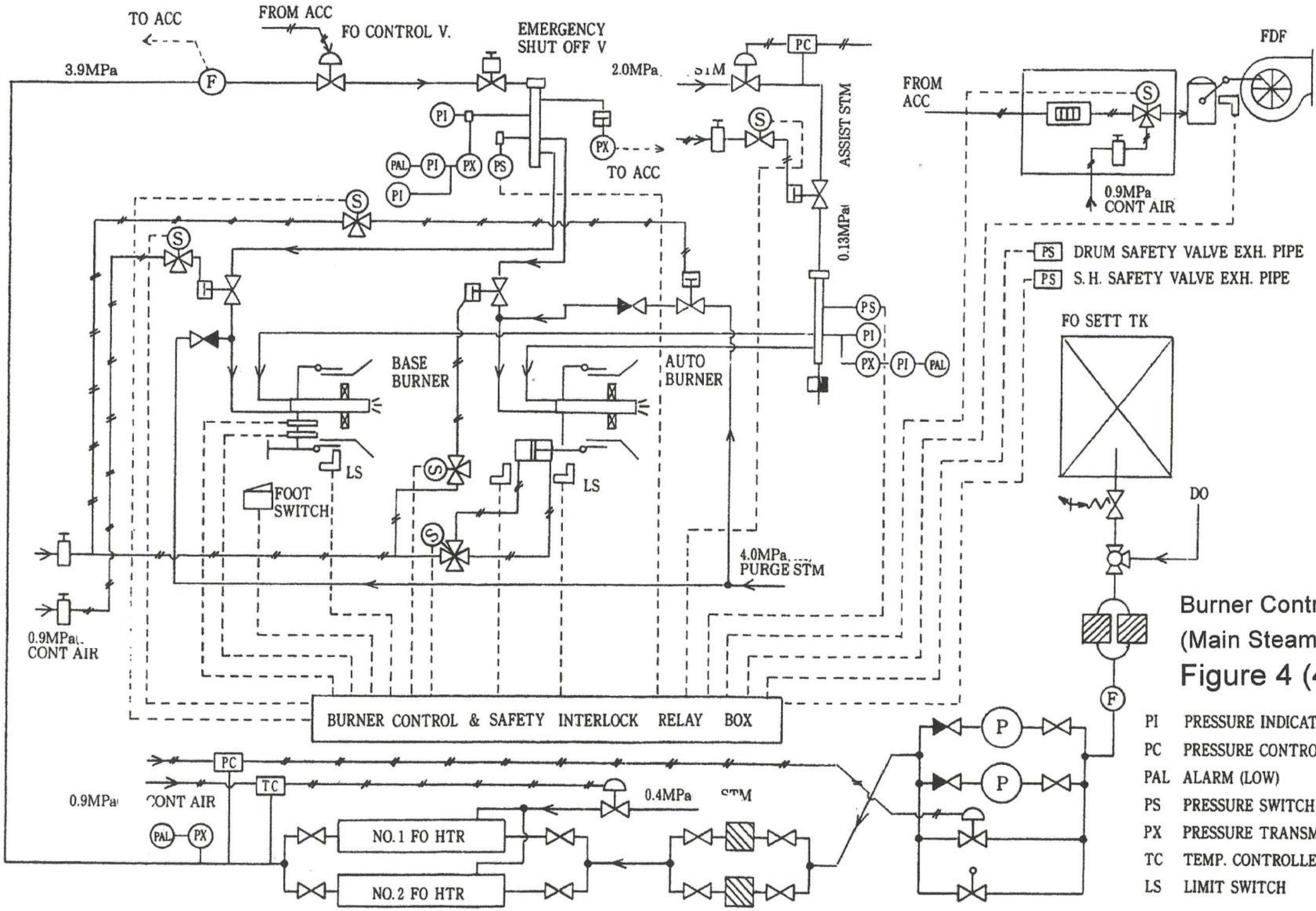
Figure 4 (1/5)



ACC System
(Main Steam Boiler)
Figure 4 (2/5)

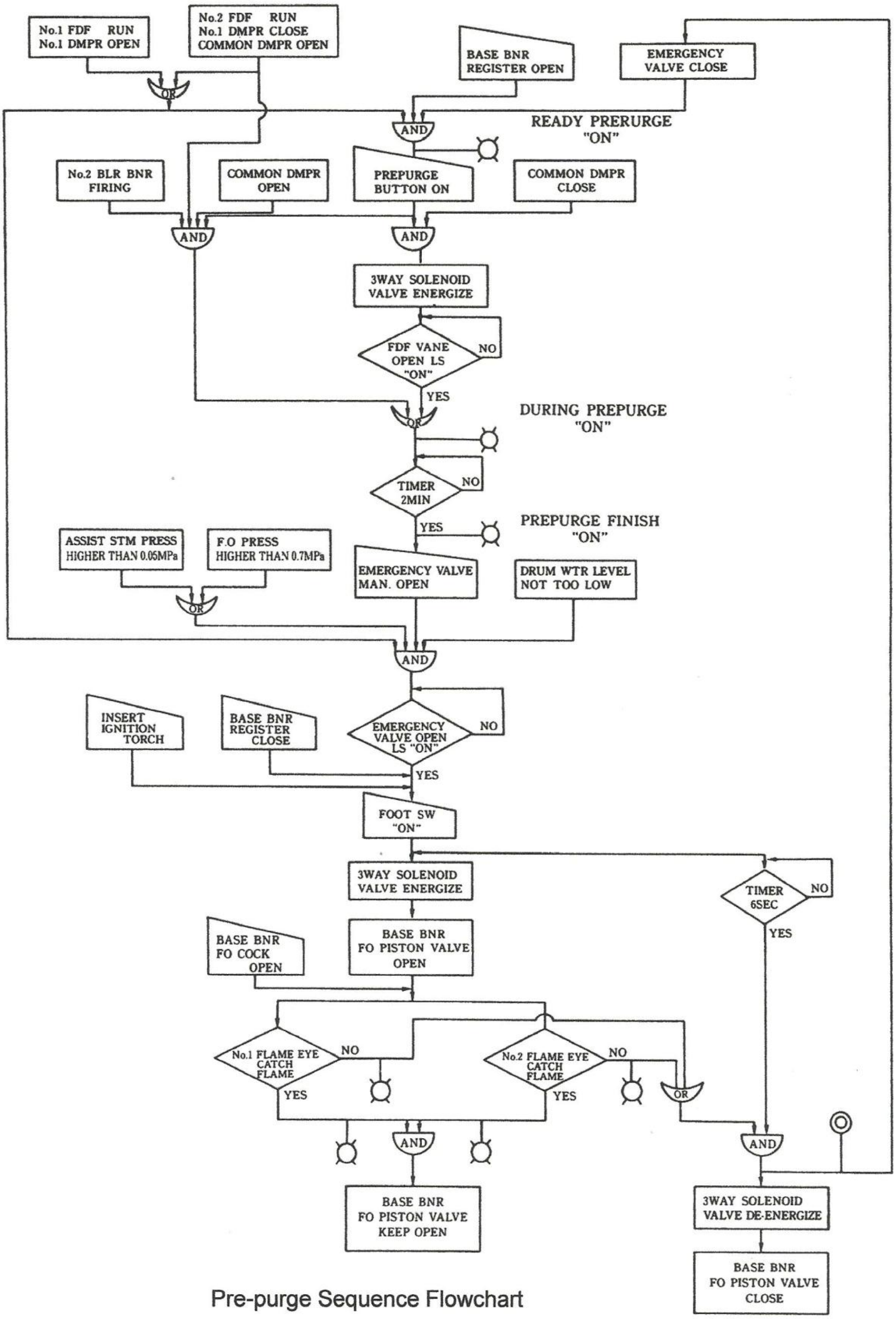


FWC and STC Systems
(Main Steam Boiler)
Figure 4 (3/5)

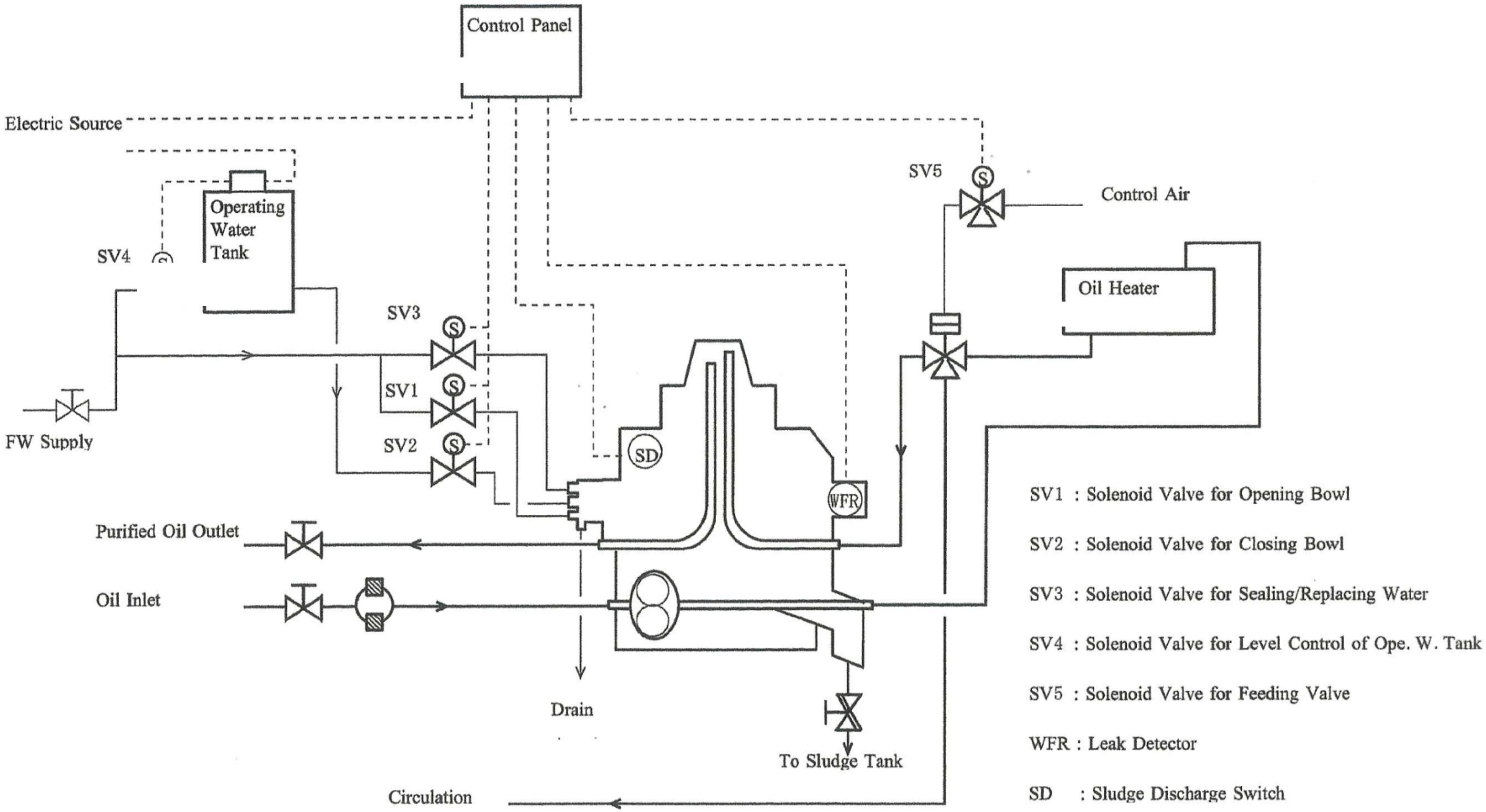


Burner Control System
(Main Steam Boiler)
Figure 4 (4/5)

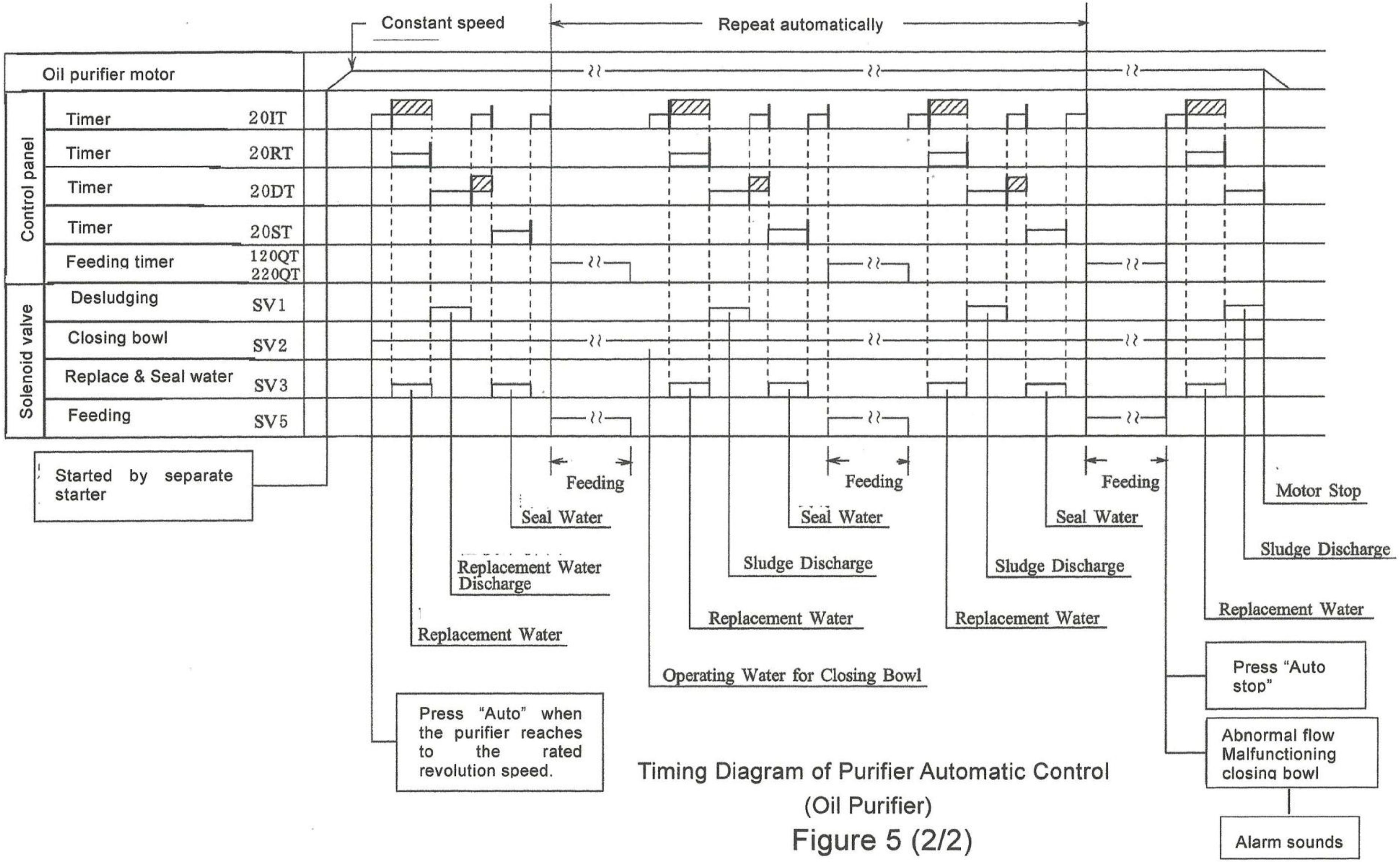
PI PRESSURE INDICATOR
PC PRESSURE CONTROLLER
PAL ALARM (LOW)
PS PRESSURE SWITCH
PX PRESSURE TRANSMITTER
TC TEMP. CONTROLLER
LS LIMIT SWITCH



Pre-purge Sequence Flowchart
(Main Steam Boiler)
Figure 4 (5/5)

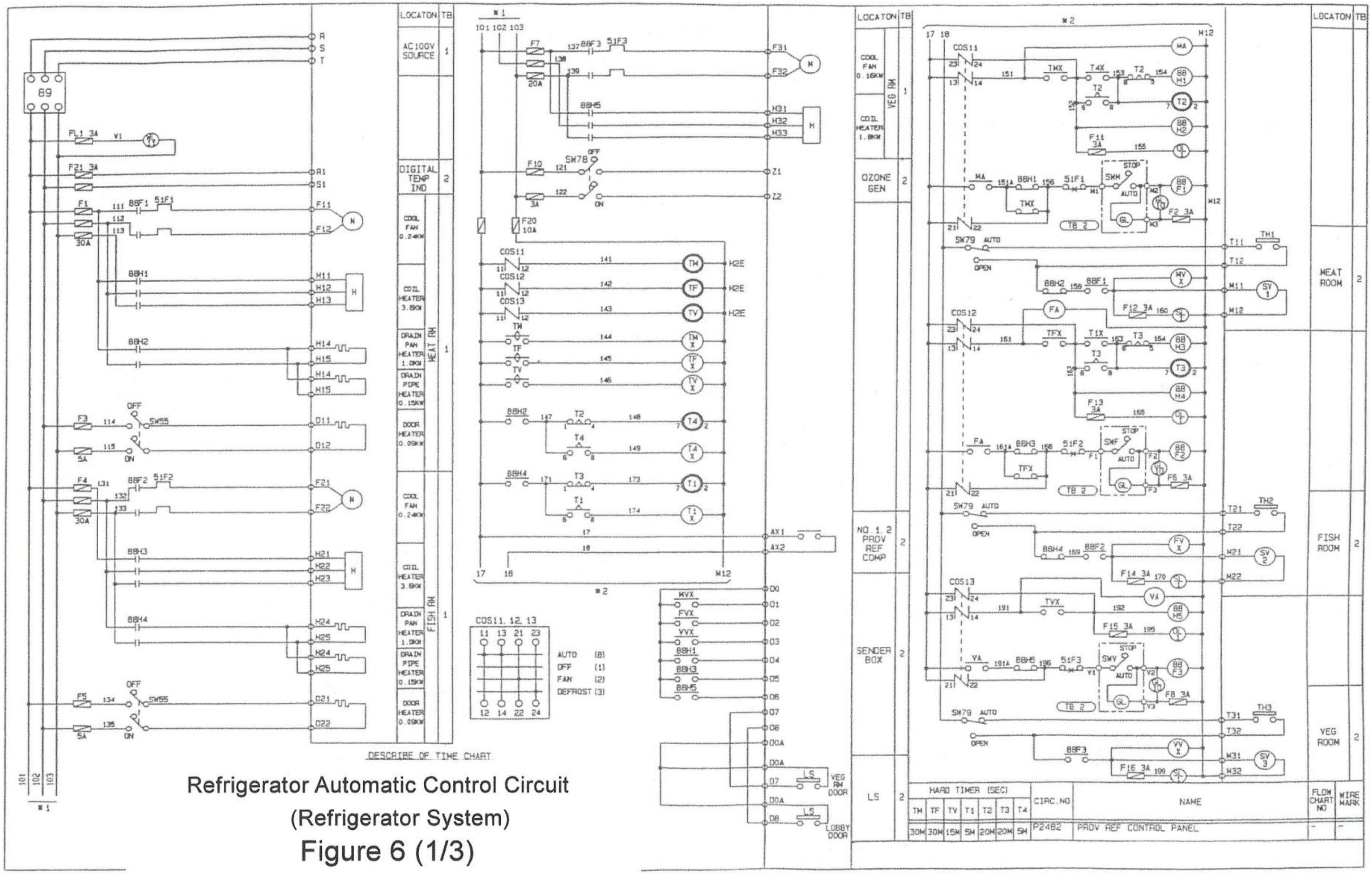


System Configuration of Purifier Automatic Control
(Oil Purifier)
Figure 5 (1/2)



Timing Diagram of Purifier Automatic Control
(Oil Purifier)

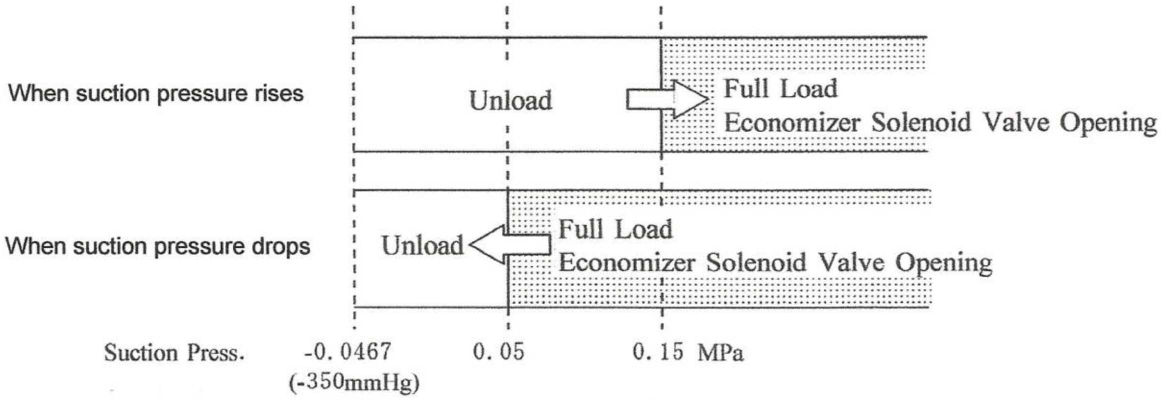
Figure 5 (2/2)



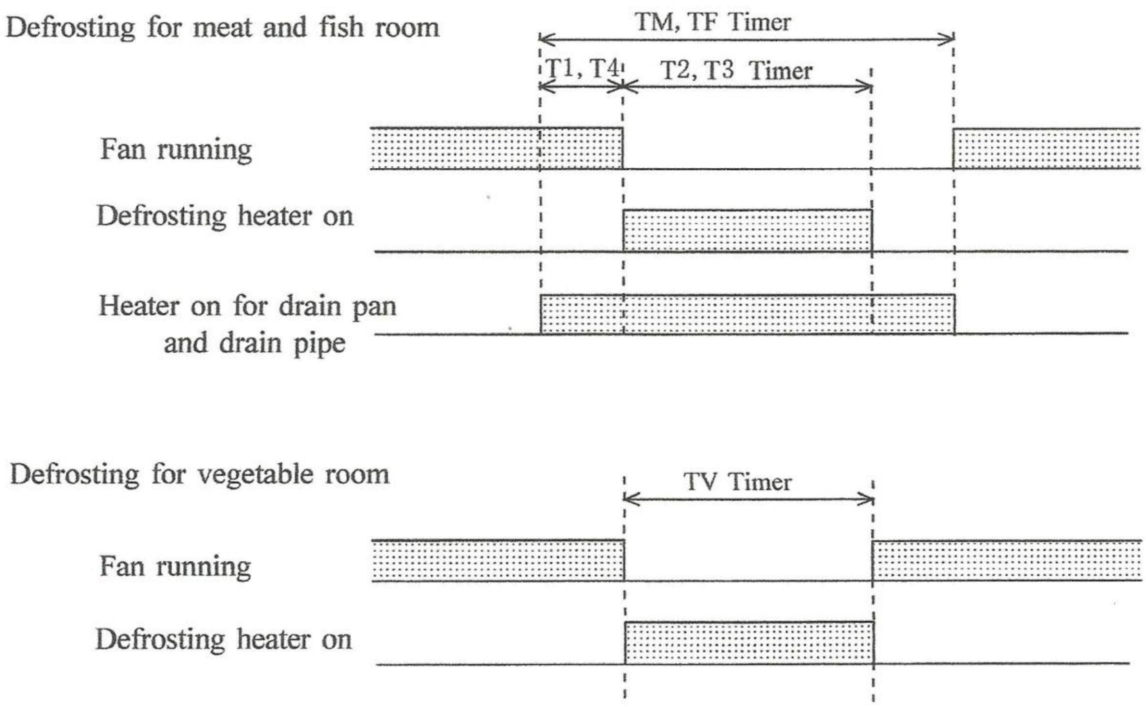
Refrigerator Automatic Control Circuit

(Refrigerator System)

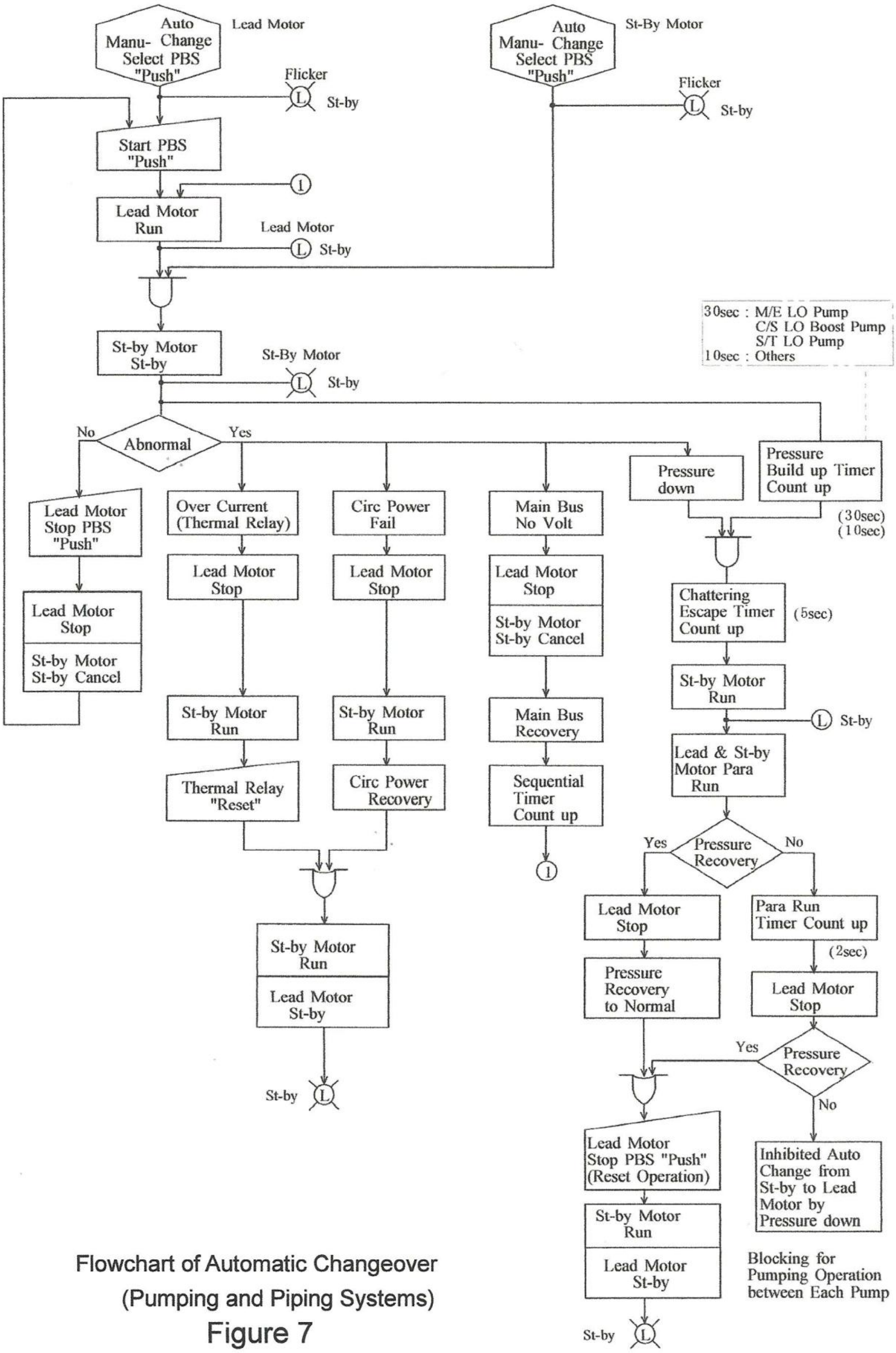
Figure 6 (1/3)



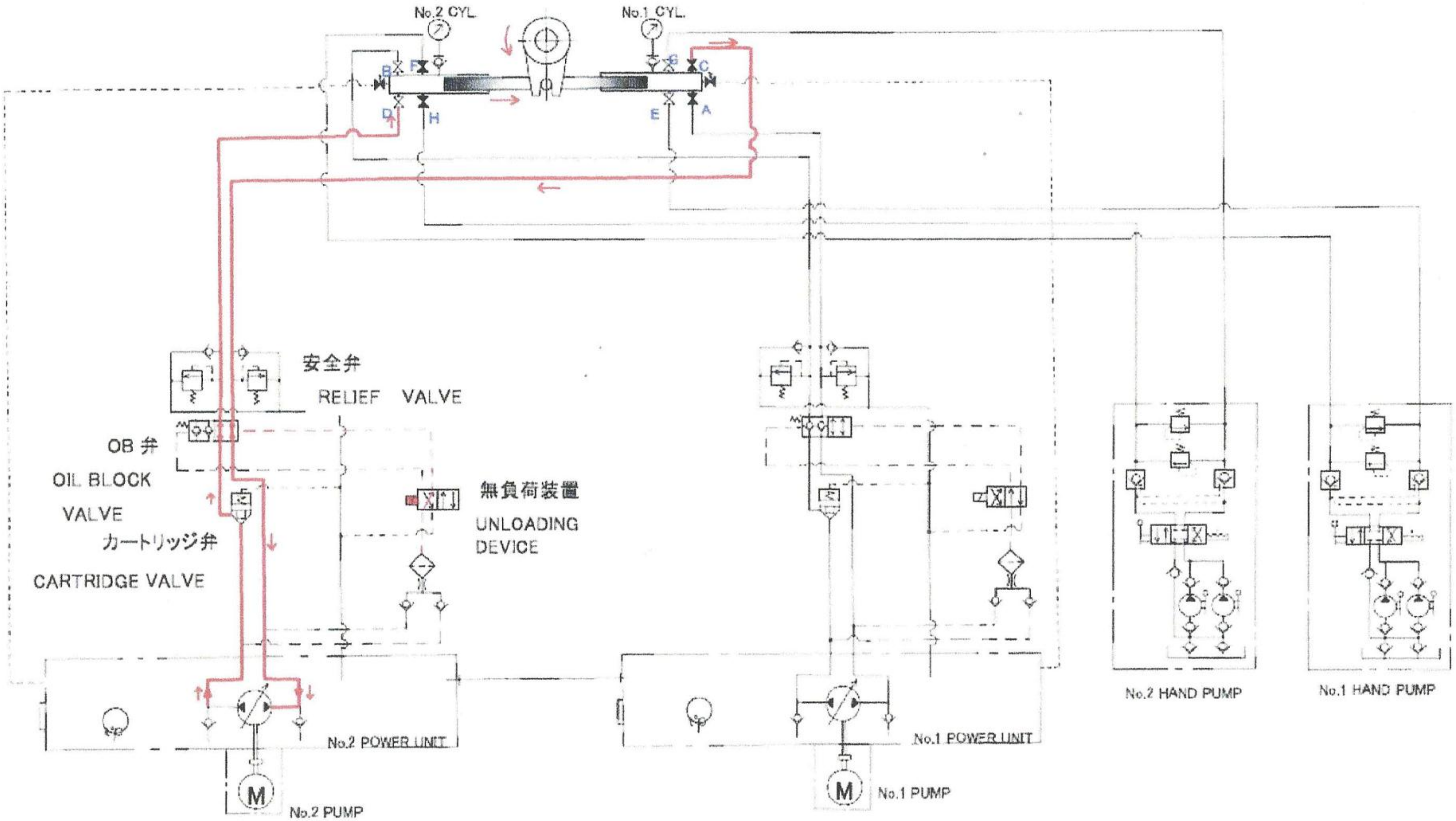
Pressure Setting for Unloader and Economizer
(Refrigerator System)
Figure 6 (2/3)



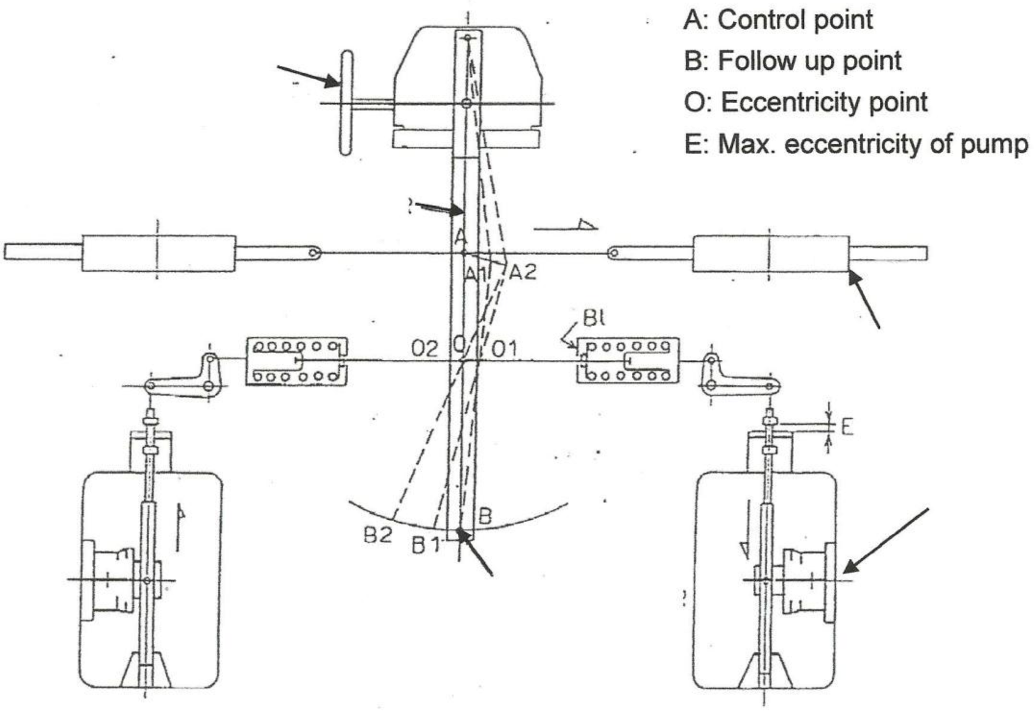
Defrosting Timer Chart
(Refrigerator System)
Figure 6 (3/3)



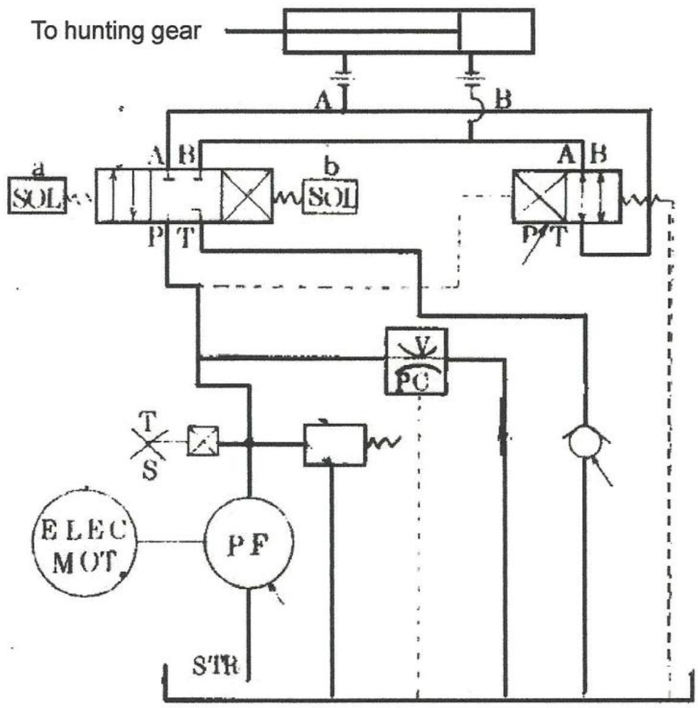
Flowchart of Automatic Changeover
(Pumping and Piping Systems)
Figure 7



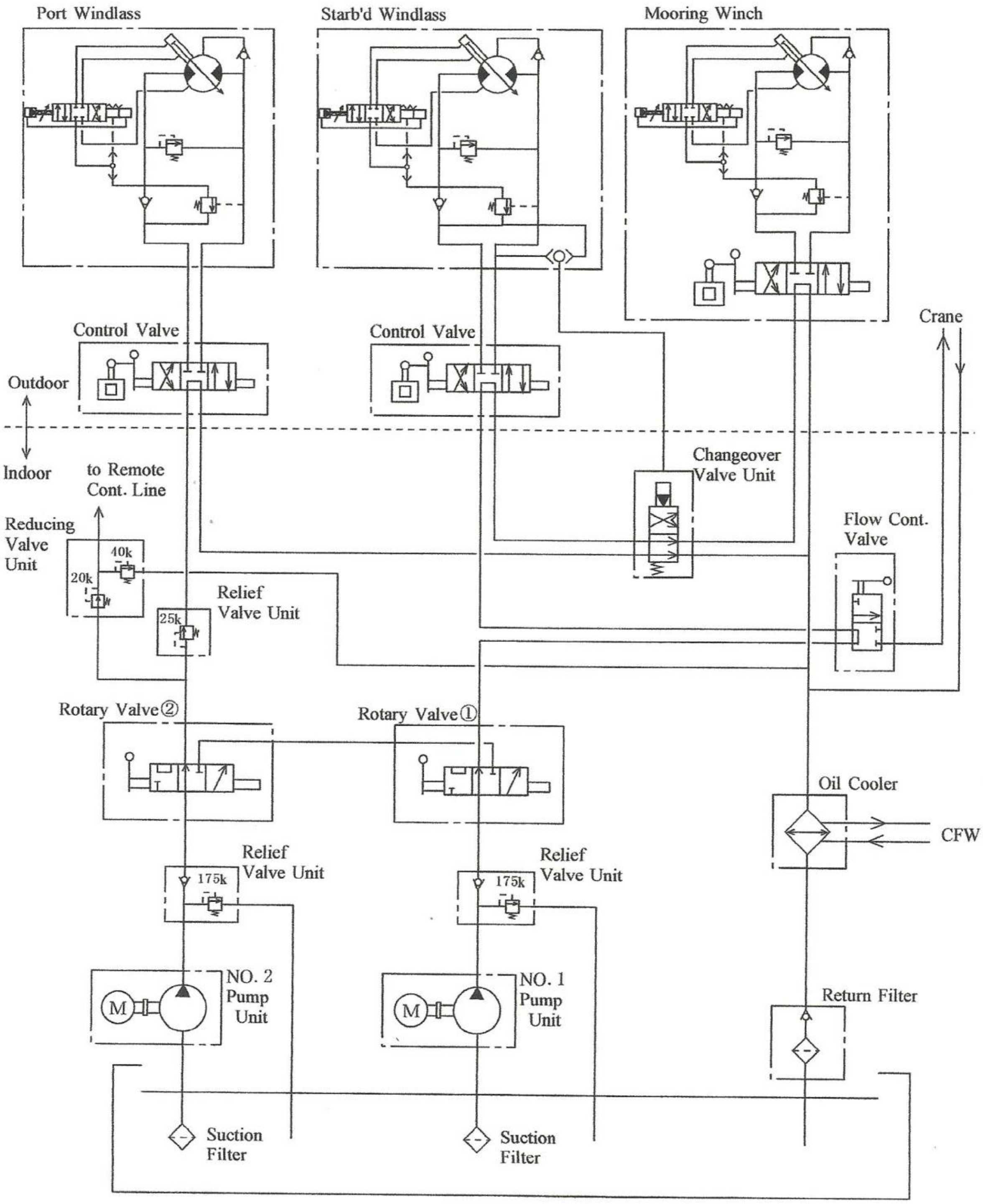
Steering Gear Hydraulic Circuit Diagram
(Steering Gear System)
Figure 8 (1/3)



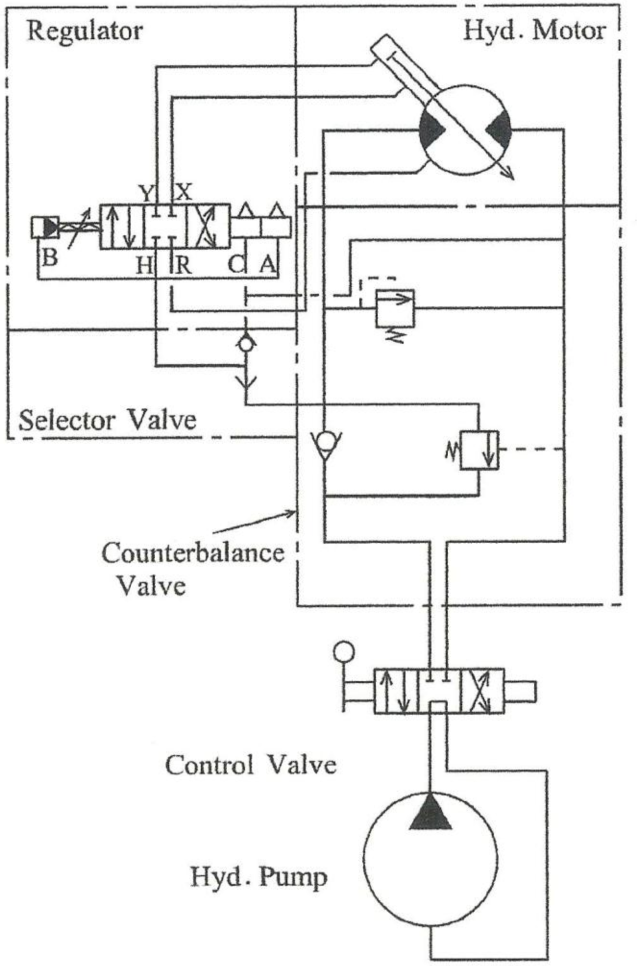
Steering Gear Control System
(Steering gear System)
Figure 8 (2/3)



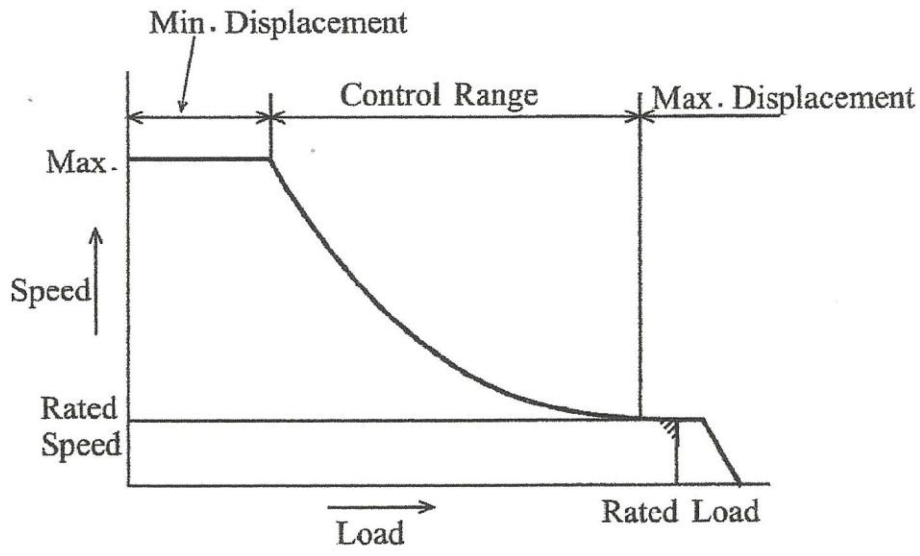
Auto Pilot Power Unit Diagram
(Steering Gear System)
Figure 8 (3/3)



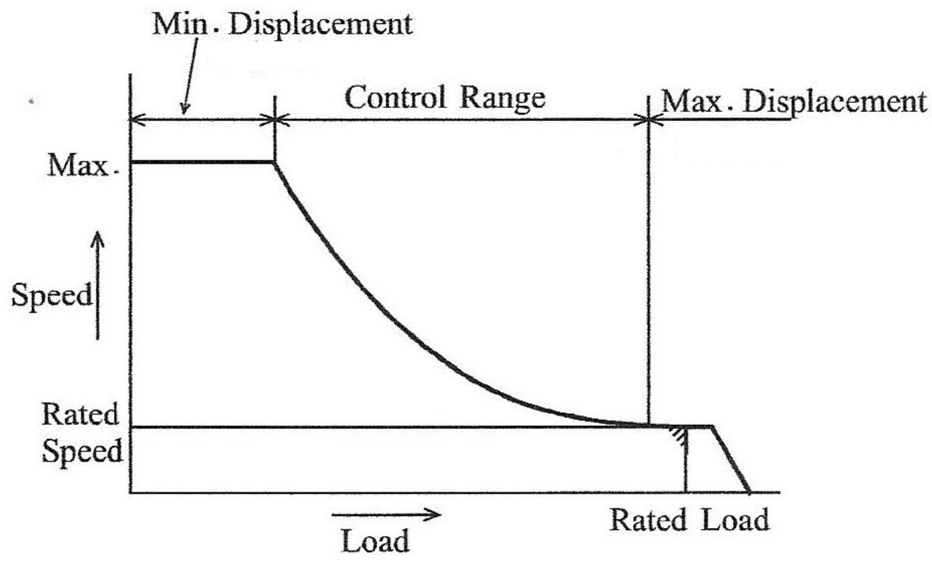
Hydraulic Circuit Diagram for Windlass and Mooring Winch
(Cargo Handling Equipment and Deck Machinery)
Figure 9 (1/3)



Hydraulic Motor Circuit Diagram
(Cargo Handling Equipment and Deck Machinery)
Figure 9 (2/3)



Speed Control by Regulator
(Cargo Handling Equipment and Deck Machinery)
Figure 9 (3/3)


Min. Displacement
Control Range
Max. Displacement
Max.
Speed
Rated
Speed
Load
Rated Load

ERS II – 11

Training Title/Scenario: Various automatic control

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment
.3 control systems
.a various automatic control methodologies and characteristics

Time allocation: 2.5 hours

Outline of the training:

The trainees watch simulation video that introduces systems and characteristics of various automatic control methodologies such as ON-OFF control, Sequential control, PID control, Programmable Logic Control (PLC) and Program control. The trainees perform operations to control simulated process values and/or machinery.

Prerequisite:

No prerequisite is necessary

Note:

This training gives the trainees general knowledge on various automatic control methodologies. The instructor may unitize common simulation video/programs used in a field of control engineering.

Specific purpose of the training:

The trainees will be able to understand characteristic and features of various control methodologies.

Implementation of the training

T in min	Training process
0 ~ 30	The instructor shows the trainees the simulation video that introduces applications, characteristics and features of various automatic control methodologies as follow. - ON-OFF control - Sequential control - PID control - Programmable Logic Control (PLC) - Program control (The instructor should brief features of each control method as necessary)
30 ~ 90	(The instructor lets the trainees perform operations to control process values and/or machinery using system diagram or illustrations displayed on the screen. The instructor names the trainees by turns) The trainees perform operations on the simulated system diagrams or illustrations confirming inputs, outputs and results of control according to the systems. (After the operations, the instructor gives the trainees assignment paper and another 30 minutes to complete it)
90 ~ 120	The trainees complete the assignment.

ASSIGNMENT

Name		Date	
Reg. No		Scenario: Various automatic control	
Class			

1. Describe briefly 1) characteristics, 2) applications and 3) system components of the following control methodologies.

1.1 ON-OFF control

1.2 Sequential control

1.3 PID control

1.4 Programmable Logic Control (PLC)

1.5 Program control

ERS II – 12

Training Title/Scenario: PID control

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment
.3 control systems
.b Proportional-Integral-Derivative (PID) control characteristics and associated system devices for process control

Time allocation: 3 hours

Outline of the training:

The trainees watch simulation video that introduces PID control and associated system devices for process control. The trainees perform operations to control process values changing setting value and PID parameters.

Prerequisite:

- Completion of ERS II – 11
- Basic theoretical knowledge on PID control

Note:

It is important to relate this training to practical applications on board and the trainees should clearly understand effects and meaning of PID parameters. The instructor may unitize common simulation video/programs used in a field of control engineering.

Specific purpose of the training:

The trainees will be able to determine optimum PID parameters understanding their effects and meaning.

Implementation of the training

T in min	Training process
0 ~ 30	The instructor shows the trainees the simulation video that introduces PID control and associated system devices for process control. (The instructor should brief features of PID control as necessary)
30 ~ 120	(The instructor lets the trainees perform operations to control process values using system diagram or illustrations displayed on the screen. The instructor names the trainees by turns) The trainees perform operations on the simulated system diagrams or illustrations changing PID parameters as follow. 1. P control 2. PI control 3. PD control 4. PID control The trainees perform "Step response test" by changing setting value seeking appropriate PID parameters. The trainees perform manual control to the controlling process value. The trainees compare manual control with PID control by changing control mode from manual to automatic and vice versa. (After the operations, the instructor gives the trainees assignment paper and another 30 minutes to complete it)
120 ~ 150	The trainees complete the assignment.

ASSIGNMENT

Name		Date	
Reg. No		Scenario: PID control	
Class			

1. Define P, I and D parameters respectively.

2. Explain differences in effects of PID parameters when controlling process values.

3. Describe briefly purposes of "Step response test".

4. List components constructing PID control system and describe their functions.

5. Describe briefly definitions of the following
- maximum overshoot
- time lag
- rise time
- settling time
- off-set

6. Explain briefly methods of determining optimum PID parameters.

ERS II – 13

Training Title/Scenario: Heat cycle, thermal efficiency and heat balance of marine steam turbine and boiler

Table A-III/2 Competence: Plan and schedule operations

Table A-III/2 KUP: Heat cycle, thermal efficiency and heat balance of the following
.1 marine diesel engine
.2 marine steam turbine
.3 marine gas turbine
.4 marine steam boiler

Time allocation: 10 hours (2.5 hours for each group)

Outline of the training :

A group of 3 ~ 5 trainees collects necessary running parameters of steam turbine plant from its system diagrams shown in ERS II – 3 and others displayed on the screen for calculating thermal efficiency following data collection tables, changing over system diagrams from one to another as necessary. (Other three groups collect data for different running conditions).
After collecting running data, the trainees change the running condition for the next data collection by other group as follow.

	Performance
First Group	Data collection of 15 nozzle and 1, 2, 3 stages bleeding condition
	Reduction of engine speed to 13 nozzle and 1, 2, 3 stages bleeding condition
Second Group	Data collection of 13 nozzle and 1, 2, 3 stages bleeding condition
	Reduction of engine speed to 11 nozzle 3 stage bleeding condition
Third Group	Data collection of 11 nozzle 3 stage bleeding condition
	Reduction of engine speed to 9 nozzle non bleeding condition
Fourth Group	Data collection of 9 nozzle non bleeding condition

The trainees calculate thermal efficiency of the steam turbine plant using the running data collected, and develop heat balance diagram and characteristic performance curve.

Prerequisite:

- Theoretical knowledge of thermal efficiency of steam turbine and boiler.
- Theoretical knowledge on simple heat calculation

Note:

The instructor should prepare specific data collection tables and calculation methods based on the functions and specifications of the simulator. The instructor sometimes needs condition settings to simplify the calculation although their theories must be taught. The instructor may make the simulation speed faster than usual to facilitate the training accordingly and conducts a review session on the issue on a different day, giving the trainees enough time for calculation and developing the diagrams.

This training needs longer time than usual for briefing and debriefing, therefore time allocation is set up as 30 min for briefing and 40 min for debriefing.

Specific purpose of the training:

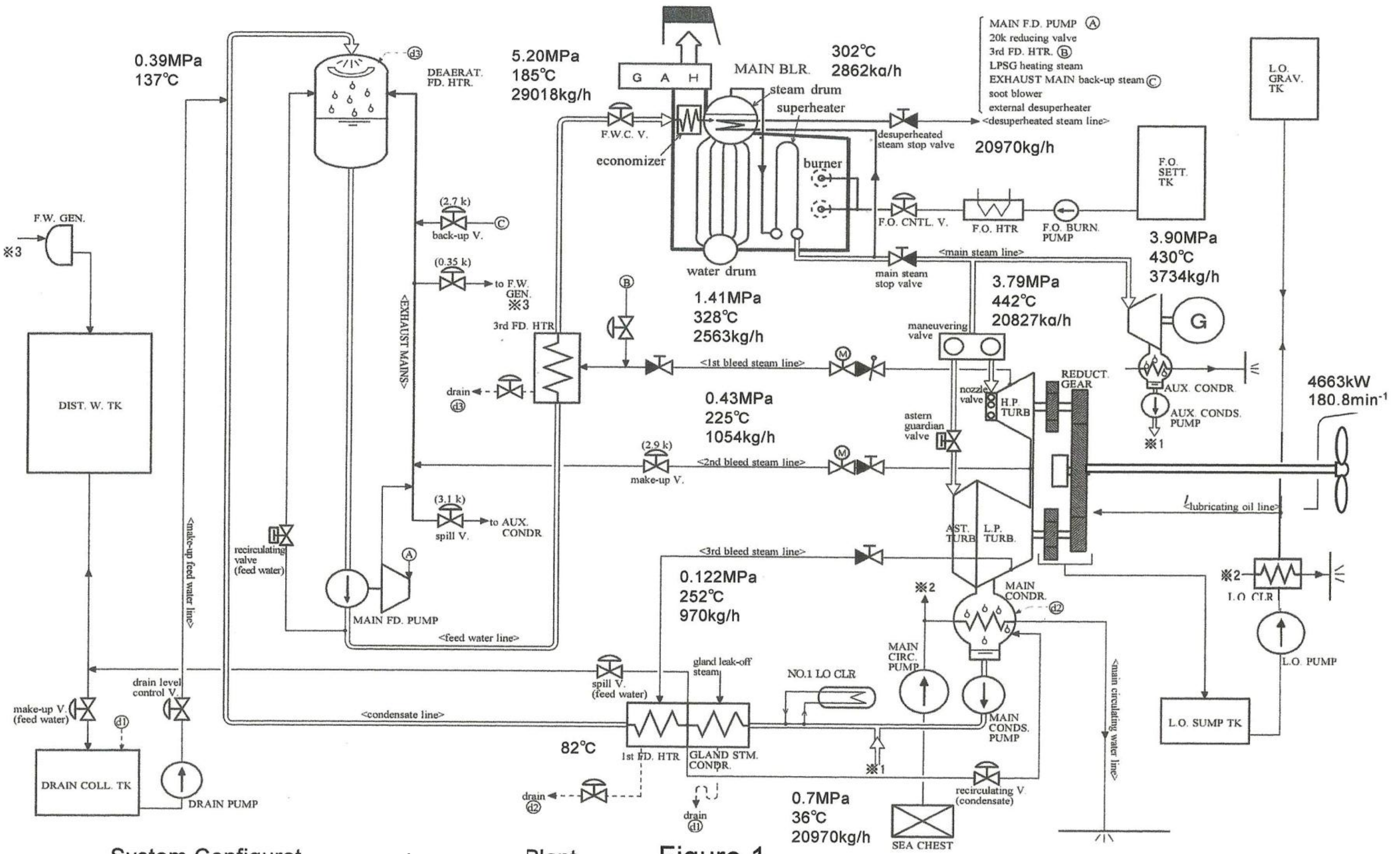
The trainees acquire knowledge on calculation of thermal efficiency of steam turbine and boiler, heat balance diagram.

Implementation of the training

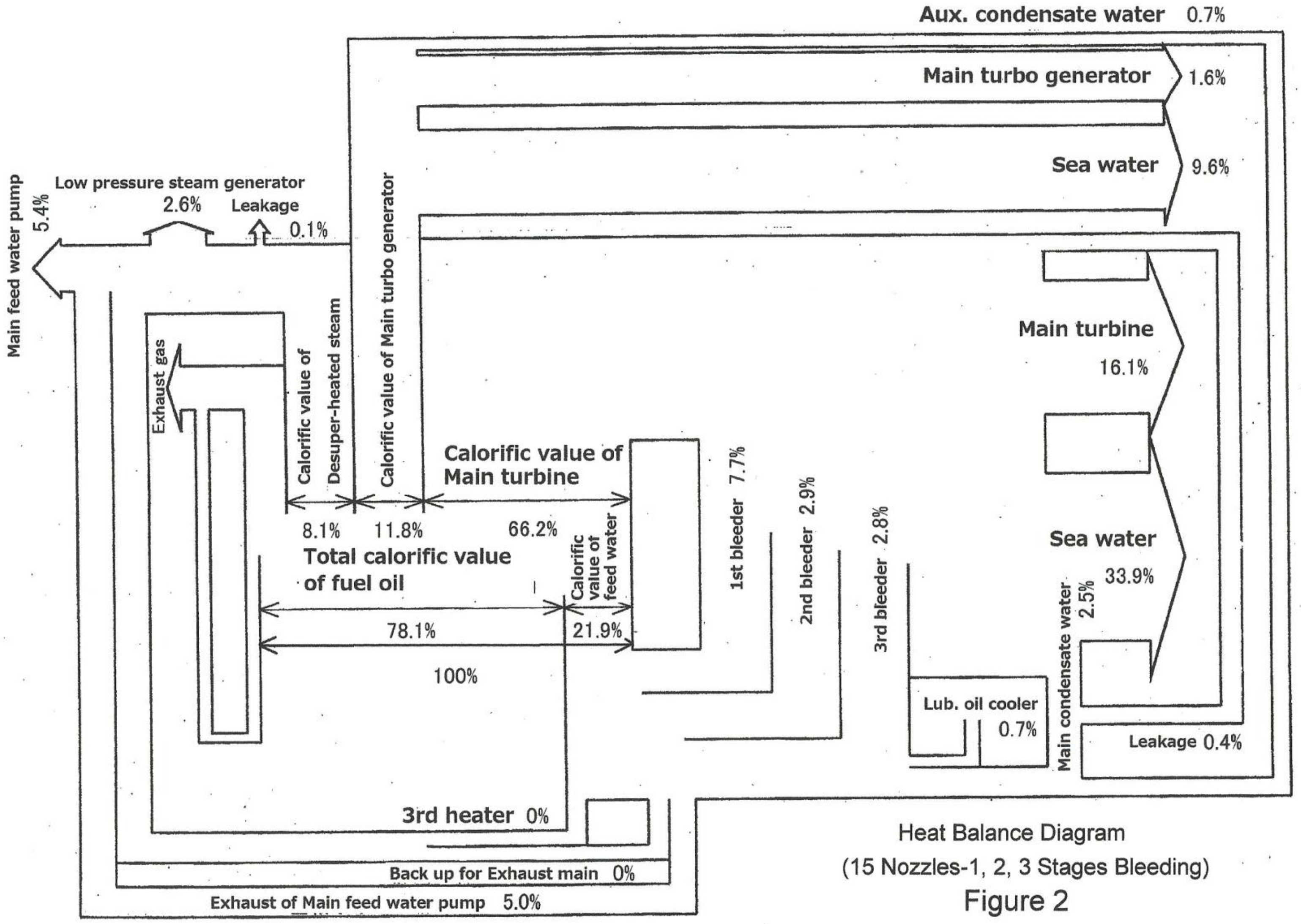
After briefing, the instructor gives the data collection tables and the calculation method, and creates Seagoing condition of the propulsion plant as 15 nozzle and 1, 2, 3 stages bleeding operation on the screen.

T in min	Training Process
0 ~ 65	The trainees must take reading of shaft revolution counter and flow meters just at the time of starting data collection. (The trainees must take readings of revolution counter and flow meters again just 60 minutes later to calculate accurately the shaft revolution speed, fuel oil consumption and others) After taking the readings, the trainees begin collection of running data from the display on the screen changing over the system diagrams such as entire system, main steam diagram, condensate diagram and others. (All trainees of the first group must record all running data for their own collection tables)

65 ~ 80	The first group reduces the engine revolution speed by closing the nozzle valve of two nozzles after taking second readings of revolution counter and flow meters. After closing the nozzle valve, the trainees confirm the propulsion plant for stable running condition. (The trainees move to the briefing room)
80 ~ 320	The other three groups take same procedures as the first group for collecting different running data. (After debriefing session, the instructor gives the trainees an assignment to calculate the thermal efficiency and all the trainees develop the heat balance diagram and characteristic performance curve. All the trainees must submit their development by the deadline as follow. - Measurement tables recorded by the trainee - Calculation results made by the trainee - Heat balance diagram calculated by the trainee - Performance curves developed by combining calculation results of other groups It would be better for the trainees to hold a review session on a different day. Evaluation should be done by their development) (After the debriefing, the instructor gives the report form and lets them fill out)



System Configurat 15 Nozzles-1, 2, 3 stages bleeding operation Plant Figure 1



Heat Balance Diagram
(15 Nozzles-1, 2, 3 Stages Bleeding)
Figure 2

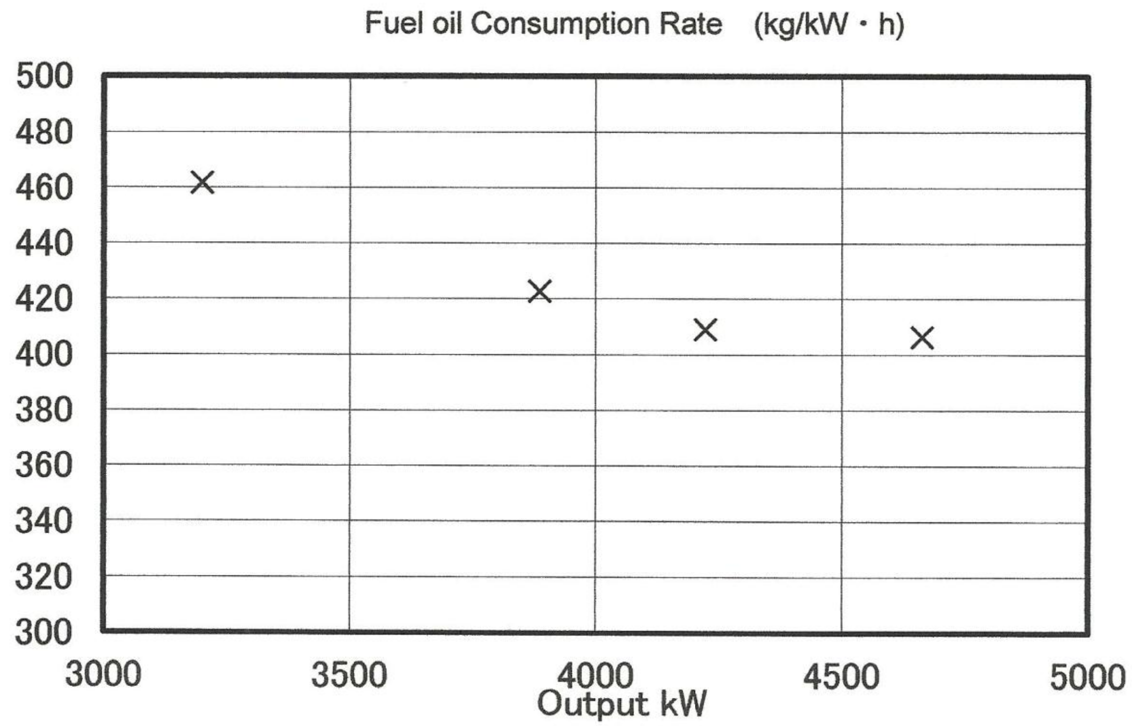


Figure 3 (1/3)

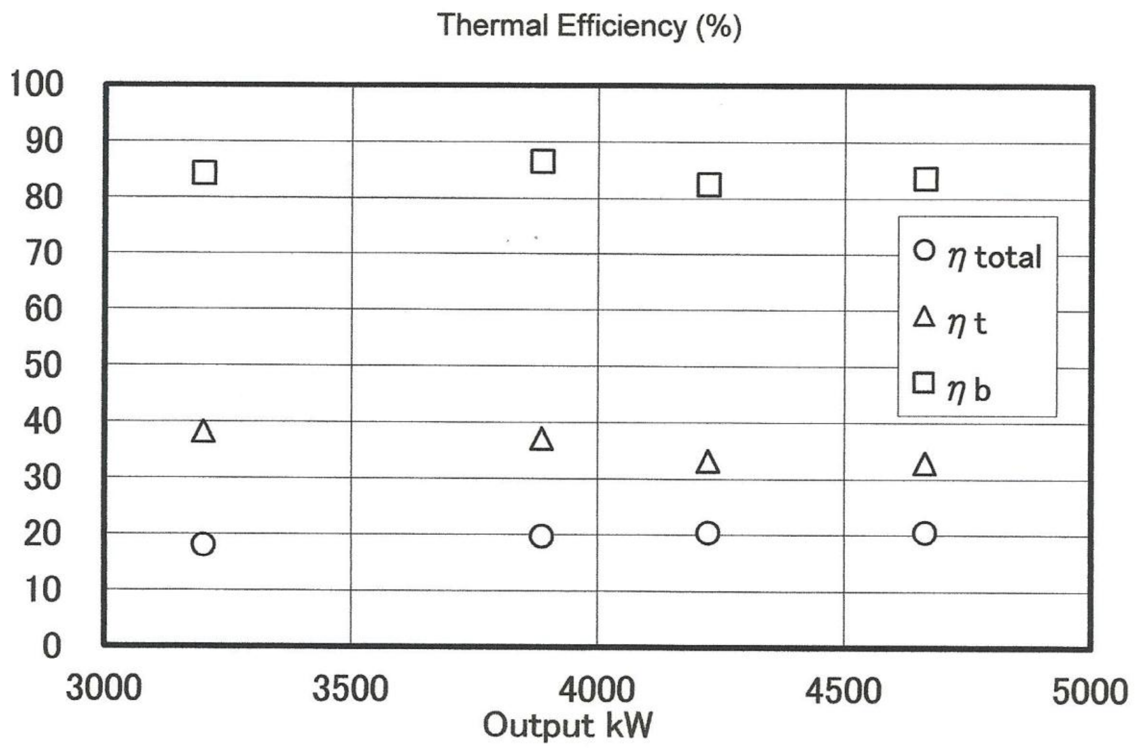


Figure 3 (2/3)

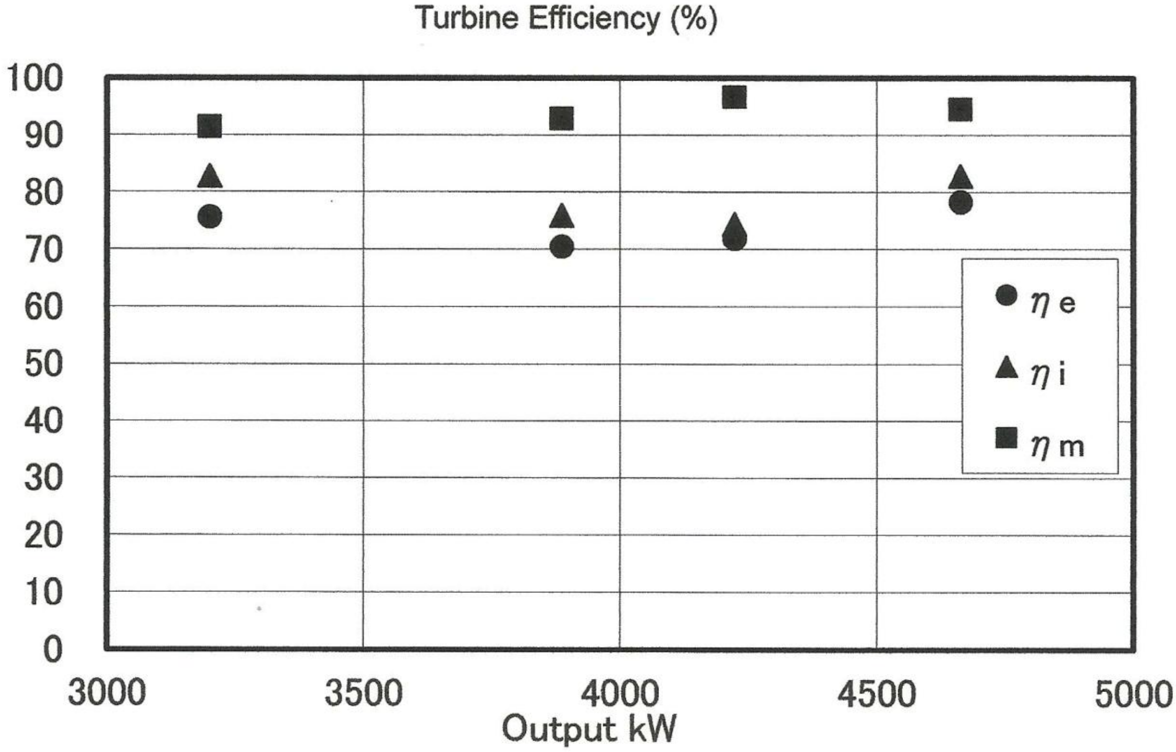

Turbine Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
3000
3500
4000
4500
5000
Output kW
η e
η i
η m

Figure 3 (3/3)

Calculation Method (Heat Balance)

Main Turbine

MCR: 5,149 kW (180 min^{-1})

NSR: 4634 kW (174 min^{-1})

1 ~ 3 Stage Bleeding Regeneration Cycle

Steam Condition

MCR/NSR: 3.9 Mpa (450 ℃)

1. Main steam $G_{SH}=G_{ME}+G_{TG}$

(1) Flow rate of superheated steam to main turbine: G_{ME} [kg/h]

Apply law of nozzle area

$$Z = \sqrt{\frac{\kappa}{\kappa=1}\{(\frac{P1}{Ps})^{\frac{2}{\kappa}} - (\frac{P1}{Ps})^{\frac{\kappa+1}{\kappa}}}$$

$$G_{ME} = \eta \times \mathrm{Ac} \times \mathrm{Z} \times \sqrt{\frac{2\times Ps}{\mathrm{Vs}}} \times 3600$$

η : Flow rate coefficient [0.9615]

Ps : Main steam inlet pressure [Pa]

Ts : Main steam inlet temperature [℃]

Vs : Specific volume at Ps and Ts [m^3/kg]

P1 : Steam pressure at the first stage of HP turbine [Pa]

k : Adiabatic index 1.3 (Adiabatic index of superheated steam)

Ac : Area of nozzles (measured value) [m^2]

18 nozzles: 16.460×10^{-4} m^2

15 nozzles: 13.712×10^{-4} m^2

13 nozzles: 11.882×10^{-4} m^2

11 nozzles: 10.056×10^{-4} m^2

9 nozzles: 8.226×10^{-4} m^2

(2) Flow rate of superheated steam to generator turbine: G_{TG} [kg/h]

Apply steam consumption rate

G_{TG} = Generator output [kW] × Steam consumption rate [kg/kW・h]

Steam consumption rate: This can be obtained from the graph provided. Where, it is necessary to correct consumption rate against measured value since the design condition is 4.02 MPa, 450℃～6.66kPa, 38℃. (Correct the consumption rate noting differences in adiabatic heat drop, in this regard, if the heat drop is more than the reference value 1185 kJ/kg, the rate can be used as it is)

(3) Other: G_{leak}
The flow rate of leaking steam from the maneuvering valve, main steam intermediate valve, nozzle vales and others can be assumed as 130 kg/h from the data of Heat balance. (Some of the leaking steam is collected in Gland condenser)

(4) Main(Superheated) steam: $G_{SH}=G_{ME}+G_{TG}+130$

2. Desuperheated steam: G_{DS} [kg/h]

(1) Flow rate of steam to main feed water pump turbine: G_{DS1} [kg/h]
Determine pump power Lp for supplying amount of feed water W to the boiler.
Pump efficiency ηp is obtained from characteristic performance curve of the pump as 0.35 approximately.

$$\mathrm{Lp}\,[\mathrm{kW}] = \frac{\mathrm{W}\times(\mathrm{Pdel}-\mathrm{Psuc})}{\eta\mathrm{p}}\times 10^{-3} \cdots\cdots ①$$

Pdel : Pump discharge pressure [Pa]
Psuc : Pump suction pressure [Pa]
W : Flow rate [m^3/sec] (Determined by conversing reading of the flow meter [l/h])

Determine G_{DS1} as follow

$G_{DS1}\times(\mathrm{hin}-\mathrm{hout})\times\eta\mathrm{m}/3.6\times10^3=\mathrm{Lp}$

hin: Specific enthalpy of steam at turbine inlet [kJ/kg]
hout: Specific enthalpy of steam at turbine outlet [kJ/kg]
ηm: Mechanical efficiency 0.82 (from record of sea trial)

$$\mathrm{GDS1} = \frac{\mathrm{Lp}\times 3.6\times 10^3}{(\mathrm{hin}-\mathrm{hout})\times\eta\mathrm{m}} \cdots\cdots ②$$

From ① and ②

$$G_{DS1} = \frac{\mathrm{W}\times(\mathrm{Pdel}-\mathrm{Psuc})\times 3.6}{(\mathrm{hin}-\mathrm{hout})\times\eta\mathrm{m}\times\eta\mathrm{p}}$$

(2) Flow rate to LPSG: G_{DS2} [kg/h]
Determine amount of feed water W_{LPSG} to LPSG as follow

$$\mathrm{WLPSG} = \frac{\mathrm{WLPSGQ}}{\mathrm{VLPSG}\times 1{,}000}$$

W_{LPSGQ} [l/hr] : Flow rate of feed water flow meter
V_{LPSG} [m^3/kg] : Specific volume of feed water

Given saturated steam of 97 % dryness is generated, determine G_{DS2} as follow.

$$G_{DS2} = \frac{\mathrm{WLPSG}\times(\mathrm{h2\,out}-\mathrm{hFin})}{\eta\mathrm{L}\times(\mathrm{h1\,in}-\mathrm{hdout})}$$

ηL: Efficiency of heat transfer including Drain cooler and LPSG; 0.9
$h_{Fin:}$ Specific enthalpy of feed water at Darin cooler inlet [kJ/kg]
$h_{Dout:}$ Specific enthalpy of drain at Drain cooler outlet [kJ/kg]

$h_{1in:}$ Specific enthalpy of primary steam at LPSG inlet ［kJ/kg］

$h_{2out:}$ Specific enthalpy of generated steam in LPSG (97% dryness) ［kJ/kg］

(3) Leaking steam from desuperheated steam system: G_{DS3} ［kg/h］

No consumption of gland steam can be assumed since Gland steam make up valve is closed under passage. (Although it actually opens during 11 and 9 nozzles operation and closes during 15 and 13 nozzle operation)

G_{DS3} = 50 ［kg/h］ is assumed as amount of leaking steam from valves and consumption of assist steam.

(4) Flow rate of heating steam to the third stage feed water heater at 9 and 11nozzles: G_{DS4} ［kg/h］

Determine GDS4 from amount of heat exchange taken place in the third stage feed water heater as follow.

$$G_{DS4} = \frac{W \times (hFout - hFin)}{\eta \times (h3in - h3out)}$$

W: Flow rate of feed water ［kg/h］ (Determine from volume of flow meter [l/h] and specific volume of water ［m^3/kg］)

η : Efficiency of heat transfer of the heat exchanger (0.95)

h_{3in}: Specific enthalpy of heating steam at the third stage feed water heater inlet ［kJ/kg］

h_{3out}: Specific enthalpy of drain at the third feed heater outlet ［kJ/kg］

h_{Fin}: Specific enthalpy of feed water at the third feed water heater inlet ［kJ/kg］

hFout: Specific enthalpy of feed water at the third feed water heater outlet ［kJ/kg］

(5) Flow rate of back up steam to the exhaust main pipe during 9 and 11 nozzles operation G_{DS5} ［kg/h］

Determine G_{DS5} from total specific enthalpy of fluid inflow to Deaerater and outflow from it.

$$G_{DS5} = \frac{W \times hdea' + 50 \times hdea'' - \{GDS1 \times hpout + GDS2 \times hdout + GDS4 \times h3out + (400 + makeup) \times hdrcl + Q \times h1out\}}{hb}$$

W: Flow rate of feed water

h_{dea}': Specific enthalpy of saturated water to the pressure of Deaerater ［kJ/kg］

h_{dea}'': Specific enthalpy of saturated steam to the pressure of Deaerater ［kJ/kg］

50: 50 kg/h is assumed as amount of steam collected in Gland condenser from the upper part of Deaerater

G_{DS1}: Flow rate of steam to Feed warer pump ［kg/h］

h_{pout}: Specific enthalpy of exhaust steam from Feed water pump ［kJ/kg］

G_{DS2}: Flow rate of heating steam to LPSG ［kg/hr］

h_{dout}: Specific enthalpy of drain at LPSG drain cooler outlet ［kJ/kg］

G_{DS4}: Flow rate of heating steam to the third stage feed water heater ［kg/hr］
h_{3out}: Specific enthalpy of heating steam drain at the third feed water heater outlet ［kJ/kg］
h_{drcl}: Specific enthalpy of drain in Drain collecting tank ［kJ/kg］
Q: Flow rate of condensate water to Deaerater ［kg/h］
h_{1out}: Specific enthalpy of condensate water at the first stage feed water heater outlet ［kJ/kg］
400: 400 kg/h is assumed as amount of drain collected in Drain collecting tank
h_b: Specific enthalpy of desuperheated steam (as throttled flow of steam causes isenthalpic change) ［kJ/kg］

(6) Flow rate of desuperheated steam: G_{DS} ［kg/h］

$$G_{DS} = G_{DS1} + G_{DS2} + G_{DS3} + G_{DS4} + G_{DS5}$$

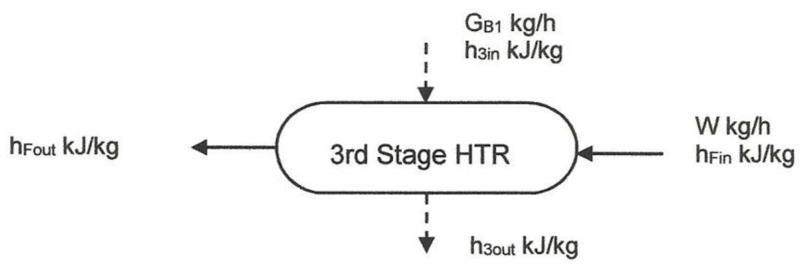
Review should be made to ensure 300 ~ 800 kg/h of G_{DS5} taking into account the previous calculations. Furthermore, correction should be made to ensure "Flow rate of feed water = flow rate of superheated steam + flow rate of desuperheated steam

3． Flow rate of bleeding

(1) Flow rate of 1st stage bleeding（15 and 13nozzles）: G_{B1} ［kg/h］

Determine G_{B1} as well as heating steam to the third stage feed water heater.

$$G_{B1} = \frac{W \times (hFout - hFin)}{\eta \times (h3in - h3out)}$$



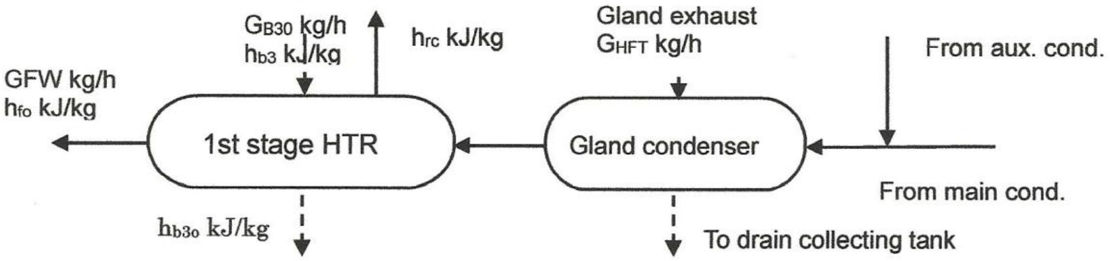
h_{3in}: Specific enthalpy of heating steam to the third stage feed water heater ［kJ/kg］
h_{3out}: Specific enthalpy of heating steam drain from the third stage feed water heater ［kJ/kg］
h_{Fin}: Specific enthalpy of feed water at the third stage feed water heater inlet ［kJ/kg］
h_{Fout}: Specific enthalpy of feed water at the third stage feed water heater outlet ［kJ/kg］
η: Efficiency of heat transfer in the heat exchanger (0.95)

(2) Flow rate of 2nd stage bleeding: G_{B2}［kg/h］
Determine G_{B2} as well as backup steam G_{DS5} to the exhaust main pipe

$$G_{B2}= \frac{W \times hdea' + 50 \times hdea'' - \{G_{DS1} \times hpout + G_{DS2} \times hdout + G_{DS4} \times h3out + (400 + makeup) \times hdrcr + Q \times h1out\}}{h_{b2}}$$

h_{b2}: Specific enthalpy of 2nd bleeding steam ［kJ/kg］

(3) Flow rate of 3rd stage bleeding steam: G_{B3} (11,13 and 15 nozzles, including gland leak off steam)
Determine G_{B3} from amount of heat exchange in 1st stage feed water heater and Gland condenser



$G_{B3} \times (h_{b3} - h_{b30}) = G_{FW} \times (h_{f0} - h_{rc})$

$$G_{B3} = \frac{G_{FW} \times (h_{fo} - hrc)}{h_{b3} - h_{b3o}}$$

G_{FW}: Flow rate of feed water to Deaerater ［kg/hr］
Determine from volume of flow meter［l/h］and specific volume［m^3/kg］
h_{b3}: Specific enthalpy of 3rd stage bleeding steam［kJ/kg］
h_{b30}: Specific enthalpy of 3rd stage bleeding steam drain［kJ/kg］
h_{f0}: Specific enthalpy of feed water at 1st stage feed water heater outlet［kJ/kg］
h_{rc}: Specific enthalpy of condensate water at Gland condenser outlet［kJ/kg］
Temperature of the re-circulation line = Inlet temperature of Gland condenser + 8 ℃
as the line once passes through the drain cooler of 1st stage feed water heater.

Flow rate of 3rd bleeding steam: G_{B30}（This does not include Gland leak off steam G_{HFL}）
$G_{B30} = G_{B3} - G_{HFT}$
Values of G_{HFL} are approximately as follow.
15 nozzles: 580 kg/h
13 nozzles: 380 kg/h
11 nozzles: 200 kg/h
9 nozzles: 100 kg/h

Calculation Method (Characteristic Performance Curve)

1. Fuel consumption rate: FR［gr/kW・h］　(Approx. 380［gr/kW・h］)

$$FR = \frac{B \times 1{,}000}{Le} \times \frac{Hh}{43{,}000}$$

Le: Shaft output［kW］

B: Fuel consumption［kg/h］

Hh: Higher calorific value [hJ/kg]

Hh = H + 5,546 – 3,278 × Density　(H: Lower calorific value [kJ/kg])

2. Total thermal efficiency : ηtotal［%］　(Approx. 22［%］)

$\eta total = 3.6 \times 10^3 / (FR \times H \div 1{,}000) \times 100$

3. Boiler efficiency: η_B［%］　(Approx. 90［%］)

$$\eta_B = \frac{G_{SH} \times (h_{SH} - h_{Fout}) + G_{DS} \times (h_{DS} - h_{Fout})}{B \times Hh} \times 100$$

G_{SH}: Consumption of superheated steam［kg/h］

G_{DS}: Consumption of desuperheated steam［kg/h］

h_{SH}: Specific enthalpy of superheated steam［kJ/kg］

h_{DS}: Specific enthalpy of desuperheated steam［kJ/kg］

h_{Fout}: Specific enthalpy of feed water at the third stage feed water heater outlet［kJ/kg］

4. Turbine effective efficiency: ηe［%］　(Approx. 70［%］)

$$\eta e = \frac{\text{Shaft output}}{\text{Work of turbine blades caaused by theoretical adiabatic expansion of steam}} \times 100$$

$$= \frac{Le \times 3.6 \times 10^3}{G_{ME}(h_{ME} - h'_{1B}) + (G_{ME} - G_{B1}) \times (h_{1B} - h'_{2B}) + (G_{ME} - G_{B1} - G_{B2}) \times (h_{2B} - h'_{3B}) + (G_{ME} - G_{B1} - G_{B2} - G_{B3}) \times (h_{3B} - h'_{C})} \times 100$$

When non bleeding,

$$\eta e = \frac{Le \times 3.6 \times 10^3}{G_{ME}(h_{ME} - h''_{C})} \times 100$$

G_{ME}: Flow rate of steam to main turbine［kg/hr］

G_{B1}: Flow rate of 1st stage bleeding steam［kg/hr］

G_{B2}: Flow rate of 2nd stage bleeding steam［kg/hr］

G_{B3}: Flow rate of 3rd stage bleeding steam［kg/hr］

h_{ME}: Specific enthalpy of steam at main turbine inlet［kJ/kg］

h_{1B}: Specific enthalpy of 1st stage bleeding steam［kJ/kg］

h_{2B}: Specific enthalpy of 2nd stage bleeding steam ［kJ/kg］

h_{3B}: Specific enthalpy of 3rd stage bleeding steam ［kJ/kg］

h_C: Specific enthalpy of steam at the end of expansion (Main condenser vacuum, dryness "x" = 0.9) ［kJ/kg］

h'_{1B}: Specific enthalpy of 1st stage bleeding steam in case of isentropic change ［kJ/kg］

h'_{2B}: Specific enthalpy of 2nd stage bleeding steam in case of isentropic change ［kJ/kg］

h'_{3B}: Specific enthalpy of 3rd stage bleeding steam in case of isentropic change ［kJ/kg］

h'_C: Specific enthalpy of steam at the end of expansion (Main condenser vacuum) in case of isentropic change from the 3rd stage bleeding point ［kJ/kg］

h''_C : Specific enthalpy of steam at the end of expansion in case of isentropic change of steam entering main turbine ［kJ/kg］

5. Turbine internal efficiency: ηi ［%］ (70～80 ［%］)

$$\eta i = \frac{\text{Work of turbine blades caused by actual setam expansion}}{\text{Work of turbine blades caused by theoretical steam expansion}} \times 100 =$$

$$\frac{G_{ME}(h_{ME}-h_{1B})+(G_{ME}-G_{B1})\times(h_{1B}-h_{2B})+(G_{ME}-G_{B1}-G_{B2})\times(h_{2B}-h_{3B})+(G_{ME}-G_{B1}-G_{B2}-G_{B3})\times(h_{3B}-h_C)}{G_{ME}(h_{ME}-h'_{1B})+(G_{ME}-G_{B1})\times(h_{1B}-h'_{2B})+(G_{ME}-G_{B1}-G_{B2})\times(h_{2B}-h'_{3B})+(G_{ME}-G_{B1}-G_{B2}-G_{B3})\times(h_{3B}-h'_C)} \times 100$$

In case of non-bleeding,

$$\eta e = \frac{h_{ME}-h_C}{h_{ME}-h''_C} \times 100$$

6. Turbine mechanical efficiency: ηm ［%］

(More than 90 ［%］ even if it is a small sized steam turbine)

$$\eta m = \frac{\text{Shaft output}}{\text{Work of turbine blades caused by actual steam expansion}} \times 100$$

$$= \frac{\eta e}{\eta i} \times 100$$

7. Theoretical thermal efficiency of bleeding turbine: ηt ［%］ (approx. 30 %)

$$\eta t = \frac{(h_{ME} - h_C) - m1\,(h_{1B} - h_C) - m2\,(h_{2B} - h_C) - m3\,(h_{3B} - h_C)}{h_{ME} - h_{Fout}} \times 100$$

hFout: Specific enthalpy of feed water outlet at the 3rd feed water heater

$m1 = \frac{G_{B1}}{G_{ME}}$ $m2 = \frac{G_{B2}}{G_{ME}}$ $m3 = \frac{G_{B3}}{G_{ME}}$ when non bleeding, m1 ~ 3 = 0

8. Propeller slip［%］

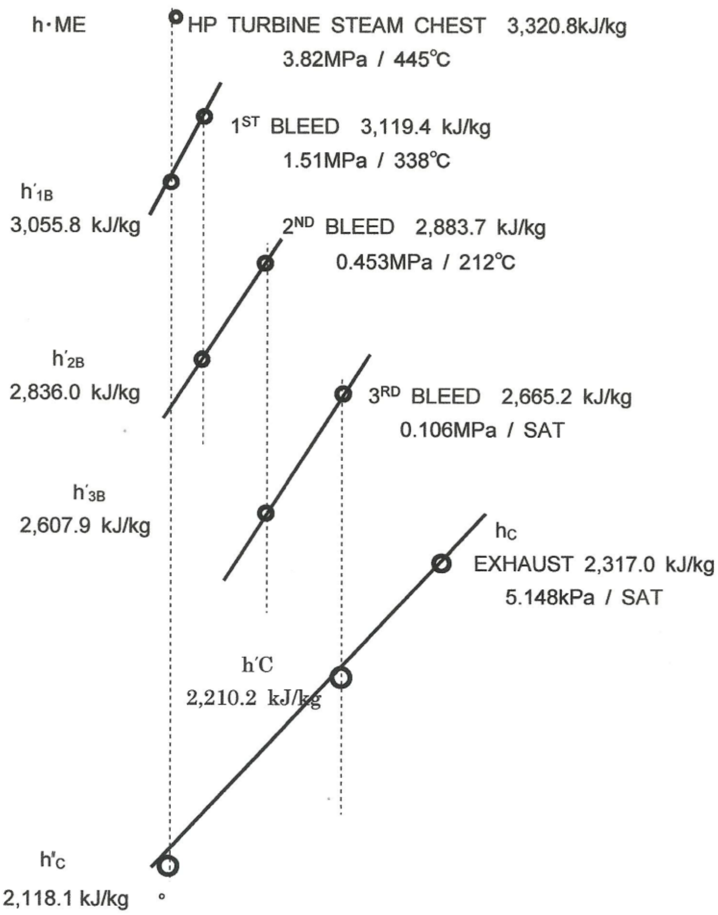
$$\text{Slip} = \frac{\text{Prop. S} - \text{V}}{\text{Prop. S}} \times 100$$

Prop. S＝Prop. P × Trev
Prop. S：Propeller speed（Knot）
Prop. P: propeller pitch ＝ 0.0019012 (mile/rev)
Trev：Total number of revolution per hour (rev)
V: Ship's speed＝Log（Knot）

9. Admiralty coefficient: C

$$C = \frac{V^3 \times D^{2/3}}{\text{SHP}}$$ D: Displacement tonnage, SHP：Shaft output (kW)

Condition Diagram of Ahead Propelling



In order to determine h_C, h'_{1B}, h'_{2B}, h'_{3B}, h'_C, at the end of actual adiabatic expansion for each number of nozzles, develop a benchmark expansion diagram, plotting "Condition Diagram of Ahead Propelling" above on the steam diagram (h – s diagram) and develop an actual adiabatic expansion diagram ensuring it in parallel to the benchmark expansion diagram and plotting beginning points of expansion obtained from pressure and temperature of the measuring points for each number of nozzles and each bleeding point. The cross point of the actual adiabatic expansion line and Main condenser vacuum is the end of adiabatic expansion "h_C".

- Internal loss:
  - Nozzle loss (Loss by fluid resistance, it becomes smaller as speed becomes higher)
  - Internal leakage loss (Leakage from labyrinth packing between diaphragms)
  - Moving blade loss (Steam leakage from moving blade edge due to centrifugal force)
  - Friction loss by rotor rotation (Windage loss)

- External loss:
  - Leakage loss of gland steam
  - Mechanical loss (Friction loss, Radiation loss)
  - Exhaust loss at the final stage (Loss by flow out speed of exhaust steam)

Summary of Heat Balance (1/3)

			15N-123B	13N-123B	11N-3B	9N-Non B
1	Calorific Value of Consumed Fuel	(MJ/h)	81482			
		(%)	**78.1**			
	Quantity of Fuel Consumption	B_L (kg/h)	1895.4			
	Higher Calorific Value	H_h (kJ/kg)	42990			
2	Calorific Value of Feed Water	(MJ/h)	22849			
		(%)	**21.9**			
	Flow rate of FW from Flow Meter	W (kg/h)	29018			
	Spe. Enthalpy of FW 3'rd FW HTR Outl	h_{fout}	787			
	Calorific V of FO + Calorific V of FW	h_{fout} (kJ/kg)	104331			
		(%)	100.0			
3	Calorific Value given to Main Turb.	(MJ/h)	69059			
		(%)	**66.2**			
	Flow rate of Steam to Main Turbine	G_{ME} (kg/h)	20827			
	Spe. enthalpy of Stem M. T Inlet	h_{ME} (kJ/kg)	3316			
4	SW to Main Cond. (Fm SW C. Line)	(MJ/h)	23316			
		(%)	**22.3**			
	Flow rate of SW	G (m^3/h)	960			
	Specific heat of SW	C (kJ/kg)	3.93			
	Density of SW	D (kg/m^3)	1030			
	Temp. SW Outlet	T_{out} ℃	25			
	Temp. SW Inlet	T_{in} ℃	19			
	SW to Main Cond. (from surplus heat)	(MJ/h)	35318			
		(%)	**33.9**			
5	1st Stage Bleed	(MJ/h)	8008			
		(%)	**7.7**			
	Flow rate of 1st Stage Bleeding	G_{B1} (kg/h)	2563			
	Spe. enthalpy of Steam 3rd FW HTR Inlet	h_{3in} (kJ/kg)	3125			
6	2nd Stage Bleed	(MJ/h)	3068			
		(%)	**2.9**			
	Flow rate of 2nd Stage Bleeding	G_{B2} (kg/h)	1054			
	Spe. enthalpy of 2nd Bleeding	h_{b2} (kJ/kg)	2911			
7	3rd Stage Bleed	(MJ/h)	2886			
		(%)	**2.8**			
	Flow rate of 3rd Stage Bleeding	G_{B3} (kg/h)	970			
	Spe. enthalpy of 3rd Bleeding	h_{b3} (kJ/kg)	2975			

Summary of Heat Balance (2/3)

			15N-123B	13N-123B	11N-3B	9N-Non B
8	Leakage from Main Turbine	(MJ/h)	431			
		(%)	**0.4**			
	Leaf off steam from Main Turbine	G_{leak} (kg/h)	130			
	Spe. enthalpy of Stem M. T Inlet	h_{ME} (kJ/kg)	3316			
9	Main Turbine	(MJ/h)	17752			
		(%)	**16.1**			
	Output	Le (kW)	4663			
10	Main Turbine Condensate Water	(MJ/h)	2562			
		(%)	**2.5**			
	Flow rate of S.S Exh. Space	(kg/h)	16110			
	Spe. enthalpy of MC Condensate	(kJ/kg)	159			
11	Calorific Value given to Gen. Turb.	(MJ/h)	12273			
		(%)	**11.8**			
	Flow rate of S.S to Gen. Turbine	G_{TG} (kg/h)	3734			
	Spe. enthalpy of Steam Inlet	h_s (kJ/kg)	3287			
12	Gen. T. output (From enthalpy of steam）	(MJ/h)	3286			
		(%)	**3.1**			
	Flow rate of S.S to Gen. Turbine	G_{TG} (kg/h)	3734			
	Spe. enthalpy of Steam Inlet	h_s (kJ/kg)	3287			
	Spe. enthalpy of Exhaust	h_{out} (kJ/kg)	2407			
13	Gen. T. output (From kW)	(MJ/h)	1692			
		(%)	**1.6**			
	Output	Lg (kW)	470			
14	SW to Aux. Condenser (from SW Circ. Line)	(MJ/h)	8258			
		(%)	**7.9**			
	Flow rate of SW	G' (m^3/h)	340			
	Specific Heat of SW	C (kJ/kg)	3.93			
	Density of SW	D (kg/m^3)	1030			
	Temp. SW Outlet	T_{out} ℃	25			
	Temp. SW Inlet	T_{in} ℃	19			
15	SW to Aux. Cond. (from surplus heat)	(MJ/h)	10003			
		(%)	**9.6**			
16	Aux. Condensate Water	(MJ/h)	578			
		(%)	**0.7**			
	Flow rate of S.S Exh. Space	G_{TG} (kg/h)	3734			
	Spe. enthalpy of Cond. Aux. Cond.	(kJ/kg)	155			

Summary of Heat Balance (3/3)

			15N-123B	13N-123B	11N-3B	9N-Non B
17	Calorific Value of Desuperheated Steam (MJ/h)		8499			
		(%)	**8.1**			
	Flow rate of DS	G_{DS} (kg/h)	2862			
	Specific enthalpy	h_b (kJ/kg)	2969			
18	Calorific Value of Leaked DS	(MJ/h)	148			
		(%)	**0.1**			
	Leaked DS from DS system	G_{DS3} (kg/h)	50			
	Spe. enthalpy of DS of B-1 and 2	h_b (kJ/kg)	2969			
19	Calorific Value of LPSG	(MJ/h)	2714			
		(%)	**2.6**			
	Flow rate of Heating Steam	G_{DS2} (kg/h)	914			
	Spe. Enthalpy of primary Steam	h_{lin} (kJ/kg)	2969			
20	Calorific Value of FW Pump	(MJ/h)	5636			
		(%)	**5.4**			
	Flow rate of Steam to FW P Turbine	G_{DS1} (kg/h)	1898			
	Spe. Enthalpy of steam Turbine In	h_{in} (kJ/kg)	2969			
21	Calorific Value of Exh. FW P	(MJ/h)	5216			
		(%)	**5.0**			
	Flow rate of Steam FW P Turbine	G_{DS1} (kg/h)	1898			
	Spe. Enthalpy of steam FW P outlet	h_{out} (kJ/kg)	2748			
	Calorific Value of backup steam to 3 HTR (MJ/h)		0			
		(%)	**0.0**			
	Flow rate of steam to 3rd HTR	G_{DS4} (kg/h)	0			
	Spe. enthalpy of Steam to 3rd HTR	h_{3in} (kJ/kg)	0			
Calorific Value of backup steam to Exh. Main (MJ/h)			0			
		(%)	**0.0**			
Flow rate of Backup steam to Exh. Main		G_{DS5} (kg/h)	0			
	Spe. enthalpy of DS in B-1 and 2	h_b (kJ/kg)	2969			
	Calorific value collected in LO CLR	(MJ/h)	753			
		(%)	**0.7**			
	Specific heat	(kJ/kg)	4.217			
	Flow rate of Condensate water	(kg/h)	19844			
	Flow rate of Aux. Condensate water	(kg/h)	3734			
	Flow rate of Main Condensate water	(kg/h)	16110			

Calculation Results of Heat balance (1/3)

				15N−123B	13N−123B	11N−3B	9N−Non B
1	Main steam (Superheated steam) G_{SH}						
	(1)	Flow rate of S.S to MT: G_{ME}					
		Flow coefficient	H	0.9615			
		Steam inlet pressure	Ps (MPa)	3.79			
		Specific volume of steam	Vs (m^3/kg)	0.08350			
		Steam press. At 1st stage	P1 (Mpa)	2.45			
		Adiabatic index	K	1.300			
		Nozzle area	Ac (m^2)	0.001371			
			Z	0.4605			
		Flow rate of S.S to MT	**G_{ME}** (kg/h)	**20827**			
	(2)	Flow rate of S.S to GT: G_{TG}					
		Gen. output (Watt meter)	Lg (kW)	470			
		Steam consumption rate	Kg/kW・h	5.90			
		Spe. enthalpy of steam at inlet	Hs (kJ/kg)	3287			
		Spe. enthalpy of exh. steam ①	H_{out} (kJ/kg)	2407			
		Adiabatic heat drop	Δh (kJ/kg)	880			
		Correction 1185/Δh	(kJ/kg)	1.3467			
		Flow rate of S.S to GT	**G_{TG} (kg/h)**	**3734**			
	(3)	**Flow rate of leaking steam**	**G_{leak} (kg/h)**	**130**			
	(4)	**Flow rate of S.S(main steam**	**G_{SH} (kg/h)**	**24691**			
2	Desuperheated steam: G_{DS}						
	(1)	Flow rate of D.S to FW pump turbine					
		Pump discharge pressure	P_{del} (Mpa)	5.40			
		Pump suction pressure	P_{suc} (Mpa)	0.48			
		Feed water flow meter	W (kg/h)	29018			
		Flow rate of feed water	W (ton/sec)	0.008061			
		Spe. enthalpy of steam at inlet	h_{in} (kJ/kg)	2969			
		Spe. enthalpy of exh. Steam	h_{out} (kJ/kg)	2748			
		Pump efficiency	Hp	0.34			
		Turbine mechanical efficiency	Hm	1.00			
		Flow rate of steam to TP	**G_{DS1} (kg/h)**	**1898**			
	(2)	LPSG heating steam					
		Flow rate by flow meter	W_{LPSCQ} (L/h)	870			
		Specific volume	V_{LPSG} (m^3/kg)	0.001011			

		Flow rate of FW to LPSG	W_{LPSG} (kg/h)	861		
		Effi. of heat trans. in Dr. CLR	η_d	0.95		
		Effi. of heat trans. in Dr CLR & LPSG	η_L	0.90		

Calculation Results of Heat balance (2/3)

				15N-123B	13N-123B	11N-3B	9N-Non B
		Spe. enthalpy of FW at Dr. CLR outlet°	h_{Fout} (kJ/kg)	504			
		Spe. enthalpy of FW at Dr. CLR inlet	h_{Fin} (kJ/kg)	202			
		Spe. enthalpy of drain at Dr. CLR inlet	h_{din} (kJ/kg)	808			
		Spe. enthalpy of drain at Dr CLR outlet	h_{dout} (kJ/kg)	378			
		Spe. enthalpy of primary steam inlet	h_{1in} (kJ/kg)	2969			
		Spe. enthalpy second. steam	h_{2out} (kJ/kg)	2679			
		Flow rate of heating steam	**G_{DS2}** (kg/h)	**914**			
	(3)	Steam leak from DS system					
		Flow rate of makeup	(L/h)	130			
		Specific volume	(m^3/kg)	0.001			
		Flow rate of makeup	(kg/h)	130			
		Flow rate of leak from DS Sys.	**G_{DS3}** (kg/h)	**50**			
	(4)	Flow rate of steam 3rd HTR					
		Flow rate of FW from flow M	W (L/h)	31102			
		Specific volume (3 HTR inlet)	(m^3/kg)	0.001072			
		Flow rate of FW	W (kg/h)	29018			
		Effi. of heat trans. in 3 HTR	H	0.95			
		Spe. enthalpy of heating steam	h_{3in}(kJ/kg)	—			
		Spe. enthalpy of steam drain	h_{3out}(kJ/kg)	—			
		Spe. enthalpy of FW inlet	h_{Fin}(kJ/kg)	—			
		Spe. enthalpy of FW outlet	h_{Fout}(kJ/kg)	—			
		Flow rate **of heating steam**	**G_{DS4}**(kg/h)	—			
	(5)	Flow rate of backup steam to exh. Main					
		Spe. enthalpy of Sa. water Dea. Press.	$h_{dea'}$(kJ/kg)	—			
		Spe. enthalpy of Sa. steam Dea Press..	$h_{dea''}$(kJ/kg)	—			
		Spe. enthalpy of DS	h_b(kJ/kg)	2969			
		Spe. enthalpy of drain in D Coll. tank	h_{drcl}(kJ/kg)	—			
		Flow rate **of backup steam to exh. Main**	**G_{DS5}**(kg/h)	—			
	(6)	Flow rate of DS	G_{DS}(kg/h)	2862			
3	Quantity of bleeding steam						

	(1)	1st stage bleeding (13,15NZ)					
		Flow rate of FW	W (kg/h)	29018			
		Effof heat trans. H exch.	H	0.95			
		Spe. enthalpy of H S to 3rd HTR	h_{3in}(kJ/kg)	3125			
		Spe. enthalpy of drain to 3rd HTR	h_{3out}(kJ/kg)	547			
		Spe. enthalpy of 3rd HTR FW inlet	h_{Fin}(kJ/kg)	571			
		Spe. enthalpy of 3rd HTR FW outlet	h_{Fout}(kJ/kg)	787			
		Flow rate of 1st bleeding	$\mathbf{G_{B1}}$ (kg/h)	**2563**			

Calculation Results of Heat balance (3/3)

				15N-123B	13N-123B	11N-3B	9N-Non B
	(2)	2nd stage bleeding (13,15NZ)					
		Spe. enthalpy of Sa. water Dea. Press.	$h_{dea'}$(kJ/kg)	589			
		Spe. enthalpy of Sa. steam Dea Pre.ss.	$h_{dea''}$(kJ/kg)	2733			
		Spe. enthalpy of 2nd B	H_{b2} (kJ/kg)	2911			
		Spe. enthalpy of darin Drain Coll. Tank	h_{drcl}(kJ/kg)	377			
		Flow rate of 2nd bleeding	$\mathbf{G_{B2}}$ (kg/h)	**1054**			
	(3)	3rd Stage Bleeding (11,13,15NZ)					
		Flow rate of FW from Dea.	G_{FW} (L/h)	20970			
		Specific volume	(m^3/kg)	0.00103			
		Flow rate of FW from Dea	(kg/h)	20359			
		Spe. enthalpy of 3rd B	h_{b3} (kJ/kg)	2975			
		Spe. Enthalpy of drain 1st FW HTR	h_{b30}(kJ/kg)	356			
		Spe. Enthalpy of Cond. W 1st FW HTR out	h_{f0}(kJ/kg)	343			
	Spe. enthalpy of Cond. W Gl. Cond out		h_{rc}(kJ/kg)	218			
		Flow rate of 3rd Bleeding	$\mathbf{G_{B3}}$ (kg/h)	**970**			

Calculation Results of Efficiency (1/2)

				15N-123B	13N-123B	11N-3B	9N-Non B
1	Fuel consumption rate						
	Output		L_e (kW)	4663			
	Flow rate of fuel consumption		B_L (L/h)	1985			
	Density		(kg/L)	0.9689			
	Volume conversion coefficient			0.9855			
	Quantity of fuel consumption		B (kg/h)	1895.4			
	Calorific value of reference fuel		H (kJ/kg)	43000			
	Higher calorific value		H_h (kJ/kg)	42990			
	Fuel oil consumption rate		FR(g/kW・h)	**406.4**			
	Fuel consumption per 100 miles		B_{100} kg/100m	11020			
2	Total thermal efficiency						
	Total thermal efficiency		η_{total} (%)	**20.6**			
3	Boiler efficiency						
	Consumption of S.H		G_{SH} (kg/h)	24691			
	Consumption of D.S		G_{DS} (kg/h)	2862			
	Spe. enthalpy of S.H		h_{SH} (kJ/kg)	3298			
	Spe. enthalpy of D.S		h_{DS} (kJ/kg)	2969			
	Spe. enthalpy of FW at 3rd HTR outlet		h_{Fout} (kJ/kg)	787			
	Boiler efficiency		η_B (%)	**83.7**			
4	Turbine effective efficiency						
	Flow rate of S.H to Main Turbine		G_{ME} (kg/h)	20827			
	Flow rate of S.H to Gene. turbine		G_{TG} (kg/h)	3734			
	Flow rate of 1st stage bleed steam		G_1 (kg/h)	2563			
	Flow rate of 2nd stage bleed steam		G_2 (kg/h)	1054			
	Flow rate of 3rd stage bleed steam		G_3 (kg/h)	970			
	Spe. enthalpy of steam M. tur. inlet		h_{ME} (kJ/kg)	3316			
	Spe. enthalpy of 1st bleed steam		h_{1B} (kJ/kg)	3125			
	Spe. enthalpy of 2nd bleed steam		h_{2B} (kJ/kg)	2911			
	Spe. enthalpy of 3rd bleed steam		h_{3B} (kJ/kg)	2920			
	Spe. enthalpy end of steam expansion		h_C (kJ/kg)	2325			
	Spe. enthalpy of Bleed steam in isentropic change	1st stage	h'_{1B} (kJ/kg)	3100			
		2nd stage	h'_{2B} (kJ/kg)	2855			
		3rd stage	h'_{3B} (kJ/kg)	2680			
Spe. Enthalpy Exh..Steam in isentropic change from 3 B			h'_C (kJ/kg)	2410			
Spe. enthalpy E. Steam in isentropic change from ME inlet			H''_C (kJ/kg)	2120			
	Turbine effective efficiency		η_e (%)	**78.3**			

Calculation Results of Efficiency (2/2)

			15N−123B	13N−123B	11N−3B	9N−Non B
5	Turbine internal efficiency					
	Turbine internal efficiency	**η_i** (%)	**82.8**			
6	Turbine mechanical efficiency					
	Turbine mechanical efficiency	**η_m** (%)	**94.6**			
7	Bleeding turbine efficiency					
		m_1	0.123			
		m_2	0.051			
		m_3	0.047			
	Bleeding turbine efficiency	**ηt** (%)	**33.0**			
8	Propeller slip					
	Total number of revolution	Trev (min^{-1})	10830			
	Propeller pitch	Prop.P mile/r	0.001901			
	Propeller speed	Prop.S	20.6			
	Log speed	Log.S (knot)	17.20			
	Propeller slip	**Slip** (%)	**16.5**			
9	Admiralty coefficient					
	Ship's speed＝Log .S	V (knot)	17.20			
	Displacement	D (ton)	6025.2			
	Shaft output（kW）	SHP (kW)	4663			
	Admiralty coefficient	**C**	**361.3**			

Data Collection Table (1/4)

Measurement item		Unit	15N-123B	13N-123B	11N- 3B	9N-Non B
General	Temperature E/R	℃	33			
	Temperature SW	℃	19			
	Ship's speed (Log)	Knots	17.20			
	(OG)	Knots	17.20			
	State of sea		Rough			
	Atmospheric pressure	hPa	1023.2			
	Weather		bc			
	Wind direction		NW			
	Wind force		5			
	Displacement	Ton	6025.2			
	Draft (F)	M	5.06			
	(A)	M	5.34			
Main turbine	Shaft revolution speed	min^{-1}	180.8			
	Shaft output	kW	4365			
	Torque	kNm	246.7			
	Pressure of S. S	MPa	3.92			
	Pressure HP T inlet	MPa	3.79			
	Temperature HT T inlet	℃	442			
	Pressure 1st stage HP T	MPa	2.45			
	Pressure 2st stage HP T	MPa	1.83			
	Temp. 2nd stage HP T	℃	374			
	Press. 1st stage Bleed	MPa	1.41			
	Temp. 1st stage Bleed	℃	328			
	Press. Receiver pipe	MPa	0.43			
	Temp. Receiver pipe	℃	225			
	Press. 3rd stage bleed	MPa	0.122			
	Temp. 3rd stage bleed	℃	252			
Main condenser	Vacuum	kPa	5.9			
	Temp. upper space of MC	℃	40			
	Temp. Condensate Water	℃	36			
	Condensate water level	±cm	10			
	Opening Recirculation V	%	38			
	Flow rate of SW	m^3/h	500			
	Temp. SW outlet	℃	25			
Cond. pump	Current Value	A	19			
	Pressure Suction	kPa	7.3			
	Pressure Discharge	MPa	0.70			

Data Collection Table (2/4)

Measurement item		Unit	15N-123B	13N-123B	11N- 3B	9N-Non B
LO Cooler	Temp. Cond. W inlet	℃	35			
	Temp. Cond. W outlet	℃	44			
	Flow rate of SW	m^3/h	150			
	Temp. SW outlet	℃	14			
	Temp. Drain Coll. Tank	℃	90			
1st stage FW HTR	Pressure	kPa	120.3			
	Temp. Cond. W Inlet	℃	45			
	Temp. Cond. W Outlet	℃	82			
	Temp. Cond. W Recirc.	℃	68			
	Temp. 1st HTR Drain	℃	85			
	Temp. Gland Exh. (D.P.)	℃	141			
	Temp. Gland Cond. Drain	℃	52			
Deaerater	Pressure	MPa	0.39			
	Temperature	℃	137			
	Level	±cm	-5			
	Press. Exh. Main Dea In	MPa	0.38			
	Temp. Exh. Main Dea. In	℃	162			
FW Pump	Pressure Steam	MPa	3.60			
	Temperature Steam	℃	275			
	Pressure Exhaust Steam	MPa	0.42			
	Temp. Exhaust Steam	℃	149			
	Pressure Pump Suction	MPa	0.48			
	Pressure Pump Discharge	MPa	5.40			
	Revolution speed	min^{-1}	7400			
Press. LPSG FW Pump Discharge		MPa	0.90			
3rd Stage FW HTR	Pressure Steam	MPa	1.50			
	Temperature Drain	℃	130			
	Temp. FW Inlet	℃	135			
	Temp. FW Outlet	℃	185			
LPSG	Press. Primary Stem	MPa	2.00			
	Temp. Primary Steam	℃	220			
	Temp. Drain CLR Drain In	℃	190			
	Temp. Drain CLR Drain Out	℃	90			

Data Collection Table (3/4)

Measurement item		Unit	15N-123B	13N-123B	11N- 3B	9N-Non B
LPSG	Temp. Drain CLR FW Inlet	℃	48			
	Temp. Drain CLR FW outlet	℃	120			
	Press. Secondary Steam	MPa	0.45			
	Temp. Secondary Steam	℃	145			
Generator Turbine	Electric Power	kW	500			
	Pressure S. Steam	MPa	3.90			
	Temperature S. Steam	℃	430			
	Pressure 1st Stage	MPa	0.45			
	Vacuum Aux. Condenser	kPa	10.3			
	Temp. Exhaust Space	℃	40			
	Temp. Aux. Cond. SW Inlet	℃	18			
	Temp. Aux. Cond. SW Out	℃	26			
	Flow rate of SW	m^3/h	340			
	Press. Aux. Cond P Suction	kPa	17.3			
	Press. Aux. Cond P Disch.	MPa	0.65			
	Temp. Condensate water	℃	37			
	Opening Recirculation V	%	52			
Boiler	Press. Super HTR Av. B-1	MPa	3.95			
	Press. Super HTR Av. B-2	MPa	3.95			
	Press. S. HTR Av. B-1 & 2	MPa	3.95			
	Temp. Super HTR Av. B-1	℃	427			
	Temp. Super HTR Av. B-2	℃	443			
	Temp. S. HTR Av. B-1 & 2	℃	435			
	Press. DS HTR Av. B-1	MPa	3.95			
	Press. DS HTR Av. B-2	MPa	3.95			
	Press. DS HTR Av. B-1& 2	MPa	3.95			
	Temp. DS HTR Av. B-1	℃	295			
	Temp. DS HTR Av. B-2	℃	308			
	Temp. DS HTR Av. B-1 & 2	℃	302			
	Temp. FO Flow Meter Out	℃	40.3			
	Press. FW Inlet Common	MPa	5.20			

Data Collection Table (4/4)

Measurement item		Unit	15N-123B	13N-123B	11N- 3B	9N-Non B
Flow meter, etc.	Shaft Revolution Speed	min^{-1}	180.5			
	Flow rate of FO	ℓ/h	1985			
	Density of FO		0.9689			
	Volume Conv. Coefficient		0.9855			
	Reference calorific Value	kJ/kg	43000			
	Higher Calorific Value	kJ/kg	42990			
	Flow rate of FO Corrected	ℓ/h	1895.4			
	Flow Rate of FW	ℓ/h	31102			
	Flow Rate of FW Deaerater	ℓ/h	20970			
	Quantity of makeup	ℓ/h	130			
	Flow Rate of LPSG FW	ℓ/h	870			
	Quantity of LPSG Makeup	ℓ/h	0			
	Electric power used	kW	470			

ERS II – 14

Training Title/Scenario: Operating limits of propulsion plant

Table A-III/2 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Table A-III/2 KUP: Operating limits of propulsion plant

Time allocation: 3 hours

Outline of the training:

The trainees perform operations on the illustrative diagrams displayed on the screen changing running conditions and watching the movement of running point and other running parameters.

Prerequisite:

Completion of ERS III - 9

Note:

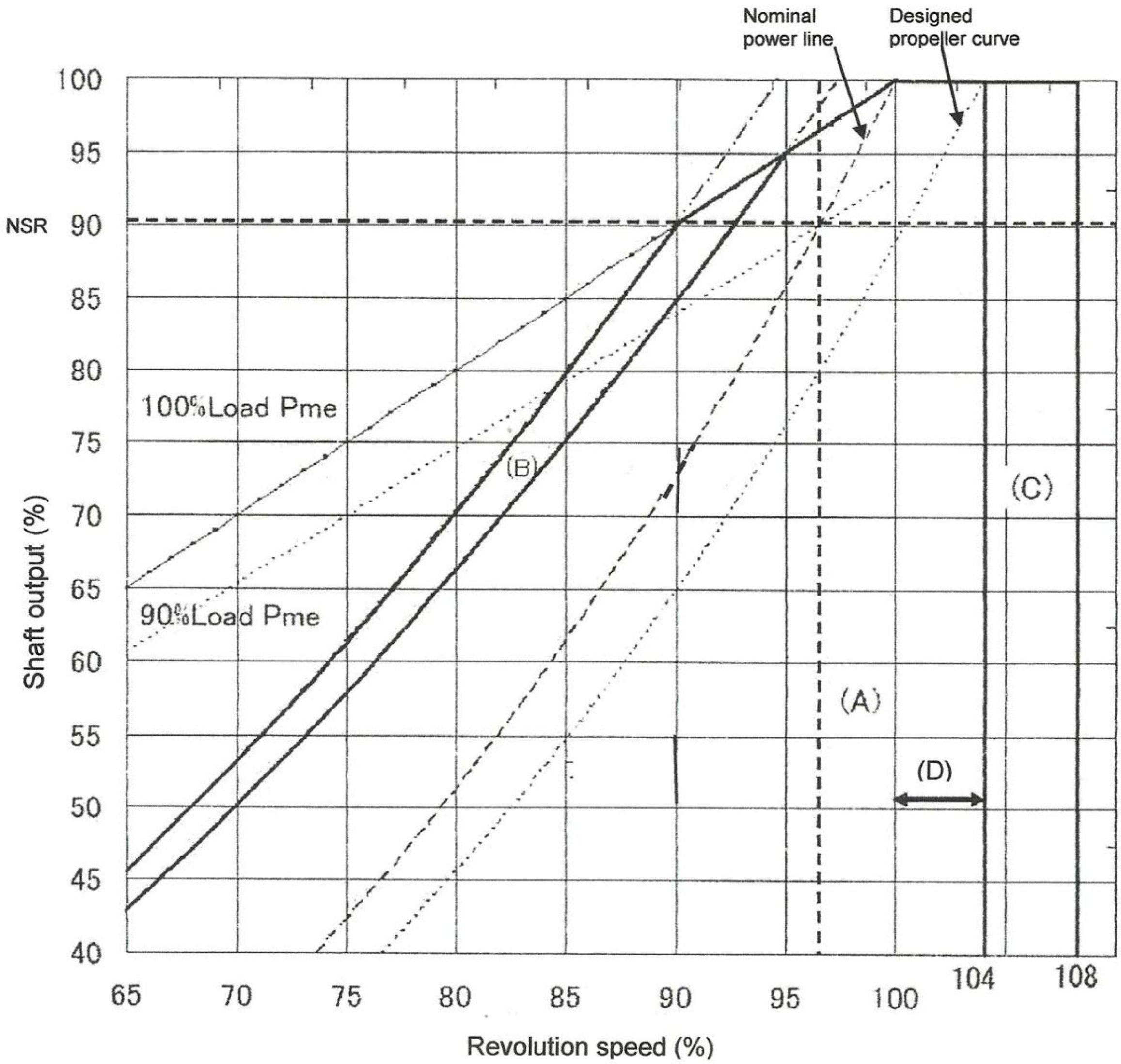
The trainees should understand differences between a diesel engine and steam turbine propulsions in propulsive characteristics.

Specific purpose of the training:

The trainees will be able to understand operating limits of main engines from various aspect.

Implementation of the training

T in min	Training process
0 ~ 60	The instructor creates "Seagoing" of main diesel engine as an initial condition and displays the illustrative maneuvering system and the figure indicating operating limits of a main diesel engine with a running point.(Refer to Figure 1) The instructor creates hull and weather conditions as follows and lets trainees maneuver the main engine. - Light condition + Calm weather - Loaded condition + Calm weather - Loaded condition + Heavy weather The trainees maneuver the main engine under these conditions in turn as follow and observe the movement of running point and other running parameters. - Revolution speed of (Harbor Full) + 20 min^{-1} - Revolution speed of (Harbor Full) + 30 min^{-1} - Revolution speed of (Harbor Full) + 40 min^{-1} - Revolution speed of Navigation Full min^{-1} - Revolution speed of Navigation Full $\times$1.05 min^{-1} The trainees record the running point on the load graph and check the running parameters concerned in operating limits. (The instructor stops simulation and creates "Seagoing' condition of main steam turbine)
60 ~ 120	The instructor lets the trainees maneuver the main steam turbine in the same manner as main diesel engine. (Refer to Figure 2) (After the debriefing, the instructor gives the report form and lets them fill out)

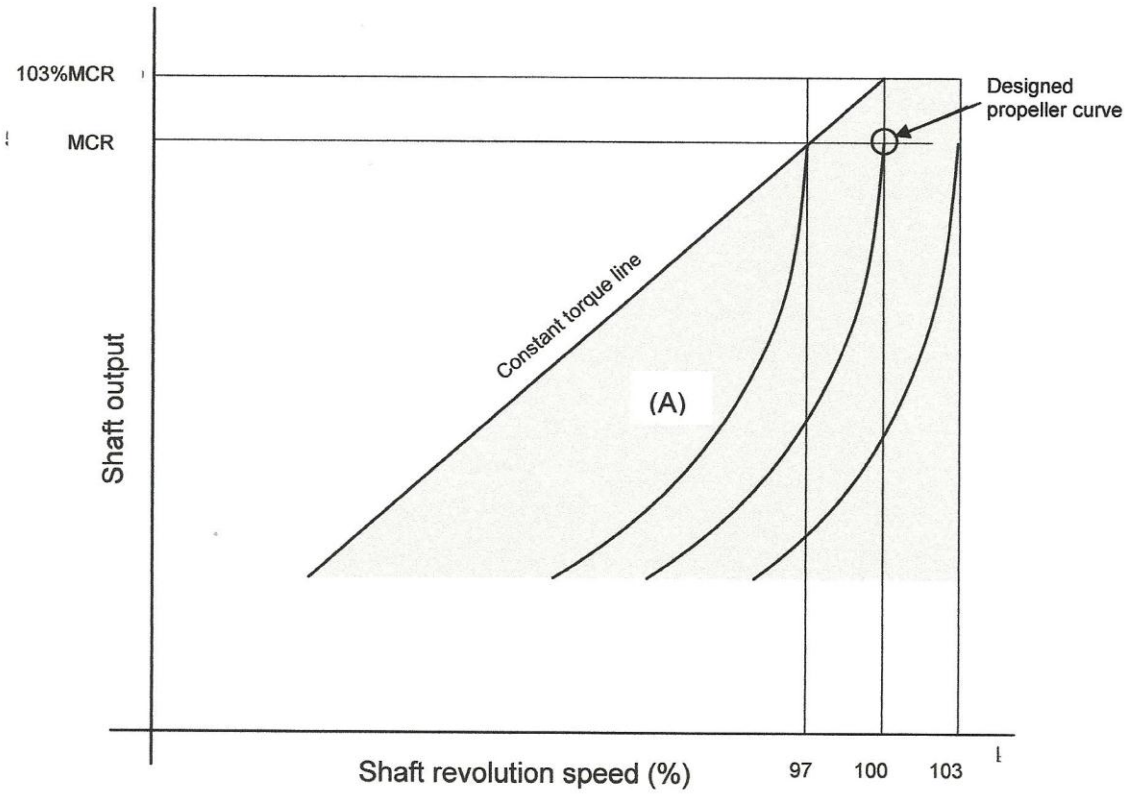


Operating Limits and Range of Diesel Engine

Figure 1

Operating limits

Continuous operation range	(A) Zone
Limited time operation range	(B) Zone
Sea trial operation range	(C) Zone
Allowable speed range for NSR	(D) Zone
Engine revolution speed	Max. 104% Min.: 35%
Cylinder maximum pressure	15.00 Mpa
Turbo charger revolution speed	Max. 20,000 min^{-1}
TC inlet exhaust gas temperature	Max. 580℃
Exhaust gas economizer gas inlet press.	Max. 350 mmAq
Pressure drop inside TC suction filter	Max. 200 mmAq
Pressure drop inside Air Cooler	Max. 300 mmAq



Operating Limits and Range of Steam Turbine

Figure 2

Operating limits

Allowable continuous operation range	(A) Zone
Non-bleeding operation shaft output	Max. 90% MCR (174 min^{-1})
Astern operation limits	Max. 30 minutes at revolution speed of 70% MCR in ahead Exhaust space temp. Max. 230℃

FAMILIARIZATION TRAINING OF ERS III

The familiarization training must be conducted before beginning any simulator training using ERS III.

Time allocation: 2.5 hours
Number of Trainees: 8 ~10
Number of Instructors: 2

Outline of the training:

After explanation on simulated propulsion plant system in the briefing room, the instructor takes trainees to the engine and control rooms and explain equipment installed in the rooms and lets them perform simple operations of the simulator.

Initial Condition:

1) Seagoing (Turbo generator and Fresh water generator are in service)
2) Standby engine

Form of Training:

A group of 8-10 trainees has explanation on simulated propulsion plant system in the briefing room and equipment of ERS III in the engine and control rooms. Individual trainee performs various simple operation on the equipment.

Prerequisite:

No prerequisite is necessary

Note:

The instructor should try to let the trainees perform simple operations such as opening and closing valves, starting and stopping pumps, checking running parameters as many times as possible. When the situation allows, the instructor lets them free to operate machinery.

Specific purpose of the training:

The trainees figure out entire system of simulated propulsion plant and acquire knowledge on particulars of:

- propulsion machinery (main engine)
- power generation system
- steam generation system
- cooling system

The trainees understand names and main functions of equipment and installations installed in the engine and control rooms as follow:

- Mimic panel
- Main engine maneuvering stand
- Group starter panel (GSP)
- Boiler control panel
- Purifier control panel
- Main console
- Main switch board (MSB)
- Communication equipment

The trainees acquire knowledge and skills on:

- operating, starting and stopping machinery on the control stand and control panels
- opening and closing valves on the mimic panel
- basic operation of equipment installed on main engine local stand in the engine room, main console and main switch board in the control room
- using communication equipment

Briefing session (30 min):

Instructor should explain the following using plant diagram and/or other visual aids:

- Purpose of familiarization training
- outline of familiarization training
- construction of simulated propulsion plant
- particulars of main machinery
- power generation system adopted
- steam generation system adopted
- cooling system
- how to carry on the training

Implementation of the training

After briefing, the instructor takes the trainees to the engine room and starts the training as follow.

T in min	Training process
0 ~ 45	(The instructor creates seagoing condition as an initial condition and starts the simulation) (Engine room) The instructor explains entire system of the simulated propulsion plant using the mimic panel. The instructor explains names and main functions of equipment and installations one by one and demonstrates basis operation of switches. The instructor demonstrates how to take readings of analogue and digital meters. The trainees try to perform operations on the mimic panel and GSP as follow. - open and close valves - rotate rotary switches to determine temperatures - read indications of analogue meters - start and stop pumps (The instructor stop the simulation and creates standby condition as an initial condition. The instructor takes the trainees to the control room)
45 ~ 90	(Control room) The instructor explains manes and main functions of equipment and installations one by one and demonstrates their basic operation. The trainees try to perform operations on main console and MSB as follow. - handle main engine maneuvering lever - remotely start and stop machinery - use data display of monitoring system - read indications of analogue meters - use communication equipment (The instructor stop the simulation and lets the trainees move to the briefing room)

Debriefing session (30 min)

The instructor states that the trainees would understand construction of the simulated propulsion plant and basic operation to proceed the simulation, and specific operation for each simulator training will be instructed when conducting the training.

The instructor should emphasize that it is most important for the trainees to have a sense of purpose (what we are going to learn) in a simulator training.

The instructor should also brief on:
- features of equipment/installation comparing to actual ones on board
- differences in operating machinery comparing to actual ones on board

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets the trainees dismiss.

ERS III – 1

Training Title/Scenario: Engineering Watch

Table A-III/1 Competence: Maintain a safe engineering watch

Table A-III/1 KUP: Thorough knowledge of principles to be observed in keeping an engineering watch, including 1) duties associated with taking over and accepting a watch, 2) routine duties undertaken during a watch, 3) maintenance of the machinery space logs and the significance of the reading taken, 4) duties associated with handing over a watch.

Time allocation: 13.5 hours
Number of Trainees: 8 ~10
Number of Instructors: 3

Outline of the training:

This training is conducted under two stable plant conditions of ship's passage and the trainees perform tasks of an engineering watch in a manner of role playing. 8-10 trainees are divided into two groups (Group A and B) and form group A/B1, 2, 3, and 4 assigning different roles to the trainees. (For example, the trainee who plays role of leader of Group A1 during the first stage should be assigned to different role other than the leader of Group A2). While Group A performs the training, Group B stays in the briefing room and observe the performance by Group A. The duration of one stage of the training is 90 minutes and four stages (360 minutes) are continuously carried out for one stable condition as follow.

A, B: Group A/B

		Implementation (90 min for each period)			
		1	2	3	4
1st Stage (Seagoing)	Performance	A1 →	B1 →	A2 →	B2
	Observation	B1 →	A1 →	B1 →	A2
2nd Stage (Speed of 50% MCR)	Performance	B3 →	A3 →	B4 →	A4
	Observation	A3 →	B3 →	A4 →	B4

Initial Condition:

1) Seagoing (Turbo generator and Fresh water generator are in service)
2) Speed of 50% MCR (One diesel generator is in service and Fresh water generator is not in service)

Form of Training:

8-10 trainees divided into two groups and roles are assigned to all the trainees as follow. The training is conducted in the group A/B1, 2, 3 and 4 respectively.

Division of roles（Steam plant and auxiliary machinery are to be combined in case of 8 trainees in total. T1, 2, 3, 4 and 5 are Trainee 1, 2, 3, 4 and 5 in the Group A and B）

	Leader	Main engine	Gen. Plant	Steam plant	Aux. machinery
Group A/B1	T1	T2	T3	T4	T5
Group A/B2	T2	T3	T4	T5	T1
Group A/B3	T3	T4	T5	T1	T2
Group A/B4	T4	T5	T1	T2	T3

Prerequisite:

Understanding of principles to be observed in keeping an engineering watch described in Chapter VIII of STCW Code.

Note:

Communication system equipment must be used for communication between the instructor room, control room, and engine room during the training, and it is desirable to use English for communication.

Specific purpose of the training:

The trainees perform tasks to be done in an actual engine room during watch period as much realistic environment as possible and will be familiar with the tasks, understanding principles and procedures to be applied to the engineering watch. The trainees will be able to demonstrate the principles and procedures in the simulated engine room by performing interrelated tasks four times under two different stable plant conditions.

In series of the training, the trainees perform the following.

- Engine room round
- Figure out the running conditions of the machinery using measurement tables
- Assess the running parameters
- Report the running condition to the leader
- Tasks instructed during the watch
- Prepare for taking over the watch

- Make entry of watch log to be taken over
- Take over the watch with oral communication
- Accept the watch

Briefing session (30 min):

Instructor should explain:
- outline of the training
- how to carry on the training
- roles of the leader of the group, persons in charge of main engine, generator plant, steam plant and auxiliary machinery as follow;
- the leader mainly;
  - figures out running condition of the propulsion plant as a whole
  - receives reports from persons in charge of the machinery
  - issues instructions of tasks to persons in charge of the machinery
  - makes entry of watch log at time of taking over the watch
  - briefs relieving watch personnel on information to be taken over
- the persons in charge of machinery mainly;
  - figure out the running condition of the machinery in charge
  - fill out measurement tables of the machinery in charge
  - perform tasks instructed by the leader
  - report necessary information to the leader
  - follow instructions given by the leader
- the instructor should emphasize:
  - knowledge obtained from the training can be applied to duties during an actual engineering watch
  - the training is conducted in a group however, the actual watchkeeping is usually carried out by one engineer officer with/without assistant, therefore it is essential for the trainees to assume all duties done during the training have to be undertaken by himself/herself in the actual watchkeeping

Instructors establish two groups of trainees A and B, assigning leader and persons in charge of each machinery as aforementioned.

Implementation of the training

After briefing and establishment of the group, the instructors let the trainees take up the first position for starting the training and start the training as follow.
(The flow of the training can be applied to both initial conditions)

1st Stage (Seagoing)

T in min	Training process
0 (1st Period)	(The instructor of Group A creates "Seagoing" as an initial condition of ERS III and starts the simulation from the instructor room.) The leader of Group A1 takes up a position in the control room and persons in charge of the machinery take up a position in the engine room. The instructor and trainees of Group B stays in the briefing room, observing the progress of the training carried out by Group A1. (The instructor describe activities taken by Group A watching the screen of CCTV system)
0 ~ 15	The leader gets to know main running conditions of the propulsion plant watching the running parameters including weather and sea condition, loading condition, and ship's speed. Persons in charge of the main engine get to know the running conditions of the machinery, filling up measurement tables with readings of the running parameters taken.
15 ~ 30	The persons in charge of the machinery enter the control room and report to the leader the running conditions of the machinery, findings and alarm if any, handing over the filled up measurement tables one by one. Other persons must listen to the person reporting the condition to the leader. (The leader asks the reporters some questions about the reports) (Example of the report by the person in charge of the main engine) - The engine load is now almost standard to the present revolution speed. - Revolution speed of TC is also in standard range and highest exhaust gas temperature is 380 degree Celsius (℃). The lowest temperature is 335 degree Celsius (℃). - There is very few difference among all temperatures of CFW outlets at the standard value as well as Piston cooling LO and Bering LO. - Opening of the HTFW temperature control valve is now 10 % cooler side. - Scavenging air temperature and pressure stay in standard values and pressure drop of the air in air coolers gets higher a little than previous watch records. - No malfunction was found and running condition of the engine is in stable.

	When all the reports are over, all the persons in charge of the machinery move to the engine room and carry on the watch) The leader discusses tasks to be done during the watch and instructions from C/E if any.
30 ~ 45	The leader instructs the persons in charge of the machinery to carry out the tasks. (Persons who have no task must observe the tasks being carried out by the other person. The following is suggested as the tasks to be done.) - Periodical changeover of auxiliary machinery from No. 1/2 to No. 2/1 such as Fuel oil purifier, LO purifier, CSW pump, CFW pump, LO pump, Fuel oil booster pump and so on. - Carrying out soot blowing for Auxiliary boiler and Exhaust gas economizer - Carrying out blowing down Auxiliary boiler water - Changing over generated fresh water supply tank - Changing over fuel oil tank to be used - Discharging the bilge water overboard through the oily-water separator - Transferring bilge from bilge wells to bilge tank - Discharging bilge of bilge tank overboard through oily water separator - Incinerating waste oil - Transferring fuel oil from bunker tanks to settling tanks - Carrying out drainage from scavenging air manifold of the main engine, compressed air reservoirs and fuel oil settling tank and service tank - Manual discharge of sludge on Fuel oil purifiers, LO purifiers if possible - Test run of emergency fire pump and diesel generator - Cleaning main engine turbocharger air and/or gas sides The persons in charge of the machinery carry out the tasks assigned and report the completion of the tasks to the leader.
45 --60	(The instructor makes one or two malfunctions that cause an alarm of machinery.) The leader gives instructions to take measures necessary to the person in charge of the alarming machinery. The person of the alarming machinery takes measures to recover the malfunctions and report it to the leader.

60 -- 75	The leader confirms the running conditions are in good working order including diagnose of P-V diagram of the main engine The persons in charge of the machinery fill out the measurement tables with readings taken for the second time.
75	All the members of Group B1 enter the engine room and make an engine room rounds checking the running parameters indicated on the mimic panel, group starter panels, control stands and main engine maneuvering stand.
75 – 85	The persons in charge of the machinery enter the control room and report to the leader the conditions of the machinery handing over the filled up measurement tables. The leader fills out the form to be handed over to the relieving watch personnel with information obtained from his/her watchkeeping and the instructor as follow and prepares for handing over the watch. - sea water temperature; - engine room temperature; - ship's speed; - main engine average revolution speed; - fuel notch of main engine; - main engine output; - fuel oil consumption during the watch; - main engine exhaust gas highest and lowest temperatures; - turbocharger revolution speed; - tasks done; - tasks to be done during the relieving watch, if any; - instructions from C/E; and - information from the bridge (The instructor should give information relating to navigational conditions such as LOG distance, OG distance and so on.)
85 – 90	The members of Group B1 enter the control room and both Group A1 and B1 stand toe to toe. The leader of Group A1 orally communicates necessary information to all the members of Group B1 for handing over the watch. (Both instructors of Group A and B listen to the communication between Group A and B observing the trainee's attitude.)

<Example of communicating pattern>

The leader of G-A: (A), All members of G-B: (B)

Any of members of the group B1 can ask the leader of Group A1 questions about the information given and others if any. (The following is only an example and its contents should be developed according to the situations)

(A): Attention!!

(B): Yes

(A): I will brief the present watch operation conditions for relieving watch

- The setting position of the main engine maneuvering lever is Navigation Full and Fuel Notch is 50.
- The last one hour average revolution of the main engine was 100 min^{-1}
- The turbo generator is currently used and setting pressure of the boiler is 0.7 Mpa and damper control of the exhaust boiler is set to auto.
- Sea water temperature is 20 degree Celsius and the engine room temperature is 35 degree Celsius.
- Orders and/or instructions of Chief engineer, if the revolution of the main engine decrease until 95 min^{-1}, report it to the Chief engineer since a heavy weather is likely expected. If there is information something special from the bridge, report it to the Chief engineer.
- Regular and/or additional tasks completed during the watch period.
- We have carried out soot blowing for the exhaust boiler.
- We have changed over generated fresh water supply tank from No1 port FW tank to No 1 starboard FW tank.
- We have changed over fuel oil tank to be used from No. 3 Port FO tank to No.3 starboard FO tank.
- We have discharged the bilge water from bilge tank overboard through the oily-water separator.
- Repair or maintenance tasks done during the watch period.
- As there was sea water leaking from the sea water service line, we have repaired the broken pipe temporarily
- The watch briefing is now over. Do you have any question?

(B): Did you receive information from the bridge?

(A): There was no information from the bridge during the watch period

(B): No further question, Thank you.

(A): Attention! You have the watch now.

(B): We have the watch now. Thank you.

(Completion of the 1st period)

90	Group A1 moves to the briefing room and watches the progress and the activities taken by Group B on the CCTV screen. (The instructor collects the measurement tables from the leader of Group A1 and gives briefing on the results of the activities made by Group A1. The instructor should also ask the trainees questions accordingly about the plant condition, running parameters, tasks and their findings during the previous watch. The instructor may give the trainees a break time as necessary)
0 (2nd Period)	The leader instructs the persons in charge of the machinery to start measurements of the machinery in the engine room. After this instruction, the training should be carried on in the same manner as the first period.
75	All the members of Group A enter the engine room with different role assignment as Group A2 and make an engine room rounds checking the running parameters indicated on the mimic panel, group starter panels, control stands and main engine maneuvering stand.
85 ~ 90	Same procedures as previous taking over the watch are taken after the leader of Group A2 took over and accepted the watch. (Completion of the second stage)
Third & Fourth Period	Third and fourth periods are carried out in the same manner as the first and second periods. (If necessary, breaking time can be taken after the completion of the 1st stage)
	(The instructor stops the simulation after completion of the fourth period)

2nd Stage (Speed of 50 % MCR)

T in min	Training process
	(The instructor starts the simulator and creates seagoing condition at speed of 50 % MCR as an initial condition) (The training is carried out in the same manner as the 1st stage as aforementioned)

Debriefing session (60 min)

The instructor should express his/her impressions first as a whole and review the following comparing to an actual engineering watch:

- if running conditions were figured out
- if reports to the leader was appropriate
- if tasks done during the watch were effective
- if communication of taking over the watch was sufficient

The instructor also emphasizes difference between the simulated engine room and an actual engine room and importance of engine room rounds as follow.

Running parameters obtained from the data display of the simulator are almost same as an actual monitoring system on board and are easy to obtain. However, unusual running sounds, vibrations, smells and heats, and water, gas, steam and oil leakages could not be obtained in the simulated engine room. For the watch officers, the importance of the engine room rounds is to find these information in actual engine room and to take actions before an alarm sounds.

From this aspect, the watch officer should be careful about any changes in the running parameters and findings during the engine room rounds, pushing out an idea that there is no problem as long as these values are within an operating range or tolerance and seeking answers or reasons for the changes.

Furthermore, it must be very important for watch officers to keep in their mind that they deal with persons who have mechanical functions and do not merely deal with machinery during their watch period. In fact, there would be many cases that the machinery does not exactly demonstrate its functions as expected despite they thought they made suitable maintenances and adjustments.

The watch officers therefore must sharpen their senses not to miss any sign from the machinery that may lead malfunctions when making the engine room rounds.

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III-1

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Engineering watch
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Engine room rounds (If inspection of machinery and running parameters, and manner of inspection were correct, effective and satisfactory)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Instruction, report and other communication (If these communication patterns were clearly recognized and oral communication were clear and effective)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Knowledge, understanding and proficiency on watch (If all the activities were based on correct knowledge and understanding, and familiar with the watch)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Watch log and other records (If the watch log, measurement table, all event log/note and other records in a written form were clear, satisfactory, effective and accurate)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Handing over the watch in oral form (If communication of handing over the watch was clear voice, effective, confident manner, understandable and satisfactory)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ____________________

Main Engine Measurement Table (1/2)

Name:				Date: Time: ~			
	Time			Temperature (℃) – Exhaust Gas	No.1 Out		
	E/R Temp. (℃)				No.2 Out		
	SW Temp. (℃)				No.3 Out		
					No.4 Out		
	Handle Position				No.5 Out		
	Governor Notch				No.6 Out		
	Shaft Rev. (min^{-1})				No.7 Out		
	Pump Notch				No.8 Out		
	SHP (kW)				No.9 Out		
	Torque (T-m)				No.10 Out		
	Thrust (Ton)				No.11 Out		
	TC Rev. (min^{-1})				No.12 Out		
	Ship Speed (K't)				TC In		
					TC Out		
	Scavenging air Temp			Temperature (℃) – Piston Cooling LO	In		
	FO In Temp.				No.1 Out		
	FO Viscosity				No.2 Out		
	FO Press. Cont. V				No.3 Out		
					No.4 Out		
	LO In Temp.				No.5 Out		
	LO Temp. Cont. V				No.6 Out		
					No.7 Out		
Temperature (℃) – Jacket CFW	In				No.8 Out		
	No.1 Out				No.9 Out		
	No.2 Out				No.10 Out		
	No.3 Out				No.11 Out		
	No.4 Out				No.12 Out		
	No.5 Out				Thrust Bearing T (AHD)		
	No.6 Out				Thrust bearing T (AST)		
	No.7 Out				TC LO Out		
	No.8 Out				TC LO Temp. Cont. V(%		
	No.9 Out				TC in Drop (mmAq)		
	No.10 Out						
	No.11 Out				Oil Mist Density		
	No.12 Out						

Main Engine Measurement Table (2/2)

Pressure (Mpa)				Temperature (℃)	Shaft Bearing LO			
	Bering LO					No. 1 Inter.		
	Camshaft LO					No. 2 Inter.		
	TC LO					No.3 Inter		
	Piston Cool LO					Aft Most		
	Scavenging air					F-S/T Seal Oil		
	Control air					Stern Tube		
	LTFW							
	FO				S/T LO CLR	LO In		
	Jacket CFW					LO Out		
	VIT Position air					LTFW In		
	FO Vent. Tank					LTFW Out		
	FO Filter Diff.							
	LO Filter Diff.			F-S/T Seal Oil Press.				
	Air Cooler Drop			S/T Bearing LO Press.				
Air Cooler	Air In Temp.			Tank Level	LO Sump Tank			
	LTFW In Temp.				TC LO H/G Tank			
	LTFW Out Temp.				CFW Exp. Tank			
					Cyl. Oil Day Tank			
LO Cooler	LO In Temp.				S/T LO Sump Tank			
	LO Out Temp.				A-S/T Seal Oil Tank			
	LTFW In Temp.							
	LTFW Out Temp.			Cont. V (%)	Jacket CFW T.			
					LTFW Temp.			
FW Cooler	HTFW In Temp.				FO HTR STM			
	HTFW Out T							
	CSW In Temp							
	CSW Out Temp.							

Power Generation System Measurement Table

Name:				Date: Time: ~				
Time				Temperature (℃)	Exhaust Gas	No.1 Out		
Generator in use						No.2 Out		
						No.3 Out		
Main Switch Board (MSB)	Gen. Voltage (V)					No.4 Out		
	BUS Voltage (V)					No.5 Out		
	Gen. Freq. (Hz)					No.6 Out		
	BUS Freq. (Hz)					TC In 1		
	Current (A)					TC In 2		
	Power (kW)					TC In 3		
	Power Factor				Jacket CFW	In		
	Insulation (MΩ)					No.1 Out		
						No.2 Out		
Diesel Generator						No.3 Out		
Revolution (min^{-1})						No.4 Out		
Fuel Notch						No.5 Out		
Pressure (Mpa)	Starting air					No.6 Out		
	Boost air					Out		
	LO			Turbo Generator				
	Jacket CFW			Pressure (Mpa)	Steam In			
	LTFW				1st stage steam			
	FO				Exhaust space			
	LO Filter Diff.				Gland steam			
Jacket CFW Cont. V					LO In			
LO Level	LO Sump Tank			Aux. Cond. V (-kPa)				
	Gen. Bea. Fore			Temperature(℃)	Steam In			
	Gen. Bea. Aft				Exhaust space			
	Governor				Condensate water			
LO Cooler	LO In Temp.				Aux. Cond. SW In			
	LO Out Temp.				Aux. Cond. SW O			
	LTFW In Temp.			Cond. Pump Suc. P				
	LTFW Out Temp.			Cond. Pump Del. P				
Air CLR	Air In			Cond. Water Level				
	Air Out			LO Sump Tank Level				
	CFW Out			LO CLR LO In Temp.				
Gen. Fore Bea. Temp				LO CLR LO Out Temp.				
Gen. Aft Bea. Temp				LO CLR LTFW In Temp.				
				LO CLR LTFW Out T				

Steam Generation System Measurement Table

Name:				Date: Time: ~			
Time							
Auxiliary Boiler				Exhaust Boiler			
Press.(Mpa)	Steam			Steam Press.(Mpa)			
	FO Burning			Temperature (℃)	Economizer In		
	Draft (mmAq)				Economizer Out		
	Feed water				Evaporator In		
Boiler water Level					Evaporator Out		
FO Burner In Temp.					Superheater In .		
FO Heater Out Temp.					Superheater Out		
Feed water Tank L					Exhaust Gas In		
Inspection Tank L					Exhaust Gas Out		
Aux. Cond.	Cond. Press.			Exh. Gas Drop P (mmAq)			
	Drain Temp.						
	LTFW In Temp.			Boiler Water Circ. Pump	In Use		
	LTFW Out T				Suc		
					Dis		
FO Burning Pump	Suc.						
	Dis.						
FO Supply Pump	Suc						
	Dis.						
Feed water Pump	In Use						
	Suc.						
	Dis.						

Auxiliary Machinery Measurement Table

Name:				Date: Time: ~			
Time							
				Fresh Water Generator (FWG)			
FO Boost Pump	In Use			Shell Vacuum			
	Suc.			Pressure (Mpa)	Feed water		
	Dis				Ejector		
FO Supply Pump	In Use				Dist. W PP Dis		
	Suc.				Ejector P Suc.		
	Dis				Ejector P Dis.		
LO Pump	In Use						
	Suc.			Temperature (℃)	Shell		
	Dis				Heater		
Crosshead LO Pump	In Use				Feed water		
	Suc.				HTFW In		
	Dis				HTFW Out		
Stern Tube LO Pump	In Use				CSW In		
	Suc.				CSW Out		
	Dis			Salinity (ppm)			
HTFW Pump	In Use			HTFW Out V Opening			
	Suc.			HTFW Bypass V Open			
	Dis						
LTFW Pump	In Use			Oil Purifier			
	Suc.			LO	Ampere (A)		
	Dis				Pressure (Mpa)		
CSW Pump	In Use				Pressure (Mpa)		
	Suc.				Temperature (℃)		
	Dis			FO	In Use		
Bilge Level	ER(P)				Ampere (A)		
	ER(S)				Pressure (Mpa)		
	ER(C)				Pressure (Mpa)		
	Aft				Temperature (℃)		
	Fore			DO	Ampere (A)		
	Cargo				Pressure (Mpa)		
Bilge Tank Level					Pressure (Mpa)		
Sep. Oil Tank Level					Temperature (℃)		
Sludge Tank Level							

ERS III – 2

Training Title/Scenario: Change-over of remote/automatic to local control

Table A-III/1 Competence: Maintain a safe engineering watch

Table A-III/1 KUP: Safety and emergency procedures; change-over of remote/automatic to local control of all systems.

Time allocation: 5 hours
Number of Trainees: 8 ~10
Number of Instructors: 3

Outline of the training:

This training is conducted under ship's harbor full speed and trainees perform operations on the mimic panel and main engine local control stand, concerning change-over of remote/automatic to local control for the machinery such as main engine, diesel generators, boilers, oil purifiers, air compressor and steering gear according to the situations.

Initial Condition:

Harbor full speed of main engine (Two diesel generators and steering gears are in service)

Form of Training:

8-10 trainees divided into two groups and roles are assigned to all the trainees as follow. The training is conducted in the group A and B respectively. For example, the group B observes activities of the group A while the group A performs operations.

Division of roles (T1, 2, 3, 4 and 5; Trainees 1, 2, 3, 4 and 5)

Stage		M Eng., Generator, Air comp.	Aux. boiler, Purifier, Steering gear
1	Performance	Group A-T1, 2	Group A-T3, 4, 5
	Observation	Group B	
2	Performance	Group B-T1, 2	Group B-T3, 4, 5
	Observation	Group A	
3	Performance	Group A-T3, 4, 5	Group A-T1, 2
	Observation	Group B	
4	Performance	Group B-T3, 4, 5	Group B-T1, 2
	Observation	Group A	

Prerequisite:

Understanding of meaning and significance to change over control position and insolate machinery

Note:

All operations must be followed to specifications of the machinery. The instructor therefore advises the trainees of specific procedures to change over the control positions before hand. The instructor also may prepare a simple guidance for the trainee's use during the training in some cases.

Specific purpose of the training:

The trainees perform the tasks to change over the control positions of the specific machinery and understand purposes of the change-over and isolation of machinery.

In this series of the training, the trainees perform operations as follow.

- change over main engine bridge control to local control under harbor full speed and control engine speed at local control stand.
- change over diesel generator remote/automatic to local control and start/stop the generator

- change over boiler automatic to local/manual ignition of burners and ignite the burner
- change over purifier automatic to local/manual operation and discharge sludge manually
- change-over air compressor automatic to local/manual operation and start and stop the compressor manually
- change over steering remote/automatic to local control and operate the rudder manually

Briefing session (30 min):

Instructor should explain:
- outline of the training
- how to carry on the training
- roles of the trainees in charge of main engine, diesel generators, aux. boiler, purifier and steering gears
- specific procedures to change over the control positions according to the specifications of the machinery

Implementation of the training

After briefing and establishment of the group, the instructor lets the trainees take up the first position for starting the training and start the training as follow.

T in min	Training process
0	The trainees of group A enter the engine room and take up the first positions according to their machinery in charge. (If there is no local control stand in the engine room by adopting electronic governor or other reasons, the trainees in charge of the main engine take up the position in the control room) The trainees of group B enter the engine room and take up suitable positions to observe the performance by the group A. (The instructor takes up the position in the engine room and another instructor in the instructor room creates harbor full speed as an initial condition of the plant and starts the simulation)
0 ~ 10	Trainee T1/2 notifies the bridge (Instructor in the instructor room) using the communication equipment as follow. T1: I am second engineer in the engine room, I will change over the control position of the main engine form the bridge to local. Bridge (instructor): All right Trainee T1/2 makes necessary procedures to change over the main engine control position to local control from the bridge on the local control stand and/or control room console. After confirming the change-over of the control position to local control stand from the bridge control, T1/2 maneuvers the main engine lever to increase/decrease the engine speed in order to make sure that control position has been changed to local and the control is functional. T1/2 sets the engine speed at harbor full speed.
10 ~ 20	After the change-over of the main engine control position, the trainee T1/2 begins to change over control position of the diesel generators. T1/2 makes necessary procedures to change over the control position for the specific number of diesel generators to local control and starts/stops the generator manually declaring orally the task instructed.

	(The instructor should instruct the trainee the task to be done. For example, start manually No. 3 diesel generator and make manually parallel running of three generators provided that three generators are in remote/automatic control and make parallel running of No. 1 and No. 3 generators removing No. 2 generator from the parallel running manually)
20 ~ 30	After the change-over of the diesel generator control position, the trainee T1/2 begins to change over control of air compressor to local/manual operation. T1/2 makes necessary procedures to change over the control of No.1 air compressor to local/manual operation declaring orally the task instructed and manually starts and stops the compressor discharging drain accordingly.
30 ~ 40	After the change-over of air compressor control, the trainee T3/4/5 begins to change over control position of combustion equipment of auxiliary boiler. T3/4/5 makes necessary procedures to change over the control of combustion equipment to local/manual operation declaring orally the task instructed and lights off manually the burner to raise the steam pressure. After the ignition of the burner, T3/4/5 stops combustion several minutes later and carries out post purge manually.
40 ~ 50	After the change-over the auxiliary boiler control, the trainee T3/4/5 begins to change over control of LO purifier. T3/4/5 makes necessary procedures to change over LO purifier control to local /manual control declaring orally the task instructed and carries out sludge discharge manually.

50 ~ 60	After the change-over the LO purifier control, the trainee T3/4/5 begins to change over control of steering gears. T3/4/5 makes necessary procedures to change over steering gear control to local from the bridge declaring orally the task instructed and alters the rudder angle manually. After completion of the serial training aforementioned, the instructor re-creates the initial condition and lets the groups change the position as planned. (The training is repeated four times in the same manner. The trainees may take a break time between stage 2 and 3)

Debriefing session (30 min)

The instructor should express his/her impressions first as a whole.

The instructor should also brief on:
- if there was mistaken procedures
- precautions when changing over remote/automatic to local control, particularly when main engine is running in remote/automatic control
- local controls or isolations of machinery are often used when starting up the plant from the port condition or cold condition

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III-2

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Change-over of remote/automatic to local control
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Main engine (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Diesel generator (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Air compressor and Purifier (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Auxiliary boiler (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Steering gear (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ____________________

ERS III – 3

Training Title/Scenario: Immediate actions to be taken in the event of fire or accident

Table A-III/1 Competence: Maintain a safe engineering watch

Table A-III/1 KUP: Safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems

Time allocation: 3 hours

Number of Trainees: 8 ~10

Number of Instructors: 3

Outline of the training:

This training is conducted by establishing urgent standby engine when the ship is on passage. Trainees receive request for urgent standby engine from the bridge due to an accident such as a fire, a person overboard, oil spill and others, and perform plant operation under direction of leader to establish urgently state of standby engine from the state of passage.

Initial Condition:

Seagoing (Turbo generator and Fresh water generator are in service)

Form of Training:

8-10 trainees divided into two groups and roles are assigned to all the trainees as follow. The training is conducted in the group A and B respectively. For example, the group B observes activities of the group A while the group A performs operations.

Stage		Performance	Observation
1	Urgent standby engine request	Group - A	Group - B
2	Urgent stop engine	Group – B	Group - A
3	Urgent standby engine request	Group – B	Group - A
4	Urgent stop engine	Group – A	Group - B

Stage	Trainees	Role of Trainees
1 & 3	T1	Watch officer in the control room and leader
	T2	Watch officer in the engine room
	T3	Rating in the control room
	T4	Rating in the engine room
	T5	Rating in the engine room
2 & 4	T1	Rating in the engine room
	T2	Rating in the engine room
	T3	Watch officer in the control room and leader
	T4	Watch officer in the engine room
	T5	Rating in the control room

Prerequisite:

Understanding of meaning and significance of urgent standby engine when accidents occur.

Note:

Responses to emergencies vary according to situations however, when emergency situations occur on board ships, urgent standby engine request must be issued as the first action from the bridge in almost all the cases. From this point of view, this training should be conducted and this simulator training cannot be applied to an individual emergency situation due to functions of the simulator ERS III.

Specific purpose of the training:

The trainees perform the tasks to establish the state of standby condition from the navigation condition and understand procedures to urgently bring the propulsion plant to the state of standby engine.

Briefing session (30 min):

The instructor should explain:
- outline of the training
- how to carry on the training
- roles of watch officers and ratings
- specific procedures to establish the state of standby engine according to the specifications of the plant machinery (The instructor may prepare or give the

trainees procedure manual that says specific procedures for the plant operation)
- this training cannot be applied to an individual emergency event such as firefighting, flooding, rescue of over boarded person, and oil spill due to functions of ERS III
- In case of the person overboard, urgent stop engine is made first and the propulsion plant will be brought to the standby condition

The instructor should emphasize:
- during a watch, the watch officer must address any situations
- standby engine request must be issued from the bridge in almost all the cases
- after the standby engine, the watch officer must address an individual situations
- it is quite essential for the watch officer to always keep the propulsion plant under control in any cases since responses to the emergencies vary according to the situations
- when the standby engine is requested, usually all hands must enter the engine room and the chief engineer must take an initiative according to the situations

Implementation of the training

After briefing and establishment of the group, the instructor lets the trainees take up the first position and start the training as follow.

1st Stage

T in min	Training process
0	The trainees T1 and T3 of the group A enter the control room and the trainees T2, 4 and 5 enter the engine room. The trainees of the group B enters the engine room and the control room standing at suitable positions to observe the performance by the group A. (The instructor takes up the position in the control room and another instructor in the instructor room creates seagoing condition as an initial condition and starts the simulation)
0 ~ 30	(The training starts with phone call to the control room) Bridge (The instructor): This is duty officer on the bridge. We have a fire in the officer's accommodation. Urgent standby engine is requested and stop ventilation and power supply to the area. T1: All right.

	T1 informs T2, 3, 4 and 5 of the information from the bridge using communication equipment in order to let everyone know the information at the same time. T1: We have a fire in the accommodation and urgent standby engine is requested. Start No.1 and No. 2 diesel generator and FO circulation of auxiliary boiler. Stop FWG and make parallel running of main air compressors. Turn off the power to the accommodation area. T2: All right T3 turns off the power to the accommodation area and starts No. 1 and No.2 diesel generator remotely from the control room. T3 makes parallel running of No.1 and No.2 diesel generators removing Turbo generator from BUS line. T4 performs operation to start FO circulation of auxiliary boiler. T5 stops supply of CFW to FWG and Dist. water pump and makes parallel running of main air compressors. T2: Started FO circulation of auxiliary boiler and set the boiler to auto. Stopped FWG. T3: Started No.1 and No. 2 diesel generators and made parallel running. Turbo generator has been removed from BUS line. T1: OK. Stop Turbo generator and keep its turning and vacuum of the condenser. Decrease main engine speed until harbor full. T4 and T5 perform operation to stop Turbo generator and close steam valves concerned. T3 changes the control mode and control position of the main engine to the control room and decreases quickly main engine speed until harbor full. T3: I have deceased the main engine speed until harbor full. T2: We stopped Turbo generator and started the turning. T1: All right. I will inform the bridge of completion of preparation for standby engine.

	T1: This is second engineer on duty. We are ready for standby engine. Bridge (Instructor): All right. Engine telegraph on the console rings for standby engine and T1 presses the S/B Eng. button to respond to it. (This is completion of the 1st stage. The instructor lets the group A change the position with the group B and creates the seagoing condition as the initial condition of ERS III)

2nd Stage

T in min	Training process
0 ~ 30	(The instructor confirms that the trainees are ready to start the training and announces using communication equipment to let everyone know simultaneously that the main engine will be stopped suddenly at the bridge and "a person over boarded" will be announced. After that the group B must bring the propulsion plant to standby condition.) The bridge (instructor) stops the main engine manually and announces "a person over boarded" requesting standby engine by engine telegraph. T5 changes the control mode and control position of the main engine to the control room responding the standby engine request. T3: The main engine was stopped. We start diesel generators. Engine room, stop FWG and start auxiliary boiler. Start parallel running of main air compressors. T4: All right T5 starts No.1 and 2 diesel generators remotely from the control room and makes parallel running of Turbo generator and No. 1 diesel generator, soon after the voltage has been established. After that, T3 makes parallel running of No. 1 and 2 diesel generators removing Turbo generator from BUS line. (Parallel run of Turbo generator and No. 1 diesel generator → No. 1 diesel generator single run → No. 1 and 2 diesel generator parallel run) (Bridge (the instructor) requests "Slow ahead engine" by engine telegraph) T5 moves the maneuvering lever of the main engine to "Slow ahead" responding to the telegraph.

	T1 and T2 perform operations to stop FWG and start auxiliary boiler. T1 and T2 also make parallel running of main air compressors. T1 and T2 close steam lines to Turbo generator after stopping the generator and keep its turning and vacuum of the condenser. (This is completion of the 2ndt stage. The instructor lets trainees of the group B change their positions and creates the seagoing condition as the initial condition of ERS III) (3rd and 4th stages are carried out in the same manner as 1st and 2nd stages. The instructor may give the trainees break time between 2nd and 3rd stages accordingly)

Debriefing session (30 min)

The instructor should express his/her impressions first saying that meaning of emergency situation such as a fire, a person over boarded, flooding, oil spill and others.

The instructor should also brief on:

- responses to emergencies vary according to the situations
- urgent standby engine must be requested in almost all the cases
- specific preparations and procedures for urgent standby engine depend on specifications of the plant machinery
- we must pay due attention to running parameters of the plant machinery however we sometimes have cases that we must ignore the range of running parameters/standards for the safety of lives even though it causes serious damage of the machinery

As for response to individual emergency other than standby engine, the instructor lists measures taken by engine department in principle as follow:

- A fire;
    - starting fire pumps,
    - cutting off power to the area
    - stopping ventilation fan and oil pumps
    - closing all outlet valves of oil tanks
    - preparing for all fire extinguishers
- Oil spill
    - preparing for oil dispersant

  - preparing for oil preventive appliances
- A person over boarded;
  - preparing for a rescue boat
- Flooding
  - starting bilge pump
  - discharging emergency bilge and direct bilge in case of engine room flooding

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 3

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Immediate actions to be taken in the event of fire or accident
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Urgent standby engine for request (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Standby engine after urgent stop engine. (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Instruction, report and other communication as a team (If these communication patterns were clearly recognized and oral communication were clear and effective)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Knowledge, understanding and proficiency on operation (If all the performances were based on correct knowledge and understanding of the propulsion plant)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ____________________

ERS III – 4

Training Title/Scenario: Engine-room Resource Management (ERM)

Table A-III/1 Competence: Maintain a safe engineering watch

Table A-III/1 KUP: Knowledge of engine-room resource management principles including 1) allocation, assignment and prioritization of resources 2) effective communication, 3) assertiveness and leadership, 4) obtaining and maintaining situational awareness, 5) consideration of team experience

Time allocation: 6 hours
Number of Trainees: 8 ~10
Number of Instructors: 3

Outline of the training :

This training aims at understanding significance of ERM requirements through teamwork in operating plant machinery as parts of an engineering watch. Namely, process of plant operation is discussed and analyzed in terms of the ERM requirements. As for the plant operation, the trainees establish a group with 8 – 10 trainees and, under direction of leader (C/E) of the group, tackle preparations for leaving a port, main engine maneuvering under standby engine and change over to state of passage in series, and recovery of blackout caused by turbo generator.

Initial Condition:

1st stage: In port (One diesel generator is in service)
2nd stage: Seagoing (Turbo generator and Fresh water generator are in service)

Form of Training:

8-10 trainees establish a group and roles are assigned to all the trainees as follow.
Division of roles（In case of 8 trainees, 1/E-B and 2/E-B are to be omitted. O: Oiler）

Stage	C/R			E/R						
	Direction & ME Man.			Main Engine			Gen. & Boiler		Auxiliaries	
	C/E	1/E-A	1/E-B	2/E-A	2/E-B	O-A	3/E-A	O-B	3/E-B	O-C
1)	T1	T2	T3	T4	T5	T6	T7	T8,	T9,	T10
2)	T10	T8	T6	T9	T7	T1	T3	T4	T2	T5

The training is implemented in a form of teamwork and operations in the engine room are carried out by the trainees who are in charge of the machinery. (For example, the operation concerning main engine system is carried out by the trainees T3, T4, T5 and T6 for the first stage, and T6, T9, T7 and T1 for the second stage)

Prerequisite:

Understanding of engine-room resource management principles (provision 8 of Part 3 "WATCHKEEPING PRINCIPLES IN GENERAL" in Section A-VIII/2 of STCW Code.)

- Understanding of procedures for preparation for leaving a port
- Understanding of procedures to change over the plant machinery to state of passage from standby engine condition

Note:

Communication system equipment must be used for communication between the instructor room, control room, and engine room during the training, and it is desirable to use English for communication.

Instructor should prepare a procedure manual of plant operation from port condition to state of passage. The leaders (C/E and/or 1/E-A) of the group may refer to the manual as necessary during the training in order to issue his/her instructions to the other trainees who are in charge of plant machinery.

Specific purpose of the training:

Let the trainees demonstrate and understand ERM requirements as much as possible through two kinds of plant operation and processes and activities taken place as a teamwork in operating plant machinery are discussed and analyzed in terms of the ERM principles and requirements.

Briefing session for the first stage (30 min)

Instructor should explain:

- outline of the training
- how to carry on the training
- roles of the leader of the group, persons in charge of main engine, generator plant, steam plant and auxiliary machinery as follow;
- the leader mainly;

  - figures out the running condition of the propulsion plant as a whole
  - receives reports from persons in charge of the machinery
  - issues instructions of tasks to persons in charge of the machinery
  - makes entry of watch log at time of taking over the watch
  - briefs relieving watch personnel on information to be taken over
- the sub-leader assists the leader
- the persons in charge of machinery mainly;
  - figure out the running condition of the machinery in charge
  - fill out measurement tables of the machinery in charge
  - perform tasks instructed by the leader
  - report to the leader necessary information
  - follow instructions issued by the leader
- Instructor should emphasize:
  - Application of ERM requirements for the competence "Maintain a safe engineering watch" described in the Table III/1 is to maintain a safe engineering watch, exerting effective communication, leadership, situational awareness and assertiveness for appropriate allocation and effective utilization of personnel, sharing and effective utilization of information, and efficient operation of plant machinery in various situations of duties concerning the engineering watch.
  - Meanings of effective communication, leadership, situational awareness and assertiveness
  - The communication includes instruction, answerback, report and dialogue and these communication patterns should be effectively carried out for maintaining the safe engineering watch.

The Instructor assigns leaders and persons in charge of each machinery to all the trainees as aforementioned.

Implementation of the training

After briefing, the instructor lets the trainees take up the first position and start the training as follow.

1st Stage (In port)

T in min	Training process
0 – 45	(The instructor in the instructor room creates In port condition as an initial condition and starts simulation and another instructor takes up in the control room) The trainees take up positions in the control room and engine room as assigned. 1/E-A issues the first instruction to begin preparation for leaving a port by using communication equipment to let everyone know the instruction. (The following is an example of communication for warming up ME with LO purifier in service for bypass purifying) (1/E-A): From now, we begin warming up ME. Line up ME CFW system and start No.1 HTFW pump (2/E-A): All right (2/E-A, B and Oiler-A open valves concerned and start No.1 HTFW pump and set No. 2 HTFW pump to auto) (2/E-A): We lined up ME CFW system and started No.1 HTFW pump. (1/E-A): All right, begin supply of warming up steam to ME. (2/E-A): All right (2/E-A, B and Oiler-A 4 open preheater steam valve and set HTFW temperature controller to 85˚C) (2/E-A): We began supply of warming up steam to main engine and set HTFW temperature controller to 85˚C (1/E-A): All right, thank you, line up ME LO system and start No. 1 LO pump (2/E-A): All right (2/E-A, B and Oiler-A check ME LO sump tank level and open valves concerned, and start No.1 ME LO pump and set No.2 ME LO pump to auto and LO temperature controller to 45 ^{0}C) (2/E-A): We started No.1 ME LO pump and set temperature controller to 45 ^{0}C (1/E-A): All right, line up FO supply system and start NO1. FO supply and booster pumps (2/E-A): All right (2/E-A, B and Oiler-A T4 open valves concerned and start NO.1 FO supply pump and No.1 FO booster pump) (2/E-A): We lined up FO supply system and started No.1 FO supply and FO booster pumps and set both No.2 pumps to auto (1/E-A): All right, Thank you. Line up stern tube LO system and start No.1 stern tube LO pump

	(3/E-B): All right (3/E-B and Oiler-C open valves concerned and start No.1 stern tube LO pump and set No.2 pump to auto (3/E-B): We lined up stern tube LO system and started No.1 stern tube LO pump and No.2 pump to auto) (1/E-A): All right, start steering gear system and make its test run. 2/E-A, start ME turning. (3/E-B): All right, we will make steering gear test run communicating with deck officer (2/E-A): All right, we start ME turning (3/E-B starts No. 1 steering gear system, and makes phone call to the bridge [instructor room]) (2/E-A and Oiler A confirm turning gear engaged and start turning motor making sure current value of turning motor) (2/E-A): We started ME turning and current value is in normal (1/E-A): All right, Thank you. 2/E-B, start No.2 generator at engine side and report the running condition. (2/E-B): All right, we will start No.2 generator at the engine side (2/E-B and Oiler-B start No.2 generator and confirm its running parameters. (2/E-B): We started No.2 generator and confirmed it in a good running condition (1/E-A): All right, we will make parallel running (1/E-B makes parallel running of No.1 and 2 generator on MSB and switches on Bow thruster and Deck machinery. 1/E-A makes phone call to bridge [Instructor])

(3/E-B): This is third engineer. I am having steering gear test run, please make third officer's presence and take the rudder angles "Port", "Starboard", "Hard port" and "Hard starboard" as usual.
(Bridge [Instructor]): Yes, I will make it
(3/E-B watches the movement of the rudder. After the "Hard port taken, stop No.1 steering gear system confirming the rudder angle is in midship and starts No. 2 steering gear and make phone call to the bridge.
(3/E-B): This is third engineer. No.1 steering gear test run was over and please make it again for No.2 steering gear
(Bridge [Instructor]): All right
(3/E-B watches the movement of the rudder again and starts No.1 steering gear for parallel running and make phone call to the bridge)
(3/E-B): This is third engineer. No.2 steering gear test run was over and confirmed they were in a good working order. I made steering gear parallel running so, please take the steering wheel at a certain interval.
(Bridge [Instructor]): All right

	(1/E-A): This is first engineer, we switched on Bow thruster and Deck machinery. (Bridge [Instructor]): All right. Thank you (3/E-B): We have completed steering gear test run and confirmed they were in a good working order. (T1): All right, Thank you for that. (This is completion of warming up main engine. C/E, 1/E-A and B must confirm ME CWF outlet temperature and proceed to ME trial run)
45 – 60	(The following is an example of conducting ME trial run) (T1): We have completed ME warming up and stop supply of warming up steam. Start No.1 boiler water circulation pump and make parallel running of main air compressors. (3/E-A): We started No.1 Boiler water circulating pump and set No.2 pump to auto. (3/E-B): We made parallel running of main air compressors in auto. (1/E-A): All right, boiler water circulating pump started and parallel run of main air compressors. (1/E-A makes phone call to bridge [Instructor]) (1/E-A): We have ME trial run shortly. Please let me know if it is OK (Bridge [Instructor]): OK, deck department is already stationed and confirmed clear aft. We can proceed. (1/E-A): Copy it, thank you. (1/E-A): Now, we begin ME trial run. Disengage ME turning gear and open starting air root valve of No1. Air reservoir. (2/E-A): We disengaged ME turning gear. (3/E-B): We opened the starting air root valve and made drainage of the line. (1/E-A): All right, we make air running. (1/E-B switches on sub-telegraph "S/B engine" and confirm response from the bridge and then, handle maneuvering lever for air running confirming ME rotation) (1/E-A): Close all indicator valves (2/E-A, and Oiler A close all the indicator valves) (2/E-A): We closed all indicator valves.

	(1/E-A): All right, we start ME. (1/E-B starts auxiliary blowers pressing engine telegraph "Dead slow ahead" and handle maneuvering lever for starting and stopping ME after several turns of ME and press engine telegraph "Stop". 1/E-B takes same actions as dead slow astern for astern engine. Finally, 1/E-B switches on sub-telegraph "F/W engine") (2/E-A): No abnormality found in the engine room (1/E-A): All right (1/E-A makes phone call to bridge [Instructor]) (1/E-A): ME trial run was over with a good condition. (Bridge [Instructor]): We copy it, thank you.
60 – 90	(The ship is leaving a port. Bridge [Instructor] requests S/B engine for leaving the port. The following is an example of communication for S/B engine.) (1/E-A): C/E, S/B engine is requested (telegraph gong sounds) (C/E): OK (1/E-A): I will respond. (1/E-A presses the sub-telegraph "S/B engine" to respond) (Bridge [Instructor]): Pilot on board. Let go all shore lines (on the phone) (1/E-A): Copy it. (on the phone) (1/E-A): Pilot on board. Let go all shore lines (Bridge [Instructor]) requests "Slow astern engine") (1/E-B): Slow astern engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph) (1/E-A): Slow astern engine (Bridge [Instructor]) requests "Stop engine") (1/E-B): Stop engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph) (Hereinafter, ME maneuvering is carried out in a same manner several times until Full way engine is requested and the pilot disembarks before Full way engine) (Bridge [Instructor] requests "Stop engine") (1/E-B): Stop engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph) (1/E-A): Stop engine (Bridge [Instructor]): The pilot disembarked (on the phone) (1/E-A): Copy it (1/E-A): Pilot disembarked. (Bridge [Instructor] requests "Slow ahead engine")

	(1/E-B): Slow ahead engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph) (1/E-A): Slow ahead engine. (Bridge [Instructor] requests "Full ahead engine") (1/E-B): Full ahead engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph) (1/E-A): Full ahead engine (Bridge [Instructor] requests "Full way engine") (1/E-B): Full way engine (Engine telegraph gong sounds) (1/E-B handles ME maneuvering lever responding to the telegraph. ME speed will be automatically moved up to navigation speed.) (1/E-A): Full way engine.
90 -120	(After the Full way engine, the trainees set the plant to state of passage. The following is an example of communication for setting up the state of passage.). (Bridge [Instructor]): We made steering gear single run. (on the phone) (1/E-A): Copy, steering gear single run confirming running lamps of steering gear. (1/E-A): Now, we make single run of diesel generator. (1/E-B switch off Bow thruster and deck machinery and make procedures for single run of diesel generator on MSB) (1/E-A): We made No. 1 generator single run, 3/E-A, stop No.2 generator at engine side when exhaust temperature goes down and begin warming up TG. (3/E-A): All right (3/E-A and Oiler B line up circulation, condensate, gland steam and LO systems of TG and begin supply of gland and warming up steam, starting turning.) (1/E-A): 3/E-B, make No.1 main air compressor single run and start ejector pump and prepare for starting FWG (3/E-B): All right (3/E-B and Oiler C line up SW system and start the ejector pump to establish the vacuum inside the FWG and stop No.2 main air compressor closing valves concerned) (3/E-B): We made No.1 main air compressor single run and started the ejector pump. (1/E-A): All right (3/E-A): We began warming up TG and we are stopping the No.2 generator as the exhaust temperature went down) (1/E-A): All right

	(3/E-A and Oiler B stop No.2 generator at engine side and make standby condition) (3/E-A): We stopped No.2 generator and made standby condition. (1/E-A): All right, we set No.2 generator to 1st standby. (1/E-B sets No.2 generator to the 1st standby on MSB) (3/E-B): The vacuum of FWG is now established, can I start FWG? (1/E-A): Start FWG (3/E-B and Oiler C open feed water valve and HTFW valves for heating, and start distilled water pump accordingly, opening distilled water supply line) (3/E-A): Warming up the turbo generator is now completed. Please let me know if I can start the turbo generator. (1/E-A): OK, start the turbo generator. (3/E-A): All right (3/E-A and Oiler B line up steam and exhaust/drain lines open steam inlet valve a little and increase the speed up to specified speed opening the valve gradually until full open.) (3/E-B): We have started FWG. (1/E-A): All right (3/E-A): We have started the turbo generator confirming a good working condition. (1/E-A): All right, we will make the turbo generator single run. (1/E-B takes procedures to make the turbo generator single run) (1/E-A): Now, we made the turbo generator single run. Stop No.1 generator at the engine side when exhaust temperature goes down) (3/E-A): All right, we will soon stop No.1 generator as the temperature is going down. (3/E-A and Oiler A stop No.1 generator and make standby condition) (3/E-A): We stopped No.1 generator and made standby condition (1/E-A): All right, we set No.1 generator to the second standby. (1/E-B sets No.1 generator to the second standby) (1/E-A): Now, we have completed setting up the state of passage (This is completion of procedures form In port to state of passage and the instructor stop the simulation. The trainees move to the briefing room)

Debriefing session for the first stage (60 min)

This is an intersessional debriefing, so the training should be simply reviewed from the aspects of ERM principles and the requirements and this review should be conducted in a form of Q and A as follow in order to let the trainees consider significance of teamwork.

For the teamwork of leaving a port as a part of an engineering watch,

- if allocations/arrangement of the personnel were appropriate
- if assignments/roles and responsibility of the personnel were appropriate
- if prioritization of the teamwork was appropriate
- if utilization of information, equipment and personnel was effective
- if functions of the equipment were satisfactory understood
- if information was appropriately understood, responded and shared
- if all communication patterns were clearly, effectively and timely carried out
- if assertiveness was reflected
- if leadership and situational awareness were exerted
- if there was notification of any doubt
- if there was consideration of team experience

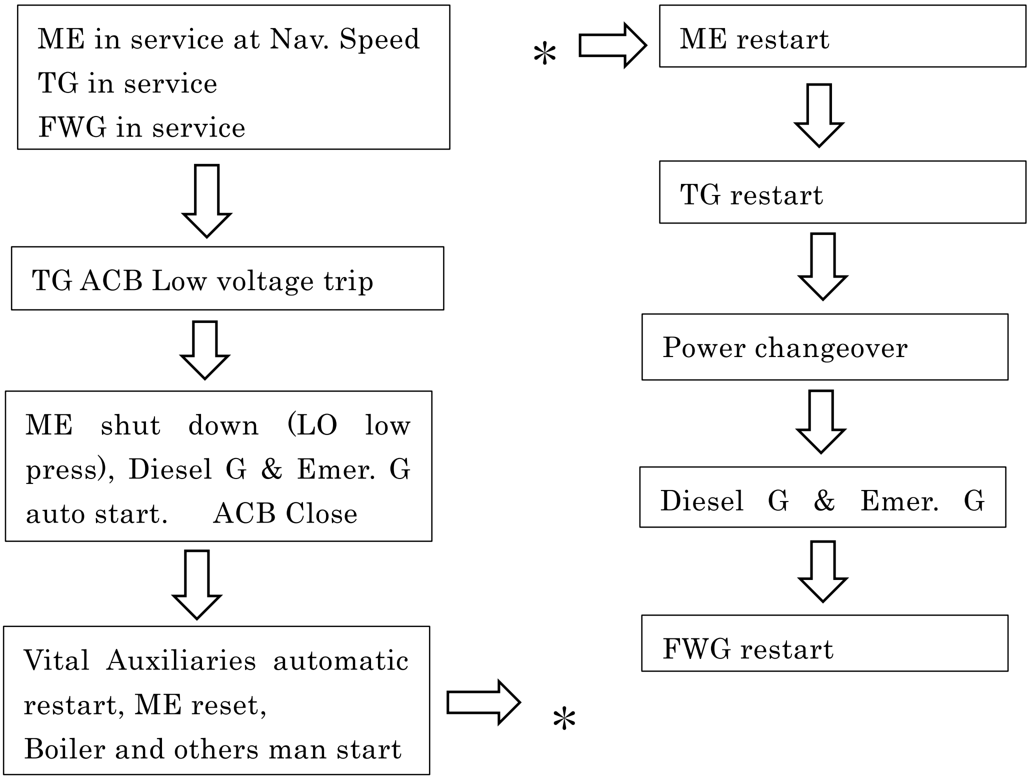
The instructor should emphasize the following taking into account the aforementioned review.

- When teamwork is necessary as parts of an engineering watch, personnel as a member of the team should understand their roles and responsibilities, and maintain effective communication in order to enhance performance of teamwork that contributes to a safe engineering watch.
- Even if there were outstanding competent persons in the team, the teamwork is not always achieve higher performance.
- All the personnel therefore should be mindful on how we can build a good teamwork. (Probably there is no correct answer, but better answer exists)
- The aforementioned review must be reflected in the next stage of ERM training.

Briefing session for the second stage (30 min):

Instructor should explain:

- The task for the team as parts of an engineering watch is recovery of blackout which means watch personnel must resume the same plant condition as before the blackout.
- Main flow of recovering blackout is as follow



- The power must be resumed as quickly as possible therefore, effective plant operation is required.
- For this purpose, a good leadership/initiative becomes more important than the first stage.
-

2nd Stage (Seagoing)

T in min	Training process
0 ~ 10	(The instructor starts simulation from Seagoing condition from the instructor room and another instructor talks up in the control room.) The trainees take up positions in the control room and engine room as assigned. The instructor announces the following, using communication equipment to let all the trainees know at the same time. - All the trainees must confirm the plant conditions in 10 minutes such as ME control position (Bridge), ME output and other major running parameters, turbo generator output, steam pressure, state of auxiliary boiler, state of diesel generator, numbers of running auxiliaries and others. - Black out will occur in five minutes after your confirmation and the team must resume the plant conditions as they were before the blackout. - The trainee assigned to 1/E-A issues instructions to any other members without the trainee assigned to C/E and the C/E must instruct 1/E-A as needed. (10 minutes later) - Now, your confirmation time was over. Blackout occurs in 5 minutes.
10 ~ 15	(The instructor gradually closes Steam inlet valve/Shut off valve of the turbo generator from the instructor room. The voltage goes down as the revolution speed of the turbo generator gradually goes down and ACB low voltage trip must be activated resulting in blackout. The blackout occurs and lightings of the control room and the engine room turn off except an emergency lighting. ME must be shut down automatically due to LO low pressure. At the same time, 1st standby diesel generator and emergency generator start and the power will resume approximately in 30 seconds. The personnel in the control room get to know the situation through the displays on the main console and MSB and must address the alarm sounds. The personnel in the engine room get to know the situation through the displays on the mimic panel and must pay attention to running conditions of the machinery.

15 ~ 25	The following is an example of communication and procedures to recover the blackout) (1/E-A): 3/E, open all drain valves on TG and confirm running conditions of No.1 diesel generator and emergency generator (1/E-B): I will reset ME. (1/E-A): OK (1/E-B makes procedures to changeover the ME control position from the bridge to the control room and sets ME maneuvering lever to "Stop" position, changing over the control mode and addressing the various alarms) (3/E-A): Opened all drain valves and confirmed a good running conditions of the generators. (1/E-A): All right, take necessary measures to FO and LO purifiers according to the situation and stop heating of FWG closing feed water valve. (3/E-B and Oiler C check the purifiers for abnormal separation and oil temperature, changing over the supply lines to the circulation line and stop heating of FWG, closing feed water valve)
25 ~ 35	(The power has resumed) (1/E-A): Confirm ME system auxiliaries restarted and begin TG turning. (2/E-A, B and Oiler A check the auxiliaries on the mimic panel) (3/E-B): We changed the supply lines of the purifiers to the circulation lines. (2/E-A): Confirmed all the auxiliaries and steering gear automatically restarted. (3/E-A): We began TG turning. (1/E-A): All right, restart other manual starting machinery. We begin preparation for restart of ME. (3/E-A, B and Oiler B, C restart Auxiliary boiler, FO and LO purifiers, ventilation fans, and others as necessary. 1/E-B makes procedures to reset ME shut down and any other failures.) (1/E-B): Now, we are ready to restart ME. (1/E-A): OK, Chief Engineer, we are starting ME. (C/E): All right, I will inform bridge of that. (C/E makes phone call to the bridge [Instructor]) (C/E): This is Chief Engineer, we restart ME soon. (Bridge [Instructor]): All right, Thank you for that.
35 ~ 45	(1/E-A): We are starting ME. (1/E-B sets ME maneuvering lever to "Slow ahead", pressing "Slow ahead" of the engine telegraph. 1/E-B increases the revolution speed of ME

	in the same manner until "Full ahead". Finally, 1/E-B sets the maneuvering lever to "Full way") (1/E-A): Begin preparation for restarting TG and FWG. (3/E-A and Oiler B establish vacuum of the condenser and condensate system as necessary. 3/E-B and Oiler C restart the ejector pump and begin supply of feed water) (3/E-A): We are ready for restarting TG. (3/E-b): We are ready for restarting FWG.
45 ~ 55	(1/E-A): All right, Increase of ME revolution is about completed. Start FWG (3/E-B and Oiler C restart FWG beginning heating and supply of feed water, and starting Dist. water pump.) (3/E-B): We restarted FWG. (1/E-A): All right, restart TG. (3/E-A): All right (3/E-A and Oiler B restart TG as follow: - Stop TG turning motor and disengage the turning gear - Establish the steam line opening drain valves - Open steam Inlet valve/Emergency shut off valve slightly and make it full open closing all drain valves) (3/E-A): We restarted TG. (1/E-A): All right. We confirmed the voltage established. We change over the diesel generators to TG. (1/E-B makes procedures to change over the diesel generator to TG on MSB)
55 ~ 60	(1/E-A): Now, TG is in service and No.1 diesel generator and emergency generator were disconnected. Stop No.1 diesel generator and emergency generator at the engine side. Furthermore, stop Auxiliary boiler. (3/E-A): All right (3/E-A and Oiler B stop No.1 diesel generator, emergency generator and the auxiliary boiler) (3/E-A): We stopped No.1 diesel generator and emergency generator making standby conditions and stopped auxiliary boiler. (1/E-A): All right, Now, we have completed recovery of the blackout. We return the control position of ME to the bridge. (1/E-B sets No.1 diesel generator to 1st standby and makes procedures to return the control position to the bridge) (This is end of the 2nd stage and all the trainees move to the briefing room)

Debriefing session for the second stage (90 min)

The process of recovering blackout should be reviewed first from the aspects of ERM principles and the requirements concerned as follow.
For the teamwork of recovering blackout as a part of an engineering watch,

- If allocations/arrangement of the personnel were appropriate
  If not, what was wrong?
- If assignments/roles and responsibility of the personnel were appropriate
  If not, what should be corrected?
- If prioritization of the teamwork was appropriate
  If not, what was wrong?
- If utilization of information, equipment and personnel was effective
  If not, how was it done?
- If functions of the equipment were satisfactory understood
- If information was appropriately understood, responded and shared
- If all communication patterns were clearly, effectively and timely carried out
- If assertiveness was reflected
- If leadership and situational awareness were exerted
  If not, how should it be done?
- If there was notification of any doubt
- If there was consideration of team experience

In light of the results of aforementioned analysis, the instructor should let the trainees discuss the significance of ERM as follow; (The instructor may cover some of the following according to the results of the analysis)

- What resources do we have generally in machinery space?
- What features does the each resource have?
- What makes it difficult to manage a human resource?
- How can ERM principles be applied to plant operation/engineering watch?
- How can ERM requirements as human elements be applied to plant operation/engineering watch?
  (Leadership, Situational awareness, Communication, Assertiveness)
- What differences do exist between small-group of two or three persons and group of ten persons in practicing ERM?
- Which should operation instructions be issued in terms of practicing ERM, taking into account differences among them?
  - Press start bottom of No1. HTFW pump
  - Start No. 1 HTFW pump
  - Establish HTFW system
- What is expected as a leader in practicing ERM?
- What is expected as engineering watch personnel?

- What relations do exist between building of a good teamwork and practice of ERM?
- What is the most important element in practicing ERM to maintain a safe engineering watch?

The instructor should conclude the debriefing saying that the idea of ERM or ERM requirements should be applied to all the duties on board ships although we have discusses ERM from the aspect of an engineering watch.

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III-4

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Engine room Resource Management (ERM)
Date of Training	

Trainee's Name & Final Disposition

T1		A B C	T6		A B C
T2		A B C	T7		A B C
T3		A B C	T8		A B C
T4		A B C	T9		A B C
T5		A B C	T10		A B C

Item	T	Mark
1. Understanding of roles and responsibilities in operating plant machinery as a part of an engineering watch (If performance/operation made by the trainee was satisfactory depending on their positions assigned and based on the correct knowledge on plant machinery)	T1	A B C D
	T2	A B C D
	T3	A B C D
	T4	A B C D
	T5	A B C D
	T6	A B C D
	T7	A B C D
	T8	A B C D
	T9	A B C D
	T10	A B C D
2. Instruction, report, answerback and other communication patterns (If all communication patterns were clearly recognized and oral communication were clear, effective and timely depending on their positions assigned)	T1	A B C D
	T2	A B C D
	T3	A B C D
	T4	A B C D
	T5	A B C D
	T6	A B C D
	T7	A B C D
	T8	A B C D
	T9	A B C D
	T10	A B C D
3. Leadership and assertiveness (If leadership and/or assertiveness were exerted depending on their positions assigned. Initiative in a small group may be also regarded as leadership)	T1	A B C D
	T2	A B C D
	T3	A B C D
	T4	A B C D

	T5	A	B	C	D
	T6	A	B	C	D
	T7	A	B	C	D
	T8	A	B	C	D
	T9	A	B	C	D
	T10	A	B	C	D
4. Situational awareness and notification of any doubt (If situational awareness was exerted depending on their positions assigned. If there was notification of any doubt or a similar event)	T1	A	B	C	D
	T2	A	B	C	D
	T3	A	B	C	D
	T4	A	B	C	D
	T5	A	B	C	D
	T6	A	B	C	D
	T7	A	B	C	D
	T8	A	B	C	D
	T9	A	B	C	D
	T10	A	B	C	D

5. Depictive evaluation in respect to behavior as a team member	
T1	
T2	
T3	
T4	
T5	
T6	
T7	
T8	
T9	
T10	

Signature of evaluator __________________________________

ERS III - 5

Training Title/Scenario: Basic construction and operation principles of; fluid flow and characteristics of lubricating oil, fuel oil and cooling systems for diesel propulsion plant

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems

Table A-III/1 KUP: Basic construction and operation principles of; fluid flow and characteristics of lubricating oil, fuel oil and cooling systems

Time allocation: 4 hours
Number of Trainees: 8 ~ 10
Number of Instructors: 1

Outline of the training:

The trainees draw system diagrams of FO supply, LO and CFW systems watching the mimic panel and answer to the questions in the assignment paper.

Initial Condition:

- Seagoing

Form of Training:

All the trainees draw/sketch the system diagrams designated first by hand watching the mimic panel of the simulator. After the hand drawing, the trainees write the drawing out fairly and answer to the questions in the assignment papers.

Prerequisite:

- Fundamental knowledge on diesel engine propulsion machinery systems.

Note:

The trainees need to pick out only designated system diagrams watching the mimic panel and this must be effective for the trainees to achieve the purpose of this topic.

Specific purpose of the training:

The trainees understand construction of systems and functions of machinery by drawing the system diagrams of the following and answering to the questions.

- Main engine FO supply system
- Main engine LO system
- Cooling FW system
- Cooling SW system

Briefing session for the first stage (30 min)

The instructor should explain:

- purpose of the training;
- how the purpose is achieved; and
- how to draw the diagrams as follow.
  - All systems constructing propulsion plant machinery are represented with necessary piping lines, valves, pumps and machinery on the mimic panel. The trainees must sketch/draw only designated systems which are FO supply system to the main engine, Main engine LO system, Cooling FW water system and Cooling SW system.

The instructor should emphasize that the systems are constructed with many equipment and machinery and any of them has functions and the trainee needs to understand these functions as well as fluid flow.

Implementation of the training

After briefing, the instructor gives the trainees two sets of drawing papers and assignment papers and lets the trainees enter the engine room.

T in min	Training process
0 ~ 90	(The instructor creates Seagoing condition as an initial condition and start the simulation, letting the trainees begin to work) Each trainee sketches and draws system diagrams by hand on the one of drawing paper of each system as follow. (2 ~ 3 trainees should draw the same system and change the position for drawing) - Main engine FO supply system (Refer to sample diagram Figure 1) - Main engine LO system (Refer to sample diagram Figure 2) - Cooling FW system (Refer to sample diagram Figure 3) - Cooling SW system (Refer to sample diagram Figure 4) (The trainees should complete the drawing within 90 minutes and the instructor stops the simulation. The trainees move to the briefing room)

Debriefing session (120 min)

The instructor instructs the trainees to write the diagrams out fairly first and answer to the questions in the assignment paper, giving 90 minutes.

The instructor collects the diagrams and assignment papers from the trainees.
The instructor gives the trainees feedback reviewing the diagrams and results of the assignment paper emphasizing that:

- only main components constructing the systems are represented on the mimic panel and these components are connected by piping;
- there are different size of piping to ensure reasonable fluid flows although this is not represented on the mimic panel;
- FO supply and LO systems are almost the same among main diesel engines; and
- features of the cooling FW system called Central cooling system;

The instructor lets trainees dismiss and evaluates the drawings and assignment papers.
(Report form is not necessary for this training)

ASSIGNMENT (1/4)

(The following questions are based on the sample diagrams Figure 1 ~ 4. The instructors should develop questions according to their own system diagrams of simulators)

Name		Date	
Reg. No		Scenario: Basic construction and operation principles of; fluid flow and characteristics of lubricating oil, fuel oil and cooling systems for diesel propulsion plant	
Class			

(Main Engine FO supply system)

1. Indicate flow of fuel oil from FO service tank to the main engine injection pump in your drawing using arrowheads

2. Describe functions of the dampers

3. Describe functions of the pressure regulating valve on the fuel oil return line.

4. Describe functions of return lines to the air separation chamber and FO service tank.

5. Describe functions of the air separation chamber.

6. Explain why FO viscosity control is necessary.

7. Describe functions of the pressure regulating valve on the circulation line of FO supply pump.

8. Describe functions of Emergency shut off valves fitted to FO and DO service tanks.

ASSIGNMENT (2/4)

(Main Engine LO system)

1. Indicate flow of LO from LO sump tank to the main engine in your drawing using arrowheads.
2. Describe types of the valves used for suction and discharge sides of LO pump.
3. Explain why these type of valves are used.
4. Describe how LO pressure is regulated.
5. Describe purpose of the emergency LO tank.
6. Describe how TC LO is supplied.

ASSIGNMENT (3/4)

(Cooling FW system)

1. Indicate flow of HTFW from Jacket CFW pump to the pump in your drawing using arrowheads.
2. Indicate flow of LTFW from Central CFW pump to the pump in your drawing using arrowheads.
3. Describe functions of FW Exp. Tank.
4. Explain how Fresh Water Generator works in HTFW system
5. Explain how temperature of HTFW is controlled.
6. Explain how temperature of LTFW is controlled.
7. Explain why non-return/check valves are used as discharge valves of LTFW pumps.
8. Explain why the system has four LTFW pumps.

ASSIGNMENT (4/4)

(Cooling SW system)

1. Indicate flow of Cooling SW from Low Sea Chest to the overboard valve in your drawing using arrowheads.
2. Describe meaning of Sea Chest and why we need the Sea Chest.
3. Explain why the system has three Sea Suction
4. Explain how we use these Sea Chests
5. Explain why Emergency Bilge Suction valve is connected to No. 1 CSW pump.
6. Explain why the system has three CSW pumps.

FO supply system/LO system/CFW system/CSW system	Reg. No		Name		Date	

Sample drawing paper

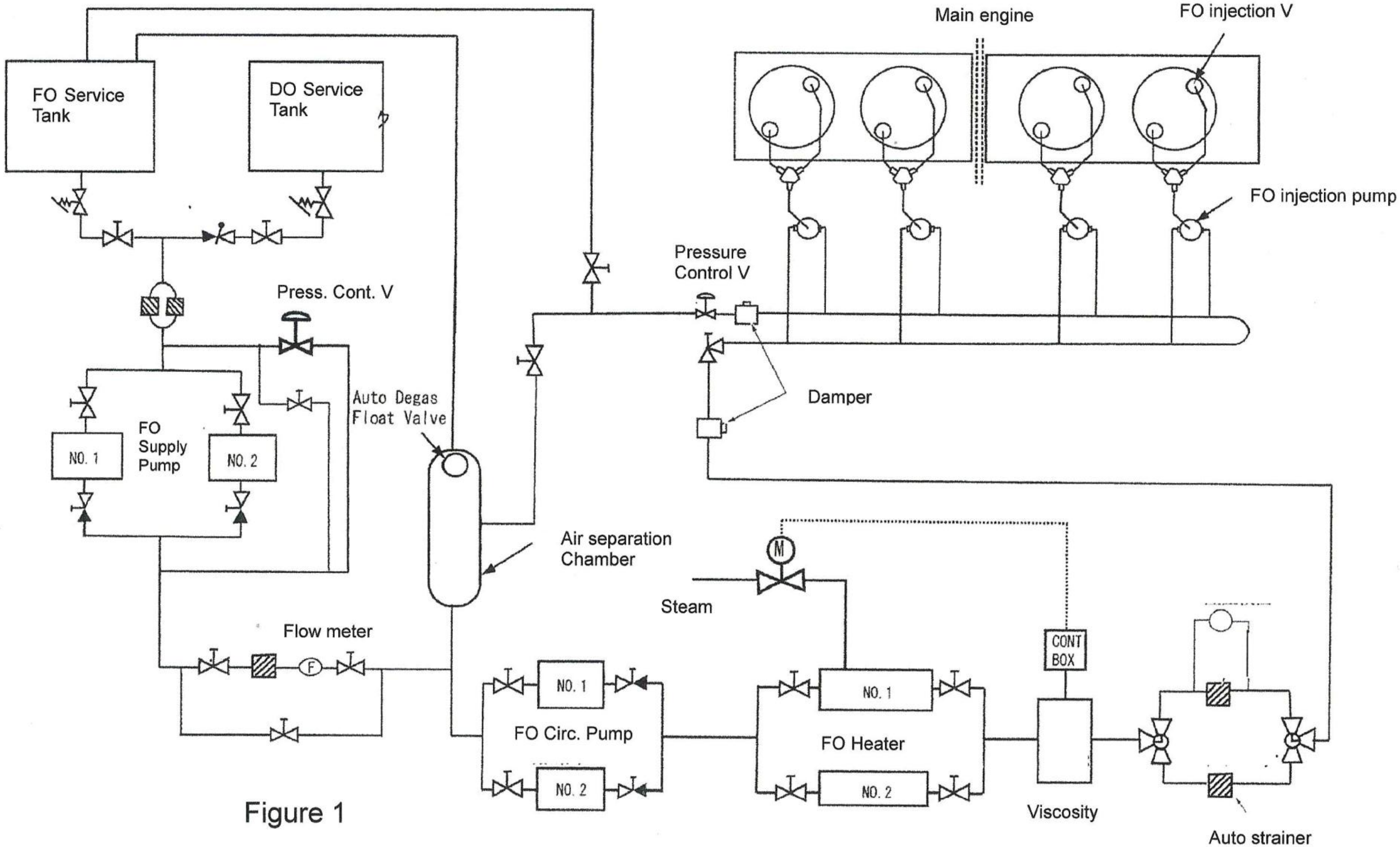

Main engine
FO injection V
FO Service Tank
DO Service Tank
FO injection pump
Pressure Control V
Press. Cont. V
Damper
Auto Degas Float Valve
FO Supply Pump
NO. 1
NO. 2
Air separation Chamber
M
Steam
Flow meter
F
CONT BOX
NO. 1
NO. 1
FO Circ. Pump
FO Heater
NO. 2
NO. 2
Viscosity
Auto strainer

Figure 1

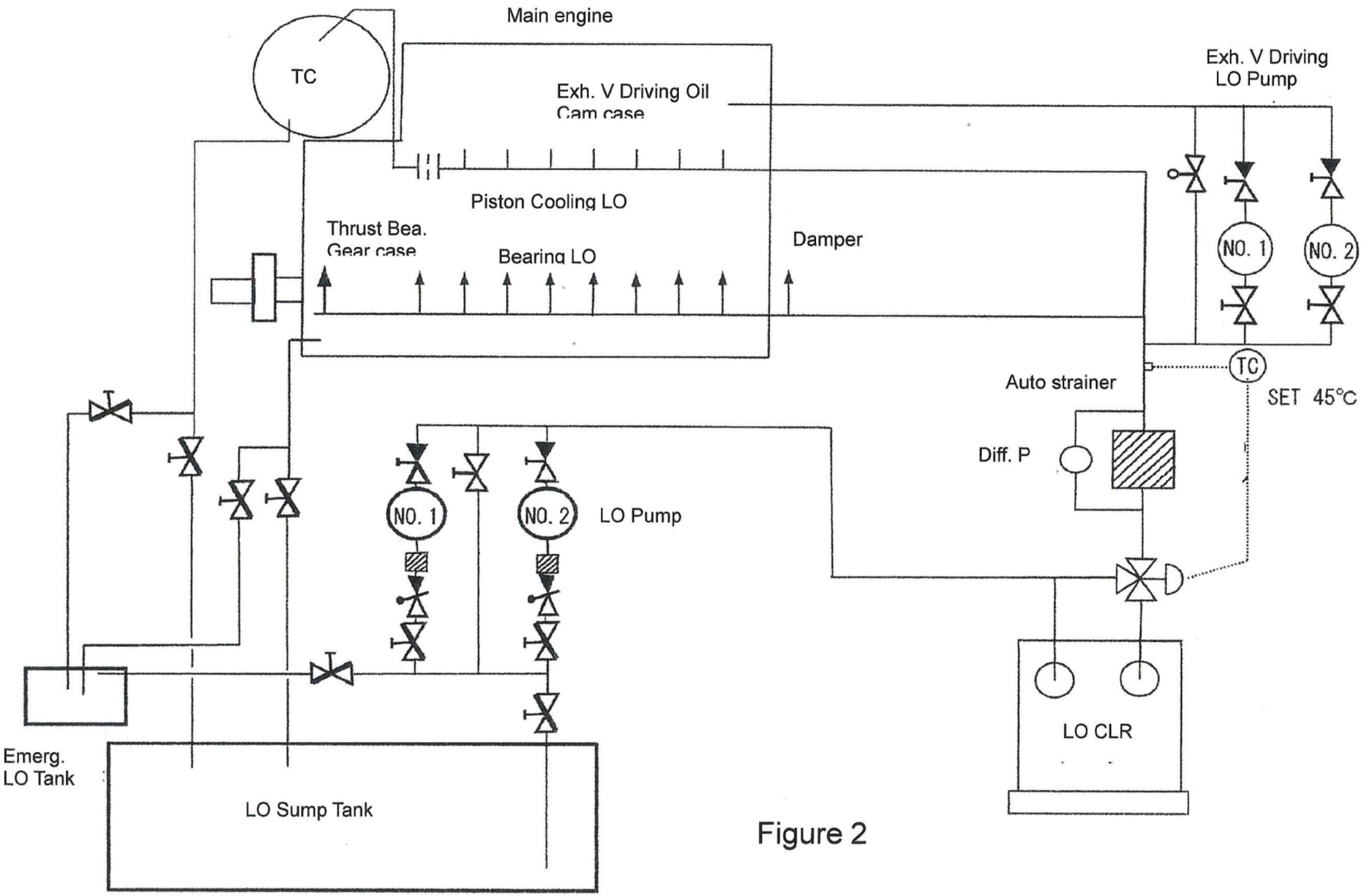

Main engine
TC
Exh. V Driving Oil
Cam case
Exh. V Driving
LO Pump
Piston Cooling LO
Thrust Bea.
Gear case
Bearing LO
Damper
NO. 1
NO. 2
TC
Auto strainer
SET 45°C
Diff. P
NO. 1
NO. 2
LO Pump
LO CLR
Emerg.
LO Tank
LO Sump Tank

Figure 2

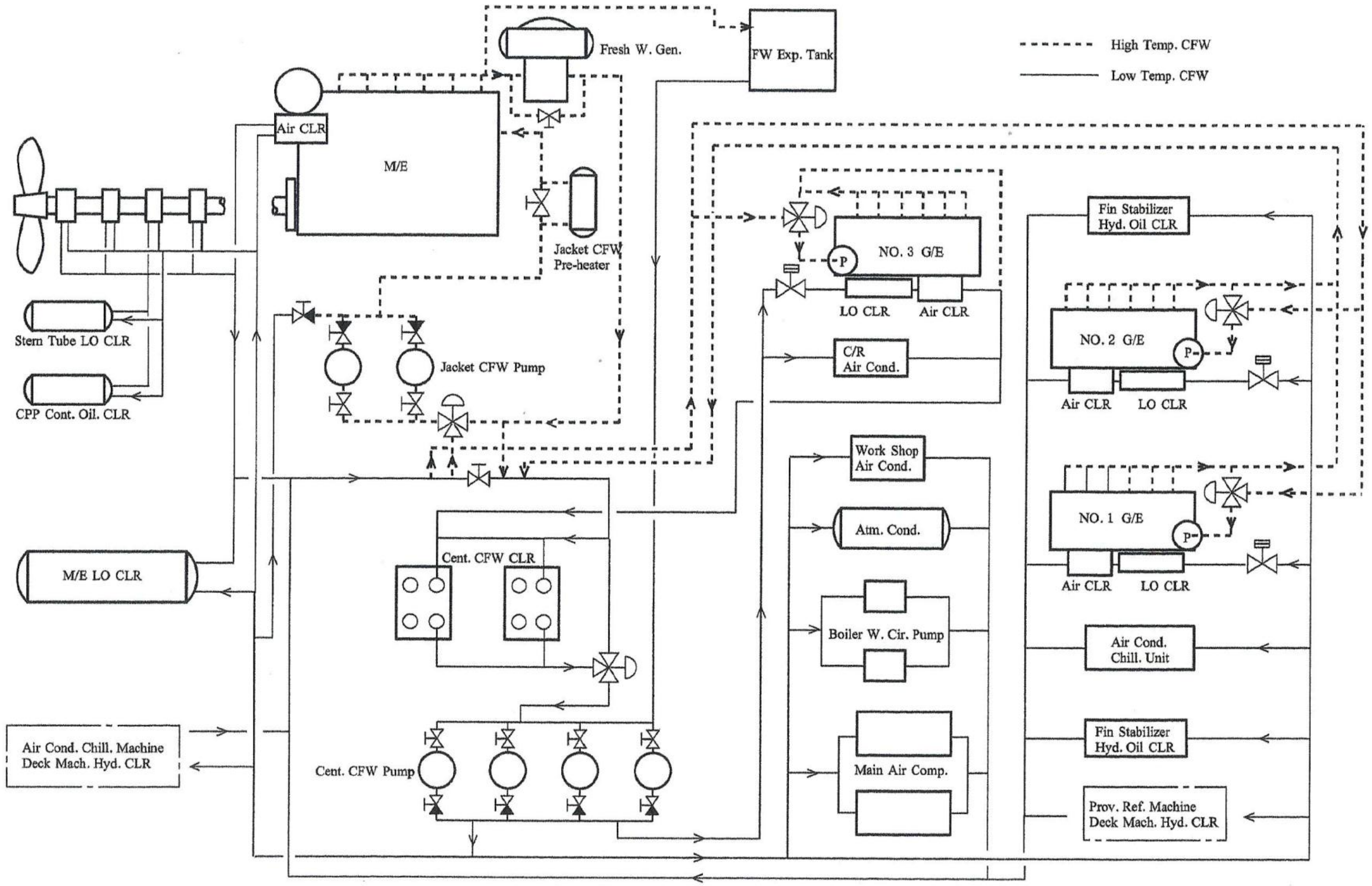

High Temp. CFW
Low Temp. CFW
Fresh W. Gen.
FW Exp. Tank
Air CLR
M/E
Jacket CFW
Pre-heater
Stern Tube LO CLR
CPP Cont. Oil. CLR
Jacket CFW Pump
M/E LO CLR
Cent. CFW CLR
Air Cond. Chill. Machine
Deck Mach. Hyd. CLR
Cent. CFW Pump
NO. 3 G/E
LO CLR
Air CLR
C/R
Air Cond.
Work Shop
Air Cond.
Atm. Cond.
Boiler W. Cir. Pump
Main Air Comp.
Fin Stabilizer
Hyd. Oil CLR
NO. 2 G/E
Air CLR
LO CLR
NO. 1 G/E
Air CLR
LO CLR
Air Cond.
Chill. Unit
Fin Stabilizer
Hyd. Oil CLR
Prov. Ref. Machine
Deck Mach. Hyd. CLR

Figure 3

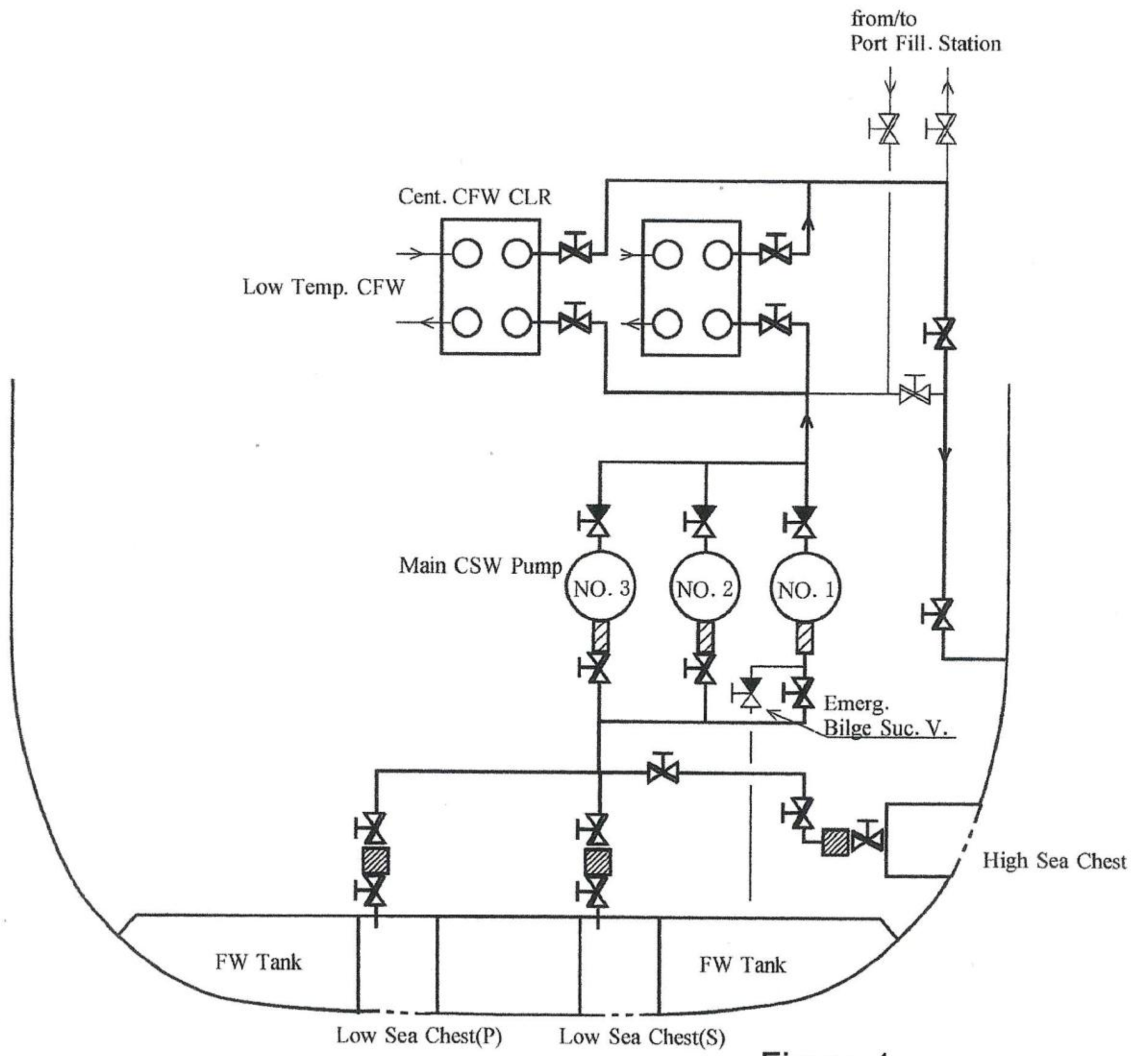

from/to
Port Fill. Station
Cent. CFW CLR
Low Temp. CFW
Main CSW Pump
NO. 3
NO. 2
NO. 1
Emerg.
Bilge Suc. V.
High Sea Chest
FW Tank
FW Tank
Low Sea Chest(P)
Low Sea Chest(S)

Figure 4

ERS III – 6

Training Title/Scenario: Operation of plant machinery

Table A-III/1 Competence: Operate main and auxiliary machinery and associated control systems

Table A-III/1 KUP: Preparation, operation, fault detection and necessary measures to prevent damage for the following machinery items and control systems
.1 main engine and associated auxiliaries
.2 steam boiler and associated auxiliaries and steam systems
.3 auxiliary prime movers and associated systems
.4 other auxiliaries including refrigeration, air conditioning and ventilation systems

Time allocation: 4 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

The trainees perform the following operations in the engine room;

- Start and stop emergency generator
- Start, stop and change over CSW pumps and LTFW pumps
- Start, stop and change over main air compressors
- Start and stop control air compressor
- Start, stop and change over diesel generators
- Fire up auxiliary boiler and raise steam pressure including lining up steam system
- Start, stop and change over oil purifiers
- Warming up, start, operate and stop main engine
- Start and stop FWG
- Warming up, start and stop Turbo generator

Initial Condition:

- Cold ship (FW, FO and LO are loaded, No machinery is in service, All valves are principally closed)
- In port

Form of Training:

4 ~ 5 trainees establish a group and the group perform the operations of the machinery one by one. The trainees may refer to a procedure manual prepared by instructors.

Prerequisite:

- Understanding of principles of warming up main engine (middle and large sized diesel engine)
- Understanding of functions of emergency generator, CSW pump, LTFW pump, main air compressor, diesel generator, auxiliary boiler, oil purifier, FWG and turbo generator

Note:

The trainees perform the operations as a group (team) although no trainee is assigned to a leader. All operations should be principally carried out in manual. This training is not for plant operation but for operation of each machinery, therefore same procedures may be sometimes repeated.

Specific purpose of the training:

Through manual operations of machinery, the trainees acquire knowledge on preparations and procedures for starting, operating and stopping machinery and their procedural theories.

Briefing session (30 min)

Instructor should explain:
- outline of the training
- how to carry on the training
- purposes of starting each machinery and establishing systems
- procedures for starting, operating and stopping each machinery and their procedural theories applied to the machinery
- significance to keep correct sequence of the procedures to prevent damage
- needs to check running condition in terms of sounds, vibration, heat and leakage when we started machinery although this cannot be done on the simulator

mplementation of the training

After briefing, instructors let the trainees enter the engine room and start the training as follow. (The following says main procedures to perform operations to start, operate and stop machinery. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage (Cold Ship)

T in min	Training process
0 ~ 10	(The instructor creates cold ship as an initial condition and starts the simulation) **Start and stop emergency generator (10 min)** Make procedures to start the emergency generator. Confirm running parameters and voltage established. Connect the generator to BUS line on MSB. Disconnect the generator from BUS line on MSB. Stop the generator. (The trainees should repeat the same procedure one more time and keep connection to BUS line at the third start)
10 ~ 25	**Start, stop and change over CSW pumps and LTFW pumps (15 min)** Perform operation to purge air in CSW pumps suction side. Start No. 1 CSW pump confirming pressure and open minimum number of valves on CSW line to ensure minimum circulation (minimum flow overboard) including temperature/pressure control valve. Perform operation to change over No. 1 CSW to No.2 CSW pump in a correct manner. Perform operation to change over No. 2 CSW to No.3 CSW pump if any Set No. 1 CSW pump as a running pump and No. 2 and 3 to auto standby. Open valves on No. 1 LTFW pump suction line and start No. 1 LTFW pump Open delivery valve of No. 1 LTFW confirming pressure. Perform operation to change over No. 1 LTFW pump to No. 2 in a correct manner. Perform operation to change over No. 2 LTFW pump to No.3 if any. Set No. 1 LTFW pump as a running pump and No. 2 and 3 to auto standby.
25 ~ 35	**Start, stop and change over main air compressors (10 min)** Open valves on LTFW line to No. 1 and 2 main air compressors (coolers) Open valves on compressed air line to No. 1 main air reservoir from No. 1

	compressor. Perform operation to start No. 1 main air compressors and supply No. 1 main air reservoir with compressed air confirming pressure and discharging drain manually. Perform operation to start No. 2 main air compressor and supply No. 1 main air reservoir with compressed air in parallel. After filling up No. 1 main air reservoir, stop No. 1 and 2 main air compressors and close supply valve to No. 1 main air reservoir. Open supply valve to No. 2 main air reservoir and start 2 main air compressors to fill up No. 2 main air reservoir. Set No. 2 main air compressor to auto. Shut down No. 1 main air compressor closing valves concerned in air and LTFW.
35 ~ 40	**Start and stop control air compressor (5 min)** Perform same operation as main air compressor and fill up control air reservoir with compressed air. Finally, set control air compressor to auto.
40 ~ 60	**Start, stop and change over diesel generators (20 min)** Open No. 1 main air reservoir outlet valve. Check No. 1 diesel generator for CFW, LO and DO/FO. Perform operation to start No. 1 diesel generator opening valves concerned in CFW, LO and DO/FO. Start No. 1 diesel generator and confirm running parameters. Connect No. 1 diesel generator to Bus line confirming voltage and frequency on MSB. Restart No. 1 CSW pump and No. 1 LTFW pump, and stop the emergency generator if necessary. Check No. 2 diesel generator for CFW. LO and DO/FO. Perform operation to start No. 2 diesel generator opening valves concerned in CFW, LO and DO/FO. Start No. 2 diesel generator and confirm running parameters. Make manually parallel running of No. 1 and 2 diesel generators on MSB. Make manually single running of No. 2 diesel generator ON MSB. Stop No. 1 diesel generator.
60 ~ 90	**Fire up auxiliary boiler and raise steam pressure including lining up steam system (30 min)** Check water level of the boiler and feedwater/cascade tank for level. Confirm the steam root valve closed and air vent valve opened.

	Open valves concerned in DO supply line and start DO circulation. Opened valves concerned in boiler water circulation line and start No. 1 boiler water circulation pump. Set No. 2 boiler water circulation pump to auto standby. Perform operation for manually lighting off the burner. About 1 minute later, perform operation for extinguishing the flame. About 1 minute later, perform operation for manually lighting off the burner. Repeat the same procedures one more time. (The instructor makes the simulation faster at this stage in order to facilitate the training saying that the simulation runs faster although we must raise the steam pressure according to the specific standard for the boiler, so that the steam pressure will reach to the desired value in a short time.) When the steam pressure reaches to 0.05 ~ 0.1 Mpa/0.5 ~ 1 bar, close air vent valve. Again, perform lighting off the burner accordingly. Line up the feedwater line and start No. 1 feed water pump. Supply feedwater control system with control air if necessary. Set No. 2 feedwater pump to auto standby. Stop No. 1 boiler water circulation pump and close valves concerned. When the steam pressure reaches to 0.4 Mpa/4 bar, open steam supply valves on steam line, Start heating FO service tank, FO settling tanks and FO bunker tanks. When the temperature of FO service tank reaches to the setting valve, change fuel oil of the boiler from DO to FO and turn on FO heater. Set the boiler to auto. (This is end of the 1st stage. The instructor creates in port condition for the 2nd stage. The instructor may give the trainees break time.)

2nd stage (In Port)

T in min	Training process
0 ~ 15	**Start, stop and change over oil purifiers (15 min)** Check No. 1 FO purifier for operating water tank level and LO level. Open valves concerned in FO and the operating water and start No. 1 FO purifier. Supply FO heater with heating steam. When No. 1 FO purifier reaches to operational revolution speed, perform operation to supply it with FO and confirm running parameters. About 3 minutes later, begin to perform operation to change over No. 1 FO purifier to No. 2 FO purifier. After changing over to No. 2 FO purifier, confirm running parameters. Set No. 2 FO purifier to automatic operation. Perform operation to stop No. 1 FO purifier. Check No. 1 LO purifier for operating water level and LO level. Open valves concerned in LO and the operating water and start No. 1 LO purifier. Supply LO heater with heating steam. When No. 1 LO purifier reaches to operational revolution speed, perform operation to supply it with LO.
15 ~ 45	**Warming up, start, operate and stop main engine (30 min)** Check the main engine for LO level, CFW expansion tank level and others. Line up HTFW line using FW Heater. Open No. 1 HTFW pump suction valve and start the pump. Set No. 2 HTFW pump to auto standby. Open No. 1 HTFW pump delivery valve and confirm the pressure and temperature. Begin worming up the main engine supplying FW Heater with heating steam. Set setting value of temperature controller to 80℃. Line up LTFW line for coolers concerning the main engine. Line up LO line for the main engine, Turbo charger and Stern tube. Start each No. 1 LO pump and set each No. 2 LO pumps to auto standby. Line up DO supply line. Open suction and delivery valves of FO supply and FO booster pumps. Start No. 1 FO supply pump and Booster pump confirming pressure and set No. 2 pumps to auto standby. Check HTFW temperature if it is above 60℃. Confirm all indicator valves opened and engage turning gear.

	Begin turning of the main engine by turning motor and check current vale. Several minutes later, stop turning and disengage turning gear. If HTFW temperature reaches to 80℃, stop supply of heating steam to FW Heater and open bypass valve closing inlet and outlet valves. Make parallel running of main air compressors. Drain No. 1 and 2 main air reservoir. Line up starting air line opening outlet valve of No. 1 main air reservoir. Carry out air running of the main engine. Close all indicator valves. (Maneuvering the main engine) Perform manually starting and stopping operation of the main engine several times within harbor speeds. Finally, set the engine speed to harbor full. After a while, increase manually the engine revolution until navigation speed.
45 ~ 60	**Start and stop FWG (15 min)** Line up ejector line and start ejector pump to establish vacuum inside the FWG. Line up CSW line to the FWG. Supply the FWG with feedwater When the vacuum reaches to 700 mmHg, supply Heater of the FWG with HTFW little by little. When level of distilled water appears in the level gauge, start distilled water pump opening supply line to filling tank. Confirm running parameters and check opening of the HTFW temperature control valve. Several minutes later, begin to perform stopping operation. Stop gradually supply of HTFW to Heater of FWG to avoid rapid change in temperature of HTFW Stop distilled water pump and close valves concerned. Stop supply of feedwater to Heater. Stop supply of CSW to Condenser. Stop the ejector pump and close valves concerned. Slightly open vacuum breaker.

60 ~ 90	**Warming up, start and stop Turbo generator (30 min)** Establish steam condenser system. Establish Turbo generator (TG) LO system. Establish TG steam system. Supply TG with sealing steam by opening TG sealing steam supply valve. (It doubles as warming up turbine rotor and casing) Start No. 1 condenser vacuum pump and set No. 2 to auto. Start No. 1 condensate pump and set No.2 pump to auto. Carry out turning of TG by turning gear for several minutes. Stop turning of TG. Rest trip if any. Start TG by slowly opening Emergency stop valve. Let TG run about 2 minutes at low speed (approx.. 1,000 min^{-1}) Increase revolution speed slowly until operational revolution speed. Open TG Emergency stop valve to 100%. Connect manually TG to BUS line on MSB. Disconnect No. 1 diesel generator from Bus line manually. Stop No. 1 diesel generator manually. Set No. 1 diesel generator to auto. Several minutes later, begin to perform stopping operation of TG. Finally set diesel generators to the condition as they were. (This is end of the 2nd stage and the instructor stop the simulation. The trainees move to the briefing room.)

Debriefing session (30 min)

The instructor iterates specific purposes of this training and importance of checking machinery in terms of running sound, vibration, heat generation and leakage which cannot be detected on the mimic panel. The instructor also should emphasize the significance of correct sequence of starting and stopping machinery to avoid damage.

The instructor should brief on:
- results of performance as a while
- theoretical aspects for sequence of starting and stopping machinery
- mistaken occurred
- needs to perform operations in a correct and reliable manner

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 6

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Operation of plant machinery
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark			
1. Emergency generator, CSW pump, LTFW pump, Air compressor, Purifier, FWG (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
2. Auxiliary boiler (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
3. Main engine (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
4. Turbo generator (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
5. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D

Signature of evaluator ______________________________

ERS III – 7

Training Title/Scenario: Routine pumping operations

Table A-III/1 Competence: Operate fuel, lubrication, ballast and other pumping systems and associated control systems

Table A-III/1 KUP: Operation of pumping systems;
.1 routine pumping operations
.2 operation of bilge, ballast and cargo pumping systems
Oily water separators (or similar equipment) requirements and operation

Time allocation: 2 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

The trainees perform the following pumping operation in the engine room as routine pumping operations;

- Transfer bunker oil to FO settling tanks
- Transfer bilge, sludge, drain and separated oil
- Send sea water for general use
- Oily water separator operation

Initial Condition:

- In port
- Seagoing

Form of Training:

4 ~ 5 trainees establish a group and the group perform the operations one by one. The trainees may refer to a procedure manual prepared by instructors.

Prerequisite:

- Understanding of meaning of pumping operations
- Understanding of the regulations concerning bilge discharge

Note:

The trainees perform the operations as a group (team) although no trainee is assigned to a leader. All operations should be principally carried out in manual. This training is not for plant operation but for pumping operations, therefore same procedures may be sometimes repeated.

Specific purpose of the training:

Through manual pumping operations, the trainees acquire knowledge on preparations and procedures for starting, operating and stopping pumping systems and their procedural theories.

Briefing session for the first stage (30 min)

Instructor should explain:

- outline and specific purpose of the training
- how to carry on the training
- procedures for starting and stopping pumps and their procedural theories applied to the systems
- precautions to be observed when transferring fuel oil
- significance to keep correct sequence of the procedures to prevent damage
- needs to check running condition in terms of sounds, vibration, heat and leakage when we started machinery although this cannot be done on the simulator

Implementation of the training

After briefing, the instructor lets the trainees enter the engine room and start the training as follow. (The following says examples of tasks to be performed and they should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage (In Port)

T in min	Training process
0 ~ 60	(The instructor creates In port condition as an initial condition with 50 ~ 70 % loaded bunker oil and starts the simulation) **Transferring bunker oil** Transfer 5 m^3 of FO from No. 2 FO tank (P) to No. 1 FO settling tank using No. 1 FO transfer pump. Transfer FO from No. 2 FO tank (S) to No. 2 FO settling tank until 90 % in level using No. 2 FO transfer pump. Transfer FO form No. 7 FO tank (C) to No. 1 FO settling tank using No. 1 FO transfer pump. Transfer 20 m^3 of FO form No. 2 FO tank (P) to No. 2 FO tank (S) using No.1 and 2 transfer pump. Transfer 0.1 m^3 of FO drain from FO drain tank to No. 1 FO settling tank using No. 1 FO transfer pump. **Transferring bilge, sludge and others** Transfer bilge from engine room bilge well (P) to bilge tank using Oily water separator bilge pump. Transfer bilge from cargo hold to bilge tank using Oily water separator bilge pump. Transfer sludge form sludge tank to waste oil tank using Waste oil transfer pump. Transfer separated oil form the tank to waste oil tank using Waste oil transfer pump. Transfer drain from drain tanks to bilge tank using Oily water separator bilge pump. **Supply sea water for general use** Start Fire/General service pump and supply sea water to fire main adjusting pressure by opening overboard valve. (After that, the instructor creates Seagoing condition for discharging bilge overboard) **Oily water separator operation** Turn on oil content monitor. Line up bilge overboard discharge line. Open sea water suction and delivery valves of Oily water separator bilge pump system.

	Start Oily water separator bilge pump and fill up the line and separator with sea water. Change over the suction valve of the pump to bilge from bilge tank and discharge 0.5 m^3 of bilge. Change over the suction valve of the pump to bilge from engine room bilge well until almost empty. Change over the suction valve of the pump to sea water to replace bilge inside the system with sea water. Stop the pump and close valves concerned. (This is end of the training. The instructor stops the simulator and lets the trainees move to the briefing room)

Debriefing session (30 min)

The instructor should brief on:

- meaning of routine pumping operations
- precautions for transferring heavy fuel oil
- needs to pay due attention to level of FO tanks
- purpose of bilge system and functions of tanks
- differences between common bilge, direct bilge and emergency bilge
- precaution for transferring bilge
- features of pumps used for bilge systems

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 7

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Routine pumping operations
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark			
1. Transferring FO (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
2. Transferring bilge (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
3. Supply sea water for general use (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
4. Discharging bilge overboard (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D
5. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A	B	C	D
	T 2	A	B	C	D
	T 3	A	B	C	D
	T 4	A	B	C	D
	T 5	A	B	C	D

Signature of evaluator ____________________________

ERS III – 8

Training Title/Scenario: Diesel generator operation

Table A-III/1 Competence: Operate electrical, electronic and control systems

Table A-III/1 KUP: Basic configuration and operation principles of the following electrical, electronic and control equipment;
.1 electrical equipment
.b preparing, starting, paralleling and changing over generators

Time allocation: 2.5 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 1

Outline of the training:

The trainees perform the following operations on MSB;
- Starting and stopping remotely diesel generators
- Making parallel running of diesel generators automatically and manually
- Making single running of diesel generator automatically and manually
- Selecting priority of standby generators
- Setting optimum load sharing/number of generators

Initial Condition:

In port

Form of Training:

4 ~ 5 trainees stand in front of MSB and one trainee performs the operation in turn. Other trainees observe his/her performance. The instructor instructs the trainee tasks to be done one by one.

Prerequisite:

- Knowledge on functions and arrangements of MSB
- Understanding of conditions for parallel running of generators

Note:

This operations should be performed by an individual trainee and the trainee should come to be well-versed in making parallel and single running of diesel generators.

Specific purpose of the training:

Through operations on MSB, the trainees acquire knowledge and skills on putting diesel generators into service, making parallel running and single running of the generators.

Briefing session for the first stage (20 min)

Instructor should explain:

- outline of the training
- how to carry on the training
- functions and arrangements of MSB
- conditions to put a generator into service and to make parallel running of the generators
- automations incorporated in the MSB for controlling generators
- precautions to be observed when handling MSB

Implementation of the training

After briefing, the instructor lets the trainees enter the control room and start the training as follow. (The following says main procedures to perform operations. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

T in min	Training process
0 ~ 20 /trainee	(The instructor creates In port as an initial condition that No. 1 diesel generator is in service and lets one trainee stand in front of MSB. The other trainees observe his/her performance from behind keeping a reasonable distance.) The trainee performs operations on MSB in turn following the instructions below. **Instruction 1** Start No. 2 diesel generator remotely and make manually parallel running of No. 1 and 2 diesel generators. **Instruction 2**

	Make manually single running of No. 2 diesel generator and set No. 1 diesel generator to second standby/priority condition, stopping it remotely. **Instruction 3** Start No. 3 generator remotely and make automatically parallel running of No.2 and 3 diesel generators. **Instruction 4** Automatically stop No. 2 diesel generator making single running of No. 3 diesel generator and setting No. 2 diesel generator to second standby/priority condition **Instruction 5** Make full automatically single running of No. 1 diesel generator and set first standby/priority for No. 2 diesel generator and second standby/priority for No. 3 diesel generator. (This is end of the first performance and the instructor lets the trainee change off to the next trainee. The training is kept up in the same manner until all the trainees complete performance however, operation patterns/combination may be changed by instructor's discretion)

Debriefing session (30 min)

The instructor should summarize the training as a whole saying his/her expression and iterates what is necessary to make parallel running of generators.

The instructor should brief on:
- mistaken or misunderstanding if any during the performance
- why parallel running is necessary
- when parallel running is used
- automations applied to generator control
- outline on how the automations are carried out
- functions incorporated in MSB relevant to automatic control of generators such as preference trip, large motor start blocking and others

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 8

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Diesel generator operation
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Starting and stopping diesel generators (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Making parallel running and single running (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ________________________________

ERS III – 9

Training Title/Scenario: Propulsive characteristics of diesel engines

Table A-III/1 Competence: Plan and schedule operations

Table A-III/1 KUP: Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption

Time allocation: 3.5 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 1

Outline of the training:

This is an experimental training/study and the trainees develop a graph indicating engine speed, engine output and fuel oil consumption by determining each value.
The trainees consider results of the experiment and understand correlation between engine speed, engine output and fuel consumption.

Initial Condition:

Main engine standby condition

Form of Training:

4 ~ 5 trainees establish a group and the group perform the experimental study by developing the graph indicating engine speed/ship's speed, engine output and fuel consumption that are determined and/or calculated from results of measuring running parameters.

Prerequisite:

Theoretical knowledge on correlation between engine output, engine speed and fuel consumption.

Note:

The trainees perform the experimental study as a group (team) although no trainee is assigned to a leader. The trainees should develop the graph as the group sharing results of measurements and calculation. The instructor needs to prepare measurement tables. With regard to engine output, the instructor also should let the trainees calculate the output from indicator diagrams giving them necessary constant values.

Specific purpose of the training:

The trainees understand correlation between engine speed/ship's speed, engine output, fuel oil consumption and other relevant running factors. The trainee come to be able to predict engine output and fuel consumption against engine speed/ship's speed.

Briefing session (30 min)

Instructor should explain showing measurement tables:
- outline of the training/experiment (herein after "experiment")
- how to carry on the experiment
- specific purposes/goal of the experiment
- how to draw the graph obtaining necessary values

Implementation of the training

After briefing, instructors let the trainees enter the control room and start the experiment as follow.

T in min	Training process
0 ~ 90	(The instructor creates Standby condition as an initial condition and starts the simulation at calm sea condition. The instructor may make simulation speed faster than usual in order to facilitate the experiment accordingly) The trainees set main engine revolution speed to "Half ahead" and take readings following the tables 2 ~ 3 minutes later. 10 minutes later, the trainees take readings again at "Half ahead". After taking readings, the trainee increase maneuvering lever to "Full ahead" and take readings 2 ~ 3 minutes later. 10 minutes later, the trainee take readings at "Full ahead". After taking readings, the trainee increase manually engine speed by 10 min^{-1} or so. And take readings 5 ~ 6 minutes later. (Print out indicator diagrams of No. 1 ~ 5 cylinders only for this revolution speed to calculate engine output) The trainees continue to take readings until navigation speed in the same manner and complete reading records of measurement. (The instructor stop the simulation and lets the trainee move to the briefing room for developing the graph.)

Debriefing session (90 min)

The instructor gives the trainees 60 minutes to calculate engine outputs and draw the graph. (All the trainees must submit the measurement table, the graph and the result of calculating shaft output)

The trainees also compare the data of shaft output taken with calculated shaft output using "$\text{Shaft output} \propto N^3$" (N: Revolution speed)

The instructor lets the trainees discusses the graph developed by the trainees and explains propeller curve as a common brief on correlations between engine speed, engine output and fuel consumption comparing to the results of calculations.

Furthermore, the instructor refers to correlation of fuel consumption between different speeds for the same distance and meaning of constant torque lines.

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

Evaluation should be done by their products.

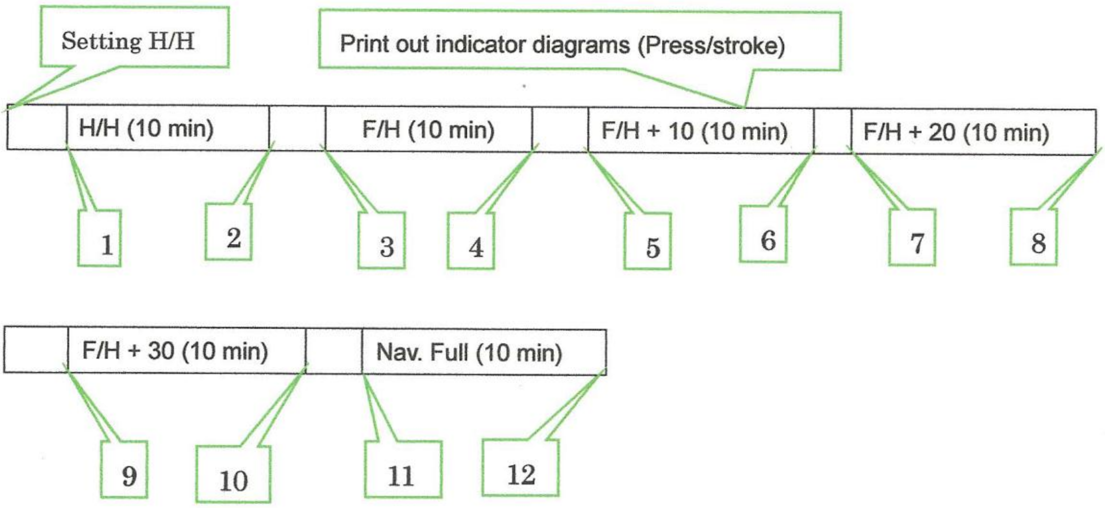
Measurement Table

Date:

Ship's Particular:

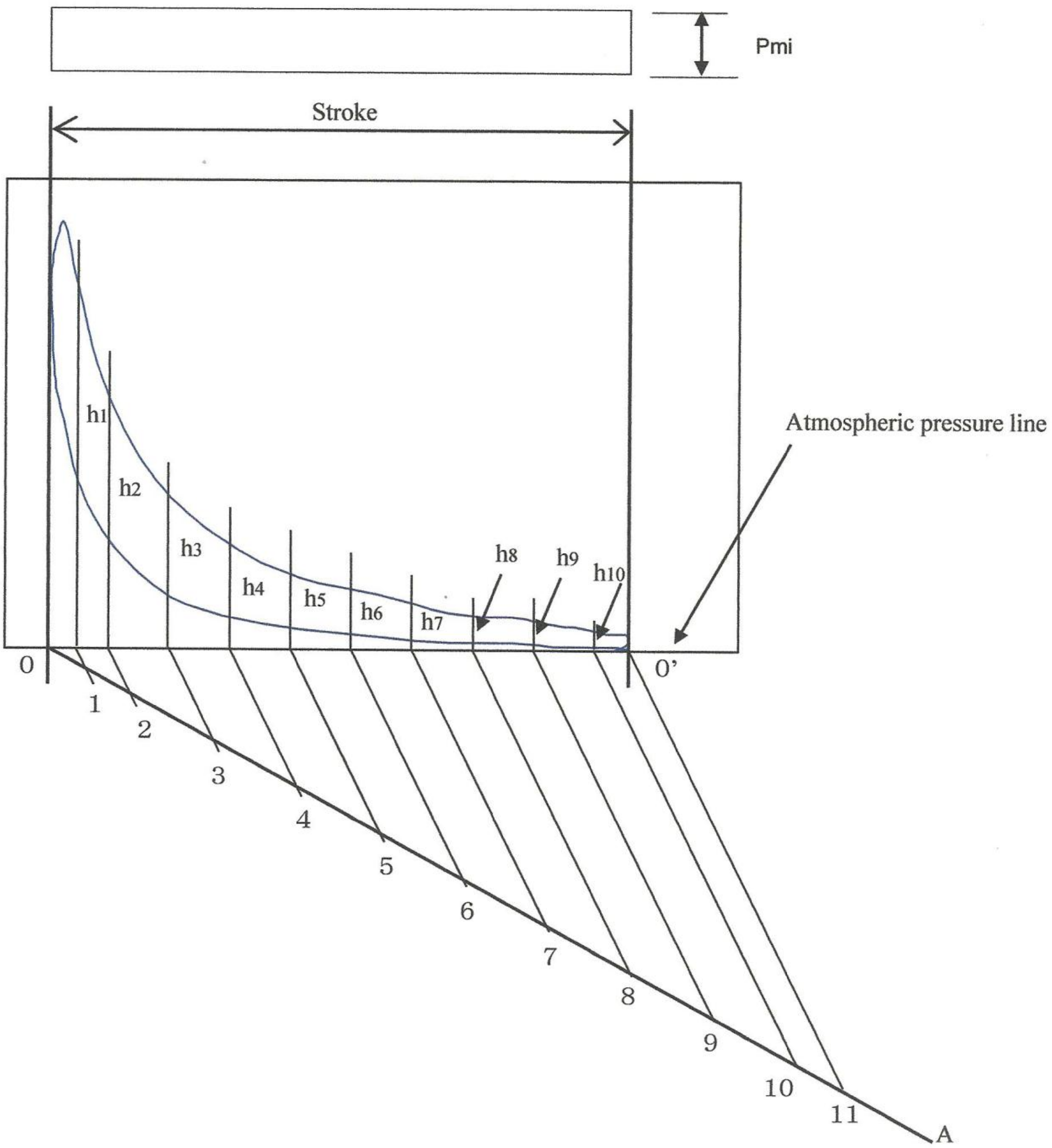
Sea condition: Wind: Load condition:

	Ship's speed		Rev. counter		Shaft output		Torque		FO flow meter	
1		Avg		min^{-1}		Avg		Avg		l/h
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										



Calculation of Mean effective Pressure and Shaft Output

An inner area of indicator diagram indicates output work per unit area produced by a piston and this can be calculated by determining mean effective pressure that is equivalent to height of the rectangle shown below. (The area of the rectangle indicates output power/works per unit area) "Ten divisions into equal method" can be applied to determine the mean effective pressure as follow.



$$\text{Measured value(mm)} = \frac{h_1 + h_2 + h_3 + \cdots + h_{10}}{10}$$

Pmi（Mpa）＝Measured value（mean）(mm)÷Spring constant of indicator
("Spring constant of indicator" is to be given)

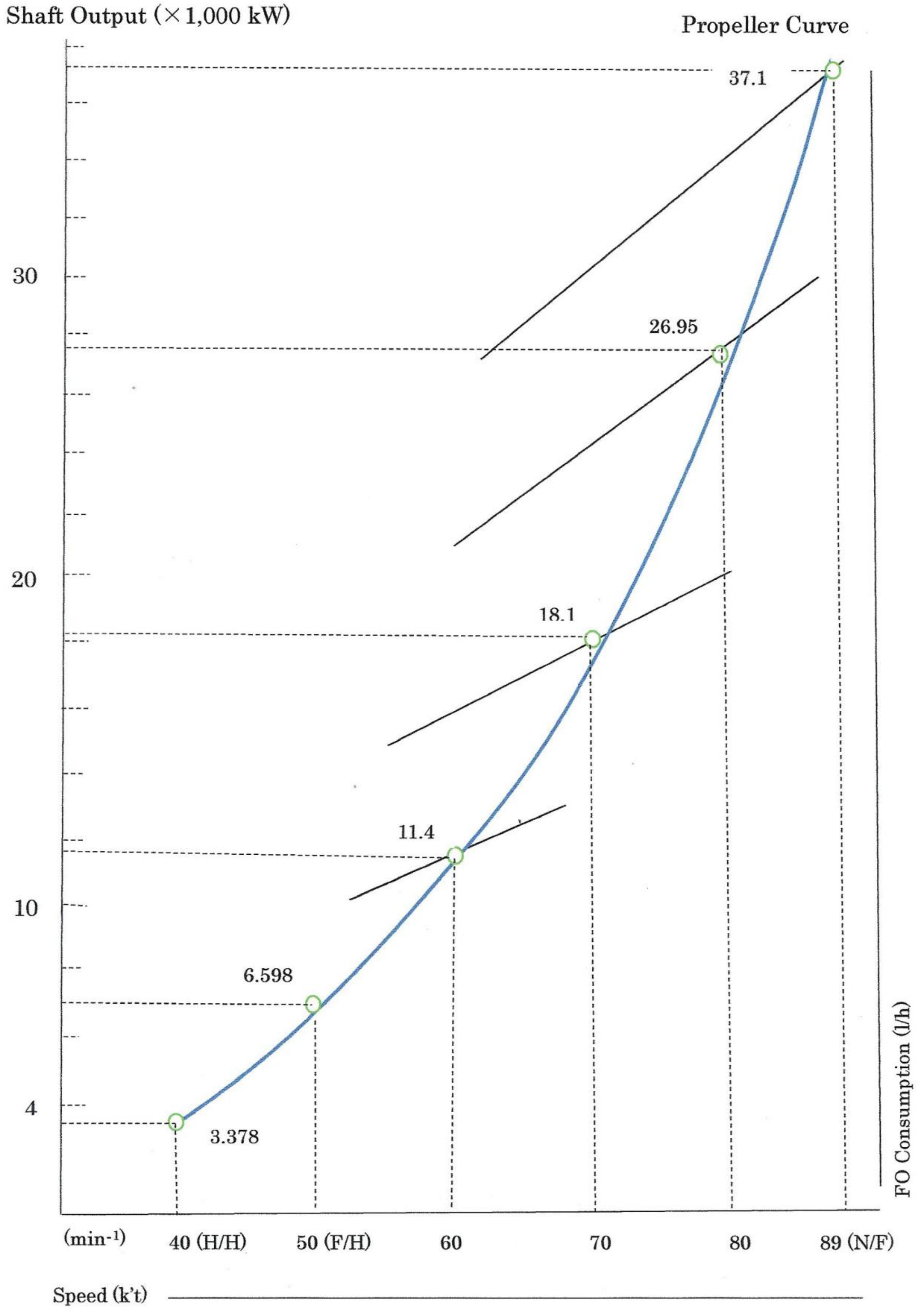
IHP (kW) = $\frac{P_{mi}}{10} \times A \times S \times \frac{N}{60} \times Z \times i$

Pmi: Mean effective pressure (Mpa)
A: Area of cylinder/Piston (cm^2)
S: Stroke (m)
N: Revolution speed (min^{-1})
Z: Number of cylinder
i: Constant (1/2 for 4 stroke and 1 for 2 stroke)

SHP (kW) = IHP $\times \eta$
SHP: Shaft horse power (kW)
η: Mechanical efficiency (To be given)

The trainees should calculate shaft output and results of the calculation should be compared with data from the monitoring system of the simulator.

Example of Shaft Output and Speed



ERS III – 10

Training Title/Scenario: Heat balance of marine diesel engine

Table A-III/1 Competence: Plan and schedule operations

Table A-III/1 KUP: Heat cycle, thermal efficiency and heat balance of the following
.1 marine diesel engine
.2 marine steam turbine
.3 marine gas turbine
.4 marine steam boiler

Time allocation: 6 hours
Number of Trainees: 8 ~ 10
Number of Instructors: 2

Outline of the training:

The trainees develop heat balance diagram and performance curve of the main diesel engine. For the purpose of developing heat balance diagram, the trainees collect running data of the main engine from the simulator and calculate thermal efficiency.

Initial Condition:

- Seagoing

Form of Training:

8 ~ 10 trainees establish two groups (A and B) and the groups collect running data/parameters following data collection tables at four stable running conditions of the main engine as 100%, 75%, 50% and 25% MCR and calculate thermal efficiency for each load. From the results of calculation and running data collected, the trainees develop heat balance diagram and engine characteristic performance curve. The instructor prepare data collection tables, calculation tables and guidance for the calculation.

	Performance
Group A	Data collection of 100 % MCR
	Reduction of engine speed to the revolution equivalent to 75 % MCR
Group B	Data collection of 75 % MCR
	Reduction of engine speed to the revolution equivalent to 50 % MCR

Group A	Data collection of 50 % MCR
	Reduction of engine speed to the revolution equivalent to 25 % MCR
Group B	Data collection of 25 % MCR

Prerequisite:

- Theoretical knowledge of thermal efficiency and engine characteristic curve.
- Theoretical knowledge on simple heat calculation

Note:

The instructor should prepare specific data collection tables and calculation methods based on the functions and specifications of the simulator since data obtained from the simulator differ from simulator to another. The instructor sometimes needs condition settings to simplify the calculation although their theories must be taught. The instructor may make the simulation speed faster than usual to facilitate the training accordingly and conducts a review session on the issue on a different day, giving the trainees enough time for calculation and developing the diagrams.

Specific purpose of the training:

The trainees acquire knowledge on calculation of thermal efficiency, heat balance diagram and engine characteristic performance curve.

Briefing session (30 min)

The instructor should explain:
- outline of the training
- how to carry on the training
- specific purpose of the training
- precaution on collecting data
- dada collection tables
- setting up revolution speed equivalent to engine loads

The instructor divide the trainees into two groups after the briefing.

Implementation of the training

After briefing, the instructor lets the trainees enter the control room and start the training as follow.

T in min	Training process
0 ~ 5	(The instructor creates Seagoing condition as an initial condition and starts the simulation. The instructor sets up 100 % MCR adjusting engine revolution speed and informs the trainees of that engine running condition will become stable in five minutes and your data collection must start 5 minutes later)
5 ~ 65	The group A takes readings of main engine revolution counter and fuel oil flow meter just at starting time of data collection. After taking readings of the counters, members of the group A work on collecting data on the mimic panel and data display of the simulator following the data collection tables. (The group B observes performance of the group A) The group A takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading.
65 ~ 80	After taking the second readings of the counters, the group A perform operation to reduce engine speed until the revolution speed equivalent to 75 % MCR. The group B prepares for data collection.
80~140	The group B takes readings of main engine revolution counter and fuel oil flow meter just at the time of starting data collection. After taking readings of the counters, members of the group B work on collecting data on the mimic panel and data display of the simulator following the data collection tables. (The group A observes performance of the group B) The group B takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading.
140 ~ 290	(Data collections are to be continued in the same manner as the first collection until completion of collecting data of 25 % MCR. The instructor stop the simulator when the data collection is completed. The instructor lets the trainees move to the briefing room.)

Debriefing session (40 min)

The instructor should brief on the following showing examples of the diagrams:

- performance of the trainees as a while
- meaning of heat balance diagram and performance curve
- need to share all data among the trainees
- calculation methods

The instructor gives the trainees an assignment to calculate the thermal efficiency and all the trainees develop heat balance diagram and characteristic performance curve. The trainees must submit their development by the deadline as follow.

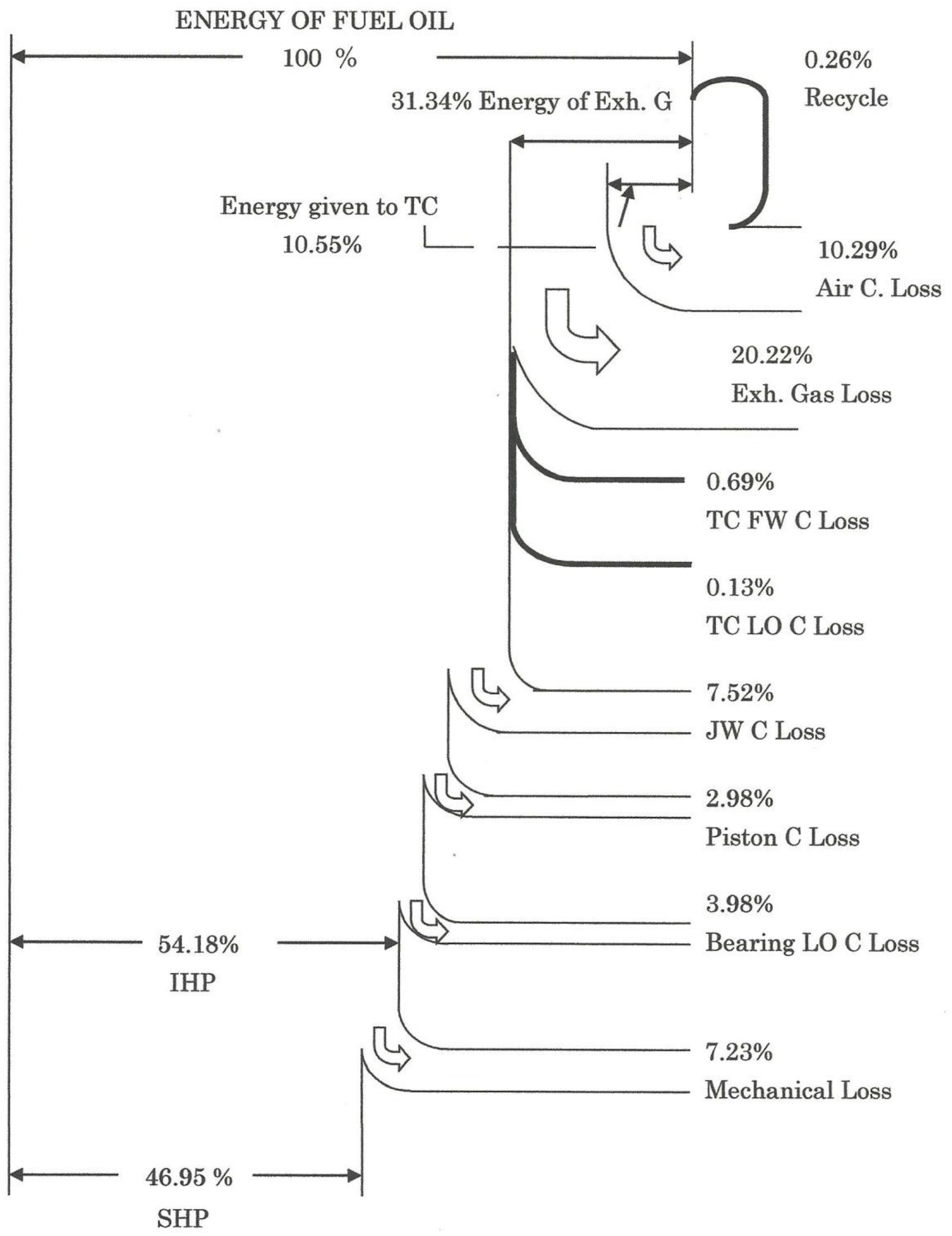
Each trainee of Group A	Measurement tables (100 and 50 % MCR) Calculation results (one half of trainees 100 or 50 % MCR) Heat balance diagram (100 and 50 % MCR) Performance curve
Each trainee of Group B	Measurement tables (75 and 25 % MCR) Calculation results (one half of trainees 75 or 25 % MCR) Heat balance diagram (75 and 25 % MCR) Performance curve

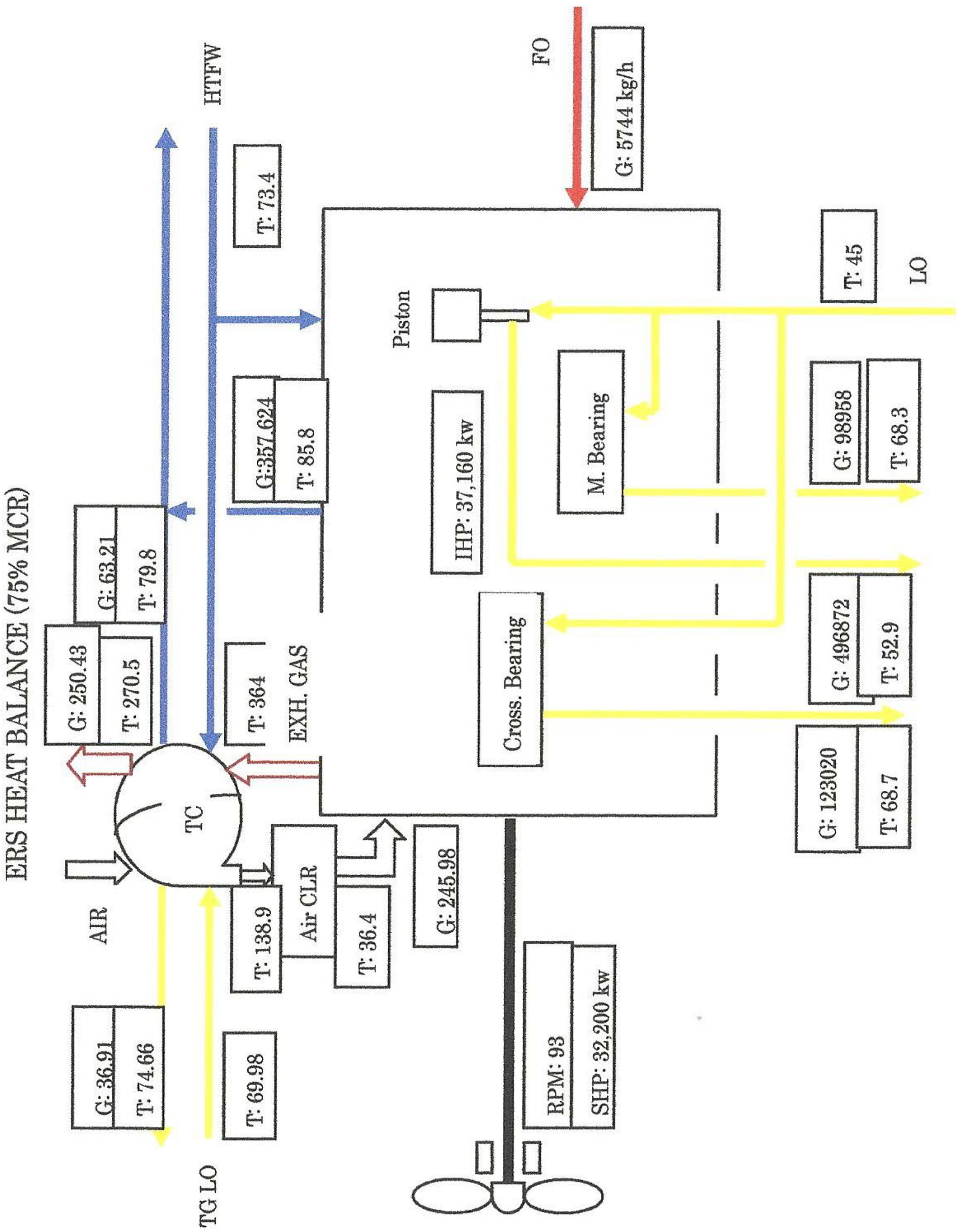
The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

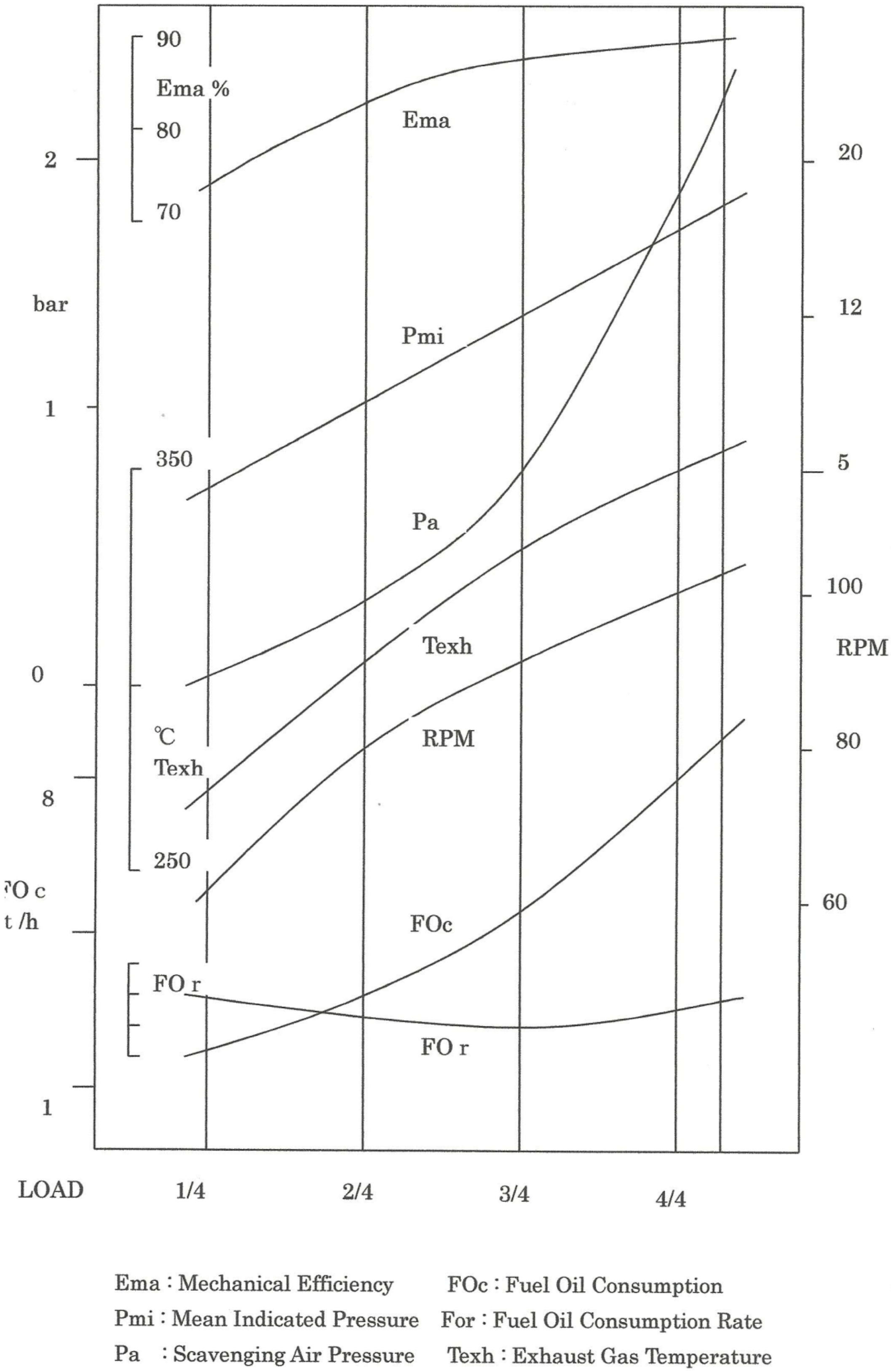
It would better for the trainees to hold a review session on a different day.
Evaluation should be done by their development.

Heat Balance (75% MCR)





Example of Engine



Characteristic Curve

Calculation Method of Thermal Efficiency

Cylinder Bore and Number: 840 mm ×12
Stroke: 2400 mm
Number of TC: 3
Continuous Service Rating: 48.6 MW
Scavenging air pressure: 2.4 bar
TC revolution speed: 9500 min^{-1}

1. Indicated Horse Power (IHP)

IHP (kW) =Σ Pmi×1.0197162×A×L×N×0.00980665 / 60 (kW)

I bar: 1.0197162 (kgf/cm^2)
A: Piston area =π×r^2 (cm^2)
L: Stroke 2.4 (m)
N: Revolution speed (min^{-1})
1 kgfm/s = 0.00980665 (kW)

2. Calorific value

1 (kW) = 860×4.18606 (kj/h)

1 (kW) = 860 (kcal/h)
1 (kcal) = 4.18605 (kj)

3. Mechanical efficiency

ηm = BHP×100 / IHP (%)

4. Fuel oil consumption rate

β = B ×1000 / IHP (g/kW・h)

B: Fuel oil consumption (kg/h)
(Flow meter reading ×Volume conversion factor×Density)

5. Total calorific value of fuel oil (Qb)

Qb = B × Qf ×Qatmo× Qfo (kj/h)

Qf: Calorific value of fuel oil = 4.18605 ×Qq (kj)
Qq: Low calorific value of fuel oil = 10300 (kcal/kg)
Qatom: Conversion coefficient to atmosphere
Qfo: Conversion coefficient to calorific value

6. Heat loss by HTFW of ME (Qjw)

Qjw = Gjw (T out – T in) ×Cfw (kj/h)

Gjw: Quantity of Jacket water of ME (kg/h)
T out: Mean outlet temperature of Jacket water (℃)
T in : HTFW inlet temperature (℃)
Cfw: Specific heat of HTFW = 4.18606 (kj/kg℃)

7. Heat loss by HTFW of TC

Qtcfw = Gtcfw (T out – T in) ×Cfw (kj/h)

Gtcfw: Quantity of TC HTFW (kg/h)
T out: Outlet temperature (℃)
T in: Inlet temperature (℃)

8. Heat loss by piston cooling LO (Qpis)

Qpis = Gpis (T out – T in) ×Clo (kj/h)

Gpis: Quantity of piston cooling LO (kg/h)
T out: Mean outlet temperature of piston cooling LO (℃)
T in: LO Inlet temperature (℃)
Clo: Specific heat of LO = 1.8837 (kj/kg℃)

9. Heat loss by bearing LO (Qbea)

Qbea = Qmb + Qcro (kj/h)

Qmb: Heat loss by main bearing
Qcro: Heat loss by crosshead and crank pin

Qmb = Gmb (T out – T in) ×Clo (kj/h)

Gmb: Quantity of main bearing (kg/h)
= (Piston LO + Main bearing LO) – (Piston LO)
T out: Mean temperature of main bearing (℃)
T in: LO inlet temperature (℃)

Qcro = Gcro (T out – T in) ×Clo (kj/h)

Gcro = Crosshead and crank pin bearing LO (kg/h)
T out: Mean temperature of crosshead and crank pin (℃)
T in: LO inlet temperature (℃)

10. Heat loss by TC LO (Qtclo)

Qtclo = Gtclo (T out – T in) ×Clo (kj/h)
Gtclo: Quantity of TC LO (kg/h)
T out: Outlet temperature of TC LO (℃)
T in: Inlet temperature of TC LO (℃)
Clo: Specific heat of LO = 1.8837 (kj/kg℃)

11. Heat loss by air cooler

Qair = Gair (T in – T out) ×Cair (kj/h)
Gair: Quantity of scavenging air (kg/h)
T in: Mean temperature of air cooler air inlet (℃)
T out: Mean temperature of air cooler air outlet (℃)
Cair: Specific heat of dry air = 1.004652 (kj/kg℃)

12. Heat loss by exhaust gas (Qexh)

Qexh = Qb – (Qihp + Qc) (kj/h)
Qihp: Indicated horse power (kj/h)
Qc: Cooling loss = Qjw + Qtcfw + Qpis + Qbea + Qtclo +Qair

13. Heat given to TC (Qin)

(1) Qin = Gexh (Hin – Hout) (kj/h)
Gexh: Quantity of exhaust gas (kg/h)
Hin: Enthalpy of inlet gas (kj/kg)
Hout: Enthalpy of outlet gas (kj/kg)

(2) Qin = Ltc ×860×4.18605
Ltc: Total shaft power of TC (kW)

14. Energy of exhaust gas (Qgas)

Qgas = Qexh + Qair + Qtclo + Qtcfw (kj/h)

Calculation Table (1/3)

Load	Unit	25%	50%	75%	100%
Ship Load	%			97.79	
Wind Speed	m/s			0	
Wind Direction	deg			90	
Ship Speed	min^{-1}			22.98	
Revolution				93.11	
IHP (Calculation)	kw			37,159.56	
Calorific Value of IHP	kj/h			133,774,536	
Brake horse Power	kw			32,200.00	
Calosific Value of BHP	kj/h			115,920,097	
Mechanical Efficeiancy	%			86.65	
Fuel Consumption.	kg/h			5744	
Fuel Consum. Rate(IHP)	g/kwh			154.58	
Fuel Consum. Rate(SHP)	g/kwh			178.39	
Mean Temp. of Exh. Gas	℃			320.28	
Mean Revolution of TC	rpm			7830.4	
Press. of Scavenging Air	bar			2.22325	
Mean Pmi	bar			15.01	
Mean Pmax	bar			131.44	
Atmospheric Pressure	bar			1.0133	
Room Temperature	℃			44.12	
SW Temperature	℃			20	
Total Calorific V of FO	kj/h			246,912,230	
Calorific Value of FO	kj/kg			43120	
Conver. Coe.to Atmos.				0.996895	
Conver. Coe. to Cal. V				1	
Heat Loss by JW of ME	kj/h			18,578,166	
Specific Heat of HTFW	kj/kg			4.18605	
Diff. T. Inlet and Outlet	℃			12.41	
Amount of JW of ME	kg/h			357,624	
Heat Loss HTFW of TC	kj/h			1,698,733	
Specific Heat of HTFW	kj/kg			4.18605	
Diff. T. Inlet and Outlet	℃			6.42	
Amount of FW of TC	kg/h			63210	

Calculation Table (2/3)

Load	Unit	25%	50%	75%	100%
Loss by Piston C. LO	kj/h			7,356,628	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet & Outlet	℃			7.86	
Quantity of Piston C LO	kg/h			496872	
Loss by Bearing Lo	kj/h			9,832,533	
Loss by Main Bearing LO	kj/h			4,335,831	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet & Outlet	℃			23.26	
Quantity of M Bearing LO	kg/h			98958	
Loss by Cro. & C Pin LO	kj/h			5,496,701	
Specific Heat of LO	kj/h			1.8837	
Diff. T. Inlet & Outlet	℃			23.72	
Quantity of Cro.& C LO	kg/h			123020	
Heat Loss of TC LO	kj/h			325,388	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet and Outlet	℃			4.68	
Quantity of TC LO	t/h			36910	
Heat Loss by Air Cooler	kj/h			25,419,205	
Specific Heat of Dry Air	kj/kg			1.004652	
Diff. T. Inlet and Outlet	℃			102.86	
Amount of Air	kg/h			245980	
Heat Loss by Exh. Gas	kj/h			49,927,040	
Heat given to TC	kj/h			26,295,150	
Diff. Enthalpy of E. Gas	kj/kg			105	
Amount of Exh. Gas	kg/h			250430	
TC Shaft Power(WS)	kj/h			24,350,780	
Energy of Exh. Gas	kj/h			77,370,367	

Calculation Table (3/3)

Load	Unit	25%	50%	75%	100%
Per. of Total Calo. Value	%			100.00	
Per. of Calo. V of IHP	%			54.18	
Per. of Calo. V of SHP	%			46.95	
Per. of Loss ME HTFW	%			7.52	
Per. of Loss TC HTFW	%			0.69	
Per. of Loss Piston C LO	%			2.98	
Per. of Loss Bearing LO	%			3.98	
Per. of Loss TC LO	%			0.13	
Per. of Loss Air Cooler	%			10.29	
Per. of Loss Exh. Gas	%			20.22	
Per. of Heat given to TC	%			9.86	
Per. of Ehx. Gas Energy	%			31.34	
Per. of Mechanical Loss	%			7.23	
Per. of Heat given to TC2	%			10.65	

Data Collection Table (1/5)

Load	unit	25%	50%	75%	100%
Ship Load	%			97.79	
Wind Speed	m/s			0	
Wind Direction	deg			90	
Revolution	min^{-1}			93.11	
Speed	knot			22.98	
Shaft Power	MW			32.2	
Fuel Link Position	%			59.25	
Atmospheric Pressure	mmWL			0.44	
Eng. Room Temp.	℃			44.12	
Air Humidity	%			90	
SW Temperature	℃			20	
IHP-1	kW			3095	
IHP-2	kW			3098	
IHP-3	kW			3103	
IHP-4	kW			3101	
IHP-5	kW			3099	
IHP-6	kW			3090	
IHP-7	kW			3091	
IHP-8	kW			3097	
IHP-9	kW			3103	
IHP-10	kW			3102	
IHP-11	kW			3098	
IHP-12	kW			3091	
Pmi-1	bar			15	
Pmi-2	bar			15.01	
Pmi-3	bar			15.04	
Pmi-4	bar			15.03	
Pmi-5	bar			15.02	
Pmi-6	bar			14.98	
Pmi-7	bar			14.98	
Pmi-8	bar			15.01	
Pmi-9	bar			15.04	
Pmi-10	bar			15.03	
Pmi-11	bar			15.01	
Pmi-12	bar			14.98	

Data Collection Table (2/5)

Load	unit	25%	50%	75%	100%
FO Consumption	kg/h			5744	
FO Temperature	℃			132.34	
HTFW Inlet Temp.	℃			73.41	
Quan. of HTFW Inlet	t/h			413.76	
Quantity of TC HTFW	t/h			63.21	
TC HTFW Outlet T.	℃			79.83	
HTFW Outlet Temp	℃			84.91	
HTFW Outlet T-1	℃			85.68	
HTFW Outlet T-2	℃			85.79	
HTFW Outlet T-3	℃			85.94	
HTFW Outlet T-4	℃			85.91	
HTFW Outlet T-5	℃			86.11	
HTFW Outlet T-6	℃			86.12	
HTFW Outlet T-7	℃			85.52	
HTFW Outlet T-8	℃			85.69	
HTFW Outlet T-9	℃			85.8	
HTFW Outlet T-10	℃			85.73	
HTFW Outlet T-11	℃			85.69	
HTFW Outlet T-12	℃			85.91	
Quantity of HTFW-1	kg/s			8.19	
Quantity of HTFW-2	kg/s			8.11	
Quantity of HTFW-3	kg/s			8.03	
Quantity of HTFW-4	kg/s			8.11	
Quantity of HTFW-5	kg/s			9.95	
Quantity of HTFW-6	kg/s			7.87	
Quantity of HTFW-7	kg/s			8.28	
Quantity of HTFW-8	kg/s			8.19	
Quantity of HTFW-9	kg/s			8.11	
Quantity of HTFW-10	kg/s			8.19	
Quantity of HTFW-11	kg/s			8.28	
Quantity of HTFW-12	kg/s			8.03	
LO Inlet Temperature	℃			44.99	
LO Outlet Temp	℃			51.71	
Quan. of PC & Ber LO	t/h			595.83	
Quan. of C head LO	t/h			123.02	

Data Collection Table (3/5)

Load	unit	25%	50%	75%	100%
Pis. C LO Outlet T-1	℃			52.75	
Pis. C LO Outlet T-2	℃			52.82	
Pis. C LO Outlet T-3	℃			52.92	
Pis. C LO Outlet T-4	℃			52.88	
Pis. C LO Outlet T-5	℃			52.84	
Pis. C LO Outlet T-6	℃			52.7	
Pis. C LO Outlet T-7	℃			52.75	
Pis. C LO Outlet T-8	℃			52.88	
Pis. C LO Outlet T-9	℃			52.94	
Pis. C LO Outlet T-10	℃			52.88	
Pis. C LO Outlet T-11	℃			52.87	
Pis. C LO Outlet T-12	℃			52.93	
Quantity of PC LO-1	kg/s			11.63	
Quantity of PC LO-2	kg/s			11.52	
Quantity of PC LO-3	kg/s			11.4	
Quantity of PC LO-4	kg/s			11.52	
Quantity of PC LO-5	kg/s			11.63	
Quantity of PC LO-6	kg/s			11.75	
Quantity of PC LO-7	kg/s			11.54	
Quantity of PC LO-8	kg/s			11.42	
Quantity of PC LO-9	kg/s			11.34	
Quantity of PC LO-10	kg/s			11.42	
Quantity of PC LO-11	kg/s			11.54	
Quantity of PC LO-12	kg/s			11.31	
Main Bearing T-1	℃			69	
Main Bearing T-2	℃			69	
Main Bearing T-3	℃			68	
Main Bearing T-4	℃			68	
Main Bearing T-5	℃			68	
Main Bearing T-6	℃			68	
Main Bearing T-7	℃			68	
Main Bearing T-8	℃			68	
Main Bearing T-9	℃			68	
Main Bearing T-10	℃			68	
Main Bearing T-11	℃			68	
Main Bearing T-12	℃			69	

Data Collection Table (4/5)

Load	unit	25%	50%	75%	100%
Crosshead Bea.T-1	℃			73	
Crosshead Bea.T-2	℃			73	
Crosshead Bea.T-3	℃			73	
Crosshead Bea.T-4	℃			73	
Crosshead Bea.T-5	℃			73	
Crosshead Bea.T-6	℃			73	
Crosshead Bea.T-7	℃			72	
Crosshead Bea.T-8	℃			73	
Crosshead Bea.T-9	℃			73	
Crosshead Bea.T-10	℃			74	
Crosshead Bea.T-11	℃			73	
Crosshead Bea.T-12	℃			74	
Crank Pin Bea.T-1	℃			70	
Crank Pin Bea.T-2	℃			70	
Crank Pin Bea.T-3	℃			70	
Crank Pin Bea.T-4	℃			69	
Crank Pin Bea.T-5	℃			70	
Crank Pin Bea.T-6	℃			70	
Crank Pin Bea.T-7	℃			70	
Crank Pin Bea.T-8	℃			70	
Crank Pin Bea.T-9	℃			70	
Crank Pin Bea.T-10	℃			70	
Crank Pin Bea.T-11	℃			70	
Crank Pin Bea.T-12	℃			71	
TC LO Inlet Temp	℃			69.98	
TC LO Outlet Temp	℃			74.66	
Quantity of TC LO	t/h			36.91	
Quantity of TC E.G-1	t/h			83.44	
Quantity of TC E.G-2	t/h			83.07	
Quantity of TC E.G-3	t/h			83.92	
TC Exh. G Inlet T-1	℃			365.16	
TC Exh. G Inlet T-2	℃			364.11	
TC Exh. G Inlet T-3	℃			363.56	
TC Exh. G Outlet T-1	℃			270.56	
TC Exh. G Outlet T-2	℃			270.15	
TC Exh. G Outlet T-3	℃			270.73	

Data Collection Table (5/5)

Load	unit	25%	50%	75%	100%
TC Revolution-1	min^{-1}			7849.2	
TC Revolution-2	min^{-1}			7818	
TC Revolution-3	min^{-1}			7824	
TC Shaft Power-1	kW			2260.9	
TC Shaft Power-2	kW			2243.1	
TC Shaft Power-3	kW			2260.1	
TC Filter Diff. Press-1	mmWL			44.83	
TC Filter Diff. Press-2	mmWL			45.7	
TC Filter Diff. Press-3	mmWL			45.96	
Air Cooler Air Inlet T-1	℃			138.85	
Air Cooler Air Inlet T-2	℃			139.32	
Air Cooler Air Inlet T-3	℃			139.69	
Air Cooler Air Out T-1	℃			36.45	
Air Cooler Air Out T-2	℃			36.39	
Air Cooler Air Out T-3	℃			36.45	
Quantity of Air-1	t/h			82.71	
Quantity of Air-2	t/h			81.54	
Quantity of Air-3	t/h			81.73	
Scavenging Air Press	Bar			1.21	
Scavenging Air Temp	℃			36.45	
Exh Gas Temp.-1	℃			313.57	
Exh Gas Temp.-2	℃			317.7	
Exh Gas Temp.-3	℃			323.13	
Exh Gas Temp.-4	℃			323.83	
Exh Gas Temp.-5	℃			327.81	
Exh Gas Temp.-6	℃			322.78	
Exh Gas Temp.-7	℃			316.31	
Exh Gas Temp.-8	℃			325.29	
Exh Gas Temp.-9	℃			321.89	
Exh Gas Temp.-10	℃			314.62	
Exh Gas Temp.-11	℃			320.48	
Exh Gas Temp.-12	℃			315.91	
Mean Exh. Gas Temp.	℃			320.28	

ERS III – 11

Training Title/Scenario: Operation of main propulsion and auxiliary machinery

Table A-III/1 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Table A-III/1 KUP: Start up and shut down main propulsion and auxiliary machinery, including associated systems

Time allocation: 3 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

4 ~ 5 trainees perform warming up, starting up and shutting/cooling down operation of the main engine as a group and each trainee handles the maneuvering lever to control the engine revolution responding to the telegraph order.

Initial Condition:

In port

Form of Training:

4 ~ 5 trainees establish a group and the group perform the operations. The trainees may refer to a procedure manual prepared by instructors.

Prerequisite:

Knowledge of principles on warming up procedures of middle and large sized marine diesel engine

Note:

As far as warming up concerned, almost same procedures as ERS III – 4 (ERM Training) will be carried out. However, this training focuses on operation of the main diesel engine only.

Specific purpose of the training:

The trainees acquire knowledge and skills on warming up, starting up and shutting down main diesel engines.

Briefing session for the first stage (30 min)

Instructor should explain:
- outline of the training
- how to carry on the training
- purposes of starting each machinery and establishing systems
- procedures for warming up, starting up and shutting/cooling down the main engine
- standards of warming up and cooling down
- significance of keeping correct sequence of the procedures to prevent damage
- needs to check running condition when starting up the engine
- what should be checked during trial run of the engine

Implementation of the training

After briefing, the instructor let the trainees enter the engine room and start the training as follow. (The following says main procedures to perform operations of warming up, starting up and shutting/cooling down main engine. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage

T in min	Training process
0 ~ 60	(The instructor creates In port condition as an initial condition and starts simulation.) The trainees perform the operations on the mimic panel as a group. Check the main engine for level of LO sump tank, FW expansion tank, Cylinder oil supply tank and Stern tube LO sump tank Start LO purifier and begin bypass purifying. Start No. 1 HTFW pump and establish HTFW system. Begin warming up main engine supplying preheater with steam. Start No. 1 LO pumps and establish LO system including TC LO system. Start No. 1 FO pumps and establish FO system. (DO use)

	Start No. 1 Stern tube LO pump and establish stern tube LO system. Confirm HTFW temperature above 70℃ and LO temperature above 40℃. Stop heating of HTFW. Make sure all indicator valves opened Engage turning gear and begin turning of the engine confirming current value of turning motor within standard and supplying the engine with cylinder oil. Stop the turning and disengage the turning gear. Make parallel running of main air compressors. Line up starting air line to the engine. Set control position of the engine to engine side/engine room. Reset abnormal, if any. (From this stage, as far as handling of the main engine concerned, it is to be done by the trainees in turn as follow) (Trainee T1) Start up the engine with air only for 1 ~ 2 rotations. Close all indicator valves. Start auxiliary blowers and perform starting up the engine in ahead side (Dead slow). Confirm fuel rack position, fuel oil injection, increase of exhaust gas temperature, increase of TC revolution speed and LO pressure. Stop the engine moving maneuvering lever to stop position and stop the auxiliary blowers. (Trainee T2) Start auxiliary blowers and perform starting up the engine in astern side (Dead slow). Confirm fuel rack position, fuel oil injection, increase of exhaust gas temperature, increase of TC revolution speed and LO pressure. Stop the engine moving maneuvering lever to stop position and stop the auxiliary blowers. Move the control position to the control room. Set maneuvering mode to auto. (Trainee T3) Perform starting up the engine at slow ahead and make sure automatic change-over of air run to fuel run and main running parameters.

	Stop the engine and confirm the auxiliary blowers stop. (Trainee T4) Perform starting up the engine at slow astern and make sure automatic change-over of air run to fuel run and the running parameters. Stop the engine and confirm the auxiliary blowers stop. Start No. 1 boiler water circulation pump and establish the system. Start engine room fans. (The instructor sets sub-telegraph to Standby Engine) (Trainee T5) Respond to the sub-telegraph at the engine console. (The instructor sets the engine telegraph to "Half ahead". Respond to the telegraph. Perform starting up the engine at half ahead and make sure automatic change-over of air run to fuel run and the running parameters. (The instructor sets the telegraph to "Full ahead" after a while) Respond to the telegraph. Increase the revolution speed until full ahead and confirm the main running parameters. (The instructor sets the sub-telegraph to "Full way" after a while) Respond to the sub-telegraph at the control console. Set the maneuvering lever to the position of sea going / navigation full confirming load up program activated. Put VIT (Variable Injection Timing) and VEC (Various Exhaust Control) into service (Group performance) Perform change-over of fuel oil to HFO supplying No. 1 FO heater and tracing line with steam. Set FO viscosity controller to auto at the predetermined setting value. Make single running of main air compressor and close starting air supply line. Set damper control of exhaust boiler to auto at predetermined setting value. Adjust air cooler LTFW outlet valves according to scavenging air temperature. Confirm revolution speed of the main engine reaches to navigation full speed by

	the load up program. Confirm main running parameters of the engine. (Main engine revolution speed, TC revolution speed, shaft output, fuel rack, etc.) (This is end of the 1st stage. The instructor stops the simulation temporarily and may give the trainees a break time)

2nd stage

T in min	Training process
0 ~ 60	(The instructor resumes the simulation and informs the trainees of request of standby engine using communication equipment) Perform reduction of the engine speed until harbor/standby full speed. Perform change-over of fuel oil to DO, stopping supply of steam to No. 1 FO heater and tracing line and setting the viscosity controller to man. Put VIT and VEC out of service. Set damper control of the exhaust boiler to man. Adjust air cooler LTFW outlet valves according to scavenging air temperature. Make parallel running of main air compressors and line up starting air supply line. (When the engine speed reaches to standby full speed, the instructor sets sub-telegraph to Standby engine informing the trainees of that various engine order will be issued and the trainees respond to the engine maneuvering order and controls the engine speed paying due attention to behaviors of remote control system and main running parameters) (Trainee T1) Respond to the request of standby engine. (The instructor sets engine telegraph to "Half ahead" Respond to the telegraph, adjusting the engine speed to "Half ahead". (The instructor sets the engine telegraph to "Slow ahead" after a while) Respond to the telegraph adjusting the engine speed to "Slow ahead". (The instructor sets the engine telegraph to "Stop engine". Respond to the telegraph moving the maneuvering lever to "Stop".

	(The instructor sets the engine telegraph to "Slow astern" after a while) (Trainee T2) Respond to the telegraph adjusting the engine speed to "Slow astern". (The instructor sets the engine telegraph to "Full astern" Respond to the telegraph adjusting the engine speed to "Full astern". (The instructor sets the engine telegraph to "Stop". Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor sets the engine telegraph to "Half ahead" after a while) (Trainee T3) Respond to the telegraph adjusting the engine speed to "Half ahead". (The instructor set the engine telegraph to "Slow aster". Respond to the telegraph adjusting the engine speed to "Slow ahead". (If crash astern is detected, manual control of the engine speed will not be functional. In such a case, maneuver the engine lever accordingly watching the revolution and fuel rack) (The instructor sets the engine telegraph to "Stop" after a while) Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor set the engine telegraph to "Dead slow". (Trainee T4) Respond to the telegraph adjusting the engine speed to "Dead slow". (The instructor sets the engine telegraph to "Full astern" after a while) Respond to the telegraph adjusting the engine speed to "Full astern". (The instructor sets the engine telegraph to "Stop") Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor sets the sub-telegraph to "Finish with engine") (Trainee T5) Respond to the sub-telegraph saying that finish with engine, open all indicators

	valves. (Trainees T1 ~ T4 open the indicator valves and report it to T5) T5 changes over the control mode to man and start the engine with air only for 1 ~ 2 rotations. (The instructor informs the trainees of that the trainees begin to perform shutting/cooling down operation from now) Engage turning gear and begin turning of the main engine supplying the engine with cylinder oil. Stop No. 1 boiler water circulating pump and close valves concerned. Close starting air line to the main engine and make single running of main air compressor. Stop No. 1 FO pumps and close valves concerned in FO supply system. After a while, stop the turning of the engine. Stop No. 1 stern tube LO pump and close valves concerned in the system. Stop No. 1 LO pumps and close valves concerned in the system. Stop No. 1 HTFW LO pump and close valves concerned in the system. Stop LO purifier. (This is end of the 2nd stage and the instructor stop the simulation. The trainees move to the briefing room.)

Debriefing session (30 min)

The instructor expresses his/her impression first as a while and explains meaning and significance of handling a main engine. From this aspect, the engine must be checked frequently in terms of running parameters other than diagnoses of the engine performance.

The instructor should brief on:
- fundamental sequence of warming up and shutting/cooling down the engine
- standards of warming up and cooling down
- limitation of main running parameters

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 11

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Operation of main propulsion and auxiliary machinery
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Checking main engine and preparation (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Warming up procedures (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Handling main engine (If handling of main engine was correct, smooth and confident)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Shutting down main engine (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ____________________________

ERS III – 12

Training Title/Scenario: Efficient operation, surveillance, performance assessment of propulsion plant and auxiliary machinery

Table A-III/1 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Table A-III/1 KUP: The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Time allocation: 4 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

4 ~ 5 trainees perform operations as a group to address heavy weather (1st stage) and malfunctions of the machinery (2nd stage), assessing the running parameters and conditions

Initial Condition:

Seagoing

Form of Training:

4 ~ 5 trainees establish a group and the group perform operations to address various situations.

Prerequisite:

- Knowledge on running limitation of propulsion machinery
- Knowledge on how to address malfunctions of propulsion plant machinery

Note:

The instructor should select malfunctions according to ability of the trainees and may advise the trainees of procedures to be taken to address the malfunctions where necessary.

Specific purpose of the training:

The trainees acquire knowledge on how to address malfunctions of machinery, assessing running parameters and conditions.

Briefing session for the first stage (30 min)

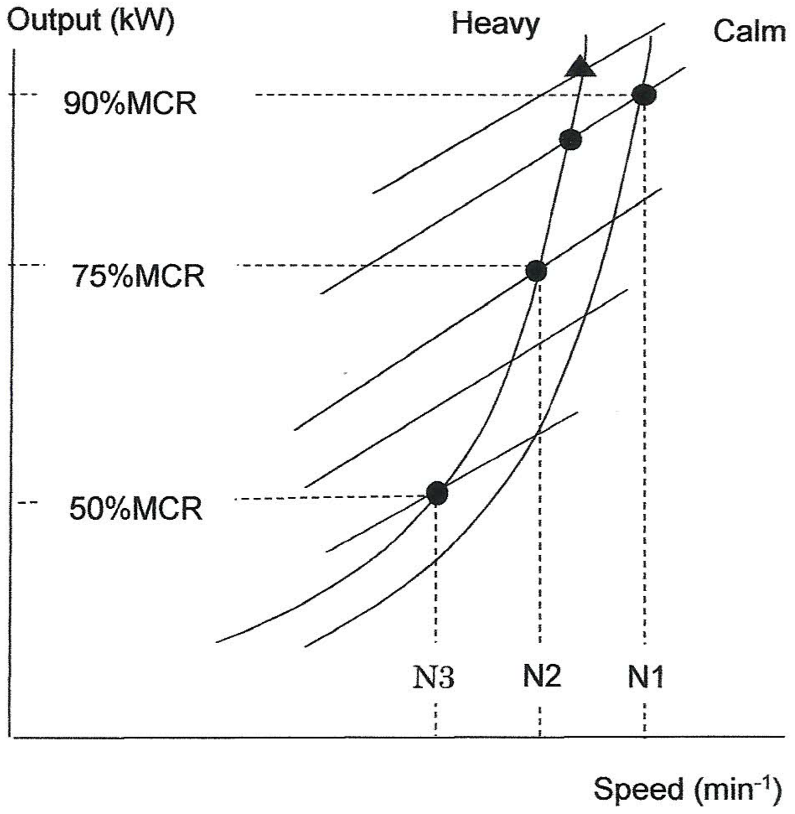
Instructor should explain:
- outline of the training
- how to carry on the training
- briefly changes in running parameters under heavier weather
- example of malfunctions and how to address the malfunctions
- assessment of running parameters and its limitation of machinery using examples

Implementation of the training

After briefing, instructors let the trainees enter the engine room and start the training as follow. (The following says main procedures to perform operations. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage

T in min	Training process
0 ~ 30	(The instructor creates Seagoing condition as an initial condition (85 ~ 90 % MCR, TG and FWG are in service) and starts the simulation. The instructor lets the trainees enter the control room and confirm the running conditions of the propulsion machinery) The trainees confirm the running conditions of the main engine by filling out measurement tables and print out indicator diagrams (Cylinder indication pressure/stroke diagram and cylinder indication pressure/crank angle diagram) for No.1, 2 and 3 cylinders. (All data can be obtained from data display of the simulator) (The instructor creates a heavy weather) After a while, the trainees record the running parameters using the measurement tables and print out the indicator diagram. The trainees assess the data and figure out the changes in the running parameters and take actions necessary.

	(Generally, when a weather condition becomes heavy, engine output will become higher with increase of hull resistance, if the engine speed is kept at the same revolution speed as before the heavy weather. Usually the engine revolution speed will go down due to the heavy weather and the engine output also goes down in case of a diesel engine however, the engine output and torque must higher than the standard against the same speed under calm weather. These phenomenon causes "torque rich" and other impacts (higher exhaust gas temperature, TC surging, etc.) on the running conditions of the main engine) The trainees assess the running conditions using output/speed diagram (propeller curve) and predicting movement of the main engine running point (new output and revolution speed), and decide measures taking into account the situations.
30 ~ 90	 The trainees report the decision to the instructor as follow and begin the operations. - We decrease the engine speed to equivalent speed of 75 % MCR

	The trainees change –over the control position to the control room and control mode of the engine to man. The trainees decrease the engine speed to the predetermined speed. (The trainees calculate value of N2 before decreasing revolution speed) After decrease of the engine speed, the trainees record the running parameters of the engine using measurement tables and print out the indicator diagram. The trainees also confirm the running condition of other systems such as power generation, FWG and steam generation systems. (The trainees assess the running conditions of the engine in terms of output, P_{mi}, P_{max} and exhaust gas temperature for the new revolution speed, and impacts on power generation system. Then the trainees decide to decrease the engine revolution to equivalent speed of 50 % MCR) The trainees report the decision to the instructor and begin the operation to decrease the revolution speed as follow. - We decrease the engine speed to equivalent speed of 50 % MCR. - We change over power generation to No. 1 diesel generator from Turbo generator (TG). - We stop FWG and start auxiliary boiler. The trainees begin the operations as follow. Start No. 1 diesel generator remotely and change over automatically the power generation to No. 1 diesel generator to TG Stop TG and close steam valves concerned beginning turning of TG. (Condenser vacuum, condensate system and LO system may be kept in a working condition) Stop supply of HTFW and feedwater to FWG and stop Distilled water pump. (Vacuum may be kept as it is) The trainees decrease the engine revolution speed to the predetermined speed. After decrease of the engine speed, the trainees record the running parameters of the engine using measurement tables and print out the indicator diagram. (This is end of the 1st stage. When the trainees fill out the measurement tables and print out the indicator diagrams, the instructor stop the simulation. The instructor may give the trainees a break time)

Measurement Table (1/2)

Time					
Sea condition					
Wind Speed	m/s				
Wind Direction	deg				
SW Temperature	℃				
Eng. room Temp.	℃				
Ship Load	%				
Rev. speed	min^{-1}				
Rev. counter	10 min				
Ship's speed	knot				
Shaft Power	MW				
Pump mark					
Fuel oil consumption	kg/h				
FO flow meter	30 min				
FO Temperature					
TC Rev. speed 1	min^{-1}				
TC Rev. speed 2	min^{-1}				
TC Rev. speed 3	min^{-1}				
Scavenging air Temp.	℃				
Scavenging air Press.	bar				
Quantity of scav. air	kg/h				
IHP-1	kW				
IHP-2	kW				
IHP-3	kW				
IHP-4	kW				
IHP-5	kW				
IHP-6	kW				
IHP-7	kW				
IHP-8	kW				
IHP-9	kW				
IHP-10	kW				
IHP-11	kW				
IHP-12	kW				

Measurement Table (2/2)

Time					
Pmi-1	bar				
Pmi-2	bar				
Pmi-3	bar				
Pmi-4	bar				
Pmi-5	bar				
Pmi-6	bar				
Pmi-7	bar				
Pmi-8	bar				
Pmi-9	bar				
Pmi-10	bar				
Pmi-11	bar				
Pmi-12	bar				
Pmax-1	bar				
Pmax-2	bar				
Pmax-3	bar				
Pmax-4	bar				
Pmax-5	bar				
Pmax-6	bar				
Pmax-7	bar				
Pmax-8	bar				
Pmax-9	bar				
Pmax-10	bar				
Pmax-11	bar				
Pmax-12	bar				
Exh. Gas Temp-1	℃				
Exh. Gas Temp-2	℃				
Exh. Gas Temp-3	℃				
Exh. Gas Temp-4	℃				
Exh. Gas Temp-5	℃				
Exh. Gas Temp-6	℃				
Exh. Gas Temp-7	℃				
Exh. Gas Temp-8	℃				
Exh. Gas Temp-9	℃				
Exh. Gas Temp-10	℃				
Exh. Gas Temp-11	℃				
Exh. Gas Temp-12	℃				

2nd stage

T in min	
0 ~ 90	(The instructor creates Seagoing condition as an initial condition and starts the simulation) The trainees enter the control room and confirm the running conditions of the propulsion machinery. (After a while, the instructor informs the trainees of beginning of the training and creates first malfunction) **Engine room bilge well high level alarm** The trainees confirm the alarm and assess the situation, preparing for starting bilge pump and transfer the bilge to bilge tank. (If there is no space in the bilge tank, discharge bilge of the bilge tank first and transfer the bilge to the bilge tank complying with the regulations concerned) (The instructor confirm the situation and creates second malfunction) **No. 1 FO settling tank low level alarm** The trainees confirm the alarm and assess the level, level of bunker tank in use, running parameter of FO transfer pump and status of valves concerned and take actions to increase the level. (The instructor confirm the situation and creates third malfunction) **FWG high salinity alarm** The trainees confirm the alarm and assess value of salinity, distilled water level, HTFW temperature, opening of HTFW bypass valve, flow rate of feedwater, vacuum, temperature of evaporation and adjust some of the running parameters to reduce the content of salinity. (The instructor confirm the situation and creates fourth malfunction) **Auxiliary boiler low water level alarm** The trainees confirm the alarm and assess the level, opening of FWC valve, running parameters of feedwater pump, cascade tank level, control parameters of FWC controller and take actions to increase the level. (The instructor confirm the situation and creates fifth malfunction)

	No. 1 FO purifier abnormal separation alarm The trainees confirm the alarm and assess running parameters of the FO purifier, resetting the purifier. The trainees need to decide actions to be taken from the results of assessment as follow. - Take actions to manually resume the operation of the purifier - Take actions to stop the purifier and restart it as usual - Take actions to change over the purifier to No. 2 FO purifier. (The instructor confirm the situation and creates final malfunction on main engine resulting in automatic slowdown) **Main engine automatic slowdown (Thrust bearing high temperature alarm)** The trainees confirm the alarm and automatic slowdown of the main engine. The trainees take immediate actions to change over the power generation to No. 1 diesel generator, keeping Turbo generator in a hot condition. The trainees urgently start auxiliary boiler and stop FWG accordingly. The trainees quickly assess main running parameters of the engine. The trainees take actions to move control position to the control room from the bridge, keeping the revolution speed at Slow ahead. The trainees locate proximate cause of the slowdown confirming running factors as follow. - LO temperature of the thrust bearing - LO pressure - LO flow rate - LO temperature control valve - Control parameters of LO temperature controller - Trouble of LO pumps - Clogged LO strainer - Fouled LO cooler The trainees perform remedy operations to recover the running condition. After the recovery of the malfunction, the trainees reset the abnormal and take actions to resume the operation the engine.

	The trainees increase the engine speed by setting the maneuvering lever to .the position as it was. As the engine speed is resumed, the trainees begin to perform operations to change over the power generation to Turbo generator, starting auxiliary boiler as well. (When Turbo generator is put into service, the instructor stop simulation and lets the trainees move to the briefing room)

Debriefing session (30 min)

For the 1st stage, the instructor lets the trainee discuss the record of running parameters including indicator diagrams.
The instructor also should brief on:

- application of propeller curve (cube curve)
- relation between engine output, revolution speed and fuel consumption
- relation between engine speed and ship's speed
- torque and torque rich
- impacts on engine running under torque rich

For the 2nd stage, the instructor should brief on:

- importance of detecting malfunction before alarm sounds
- there are several proximate causes for one malfunction
- needs to be well-versed in handling machinery to address malfunctions

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

ERS III – 9

Training Title/Scenario: Propulsive characteristics of diesel engines

Table A-III/1 Competence: Plan and schedule operations

Table A-III/1 KUP: Propulsive characteristics of diesel engines, steam and gas turbines including speed, output and fuel consumption

Time allocation: 3.5 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 1

Outline of the training:

This is an experimental training/study and the trainees develop a graph indicating engine speed, engine output and fuel oil consumption by determining each value.
The trainees consider results of the experiment and understand correlation between engine speed, engine output and fuel consumption.

Initial Condition:

Main engine standby condition

Form of Training:

4 ~ 5 trainees establish a group and the group perform the experimental study by developing the graph indicating engine speed/ship's speed, engine output and fuel consumption that are determined and/or calculated from results of measuring running parameters.

Prerequisite:

Theoretical knowledge on correlation between engine output, engine speed and fuel consumption.

Note:

The trainees perform the experimental study as a group (team) although no trainee is assigned to a leader. The trainees should develop the graph as the group sharing results of measurements and calculation. The instructor needs to prepare measurement tables. With regard to engine output, the instructor also should let the trainees calculate the output from indicator diagrams giving them necessary constant values.

Specific purpose of the training:

The trainees understand correlation between engine speed/ship's speed, engine output, fuel oil consumption and other relevant running factors. The trainee come to be able to predict engine output and fuel consumption against engine speed/ship's speed.

Briefing session (30 min)

Instructor should explain showing measurement tables:
- outline of the training/experiment (herein after "experiment")
- how to carry on the experiment
- specific purposes/goal of the experiment
- how to draw the graph obtaining necessary values

Implementation of the training

After briefing, instructors let the trainees enter the control room and start the experiment as follow.

T in min	Training process
0 ~ 90	(The instructor creates Standby condition as an initial condition and starts the simulation at calm sea condition. The instructor may make simulation speed faster than usual in order to facilitate the experiment accordingly) The trainees set main engine revolution speed to "Half ahead" and take readings following the tables 2 ~ 3 minutes later. 10 minutes later, the trainees take readings again at "Half ahead". After taking readings, the trainee increase maneuvering lever to "Full ahead" and take readings 2 ~ 3 minutes later. 10 minutes later, the trainee take readings at "Full ahead". After taking readings, the trainee increase manually engine speed by 10 min^{-1} or so. And take readings 5 ~ 6 minutes later. (Print out indicator diagrams of No. 1 ~ 5 cylinders only for this revolution speed to calculate engine output)

	The trainees continue to take readings until navigation speed in the same manner and complete reading records of measurement. (The instructor stop the simulation and lets the trainee move to the briefing room for developing the graph.)

Debriefing session (90 min)

The instructor gives the trainees 60 minutes to calculate engine outputs and draw the graph. (All the trainees must submit the measurement table, the graph and the result of calculating shaft output)

The trainees also compare the data of shaft output taken with calculated shaft output using "$\text{Shaft output} \propto N^3$" (N: Revolution speed)

The instructor lets the trainees discusses the graph developed by the trainees and explains propeller curve as a common brief on correlations between engine speed, engine output and fuel consumption comparing to the results of calculations.

Furthermore, the instructor refers to correlation of fuel consumption between different speeds for the same distance and meaning of constant torque lines.

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

Evaluation should be done by their products.

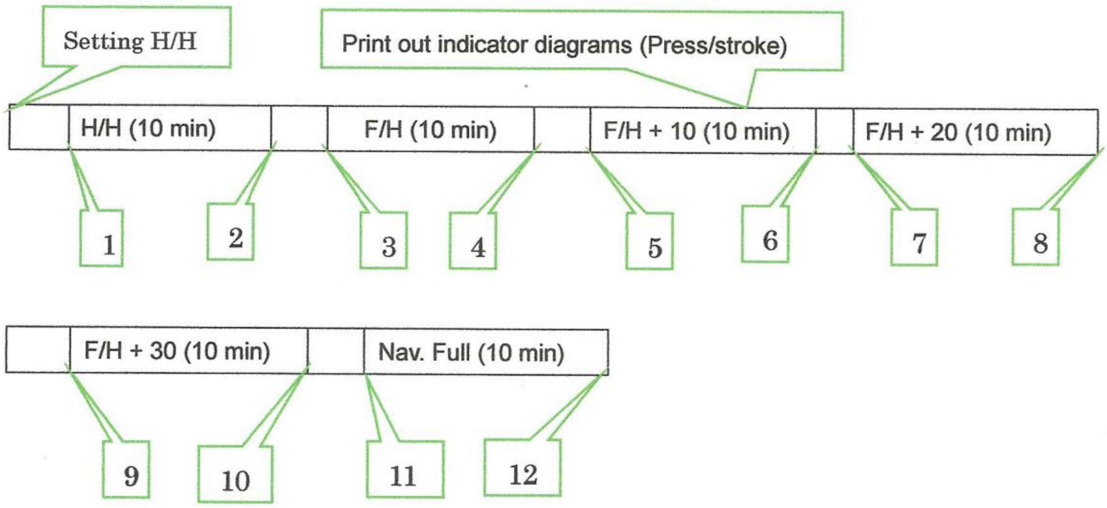
Measurement Table

Date:

Ship's Particular:

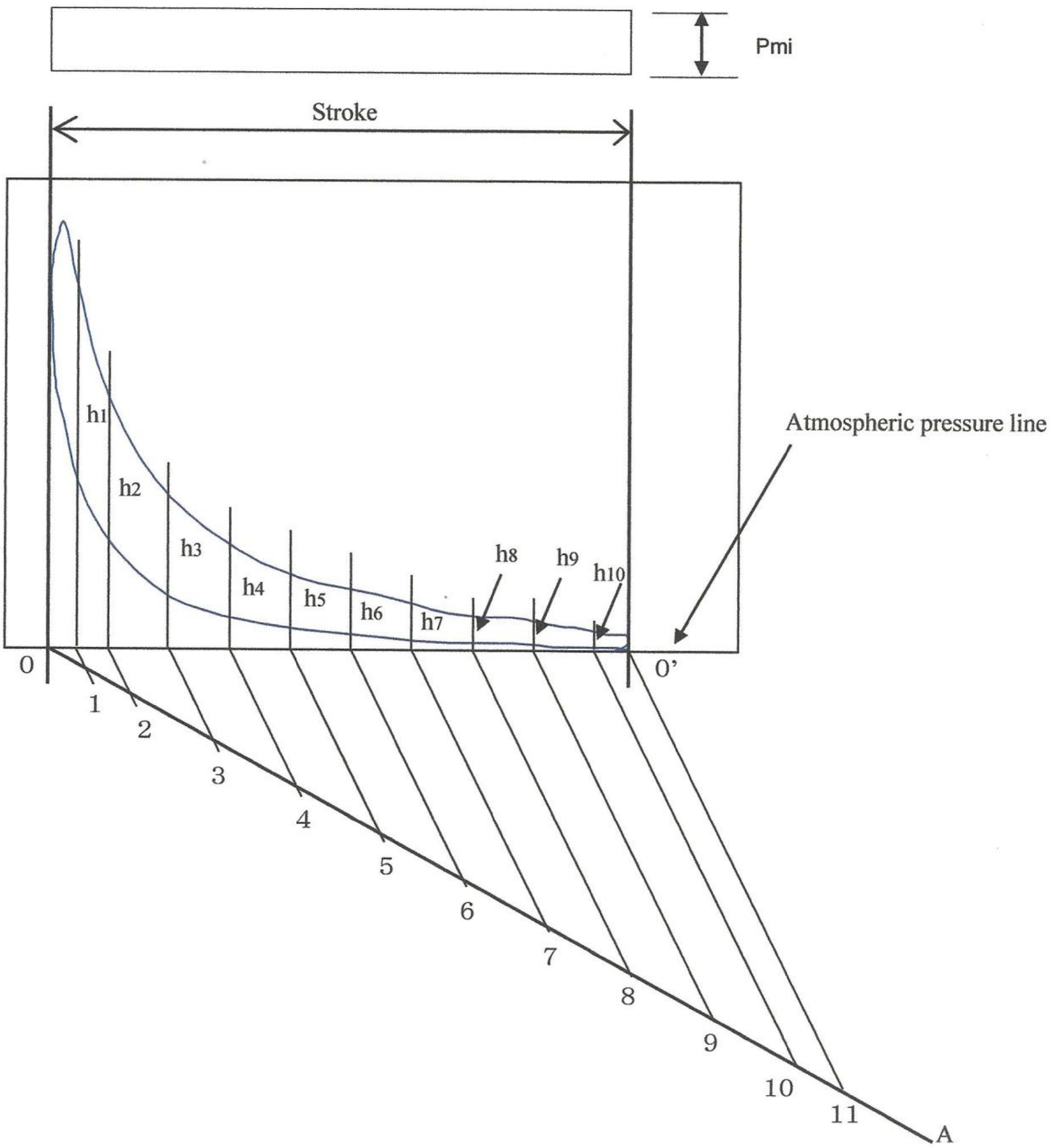
Sea condition: Wind: Load condition:

	Ship's speed		Rev. counter		Shaft output		Torque		FO flow meter	
1		Avg		min^{-1}		Avg		Avg		l/h
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										



Calculation of Mean effective Pressure and Shaft Output

An inner area of indicator diagram indicates output work per unit area produced by a piston and this can be calculated by determining mean effective pressure that is equivalent to height of the rectangle shown below. (The area of the rectangle indicates output power/works per unit area) "Ten divisions into equal method" can be applied to determine the mean effective pressure as follow.



$$\text{Measured value(mm)} = \frac{h_1 + h_2 + h_3 + \cdots + h_{10}}{10}$$

Pmi（Mpa）＝Measured value（mean）（mm）÷Spring constant of indicator
("Spring constant of indicator" is to be given)

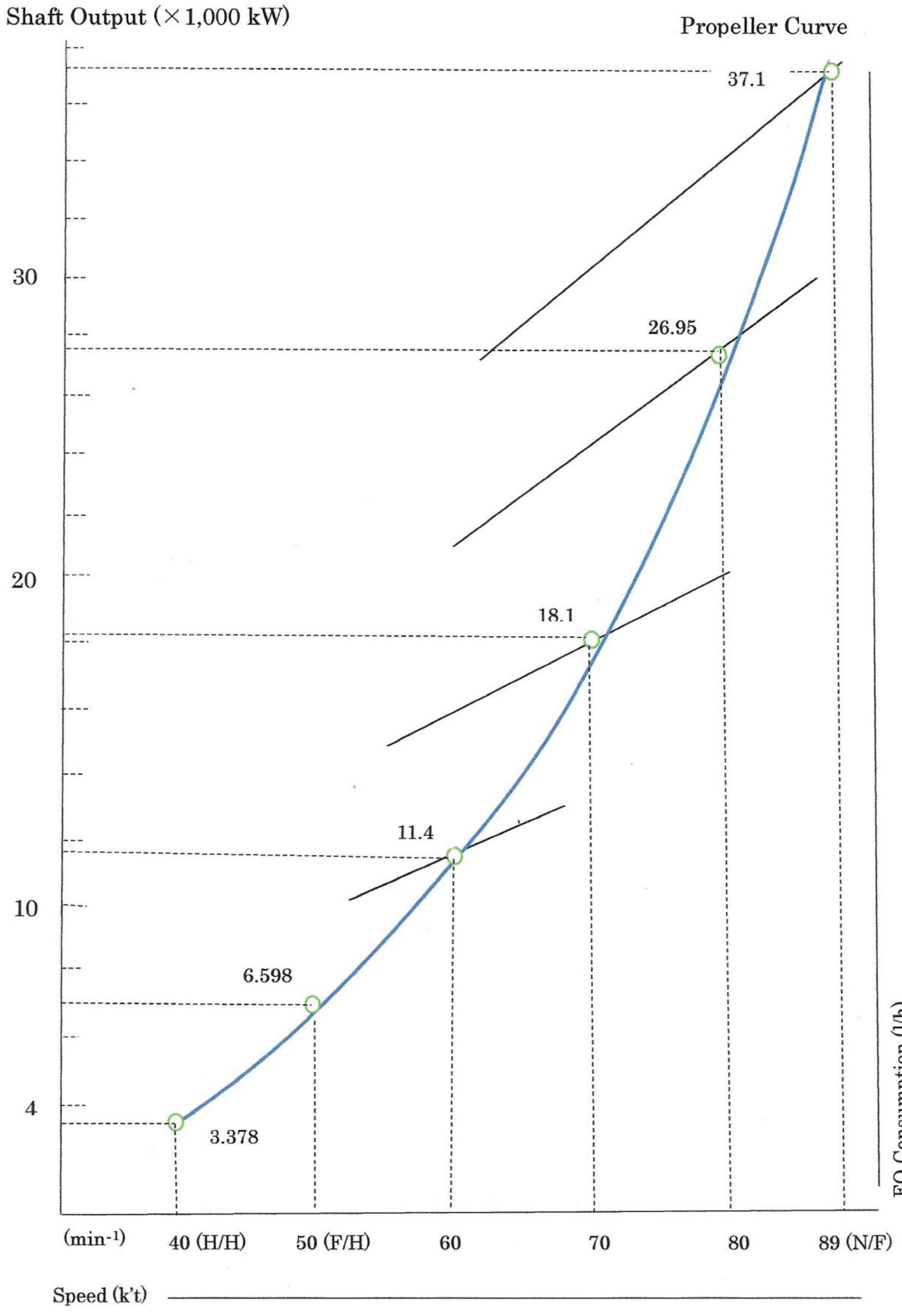
IHP (kW) = $P_{mi} \times 10.197162 \times A \times S \times \frac{N}{60} \times 0.00980665 \times Z \times i$

Pmi: Mean effective pressure (Mpa)
A: Area of cylinder/Piston (cm^2)
S: Stroke (m)
N: Revolution speed (min^{-1})
Z: Number of cylinder
i: Constant (1/2 for 4 stroke and 1 for 2 stroke)
Mpa = 10.197162 kgf/cm^2
1 kgfm/s = 0.00980665 (kW)

SHP (kW) = IHP $\times \eta$
SHP: Shaft horse power (kW)
η: Mechanical efficiency (To be given)

The trainees should calculate shaft output and results of the calculation should be compared with data from the monitoring system of the simulator.

Example of Shaft Output and Speed



ERS III – 10

Training Title/Scenario: Heat balance of marine diesel engine

	Performance
Group A	Data collection of 100 % MCR
	Reduction of engine speed to the revolution equivalent to 75 % MCR
Group B	Data collection of 75 % MCR
	Reduction of engine speed to the revolution equivalent to 50 % MCR
Group A	Data collection of 50 % MCR
	Reduction of engine speed to the revolution equivalent to 25 % MCR
Group B	Data collection of 25 % MCR

Prerequisite:

- Theoretical knowledge of thermal efficiency and engine characteristic curve.
- Theoretical knowledge on simple heat calculation

Note:

The instructor should prepare specific data collection tables and calculation methods based on the functions and specifications of the simulator since data obtained from the simulator differ from simulator to another. The instructor sometimes needs condition settings to simplify the calculation although their theories must be taught. The instructor may make the simulation speed faster than usual to facilitate the training accordingly and conducts a review session on the issue on a different day, giving the trainees enough time for calculation and developing the diagrams.

Specific purpose of the training:

The trainees acquire knowledge on calculation of thermal efficiency, heat balance diagram and engine characteristic performance curve.

Briefing session (30 min)

The instructor should explain:
- outline of the training
- how to carry on the training
- specific purpose of the training
- precaution on collecting data
- dada collection tables

- setting up revolution speed equivalent to engine loads

The instructor divide the trainees into two groups after the briefing.

Implementation of the training

After briefing, the instructor lets the trainees enter the control room and start the training as follow.

T in min	Training process
0 ~ 5	(The instructor creates Seagoing condition as an initial condition and starts the simulation. The instructor sets up 100 % MCR adjusting engine revolution speed and informs the trainees of that engine running condition will become stable in five minutes and your data collection must start 5 minutes later)
5 ~ 65	The group A takes readings of main engine revolution counter and fuel oil flow meter just at starting time of data collection. After taking readings of the counters, members of the group A work on collecting data on the mimic panel and data display of the simulator following the data collection tables. (The group B observes performance of the group A) The group A takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading.
65 ~ 80	After taking the second readings of the counters, the group A perform operation to reduce engine speed until the revolution speed equivalent to 75 % MCR. The group B prepares for data collection.
80~140	The group B takes readings of main engine revolution counter and fuel oil flow meter just at the time of starting data collection. After taking readings of the counters, members of the group B work on collecting data on the mimic panel and data display of the simulator following the data collection tables. (The group A observes performance of the group B) The group B takes reading of main engine revolution counter and fuel oil flow meter just at the time of 60 minutes later from the first reading.

140 ~ 290	(Data collections are to be continued in the same manner as the first collection until completion of collecting data of 25 % MCR. The instructor stop the simulator when the data collection is completed. The instructor lets the trainees move to the briefing room.)

Debriefing session (40 min)

The instructor should brief on the following showing examples of the diagrams:
- performance of the trainees as a while
- meaning of heat balance diagram and performance curve
- need to share all data among the trainees
- calculation methods

The instructor gives the trainees an assignment to calculate the thermal efficiency and all the trainees develop heat balance diagram and characteristic performance curve. The trainees must submit their development by the deadline as follow.

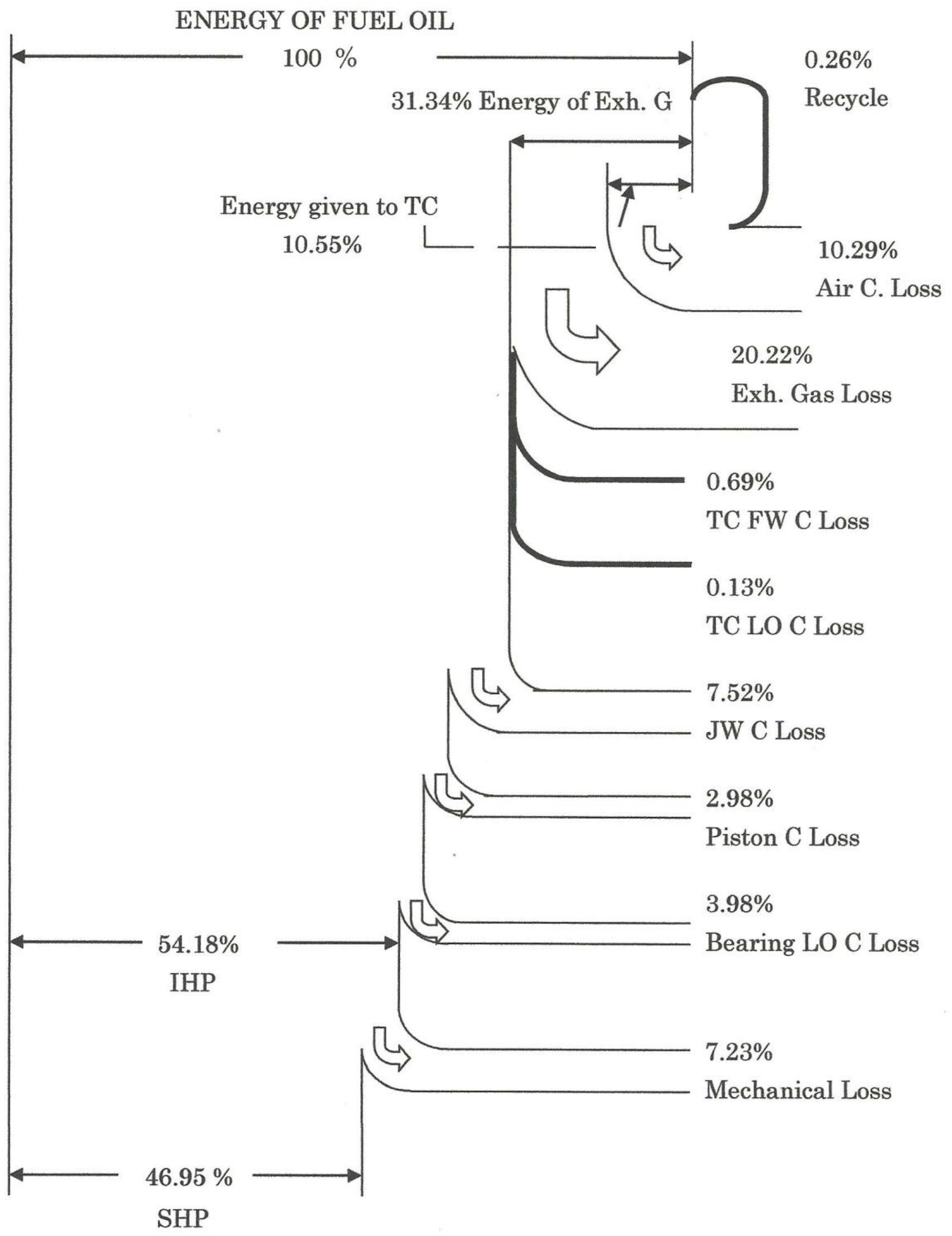
Each trainee of Group A	Measurement tables (100 and 50 % MCR) Calculation results (one half of trainees 100 or 50 % MCR) Heat balance diagram (100 and 50 % MCR) Performance curve
Each trainee of Group B	Measurement tables (75 and 25 % MCR) Calculation results (one half of trainees 75 or 25 % MCR) Heat balance diagram (75 and 25 % MCR) Performance curve

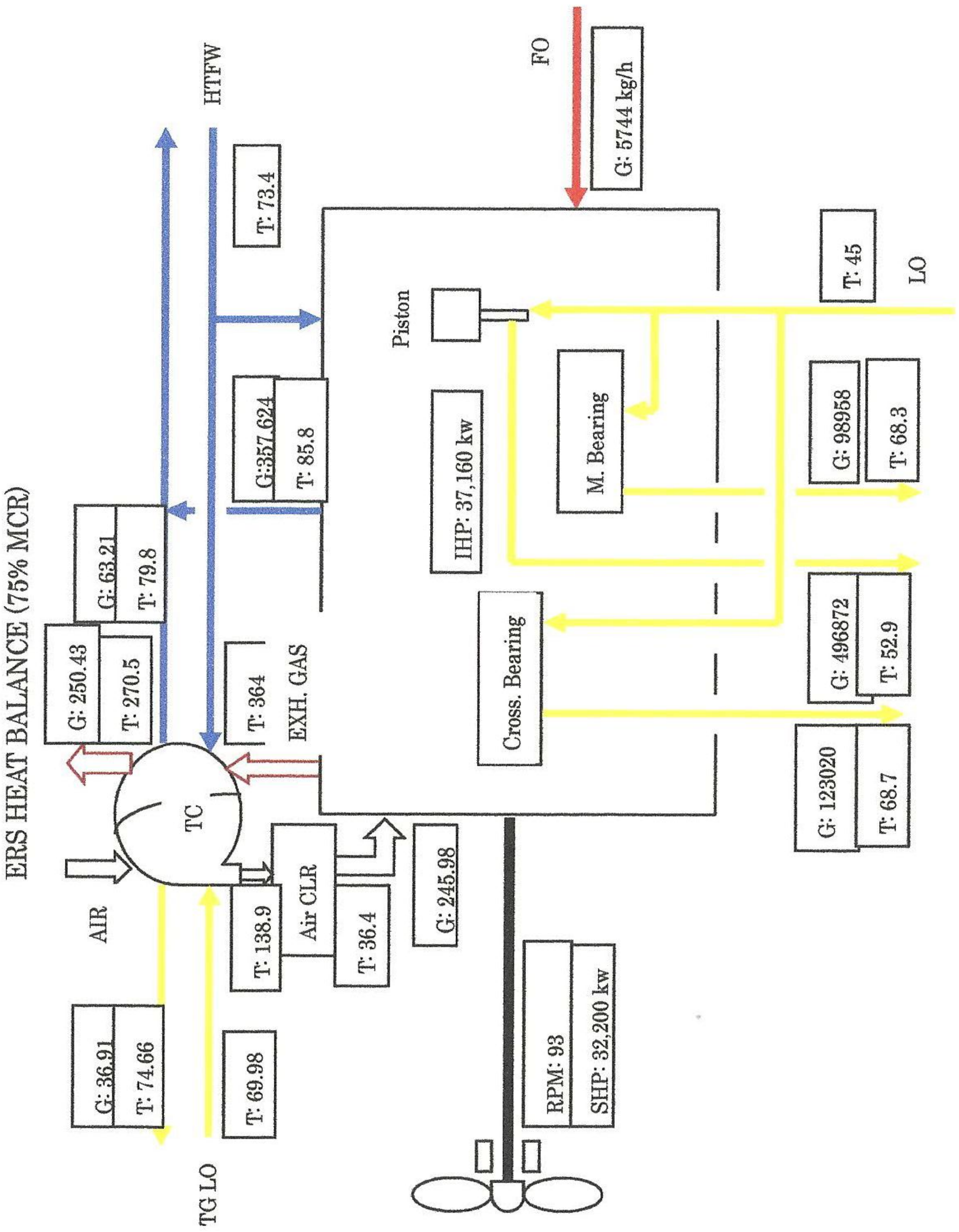
The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

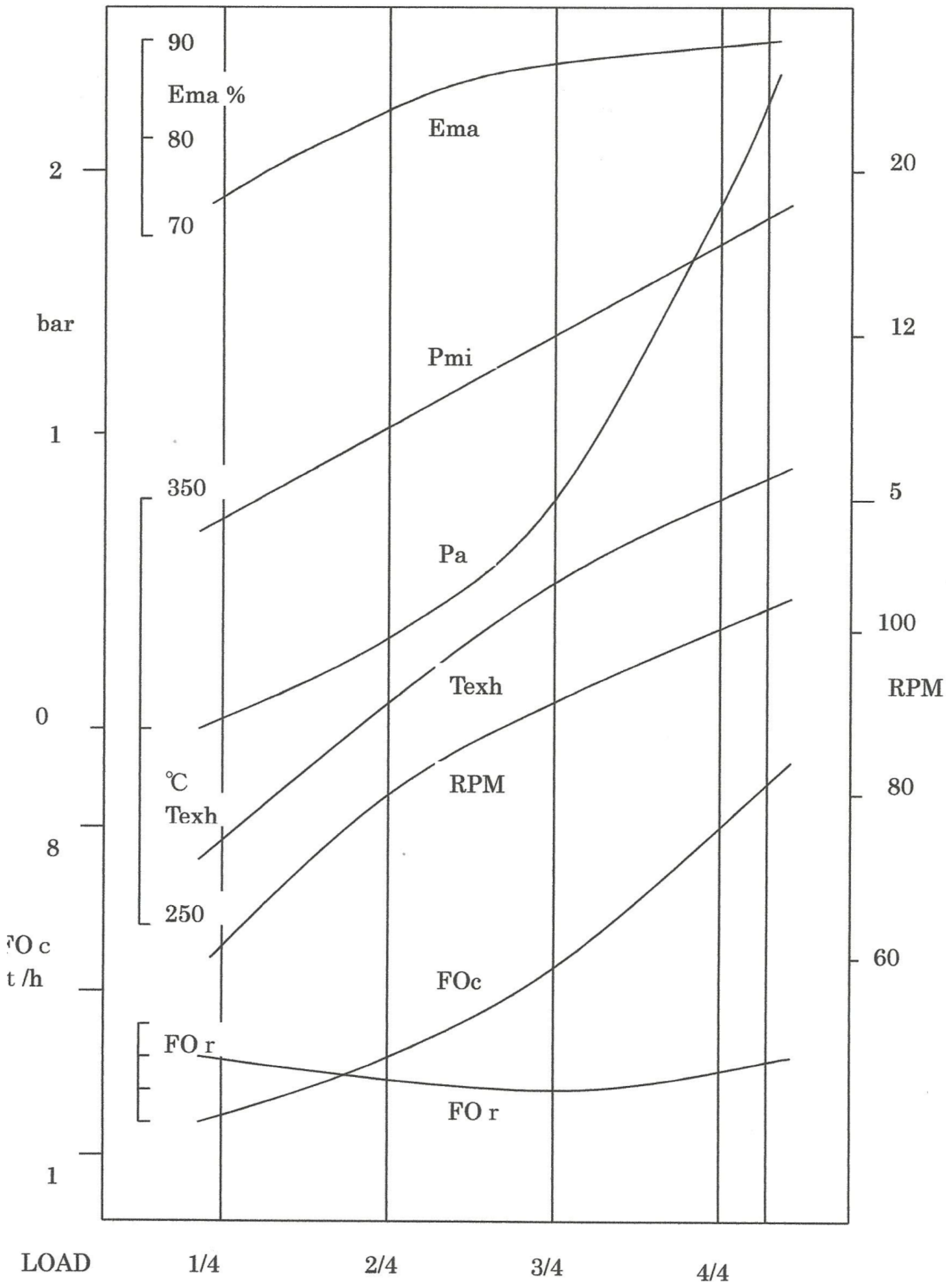
It would better for the trainees to hold a review session on a different day.
Evaluation should be done by their development.

Heat Balance (75% MCR)




ERS HEAT BALANCE (75% MCR)
HTFW
FO
G: 5744 kg/h
T: 73.4
T: 45
LO
Piston
M. Bearing
G:357.624
T: 85.8
IHP: 37,160 kw
G: 98958
T: 68.3
G: 63.21
T: 79.8
G: 250.43
T: 270.5
T: 364
EXH. GAS
Cross. Bearing
G: 496872
T: 52.9
G: 123020
T: 68.7
TC
AIR
Air CLR
T: 138.9
T: 36.4
G: 245.98
G: 36.91
T: 74.66
T: 69.98
TG LO
RPM: 93
SHP: 32,200 kw

Example of Engine Characteristic Curve



Ema : Mechanical Efficiency
Pmi : Mean Indicated Pressure
Pa : Scavenging Air Pressure
FOc : Fuel Oil Consumption
For : Fuel Oil Consumption Rate
Texh : Exhaust Gas Temperature

Calculation Method of Thermal Efficiency

Cylinder Bore and Number: 840 mm ×12
Stroke: 2400 mm
Number of TC: 3
Continuous Service Rating: 48.6 MW
Scavenging air pressure: 2.4 bar
TC revolution speed: 9500 min^{-1}

1. Indicated Horse Power (IHP)

IHP (kW) =Σ Pmi×10.197162×A×L×N×0.00980665 / 60 (kW)

1 Mpa: 10.197162 (kgf/cm^2)
A: Piston area =π×r^2 (cm^2)
L: Stroke 2.4 (m)
N: Revolution speed (min^{-1})
1 kgfm/s = 0.00980665 (kW)

2. Calorific value

1 (kW) = 860×4.18606 (kj/h)

1 (kW) = 860 (kcal/h)
1 (kcal) = 4.18605 (kj)

3. Mechanical efficiency

ηm = BHP×100 / IHP (%)

4. Fuel oil consumption rate

β = B ×1000 / IHP (g/kW･h)

B: Fuel oil consumption (kg/h)
(Flow meter reading ×Volume conversion factor×Density)

5. Total calorific value of fuel oil (Qb)

Qb = B × Qf ×Qatmo× Qfo (kj/h)

Qf: Calorific value of fuel oil = 4.18605 ×Qq (kj)
Qq: Low calorific value of fuel oil ~~= 10300 (kcal/kg)~~
Qatom: Conversion coefficient to atmosphere
Qfo: Conversion coefficient to calorific value

6. Heat loss by HTFW of ME (Qjw)

Qjw = Gjw (T out – T in) ×Cfw (kj/h)

Gjw: Quantity of Jacket water of ME (kg/h)
T out: Mean outlet temperature of Jacket water (℃)
T in : HTFW inlet temperature (℃)
Cfw: Specific heat of HTFW ~~= 4.18606~~ (kj/kg･K)

7. Heat loss by HTFW of TC

Qtcfw = Gtcfw (T out – T in) ×Cfw (kj/h)

Gtcfw: Quantity of TC HTFW (kg/h)
T out: Outlet temperature (℃)
T in: Inlet temperature (℃)

8. Heat loss by piston cooling LO (Qpis)

Qpis = Gpis (T out – T in) ×Clo (kj/h)

Gpis: Quantity of piston cooling LO (kg/h)
T out: Mean outlet temperature of piston cooling LO (℃)
T in: LO Inlet temperature (℃)
Clo: Specific heat of LO ~~= 1.8837~~ (kj/kg･K)

9. Heat loss by bearing LO (Qbea)

Qbea = Qmb + Qcro (kj/h)

Qmb: Heat loss by main bearing
Qcro: Heat loss by crosshead and crank pin

Qmb = Gmb (T out – T in) ×Clo (kj/h)

Gmb: Quantity of main bearing (kg/h)
= (Piston LO + Main bearing LO) – (Piston LO)
T out: Mean temperature of main bearing (℃)
T in: LO inlet temperature (℃)

Qcro = Gcro (T out – T in) ×Clo (kj/h)

Gcro = Crosshead and crank pin bearing LO (kg/h)
T out: Mean temperature of crosshead and crank pin (℃)
T in: LO inlet temperature (℃)

10. Heat loss by TC LO (Qtclo)

Qtclo = Gtclo (T out – T in) ×Clo (kj/h)

Gtclo: Quantity of TC LO (kg/h)
T out: Outlet temperature of TC LO (℃)
T in: Inlet temperature of TC LO (℃)
Clo: Specific heat of LO ~~= 1.8837~~ (kj/kg･K)

11. Heat loss by air cooler

Qair = Gair (T in – T out) ×Cair (kj/h)

Gair: Quantity of scavenging air (kg/h)
T in: Mean temperature of air cooler air inlet (℃)
T out: Mean temperature of air cooler air outlet (℃)
Cair: Specific heat of dry air ~~= 1.004652~~ (kj/kg･K)

12. Heat loss by exhaust gas (Qexh)

Qexh = Qb – (Qihp + Qc) (kj/h)

Qihp: Indicated horse power (kj/h)
Qc: Cooling loss = Qjw + Qtcfw + Qpis + Qbea + Qtclo +Qair

13. Heat given to TC (Qin)

(1) Qin = Gexh (Hin – Hout) (kj/h)

Gexh: Quantity of exhaust gas (kg/h)
Hin: Enthalpy of inlet gas (kj/kg)
Hout: Enthalpy of outlet gas (kj/kg)

(2) Qin = Ltc ×860×4.18605

Ltc: Total shaft power of TC (kW)

14. Energy of exhaust gas (Qgas)

Qgas = Qexh + Qair + Qtclo + Qtcfw (kj/h)

Calculation Table (1/3)

Load	Unit	25%	50%	75%	100%
Ship Load	%			97.79	
Wind Speed	m/s			0	
Wind Direction	deg			90	
Ship Speed	min^{-1}			22.98	
Revolution				93.11	
IHP (Calculation)	kw			37,159.56	
Calorific Value of IHP	kj/h			133,774,536	
Brake horse Power	kw			32,200.00	
Calosific Value of BHP	kj/h			115,920,097	
Mechanical Efficeiancy	%			86.65	
Fuel Consumption.	kg/h			5744	
Fuel Consum. Rate(IHP)	g/kwh			154.58	
Fuel Consum. Rate(SHP)	g/kwh			178.39	
Mean Temp. of Exh. Gas	℃			320.28	
Mean Revolution of TC	rpm			7830.4	
Press. of Scavenging Air	Mpa			0.222325	
Mean Pmi	Mpa			1.501	
Mean Pmax	Mpa			13.144	
Atmospheric Pressure	Mpa			0.10133	
Room Temperature	℃			44.12	
SW Temperature	℃			20	
Total Calorific V of FO	kj/h			246,912,230	
Calorific Value of FO	kj/kg			43120	
Conver. Coe.to Atmos.				0.996895	
Conver. Coe. to Cal. V				1	
Heat Loss by JW of ME	kj/h			18,578,166	
Specific Heat of HTFW	kj/kg			4.18605	
Diff. T. Inlet and Outlet	℃			12.41	
Flow rate of JW of ME	kg/h			357,624	
Heat Loss HTFW of TC	kj/h			1,698,733	
Specific Heat of HTFW	kj/kg			4.18605	
Diff. T. Inlet and Outlet	℃			6.42	
Flow rate of FW of TC	kg/h			63210	

Calculation Table (2/3)

Load	Unit	25%	50%	75%	100%
Loss by Piston C. LO	kj/h			7,356,628	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet & Outlet	℃			7.86	
Flow rate of Piston C LO	kg/h			496872	
Loss by Bearing Lo	kj/h			9,832,533	
Loss by Main Bearing LO	kj/h			4,335,831	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet & Outlet	℃			23.26	
Flow rate of M Bearing LO	kg/h			98958	
Loss by Cro. & C Pin LO	kj/h			5,496,701	
Specific Heat of LO	kj/h			1.8837	
Diff. T. Inlet & Outlet	℃			23.72	
Flow rate of Cro.& C LO	kg/h			123020	
Heat Loss of TC LO	kj/h			325,388	
Specific Heat of LO	kj/kg			1.8837	
Diff. T. Inlet and Outlet	℃			4.68	
Flow rate of TC LO	t/h			36910	
Heat Loss by Air Cooler	kj/h			25,419,205	
Specific Heat of Dry Air	kj/kg			1.004652	
Diff. T. Inlet and Outlet	℃			102.86	
Flow rate of Air	kg/h			245980	
Heat Loss by Exh. Gas	kj/h			49,927,040	
Heat given to TC	kj/h			26,295,150	
Diff. Enthalpy of E. Gas	kj/kg			105	
Flow rate of Exh. Gas	kg/h			250430	
TC Shaft Power(WS)	kj/h			24,350,780	
Energy of Exh. Gas	kj/h			77,370,367	

Calculation Table (3/3)

Load	Unit	25%	50%	75%	100%
Per. of Total Calo. Value	%			100.00	
Per. of Calo. V of IHP	%			54.18	
Per. of Calo. V of SHP	%			46.95	
Per. of Loss ME HTFW	%			7.52	
Per. of Loss TC HTFW	%			0.69	
Per. of Loss Piston C LO	%			2.98	
Per. of Loss Bearing LO	%			3.98	
Per. of Loss TC LO	%			0.13	
Per. of Loss Air Cooler	%			10.29	
Per. of Loss Exh. Gas	%			20.22	
Per. of Heat given to TC	%			9.86	
Per. of Ehx. Gas Energy	%			31.34	
Per. of Mechanical Loss	%			7.23	
Per. of Heat given to TC2	%			10.65	

Data Collection Table (1/5)

Load	unit	25%	50%	75%	100%
Ship Load	%			97.79	
Wind Speed	m/s			0	
Wind Direction	deg			90	
Revolution	min^{-1}			93.11	
Speed	knot			22.98	
Shaft Power	MW			32.2	
Fuel Link Position	%			59.25	
Atmospheric Pressure	mmWL			0.44	
Eng. Room Temp.	℃			44.12	
Air Humidity	%			90	
SW Temperature	℃			20	
IHP-1	kW			3095	
IHP-2	kW			3098	
IHP-3	kW			3103	
IHP-4	kW			3101	
IHP-5	kW			3099	
IHP-6	kW			3090	
IHP-7	kW			3091	
IHP-8	kW			3097	
IHP-9	kW			3103	
IHP-10	kW			3102	
IHP-11	kW			3098	
IHP-12	kW			3091	
Pmi-1	Mpa			1.5	
Pmi-2	Mpa			1.501	
Pmi-3	Mpa			1.504	
Pmi-4	Mpa			1.503	
Pmi-5	Mpa			1.502	
Pmi-6	Mpa			1.498	
Pmi-7	Mpa			1.498	
Pmi-8	Mpa			1.501	
Pmi-9	Mpa			1.504	
Pmi-10	Mpa			1.503	
Pmi-11	Mpa			1.501	
Pmi-12	Mpa			1.498	

Data Collection Table (2/5)

Load	unit	25%	50%	75%	100%
FO Consumption	kg/h			5744	
FO Temperature	℃			132.34	
HTFW Inlet Temp.	℃			73.41	
Quan. of HTFW Inlet	t/h			413.76	
Quantity of TC HTFW	t/h			63.21	
TC HTFW Outlet T.	℃			79.83	
HTFW Outlet Temp	℃			84.91	
HTFW Outlet T-1	℃			85.68	
HTFW Outlet T-2	℃			85.79	
HTFW Outlet T-3	℃			85.94	
HTFW Outlet T-4	℃			85.91	
HTFW Outlet T-5	℃			86.11	
HTFW Outlet T-6	℃			86.12	
HTFW Outlet T-7	℃			85.52	
HTFW Outlet T-8	℃			85.69	
HTFW Outlet T-9	℃			85.8	
HTFW Outlet T-10	℃			85.73	
HTFW Outlet T-11	℃			85.69	
HTFW Outlet T-12	℃			85.91	
Flow rate of HTFW-1	kg/s			8.19	
Flow rate of HTFW-2	kg/s			8.11	
Flow rate of HTFW-3	kg/s			8.03	
Flow rate of HTFW-4	kg/s			8.11	
Flow rate of HTFW-5	kg/s			9.95	
Flow rate of HTFW-6	kg/s			7.87	
Flow rate of HTFW-7	kg/s			8.28	
Flow rate of HTFW-8	kg/s			8.19	
Flow rate of HTFW-9	kg/s			8.11	
Flow rate of HTFW-10	kg/s			8.19	
Flow rate of HTFW-11	kg/s			8.28	
Flow rate of HTFW-12	kg/s			8.03	
LO Inlet Temperature	℃			44.99	
LO Outlet Temp	℃			51.71	
Flow rate of PC & Ber LO	t/h			595.83	
Flow rate of C head LO	t/h			123.02	

Data Collection Table (3/5)

Load	unit	25%	50%	75%	100%
Pis. C LO Outlet T-1	℃			52.75	
Pis. C LO Outlet T-2	℃			52.82	
Pis. C LO Outlet T-3	℃			52.92	
Pis. C LO Outlet T-4	℃			52.88	
Pis. C LO Outlet T-5	℃			52.84	
Pis. C LO Outlet T-6	℃			52.7	
Pis. C LO Outlet T-7	℃			52.75	
Pis. C LO Outlet T-8	℃			52.88	
Pis. C LO Outlet T-9	℃			52.94	
Pis. C LO Outlet T-10	℃			52.88	
Pis. C LO Outlet T-11	℃			52.87	
Pis. C LO Outlet T-12	℃			52.93	
Flow rate of PC LO-1	kg/s			11.63	
Flow rate of PC LO-2	kg/s			11.52	
Flow rate of PC LO-3	kg/s			11.4	
Flow rate of PC LO-4	kg/s			11.52	
Flow rate of PC LO-5	kg/s			11.63	
Flow rate of PC LO-6	kg/s			11.75	
Flow rate of PC LO-7	kg/s			11.54	
Flow rate of PC LO-8	kg/s			11.42	
Flow rate of PC LO-9	kg/s			11.34	
Flow rate of PC LO-10	kg/s			11.42	
Flow rate of PC LO-11	kg/s			11.54	
Flow rate of PC LO-12	kg/s			11.31	
Main Bearing T-1	℃			69	
Main Bearing T-2	℃			69	
Main Bearing T-3	℃			68	
Main Bearing T-4	℃			68	
Main Bearing T-5	℃			68	
Main Bearing T-6	℃			68	
Main Bearing T-7	℃			68	
Main Bearing T-8	℃			68	
Main Bearing T-9	℃			68	
Main Bearing T-10	℃			68	
Main Bearing T-11	℃			68	
Main Bearing T-12	℃			69	

Data Collection Table (4/5)

Load	unit	25%	50%	75%	100%
Crosshead Bea.T-1	℃			73	
Crosshead Bea.T-2	℃			73	
Crosshead Bea.T-3	℃			73	
Crosshead Bea.T-4	℃			73	
Crosshead Bea.T-5	℃			73	
Crosshead Bea.T-6	℃			73	
Crosshead Bea.T-7	℃			72	
Crosshead Bea.T-8	℃			73	
Crosshead Bea.T-9	℃			73	
Crosshead Bea.T-10	℃			74	
Crosshead Bea.T-11	℃			73	
Crosshead Bea.T-12	℃			74	
Crank Pin Bea.T-1	℃			70	
Crank Pin Bea.T-2	℃			70	
Crank Pin Bea.T-3	℃			70	
Crank Pin Bea.T-4	℃			69	
Crank Pin Bea.T-5	℃			70	
Crank Pin Bea.T-6	℃			70	
Crank Pin Bea.T-7	℃			70	
Crank Pin Bea.T-8	℃			70	
Crank Pin Bea.T-9	℃			70	
Crank Pin Bea.T-10	℃			70	
Crank Pin Bea.T-11	℃			70	
Crank Pin Bea.T-12	℃			71	
TC LO Inlet Temp	℃			69.98	
TC LO Outlet Temp	℃			74.66	
Flow rate of TC LO	t/h			36.91	
Flow rate of TC E.G-1	t/h			83.44	
Flow rate of TC E.G-2	t/h			83.07	
Flow rate of TC E.G-3	t/h			83.92	
TC Exh. G Inlet T-1	℃			365.16	
TC Exh. G Inlet T-2	℃			364.11	
TC Exh. G Inlet T-3	℃			363.56	
TC Exh. G Outlet T-1	℃			270.56	
TC Exh. G Outlet T-2	℃			270.15	
TC Exh. G Outlet T-3	℃			270.73	

Data Collection Table (5/5)

Load	unit	25%	50%	75%	100%
TC Revolution-1	min^{-1}			7849.2	
TC Revolution-2	min^{-1}			7818	
TC Revolution-3	min^{-1}			7824	
TC Shaft Power-1	kW			2260.9	
TC Shaft Power-2	kW			2243.1	
TC Shaft Power-3	kW			2260.1	
TC Filter Diff. Press-1	mmWL			44.83	
TC Filter Diff. Press-2	mmWL			45.7	
TC Filter Diff. Press-3	mmWL			45.96	
Air Cooler Air Inlet T-1	℃			138.85	
Air Cooler Air Inlet T-2	℃			139.32	
Air Cooler Air Inlet T-3	℃			139.69	
Air Cooler Air Out T-1	℃			36.45	
Air Cooler Air Out T-2	℃			36.39	
Air Cooler Air Out T-3	℃			36.45	
Flow rate of Air-1	t/h			82.71	
Flow rate of Air-2	t/h			81.54	
Flow rate of Air-3	t/h			81.73	
Scavenging Air Press	Mpa			0.121	
Scavenging Air Temp	℃			36.45	
Exh Gas Temp.-1	℃			313.57	
Exh Gas Temp.-2	℃			317.7	
Exh Gas Temp.-3	℃			323.13	
Exh Gas Temp.-4	℃			323.83	
Exh Gas Temp.-5	℃			327.81	
Exh Gas Temp.-6	℃			322.78	
Exh Gas Temp.-7	℃			316.31	
Exh Gas Temp.-8	℃			325.29	
Exh Gas Temp.-9	℃			321.89	
Exh Gas Temp.-10	℃			314.62	
Exh Gas Temp.-11	℃			320.48	
Exh Gas Temp.-12	℃			315.91	
Mean Exh. Gas Temp.	℃			320.28	

ERS III – 11

Training Title/Scenario: Operation of main propulsion and auxiliary machinery

Table A-III/1 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery
Table A-III/1 KUP: Start up and shut down main propulsion and auxiliary machinery, including associated systems

Time allocation: 3 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

4 ~ 5 trainees perform warming up, starting up and shutting/cooling down operation of the main engine as a group and each trainee handles the maneuvering lever to control the engine revolution responding to the telegraph order.

Initial Condition:

In port

Form of Training:

4 ~ 5 trainees establish a group and the group perform the operations. The trainees may refer to a procedure manual prepared by instructors.

Prerequisite:

Knowledge of principles on warming up procedures of middle and large sized marine diesel engine

Note:

As far as warming up concerned, almost same procedures as ERS III – 4 (ERM Training) will be carried out. However, this training focuses on operation of the main diesel engine only.

Specific purpose of the training:

The trainees acquire knowledge and skills on warming up, starting up and shutting down main diesel engines.

Briefing session for the first stage (30 min)

Instructor should explain:
- outline of the training
- how to carry on the training
- purposes of starting each machinery and establishing systems
- procedures for warming up, starting up and shutting/cooling down the main engine
- standards of warming up and cooling down
- significance of keeping correct sequence of the procedures to prevent damage
- needs to check running condition when starting up the engine
- what should be checked during trial run of the engine

Implementation of the training

After briefing, the instructor let the trainees enter the engine room and start the training as follow. (The following says main procedures to perform operations of warming up, starting up and shutting/cooling down main engine. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage

T in min	Training process
0 ~ 60	(The instructor creates In port condition as an initial condition and starts simulation.) The trainees perform the operations on the mimic panel as a group. Check the main engine for level of LO sump tank, FW expansion tank, Cylinder oil supply tank and Stern tube LO sump tank Start LO purifier and begin bypass purifying. Start No. 1 HTFW pump and establish HTFW system. Begin warming up main engine supplying preheater with steam. Start No. 1 LO pumps and establish LO system including TC LO system. Start No. 1 FO pumps and establish FO system. (DO use) Start No. 1 Stern tube LO pump and establish stern tube LO system.

	Confirm HTFW temperature above 70℃ and LO temperature above 40℃. Stop heating of HTFW. Make sure all indicator valves opened Engage turning gear and begin turning of the engine confirming current value of turning motor within standard and supplying the engine with cylinder oil. Stop the turning and disengage the turning gear. Make parallel running of main air compressors. Line up starting air line to the engine. Set control position of the engine to engine side/engine room. Reset abnormal, if any. (From this stage, as far as handling of the main engine concerned, it is to be done by the trainees in turn as follow) (Trainee T1) Start up the engine with air only for 1 ~ 2 rotations. Close all indicator valves. Start auxiliary blowers and perform starting up the engine in ahead side (Dead slow). Confirm fuel rack position, fuel oil injection, increase of exhaust gas temperature, increase of TC revolution speed and LO pressure. Stop the engine moving maneuvering lever to stop position and stop the auxiliary blowers. (Trainee T2) Start auxiliary blowers and perform starting up the engine in astern side (Dead slow). Confirm fuel rack position, fuel oil injection, increase of exhaust gas temperature, increase of TC revolution speed and LO pressure. Stop the engine moving maneuvering lever to stop position and stop the auxiliary blowers. Move the control position to the control room. Set maneuvering mode to auto. (Trainee T3) Perform starting up the engine at slow ahead and make sure automatic

	change-over of air run to fuel run and main running parameters. Stop the engine and confirm the auxiliary blowers stop. (Trainee T4) Perform starting up the engine at slow astern and make sure automatic change-over of air run to fuel run and the running parameters. Stop the engine and confirm the auxiliary blowers stop. Start No. 1 boiler water circulation pump and establish the system. Start engine room fans. (The instructor sets sub-telegraph to Standby Engine) (Trainee T5) Respond to the sub-telegraph at the engine console. (The instructor sets the engine telegraph to "Half ahead". Respond to the telegraph. Perform starting up the engine at half ahead and make sure automatic change-over of air run to fuel run and the running parameters. (The instructor sets the telegraph to "Full ahead" after a while) Respond to the telegraph. Increase the revolution speed until full ahead and confirm the main running parameters. (The instructor sets the sub-telegraph to "Full way" after a while) Respond to the sub-telegraph at the control console. Set the maneuvering lever to the position of sea going / navigation full confirming load up program activated. Put VIT (Variable Injection Timing) and VEC (Various Exhaust Control) into service (Group performance) Perform change-over of fuel oil to HFO supplying No. 1 FO heater and tracing line with steam. Set FO viscosity controller to auto at the predetermined setting value. Make single running of main air compressor and close starting air supply line. Set damper control of exhaust boiler to auto at predetermined setting value. Adjust air cooler LTFW outlet valves according to scavenging air temperature. Confirm revolution speed of the main engine reaches to navigation full speed by the

	load up program. Confirm main running parameters of the engine. (Main engine revolution speed, TC revolution speed, shaft output, fuel rack, etc.) (This is end of the 1st stage. The instructor stops the simulation temporarily and may give the trainees a break time)

2nd stage

T in min	Training process
0 ~ 60	(The instructor resumes the simulation and informs the trainees of request of standby engine using communication equipment) Perform reduction of the engine speed until harbor/standby full speed. Perform change-over of fuel oil to DO, stopping supply of steam to No. 1 FO heater and tracing line and setting the viscosity controller to man. Put VIT and VEC out of service. Set damper control of the exhaust boiler to man. Adjust air cooler LTFW outlet valves according to scavenging air temperature. Make parallel running of main air compressors and line up starting air supply line. (When the engine speed reaches to standby full speed, the instructor sets sub-telegraph to Standby engine informing the trainees of that various engine order will be issued and the trainees respond to the engine maneuvering order and controls the engine speed paying due attention to behaviors of remote control system and main running parameters) (Trainee T1) Respond to the request of standby engine. (The instructor sets engine telegraph to "Half ahead" Respond to the telegraph, adjusting the engine speed to "Half ahead". (The instructor sets the engine telegraph to "Slow ahead" after a while) Respond to the telegraph adjusting the engine speed to "Slow ahead". (The instructor sets the engine telegraph to "Stop engine". Respond to the telegraph moving the maneuvering lever to "Stop".

	(The instructor sets the engine telegraph to "Slow astern" after a while) (Trainee T2) Respond to the telegraph adjusting the engine speed to "Slow astern". (The instructor sets the engine telegraph to "Full astern" Respond to the telegraph adjusting the engine speed to "Full astern". (The instructor sets the engine telegraph to "Stop". Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor sets the engine telegraph to "Half ahead" after a while) (Trainee T3) Respond to the telegraph adjusting the engine speed to "Half ahead". (The instructor set the engine telegraph to "Slow aster". Respond to the telegraph adjusting the engine speed to "Slow ahead". (If crash astern is detected, manual control of the engine speed will not be functional. In such a case, maneuver the engine lever accordingly watching the revolution and fuel rack) (The instructor sets the engine telegraph to "Stop" after a while) Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor set the engine telegraph to "Dead slow". (Trainee T4) Respond to the telegraph adjusting the engine speed to "Dead slow". (The instructor sets the engine telegraph to "Full astern" after a while) Respond to the telegraph adjusting the engine speed to "Full astern". (The instructor sets the engine telegraph to "Stop") Respond to the telegraph moving the maneuvering lever to "Stop". (The instructor sets the sub-telegraph to "Finish with engine") (Trainee T5) Respond to the sub-telegraph saying that finish with engine, open all indicators valves.

	(Trainees T1 ~ T4 open the indicator valves and report it to T5) T5 changes over the control mode to man and start the engine with air only for 1 ~ 2 rotations. (The instructor informs the trainees of that the trainees begin to perform shutting/cooling down operation from now) Engage turning gear and begin turning of the main engine supplying the engine with cylinder oil. Stop No. 1 boiler water circulating pump and close valves concerned. Close starting air line to the main engine and make single running of main air compressor. Stop No. 1 FO pumps and close valves concerned in FO supply system. After a while, stop the turning of the engine. Stop No. 1 stern tube LO pump and close valves concerned in the system. Stop No. 1 LO pumps and close valves concerned in the system. Stop No. 1 HTFW LO pump and close valves concerned in the system. Stop LO purifier. (This is end of the 2nd stage and the instructor stop the simulation. The trainees move to the briefing room.)

Debriefing session (30 min)

The instructor expresses his/her impression first as a while and explains meaning and significance of handling a main engine. From this aspect, the engine must be checked frequently in terms of running parameters other than diagnoses of the engine performance.

The instructor should brief on:

- fundamental sequence of warming up and shutting/cooling down the engine
- standards of warming up and cooling down
- limitation of main running parameters

The instructor gives trainees "TRAINEE'S REOPT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 11

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Operation of main propulsion and auxiliary machinery
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
6. Checking main engine and preparation (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
7. Warming up procedures (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
8. Handling main engine (If handling of main engine was correct, smooth and confident)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
9. Shutting down main engine (If procedures were correct and smooth. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
10. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ____________________________

ERS III – 12

Training Title/Scenario: Efficient operation, surveillance, performance assessment of propulsion plant and auxiliary machinery

Table A-III/1 Competence: Operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Table A-III/1 KUP: The efficient operation, surveillance, performance assessment and maintaining safety of propulsion plant and auxiliary machinery

Time allocation: 4 hours
Number of Trainees: 4 ~ 5
Number of Instructors: 2

Outline of the training:

4 ~ 5 trainees perform operations as a group to address heavy weather (1st stage) and malfunctions of the machinery (2nd stage), assessing the running parameters and conditions

Initial Condition:

Seagoing

Form of Training:

4 ~ 5 trainees establish a group and the group perform operations to address various situations.

Prerequisite:

- Knowledge on running limitation of propulsion machinery
- Knowledge on how to address malfunctions of propulsion plant machinery

Note:

The instructor should select malfunctions according to ability of the trainees and may advise the trainees of procedures to be taken to address the malfunctions where necessary.

Specific purpose of the training:

The trainees acquire knowledge on how to address malfunctions of machinery, assessing running parameters and conditions.

Briefing session for the first stage (30 min)

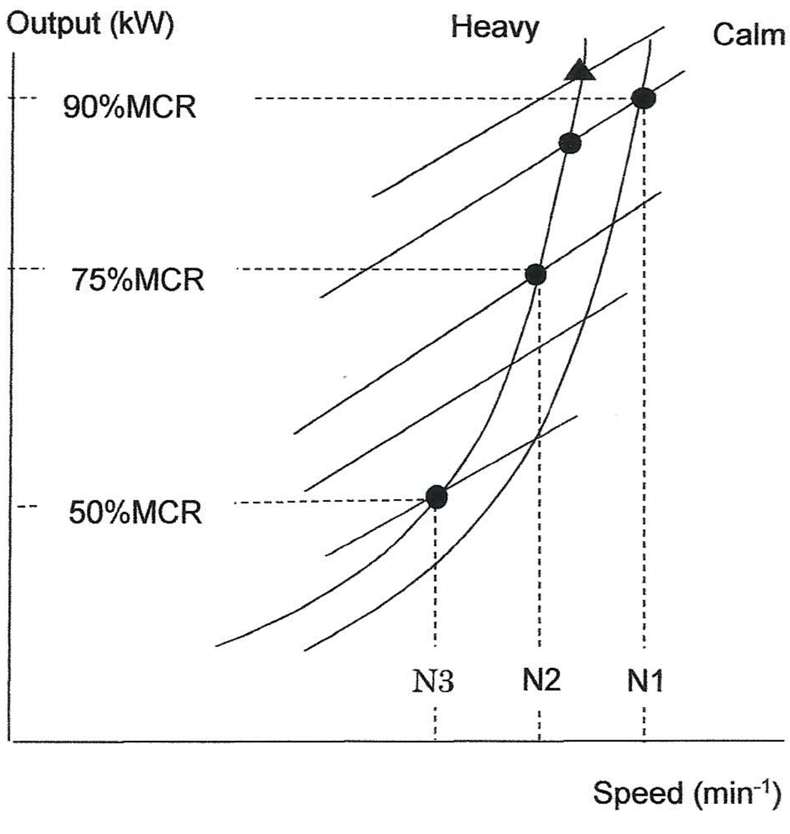
Instructor should explain:
- outline of the training
- how to carry on the training
- briefly changes in running parameters under heavier weather
- example of malfunctions and how to address the malfunctions
- assessment of running parameters and its limitation of machinery using examples

Implementation of the training

After briefing, instructors let the trainees enter the engine room and start the training as follow. (The following says main procedures to perform operations. Detail and specific procedures should be developed and prepared for the trainees according to specifications and functions of each simulator.)

1st Stage

T in min	Training process
0 ~ 30	(The instructor creates Seagoing condition as an initial condition (85 ~ 90 % MCR, TG and FWG are in service) and starts the simulation. The instructor lets the trainees enter the control room and confirm the running conditions of the propulsion machinery) The trainees confirm the running conditions of the main engine by filling out measurement tables and print out indicator diagrams (Cylinder indication pressure/stroke diagram and cylinder indication pressure/crank angle diagram) for No.1, 2 and 3 cylinders. (All data can be obtained from data display of the simulator) (The instructor creates a heavy weather) After a while, the trainees record the running parameters using the measurement tables and print out the indicator diagram. The trainees assess the data and figure out the changes in the running parameters and take actions necessary. (Generally, when a weather condition becomes heavy, engine output will become

	higher with increase of hull resistance, if the engine speed is kept at the same revolution speed as before the heavy weather. Usually the engine revolution speed will go down due to the heavy weather and the engine output also goes down in case of a diesel engine however, the engine output and torque must higher than the standard against the same speed under calm weather. These phenomenon causes "torque rich" and other impacts (higher exhaust gas temperature, TC surging, etc.) on the running conditions of the main engine) The trainees assess the running conditions using output/speed diagram (propeller curve) and predicting movement of the main engine running point (new output and revolution speed), and decide measures taking into account the situations.
30 ~ 90	 The trainees report the decision to the instructor as follow and begin the operations. - We decrease the engine speed to equivalent speed of 75 % MCR The trainees change –over the control position to the control room and control mode of the engine to man. The trainees decrease the engine speed to the predetermined speed. (The trainees calculate value of N2 before decreasing revolution speed) After decrease of the engine speed, the trainees record the running parameters of

	the engine using measurement tables and print out the indicator diagram. The trainees also confirm the running condition of other systems such as power generation, FWG and steam generation systems. (The trainees assess the running conditions of the engine in terms of output, P_{mi}, P_{max} and exhaust gas temperature for the new revolution speed, and impacts on power generation system. Then the trainees decide to decrease the engine revolution to equivalent speed of 50 % MCR) The trainees report the decision to the instructor and begin the operation to decrease the revolution speed as follow. - We decrease the engine speed to equivalent speed of 50 % MCR. - We change over power generation to No. 1 diesel generator from Turbo generator (TG). - We stop FWG and start auxiliary boiler. The trainees begin the operations as follow. Start No. 1 diesel generator remotely and change over automatically the power generation to No. 1 diesel generator to TG Stop TG and close steam valves concerned beginning turning of TG. (Condenser vacuum, condensate system and LO system may be kept in a working condition) Stop supply of HTFW and feedwater to FWG and stop Distilled water pump. (Vacuum may be kept as it is) The trainees decrease the engine revolution speed to the predetermined speed. After decrease of the engine speed, the trainees record the running parameters of the engine using measurement tables and print out the indicator diagram. (This is end of the 1st stage. When the trainees fill out the measurement tables and print out the indicator diagrams, the instructor stop the simulation. The instructor may give the trainees a break time)

Measurement Table (1/2)

Time					
Sea condition					
Wind Speed	m/s				
Wind Direction	deg				
SW Temperature	℃				
Eng. room Temp.	℃				
Ship Load	%				
Rev. speed	min^{-1}				
Rev. counter	10 min				
Ship's speed	knot				
Shaft Power	MW				
Pump mark					
Fuel oil consumption	kg/h				
FO flow meter	30 min				
FO Temperature					
TC Rev. speed 1	min^{-1}				
TC Rev. speed 2	min^{-1}				
TC Rev. speed 3	min^{-1}				
Scavenging air Temp.	℃				
Scavenging air Press.	Mpa				
Quantity of scav. air	kg/h				
IHP-1	kW				
IHP-2	kW				
IHP-3	kW				
IHP-4	kW				
IHP-5	kW				
IHP-6	kW				
IHP-7	kW				
IHP-8	kW				
IHP-9	kW				
IHP-10	kW				
IHP-11	kW				
IHP-12	kW				

Measurement Table (2/2)

Time					
Pmi-1	Mpa				
Pmi-2	Mpa				
Pmi-3	Mpa				
Pmi-4	Mpa				
Pmi-5	Mpa				
Pmi-6	Mpa				
Pmi-7	Mpa				
Pmi-8	Mpa				
Pmi-9	Mpa				
Pmi-10	Mpa				
Pmi-11	Mpa				
Pmi-12	Mpa				
Pmax-1	Mpa				
Pmax-2	Mpa				
Pmax-3	Mpa				
Pmax-4	Mpa				
Pmax-5	Mpa				
Pmax-6	Mpa				
Pmax-7	Mpa				
Pmax-8	Mpa				
Pmax-9	Mpa				
Pmax-10	Mpa				
Pmax-11	Mpa				
Pmax-12	Mpa				
Exh. Gas Temp-1	℃				
Exh. Gas Temp-2	℃				
Exh. Gas Temp-3	℃				
Exh. Gas Temp-4	℃				
Exh. Gas Temp-5	℃				
Exh. Gas Temp-6	℃				
Exh. Gas Temp-7	℃				
Exh. Gas Temp-8	℃				
Exh. Gas Temp-9	℃				
Exh. Gas Temp-10	℃				
Exh. Gas Temp-11	℃				
Exh. Gas Temp-12	℃				

2nd stage

T in min	
0 ~ 90	(The instructor creates Seagoing condition as an initial condition and starts the simulation) The trainees enter the control room and confirm the running conditions of the propulsion machinery. (After a while, the instructor informs the trainees of beginning of the training and creates first malfunction) **Engine room bilge well high level alarm** The trainees confirm the alarm and assess the situation, preparing for starting bilge pump and transfer the bilge to bilge tank. (If there is no space in the bilge tank, discharge bilge of the bilge tank first and transfer the bilge to the bilge tank complying with the regulations concerned) (The instructor confirm the situation and creates second malfunction) **No. 1 FO settling tank low level alarm** The trainees confirm the alarm and assess the level, level of bunker tank in use, running parameter of FO transfer pump and status of valves concerned and take actions to increase the level. (The instructor confirm the situation and creates third malfunction) **FWG high salinity alarm** The trainees confirm the alarm and assess value of salinity, distilled water level, HTFW temperature, opening of HTFW bypass valve, flow rate of feedwater, vacuum, temperature of evaporation and adjust some of the running parameters to reduce the content of salinity. (The instructor confirm the situation and creates fourth malfunction) **Auxiliary boiler low water level alarm** The trainees confirm the alarm and assess the level, opening of FWC valve, running parameters of feedwater pump, cascade tank level, control parameters of FWC controller and take actions to increase the level. (The instructor confirm the situation and creates fifth malfunction)

	No. 1 FO purifier abnormal separation alarm The trainees confirm the alarm and assess running parameters of the FO purifier, resetting the purifier. The trainees need to decide actions to be taken from the results of assessment as follow. - Take actions to manually resume the operation of the purifier - Take actions to stop the purifier and restart it as usual - Take actions to change over the purifier to No. 2 FO purifier. (The instructor confirm the situation and creates final malfunction on main engine resulting in automatic slowdown) **Main engine automatic slowdown (Thrust bearing high temperature alarm)** The trainees confirm the alarm and automatic slowdown of the main engine. The trainees take immediate actions to change over the power generation to No. 1 diesel generator, keeping Turbo generator in a hot condition. The trainees urgently start auxiliary boiler and stop FWG accordingly. The trainees quickly assess main running parameters of the engine. The trainees take actions to move control position to the control room from the bridge, keeping the revolution speed at Slow ahead. The trainees locate proximate cause of the slowdown confirming running factors as follow. - LO temperature of the thrust bearing - LO pressure - LO flow rate - LO temperature control valve - Control parameters of LO temperature controller - Trouble of LO pumps - Clogged LO strainer - Fouled LO cooler The trainees perform remedy operations to recover the running condition. After the recovery of the malfunction, the trainees reset the abnormal and take actions to resume the operation the engine.

	The trainees increase the engine speed by setting the maneuvering lever to .the position as it was. As the engine speed is resumed, the trainees begin to perform operations to change over the power generation to Turbo generator, starting auxiliary boiler as well. (When Turbo generator is put into service, the instructor stop simulation and lets the trainees move to the briefing room)

Debriefing session (30 min)

For the 1st stage, the instructor lets the trainee discuss the record of running parameters including indicator diagrams.
The instructor also should brief on:
- application of propeller curve (cube curve)
- relation between engine output, revolution speed and fuel consumption
- relation between engine speed and ship's speed
- torque and torque rich
- impacts on engine running under torque rich

For the 2nd stage, the instructor should brief on:
- importance of detecting malfunction before alarm sounds
- there are several proximate causes for one malfunction
- needs to be well-versed in handling machinery to address malfunctions

The instructor gives trainees "TRAINEE'S REPORT FORM" and lets them fill out.

The instructor collects the report forms and lets trainees dismiss.

TRAINEE'S EVALUATION FORM FOR ERS III - 12

Trainee's Class	
Instructor attended	
Training Title/ Scenario	Efficient operation, surveillance, performance assessment of propulsion plant and auxiliary machinery
Date of Training	

Trainee's Name and Final Disposition			T3		A B C
T1		A B C	T4		A B C
T2		A B C	T5		A B C

Item	T	Mark
1. Assessment of situation under heavy weather (If all necessary factors were checked and if changes were recognized. If assessment of running parameters was appropriate and if decision making was correct and effective)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
2. Operation of main engine under heavy weather (If procedures were correct, smooth and confident. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
3. Assessment of malfunctions (If malfunctions were correctly recognized. If decision making was correct and effective)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
4. Operation of machinery (If procedures were correct, smooth and confident. If the procedures were completed within expected length of time)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D
5. Incentive, Cooperativeness, Attentiveness, Prudence (If any of them was found or outstanding)	T 1	A B C D
	T 2	A B C D
	T 3	A B C D
	T 4	A B C D
	T 5	A B C D

Signature of evaluator ______________________________