

动力设备操作

OPERATING OF POWER EQUIPMENT

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内 容 提 要

本书是按照集美大学航海类轮机工程专业教学大纲和中华人民共和国海事局 2006 年最新颁布的《海船船员适任证书考试大纲》的要求编写的。全书依托集美大学轮机工程学院自动化机舱已有的设备,内容涵盖了评估大纲所要求设备的所有操作训练,系统地介绍了各种船舶动力设备的操作训练及其管理时的注意事项。

全书共分 13 个操作训练项目,每个项目均采用中英文对照的方式进行编写,其内容包括:船舶推进装置的操作与管理、主机遥控系统的操作与管理、船舶动力系统的操作与管理、柴油发电机的操作与管理、船舶舵机的操作与管理、船舶辅锅炉的操作与管理、分油机的操作与管理、船舶油水分离器的操作与管理、船舶空压机的操作与管理、船舶制冷装置的操作与管理、集中式空调装置的操作与管理、造水机的操作与管理、泵系的操作与管理。

本书主要作为高等航海类院校轮机工程专业本、专科生的教材,也可用于各类轮机培训班的实习与训练,还可供船舶轮机管理人员及其他有关技术人员参考。

ABSTRACT

This book is compiled in according with Jimei University marine engineering professional teaching syllabus and the requirements of “Test for Competency and Assessment Syllabus for Seafarers” stipulated by Marine Safety Administration of People Republic of China. This book is on the base of the existing devices in the automatic room of marine engineering institute, its contents contain all the operational training for devices which are required by the evaluating syllabus, what is more, this book systematically relates the operational training about each kind of ship’s device and their managing attentive items while running and stopping.

There are thirteen operational training items in this book, each item is compiled in the mode of Chinese language then its English translation, its main contents are: The operations and managements of ship’s propulsion unit; The operations and managements of main engine remote control system; The operations and managements of ship’s main engine service systems; The operations and managements of diesel generator; The operations and managements of steering gear; The operations and managements of auxiliary boiler; The operations and managements of purifier; The operations and managements of ship’s oil-water separator; The operations and managements of ship’s air compressor; The operations and managements of shipping refrigeration equipment; The operations and managements of centralized air conditioning system; The operations and managements of fresh water generator; The operations and managements of pump system.

This book is mainly used as the textbook for marine engineering professional students in colleges and universities. It can be used in the various marine engineering training classes as teaching materials. At the same time, marine engineering officers and the concerned technicians can use it as a reference book in their work.

前 言

本书是根据集美大学轮机工程专业本科教学大纲要求编写的。轮机工程专业是一个实践性很强的专业,该专业的培养目标是培养学生成应用型人才。一方面,本书不仅能够有效地培养学生的实践动手能力,而且通过各种设备的操作训练,在实践过程中培养学生分析问题和解决问题的能力。另一方面,本书也是为了满足《STCW 公约》对海员培训提出的要求,并根据国家海事局颁布的《海船船员适任考试和评估大纲》和《中华人民共和国海船船员适任考试、评估和发证规则》有关“申请轮机部船员适任证书评估项目”的要求,基于轮机工程学院“轮机自动化机舱”实验室已有设备的实际情况组织编写而成,内容涵盖了“评估大纲”所要求的所有设备的操作训练,较系统地介绍了各种船舶动力设备的操作训练及其管理时的注意事项。

本书的主要内容包括:船舶推进装置的操作与管理、主机遥控系统的操作与管理、船舶动力系统的操作与管理、柴油发电机的操作与管理、船舶舵机的操作与管理、船舶辅锅炉的操作与管理、分油机的操作与管理、船舶油水分离器的操作与管理、船舶空压机的操作与管理、船舶制冷装置的操作与管理、集中式空调装置的操作与管理、造水机的操作与管理、泵系的操作与管理。本书的编写注重实践性和适用性的统一、正确操作训练与动手能力培养的统一、分析问题与解决问题的统一。更为重要的是,本书采用的中英文对照编写方式,能让学生在平时的操作训练过程中,不断提高自身专业英语的听、说、读、写能力,为学生今后的工作打下坚实的基础。本书主要作为高等航海类院校轮机工程专业本、专科生的教材,可用于各类轮机培训班的实习与训练,也可供船舶轮机管理人员及其他有关技术人员参考。

全书由具有丰富实践经验并长期从事远洋船舶轮机管理工作的高级轮机长王永坚(硕士研究生)担任主编,黄加亮副教授担任副主编。此外,高占斌高级实验师以及轮机工程学院的硕士研究生姜传立也参与了部分章节的英文编写工作。

在本书的编写过程中,参考了许多有关文献及资料,并紧密结合“轮机自动化机舱”实验室的实际情况。本书的编写还得到了集美大学轮机工程学院领导和“轮机自动化机舱”实验室同事们的大力支持,同时也要特别感谢范志贤副教授的无私帮助。杨国豪教授、蔡振雄教授和陈景锋副教授担任了本书的主审,他们认真地审阅了本书的各章节,提出了许多宝贵的意见。本书的出版也得到了大连海事大学出版社的大力支持,在此一并表示衷心感谢。

由于编者的水平有限,书中的缺点和不妥之处在所难免,恳请各位读者不吝指正。

编者

2008年3月

FOREWORD

The book "Operating Power Equipment" is compiled in according with marine engineering professional teaching syllabus. Marine engineering profession is a profession with stronger practicality. The cultivating aim of marine engineering profession is to cultivate students to become applied person. Power equipment operation not only effectively cultivates students' manual practical ability, but also through all kinds of devices' operational training, during the practical training, the student's abilities for analyzing the problems and solving the problems can be cultivated. On the other hand, the purpose of the compilation of "Operating Power Equipment" is also to meet to the following requirements: STCW Convention, "Test for Competency and Assessment Syllabus for Seafarers" stipulated by Marine Safety Administration of People Republic of China (China MSA), the regulations on examination, assessment and certificate of competency for seafarers of People Republic of China and "assessment items of applying for certificate for competency for seafarers in engine department" issued by Marine Safety Administration of People Republic of China. Also, this book is on the base of the existing devices in the automatic room of marine engineering institute. It is compiled in the mode of Chinese language then its English translation. Its contents contain all the operational training for devices which are required by the evaluating syllabus, what is more, this book systematically relates the operational training about each kind of ship's device and their managing attentions while running and stopping.

The main contents of this book are: The operations and managements of ship's propulsive equipment; The operations and managements of main engine remote controlling system; The operations and managements of ship's main engine service systems; The operations and managements of diesel generator; The operations and managements of steering gear; The operations and managements of auxiliary boiler; The operations and managements of purifier; The operations and managements of ship's oily-water separator; The operations and managements of ship's air compressor; The operations and managements of shipping refrigeration equipment; The operations and managements of centralized air conditioning system; The operations and managements of fresh water generator; The operations and managements of pump system. The compiler of the book emphasizes on the unify of practice and applicability, the unify of correct operations and manual practical ability, the unify of analyzing problems and solving problems. What is more important, this book is compiled in the mode of Chinese language then its English translation, it helps students to improve their abilities of special English listening, spoken, reading and writing. All will help students to lay a firm foundation for their future work. This book is mainly used as the textbook for marine engineering professional students in colleges and universities. It can be used in the various marine engineering training classes as teaching materials. At the same time, marine engineering officers and the concerned technicians can use it as a reference book in their work.

As the chief editor of this book, it is compiled by senior Chief Engineer Wang Yongjian (mas-

ter) who is in possession of practical experience and pursues the engine managing works in the ocean ships for a long time. As the associate editor, Associate Professor Huang Jialiang compiles part chapters, furthermore, Gao Zhanbin and graduator in engineering institute Jiang Chuanli also takes part in part of English translation's works.

In the process of the compilation, a lot of relative books and materials are being referred, at the same time, the practical conditions for automatic room are closely to be considered. In addition, we have received general support and help from leaders and colleagues, especially; we must show our sincere thanks to Associate Professor Fan Zhixian for his selfless help. Professor Yang Guohao, Professor Cai Zhenxiong and Associate Professor Chen Jingfeng have taken time from their busy schedules to read and correct some of the contents and provide many valuable suggestions. To publish this book, we have also received the help and support from Dalian Marine University Press. To all of the above people, along with many others that space does not permit us to name, we express our most sincere thanks.

This book is of course not permit without its errors and oversights, due to limitations in our human capabilities and also a hectic schedule. We sincerely hope that our readers and users will kindly share any comments and suggestions, so that we may further improve it in the future revisions.

Compilers

March, 2008

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项目一 船舶推进装置的操作与管理

一、操作训练目的

通过操作训练,使学员熟练掌握船舶推进装置备车、冲车及试车的各项操作,并掌握机动及定速后的操作与管理,熟知操作及管理中的注意事项。

二、操作内容

- (1) 船舶推进装置备车时各系统的准备及冲、试车操作;
- (2) 船舶推进装置机动时的操作;
- (3) 船舶推进装置换油操作及定速后管理;
- (4) 船舶推进装置完车操作。

三、训练设备

自动化机舱主推进装置一套,包括主机及其各配套服务系统、传动齿轮箱及其配套系统、水力测功器及其配套系统。

四、主要设备及其技术参数

1. 主机

型号:6PSHTdM-26H

缸数×缸径×行程:6×260 mm×320 mm

额定功率×额定转速:662 kW×720 r/min

平均有效压力:1.104 MPa

最大爆发压力:9.5 MPa

燃油消耗率:211 g/(kW·h)

滑油消耗率:1.36 g/(kW·h)

最低稳定转速:300 r/min

废气涡轮增压器:ABB VTR-250

气动液压调速器:RHD-6

2. 减速齿轮箱(GWC 30/32-01)

速比:2:1

输入功率:750 kW

输入转速:720 r/min

弹性联轴器:YULASTIC-LC4010

3. 水力测功器(Y2000 型)

最大吸收功率:1200 kW

允许最高转速:1000 r/min

五、实操过程

1. 船舶推进装置备车时各系统的准备及冲、试车操作

1) 船舶推进装置航前备车

轮机部值班人员接到驾驶台“备车”指令后,应立即通知轮机长、值班轮机员和有关人员

进入机舱进行备车工作,由值班轮机员回车令备车并着手对车钟、对时钟和对舵工作,随后进行以下各项准备工作。(备车的主要目的是确保主机运转灵活,动力系统保证油、水、气、汽、电供给充足,控制系统工作正常,热工参数值处于正常工作范围)

(1)压缩空气系统的备车操作(压缩空气系统图见附录一图4)

①保证压缩空气供给充足:值班期间,应经常保持空气瓶压力(1.5~3.0 MPa)充足。备车时,应按操作规程使空压机自动控制系统投入工作或手动起动空压机,给主空气瓶充气达到设定值(2.5 MPa左右),并经常监视空压机的工作状态。

②保证气源洁净:打开主空气瓶放残阀,直至确信空气瓶中无残油、残水。

③保证控制空气系统工作正常并供给洁净合格的控制空气(0.7 MPa)。(应经常检查气源净化装置的工作状况)

④供给起动空气:打开空气瓶出口阀、中间截止阀和主起动阀。

(2)淡水冷却系统的备车操作(冷却水系统图见附录一图2)

①柴油主机的暖机与切换操作:船舶推进装置通常在停航期间利用副机冷却水进行暖缸工作,备车时应关闭暖缸阀并使其他相关阀门处于正常工作位置。

②检查膨胀水柜水位,必要时补水。

③起动淡水循环泵并确认其运转正常。

④正确进行冷却水系统各部位的驱气操作,确保冷却水压力处于正常工作范围。

(3)滑油系统的备车操作(滑油系统图见附录一图1)

①油位的检查和补充:检查主机滑油循环柜、摇臂油柜、调速器、增压器、传动齿轮箱以及轴系中间轴承、艉轴承高低油柜、凸轮轴、艉轴封等装置的油位,必要时进行补充。

②循环润滑或加热:检查确认主机滑油泵状态正常,滑油系统各阀件处于工作位置后起动主机滑油泵,检查并调整油压(0.4 MPa以上)正常;如油温太低,还可起动滑油分油机输油泵及电加热器,循环加热循环柜滑油;若停航时间较长,应起动齿轮箱预润滑油泵,进行预润滑。

③手动注油:通常主机起动前,应人工加注气缸油;如停机时间较长,起动前,摇臂应人工注油,水力测功器滚珠轴承应加注牛油。

(4)燃油系统的备车操作(燃油系统图见附录一图3)

①检查油位:检查轻油及重油日用柜和沉淀油柜油位,必要时分油入日用柜并给沉淀柜补油;

②检查阀门:检查并确认系统各阀件处于正常位置;

③检查并起动燃油循环泵(或增压泵):系统驱气、放残;

④加热:根据使用油品适度加热。

(5)喷油器冷却系统的备车操作

喷油器采用燃油进行冷却,冷却循环油泵由主机驱动,备车时应检查确认该冷却系统的各阀件处于正常工作位置,检查油柜的油位,必要时进行补充。

(6)海水冷却系统的备车操作

本装置设有高温海水冷却系统和低温海水冷却系统,每个冷却系统的冷却对象不同。其中,高温海水冷却系统用于主机缸套水的冷却,低温海水冷却系统用于冷却以下设备:大气冷凝器、两台主空压机冷却器、减速齿轮箱冷却器、空气冷却器、副机冷却器。低温海水冷却系统也提供水力测功器的工作水,应急情况下两个系统又可互为备用。海水冷却系统原理见附录

一图2,备车时应检查确认海水泵运转灵活,各阀件开启正常,接通变频器电源,为适时进行高温海水泵的变频控制做准备。

2) 柴油主机的盘车、冲车和试车

该项操作应通知驾驶台并征得值班驾驶员的同意后方可进行。

①准备工作:检查并确认缸盖、轴系等无阻碍转车的情况,检查并确认应注油处均已注油(人工加注气缸油),确认示功阀已开启。

②盘车:搭上盘车机转车数圈,检查有无异常(异响或异常阻力等),确认正常后,脱开盘车机。

③冲车:旋开起动控制阀上的保护帽,按下起动控制阀顶杆进行冲车,检查示功阀有无残油、水等异物吹出,确认正常后关闭示功阀。

④起动与试车:检查并确认各项准备工作已切实做好;通知驾驶台;起动柴油主机并使其怠速运转;使用换向手柄进行换向操作试验;低转速短时间运转,确认主机工作正常;将操作部位转换开关转至遥控位置(集控室或驾驶台),起动试车均正常后,通知驾驶台主机已备妥并进入备车停车状态。

2. 船舶推进装置机动操作

机动操作:按照驾驶台车令迅速准确操纵主机,这是保证船舶安全的首要前提。

(1) 热工参数的监测和调整:机动航行期间,动力装置负荷变化幅度大且频繁,应保证油、水、气、汽、电等系统的各热工参数值在正常范围内。所有热工参数监测既可在机旁由常规测量仪表监测,也可在集控室由巡回监测与报警装置自动监测,如某参数值超出工作范围,则自动给出报警信号,通知值班轮机员进行调整。

(2) 主机缸套冷却水温度通过计算机及变频器自动调节高温海水泵的转速来控制温度恒定。

(3) 冷却水(淡水、海水)压力通过调节离心泵出口阀进行。

(4) 燃油压力、滑油压力通过旁通阀或调压阀进行调节。

(5) 燃油黏度(温度)由黏度计自动调节,也可由人工旁通蒸气阀调节。

(6) 滑油温度由恒温阀自动调节,也可手动调节,还可用旁通海水量的办法来调节温度。

(7) 扫气温度可通过中冷器冷却海水旁通阀进行调节。

3. 船舶推进装置换油操作及定速后管理

(1) 换油操作

大部分主推进装置在进港前或出港后必须进行轻/重油转换操作,出港后换油操作步骤如下:

① 开大加热蒸气阀逐渐提高轻油的进机温度;

② 待轻油进机温度满足换油要求时转换换油阀,停轻油供重油;

③ 燃油黏度调节装置启动运行;

④ 人工调整的蒸气阀关闭,由黏度调节装置进行自动控制;

⑤ 确认轻/重油已转换妥当后,通知驾驶台;

⑥ 视情况关闭主起动空气。

(2) 定速后管理

① 定速后管理的基本要求是:

保证动力装置各自动控制系统工作正常;保证油、水、气、汽、电供给充足;各工作系统无泄漏现象,各运行设备无异常声响和振动;各工作参数值运行在最佳设定值上。

② 定时按巡回检查路线检查、记录(机舱值班)各运行参数,发现问题及时处理。

巡回检查的内容包括:

(a) 液位的检查:膨胀水柜水位、燃油日用柜(沉淀柜)油位、滑油循环柜油位、摇臂油箱油位、调速器油位、增压器油位、传动齿轮箱油位、水池水位。

(b) 压力的检查:主机滑油压力、摇臂润滑油压力、传动齿轮箱润滑油压力和工作油压力、主机缸套冷却水压力、高温海水压力、低温海水压力、喷油器冷却油压力、增压空气(扫气空气)压力、燃油进机压力、控制空气压力、水力测功器水压力、空气瓶压力。

(c) 温度的检查:主机滑油各测点温度、冷却淡水各测点温度、喷油器冷却油各测点温度、增压空气温度、各缸排气温度、燃油系统各测点温度、增压器滑油温度、调速器润滑油温度、传动齿轮箱润滑油温度、水力测功器水温度。

(d) 转速的检查:主机转速、增压器转速。

(e) 检查设备有无异常响声、气味、振动、泄漏等。

(f) 各处放残检查,需要人工注油处注油润滑。

4. 船舶推进装置完车操作

(1) 完车前的操作

① 接驾驶台“换油、备车”通知后,逐渐降低燃油进机温度,待达到要求的温度时,转换重/轻油转换阀,直到认定轻油已完全替换重油时,告知驾驶台。通常换油时间为1 h。

② 按驾驶台车令操纵主机,逐渐减速,低速运行,降温,最后停车。

(2) 完车操作

接驾驶台“完车、完舵”通知后,进行如下操作:

① 如果是驾驶台遥控,此时应把操车位置转到集控室或机旁;

② 开启示功阀(冲车,注气缸油同时转车);

③ 关闭空气系统主停气阀及气瓶出口阀;

④ 关闭操纵控制空气,并放气;

⑤ 停燃油增压泵(或循环泵)及黏度控制装置,关闭有关阀门;

⑥ 打开扫气箱、增压器放残阀;

⑦ 让主机淡水泵继续运行约30 min后停止,并转发电柴油机冷却水进主机暖机;

⑧ 主滑油泵视情况或运转30 min后停止,或保持运转。

上述操作检查确认无误后进入停航值班。

六、操作及管理时的注意事项

(1) 主柴油机起动前应分别对冷却水系统、燃油系统、滑油系统以及起动压缩系统进行检查,以确保各系统处于正常可用状态。

(2) 起动后,应保证油、水、气、汽、电等系统各热工参数值在正常范围内,检查各管路连接处有无泄漏,倾听柴油机有无异常声响,保证柴油机无振动现象。

(3) 换油操作时应避免油温突变,定速航行时应加强巡回检查,将各热工参数控制在正常范围之内。

七、训练要求

在教师的指导下,学员应独立完成操作内容中规定的各项训练要求,并完全掌握操作时的各种注意事项。

八、思考题

(1) 结合实际设备,试分析主机完车以后,滑油泵及主淡水泵须继续运行一段时间的原因。

(2) 结合实际设备,试分析下列操作的主要目的:

- ① 主机备车前,须合上盘车机盘车 1~2 转的目的;
- ② 主机完车后,须合上盘车机盘车的目的;
- ③ 盘车时,从示功阀处吹出大量白色泡沫状液体的可能原因。

九、训练实习报告

实习报告的要求和格式另行成册。

Item One

The operations and managements of ship's propulsion unit

I. The purposes of operational training

through operational training students can master the operations of stand-by main engine, blowing cylinder, trying main engine and master how to operate and manage propulsion unit at the maneuver and after the speed being constant, students should be also familiar with operational and managing attentive items very well.

II. The operational contents

- (1) Relevant system's preparations while ship's propulsion unit being stand-by and the operations of blowing, trying main engine;
- (2) The maneuver operations for ship's propulsion unit;
- (3) The operations of changing fuel oil and the management after main engine's speed being constant;
- (4) The operations of "FINISH WITH ENGINE".

III. Training equipments

Ship's propulsion unit—one set, including main engine, relevant system serving to propulsion unit, reducing gear case and its service system, hydraulic dynamometer and its service system.

IV. Equipment and its technical parameter

1. Main engine

Type: 6PSHTdM-26H

Cyl. number * cyl. diameter * stroke: $6 \times 260 \text{ mm} \times 320 \text{ mm}$

Rating power * rating revolution: $662 \text{ kW} \times 720 \text{ r/min}$

Average effective pressure: 1.104 MPa

Maximum explosive pressure: 9.5 MPa

Fuel oil consumed ratio: $211 \text{ g}/(\text{kW} \cdot \text{h})$

Lube oil consumed ratio: $1.36 \text{ g}/(\text{kW} \cdot \text{h})$

Minimum stable speed: 300 r/min

Type of turbocharger: ABB VTR-250

Pneumatic-hydraulic governor: RHD-6

2. Type of reducing gear (GWC 30/32-01)

Speed ratio: 2:1

Input power: 750 kW

Input revolution: 720 r/min

Elastic shaft coupling: YULASTIC-LC4010

3. Type of hydraulic dynamometer (Y2000)

Maximum receiving power: 1200 kW

Permissive maximum revolution: 1000 r/min

V. Practical operational process

1. Relevant system's preparations while stand-by engine and the operations of blowing, trying main engine

1) Stand-by engine before sailing

The person being on duty in engine department receives the order "STAND/BY ENGINE", he should inform c/e, duty engineer and relevant persons to complete the preparations immediately, the above order should be ensured by duty engineer, then telegraph, ship clock and steering gear must be tested with bridge, the following operations may be prepared. (The aim of stand-by engine is to ensure main engine rotation's flexibility, serving system should supply adequate oil, water, air, steam and electricity to main engine, the controlling system must be in normal, the thermal parameters should be in normal range.)

(1) The operations of compressed air system while stand-by engine (The diagram of compressed air system is shown in Appendix 1 fig. 4)

① Compressed air should be sure to supply adequately: during on duty, compressed air bottle must be kept adequate (1.5 ~ 3.0 MPa). While stand-by engine, air compressor should be put into use in automatic mode or in manual mode to supply compressed air to air bottle up to enacting value (2.5 MPa), the working conditions of compressor must be monitored.

② Air resource should be kept clean: open main compressed air bottle's waste cock to discharge sludge and wasting-water.

③ The controlling air system should be kept in good condition and supply clean and qualified air to controlling system (0.7 MPa).

④ Supplying starting compressed air: open bottle's outlet valve, middle stop-valve and main starting valve.

(2) The operations of F. W. cooling system while stand-by engine. (The diagram of cooling water system is shown in Appendix 1 fig. 2)

① Main engine's warming and it's changing: ship's propulsion unit often uses generator engine's cooling water to warm up during stopping, while stand-by engine, relevant valve and warming valve must be closed to keep main engine in working condition.

② Inspect water level of expansive tank, if necessary, add water to the tank.

③ Start F. W. circulating pump and ensure its running is normal.

④ Correctly clear off the air which exists in each part of cooling water's system, keep the pressure in system in normal range.

(3) The operations of lube oil system while stand-by engine (The diagram of lube oil system is shown in Appendix 1 fig. 1)

① Oil level's inspection and adding: inspect the following oil level: main engine lube oil circulating tank, rocker oil tank, governor, turbocharger, driving gear case (intermediate bearing, stern shaft bearing's high/low oil tank, cam shaft and stern seal), if necessary, add lube oil to tank.

② Lube oil being circulated and heated: after inspecting main lube oil pump and all valves in the system being in correct position, start main lube oil pump, then examine and adjust the pressure