COURSE MANUAL

MAINTENANCE AND REPAIR

OPERATIONAL LEVEL

PROJECT: COMPETING
PROJECT NO: 601165-EPP-1-2018-1-NL-EPPKA2-SSA
AUTHOR: Colegiul Tehnic Dierna
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PREFACE

In order to help education and training entities to meet the requirements of Competence Standards for inland navigation personnel, as mandated by the Directive (EU) 2017/2397 concerning the recognition of professional qualifications in inland waterway transport, and the Delegated Directive (EU) 2020/12 supplementing the Directive (EU) 2017/2397 with regard to the standards for competences and corresponding knowledge and skills for practical examinations, for the approval of simulators and for medical fitness, the transnational Course Manual Maintenance and Repair for Operational Level personnel was developed.

This Course Manual will be a useful transnational training tool for conducting the Trai-the-trainer session and is intended to assist education and training providers and their teaching staff in organising and introducing new education & training programmes, or in improving, updating and supplementing existing didactic materials with the ultimate aim of raising quality and effectiveness of the education & training programmes.

Since education & training systems as well as the cultural background of inland navigation topics differ considerably from one country to another, the Maintenance and Repair Work Course Manual has been designed as a way to support the preparation, organisation and planning of effective teaching and training and to be used as a part of the quality assurance processes of the education and training institutes.

Technical content and levels of knowledge and abilities are in line with the applicable Delegated Directive (EU) 2020/12 supplementing the Directive (EU) 2017/2397 in regard to the standards for competences and corresponding knowledge and skills, for practical examinations, for the approval of simulators and for medical fitness, as it is an essential tool for crew members at Operational Level to be able to assist the management of the craft in situations involving manoeuvring and handling on all types of waterways and in all types of ports.

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1. GENERAL INFORMATION

1.1 Course curriculum - general requirements

1	**Aim**	Provide training to assist in the implementation of the Directive (EU) 2017/2397 on the recognition of professional qualifications in inland navigation and ES-QIN-Standards of competence – Maintenace and Repair for crewmembers at the OL.
2	**Objective**	Provide training and practical guidance for trainees in order to be able to assist the management of the craft in situations involving manoeuvring and handling a craft on inland waterways.
3	**Entry standards**	See Directive (EU) 2017/2397 - Annex 1.
4	**Course certificate**	On successful completion of the course, a document can be issued, stating that the holder passed this learning module.
5	**Course intake limitation**	Admittance may be limited by the capacity of the educational infrastructure used for this learning module (i.e in the simulation room max. 4 trainees, on board of the real/training craft -max.12 trainees etc.).
6	**Staff requirements**	The trainer should meet the requirements of the Directive (EU) 2017/2397, Art. 18.
7	**Training facilities, equipment and teaching aids**	For the theoretical part of the course, a classroom is required with video presentation equipment, teaching aids etc. For the practical part of the course, a real/training craft or full mission ship-handling simulators (FMSHS) are mandatory.
8	**Learning objectives**	*The boatman shall be able to assist the management of the craft in maintaining and repairing the craft, its tech and its equipment.* At the end of the course the trainee shall be able to: • Work with different types of materials and tools used for maintenance and repair work; • Protect health and the environment when coducting maintenance and repair work; • Maintain technical hardware according to the technical instructions; • Safely handle wires and ropes; • Tie knots and splices according to their use and maintain these; • Prepare and carry out work plans as a member of a team and check the results.
9	**Assessment & evaluation**	Minimum requirements for assessment & evaluation of the trainees for passing the learning module (i.e. minimum grade for the theoretical exam, for the practical exam etc.) i.e. Online training record book as a pathway for the course.

2. INSTRUCTOR MANUAL

2.1 Introduction

This instructor's manual offers guidance on the materials which should be present during the Navigation OL level course, and has been arranged under the eleven Learning Outcomes (competences) identified in the course outline. The reference materials indicated may be supplemented by additional texts or materials at the discretion of the instructor.

The course outline and indicative timetable also provide a guidelineon the time allocation for the course, because the time actually taken for each subject area may vary especially in respect of time allocated to practical activities. The detailed teaching syllabus must be carefully studied and appropriate lesson plans or lecture notes compiled. A template of a lesson plan is presented under 2.2.

Each lesson should begin with a statement of the learning outcomes that should be achieved. At the end of each lesson, the participants need to be told which associated sections of the reference materials they should read and any activity they should undertake. Any questions arising from reading these materials and these activities must be addressed promptly at an appropriate time.

The various subjects should be presented in such a way that the course participants are interactively involved in the lessons and the learning process. Questions from the course participants should be encouraged, as should answers to such questions given by other course participants.

Lessons should aim to provide participants with as much practical training and experience as possible, so that they can develop their knowledge and skills in the tasks they will be expected to carry out. Course materials for additional study must be prepared and distributed online or offline if required.

2.2 Lesson plan

This lesson plan is just a template to give teachers/ trainers a general idea on how to design their lessons for the various competences. This template can be used for every competence and adapted as appropriate for the institute to use.

Competence 4.1.1 The boatman shall be able to assist the management of the craft in maintaining and repairing the craft, its tech and equipment;
Learning objective
Learning outcomes
Required equipment

Lesson structure			
Learning activity	Didactical method (ABC method)	Materials	Time

2.3 Background material

Bibliographical material, reference documents, and other didactic materials are presented in Annex 1 of this Course Manual.

2.4 Practical training

This practical training course links the theoretical content of the lessons to their practical application.

Case studies
Theoretical topics are worked out in detail independently by each candidate on the basis of case studies. The candidate is required to deepen his or her knowledge of clearly defined theoretical topics by compiling a variety of facts and figures on ech topic and then presenting these in front of his or her classmates afterwards.

Discussions and reflection, interactive learning
Possible solutions to theoretical and practical topics can be discussed among (parts of) the class group. Different views and opinions on a defined subject are exchanged and discussed by the participants in order to broaden the view of the individual on a particular problem and show various potential solutions and their respective advantages and disadvantages. A discussion should be monitored and supervised (encouraged or crystallized) if necessary, in order to make sure that every participant actively participates.

Team work
The assignments are done either individually or in groups, depending on the objective. An individual assignment should encourage and demonstrate the competences of the individual. In the team work assignment, the participants will have exposure to a wide range of experiences ranging from quick problem-solving involving synergy, to experiences which may relate to such aspects as interpersonal difficulties in a group setting. Depending on the objective of the assignment, the team should be assembled in advance and the assignment and any rules of the work process should be communicated to the group in a very clear and formal manner.

Annex 2 of this course manual contains several exercises, case studies and practical scenarios that are useful for the students' practical training and exams. The ETRB is the tool that the students can be tested on.

2.5 Classroom facilities and educational tools

For the theoretical part of the course, a classroom is required with video presentation equipment, teaching aids etc. For the practical part of the course, a school ship or laboratory equipped with specific hardware is required.

2.6 Examination & assessment

According to the Directive (EU) 2017/2397 article 17, assessment of competences:

1. The Commission shall adopt delegated acts in accordance with Article 31 to supplement this. Directive by laying down the standards for competences and corresponding knowledge and skills in compliance with the essential requirements set out in Annex II.
2. Member States shall ensure that persons who apply for the documents referred to in Articles 4, 5 and 6 demonstrate, where applicable, that they meet the standards of competence referred to in paragraph 1 of this Article by passing an examination that was organised:

(a) under the responsibility of an administrative authority in accordance with Article 18 or;
(b) as part of a training program approved in accordance with Article 19.

The essential requirements set out in Annex II of the Directive (EU) 2017/2397 for Maintenance and Repair Operational Level are:

The boatman is able to assist the management of the craft in maintaining and repairing the craft, its hardware and its equipment:

- Is able to work with different types of materials and tools used for maintenance and repair work;
- Is able to protect health and environment when carrying out maintenance and repair work;
- Is able to follow technical instructions to servive and maintain technical hardware;
- Is able to handle wires and ropes safely;
- Is able to tie knots and splices according to their use and maintain them;
- Is able to prepare and carry out work plans as a member of a team and check the results.

In order to assess the progress and level of understanding of the students, formative testing of the students is needed. The main goal of these tests is to give feedback to the student.
A standard for the practical exam for Boatman has been developed in CESNI QP.

Examples of assessments for the separate competences for Maintenance and Repair on Operational Level on the Illias platform.

3. REGULATION AND CERTIFICATION

According to Chapter 2, Union Certificates of Qualification, Obligation to carry a Union certificate of qualification as a deck crew member as stated in article 4, Directive (EU) 2017/2397:

1. Member States shall ensure that deck crew members who navigate on Union inland waterways carry either a Union certificate of qualification as a deck crew member issued in accordance with Article 11 or a certificate recognised in accordance with Article 10(2) or (3).

2. For deck crew members other than boatman, the Union certificate of qualification and the service record book as referred to in Article 22 shall be presented in a single document.

3. By way of derogation from paragraph 1 of this Article, certificates held by persons involved in the operation of a craft, other than boatmasters, issued or recognised in accordance with Directive 2008/106/EC, and therefore in accordance with the STCW Convention, shall be valid on sea-going ships operating on inland waterways.

In Directive (EU) 2017/2397 in the Annex I the minimum requirements for certification as a boatman are as follows:

Every applicant for a Union certificate of qualification shall:
(a)
- Be at least 17 years of age;
- Have completed an approved training programme, as referred to in Article 19, which was of a duration of at least two years, and which covered the standards of competence for the Operational Level set out in Annex II;
- Have accrued sailing time of at least 90 days as part of this approved training programme.

or

(b)
- Be at least 18 years of age;
- Have passed an assessment of competence by an administrative authority as referred to in Article 18, to verify that the standards of competence for the Operational Level set out in Annex II are met;
- Have accumulated sailing time of at least 360 days, or have accumulated sailing time of at least 180 days if the applicant can also provide proof of work experience of at least 250 days that the applicant acquired on a sea-going vessel as a member of the deck crew.

or

(c)
- Have a minimum of five years' work experience prior to the enrolment in an approved training programme, or have at least 500 days' work experience on a sea-going vessel as a member of the deck crew prior to the enrolment in an approved training programme, or have completed any vocational training programme of at least three years' duration prior to the enrolment in an approved training programme;
- Have completed an approved training programme as referred to in Article 19, which was of a duration of at least nine months, and which covered the standards of competence for the Operational Level set out in Annex II;
- Have accumulated sailing time of at least 90 days as part of that approved training programme.

4. LESSON MATERIALS

The lesson materials referred to in this course manual are for inspiration and are free to use for the teachers from the educational institutes. The lesson materials can be accessed on the Edinna website (www.edinna.eu/).

As already mentioned in chapter 2, background material and practical activities can be found in respectively annex 1 and annex 2 of this course manual. The background material referenced can be used as additional documentation for the teachers to create their lessons and/or add more details. Annex 2 consists of suggestions and examples of exercises, case studies and/or practical scenarios.

Thematic content of the Course Manual for MAINTENANCE AND REPAIR WORK- OL is presented in Annex 4 of this document, which is linked to the European Standard for Qualifications in Inland Navigation (ES-QIN), Part I, Chapter 2, Point 5 Maintenance and repair work[1].

COMPETENCES OF MAINTENANCE AND REPAIRWORK - OL

The numbering of the chapters is in accordance with the Standards for competences for the Operational level- MAINTENANCE AND REPAIR WORK.

OL 1 – Maintenance and repair work

1 https://www.cesni.eu/en/standards-and-explanatory-notices/#02

4.1 The boatman is able to assist the management of the craft in maintaining and repairing the craft, its hardware and its equipment

Competence	Knowledge and skills
1. **Works with different types of material and tools for maintenance and repair work;**	1. Knowledge of the required tools and maintenance of equipment and of safe work practices and environmental protection rules. 2. Ability to use relevant methods for craft maintenance including ability to choose different materials. 3. Ability to correctly maintain and store tools and maintenance equipment. 4. Ability to conduct maintenance work according to safe work practices and environmental protection.
2. **Observes standards of safe work practices when carrying out maintenance and repaire;**	1. Knowledge of applicable cleaning and maintenance procedures and hygiene regulations. 2. Ability to clean all living quarters and the wheelhouse, and to carry out housekeeping duties in accordance with the rules of hygiene, including responsibility for their own living quarters. 3. Ability to clean the engine rooms and engines using the required cleaning materials. 4 Ability to clean and maintain exterior parts, the hull and the decks of the craft in the correct order using the required materials according to environmental protection rules. 5. Ability to take care of the craft and waste disposal according to environmental protection rules.
3. **Is able to maintain technical hardware according to environmental protection regulationst;**	1. Knowledge of technical instructions for maintenance and maintenance programmes. 2. Ability to take care of all technical equipment according to instructions and their intended use.
4. **Is able to work with different types of ropes and wires;**	1. Knowledge of characteristics of different types of ropes and wires. 2. Ability to use and store them according to safe work practices and rules.
5. **Is able to tie and combine knots according to the purpose and maintenance requirements;**	1. Knowledge of procedures that must be followed in order to ensure safe towage and coupling using the means available on board. 2. Ability to splice wires and ropes. 3. Ability to tie knots according to their use. 4. Maintain wires and ropes.
6. **Is able to prepare and carry out work plans as a member of a team and check results;**	1. Knowledge of the principles of team work. 2. Ability to carry out maintenance and simple repairs independently as part of the team. 3. Ability to carry out more complex repairs under supervision. 4. Ability to apply various work methods including team work according to safety instructions. 5. Ability to evaluate the quality of work.

5. EFFECT OF THE HUMAN ELEMENT ON SUSTAINABLE SHIPPING

The personal activities of deck crew members on board vessels have a direct bearing on the sustainability of inland shipping. Due to the standardisation of training and comformity with Directive (EU) 2017/2397 concerning the recognition of professional qualifications in inland shipping, navigational safety will improve.

Different factors affect the development of sustainability in shipping, ranging from regulatory to socio-economic factors, market-related aspects and human factors, which all together contribute in different ways to the development of these three pillars. Since many different stakeholders are involved in the process, it follows that one of the main factors in supporting Sustainable Shipping is the understanding of the concerns, needs and expectations of all parties.

The shipping industry is run by people for people. People design ships, build them, own them, crew them, maintain them, repair them and salvage them. People regulate them, survey them, bankroll them and investigate them when things go wrong. While these people differ in all sorts of ways, they are all, nevertheless, people – with the same basic set of aptitudes and vulnerabilities.

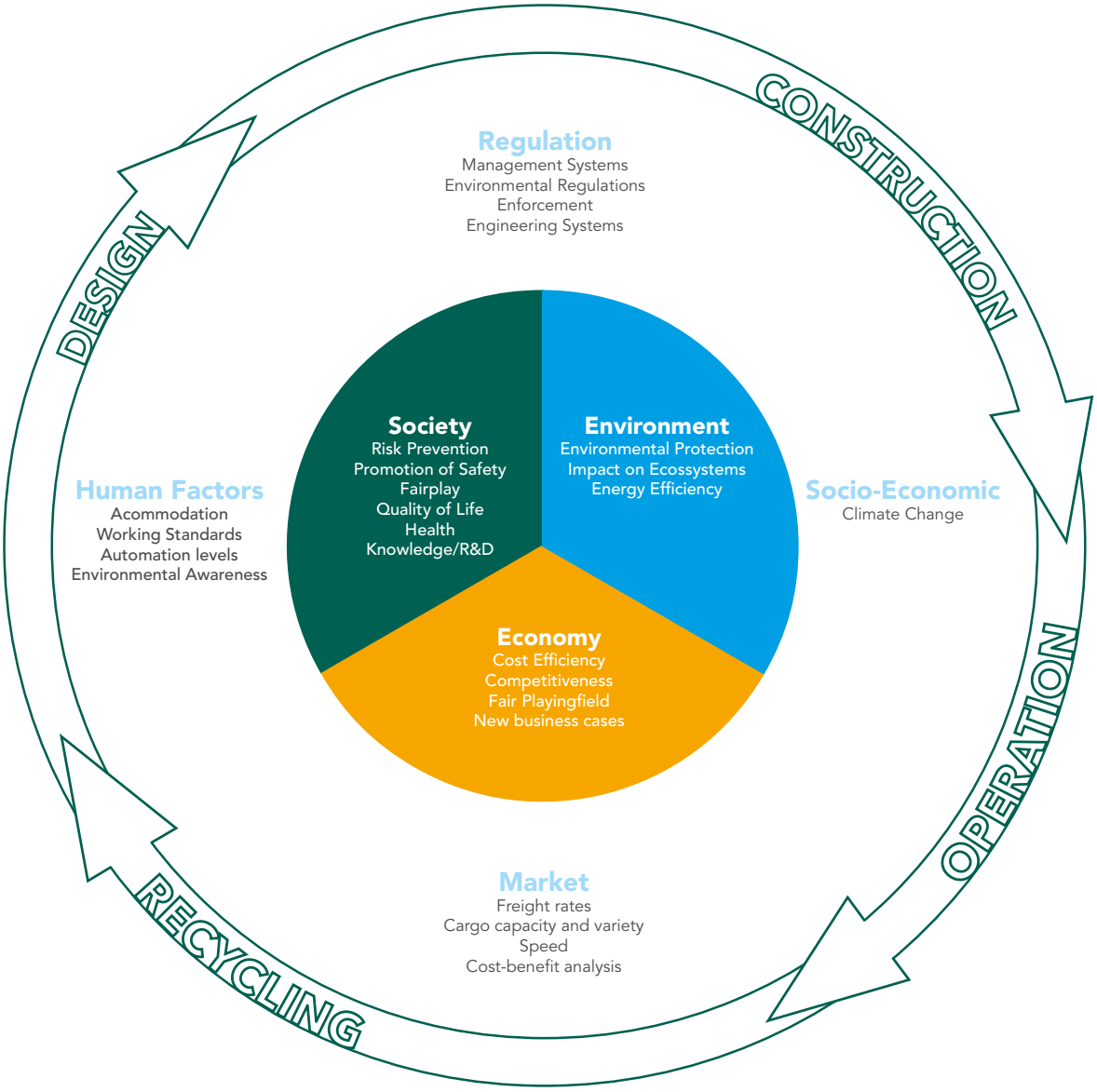

Figure 1 https://www.maintworld.com/R-D/Application-of-European-Qualification-Framework-EQF-in-Maintenance

Humans are not simply an element like the weather. They are at the very centre of the shipping industry. They are the secret to its successes and the victims of its failures. It is human nature that drives what happens every day at work – from the routine tasks of inspecting a craft right through to policy decisions.

The eight aspects of human nature are:

1. **People actively try to make sense of things**
   What's obvious to you may be far from apparent to somebody else. We explain how it is that most of what you see and understand is down to you and your expectations, rather than a response to 'what's out there'. The key problem is ensuring that the sense you make of things is enough for you to deal effectively with the reality of a continuously unfolding situation – a situation that you must also share with your colleagues.

2. **People take risks**
   Everyone constantly takes risks. In a world that is essentially uncertain, this is not only normal, but also inevitable. We explain that the human perception of risk differs greatly from the probability of events actually taking place. The key problem is to ensure that your own perception of risk is consistent with the world you are interacting with.

3. **People make decisions**
   We explain the difference between how people think they make decisions and how they actually do that – and how the decision making of experts is quite different from the way they did it when they were learning. We also explain why experience does not necessarily lead to expertise, but that expertise always needs experience – and lots of it. The key issue is to understand what the components of a good decision entail, and how to recognise when you are about to make a bad one.

4. **People make mistakes**
   A fundamental human strength depends directly on the ability to make, and then recover from, mistakes. Without error there can be no learning or development. And without these, organisations cannot achieve their goals. The important aspect here is in ensuring that potentially harmful or expensive mistakes are prevented, caught in time or minimised before they have a chance to escalate enough to matter. We explain how this depends as much on organisational culture as on individual competence.

5. **People get tired and stressed**
   We explain the causes and consequences of fatigue and stress, and explain what you can do to avoid them or lessen their impact. We also explain why workload turns out to be as much to do with your own experience, as the actual demands placed on you by the job.

6. **People learn and develop**
   People learn all the time. This is something that they can't stop themselves from doing. The main issue concerns ensuring that they learn the right things at the right time. People also have aspirations that can be harnessed by an organisation to foster its own security and profitability. However, in the absence of good management, people's aspirations will either be ignored or permitted to dominate – with potentially disastrous consequences either way. We explain the enormous strength that effective, well-timed training can give to an organisation.

7. **People work with each other**
   Working with each other sometimes requires us to work as individuals in pursuit of our own goals, and at other times, as members of a team with a common purpose. The key issue here is in ensuring that we have effective 'people' skills, as well as technical task skills. We explain what these other skills are, why they are important and what can go wrong when they are absent.

8. **People communicate with each other**
   Successful communication entails the clear transmission of a message. We explain what has to happen in order for communication to be successful. We explain the responsibilities of both listener and messenger.

These are eight things we do that help make us human. They are unavoidable and will not go away. Understanding a bit more about their nature and how you can deal with them more effectively will change your behaviour – and, maybe, that of those around you.

6. REFERENCE TO NQF, EQF, ECTS

Nowadays, the European Union (EU) consists of 27 member states, and each state has got a different education system. Therefore, the European Commission (EC) prepared the European Qualifications Framework (EQF) because it wanted to:

- Make national qualifications more comprehensible across Europe;
- Standardise national qualification systems of different countries to a common European reference framework;
- Promote the mobility of workers and learners amongst the countries of the EU and to facilitate lifelong learning.

The EQF system features eight reference levels (figure 2), each level describes what a learner has to know, understand and be able to do[2].

Inland Waterway Transport (IWT) plays a significant role in the EU where cargo exchange is concerned. Especially on an international scale along the European waterways network. On one hand, this form of transport is still more economical than any other mode of transport for many types of cargo, particularly such as bulk, general, liquid cargo and containers. On the other hand, it is also the most environmentally friendly form.

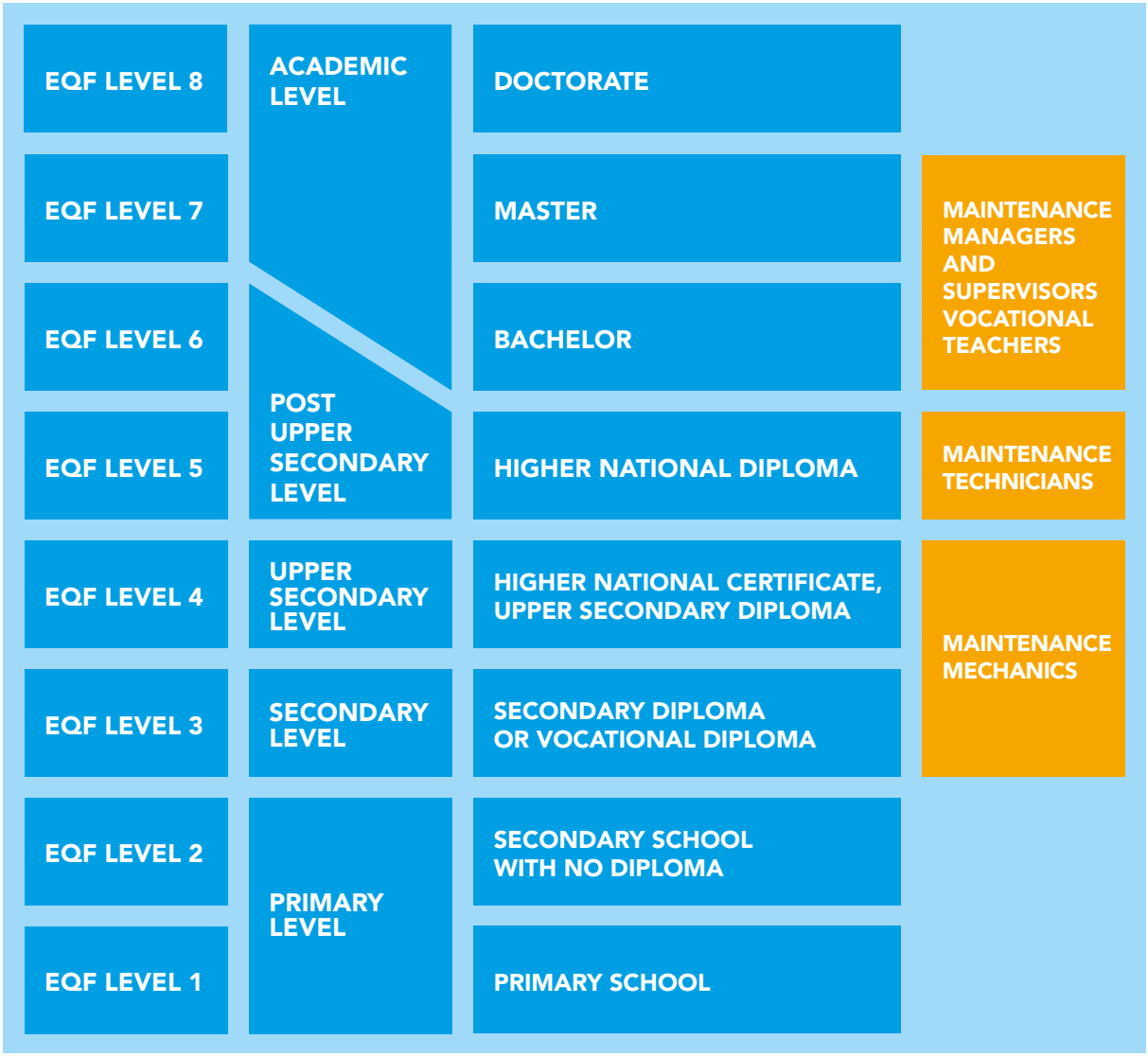

Figure 2 EQF levels compared with completed education and maintenance personnel positions.

2 http://www.maintworld.com/R-D/Application-of-European-Qualification-Framework-EQF-in-Maintenance, 1 December 2016

Germany	DQR Deutscher Qualifikationsrahmen für lebenslanges Lernen	www.dqr.de
The Netherlands	NLQF Nationaal Coördinatiepunt	www.nlqf.nl
Romania	anc Autoritatea Națională pentru Calificări	www.anc.edu.ro
Slovakia	TREXIMA PEOPLE . PROFESSION . PROSPERITY	www.trexima.sk/new

Table 1 Overview of national organisations in the EQF context

The IWT sector involves a variety of job positions related to its various segments, such as vessels, ports and waterways. Project IWTCOMP focused on EQF and job qualifications in IWT in 4 countries (Germany, the Netherlands, Romania and Slovakia) because each country uses a different education system. In all the countries involved in the project there are websites and organisations dedicated to the use of EQF in their respective national contexts. Below, you will find an overview of these organisations.

Slovakia used to have two vocational schools which prepared students for the job positions in IWT but they were closed because of low interest among young people to work in this field. Nowadays, the Transport Authority assesses candidates for lower-level job positions in IWT, such as skippers, captains, boatmen (EQF 2 and 4). Before the exams, it organises relevant courses for the applicants. The exam comprises an oral and a written part and covers various aspects of IWT. The Department of Water Transport at the University of Zilina trains students for higher-level job positions (EQF 6, 7, 8) in IWT. The curriculums are approved by the Ministry of Education, Science, Research and Sport of the Slovak Republic and its regulatory body (Accreditation Commission). They are prepared according to the requirements of professional practice and standards of higher education in Slovakia.

In Germany, there is a combined system of education in schools and at shipping companies that ends with centralised exams conducted by the German Chamber of Commerce. Both schools and companies are required to follow the curricula, but they are not responsible for the exams. The exams consist of two parts, one that focuses on knowledge and and the other focuses on skills. As such, both the school and the shipping company contribute to the education of the students that enables them to pass the centralised exams.

In Romania, there are dedicated programmes for the IWT Boatman (EQF 2) certification. Vocational schools offer courses for the Boatman qualification.

In the Netherlands, qualifications set for the different levels of education within the IWT sector. For each educational level there is a set of qualifications given by the national contact point in cooperation with the IWT work field and educational institutes. The Netherlands government decided to place the Captain/Manager IWT qualification at NQF level 5 (EQF5), but in a later stage, this was withdrawn and placed at NQF level 4 (EQF4).

In conclusion, although the EQF system for inland water transport has been accepted in all EU countries, this EQF system is not used by all countries. The reason for this is that some institutes have to focus on the professional competences based on national and international legislation. The curricula at schools, universities and training centres are prepared according to the international or national standards in cooperation with the international or national authorities (the Rhine Commission, the Danube Commission, the Ministries of Education), shipping companies and other authorities that work in the field of IWT in the Rhine or Danube Regions. It depends on the (higher or lower) level of general education per country.

ANNEX 1

Reference Documents

- Directive (EU) 2017/2397 on the recognition of professional qualifications in inland navigation;
- Delegated Directive (EU) 2020/12 supplementary Directive (EU) 2017/2397regarding the standards for competences and corresponding knowledge and skills, for the practical exams, for the approval of simulators and for medical fitness;
- Owner Manuals for maintenance of the main engines and generators' engines – detailed further for crew member usage;
- Worker protection standards for the maritime sector – Dutch Ministry of Transport 1982;
- International Chamber of Shipping, "Guidelines on the application of The ILO Maritime Labour Convention", Third Edition;
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ANNEX 2

Practical scenarios

Planned "maintenance and repair" work form an integral part of all voyage preparatory work (Competence 5.1.1, 5.1.2, 5.1.3).

The scheduling of maintenance work is made on the basis of the evaluation of voyage time schedules and implicitly of the operating times of the main machinery, auxiliary machinery and systems. Once the times have been established, e.g. 90 travel days x 24 hours / operating days, the maintenance manuals of the equipment provided by their manufacturers in the form of "Owner Manuals" are used and the planned work is specified to accommodate the different operating times. The need for supplies (oil changes, oil and fuel filter, filling of waste water treatment tanks, air filter, engine oil, vaseline, etc.) and spare parts and materials (belts, injectors, various parts and sub-assemblies with timetables for replacement after a certain number of operating hours, as indicated in the operating instructions, lashing and manoeuvring ropes, work protection materials also needs to be taken into account.

Lessons learned / Conclusions

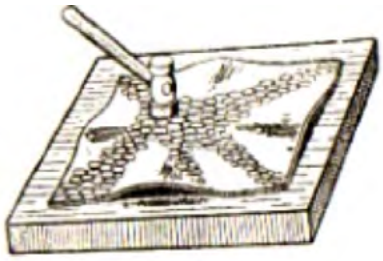
For a smooth trip, the planned maintenance and repair work must be integrated into the voyage planning.

Scenario 1

5.1.1.2 Able to use relevant methods for craft maintenance including the ability to choose different kinds of materials

The Practical assignment assesses all the necessary knowledge and skills of the competence:

Practical evaluation straightening plating



Straightening plating
What are the assessment criteria for this assignment?
How to straighten plating?
What tools are used?
Where does the straightening of plating begin?
Attitude.
Works in a safe way for him-/herself and others.

Scenario 2

5.1.2.2 Able to clean all living quarters and the wheelhouse and to carry out house-keeping tasks properly, in compliance with the rules on hygiene, which includes taking responsibility for his/her own living quarters

Practical work of cleaning and sanitizing the living quarters.

This practical test covers the following components:

A Theoretical knowledge about cleaning spaces and the substances used (oral)
B What the ship's microclimate entails (oral)
C Cleaning the wheelhouse (practical)
D Safety aspects when using cleaning substances (practical)

Ask 1 question about each item in the list and mark the selected option:	
A.1	The chemical combustion reaction of a substance with oxygen, accompanied by the development of heat and sometimes flames is called: ☐ ignition ☐ combustion ☐ inflammation
A.2	What are (is): ☐ toxic substances ☐ caustic substances ☐ flammable substances ☐ explosive substances

Ask 2 question about each item in the list and mark the selected option:	
B.1	Name or point out the following parts: ☐ air temperature ☐ air humidity ☐ artificial microclimate ☐ noise
B.2	The so-called vibration disease is characterized by: ☐ fatigue, shoulder pain, weight loss, restless sleep, followed by pain in the fingers and joints that worsens especially at night ☐ drowsiness, inattentiveness, nervousness, headache and reduced appetite ☐ joint pain, muscle aches, skin disease, shortness of breath

Have both parts of the list be carried out	
C.1	Clean objects from the wheelhouse
C.2	Disinfect objects from the wheelhouse

Assess both parts on the list:	
D.1	Carries out the work of part C in a safe manner / pays attention to safety aspects
D.2	Wears the necessary PPE in the right way during this work

Teaming up
Assessment aspects - cooperation:
Consults in advance with the practical instructor about the division of tasks
Uses the proper PPE
Coperation
Attitude
Works safety
Adheres to the agreed tasks when carrying out work
Checks his/her work

Scenario 3

5.1.3.1 Knows the technical instructions for maintenance programs

Practical assignment on a training ship.

Routine maintenance work performed by the ship's crew
Assessment aspects:
Current maintenance work on ships
Repair work
What the Preventive Repair System is about
Technical revision (Rt)
Current repairs (Rc)
Overhaul (Rk)

ANNEX 3

Standards for the practical exam for obtaining a certificate of qualification (boatman) – module 5- maintenance & repairs

The draft standard for the OL practical exam sets the framework for practical exams for OL. In order to provide guidance to the authorities on how to conduct an exam for this purpose, the CESNI/QP working group has decided to develop a model exam in accordance with the ES-QIN.

In these draft standards of practical exams for the OL, elements of knowledge and skills that shall be tested during the practical exam are specified. Listed are all elements as described in the tables of competence standards on OL as "ability". Skills are usually tested during a practical exam. However, some abilities have knowledge elements. In this model exam, the term "exam element" is used to indicate both skills and knowledge.

The model exam is carried out on the assumption that the candidate has passed the knowledge elements (theoretical exam) relating to the standards of competence for OLas well as the assessment of the skills that for practical reasons were not assessed on board the craft during this practical part prior to the model examination.

For practical reasons, the exam is divided into three parts:

Part 1: Maintenance and repair materials and tools to be used

- Part 1a Knowledge of the required tools and maintenance of equipment and of safe work practices and environmental protection rules;
- Part 1b Ability to use relevant methods for craft maintenance including ability to choose different materials;
- Part 1c Ability to correctly maintain and store tools and maintenance equipment;
- Part 1d Ability to conduct maintenance work according to safe work practices and environmental protection rules.

Part 2: Maintenance and repair work compliance with safety and hygiene standards

- Part 2a Knowledge of applicable cleaning and maintenance procedures and rules of hygiene;
- Part 2b Ability to clean all living quarters, the wheelhouse and keep everything clean and tidy, observing the rules of hygiene, including taking responsibility for their own living quarters;
- Part 2c Ability to clean the engine rooms and engines using the required cleaning materials;
- Part 2d Ability to clean and to maintain external parts, the hull and the decks of the craft in the correct order using the required materials according to environmental protection rules;
- Part 2d Ability to take care of the craft and everyday waste disposal according to environmental protection rules.

Part 3: Maintenance and repair work- compliance with technical instructions

- Part 3a Knowledge of technical instructions for maintenance and maintenance programmes;
- Part 3b Ability to take care of all technical equipment according to instructions and to use maintenance programmes (including digital) under supervision.

The examination elements are listed in the table below:

No.	Competences	Examination elements	Category I - II
1.	0.5.1	clean all living quarters, the wheelhouse and keep everything clean and tidy, observing the rules of hygiene, including taking responsibility for their own living quarters;	I
2.	0.5.1	clean the engine rooms and engines using the appropriate cleaning materials;	I
3.	0.5.1	clean and maintain external parts, the hull and the decks of the craft in the correct order using the appropriate materials according to environmental rules;	I
4.	0.5.1	take care of the craft and everyday waste disposal according to environmental rules;	I
5.	0.5.2	maintain and take care of all technical equipment according to technical instructions and use maintenance programmes (including digital);	I
6.	0.5.3	use and store ropes and wires according to safe work practices and rules.	I

Skills contained in examination elements numbered 1 to 6 (practical skills on deck) can be tested during an approved training programme.

No.	Competences	Examination elements	Category I - II
1.	0.5.1	clean all living quarters, the wheelhouse and keep everything clean and tidy, observing the rules of hygiene, including taking responsibility for their own living quarters;	I
2.	0.5.1	clean the engine rooms and engines using the appropriate cleaning materials;	I
3.	0.5.1	clean and maintain external parts, the hull and the decks of the craft in the correct order using the appropriate materials according to environmental rules;	I
4.	0.5.1	take care of the craft and everyday waste disposal according to environmental rules;	I
5.	0.5.2	maintain and take care of all technical equipment according to technical instructions and use maintenance programmes (including digital);	I
6.	0.5.3	use and store ropes and wires according to safe work practices and rules.	I

ANNEX 4

This annex contains the thematic content of the competences of Maintenance and Repair Work on a management level as set out in chapter 4.

COMPETENCES OF MAINTENANCE AND REPAIR WORK – OL

The numbering of the chapters is in accordance with the Standards of competence for management level 5. Maintenance and repair work.

5.1 The boatman has the ability to assist the management of the craft in maintaining and repairing the craft, its technical hardware and its equipment

Competences:

1. The boatman has the ability to work with different types of materials and tools used for maintenance and repair work.
2. The boatman has the abilityto protect health and environment when performing maintenance and repair.
3. The boatman has the ability to maintain technical hardware according to technical instructions.
4. The boatman has the ability to safely handle wires and ropes.
5. The boatman has the ability to tie knots and splices according to their use and maintain them.
6. The boatman has the ability to prepare and carry out working plans as a member of a team and check the results.

5.1.1 The boatman has the ability to work with different types of materials and tools used for maintenance and repair work

Knowledge and skills

5.1.1.1 Knowledge of the required tools, maintenance of equipment, of safe work practices and environmental protection rules

5.1.1.2 Has the ability to use relevant methods for craft maintenance including the ability to choose different kinds of materials

5.1.1.3 Has the ability to correctly maintain and store tools and maintenance equipment

5.1.1.4 Has the ability to conduct maintenance work according to safe work practices and environmental protection rules

Repairs to the metal hull of a vessel

In order to extend the service life of a ship, measures are taken and a series of maintenance and repair work is carried out. Protection measures, the prevention of damage and degradation is all the more necessary as the operating conditions are severe. This entails specific characteristics depending on the type and destination of the vessel.

When the ship is repaired, the work carried out during the repairs must be registered, namely:

- A quick work note made of the the condition of the joint cords, the presence of corrugations or warping and cracks in the curb, the degree of plating wear, the condition of the keel rollers, the connection of the plating with the ship's extremities, the condition of the bottom sockets, the condition of the rudder; The surface of the plating to be used must be determined on the tabs with a spacing of 10 frames on either side of the place that has been identified for the repair;
- The frame for which the elements between two sealed bridges are taken into account. The need to replace the plating is determined according to the classification register of shipping on the basis of the permissible wear and tear. Flexible metal rules or a special protractor called "arrow" are used to determine the curvature of the warping. The warping is measured both in longitudinal and transverse direction. The permissible warping sizes are estsblished depending on where they are located according to rules. In general, the size of warping cannot exceed 0.2 A (where A represents the distance between the frames). After establishing the place where they are situated on the hull of the ship, they are divided into three categories (the tolerance value allowed for each category is expressed by the arrow of the local corrugation of the warping):
  - The first category includes the bottom cover and the double bottom cover on a length of 0.5 L from the middle, tear plate, the belt and hull along the length of the vessel. In this cae, a deformation width of 350-750 mm and plating thickness of 5-20 mm, a local deformation arrow from 4 to 8 mm is allowed;

- The second catrgory includes the cover of the deck, the bottom and the double buttom which are located at 0.25 L from the ship's extremities, the hull cover, the deck cover between the storage openings and the intermediate decks along the entire length of the ship, allowing arrows up to 12 mm;
- The thitd category consists of exterior walls and open decks or suprastructures, which extend to a maximum of 0.5 L, the parapet, the decks of living quarters, the smokestack, the open partitions and other structures which require a suitable appearance and that arrows are allowed for no more than 15 mm.

A. STRAIGHTENING REPAIR METHODS

Removal of local deformation, both of the frame and of the metal sheets is done with the help of local heating. Usually, the hot straightening of the identified deformation is done by heating the deformed surface and lightly hitting the heated area with wooden hammers first on the cooler area and then on the red heated area.

The temperature of the local heating must be high enough to allow malleable deformation of the metal, but at the same time will not worsen the qualities of the metal.

It has been established through experimentation that for low-carbon steel plating with thicknesses up to 6-8 mm, straightening can be done hot.

If cooling with water is authorised for certain structures, the application of this process to low-alloy steels alters their original properties, resulting in hardening of the metal in the cooled area. Also, the hammer is no longer used after cooling the steel below the temperature of 873K because the metal then becomes brittle.

For the elimination of deformation by means of heating, no precise methods have been established. All currently applicable methods tend to perform hot straightening without hammering and especially without cooling.

Figure a, shows the method of straightening metal sheets up to 6mm thick. The heating order for the metal sheets is indicated by numbers. The diametre of the heated surface is 35-60 mm and the distance between them 70-160 mm, deformations with 30 mm arrows can be corrected with this method.

Another method involves heating the metal sheet using points with diameters of 20-40 mm. The straightening sequence is numbered (fig. b). Apart from the fact that metal sheets with a thickness of more than 6 mm cannot be straightened properly preserving their integrity, this method requires a high consumption of oxigen and acetylene.

Figure c shows the linear straightening method that is used for straightening thin metal sheets. The heating is done at a temperature of 873-973 K, the width of the heated surface being of 4-5 mm followed by continued hammering at a distance of 300-400 mm behind the flame.

A variant of the linear straightening method is represented in figure d, which can be used when straightening metal sheets with an arrow up to 25 mm and thickness between 5-15 mm without the need to hit the metal sheet. The heating of the deformed sheet is zigzagged on a width of 15 mm and a length of 120 mm at a temperature of 1123K, adapting the diameter of the burner according to the thickness of the sheet. The distance between two vertically heated surfaces is of 70–100 mm, and 200 mm horizontally. The direction of heating is shown in the figure by arrows.

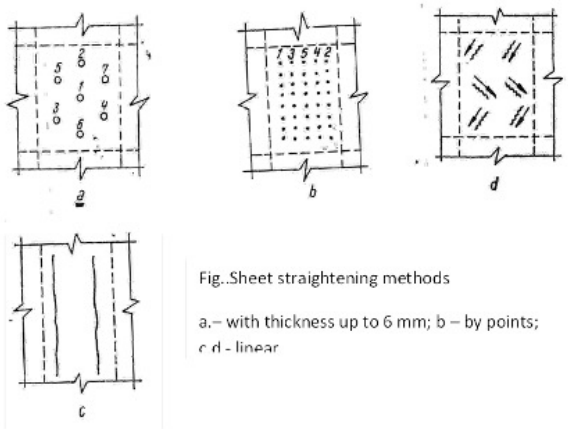


Fig..Sheet straightening methods

a.– with thickness up to 6 mm; b – by points;
c,d - linear

The method gives good results in practice, being the most used at present. When using the methods shown, a number of rules must be observed:

- As a general rule, the straightening of any part of the ship begins with the straightening of the frame first and afterwards moves on to the metal sheet. Reversing the order of this straightening work can lead to very large deformations, especially to the ship extremities;
- The straightening of any part of the ship begins with the horizontal surfaces (decks; platforms) and only after that the vertical surfaces have been straightened (walls, shell plating);
- Special attention must be paid to how small vessels are straightened. Carrying out a large number of heating operations on one metal sheet in comparison with the others can lead to the general deformation of the vessel. The same thing can happen if the deck or bottom is overheated.

B. REPAIR METHODS USING PATCHES AND DOUBLES

If the repair of the ship's hull cannot be done by straightening, the application of patches is used. Patches are applied where the metal sheet is pierced over a large portion or where warping is more pronounced. In this case, the patch size must be determined according to the metal sheet which needs to be straightened or replaced. The sheet to be replaced is then cut with an oxyacetylele flame after a contour has been determined, then the cut corners are rounded so that no inernal stress occurs and to improve welding. Before cutting and tracing, scrape that part out until it reaches clean metal.

After cutting, a template is made out of cardboard, a thinner metal sheet or various other kinds of slats and after that, the patch is made of the same material as the ship's plating. If the shell is curved, the patch will be shaped accordingly. After fabricating the patch, its edges and the edges of the cut are treated.

The patch must be smaller than the cut, by 0.5 mm on two of the adjacent sides, and by 2-2.5 mm on the other two to avoid deformation. After testing the patch on the area, spot welding is then applied. The length of the clamps should be 5–10 mm, with a 300–400 mm distance between them. After the patch has been spot welded, it is welded in steps at the level of the metal sheet. If the patch has a larger surface, then its edge is corrugated because during the welding, deformations that occur are replaced by these corrugations.

Besides patches, doubles are also used. Doubles are used on bridges, on the double bottom deck, and on walls. To mount these, first scrape off the metal sheet, then treat the area to be covered and then cover it so that it matches the shape marked on the surface.

The edge of the metal sheet over which the double is applied is painted with lead minium, after that the double is first placed between welding points and then welded. Usually, the edges are not treated, but corner joint welding is carried out.

If the surface of the double is larger than one square metre then rivets are applied in the middle of the metal sheet to bind the double to the metal sheet over it was placed over.

C. REPAIRING METHODS OF WELDED SEAMS

Welded seams are repaired if their thickness has decreased by 10% of the initial thickness. Defective welding portions shall be examined with a magnifying glass, shall be leak-tested or totally radiographed.

Leak-proof welding cords are chiselled. After chamfering the edges and clening those, the cord is welded to its original shape and dimension.

The welding is performed after a well-established technological process in order not to produce high tensile stress.

Inside fuel or petroleum products compartements the welding is done after emptying the tank, complete cleaning and washing it and after what the compartement has been ventilated.

For detrmining the dimension of the welding points (both when appling the patches and the distance between them) it is reommended:

- For joints with elements up to 4 mm thick, the high of the welding points must not excced the thickness of the jionts;
- For joints with elements greater than 4 mm thick, the height of the welding points shall not exceed 0.5 -0.7 of the minimum thickness of the elements to be welded;
- For corner joints, the weld point must be proportional to the thikness of the elements to be welded (it varies between 3–6 mm);
- For all types of joints the length of the welding points shall be proportional to the thickness of the elements and between 15–40 mm;
- The distance l between the welding points for orientation is determined by the formula:
  l = (20–40) S+50 mm.
  Where S is the thikness of the elements to be welded, expressed in milimetres.

The application of the welding points is done in such a way as to keep the play between elements when assamblying, not to have great deformation in case the constructive are replaced, but not entirely.

D. REPLACEMENT OF VARIOUS WRAPPING AND FRAMING ELEMENTS OF THE SHIP

The indicated repair methods, possibly the partial replacement of some elements, shall also apply to the keel plating, bow and stern plating, from the gurne, to the corners of tears, to deck profiles and openings, to living cabins, machine compartment, water, oil, or fuel tank, etc.

At the docks the repair consists in the partial straightening of the pipes or their profiles as well as of the gussets, possibly the replacement of some gussets.

At the whellhouse the elements to be repaired are the mounted wall panels, as well as the framing profiles. At the warehouse holes the elements that are repaired are the walls of the wearhouse openings, of the closing covers as well as the replacement of small structural elements such as gusssets, profiles, cover gaskets.

On metal panels, in the compartments of buldings and machines, the elements that are repaired are the sheets and profiles, and the operations consist in the removal amd replacement of damaged elements.

In case of replacement of some welded structural elements by other, all the parts to be replaced, before assamblying, are checked both in shape and size, using for this pupose the execution drawings and tracing tamplets.

Maintenance of the hull

As maintenance work on board the ship, which is the subject of the work plan on the deck section, we list:

- Scraping, brushing, patching and painting;
- Sheet straightening;
- Lubrication of loading installation, including the anchoring installation;
- Wire maintenance;
- Inerior works – in the food compartement, in bathrooms;
- Maintenance of inventory material: emergency materials, lifeboats, fire installation;
- Performing sailing work;
- General maintenance of the ship's hull on the outside, without ignoring the inside(where appropriate).

1. SHEET STRAIGHTENING

Manual staightening is applied to small and medium-sized semi-fihished products with low or medium hardness.

Mechanical straightening is applied for large semi-finished products with medium or high hardness.

Cold straightening (manual) highlights two categories of deformations:

- Deformations due to the bending moment necessary for straightening;
- Crushing deformations.

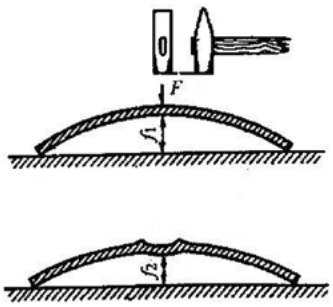


Figure 3 staightening deformations

1. Cold straightening, with rare and strong blows is applied for large deformations, for materials with good plastic deformation capacity;
2. Cold straightening, with frequent and light blows is applied to soft materials, hardened parts;
3. Cold straightening, by causing the bending moment is applied to bars, pipes by fastening in special devives (vises).

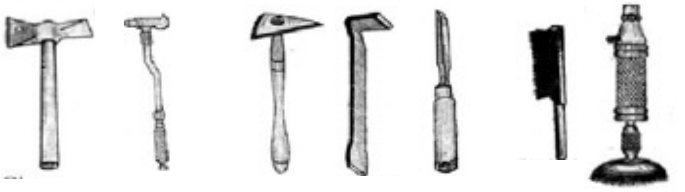
2. MANUAL RUST CLEANING AND SCRAPING

The preparations of metallic surfaces for painting are carried out by replacing old paints and then a complete cleaning of the rust that penetrated under the paint, follows. If the old paint is in thick layers and needs to be removed completely, than the metal sheet is hammered with a special hammer, then scraped and finally cleaned well with a wire brush. The instruments for manual rust ceaning and scraping are:

- **The manual rust cleaning hammer** - it is a hammer that has both its ends pointed (it can also be pneumatic);
- **The scraper** – which can also by made on board of the ship from a piece of sheet steel bent at and end and well sharpened to shave off the paint;
- **Wire brushes can be** – normal
  - pneumatic.

The cleaning of the rust from the metal is done with scrapers and then with wire brushes, and then the final removal of the rust residues is done by clening it wiht oil.

After the metal surface has been hammered and thoroughly cleaned of rust with a wire brush, it is covered wit a thin layer of boiled linseed oil and after its drying it is primed. For covering metallic surfaces with primer, lead minium is used and in its absence iron minium mixed with natural oil is used.



Manual hammer | Mechanical hammer | Types of missiles | Manual wire brush

3. POLISHING

Polishing is the technological operation of suprafinishing the surfaces with the help of abrasive pastes applied on the edges of cloth or fabric disks that rotate at high speed (over 30-40 m/s).

Polishing is performed only after a very fine sanding and it aims to obtain surfaces with a high degree of smoothness (mirror).

4. LUTING AND PAINTING

After the preparstory opertions are completed, the paints are prepared and the the painting operation itself begins.

Painting the ship is a very important operation on board of the vesssal and it is performed by the best sailors, trained in the use of paints, handling brushers and compliance with labor protection rules.

Paints used in painting the ship can be

- Anticorrosion (to protect the surfaces aginst the rust);
- Antifouling (for the protection of quick-work against algae and shells);
- Flame retardants (that do not maintain combustion – machine compartements are painted with them).

Before painting, the paints are prepared by mixing the dyes with:

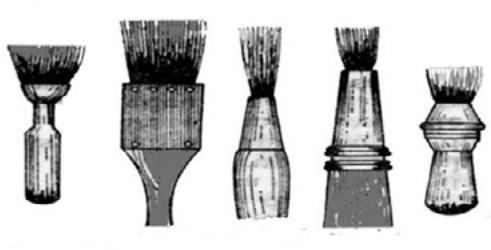
- Oils (boiled linseed oil, hemp oil etc.);
- Resins (rosin serlac etc.);
- Solvent (white-spirt, benzene, acetone, turpentine);
- Siccatives (substances that accelerate the drying of paints witout changing their properties).

Keeping the paints on board of the vessel as well as their preparation and use, are operations that fall within the attribution of the crew chiefs and constitute one of the main forms of manifesting their skill and mastery.

The tools used in the ship's painting operation are brushes, rollers and spayers.

The **brushes** used for manual painting of the ship have different sizes and forms.

Types of brushes for painting



Berore using them, the new brushes are kept in fresh water for 15-20 minutes. Also the new brushes are tightly tied with ropes (or patronized with metal tape) to give them greater strength and to be more comfortable to work with.

After each use the brushes are kept in a vessel/bowl (jar) full with thinner, after that they are washed with turpentine or oil.

The use of brushes during the painting of the ship is done in compliance with the following rules:

- The brush is held by the heandle so as not to soil the hands and is applied on the metal surface in an oblique position (not perpendicular);
- The brush is soaked in the paint box with its tip (about 1/3 of the brush) so as not to take much paint at once;
- The brush is again soaked in the paint only after the existing one on the brush is completely used;
- The paint spreads well with brushstrokes along the metal surface.

Manual painting is done from up to down. For each new stroke the brush is lift up from the object (painted surface);

- At every 10-15 minutes the paint is mixed with a wooden stick, to avoid deposits at the bottom of the box;
- The painting is done in thin layers (you better paint an object twice, each time with a thin layer of pain, than once with a thick layer of paint);
- Under no circimstances should a second coat/layer of paint be applied until the first coat/layer is dried.

Spray painting is, usually, used when large surfaces are painted – the ship's hull, suprastructures. When using sprays, we also must take into consideration and respect the following rules:

- The distance between the spary and the surface that needs to be painted should be between 25-35 cm;
- The spay paint should be directed on a perpendicular direction to the painted surface;
- The paint is applied on stripes with a coating of 15-20 mm;
- When stopping working with the sprayer, place it in a bowl with turpentine (or any other thinner) so that the paint does not dry out.

Maintenance of engines and installations

The overhaul of a machine or installation must be done in two situations, namely:

- If, following a control of the unit functions, signs of abnormal operation are observed. In this case, the overhaul will find the part that started to break down and to disturbed the operation of the unit of which it is part;
- If the installation that ensures the filtration of liquids used on board (fuels, lubricants, water for heat supply) cannot fulfill its role due to impurities.

The crew is oblidged to comply with the preventive maintenance deadlines inducated by the manufacturers.

Ships - are equipped with spare measuring devices so that the defective ones can be replaced (thermometers, manometers, ammeters, voltmeters etc) and with consumables in sufficient quantities and of good quality.

- Are equipped with the tools and spare parts needed to repair the installations.

Daily maintenance of machinery and naval installation when the ship is in operation, is performed:

- For Diesel engines, for each 8 hours of operation, fuel, oil and water filters are cleaned;
- At the fuel tanks to supply the enginrs, water is eliminated;
- For oil baths, these are supplemented with oil;
- At compressed air launch batteries, they are purged;

- In the case of alternative steam engines, it is checked if all the nuts of the machine are tight and if the split nailsare not missing and nor the other elements of security;
- Drain valves for cylinders, drawer boxes, heating spaces and steam pipes are opened to remove water from steam condensation. Great importance must be given to steam losses because their consequence is a reduction in fresh water supply and an increase in fuel consumption. It is necessaty to detect and fix these leaks. The operation of the machine is checked by means of the indicated diagrams. The rods of the pistons, drawers, slides and all the joints of the machine area greased. At short intervals, we must check the oil in lubrication cans and whether the filters are clean. For automatic lubricators it is checked whether the number of drops per time unit is constant. The degree of heating is checked at joints and if it is excessive, the respective adjustment is loosen;
- In case of steam turbines the axial and radial clearances of the turbine rotor, the reducer and axial and radial bearings are checked. The condition and operation of speed regulator and the quick-closing valve are checked. During the turbine operation, the maintenance of the operating speed, the preassure and the normal temperature of the oil circuit will be followed. Steam seals are minitored. It is periodically checked if the water has not penetrated the oil;
- In case uf steam boilers, the operation of the boiler fittings and ancillary installation is continuously checked, the safety valves are tested manually, the level bottles are purged, the purge devices are checked, the sprayer air registers are checked. Daily, the manometer is connected to the atmosphere with the help of the three-way tap, checking if the indicator needle retutns to zero. By contacting the boiler, it is checked that the connection hole is not clogged. Simultaneously with the operations of servicing and surevision of the boiler itself, the ancillary installations of the boiler, the superheater, the pumps, the sprayer, the pipes,ect, must be serviced and supervised;
- At the bridge installations the mechanismes, namely the rudder machine and winches, need a daily maintenance. Thus, it is checked the lubtication for the rudder machine, the oil and the consistent grease are checked, the tighteness of the piping for electohydraulic installation is checked;
- At winches the fixing cables and chains are checeked, the operation of the brakes and the all level for the reducers are veriffied. The external lubrication of the moving organs is ensured. The electrical motors are controlled from the point of view of heating;
- To pipes mounted on ships the leaks are removed by replacing the seals;
- To the propulsion system the lubrication of the etambou bushes is ensured, and for the paddle wheels the tightening of the removable joints is checked;
- At the electrical installation of the ship, faulty lighting fixture, fuses, worn telephone and bell parts are replaced and if it is necessary, cables are partly replaced and the correct operation af all measuring and control devices are checked.

If the ship arrives in port and it is immobilized at the quays, the daily maintenance consists of: for the external cleaning of the engines, appliances and installation from the machine compartement, only linen cloths will be used for this operation; removing leaks and repairing defects observed during running/ cruise, cleaning filters and lubricating all joints.
In case of steam engines, when parked in the harbour, the greases are emptied, cylinders are purged, the joints are checked, the working faces of the cylinders and centering of the pistons are checked, the drawer boxes are opened and the mirrors are rigorously controlled.

In case of stopping the turbine, when stationed in the harbour, this one will be daily rotated. On this occasion the axial and radial clearances of the rotor are verified, the actuation of the regulator, the operation of the valves and taps and their condition is also checked. Stone deposits and other impurities, corrosion, cracks, rigidity of fixing pallets will be monitored and detected.

Works on internal combustion engines

Keeping engines in good working order involves regular cleaning and overhauls at prior established intervals. The parts under revision are disassembled, cleaned, examined and measured where necessary. Depending on the findings, the parts are repaired, replaced, or if they can still be used in their condition, they are reassembled.

In general, the maintenance works consist of:
- Cleaning fuel, oil, water filters for every 8 hours of run/cruise;
- Purging fuel tanks;
- Drawing up unfolded diagrams of burns for all cylinders;
- Cleaning and checking injectors, valves, injestion pump fans, launcher distribution at every 250-hour of run/cruise;
- Disassembly, cleaning and inspection of all cylinder heads, including intake, exhausted and safety valves every 750 hours of operation. In case of leaks, the valves are worn in on their seats;
- Checking the lubrication system;
- Checking and cleaning the sweep valves on 2-stroke engines;
- Disassembling, cleaning and checking the pistons of the engine, compressor, and sweep pump every 1500 hours of operation;

- Checking the pumps driven by the main engine, namely the lubrication, circulation and bilge pumps;
- Removing the stone from the cooling space, the piston sleeve and the cylinder head.

At every 3000 hours of running the engine is completely dismantled and overhauled.
The deadlines indicated must; first, take into consideration the indications of the aggregates building companies.

The quality of the oil in the lubrication circuit is of great importance, therefore, at regular intervals, it is checked. In general, oil changing, is done when:
- The viscosity of the circuit oil increases compared to the initial viscosity by more than 15% for plunger engines and by more than 5% for crosshead rotors;
- The Conradson coke index increases by 2% in the case of plunger engines and by 1% in the case of crosshead engines;
- An organic acidity of 2 mg KOH/g is observed in the case of plunger engines and 1mg KOH/g in case of crosshead engines.

The cleaning of parts in case of revision is done with diesel.

The parts that have been reconditioned must be washed again or blown with compressed air to remove scraping residues.

In case of the crankshaft, measuring the deviation from the angular position of its cranks is a larger work. It is executed with a special rapporteur and a level. The level also measures the angular deviation between the two arms of one and the same cranks, placing the level consecutively on the two arms. In case of deviations, therefore the twisting of the shaft, it must be subjected to very thorough general control, because bends and cracks can appear.

Bending of the crankshaft is highlighted by the beats presented to them by the spindles during the rotation of the shaft and which can be accurately measured with the comparator.

The comparator is provided with a special spring support that is mounted between the arms of the crancks. The distances thus measured in vertical and horizontal position of the cranks give the alignment of the crankshaft.

The comparator will give positive indications if the distances between the arms in the PMI position will be greater than in the PME position, namely the shaft will be bent down.

The engine crew has the duty to inspect the bolt joints that secure the engine crankcase to the pedestal and those that secure the block cylinder head. Improper tightening of these bolts can lead to shocks and even total unscrewing.

The only safe control is the use of torque wrenches, which can be adjusted for a certain tightening moment, according to the documentation. In the absence of these wrenches, the mechanic's experience matters. The tightening of the bolts must be done in steps and evenly, successively tightening a pair of diametrically opposed bolts.

In the case of bearings, the maintenance of functional clearences ensures normal lubrication. These motions are ensured by adding or removing additives or by adjusting the anti-friction metal layer. However, if the clearances increase due to the ovalization of the bearings, it is necessary to refill the bearing.

Sailing works

The operation – sailing works – is assigned to all sailing works carried out on board the ship from rope handling to making knots and braids.

The most complicated sailing works are those that refer to the splicing of the ropes, to the execution of the braiding of the rope and to making certain household objects for life on board.

Sailing works are performed with yhe help of special tools, such ass: spike, splaicing hammer, beetle/knocker, wrapping bettle/knocker, splaicing spoon or shovel, splaicing clamps.

a. Splaices

By splaicing, it is meant the braiding of the strands of the ends of two ropes, or the braiding of the strands of one end of rope, between the strands of the same rope, without knotting them and without introducing foreign elements.

The spalicing of the ropes is performed with two purposes: joining two ends of the rope in the same way and making a loop/dead-eye or eye at the end of a rope. Two kinds of splaices are used to join two ropes:
- **Short splaice** which is a resistant splaicing, which thickens the rope at the place of connection and cannot be used when passing through a notch. Short splaicing is perfotmed by loosening the strands of both ends of the rope over a distance equal to 6-7 times the circumference of the rope, then the strands of one rope are inserted crosswise through the strands of the other rope, pulling them 2-3 times under a strand and over another; when the loose strands of one end are finished passing through the braided strands of the other end of the rope it is said that a passage is finished; after that , the same procedure is followed for the second passage by inserting the loosen end of one through

the braided strands of the other end; when the operation is over, the loose shingles are cut and the rope is wraped (whipped) with merlin, and the lines are whipped with thread by the sail. A short splaicing is beaten well with the hammer (beetle/ knocker) and then rolled so that the new strands settle well in the place of the old ones;

- **Long spalice** does not thicken the rope at the place of connection and allows it to be used when passing through a notch. For the long splaicing, one or two strands are unrolled from each end to a length of 12-14 times the circumference of the rope, and then it is tied so as not to further unravel. The two ends are joined as for a short splaicing, and then a strand of rope 1 is taken and wrapped (twisted) in the place of the untiedstrand of rope 2. The same is done with the strands of rope 2 which are wound on rope 1 in the place left free from the release of its own unfolded strand. The strands left free are passed under the neighboring strand, then they are thinned, about two more passes are made over the neighboring strands as in a short splaicing. Any long splaicing is beautiful; has a thickness almost like the original rope, but is less resistent;
- **Splaicing a rope eye or a loop/dead-eye** (an eye of high dimesions) it is done at the end of a rope, as it follows: the rope is unfolded at its end into its three (or four) strands, and then it is bent to form the eye. The strands of the working end are passed between the strands of the rope in a similar way as the passages of the short splaicing. After a few passes the strands become thinner and are passed 2-3 more times through the strands of the rope. The remaining ends arecut, then the splaicing is wound with merline or sail thread, depending on the thickness of the rope. When splaicing wire ropes or their loops/dead-eye, the connection must be well protected against water penetration between the splaicing strands. That's why the splaicing is wrapped tightly with tilt/awning cloth and then whipped with thin wire or hemp merline.

b. Whippings, ties and wraps

Whipping is the wrapping of the rope ends with line (or merline) to prevent disintegration. Wire ropes are whipped with sailing thread or thin wire. The ties are sailing works done to secure two parallel ropes that pull just as hard. They are executed in turns as in the whipping or in turns in eight.

The ties are of several kinds:

- **Wide tie** which is to whipping of a crane or when two ropes that are equally strong must be tied;
- **Round tie** which differs from the wide tie by the facts that over the turns initially taken, another row of superior turns is added above the others;
- **The Portuguese tie** which differs from the round tie by the fact that the first row of turns is taken in the shape of 8, after which round turns are taken above them.

The wrapping is an operation defined by its own name. The wrappings are made with the pursose to protect the ropes against friction when crossing metal parts. It consists in covering the rope with stripes of sail cloth 8-12 cm wide and placed in helix (covering the edges of each vault). The sailcloth is tightly tightened with merline thread (or sail thread).

The wrapping of thick ropes is preceded by filling the gaps between the cords, with lines or merline, so that the rope reaches a uniform and smooth surface, on which the adhesion of the strips of sail cloth with which it is wrapped is achieved.

c. Various works

In seafaring practice, a series of sailing works are performed that use splaicing, whipping or braiding of the ropes.

Of the works performed on splaicing we can mention – single walnut, double and elongated head. These are knots made by braiding the strands at the end of a non-whipping rope. They are used at the ends of railing ropes, at the ends of boat currents, at maneuvering arms of the mouths, at the ends of the handle of wooden or waterproof cloth bucket, etc. Splaiced knots like the walnits, but with added strands are also executed to the ropes that serve as swivel-hook or mobile horizontal mast hangers.

Among the works performed by braiding the ropes or theit component parts are given as exemple: boat straps, braided mats and woven mats, nets, berth ballons, etc.

Mats are woven or braided hemp rugs used on board to protect wooden parts against wear or to wipe the shoes. Nets are made by braiding ropes and are used on board of the ship for protecting people who work on board or are stretched under the ladder as a measure of labor protection when boarding people on board.

Tools used for splacing ropes:

d. Chain maintenance

During operation, the anchor chain must be checked systematically to ensure that links are not cracked and the bridges are not loosened.

The anchor chain should not be used if cracked links or a broken bridge are found, as this could endarger the ship – in case of a storm when the ship is at anchor the chain could break.

Whenever the ship is put on the dock, the crew must remove the chain from the well spread it on the dock deck and clean it of rust and old paint. On this occasion, the chain is checked link by link, paying special attention to the connecting keys, which are disassembled and lubricated.

During the annual checks, the chain keys that have been subjected to higher stresses (for exemple key three or four) can be replaced with the less used chain keys (for exemple key 5 or 6 that were in the well of the chain).

After the chain has been cleaned – hammered, scraped, brushed- it is painted with minium and then with paint. In order for a chain to be well maintened and not present a danger during operation, it is necessary that on each turn it is well washed by mud, with special washing installations arranged in the nostril of the anchor or manually with the help of a hose. The links in the effort zone (those that have been supported againt the nostril and those at the stop) must be hammered after each turn to discover any broked links.

5.1.2 The boatman has the ability to work with different types of materials and tools used for maintenance and repair operations

5.1.2.1 Knowledge of applicable cleansing and preserving procedures and rules of hygiene 5.1.2.2 Ability to clean all accommodation spaces, the wheelhouse and keep the household in a proper way complying to rules of hygiene, including taking responsibility for their own accommodation space

5.1.2.3 Ability to clean the engine rooms and engines using the required cleaning materials

5.1.2.4 Ability to clean and to preserve the outer parts, the hull and the decks of the craft in the correct order using the required materials according to environmental protection rules

5.1.2.5 Ability to take care of the craft and everyday waste disposal according to environmental protection rules

Occupational hygiene notions

Hygiene is the science of preserving and strengthening human health.

It deals with the study of environmental factors that influence body growth and development, the causes that produce diseases and the methods used to combat them. If the hygienic rules are not known and observed, the normal functioning of the organism can be disturbed and the state of malaise, disease appears. Hygiene teaches us how to prevent the diseases, how to keep our health. **The hygiene is a science.**

Hygiene teaches us not only how to prevent the disease, but also how to strengthen our health. It shows us the harmful and beneficial factors on which our health depends. These factors are multiple and act differently on our body.

Hygiene helps us develop an emotionally balanced personality, self-control in difficult situations, with intelligence capable of solving various problems that life raises. A natural consequence of knowing and applying in practice the principles and rules of hygiene is the prolongation of human life.

The application and observation of the hygiene regulations on which our health depends require much less effort than the one we put it trying to cure ourselves of a disease after it has appeared. The disease leads to physical and mental suffering, interruption of physical activities, separation from friends and acquaintances, spending on drugs, etc. Even after they have healed, some diseases leave traces that weaken the body's work capacity and endurance. A healthy man works with pleasure, can enjoy life, looks to the future with confidence. The sick man suffers a lot, he becomes distrustful of his own strength and that of other people, he is unhappy.

Occupational hygiene is the science that deals with maintaining and strengthening the workers' health at work, occupational safety measures and the prevention and control of occupational diseases.

The industrial environment must meet certain hygienic conditions that ensure the maintenance of the health and working power of workers. The measures for the protection and organisation of work, aim to ensure, first and foremost, the appropriate microclimate for workers.

a. The hygienic conditions of the microclimate from the industrial sector.

The microclimate refers to:

- **Rooms** where the activity takes place must be large, spacious, well maintained and clean, to favour the free movement of workers and the avoidance of accidents and occupational hazards;

- **The air temperature** must be of 18-20 0C. There are situations in which the workers have to work at lower temperatures which can lead to a decrease of the body's natural resistance to various diseases: rheumatism, tonsillitis, bronchitis, etc. In these situations the protective clothing consists of clothes, footwear and gloves that are not conductive of heat and moisture, bur air permeable;
- **Air humidity.** Normal humidity varies between 50% and 70%.Outside these limits the air is considered dry or humid. Dry air disturbs the breath, dries the mucous membranes and gives an unpleasant sensation. Humid air makes breathing and evaporation of transpiration difficult and decreases body's resistance to diseases;
- **Normal atmospheric pressure** is of 760 mmHg, and the small variations are not felt by human body. Yet, there are situations when the workers must work at higher or lower pressure. Those working at high altitudes are exposed to low pressure, in these cases, it is sometimes necessary to use oxygen masks as a protective measure. Those working on foundations, bridges and underwater works are exposed to high pressure, etc. Sudden transition from low pressure to normal pressure should be avoided, as it causes joint pain, muscle pain, skin disease, and shortness of breath (caeson disease).
  Prevention of accidents and occupational diseases due to microclimate factors is achieved through technical and organizational measures appropriate to the situation.

b. Chemical pollutants

An important risk factor that occurs in the physical environment is the chemical pollutants, represented by the harmful substances that are released into the workplace atmosphere: gases, vapours, aerosols, dust.

The main dangers generated by chemical toxins are: intoxications, chemical burns and explosions. The following categories of harmful chemicals are distinguished:

- **Toxic substances** – are those that enter the body (through breathing, through skin or through eating), affect its functions and cause poisoning;
- **Caustic substances** – are those that in direct contact with the body cause burns (chlorine, nitrogen oxide, arsenic, perchloric acid). The most common are the skin burns, and the most dangerous are those to the airways and digestive tract;
- **Flammable substances** – are those with fire hazard, if they meet favourable conditions;
- **Explosive substances** – are those in which, following very quick chemical reactions, in a short time, new products with heat release result. Many substances in contact with air can cause explosive mixtures (gasoline, toluene, acetone, acetic acid, coal powder, metal powders of zinc, aluminium, and magnesium).

Prevention is characterised in the case of toxins by:

Technical measures:
- Mechanisation and sealing of technological processes;
- Replacement of toxic substances with others less toxic or not toxic at all;
- Replacement of dry processes with wet processes;
- General , partial, local or combined ventilation;
- Adequate protective and work equipment, etc.

Organisational measures:
- Medical examination at employment and periodically;
- Proper storage and handling of substances;
- Cleaning the workshops;
- Protective nutrition;
- Workers' training etc.

c. Industrial powders

Industrial dust occurs during the work process, due to various machines or installations (grinders, blasting machines, sieves, etc.). The powders act on the body mechanically or chemically. Those that constitute chemical toxins have been presented previously.

d. Noise and tremors

The noise is a harmful factor, common in a number of industrial activities, such as filing and cutting metals, riveting, drilling with compressors, testing engines, etc. it is a harmful action on the whole body, but especially on the nervous system. Workers exposed to continuous nose become drowsy, inattentive, and nervous, have headaches and reduced appetite. Due to continuous and irregular stimuli caused by noise, the ear gradually loses its normal functioning and in a few years the so-called *professional deafness* is installed.

Tremors are vibratory movements produced by running machines. Their long action and of a certain intensity, causes the so-called *vibration disease*. The disease begins with fatigue, shoulder pain, weight loss and restless sleep. Then pain is installed in fingers and joints, pain that worsens especially at night.

The measures to combat noise and vibration can be:
Technical measures:
- Correct balancing of machine parts;
- Avoiding high pressures in installations;
- Attenuation of noise propagation from the source through protective screens;
- Maintenance of equipment in good condition;
- Sound insulation of equipment (antiphonic encapsulation, shielding etc.);
- Rational location of noise sources in separate buildings or rooms;
- Soundproofing of platforms, floors and walls;

- Insulation of machine operations in soundproof booths;
- Insulation of the foundations of vibration generating machines (elastic insulation, springs);
- Use of personal protective equipment (internal or external earmuffs, vibrio-insulating gloves, vibrio-insulating clothing).

Organisational measures:
- Medical examination of workers at employment and periodically, and non-admission to work of those with hearing impairment, respiratory tract, nervous system, joints;
- Workers change after certain intervals from the machines that produce vibration;
- Staff training.

Staff training and education

Labour protection training at the level of physical and legal persons comprises three phases:
- General introductory training;
- On-the-job training;
- Periodic training.

1. General introductory training is done to:

a) new employees;
b) those transferred from one unit to another;
c) those who came to the unit as detached;
d) pupils from vocational school, technical highschool, and students for professional practice;
e) persons from the unit on probationary period foe employment.

The purpose of the general introductory training is to inform about the specific activities of the unit and the main labour protection measures to be observed during work.

2. On-the-job training

It is made after the general introductory training and aims to present the risks and prevention measures specific to the workplace where the person was assigned.

On-the-job training is done by the direct manager of the workplace.

The duration of the on-the-job training depends on the complexity of the machine or workplace to be worked on and will not be less than eight hours spread over the probation period.

3. Periodic training

It is made to the entire stuff and aims to deepen the rules of labour protection. This training must be completed with practical demonstration.
The periodic training is done by the workplace manager.

The interval between two periodic training for workers will be established by own instructions according to the workplace conditions, but will not be longer than 6 months.

The periodic training will be done in addition to the scheduled one, in the following cases:
- When an employee was absent from production for more than 30 days;
- When the technological process has changed or the equipment and tools have changed;
- When there have been changes in labour protection rules;
- When resuming work after an accident at work;
- When executing special works.

Labour protection training (general introductory, on-the-job, periodic) will be obligatory recorded in the individual training sheet with the indication of the taught material, the duration and the date of the training.

The training sheet is signed by the trainee, by the person who performed and verified the instruction, thus confirming that the taught material has been mastered.

The training sheet is drawn up for permanent staff, employed by civil agreements or detached, for seasonal, temporary or daily workers and will be kept by the manager of the work process, respectively by the one in charge of carrying out the training at the work place.

Protective and work equipment

It represents the means with which each participant in the work process is equipped, in order to be protected against the risk factors of occupational injury and illness.

Personal protective equipment is provided free of charge, to all employees exposed to the risk of accidents and occupational diseases.

The working staff, as well as the other categories of persons benefiting from personal protective equipment are obliged to have knowledge of its characteristics, to use it only for the purpose for which it was assigned, to present it for the provided period checks, to require its replacement or completion when it no longer ensures the fulfilment of the protection function.

The degradation of the personal protective equipment through the fault of the personal to whom it has been assigned, or its alienation, before the expiry of the prescribed period of use, brings them liable for the damage caused, according to the law.

Failure to wear the personal protective equipment if it is properly granted and in working order, or its use foe purposes or conditions other than those provided for the instructions for use, will be penalized in accordance with the law.

Worker protection measures for activities with hand tools

1. The hand tools must be made of materials appropriate to the performed operations.
2. In the case of activity in atmospheres with a risk of explosion, use tools made of materials which do not produce sparks by impact or friction.
3. Electrically or pneumatically operated hand tools must be fitted with tool clamps and devices to prevent their uncontrolled operation.
4. For the tools that present a risk of accidents (grinder stones, saw blades, drills, etc.), these will be protected against accidental contact with hand or other part of the body.
5. Pneumatically operated rotary hand tools will be equipped with speed limiters.
6. Steel percussion tools (hammers, chisels, thorns, heads) must be made of suitable heat-treated steels so that they do not deform or crack during use.
7. It is strictly forbidden to use tools with cracked, deformed, chipped surfaces, or improvised tools.
8. Tool tails and handles must be securely fastened and smooth enough to hold them safe and comfortably. Metal wedges will be used to fix the tails and handles in the tools.
9. Hand tools provided with joints (scissors, pliers, wrenches, etc.) must not move within the joint. They shall be positioned so as to have the grip facing outwards.
10. When working at heights, hand tools are kept in study bags and securely fastened to the body to prevent falling.
11. During transportation the sharp parts of the hand tools must be protected with suitable sheaths or guards.

Worker protection measures for machine tool work

I. General measures

1. Stopping the machine tools when changing devices, fixing and removing parts, repairing, cleaning, lubricating and removing chips, or leaving from the machine.
2. Use of screens of the protective devices, goggles and other personal protective equipment.
3. Maintenance of the machine, of the workplace and tools in perfect technical condition and cleanliness.
4. Checking the technical condition of the machine, tools and devices both before and after stopping work and announcing when handing over the shift change, all the defects found.

II. Specific measure for drilling machines

1. It is forbidden to hold the pieces by hand or wrenches, pliers, etc. The fixing is mandatory done in vise/vice or special devices.
2. The drills will be well fixed and centred in mandrels or tool-holder.
3. The tools are removed from the support only after stopping the machine and after breaking them mechanically.
4. It is forbidden to work on drilling machines without covering the head or holding it under the helmet.

III. Specific measures for abrasive tools

1. The transport, storage, loading, installation and operation of abrasive bodies will be done in strict compliance with the profile standards.
2. The installation of abrasive discs on machines will be done only by trained workers, after installation it is mandatory to check the perfect centring.
3. The abrasive discs are mounted in such a way as to exclude the possibility of movement on the shaft, during and due to rotation.
4. The abrasive bodies must be protected during operation with a protective housing which must cover the entire non-working part.
5. All abrasive bodies will be subjected to sound testing for cracks, resistance to rotation and imbalance.

Worker protection measures when using electical installation and equipement

1. Ensuring the inaccessibility of the elements that are part of the electrical circuits by electrical insulation of the conductors, the use of grounded protective housing, the fencing with wire mesh or perforated boards respecting the required distance to the live elements, the placement of electrical conductors at a height inaccessible to humans.
2. Use of low voltage (of 12, 24 and 36 V) for portable lamps and power tools, avoid twisting or winding of the power cord while working, avoid passing the cable over the access road and in places for material storage, prohibiting the repair or repair of defects during operation.
3. Use of individual means of protection (main – insulating rods, insulating pliers, tools with insulating handles, and secondary – protective equipment, rubber mats, insulating platforms and grills) and warning means (warning plates, safety indicators, temporary fences).
4. Automatic disconnection in the event of a dangerous touch voltage or dangerous current leakage.
5. Protection separation by means of separation transformers.
6. Additional protective insulation.
7. Grounding protection.
8. Null protection.
9. Protection by equalizing potentials.

Labour protection measures for the manual handling and transport of materials

1. The operation of loading, unloading, manual transport and storage of materials must be carried out under the supervision of the work team manager, by well-trained stuff in this purpose and over 16 years.
2. For very dangerous materials (toxic, explosive, carcinogenic, etc.) the minimum age for handling is 18 years.
3. The places where the loading-unloading and storage operation are carried out, as well as the access roads must be level and arranged for water drainage and usually paved.
4. In the case of loading-unloading operations of vehicles on the ramp, a bridge is placed between it and the vehicles to take over the existing unevenness.
5. Manual transport distances may not exceed 60m and the level differences must be of a maximum 4m (stairs, scaffolding). The maximum height at which the maximum permissible loads can be lifted vertically is 1.5 m.
6. When lifting, unloading and transporting loads exceeding the above values, as well as in the cases where the level difference is greater than 4 m, it is mandatory to work on teams or mechanized.
7. Manual transport of weights on inclined plans must be limited to 25 kg without interruption and 30 kg with interruption for men and 12 kg with interruption for women.

Fire and explosin prevention

Measures and means to prevent fires and explosions:

1. Eliminating the possible causes of fire and explosions, by the technological process design.
2. Avoid the formation of explosive mixtures in the production halls by periodically cleaning the dust on all surfaces charged with static electricity.
3. Increasing the relative humidity of air, where products allow.
4. Provision of automatic disconnection devices in case of failure.
5. Provision of fuel de pots with special installation for automatic triggering of water spraying when the temperature rises.
6. Arranging smoking spaces.
7. Ensuring a good evacuation of people and goods from building in case of fire.
8. Installation of fire stairs, water inlets with the necessary equipment (hoses, pumps, etc.).
9. Fireproofing of combustible materials under construction.
10. Marking hazardous areas, explosive environments, escape routes from buildings and ensuring good conditions for rapid fire fighting.
11. Organising volunteer and specially hired fire brigades.
12. Banning the use of open flames, smoking hazardous environments.
13. Establishing precise tasks for preventing and combating fires and ensuring their processing and display.
14. Workers training and dissemination of technical knowledge on the cause and prevention of fire.
15. Endowment with equipment and technical materials for fighting fires (shovels, hand pumps, manual fire extinguishers, motor pumps, self-pump, water mains, etc.).

Protection caps

KENTUCKY
Protection helmet

FIREFIGHTER
Protection helmet

Antiphon helmet

Antiphons

EAR Classic

EAR Ultra fit

Welder mask

Welder helmet

Welder goggles

Welder goggles

Support and visor
for electricians

Full face mask
(Panorama Nova)

Simple half mask

Half mask with valve
(FFP2-SL)

Half mask with valve
(FFP3-SL)

Painter's suit

First aid kit

Indicators for labour protection

Corrosive materials

Flammable materials

Explosive materials

Toxic materials

Radioactive materials

Suspended weights

Handling vehicles

Electrical hazard

General danger

Laser radiation

Combustible materials

Non-ionizing radiation

Strong magnetic field

Danger of tripping

Uneven fall

Do's and don'ts

✓ When stationary, secure the wheels with brakes

✓ Choose well-sized tools

⊘ Do not increase the actuating force

⊘ Do not use tools created in millimetres for parts in inches

⊘ Do not strike tools that are not designed for this purpose

⊘ Do not change the shape and dimensions

✓ Correct positioning during actuation properly

⊘ Do not use srewdrivers as chisels

⊘ Do not operate on live networks except with insulated tools

✓ The impact surface must be larger than the surface that

⊘ Do not hit surfaces with the same hardness

⊘ Do not use worn or defective tools

5.1.3 The boatman shall be able to maintain technical devices according to technical instructions

5.1.3.1 Knowledge of technical instructions for maintenance and maintenance programmes

5.1.3.2 Ability to take care of all technical equipment according to instructions and to use maintenance programmes (including digital) under supervision

The Ship's Maintenance and Repair

A ship is considered to be on operation when its hull ensures buoyancy, when its machines, installations, equipment and endowments are complete and in working order, when its crew is complete, according to the scheme developed on legal basis and on board requirement, and the ship is fit for immediate use according to its destination, even if it is not actually used.

Beginning from the facts presented above, it turns out that a well-mantained ship has the time allotted for accidental or planed short-term repairs, this ship brings profit through optimum efficiency. For the above purposes, each crew member is required to know at his/her place of work the technical rules for the operation, maintenance, overhaul and repair of machines, installations, equipment, etc.

1. The ship's daily maintenance

The day-to-day maintenance of the ship is part of the day-to-day maintenance done by the crew of the ship. Within this works, which are daily done, are primarly included the workplace cleaning, that is waste disposal, washing decks and rooms intened for the management of the ship, cabins, rooms with socio-cultural utilities, cleaning the machines compartment, mechanism compartments, pumps, refrigeration systems, deck leaks.

Within these daily maintenance operations of naval machinery and installation when the ship is in operation, the following works are executed:

- **To the Diesel engine,** at every eight hours of operation, the fuel, oil and water filters are cleaned;
- **To fuel tanks to supply the engines**, water is removed from them;
- **To oil baths,** these are supplemented with oil;
- **To compressed air launch culinders,** they are purge;
- **In the case of alternative steam engines,** it is checked that all the nuts of the machine are tight and that the split nails or other safety elements are not missing. Drain valves for cylinders, drawer boxes, heating spaces and steam pipes are opened in order to remove water from the condensation of steam. Great importance must be given to steam losses, as their consequence is a reduction in the supply of fresh water and an increase in fuel consumption. It is necessary to detect these leaks and remedy them. The machine operation is controlled by means of diagrams. The rods of thepistons, drawers, sliders and all the joints of the machine are greased. At short intervals, check the oil lubrication cans and whether the filters are clean. For automatic lubricators it is checked if the number of drops per time unit is kept constant. The degree of heating is checked at joints and if it is excesive, the respective adjustment is lossened;
- **In the case of steam turbines,** we check the axial and radial clearance of the tutbine rotor, of the reducer and of the axial and radial bearings. The condition and operation of the speed controller and quick-closing valve are checked. During the operation of the turbine, care must be taken to maintain the operating speed, pressure and normal temperature of the oil cicuit. Steam seales are monitored. It is periodically checked if the water has not penetrated the oil;
- **In steam bolers,** the operation of the boiler fittings and ancillary installations is continuously checked, the safety valves are tested manually, the level bottles are purged, the operation of the purge devices is checked, the operation of the air registers of the sprayers is checked.

Every day, the manometer is connected to the atmosphere with the help of the three-way valve, checking if the indicator needle returns to zero. By re-contacting the boiler, it is checked that the connection hole is not clogged.

Simultaneously with the operations of servicing and supervision of the boiler itself, the auxiliary installations of the boiler , the superheater, the pumps, the sprayers, the pipes, etc. must be properly supervised and serviced;

- **Deck installations** require daily maintainance for teir mechanisms, ie. rudder machine and winches. Thus, the lubrication is checked on the rudder machine, the oil and the consistent grease are filled in, the tightness of the piping for electohydraulic installation is checked;
- **At the winches,** the fixing of cables and chains is checked, the brakes operation and the oil level at the reducers is checked. The external lubrication of the moving organs is ensured. The electric motors are controlled from the point of view of heating;
- **In the case of pipes mounted on ships,** leaks are removed by replacing the seals;
- **For the propulsion system,** the lubrication of the etabou bushings is ensured, and for the paddle wheels the tightening of the joints is checked;

- **For the electrical installation** of the ship replace the defective lighting fixture, fuses, worn parts of telephones and bells, if necessary partially replace the cables and check the correct operation of all measuring and control devices.

If the ship arrives in the harbor and is immobilized at the quays, the daily maintenance consist of: external cleaning of engines, appliances and installations in the machine compartment, for this operation only linen cloths will be used,removal of leaks and repair of defects observed during the march, cleaning of filters andlubrication of all joints.

In the case of steam engines, also when in harbour, the greases are emptied, the cylinders are purged, the joints are checked, the working faces of the cylinders and the centring pistons are checked, the drawer boxes are opened and the mirrors are rigulously controlled.

In case of stopping the turbine, when in harbour, it will be daily rotated. On this occasion the axial and radial clearances of the regulator, the operation of valves and taps are checked and also their condition is checked. Stone deposits and other impurities, corrosion, cracks and rigidity of fixing the pallets will be monitored and detected.

2. Routine maintenance work performed by the crew

In order to avoid special phenomena, no member of the crew has the right to operate the equipment, other than those provided for in the duties. They must be operatedin accordance with the technical instructions which must exist on board the vessel in the national language of the crew. During use, each navigator has the obligation to monitor the operation, permanently or periodically, to notice the trends of abnormal operation and to intervene at the appropriate time. It is forbidden to exceed the number of operating hours as well as to postpone technical inspections and maintenance works, except in well-justified sitistions.

To extend the life of a ship, measures are taken and a series of maintenance and repair works are carried out. Measures to protect and prevent damage and degradation are all the more necessary as the operating conditions are more severe. The have specific characteristics depending on the type and destination of the vassel.

The works to which ships are subjected fall into two large categories:
- Routine maintenance work;
- Repairs.

Routine maintenance work is performed daily by the ship's crew and are indended to keep the ship in good working state, in order to be able to perform the maneuvers required when stationary or in motion.

Repair works ensures the good technical conditions of ships and are works that are carried out in the form of a preventing regime of planned repairs, some of them having a periodic character. The characteristic of the system of periodic, preventive, planned repairs consist in the periodic removal of the ships or parts of their endowments from the operation for the execution of some repairs with determined volume.

The preventive repair system aims:
- Maintain the ship in perfect working order for operation needs;
- Peventing the early decommissioning of the ship;
- Timely shutdown of ships for repairs in accordance with the annual repair plan;
- Rational preparation of reapir works, timely preparation of necessary materials and spare parts ;
- Minimizing the downtime for the repair of the ship;
- Increasing the nimber of the ship's operating hours between two repairs;
- Reducing the cost of repair.

Depending on the service life of the ship, the following types of repairs shall be established:
- **Technical overhaul** which is carried out annualy in order to determine the technical conditions of the ship and to establish the main works to be carried out in order to continue to ensure the proper functioning and operation of the ship. In addition to determinining the technical conditions, during technical overhaul some works, such as, can be carried out: decarbonisation of engines, washing and cleaning of sludge and stone of boilers, adjustment of engines and mechanisms, checking all installations and carrying out minor repairs to ensure the normal operation of the ship until the next planned reapir. On the occasion of technical overhaul, the seagoing ships stand on the dock for the cleaning and painting of the living work;
- **The current repair** is the repair that is carried out periodically, in a planned way , in order to replace the used elements or to recondition them. In accordance with the rules in force, current repairs are classifed:
  - Current repair of the 1st degree;
  - Current repair of the 2nd degree.

  Current repairs of the 1st degree are executed at a period between 2 – 6 years depending on the type of the ship, its service life, exploitation conditions.Current repairs of the 2nd degree are executed at a period between 4 – 6 years.
  The nature and volume of the works are established for each category of repairs according to the shipowners' regulations.
- **Capital repair**, is the repair, which is performed in a planned manner at an interval of 6 – 24 years depending on the type of the ship, duration of service and operating conditions.

The execution of this category of repairs aims to maintain the initial technical performance and prevent te decommissioning of ships before the deadline.

At the expiry of the period provided for a repair of a higher degree, the repair of the lower type with the same expiry date shall not be carried out.

For the execution of maintenance and repair works, it is necessary in some cases to remove the ship from the water on the dock or land that is to lift the ship on hold, an operation called *docking*. After lifting, *the fairing* is performed fist, that is the cleaning and painting of the living work. The cover of the live work is checked, by performing repairs or replacement of sheets. The control and repair of the shaft line is performed, the steering installation is checked and repaired. The appendix and the equipment related to the living work are also checked and repaired.

Docking, in the case of seagoing ships is an operation that must be repeated annually for the performance of fairing works. River vassels are docked in case of current second – degree repairs.

The exact specification of the repair works shall be drawn up according to criteria established by the MT and shall be finalised upon introduction of the ship for repair, following the findings made by the repair yard, the supervisory board and the Registry representative. At the same time, the technical documentation that determines the technology and the volume of the repair works is prepared.

The specification of the repair is submitted to the repair yard three months before the start of the current repair and six months before the start of the year in which the capital repair is planned.

In order for the works to be executed correctly, the defective elements, the place where theu are located, the nature and the size of the defect, as well as the degree of corrosion of the sheets and profiles are established in advance.

For the execution of repairs of all types, it is absolutely mandatory that there is adequate documentation so that the estimate of the works can be drawn up and the repairs should take as little as possible, in order to shorten as much as possible the time of stationing the ship in the shipyards.

The repair documentation consists of the specification of the repair works and specifications. When drawing up the specifications we shall take into account:

- The list of findings drawn up on the occasion of the technical review;
- The expert documents of the technical bodies and of the classification Registers;
- Permissible wears of sheets, machines and installations.

The specifications shall be drawn up taking into account thr repicatulative statement made by the Fleet-Maintenance and Repair Service together with the shipyard for the repair of defects found and the repairs to be carried out. The results of tests carried out during the last navigation period shall also be taken into account.

In case of replacement of aggregates or modification of the vessel structure, the technical documentation shall be supplemented by a stability calculation (how the modification made affects the stability or other characteristics of the vessel). The stability calculation will be endorsed by the Classification register.

The modification works are executed not only after the approval of the calculation. The list of equipment, aggregates and parts to be replaced and to be purchased in the country shall be handed over to the shipyard carrying out the repair together with the works specification. The list of equipment, aggregates and import parts is handed over to the shipyars 20 month sbefore the year of repair.

The operation in good condition for a longer or shorter period of time of a ship depends to a large extent on the professional level of the personal serving the various installations or units on board and on the conscientiousness with which they identify and remedy defects in the operation of the units.

Early determination of the beginning of failure of a part of the aggregates can be done only when the staff ensures a continuous control of the machines. As repairs are carried out by the crew as a result of judicious control of the operation of installations, it is necessary to read the measuring devices, measure the games, check the auxiliary systems that serve the unit, cool, lubricate and detect the appearance of noises or vibrations abnormal in the operation of units, to constitute a permanent task which subsequently gives the possibility of intervention.

The overhaul of a machine or installation must be done in two situations, namely:

- If, following the control of operation of the unit, signs of abnormal operations are observed. In this case, the overhaul will find the part that stared to break down and that disturbed the operation of the unit of which it is part;
- If the installation that ensuresthe filtration of the liquids used on board (fuel, lubricant, heat supply water) cannot fulfil its role due to the deposited impurities. In fact, the cew is obliged to comply with the preventive maintenance deadline indicated by the manufacures.

Defects found in the revosions shown above are remediate by the crew.

Forguidance and forship crew to be able to draw up a detailed inspection plan of certain component parts of the aggregates and equipment, they may generally be consideredto consist of three categories of parts:

- Parts that wear out quikly, due to the effort of high frequency mechanical, chemical or thermal actions (high speed gears, bearings, spindles, valves, fuel injection systems, fixed and mobile electrical contacts, etc);
- Parts that wear out slowly, due to the mechanical, chemical or thermal effect of low frequency (low speed gears);
- Parts that practically do not wear out (chassis, frames, etc.).

Although different parts of aggregates are organically connected to each other by joints or contact surfaces and although thei wear progresses simultaneously, they do not reach wear limit at the same time. The differentiation of the duration of different interconnected bodies is due either to the diversity of the materials from which they are made or the different intensity of request. It is essential to replace or rectify worn elements and parts in time, as this avoids the permanent wear of the other elements or parts of the unit with which they are in contact and whose service life is longer.

Control, overhaul and repair work on the ship's appliances and units, is also mandatory during the march to ensure the proper operation.

If the nature and volume of the repair that has occurred exceed the crew's performance, these cases shall be dealt with in accordance with the instructions given by the company operating the vassels by means of fleet repair sevices and specialist workshop.

For the situation in which the ship is stationed in ports, the crews must carry out control and overhaul works, following that on the repairs to be made with the means of the board it is decided by the repair services of the respective fleet depending on the training level of the respective crew.

In case of stationing in foreign ports, repairs will also be carried out with the means of the board. In case, some units need repairs, which cannot be performed by the crew, they can be carried out with the help of workshops in the respective ports, based on the instructions given by the operating unit. Such repairs may be postponed for execution in the country only if the ship's crew consider that precautions can be taken to ensure the return of the ship.

In order for the crew to be able to carry out a series of overhauls and repairs to ensure the normal operation of the ships, they must be equipped with the necessary tools and spare parts. The lack of tools leads to the situation of not being able to carry out the repair or in the best case to execute a work of poor quality. Ships must be equipped with spare measuring devices in order to be able to replace the defective ones (thermometers, manometers, ammeters, volmeteres, etc.) and with combustible materials in sufficient quantities and of good quality, knowing that the lack of any materials, no matter how insignificant, creates difficulties in the maintenance of machines and other on-board systems.

The relevant services of the ship's operating units must verify the permanent existence of inventory materials and spare parts on board of the vessel and take care of completion where deficiencies will be established.

3. The ship's operation, maintenance, overhaul and repair

Each member of the crew is required to know at his workplace the machinery, installation, apparatus, equipment as well as the technical rules regarding their operation, maintenance, overhaul and repair. Operation must be carried out safely and at optimum capacity. The head of the service has the obligation to train subordinate staff and assistance is provided to ensure the correct operation in conditions of labour protection.

No crew member shall be allowed to use on-board equipment unless assigned by role or service duties. For this purpose, each technical equipped station must have the displayed instruction for operation, maintenance, overhaul and repair.

While the equipment is in operation, crew members must constantly or periodically monitor and keep records of the time of operation of malfunctions and anomalies in operation. In case of interruption, crew members must intervene immediately for re-commissioning.

It is forbidden to exceed the number of operating hours set out in the technical instructions witout carrying out the planned technical overhauls and carrying out the necessary maintenance work. If it is necessary to extend the operating time beyond the established one, the approval of the shipowner will be requested. This will be mentioned in the logbook or car, as appropriate.

Revisions, tests and repairs shall be carried out in accordance with the instructions of the shipowner and the regulations in force. The ship's crew ie required to supervise the execution of work performed by personnel belonging to shipyards or other workshops. Before docking the ship, all the preparation required by the master of the dock must be made, including: unloading the ship, unloading fuel and lubricants, removing drinking water from the ship, handing over

the tailings, releasing all compartments for the works, carrying out the labour protection instruction and PSI, establishing the service schedule with clear responsabilities. At dock, the responsibility for the safety of the ship lies with the master of the dock, from the moment the bow of the ship intersects the transverse line of the dock until the removal from the dock.

In this regard, from the point of view of the maneuver, the crew executes the orders of the dock commander, also from the point of view of compliance with PSI rules. After lifting the vessel on the dock, the captain, the chief engineer and the second captain together with the shipyard representative shall examine in detail the condition of the hull, the roll keels, the condition of the rudder, the propellers, the propeller shaft, the gauge, the zinc, the bottom socket, the anchor chains as well as the rudder and propeller lap. Accordingly, a statement of findings is concluded between the above-mentioned persons.

The work carried out on the live work is supervised especially by the second and thechief engineer, and in the logbook all the openings that are practiced in the hull of the ship are recorded, including their closing. Prior to launching the ship, the master shall ensure that all such openings have been sealed.

The lifting of the ship on the dock or on the hold is done with the shipyard's machines. The captain and the crew are required to participate directly in maneuvering operation to rise or lower the ship from the dock or hold. The captain and the heads of service on board, during the construction or repair of the ship, have the obligation:

- To permanently cooperate with tge shipowner's supervisory board;
- To minitor compliance with the deadlines;
- To attend all tests include in the test program;
- To record and reportto the shipowner in writing, all comments on the condition and operation of the technical means on board.

The captain and the heads of services, as well as other persons empowered under the supervision of the works, are not entitled to sign acknowledgments if:

- The works are not finished;
- The works are not of adequate quality;
- The works do not develop the normal parametres during the tests.

Maintenance and repair work

Maintenance and repair work must be carried out on board the ship, both on the hull, the machinery and on the installations. Maintenance must be carried out in accordance with the manufacturer's technical requirements and seafaring practice.

The day shift participates in the maintenance works, led by the crew chief on deck, in the machinery with the help of a mechanic, a turner, an electician. The entire crew, in relation to the service tasks, participates in the repair tasks (officers, on the command line, and the certified personnel, on the execution line).

The maintenance activity is organized in a planned manner, based on a plan drawn up at the beginning of the voyage, which must take into account the situation of the ship, the maintenance work to be performed, the personnel available for works, the planned duration of the voyage, the time required for carring out the works, the time required for the training activity as well as the hydrometeorological conditions. This plan is broken into weeks, the team leader together with the second setting daily the work to be done.

4. Final acceptance of work performed on board ships

If the work is not carried out with the means on board, then the crew has the task of supervising the way in which these are carried out, so that when they are completed, the quality is the desired one. For the performanceof off-board operations, the ship's management issues orders, receives offers, analyses and concludes contracts, ddecides on the persons to supervise this work and instructs them on how the work is to be carried out. These persons are obliged to follow the instructions received and any observations they make in connection with the work shall be notified to the head of service.

The inal reception of the work is made by the head of the service, in the presence of the persons managing the respective work. The final documents are signed by the head of service and endorsed by the captain. Of particular importance is the deadline for the completion of the works, which must not exceed the initially set deadline, as the ship may accumulate unproductive delays, detrimental to shipowners.
The works reffered to above may be accidental or planned ones. For the planned works it is necessary to ensurethe necessary documentation, such as: the docking plan, the schemes of the different installations, the technical books, etc.

The lists of planned works are drawn up well in advance and sum up all the work to be carried out on the ship regardless of the section. To this end, there must be a register of works on board showing which works cannot be carried out with the means on board, so that the works carried out by external offer are as few as possible, so that they can be carried out in a as short a time as possible to remove the ship from the exploiters.

Carrying out the work with the means of the ship represents a saving of time and money for the benefit of the shipowner, and money for the benefit of the crew because, by convention, the crew can undertake to the shipowner to performed paid work as a result of the agreement.

5. Preparation for operation, maintenance, inspection Rule 19

1. This rule is applied to all ships. The ships built before July 1st, 1986, shall comply as far as possible with the requirements of paragraphs 3 şi 6.2.
2. Preparation for operation. Before the ship leaves the harbour, as well as during the voyage, all rescue equipment must be in working order and ready for use immediately.
3. Maintenance.
   - 3.1 Instruction shall be provided for the maintenance on board of life-saving appliances which comply with the requirements of rule 52, after which maintenance work shall be carried out.
   - 3.2 The administration may accept in place of the instructions required by paragraph 3.1 a planned on-board maintenance program that includes the requirement of rule 52.
4. Current maintenance. Currents used at launch must be reversed at intervals not exceeding 30 months and will be replaced when necessary as a result of their deterioration or at intervals not exceeding five years, which of these periods is shorter.
5. Spare parts and repair equipment. Soare parts and repair equipment shall be provided for lfie-saving appliances and their components which wear out quickly and must be replaced regularly.
6. The weekly inspection. The following tests and inspection will be performed weekly:
   - 6.1 All lifeboats, emergency boats and launching devices shall be visually inspected to ensure that they are ready for use.
   - 6.2 The engines of all lifeboats and emergency boats shall be operated back and forth for a total period of 3 minutes provided that the ambient temperature is above the minimum temperature required to start the engine. In special cases, the administration may give up these requests for the ships built before 1 July 1986.
   - 6.3 The general emergency alarm system shall be tested.
7. The momthly inspections. The inspection of life-saving appliances, including lifeboat equipment, shall be carried out on a monthly basis, compling to the checklist required by rule 52.1, to ensure that they are complete and in good condition. An inspection report will be recorded in the logbook.
8. Inspection of inflatable life rafts, life jackets and inflatable emergency boats.
   - 8.1 Every inflatable life raft and every life jacket must be subject of maintenance:
     - At intrevals not exceeding 12 months. However, where necessary and reasonable, the administration may extend this period to 17 months.
     - In an appoved maintenance station, suitable for their maintenance, which has means of maintenance and it is serviced by suitable qualified personnel.
   - 8.2 Repairs and maintenance of inflatable boats must be carried out in accordance with the manufacturer's instructions. Emergency can be performed on board the ship, normal repairs will be performed at an approved maintenance station.
9. Periodic maintenance of hydrostatic triggering devices. The hydrostatictriggering devices must be subjected to maintenance work:
   - 9.1 At intrevals not exceeding 12 months. However, where necessary and reasonable, the administration may extend this period to 17 months.
   - 9.2 In an appoved maintenance station, suitable for their maintenance, which has means of maintenance and it is serviced by suitable qualified personnel.

6 . On-board maintenance instructions Rule 52 (requirementsfor means of rescue)

The instructions for the maintenance of life-saving appliance on board must be easly understood, illustrated where possible, and shall include for each means of rescue the following:

1. A checklist used for inspections demanded by rule 19.7.
2. Instructions regarding the maintenance and repair.
3. Program for the periodical maintenance.
4. Scheme of lubrication points and indication of their recommended lubricants.
5. The list of parts that may be replaced.
6. List of spare parts sources.
7. A register for recording inspections and maintenance work.

COMPETING

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