RULES
FOR THE CLASSIFICATION OF SHIPS

Part 9 – MACHINES
July 2022

Amendments No. 2
July 2023

CROATIAN REGISTER OF SHIPPING

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By the decision of the General Committee of Croatian Register of Shipping,

Amendments No. 2 to the
RULES FOR THE CLASSIFICATION OF SHIPS
Part 9 – MACHINES

have been adopted on 26th June 2023 and shall enter into force on 1st July 2023

GENERAL TERMS AND CONDITIONS

(March 2022)

Article 1
GENERAL

1.1 CROATIAN REGISTER OF SHIPPING (hereinafter: the *Register*) shall at all times remain an independent contractor and neither the *Register* nor any of its officers, surveyors, auditors, inspectors, agents, appointers, officers or managers shall act as an employee, servant or agent of any other party in the performance of the Services rendered by the *Register*.

1.2 The *Register* acts as a service provider. The Services provided by the *Register* cannot be construed as a commitment by the *Register* to achieve any result or as a warranty.

1.3 The provision of Services is subject to these General Terms and Conditions. No other terms and conditions shall apply, either expressly or by implication, unless expressly agreed in writing between the Parties.

1.4 These General Terms and Conditions shall be incorporated into, or referred to in any Contract and shall prevail over and exclude any other terms and conditions that the Client may wish to impose.

Any amendments to and/or deviations from these General Terms and Conditions, as well as any additional terms and conditions of the Client, shall be binding or valid only if set forth in writing and duly signed by the authorised representatives of both Parties.

1.5 The invalidity of one or more provisions of these General Terms and Conditions shall not affect the remaining provisions.

1.6 The Client acknowledges that the latest version of these General terms and Conditions and the latest version of applicable Rules apply to the Services provided by the *Register*.

1.7 Definitions in these General Terms and Conditions take precedence over other definitions that may appear in other documents issued by the *Register*.

1.8 The Client should at all times be aware of the provisions of these General Terms and Conditions, as they may be further amended, with their latest up to date version available on the web site of the *Register*.

Article 2
DEFINITIONS

2.1 **Certificate** means either a class certificate or statutory certificate, statement, attestation, statement of compliance, and a report following the Services provided by the *Register*.

2.2 **Certification** means the activity of certification in application of international and national standards and international industry practice provided by the *Register*.

Certification is an appraisement given by the *Register* to the Client and cannot be construed as an implied or express warranty of safety, fitness for purpose, seaworthiness of the vessel or its value for sale, insurance or chartering.

The purpose of Certification is to provide classification and statutory services and assistance to the maritime industry, Flag State Administrations, and regulatory authorities relating to maritime safety and pollution prevention.

2.3 **Classification** includes all activities and Services provided by the *Register* in accordance with the Rules. Classification may or may not be accompanied by the issuance of a Certificate of class with reference to the Rules.

Certificate of class is valid only if issued by the *Register*.

However, Certificate of class should not be construed as a guarantee of the safety, fitness for purpose or seaworthiness of the vessel. It is merely an attestation that the vessel complies with the Rules developed and published by the *Register*.

In addition, the *Register* is not a guarantee of the safety of life or property at sea or the seaworthiness of a vessel because, although the classification of a vessel is based on the assumption that the vessel will be properly loaded, operated, and maintained by competent and qualified personnel, the *Register* has no control over how a vessel is operated and maintained between the periodic surveys it conducts.

2.4 **Statutory certification** means certification made by the *Register* on behalf of the Flag State Administrations when and to the extent that the *Register* has been authorised to do so by the respective Flag State.

Statutory certification and services include the assessment of vessels registered by the Flag State and/or ship management companies to determine whether such ships/companies comply with the applicable requirements of international conventions, codes and national legislation, and the issuance of, or assistance in the issuance of, the appropriate certificates and documents.

Statutory certification includes, but is not limited to, certification, survey, and issuance of statutory certificates on behalf of the Flag State.

In cases where the *Register* acts on behalf of Flag State Administrations, the *Register* shall follow guidance issued by IMO (Resolutions, Circulars, etc.) or by IACS through Unified Interpretations (UI), unless otherwise directed by the Flag State.

2.5 **Client** means the shipowner, company, shipyard and/or party requesting Services or taking ownership of a classed vessel. In cases where shipowners have authorized another party to operate the vessel on their behalf, that party shall be considered as the company.

In addition to the above the Client means the person and/or entity that has requested Services from the *Register* and that has entered into a Contract or an agreement for Services with the *Register*.

2.6 **Parties** means the *Register* and Client together.

2.7 **Party** means the *Register* or the Client.

2.8 **Contract** means the contract in the form of a written agreement between the Client and the *Register* requesting Services, including these General Terms and Conditions and the Rules.

The provisions related to the Contract in these General Terms and Conditions shall apply even if there is no written agreement between the Client and the *Register*.

The Client may request the *Register* in writing to make a change to the contracted Services. However, the *Register* shall not be obligated to accept or execute any such change until a written agreement has been signed with the Client regarding the compensation and the possible impact of the change on the schedule as an addendum to the originally contracted Services.

2.9 **Services** shall mean the services specified in 2.2. 2.3 and 2.4, but also other services related to certification, classification and statutory certification, such as, but not limited to: ISM Code certification, ISPS Code, MLC 2006 certification, fuel oil consumption reporting, IHM certification, approval of manufacturers and service providers, certification of materials and products, training activities, conformity assessment, and any other relevant activities such as third party inspections, testing, shore and shipboard trials.

The Services provided by the *Register* are performed on a random basis and in no case include a full inspection of all items.

The *Register* shall provide the Services in accordance with related Contract(s), the provisions of these General Terms and Conditions, Rules, the international and national standards, the international conventions, the EU Regulations, the Flag State requirements and the industry practices applicable to the particular Service and always assuming that the Client is aware of these standards and the industry practices.

When providing Services, the *Register* does not guarantee the accuracy of the information or advice provided.

In providing Services, the *Register* does not assess compliance with standards other than the Rules, international and national standards, international conventions, EU regulations, Flag State requirements and industry practice, to the extent agreed in writing or specified in the Contract.

2.10 The ***Register*** means the Croatian Register of Shipping, an entity organized and existing under Croatian law, which, according to the Law on the Croatian Register of Shipping (Official Gazette No. 1996/81, 2013/76 and 2020/62) and the Charter of the *Register*, is an independent, not-for-profit, but public welfare oriented, public foundation that performs tasks:

- classification of sea-going ships,
- statutory certification of sea-going ships on behalf of the Flag State Administrations,
- classification of inland navigation vessels,
- statutory certification of inland navigation vessels,
- statutory certification of recreational crafts,
- certification of materials and products,
- conformity assessment of recreational crafts,
- conformity assessment of marine equipment,
- conformity assessment of pressure vessels,
- certification/registration of quality management systems.

2.11 **Vessel** means a ship, vessel, unit or offshore structure of any kind, whether or not connected to the shore or sea/river bed, located at sea or in inland waters and intended for transportation or special operations on the water, as decided by the *Register*.

2.12 **Rules** means the Rules for the classification, guidelines, instructions, or other documented evidence of the *Register* related to the Services provided.

The competent interpretation of the requirements specified in the Rules or other regulations published by the *Register* shall be the exclusive responsibility of the *Register's* Head Office, notwithstanding any possible different interpretations by other parties.

In cases where the Rules do not contain detailed requirements, the specific approval by the *Register* shall be based on the principles of the Rules and shall ensure a safety standard equivalent to that of the Rules.

Article 3
RESPONSIBILITIES

3.1 It is the Client's responsibility to ensure that all surveys required for vessel's class maintenance are conducted in a timely manner and in accordance with the Rules.

3.2 The *Register* may suspend or withdraw the vessel's existing Certificate of class in the event of serious deficiencies and replace it with a new Certificate of class with a shortened period of validity during which the deficiencies are to be rectified.

In addition, the *Register* shall suspend or withdraw a vessel's Certificate of class if the deficiencies are of such a magnitude as to endanger the class of the vessel, its safety and integrity, the safety of the crew, passengers, or the marine environment, and shall require that the vessel is to be inspected at the first port of call where the necessary repairs are to be carried out.

3.3 The Client should inform the *Register*:

(i) in the event of a change in the intended use of a vessel, a conversion and alteration of the hull, machinery installations and other equipment affecting the Class of the vessel assigned by the *Register*. Conversions and alterations must be made under the supervision of the *Register* and must comply with the requirements of the Rules and/or additional requirements of the *Register*,

(ii) in cases where the vessel has been damaged to such an extent that the Class of the vessel is likely to be affected and the safety and integrity of the vessel is likely to be compromised. In such cases, the vessel must be surveyed at the first port of call or as further directed by the *Register*. The survey shall be to the extent deemed necessary by the *Register*, by taking into account the extent of the damage.

(iii) in cases where class-related deficiencies and/or defects are found as a result of a Flag State inspection or Port State Control. Should the Client fail to notify the *Register* of the detention of the vessel by Port State Authorities due to class related deficiencies, the *Register* reserves the right to suspend or withdraw the Certificate of class.

3.4 The *Register* shall have full control over Certificates issued and may suspend or withdraw a Certificate at any time in its sole discretion if the Client fails to comply with the following requirements set forth in the *Rules for the Classification of Ships, Part 1 - General Requirements, Chapter 1 - General Information*, as applicable:

(i) para. 5.3 - *Maintenance of the validity of Certificate of Class*,
(ii) para. 5.4 - *Period of Validity*,
(iii) para. 5.5 - *Extension of the Period of Validity*,
(iv) para. 5.6 - *Suspension and Reinstatement of Class in the Case of Overdue Surveys*, and
(v) para. 5.7 - *Withdrawal of Class*.

3.5 The *Register* may suspend or withdraw a Certificate at any time in its sole discretion if the Client fails to comply with the following requirements set forth in the *Rules for the Classification of Inland Navigation Vessels, Part 1 - Classification and Surveys, Chapter I - Principles of Classification*, as applicable:

(i) para. 2.8 - *Maintenance of the Validity of the Certificate of Class*,
(ii) para. 2.9 - *Extension of validity of the Certificate of Class*,

and following requirements set forth in the *Rules for the Classification of Inland Navigation Vessels, Part 1 - Classification and Surveys, Chapter II - Classification*, as applicable:

(iii) para. 2.1 – *Suspension of Class*,
(iv) para. 2.2 – *Withdrawal of Class*.

3.6 In addition to clauses 3.2, 3.4 and 3.5 of this Article, the *Register* reserves the right to terminate the Services and related Contract in the event of a breach of the provisions of these General Terms and Conditions.

3.7 If the Client fails to provide the *Register* with the required access or information at the agreed times or fails to prepare for the Service in a timely manner, the *Register* may suspend the provision of the Service until it receives the Client's instructions for access and/or the required information.

The *Register* shall not be liable for the consequences of such suspension, and the Client shall be responsible for the *Register's* additional fees and other unnecessary costs and expenses incurred by the *Register*.

3.8 The Client is obliged to perform timely payments of the invoices for provided Services. However, the *Register* may retain or withhold any Service or Certificate to the Client in the case of outstanding payments, whether mutually related or not, arising out of the entire business relationship with the Client.

Article 4
HEALTH, SAFETY AND ENVIRONMENT

4.1 Both the *Register* and the Client shall apply reasonable standards to promote safety, health, and environmental protection and to provide a safe working environment for their personnel.

4.2 The Client shall provide the *Register* with all access and information necessary for the safe and efficient performance of the requested Services as required by the Rules.

4.3 During the survey, personnel of the *Register* should have secure access to all work that directly or indirectly affects the Service.

4.4 The *Register* has the right to refuse to conduct an activity or visit an area or site if the *Register* in its sole discretion, believes that relevant risks are unacceptable or are not adequately addressed, contained, or otherwise mitigated. Such a decision shall suspend the obligations of both Parties under the Contract without incurring any liability or penalty until the Parties agree on how to proceed.

Article 5
THIRD PARTIES AND SUBCONTRACTORS

5.1 Each specific Contract, including any Certificates issued, relates specifically to the Client, and no rights, obligations, interests, claims, benefits or Certificates issued shall extend to any third party without the prior written consent of the *Register*.

5.2 The Client shall not be entitled to grant any right to use the Certificates to any third party without the prior written consent of the *Register*.

5.3 The Client shall not without *Register's* consent, cede, assign, transfer, subcontract or deal in any manner with all or any of its rights or obligations under any Service and related Contract.

5.4 With regard to third party rights to access information and Certificates under confidentiality clause reference is to be made to Article 9.

Article 6
TAXES

6.1 Each Party shall be responsible for and shall bear all taxes, duties or similar governmental charges levied or imposed on any activity of that Party.

6.2 Prices, fees, rates, or remuneration are exclusive of any form of sales tax, value added tax, administrative fees and services tax and/or other similar taxes, including any surcharges. If any such indirect tax is or becomes applicable to the Services provided under the Contract, the Client shall be responsible for the payment of such indirect taxes.

Article 7
PAYMENT OF INVOICES

7.1 The provision of Services by the *Register*, whether complete or not, shall include payment of fees thirty (30) days after issuance of the invoice for the portion of the Services performed.

7.2 In the event that the Client fails to meet the requirements for payment in accordance with the instalments and terms of payment contained herein, the *Register* reserves the right to charge the Client with the interest rate in accordance with the applicable laws of the Republic of Croatia.

7.3 If the Client disputes an invoice or part of an invoice, the Client shall notify *Register* thereof in writing without undue delay. If no notification is received by the due date, Client shall be deemed to have accepted the invoice in full. If only part of an invoice is disputed, the undisputed amount must be paid by the due date.

Consequently, no disputes arising between the *Register* and the Client shall interfere with prompt payment of invoices by the Client. Any rights of lien or retention in favour of the Client or otherwise, are hereby excluded.

7.4 In the event of cancellation of all or part of the Services prior to their final completion, the Client shall pay all costs incurred by the *Register* on pro-rata basis for the portion of the Services provided to date. In such event, the *Register* will not claim the Client for loss of profit or reduced income. All reasonable costs directly attributable to the early termination and all amounts due to the *Register* at that time shall become immediately due and payable.

7.5 In the event of termination of the Service and related Contract, the *Register* shall be entitled to retain any payments, deposits or prepayments of fees made by the Client prior to the date of termination up to the amount to which the *Register* is entitled.

Article 8
TERMINATION

8.1 The Parties shall have the right to terminate the Services and the related Contract(s) by written notice to the other Party, and without prejudice to Article 7, in the following cases:

(i) if the other Party commits a material breach of these General Terms and Conditions and/or the Contract and fails to rectify such breach in accordance with clause 8.4 of this Article,
(ii) if the other Party becomes insolvent, is unable to pay its debts as they become due, or becomes subject to bankruptcy proceedings, administration, receivership, dissolution, liquidation, winding up or otherwise ceases to carry on its business; or
(iii) for convenience, after giving the other Party thirty (30) days' prior written notice of termination.

8.2 The Classification issued for the relevant vessel and the Certificates previously issued shall remain valid until the effective date of termination or, in the event of such termination, immediately, subject to compliance with Article 3 and Article 7.

8.3 If, in the reasonable opinion of the *Register*, the Client breaches or is suspected of breaching Article 14 or Article 15, the *Register* shall have the right to terminate the Service and related Contract with immediate effect.

8.4 Notwithstanding the provisions of clause 8.1 of this Article, the Party intending to terminate Services for non-compliance or breach of the provisions of these General Terms and Conditions shall notify the other Party of the non-compliance or violation of the provisions of these General Terms and Conditions and set a reasonable deadline of 15 (fifteen) days for the other Party to remedy the breaches of the provisions of these General Terms and Conditions.

If the Party fails to remedy the breaches of the provisions of these General Terms and Conditions within the aforementioned period, the other Party shall have the right to terminate Services without further notice.

8.5 Termination of the Service and related Contract pursuant to the provisions of these General Terms and Conditions shall not give either Party the right to claim any additional compensation, indemnity or reimbursement from the other Party as a result of such termination, but such termination shall not affect any rights or remedies available to a Party at the time the termination becomes effective or any obligations or liabilities incurred by a Party.

Article 9
CONFIDENTIALITY

9.1 The Parties agree to keep confidential all facts, data, information, etc. related to the other Party's business that they have learned in the course of providing Services. Such information and data shall not be disclosed by the Parties to any third party and shall not be used or misused to the detriment of the other Party.

9.2 The *Register* will keep confidential any data, plans or other technical information received from the Client and will not disclose it to any third party outside the *Register*, unless authorised by the Client. This obligation shall continue to apply after termination of the Services. This obligation shall not apply to any data, plans or other technical information that was in the possession of the *Register* prior to being disclosed to the *Register* by or on behalf of the Client, or that becomes publicly available through no fault of the *Register*, or is otherwise provided to the *Register* by an independent source that is under no obligation of confidentiality to the *Register*.

9.3 Certificates issued by the *Register* to the Client as a result of the Services provided shall not be covered by the confidentiality Article.

Notwithstanding the foregoing, the Client shall be entitled to disclose any data to its affiliates involved in the transactions related to the Services or the Client's core activities.

9.4 Notwithstanding clause 9.1 and clause 9.2 of this Article, the *Register* shall have the right to disclose the Confidential Information to the following parties if required by regulations of:

(i) authorised representatives of the Flag State Administration,
(ii) authorised audit teams (i.e., accreditation body or EC auditors),
(iii) the International Association of Classification Societies (IACS),
(iv) a court of competent jurisdiction, government agency, or other relevant public authority, in accordance with applicable law, court order, or other public regulation.

9.5 The Client acknowledges that the *Register* is required to provide access to information to the EU Commission or any person acting on its behalf in accordance with applicable EU requirements and that the Client shall give the EU Commission with unrestricted access to the vessels for the purpose of inspection.

9.6 The obligations in this Article shall survive the conclusion of the Service or the termination of related Contract and shall continue for as long as the relevant information remains confidential.

Article 10
INTELLECTUAL PROPERTY

10.1 Each Party shall be the sole owner of all rights to its Intellectual Property created before or after the effective date of these General Terms and Conditions, whether or not associated with any Contract between the Parties.

10.2 The Intellectual Property developed by the *Register* for the provision of the Services, including but not limited to drawings, calculations and reports, shall remain the exclusive property of the *Register*.

Article 11
PROFESSIONAL ETHICS

11.1 Each of the Parties warrants that, with respect to the matters contemplated herein, neither it nor its affiliates has made or will make, directly or indirectly, any offer, payment, gift or authorization of money to any government official or employee, political party, public official or candidate for the benefit or advantage thereof.

11.2 In providing the Services, the *Register* shall strictly adhere to the requirements of its Code of Ethics relating to business activities.

Article 12
FORCE MAJEURE

12.1 For the purposes of these General Terms and Conditions, the term "Force Majeure" includes any event that directly or indirectly prevents the Parties from fulfilling their obligations due to events beyond their control, such as: strikes, wars, riots, piracy, civil commotion, malicious damage, pandemic, compliance with laws or government orders, rules, regulations or directives, sanctions and embargoes, accidents, defects of plants or machinery, seizures, fires, floods, storms and the like.

12.2 If either Party is prevented or delayed from performing its obligations by Force Majeure, such Party shall promptly notify the other Party in writing of the circumstances of the Force Majeure and its influence and, after such notification, shall not be liable for performance of any obligations prevented by the influence of the Force Majeure during its duration. Upon termination of the influence of the Force Majeure, the same Party should proceed with the planned activities in order to fulfil its obligations.

12.3 If one of the Parties is prevented by Force Majeure in its activities and fulfilment of its obligations and this event lasts continuously for three (3) months, the other Party shall be entitled to terminate the Service and related Contract without liability.

12.4 Neither of the Parties shall be liable for non-compliance with these General Terms and Conditions due to Force Majeure. If one of the Parties is prevented from fulfilling its obligations under these General Terms and Conditions due to Force Majeure, it shall immediately notify the other Party in writing within a reasonable period of time, stating the reasons for the Force Majeure and providing relevant evidence, if any.

Article 13
INDEMNIFICATIONS

13.1 Each Party shall indemnify the other Party against all claims arising out of the performance of the Services in respect of bodily injury, illness or death of any of its employees or other representatives and in respect of loss of or damage to the Party's property.

This provision shall apply whether or not the damage is caused or contributed to by the negligence of the other Party. Both Parties are obliged to take out separate insurances for these liabilities.

13.2 The Client shall indemnify the *Register* from and against all claims arising from the Client's violation of the provisions of these General Terms and Conditions and from the misuse of the Certificates issued by the *Register*.

13.3 The Client shall indemnify the *Register* against any financial responsibility or amounts arising from non-payment, late payment or payment of withholding taxes to the non-relevant tax authority or any other relevant governmental body.

13.4 Each Party shall notify the other Party without undue delay as soon as it becomes aware of any incident that could give rise to a claim against the other Party in respect of the Service provided and related Contract.

Article 14
ANTI-CORRUPTION

14.1 Each Party agrees that in performing its obligations under any Service, it will ensure that its affiliates, employees and/or agents, subsidiaries, subcontractors, consultants, and any other persons providing Services will:

(i) comply with all applicable anti-bribery and anti-corruption laws (collectively, Anti-Bribery Laws) and, in particular, do not, directly or indirectly, offer, promise, grant, authorise the payment of, or confer any financial or other benefit on any public or government official:
- to a public or governmental official to obtain or retain business with the intent to influence such official in his or her capacity as an official, if such official is not permitted or required by written law to be influenced by the offer, promise or gift; or
- to another person with the intent to induce or reward the improper performance of a function or activity or for any other illegal purpose,

(ii) maintain adequate systems and procedures designed to prevent activities, practises, or conduct in connection with services that would constitute an offence under an anticorruption law; and
(iii) take reasonable steps to prevent similar acts by customers, contractors, subcontractors, agents and other third parties, persons under its control or influence.

14.2 Any failure by a Party to comply with or ensure compliance with its obligations under this Article shall, notwithstanding anything to the contrary in these General Terms and Conditions, be deemed a breach of these General Terms and Conditions which shall entitle the other Party to suspend and/or terminate the Services by notice in writing with immediate effect without further liability to the other Party except for any liability which may have arisen prior to the date of termination or suspension (as the case may be).

14.3 If a Party elects to suspend the provision of Services under these General Terms and Conditions pursuant to this Article, it shall have the sole and absolute discretion to determine:

(i) when it will resume performance (if at all); and
(ii) extend the period for performance of its obligations under the Services in its sole discretion.

Article 15
SANCTIONS

15.1 Each Party shall conduct all activities in compliance with all laws, statutes, rules, economic and trade sanctions (including, but not limited to, U.S. sanctions and EU sanctions) and regulations applicable to such Party, including, but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption, copyright and trademark protection, personal data protection.

15.2 Each Party hereby represents and warrants that it is not or will not be subject to any economic or trade sanctions ("Sanctions") imposed by the United States of America, the European Union, the United Kingdom, any EU Member State, or the United Nations with respect to any country and/or by any sanction giver with respect to any company/individual.

15.3 Each Party represents and warrants that it will strictly comply with all Sanctions.

15.4 Nothing in these General Terms and Conditions shall be construed as causing or obligating either Party to act or refrain from acting in a manner inconsistent with, punishable by, or prohibited by any Sanctions.

15.5 Neither Party shall be obligated to perform any obligation arising under these Terms and Conditions (including, without limitation, the obligation to):

(i) perform, deliver, accept, sell, purchase, pay or receive any funds to, from or through any person or entity; or
(ii) engage in any other action whatsoever,

if doing so violates or is inconsistent with sanctions and/or recommendations of international (intergovernmental) organisations to combat the financing of terrorism and other criminal activities and/or money laundering or exposes such Party to investigation or penalties.

15.6 In the event that a Party breaches any Sanctions or the Party's Business and/or Transactions arising out of or in connection with these General Terms and Conditions breach any Sanctions or otherwise violate the recommendations of one or more international (intergovernmental) organisations for combating the financing of terrorism and other criminal activities and/or money laundering, the other Party shall be entitled to terminate these General Terms and Conditions by written notice with immediate effect without incurring any liability to the other Party, except for liabilities (if any) incurred prior to the date of termination.

Article 16
LIABILITY

16.1 The *Register* is not, and cannot be considered as, an underwriter, consulting engineer, naval architect, shipbuilder, shipowner, or ship management company, nor can it assume the obligations and responsibilities associated with such functions, although the *Register's* experience may enable it to respond to inquiries about matters not covered by its Rules, policies, instructions, or other documented evidence.

16.2 The practices and procedures of the *Register* shall be selected by the *Register* in its sole and absolute discretion based on its experience and knowledge and in accordance with generally accepted professional standards in the relevant field of classification societies.

16.3 Nothing herein contained shall release any designer, naval architect or engineer, shipbuilder or manufacturer, shipyard, vendor, supplier, contractor or subcontractor, repairer or owner, from any information, report, certificate or similar document issued in connection with the provision of Services by the *Register*, operator, manager or other person or entity from any express or implied warranty or other contractual obligation or responsibility, or from any negligent act, error or omission of any kind whatsoever, nor shall they create any right, claim or benefit for any third party.

16.4 The *Register* shall exercise due care in the selection or appointment of its surveyors and all other employees whose presence and work is necessary for the provision of the Services.

16.5 If any person or entity using the Services of the *Register* suffers any loss, damage or expense that is or is shown to have been caused by a negligent act, omission or error of the *Register's* officers, surveyors, auditors, inspectors, agents, appointers, officers or managers, or those purporting to act in the name of and on behalf of the *Register*, or a negligent inaccuracy, advice, report or evidence given by or in the name of or/and on behalf of the *Register*, then the liability of the *Register* is limited in respect of any direct or indirect claim shall be limited to an amount not exceeding five times the fee charged or to be charged by the *Register* for the relevant Service.

16.6 Any liability for consequential damages is expressly excluded.

For purposes of this clause, consequential damages include, without limitation:

(i) indirect or consequential damages,
(ii) loss and/or delay of production, loss of products, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case directly or indirectly.

16.7 The Parties are not entitled to assign the performance of obligations under these General Terms and Conditions or parts thereof to third parties without the prior written consent of the other Party.

16.8 If during the term of the Contract, there is a transfer of function due to change of status (merger, acquisition, division, etc.), all obligations and rights under these General Terms and Conditions and associated Contract will be transferred to the legal successor of the Party concerned.

Article 17
GOVERNING LAW AND RESOLVING OF DISPUTES

17.1 These General Terms and Conditions and any dispute or claim between the Parties arising from or in connection with it, or the Services provided hereunder, will be governed and interpreted in accordance with the English law.

17.2 The Parties shall use their reasonable efforts to resolve any claim or dispute arising in relation to rendered Service by negotiations within a reasonable time.

17.3 Should the Parties fail to resolve any claim or dispute by negotiations, the dispute shall be exclusively subject to the jurisdiction of the Permanent Arbitration Court with the Croatian Chamber of Economy in Zagreb, Republic of Croatia.

17.4 The Parties agree to keep the any arbitration proceedings confidential.

17.5 Notwithstanding the above, any claim not presented within three (3) months of the completion of the particular Services, or within three (3) months of from the date when the events which are relied on were first discovered by the Client, shall be deemed waived and absolutely time barred.

17.6 Any objections against the line adopted by any of the *Register's* servants in fulfilling their duties or against the conclusions reached are to be raised to the *Register* by the Party as soon as possible.

If the Party is not satisfied with the final conclusions and interpretations by the *Register* the arbitration lays upon the Commission for appeal for Classification and Statutory certification of ships, which is to be formed according to the Regulation 39 of the Charter of the *Register*.

INTRODUCTORY NOTES

These amendments shall be read together with the requirements in the Rules for the Classification of Ships, Part 9 – Machines, edition July 2022, as amended by Amendments No. 1, edition January 2023.

Table 1 contains review of amendments, where items changed or added in relating to previous edition are given, with short description of each modification or addition. All major changes throughout the text are shaded.

TABLE 1 – REVIEW OF AMENDMENTS

This review comprises amendments in relation to the Rules for the Classification of Ships, Part 9 – Machines, edition July 2022, as amended by Amendments No.1, edition January 2023.

ITEM	*DESCRIPTION OF THE AMENDMENTS*
SECTION 4 – GEARS, REVERSIBLE AND FLEXIBLE COUPLINGS	
Head 4.2	Existing item 4.2.2 has been amended to include requirements contained in IACS UR M56, Corr.2, Mar 2023
SECTION 6 – DECK MACHINERY	
Head 6.2	Existing item 6.2.1 has been amended to include requirements contained in IACS UR M42, Rev.6 Mar 2022

This Part of the Rules includes the requirements of the following international Organisations:

International Maritime Organization (IMO)

Conventions:	International Convention for the Safety of Life at Sea, 1974 (SOLAS 74) and all subsequent and applicable amendments adopted up to MSC 106 Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS PROT 1988) International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) and all subsequent and applicable amendments adopted up to MEPC 79
Circulars:	MSC.1/Circ.1425

International Association of Classification Societies (IACS)

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International Organisation for Standardisation:
ISO 1122-1:1998 Corr. 1:1999 Corr. 2:2009, ISO 1328-1:2013, ISO 1328-2:2020, ISO 6336-1:2019, ISO 6336-2:2019, ISO 6336-3:2019, ISO 6336-5:2016, ISO 19019:2005

4 GEARS, REVERSIBLE AND FLEXIBLE COUPLINGS

■ **Head 4.2 GEARING,** item 2.20.1 has been amended and should be read as follow:

4.2.1 Definitions and general requirements

4.2.1.1 The following definitions apply in the present chapter (see also standard ISO 1122-1):

Gear – toothed member designed to transmit motion to, or receive motion from, another toothed member, by means of successively engaging teeth.

Gear pair – mechanism consisting of two gears able to rotate around axes relative positions of which are fixed and one gear turns the other by the action of teeth successively in contact.

Pinion – the gear of a gear pair which has the smaller number of teeth.

Wheel – the gear of a gear pair which has the larger number of teeth.

External gearing – a gear pair consisting of a pinion and a wheel, both with external toothing.

Internal gearing – a gear pair consisting of a pinion with external toothing and a wheel with internal toothing.

Planetary gear – combination of coaxial elements in which one or more are **annulus gears** (with internal toothing) and one or more are **planet carriers**. They turn around common axes and support one or more **planet gears** which mesh the annulus gears and one or more **sun gears**.

4.2.1.2 The requirements of this chapter are applicable to propulsion and auxiliary gearing with cylindrical pinions and wheels, external and internal toothing, having spur or helical teeth with involute profile, provided that the axes of the shafts are parallel.

4.2.1.3 Planetary gears shall be balanced. The rim of the epicyclical wheel with more than 3 planetary gears shall be self-adjustive in radial direction.

4.2.2 Pinions and gear wheels

4.2.2.1 The following calculation procedures are mainly based on the actual edition of ISO 6336 series international standards series for the calculation of load capacity of spur and helical gears.

These requirements apply to enclosed gears, both intended for main propulsion and for essential auxiliary services, which accumulate a large number of load cycles (several millions), whose gear set is intended to transmit a maximum continuous power equal to, or greater than:

- 220 kW for gears intended for main propulsion
- 110 kW for gears intended for essential auxiliary services

The following calculation procedures deal with the determination of load capacity of external and internal involute spur and helical gears, having parallel axis, with regard to surface durability (pitting) and tooth root bending strength and to this purpose the relevant basic equations are provided in 4.2.2.8 to 4.2.2.15.

All influence factors are defined regarding their physical interpretation. Some of the influence factors are determined by the gear geometry or have been established by conventions. These factors are to be calculated in accordance with the equations provided. Other factors, which are approximations, can be calculated according to methods acceptable to the *Register*.

The values in formulae which refer to pinions have an index 1, and the values referring to wheels have an index 2. This is valid both for outer and inner gear pairs.

4.2.2.2 The hardness of the pinion teeth material shall be at least 15% higher than that of the wheel teeth material. This requirement does not apply to gears with strengthened surface (carburated, nitrided, surface hardened, etc.).

4.2.2.3 The radius of curvature of tooth root fillets shall be at least $0{,}3m_n$.

4.2.2.4 The strength of teeth and other parts of pinions and wheels shall be confirmed by calculation. The additional loads due to torsional vibrations, stormy weather, manoeuvres, towage, different loading of a ship, propeller resistance irregularity and its dependence on number of blades shall be taken into account.

4.2.2.5 In designing the propulsion gears for ships with ice strengthening, the requirements of 4.2.3.2 shall be taken into account.

4.2.2.6 Technical documentation of gearing, which shall be submitted to the *Register* for approval, shall contain the following data:

a – centre distance [mm]
(for internal gearing: $a < 0$);

a_d – sum of radii of reference circle [mm];

b – common facewidth of a gear pair at reference cylinder [mm];

b_1, b_2 – root face width of pinion, wheel [mm]
(not to be taken higher than: $b + 2m_n$);
d – reference diameter [mm];
d_1, d_2 – reference diameter of pinion, wheel [mm];
d_{a1}, d_{a2} – tip diameter of pinion, wheel [mm];
d_{b1}, d_{b2} – base diameter of pinion, wheel [mm];
d_{f1}, d_{f2} – root diameter of pinion, wheel [mm];
d_{w1}, d_{w2} – working diameter of pinion, wheel [mm];
F_t – nominal tangential load [N];
F_{bt} – nominal tangential load on base cylinder in the transverse section [N];
HV_1, HV_2 – Vickers hardness of tooth surface [HV];
h – tooth depth [mm];
h_{ao} – tooth root height factor of the tool (basic rack):
ISO recommendation: $h_{ao} = 1{,}25$
DIN recommendation: $1{,}10 \leq h_{ao} \leq 1{,}30$;
k – tip shortening factor,
m_n – normal module [mm];
m_t – transverse module [mm];
n_1, n_2 – rotational speed of pinion, wheel [rpm];
N_{pl} – number of satellites in planetary gears;
P – maximum continuous power transmitted by the gear set [kW];
Q – gearing quality i.e. grade of accuracy;
R_{m1}, R_{m2} – tensile strength of the material for pinion, wheel [N/mm²];
R_{eH1}, R_{eH2} – yield strength of the material for pinion, wheel [N/mm²];
R_{z1}, R_{z2} – average peak-to-valley surface roughness, [µm];
S_F – safety factor for tooth root stress.
S_H – safety factor for contact stress (pitting)
T_1, T_2 – torque in way of pinion, wheel [Nm];
u – gear ratio, $u = z_2/z_1$;
v – linear velocity at pitch diameter [m/s];
x_1, x_2 – addendum modification factor of pinion, wheel;
z_1, z_2 – number of teeth of pinion, wheel
(for internal gearing: $z_2 < 0$);
z_{n1}, z_{n2} – virtual number of teeth of pinion, wheel;
α_n – normal pressure angle at reference cylinder [°];
α_t – transverse pressure angle at reference cylinder [°];
α_{tw} – transverse pressure angle at working pitch cylinder [°];
β – helix angle at reference cylinder [°];
β_b – helix angle at base cylinder [°];
ν_{40} – kinematic viscosity of lubricating oil at 40°C [mm²/s];
ν_{50} – kinematic viscosity of lubricating oil at 50°C (if ν_{40} is unknown) [mm²/s];
φ – angle of twist, due to torsion, for the driving shaft at full load for dual tandem gears [°];
ρ_{ao} – tooth fillet radius factor of the tool (basic rack)
ISO recommendation: $\rho_{ao} = 0{,}38$
DIN recommendation: $0{,}25 \leq \rho_{ao} \leq 0{,}45$;
σ_{FE} – bending endurance limit;
σ_{Hlim} – endurance limit for contact stress [N/mm²]
σ_{f1}, σ_{f2} – normal circumferential shrink fit stress (if a gear is connected to the shaft by a shrinkfit) [N/mm²];

ε_α – transverse contact ratio;

ε_β – overlap ratio;

ε_γ – total contact ratio.

Note 1: For internal gear pairs diameters d_2, d_{w2}, d_{a2}, d_{f2} and d_{b2} and gear ratio u are negative.

Note 2: The type of prime mover and of driven machinery shall be stated in the documentation.

4.2.2.7 Dimensions and geometrical values

Dimensions and geometrical values of cylindrical gear pairs are calculated in accordance with the following formulae:

$$\alpha_t = \text{arc tan}\left(\frac{\tan\alpha_n}{\cos\beta}\right)$$

$$\beta_b = \text{arc tan}\left(\tan\beta \cdot \cos\alpha_t\right)$$

$$m_t = m_n / \cos\beta$$

$$d_{1,2} = m_t \cdot z_{1,2}$$

$$d_{b1,2} = d_{1,2} \cdot \cos\alpha_t$$

$$a_d = \left(d_1 + d_2\right)/2$$

$$\alpha_{tw} = \text{arc cos}\left(\frac{a_d}{a} \cdot \cos\alpha_t\right)$$

$$d_{w1} = 2a \cdot \frac{1}{1+u}$$

$$d_{w2} = 2a \cdot \frac{u}{1+u}$$

$$z_{n1,2} = \frac{z_{1,2}}{\cos\beta \cdot \cos^2\beta_b}$$

$$x_1 + x_2 = \left(z_1 + z_2\right) \cdot \frac{\tan\alpha_{tw} - \tan\alpha_t - \left(\alpha_{tw} - \alpha_t\right)\pi/180^o}{2 \cdot \tan\alpha_n}$$

$$\cos\alpha_{tw} = \frac{m_t\left(z_1 + z_2\right)}{2a} \cdot \cos\alpha_t$$

$$k = \frac{a - a_d}{m_n} - \left(x_1 + x_2\right)$$

$$d_{a1,2} = d_{1,2} + 2 \cdot \left(h_{ao} + k + x_{1,2}\right) \cdot m_n$$

$$\varepsilon_\alpha = \frac{\sqrt{d_{a1}^2 - d_{b1}^2} + \text{sign}\left(z_2\right)\sqrt{d_{a2}^2 - d_{b2}^2} - 2a\sin\alpha_{tw}}{2m_t\pi\cos\alpha_t}$$

$$\varepsilon_\alpha = \frac{b\sin\beta}{m_n\pi}$$

$$\varepsilon_\gamma = \varepsilon_\alpha + \varepsilon_\beta$$

If the transverse contact ratio $\varepsilon_\alpha \geq 2$, the gear pairs shall be specially considered by *Register*.

The tip diameters $d_{a1,2}$ may be in discordance with the calculated theoretical values, depending on the eventual interference and the least permissible tip clearance. They may be rounded up, when some slight changes in the value of tip clearance and transverse contact ratio ε_α may appear.

4.2.2.8 Nominal tangential load

The nominal tangential load, F_t, tangential to the reference cylinder and perpendicular to the relevant axial plane, is calculated directly from the maximum continuous power transmitted by the gear set by means of the following equations:

$$T_{1,2} = \frac{30 \cdot 10^3 P}{\pi \cdot n_{1,2}} \quad (4.2.2.8\text{-}1)$$

$$F_t = 2000 \cdot \frac{T_{1,2}}{d_{1,2}} \quad (4.2.2.8\text{-}2)$$

4.2.2.9 General influence factors

Application factor, K_A

Factor K_A accounts for additional dynamic loads from sources external to the gearing.

For gears designed for infinite life, factor K_A is defined as the ratio between the maximum repetitive cyclic torque applied to the gear set and the nominal rated torque.

The nominal rated torque is defined by the rated power and speed and is the torque used in the rating calculations.

The factor K_A mainly depends on:
- characteristics of driving and driven machines;
- ratio of masses;
- type of couplings;
- operating conditions (overspeeds, changes in propeller load conditions, etc.).

When operating near a critical speed of the drive system, a careful analysis of conditions must be made.

Factor K_A should be determined by measurements or by system analysis (e.g. from the calculation of torsional vibrations, taking into account the possible combinations of various working conditions, or on the basis of the measurement results on similar installations) acceptable to the *Register*. Where a value determined in such a way cannot be supplied, the following values can be taken.

a) Main propulsion:
   - diesel engine with hydraulic or electromagnetic slip coupling, K_A = 1,00
   - diesel engine with high elasticity coupling, K_A = 1,30
   - diesel engine with other couplings, K_A = 1,50

b) Auxiliary gears:
   - electric motor, K_A = 1,00
   - diesel engine with hydraulic or electromagnetic slip coupling, K_A = 1,00
   - diesel engine with high elasticity coupling, K_A = 1,20

   diesel engine with other couplings, K_A = 1,40

- In other cases value of K_A is determined in agreement with the *Register*.

NOTE: Where the vessel, on which the reduction gear is being used, is receiving an Ice Class notation according to the provisions of the *Rules for the classification of ships, Part 29 – Polar class hsips and ice class ships*, the application factor or the nominal tangential force should be adjusted to reflect the ice load associated with the requested Ice Class, i.e. applying the design approach in *IACS Unified Requirement I3* when applicable (see also 4.2.3.2).

Load sharing factor, K_γ

Factor K_γ accounts for the unequal distribution of load in multiple-path transmissions (dual tandem, epicyclic, double helix, etc.):

K_γ is defined as the ratio between the maximum load through an actual path and the evenly shared load. The factor mainly depends on accuracy and flexibility of the branches.

The load sharing factor K_γ should be determined by measurements or by system analysis.

Where a value determined in such a way cannot be supplied, the following values can be considered for epicyclic gears with:
- 1 to 3 planetary gears, K_γ=1,00
- 4 planetary gears, K_γ=1,20
- 5 planetary gears, K_γ=1,30
- 6 planetary gears and over, K_γ=1,40

For dual tandem gears : K_γ= 1+0,2/φ

Internal dynamic factor, K_v

Factor K_v accounts for internally generated dynamic loads due to vibrations of pinion and wheel against each other.

This factor is defined as the ratio between the maximum load which dynamically acts on the tooth flanks and the maximum externally applied load ($F_t K_A K_\gamma$).

The factor K_v mainly depends on:
- transmission errors (depending on pitch and profile errors);
- masses of pinion and wheel;
- gear mesh stiffness variation as the gear teeth pass through the meshing cycle;
- transmitted load including application factor;
- pitch line velocity;

- dynamic unbalance of gears and shaft;
- shaft and bearing stiffnesses;
- damping characteristics of the gear system.

Hereafter presented method, as described in a) and b) below, for calculation of the factor K_v may be applied only to cases where all the following conditions are satisfied:

- running velocity in the subcritical range, i.e.:

$$\frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}} < 10 \text{ m/s}$$

- spur gears or helical gears with $\beta \leq 30°$
- pinion with relatively low number of teeth, $z_1 < 50$
- solid disc wheels or heavy steel gear rim.

This method may be applied to all types of gears if

$$\frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}} < 3 \text{ m/s}$$

as well as to helical gears where $\beta > 30°$.

For gears other than the above, reference is made to *Method B* outlined in the reference standard *ISO 6336-1:2019*.

a) For spur gears and for helical gears with overlap ratio $\varepsilon_\beta \geq 1$

$$K_v = 1 + \left(\frac{K_1}{K_A \frac{F_t}{b}} + K_2 \right) \cdot \frac{v \cdot z_1}{100} K_3 \sqrt{\frac{u^2}{1+u^2}} \qquad (4.2.2.9\text{-}1)$$

In the formula above, if $K_A F_t/b$ is less than 100 N/mm, this value is assumed to be equal to 100 N/mm.

Factors K_1, and K_2 for spur gears (β=0°) and for helical gears (β>0°) are specified in the following Table.

Table 4.2.2.9-1
Factors K_1 and K_2 for internal dynamic factor K_v calculation

accuracy, Q[1)]	**3**	**4**	**5**	**6**	**7**	**8**
K_1 spur gears	2,1	3,9	7,5	14,9	26,8	39,1
K_1 helical gears	1,9	3,5	6,7	13,3	23,9	34,8
K_2 spur gears	0,0193					
K_2 helical gears	0,0087					
[1)] ISO accuracy grades according to ISO 1328-1:2013. In case of mating gears with different accuracy grades, the grade corresponding to the lower accuracy should be used.						

Factor K_3 is to be in accordance with the following:

If $\frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}} \leq 0{,}2$ then $K_3 = 2{,}0$

If $\frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}} > 0{,}2$ then $K_3 = 2{,}071 - 0{,}357 \cdot \frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}}$

b) For helical gears with overlap ratio ε_β<1 the value K_v is determined by linear interpolation between values determined for spur gears ($K_{v\alpha}$) and helical gears ($K_{v\beta}$) in accordance with:

$$K_v = K_{v\alpha} - \varepsilon_\beta \left(K_{v\alpha} - K_{v\beta} \right) \qquad (4.2.2.9\text{-}2)$$

where:

$K_{v\alpha}$ – K_v value for spur gears (β=0°), in accordance with a);

$K_{v\beta}$ – K_v value for helical gears (β>0°), in accordance with a).

Face load distribution factors, $K_{H\beta}$ and $K_{F\beta}$

Factors $K_{H\beta}$ for contact stress and $K_{F\beta}$ for tooth root bending stress, accounts for the effects of non-uniform distribution of load across the face width.

Factor $K_{H\beta}$ is defined as follows:

$$K_{H\beta} = \frac{\text{max load per unit face width}}{\text{mean load per unit face width}}$$

$K_{F\beta}$ is defined as follows:

$$K_{F\beta} = \frac{\text{max bending stress at tooth root per unit face width}}{\text{mean bending stress at tooth root per unit face width}}$$

The mean bending stress at tooth root relates to the considered face width b_1 respectively b_2.

$K_{F\beta}$ can be expressed as a function of the factor $K_{H\beta}$.

The factors $K_{H\beta}$ and $K_{F\beta}$ mainly depend on:
- gear tooth manufacturing accuracy;
- errors in mounting due to bore errors;
- bearing clearances;
- wheel and pinion shaft alignment errors;
- elastic deflections of gear elements, shafts, bearings, housing and foundations which support the gear elements;
- thermal expansion and distortion due to operating temperature;
- compensating design elements (tooth crowning, end relief, etc.).

The face load distribution factors, $K_{H\beta}$ for contact stress, and $K_{F\beta}$ for tooth root bending stress, are to be determined according to the *Method C* outlined in the reference standard *ISO 6336-1:2019*.

Alternative methods acceptable to the *Register* may also be applied.

a) In case the hardest contact is at the end of the face width $K_{F\beta}$ is given by the following equations:

$$K_{F\beta} = K_{H\beta}^{N}$$

$$N = \frac{(b/h)^2}{1 + (b/h) + (b/h)^2}$$

where:

(b/h) – face width/tooth height ratio,
the minimum of b_1/h_1 or b_2/h_2.

For double helical gears, the face width of only one helix is to be used.

When $b/h<3$ the value $b/h=3$ is to be used.

b) In case of gears where the ends of the face width are lightly loaded or unloaded (end relief or crowning):

$$K_{F\beta} = K_{H\beta}$$

Transverse load distribution factors, $K_{H\alpha}$ and $K_{F\alpha}$

Factors $K_{H\alpha}$ for contact stress and $K_{F\alpha}$ for tooth root bending stress, account for the effects of pitch and profile errors on the transversal load distribution between two or more pairs of teeth in mesh.

The factors $K_{H\alpha}$ *and* $K_{F\alpha}$ mainly depend on:
- total mesh stiffness;
- total tangential load F_t
- factors K_A, K_γ, K_v, $K_{H\beta}$
- base pitch error;
- tip relief;
- running-in allowances.

The transverse load distribution factors, $K_{H\alpha}$ for contact stress and $K_{F\alpha}$ for tooth root bending stress, are to be determined according to *Method B* outlined in the reference standard *ISO 6336-1:2019*.

4.2.2.10 Tooth root bending strength

The criterion for tooth root bending strength is the permissible limit of local tensile strength in the root fillet. The root stress σ_F and the permissible root stress σ_{FP} shall be calculated separately for the pinion and the wheel.

Both gears of a gear pair shall satisfy the following tooth root strength criterion:

$$\sigma_{F1,2} \le \sigma_{FP1,2} \quad (4.2.2.10)$$

where:

$\sigma_{F1,2}$ – tooth root bending stress for pinion, wheel [N/mm²] (see 4.2.2.12-1);

$\sigma_{FP1,2}$ – permissible tooth root stress [N/mm²] (see 4.2.2.13-1).

4.2.2.11 Surface durability (pitting)

Both gears of a gear pair shall satisfy the following surface durability criterion based on the Hertz pressure on the operating pitch circle or at the inner points of single pair contact:

$$\sigma_{H1,2} \leq \sigma_{HP1,2} \quad (4.2.2.11)$$

where:

$\sigma_{H1,2}$ – Hertz contact stress for gear flank surface [N/mm²] (see 4.2.2.14-1);

$\sigma_{HP1,2}$ – permissible Hertz contact stress [N/mm²] (see 4.2.2.15-1).

4.2.2.12 Tooth root bending stress

Tooth root bending stress shall be calculated in accordance with the following:

$$\sigma_{F1,2} = \frac{F_t}{b\ m_n} \cdot Y \cdot K_F \ \text{[N/mm²]} \quad (4.2.2.12\text{-}1)$$

where:

F_t – nominal tangential load at reference cylinder (see 4.2.2.8-2) [N]

$$Y = Y_{Fa1,2} \cdot Y_{Sa1,2} \cdot Y_\varepsilon \cdot Y_\beta \quad (4.2.2.12\text{-}2)$$

$$K_F = K_A \cdot K_\gamma \cdot K_v \cdot K_{Fa} \cdot K_{F\beta} \quad (4.2.2.12\text{-}3)$$

The following formulae and definitions for the calculation of tooth root bending stress apply to gears having rim thickness greater than $3{,}5m_n$.

The result of rating calculations made by following this method are acceptable for normal pressure angles up to 25° and reference helix angles up to 30°.

For larger pressure angles and large helix angles, the calculated results should be confirmed by experience as by *Method A* of the reference standard *ISO 6336-3:2019*.

Tooth form factor, Y_F

This factor represents the influence on nominal bending stress of the tooth form with load applied at the outer point of single pair tooth contact. Y_F shall be determined separately for the pinion and the wheel.

In the case of helical gears, the form factors for gearing shall be determined in the normal section, i.e. for the virtual spur gear with virtual number of teeth Z_n.

The tooth form factor, Y_F, is to be calculated as follows:

$$Y_F = \frac{6\frac{h_F}{m_n}\cos\alpha_{Fen}}{\left(\frac{s_{Fn}}{m_n}\right)^2 \cos\alpha_n} \quad (4.2.2.12\text{-}4)$$

where (see Figure 4.2.2.12-1):

h_F – bending moment arm for tooth root stress for application of load at the outer point of single tooth pair contact [mm];

α_{Fen} – pressure angle at the outer point of single tooth pair contact in the normal section [°];

s_{Fn} – tooth root normal chord in the critical section [mm].

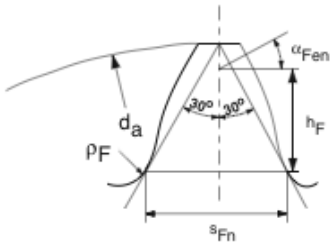

Fig. 4.2.2.12-1
Dimensions of h_F, s_{Fn} and α_{Fen} for external gear

For the calculation of h_F, s_{Fn} and α_{Fen}, the procedure outlined in the reference standard *ISO 6336-3:2019* is to be used.

Stress correction factor, Y_S

This factor is used to convert the nominal bending stress to the local tooth root stress, taking into account the stress concentration due to tooth root fillet and the fact that not only bending stresses arise at the root.

Y_S applies to the load application at the outer point of single tooth pair contact. Y_S shall be determined separately for the pinion and for the wheel.

The stress correction factor, Y_S, is to be determined with the following equation (having range of validity: $1 \le q_s \le 8$):

$$Y_S = (1.2 + 0.13L) q_s^{\left(\frac{1}{1.21+2.3/L}\right)} \quad (4.2.2.12\text{-}5)$$

where:

$$q_s = \frac{s_{Fn}}{2\rho_F} \quad (4.2.2.12\text{-}6)$$

$L =$ s_{Fn} / h_F

q_s – notch parameter

ρ_F – root fillet radius in the critical section [mm]

s_{Fn} – ditto as for factor Y_F

h_F – ditto as for factor Y_F

For the calculation of ρ_F the procedure outlined in the reference standard *ISO 6336-3:2019* is to be used.

Helix angle factor, Y_β

This factor converts the stress calculated for a point loaded cantilever beam representing the substitute gear tooth to the stress induced by a load along an oblique load line into a cantilever plate which represents a helical gear tooth.

The helix angle factor, Y_β is to be calculated as follows:

$$Y_\beta = 1 - \varepsilon_\beta \frac{\beta}{120} \quad (4.2.2.12\text{-}7)$$

The value 1,0 is substituted for ε_β when $\varepsilon_\beta > 1{,}0$ and 30° is substituted for $\beta > 30°$.

Rim thickness factor, Y_B

Factor Y_B, is a simplified factor used to de-rate thin rimmed gears. For critically loaded applications, this method should be replaced by a more comprehensive analysis.

Factor Y_B is to be determined as follows:

a) for external gears:

$$Y_B = 1 \qquad \text{for } s_R / h \ge 1.2$$

$$Y_B = 1{,}6 \cdot \ln\left(2{,}242 \frac{h}{s_R}\right) \quad \text{for } 0{,}5 < s_R / h < 1{,}2$$

where:

s_R – rim thickness of external gears [mm]

h – tooth height [mm]

The case $s_R / h \le 0{,}5$ is to be avoided.

b) for internal gears:

$Y_B = 1$ for $s_R / m_n \ge 3{,}5$

$Y_B = 1{,}15 \cdot \ln\left(8{,}324 \frac{m_n}{s_R}\right)$ for $1{,}75 < s_R / m_n < 3{,}5$

where:

s_R – rim thickness of internal gears [mm]

The case $s_R / m_n \le 1{,}75$ is to be avoided.

Deep tooth factor, Y_{DT}

Factor Y_{DT} adjusts the tooth root stress to take into account high precision gears and contact ratios within the range of virtual contact ratio $2{,}05 \le \varepsilon_{\alpha n} \le 2{,}5$, where:

$$\varepsilon_{\alpha n} = \frac{\varepsilon_\alpha}{\cos^2 \beta_b}$$

Factor Y_{DT} is to be determined as follows:

$Y_{DT} = 0{,}7$ for $Q \le 4$ and $\varepsilon_{\alpha n} > 2{,}5$

$Y_{DT} = 2{,}366 - 0{,}666 \cdot \varepsilon_{\alpha n}$ for $Q \le 4$ and $2{,}05 < \varepsilon_{\alpha n} \le 2{,}5$

$Y_{DT} = 1{,}0$ for all other cases

4.2.2.13 Permissible tooth root stress

Permissible tooth root stress σ_{FP} is determined from the formula:

$$\sigma_{FP1,2} = \frac{\sigma_{FE1,2} \cdot Y_{d1,2} \cdot Y_N}{S_F} Y_{\delta relT} \cdot Y_{RrelT1,2} \cdot Y_x \quad \text{[N/mm²]} \quad (4.2.2.13\text{-}1)$$

Safety factor for tooth root bending stress, S_F

Safety factor S_F can be assumed by the *Register* taking into account the type of application.

The following guidance values can be adopted:

a) For main propulsion gears:

S_F = 1,55 … 2,00

b) For auxiliary gears:

S_F = 1,40 … 1,45

For gearing of duplicated independent propulsion or auxiliary machinery, duplicated beyond that required for class, a reduced value can be assumed at the discretion of the *Register*.

Bending endurance limit, σ_{FE}

For a given material, σ_{FE} is the local tooth root stress which can be permanently endured.

According to the reference standard ISO 6336-5:2016 the number of $3 \cdot 10^6$ cycles is regarded as the beginning of the endurance limit.

σ_{FE} is defined as the unidirectional pulsating stress with a minimum stress of zero (disregarding residual stresses due to heat treatment). Other conditions such as alternating stress or prestressing, etc. are covered by the design factor Y_d.

The σ_{FE} values are to correspond to a failure probability 1% or less.

The endurance limit mainly depends on:

- material composition, cleanliness and defects;
- mechanical properties;
- residual stresses;
- hardening process, depth of hardened zone, hardness gradient;
- material structure (forged, rolled bar, cast).

The bending endurance limit, σ_{FE} is to be determined, in general, making reference to values indicated in the reference standard *ISO 6336-5:2016*, for material quality *MQ*.

Design factor, Y_d

This factor takes into account the influence of load reversing and shrink fit prestressing on the tooth root strength, relative to the tooth root strength with unidirectional load as defined for σ_{FE}.

The design factor, Y_d, for load reversing, is to be determined as follows:

Y_d =1,0 in general;

Y_d =0,9 for gears with occasional part load in reversed direction, such as main wheel in reversing gearboxes;

Y_d =0,7 for idler gears

Life factor, Y_N

This factor accounts for the higher tooth root bending stress permissible in case a limited life (number of cycles) is required.

The factor mainly depends on:
- material and heat treatment;
- number of load cycles (service life);
- influence factors $Y_{\delta relT}$,Y_{RrelT} and Y_X.

The life factor, Y_N, is to be determined according to *Method B* outlined in the reference standard *ISO 6336-3:2019*.

Relative notch sensitivity factor, $Y_{\delta relT}$

This factor indicates the extent to which the theoretically concentrated stress lies above the fatigue endurance limit. The factor mainly depends on material and relative stress gradient.

The relative notch sensitivity factor, $Y_{\delta relT}$, is to be determined as follows:

$$Y_{\delta relT} = \frac{1+\sqrt{0{,}2\rho'(1+2q_s)}}{1+\sqrt{1{,}2\rho'}}$$

where:

q_s – notch parameter (see clause 3.4)

ρ' – slip-layer thickness, mm, from the following table

Table 4.2.2.12-1
Slip-layer thickness

Material		ρ' [mm]
case hardened steels, flame or induction hardened steels		0,0030
through-hardened steels[1)], yield point R_e=	500 N/mm²	0,0281
	600 N/mm²	0,0194
	800 N/mm²	0,0064
	1000 N/mm²	0,0014
nitrided steels		0,1005
[1)] The given values of ρ' can be interpolated for values of yield point R_e not stated above		

Relative surface factor, Y_{RrelT}

This factor takes into account the dependence of the root strength on the surface condition in the tooth root fillet, mainly the dependence on the peak to valley surface roughness.

The relative surface factor, Y_{RrelT} is to be determined from the following Table.

Table 4.2.2.12-2
Relative surface factor depending on the material and approximate height of surface roughness

$R_z < 1$	$1 \le R_z \le 40$	Gear material
1,120	$1{,}674 - 0{,}529(R_z + 1)^{0,1}$	case hardened steels, through-hardened steels ($\sigma_B < 800$ N/mm^2)
1,070	$5{,}306 - 4{,}203(R_z + 1)^{0,01}$	normalised steels ($\sigma_B < 800$ N/mm^2)
1,025	$4{,}299 - 3{,}259(R_z + 1)^{0,0058}$	nitrided steels

where:

R_z – mean peak-to-valley roughness of tooth root fillets [µm],

σ_B – tensile strength, [N/mm²]

The method applied here is only valid when scratches or similar defects deeper than $2R_z$ are not present.

If the roughness stated is an arithmetic mean roughness, i.e. R_a value (=*CLA* value) (=*AA* value) the following approximate relationship can be applied:

$$R_a = CLA = AA = R_Z/6$$

Size factor, Y_X

This factor takes into account the decrease of the strength with increasing size.

The factor mainly depends on:
- material and heat treatment;
- tooth and gear dimensions;
- ratio of case depth to tooth size.

The size factor, Y_X, is to be determined as follows:

a) generally:

$Y_x = 1{,}0$ for $m_n \le 5$

b) normalised and through-hardened steels:

$Y_x = 1{,}03 - 0{,}006 m_n$ for $5 < m_n < 30$

$Y_x = 0{,}85$ for $m_n \ge 30$

c) for surface hardened steels:

$Y_x = 1{,}05 - 0{,}01 m_n$ for $5 \le m_n < 25$

$Y_x = 0{,}80$ for $m_n \ge 25$

4.2.2.14 Hertz contact stress for gear flank surface

Hertz contact stress for gear flank surface σ_H at the operating pitch circle, or at the inner point of single pair contact is calculated from the formula:

$$\sigma_{H1,2} = Z\sqrt{\frac{F_1}{d_1 b}\ \frac{u+1}{u}\ K_H} \quad \text{[N/mm²]} \quad (4.2.2.14\text{-}1)$$

where:

$K_H = K_A \cdot K_\gamma \cdot K_v \cdot K_{H\alpha} \cdot K_{H\beta}$

$= Z_B \cdot Z_H \cdot Z_E \cdot Z_\varepsilon \cdot Z_\beta$ for pinion,

$Z = Z_B \cdot Z_H \cdot Z_E \cdot Z_\varepsilon \cdot Z_\beta$ for wheel.

Single pair tooth contact factors, Z_B and Z_D

Factors Z_B for pinion and Z_D for wheel account for the influence of the tooth flank curvature on contact stresses at the inner point of single pair contact in relation to factor Z_H.

The factors transform the contact stresses determined at the pitch point to contact stresses considering the flank curvature at the inner point of single pair contact. These factors, Z_B for pinions and Z_D for wheels, are to be determined as follows:

a) For spur gears (β=0°):

$Z_B = 1$ for $M_1 \le 1$

$Z_B = M_1$ for $M_1 > 1$

$Z_D = 1$ for $M_2 \le 1$

$Z_D = M_2$ for $M_2 > 1$

b) For helical gears ($\beta > 0°$), on condition that $\varepsilon_\beta < 1$:

$Z_B = M_1 - \varepsilon_\beta (M_1 - 1)$

If $Z_B > 1$ then $Z_B = 1$ shall be used further.

$Z_D = M_2 - \varepsilon_\beta (M_2 - 1)$

If $Z_D > 1$ then $Z_D = 1$ shall be used further.

c) For helical gears ($\beta > 0°$), on condition that $\varepsilon_\beta \ge 1$:

$Z_B = 1$

$Z_D = 1$

In the above formulas M_1, M_2, M_{11}, M_{12}, M_{21} i M_{22} are determined as follows:

$$M_1 = \frac{\tan \alpha_{tw}}{\sqrt{M_{11} M_{12}}}$$

$$M_2 = \frac{\tan \alpha_{tw}}{\sqrt{M_{21} M_{22}}}$$

$$M_{11} = \sqrt{\left(d_{a1} / d_{b1}\right)^2 - 1} - \frac{2\pi}{z_1}$$

$$M_{12} = \sqrt{\left(d_{a2} / d_{b2}\right)^2 - 1} - \left(\varepsilon_\alpha - 1\right)\frac{2\pi}{z_2}$$

$$M_{21} = \sqrt{\left(d_{a1} / d_{b1}\right)^2 - 1} - \left(\varepsilon_\alpha - 1\right)\frac{2\pi}{z_1}$$

$$M_{22} = \sqrt{\left(d_{a2} / d_{b2}\right)^2 - 1} - \frac{2\pi}{z_2}$$

d) For internal gears, Z_D shall be taken as equal to 1.

Zone factor, Z_H

This factor accounts for the influence on the Hertzian pressure of tooth flank curvature at pitch point and transforms the tangential load at the reference cylinder to the normal load at the pitch cylinder. It is calculated as follows:

$$Z_H = \sqrt{\frac{2 \cdot \cos \beta_b}{\cos^2 \alpha_t \cdot \tan \alpha_{ttw}}}$$

Elasticity factor, Z_E

This factor accounts for the influence of the gear material properties expressed by Young's moduli E_1, E_2 and Poisson's ratios ν_1, ν_2 on the contact stress. It is calculated as follows:

$$Z_E = \frac{1}{\sqrt{\pi \left(\frac{1-\nu_1^2}{E_1} + \frac{1-\nu_2^2}{E_2} \right)}} \left[\sqrt{\mathrm{N/mm^2}} \right]$$

For steel gears with:

$E_1 = E_2 = 206\,000$ N/mm²

$\nu_1 = \nu_2 = 0{,}3$

the value of factor Z_E amounts to $189{,}8\sqrt{\mathrm{N/mm^2}}$.

Contact ratio factor, Z_ε

Factor Z_ε accounts for the influence of the transverse contact ratio ε_α and the overlap ratio ε_β on the specific surface load of gears. It is calculated as follows:

a) For spur gears (β=0°):

$$Z_\varepsilon = \sqrt{\frac{4-\varepsilon_\alpha}{3}}$$

b) For helical gears (β>0°):

$$Z_\varepsilon = \sqrt{\frac{4-\varepsilon_\alpha}{3}\cdot(1-\varepsilon_\beta)+\frac{\varepsilon_\beta}{\varepsilon_\alpha}} \qquad \text{for } \varepsilon_\beta<1$$

$$Z_\varepsilon = \sqrt{\frac{1}{\varepsilon_\alpha}} \qquad \text{for } \varepsilon_\beta\geq 1$$

Helix angle factor, Z_β

Factor Z_β accounts for the influence of helix angle on surface durability, allowing for such variables as the distribution of load along the lines of contact. It is dependent only on the helix angle. It is calculated as follows:

$$Z_\beta = \sqrt{\frac{1}{\cos\beta}}$$

4.2.2.15 Permissible Hertz contact stress

Permissible Hertz contact stress σ_{HP} shall be evaluated according to formula:

$$\sigma_{HP1,2} = \frac{\sigma_{H\,\mathrm{lim}1,2}\cdot Z_{NT}}{S_{H\,\mathrm{min}}}\cdot Z_{L1,2}\cdot Z_{v1,2}\cdot Z_{R1,2}\cdot Z_w\cdot Z_{x1,2} \quad [\mathrm{N/mm^2}] \quad (4.2.2.15\text{-}1)$$

Safety factor for contact stress, S_H

Safety factor S_H can be assumed by the *Register* taking into account the type of application.

The following guidance values can be adopted:

a) For main propulsion gears:

S_H = 1,20 … 1,40

b) For auxiliary gears:

S_H = 1,15 … 1,20

For gearing of duplicated independent propulsion or auxiliary machinery, duplicated beyond that required for class, a reduced value can be assumed at the discretion of the *Register*.

Endurance limit for contact stress, σ_{Hlim}

For a given material, σ_{Hlim} is the limit of repeated contact stress which can be permanently endured. The value of σ_{Hlim} can be regarded as the level of contact stress which the material will endure without pitting for at least $5\cdot10^7$ load cycles.

For this purpose, pitting is defined by:

a) for not surface hardened gears:

pitted area > 2% of total active flank area

b) for surface hardened gears:

pitted area > 0,5% of total active flank area, or

pitted area > 4% of one particular tooth flank area.

The σ_{Hlim} values are to correspond to a failure probability of 1% or less.

The endurance limit mainly depends on:

- material composition, cleanliness and defects;
- mechanical properties;
- residual stresses;
- hardening process, depth of hardened zone, hardness gradient;
- material structure (forged, rolled bar, cast).

The endurance limit for contact stress σ_{Hlim}, is to be determined, in general, making reference to values indicated in the standard *ISO 6336-5:2016*, for material quality *MQ*.

Life factor, Z_N

This factor accounts for the higher permissible contact stress in case a limited life (number of cycles) is required.

The factor mainly depends on:
- material and heat treatment;
- number of cycles;
- influence factors Z_R, Z_v, Z_L, Z_W and Z_X.

The life factor Z_N is to be determined according to *Method B* outlined in the reference standard *ISO 6336-2:2019*.

Lubrication film influence on contact stress

Influence factors of lubrication film on contact stress Z_L, Z_v and Z_R may be determined for the softer material, where gear pairs are of different hardness.

The factors mainly depend on:
- viscosity of lubricant in the contact zone;
- the sum of the instantaneous velocities of the tooth surfaces;
- load;
- relative radius of curvature at the pitch point;
- surface roughness of teeth flanks;
- hardness of pinion and gear.

Lubricant factor, Z_L

This factor accounts for the influence of the type of lubricant and its viscosity. It is calculated as follows:

$$Z_L = C_{ZL} + \frac{4\left(1 - C_{ZL}\right)}{\left(1{,}2 + \frac{134}{v_{40}}\right)^2}$$

In the range 850 N/mm^2 $\leq \sigma_{H\lim} \leq$ 1200 N/mm^2, C_{ZL} is to be calculated as follows:

$$C_{ZL} = \left(0{,}08\frac{\sigma_{H\lim} - 850}{350}\right) + 0{,}83$$

If σ_{Hlim}<850 N/mm^2, then take C_{ZL} = 0,83

If σ_{Hlim}>1200 N/mm^2, then take C_{ZL} = 0,91

where:

v_{40} – nominal kinematic viscosity of the oil at 40°C [mm^2/s]

Velocity factor, Z_v

This factor accounts for the influence of the pitch line velocity. It is calculated as follows:

$$Z_v = C_{ZV} + \frac{2\left(1 - C_{ZV}\right)}{\sqrt{0.8 + \frac{32}{v}}}$$

In the range 850 N/mm^2 $\leq \sigma_{Hlim} \leq$ 1200 N/mm^2, C_{ZV} is to be calculated as follows:

$$C_{ZV} = C_{ZL} + 0{,}02$$

Roughness factor, Z_R

This factor accounts for the influence of the surface roughness on the surface endurance capacity. It is calculated as follows:

$$Z_R = \left(\frac{3}{R_{z10}}\right)^{C_{ZR}}$$

where:

$$R_z = \frac{R_{z1} + R_{z2}}{2}$$

The peak-to-valley roughness determined for the pinion R_{z1} and for the wheel R_{z2} are mean values for the peak-to-valley roughness R_z measured on several tooth flanks (R_z as defined in the reference standard *ISO 6336-2:2019*).

$$R_{z10} = R_Z \sqrt[3]{\frac{10}{\rho_{red}}}$$

Relative radius of curvature:

$$\rho_{red} = \frac{\rho_1 \cdot \rho_2}{\rho_1 + \rho_2}$$

wherein:

$$\rho_{1,2} = 0.5 \cdot d_{b1,2} \cdot \tan \alpha_{tw}$$

(also for internal gears, d_b negative sign)

If the roughness stated is an arithmetic mean roughness, i.e. R_a value (=*CLA* value) (=*AA* value) the following approximate relationship can be applied:

$$R_a = CLA = AA = R_z / 6$$

$C_{ZR} = 0{,}150$ for $\sigma_{Hlim} < 850$;

$C_{ZR} = 0{,}32 – 0{,}0002 \cdot \sigma_{Hlim}$, for $850 \leq \sigma_{Hlim} \leq 1200$;

$C_{ZR} = 0{,}080$ for $\sigma_{Hlim} > 1200$.

Hardness ratio factor, Z_W

This factor accounts for the increase of surface durability of a soft steel gear meshing with a significantly harder gear with a smooth surface in the following cases:

a) Surface-hardened pinion with through-hardened wheel

$$Z_W = 1{,}2 \cdot \left(\frac{3}{R_{zH}} \right)^{0{,}15} \qquad \text{for } HB < 130$$

$$Z_W = \left(1{,}2 - \frac{HB - 130}{1700} \right) \cdot \left(\frac{3}{R_{zH}} \right)^{0{,}15} \qquad \text{for } 130 \leq HB \leq 470$$

$$Z_W = \left(\frac{3}{R_{zH}} \right)^{0{,}15} \qquad \text{for } HB > 470$$

where:

HB – Brinell hardness of the tooth flanks of the softer gear of the pair

R_{zH} – equivalent roughness [µm]

$$R_{zH} = \frac{R_{z1} \cdot (10 / \rho_{red})^{0.33} \cdot (R_{z1} / R_{z2})^{0.66}}{(v \cdot \nu_{40} / 1500)^{0.33}}$$

ρ_{red} – relative radius of curvature (the same as for factor Z_R)

b) Through-hardened pinion and wheel

When the pinion is substantially harder than the wheel, the work hardening effect increases the load capacity of the wheel flanks. Z_W applies to the wheel only, not to the pinion.

$$Z_W = 1 \qquad \text{for } HB_1/HB_2 < 1{,}2$$

$$Z_W = 1 + \left(0{,}00898 \frac{HB_1}{HB_2} - 0{,}00829 \right) \cdot (u - 1) \qquad \text{for } 1{,}2 \leq HB_1/HB_2 \leq 1{,}7$$

$$Z_W = 1 + 0{,}00698 \cdot (u - 1) \qquad \text{for } HB_1/HB_2 > 1{,}7$$

If gear ratio u>20 then the value u=20 is to be used.

In any case, if calculated Z_W <1 then the value Z_W =1,0 is to be used.

Size factor, Z_X

This factor Z_X accounts for the influence of tooth dimensions on permissible contact stress and reflects the non-uniformity of material properties.

The factor mainly depends on:
- material and heat treatment;
- tooth and gear dimensions;
- ratio of case depth to tooth size;
- ratio of case depth to equivalent radius of curvature.

For through-hardened gears and for surface-hardened gears with adequate case depth relative to tooth size and radius of relative curvature Z_X=1. When the case depth is relatively shallow then a smaller value of Z_X should be chosen.

4.2.3 Shafts

4.2.3.1 The shaft diameter of a larger wheel is not to be less than 1,10 times the diameter of the intermediate shafts when the pinions are set at an angle of 120° or more and not less than 1,15 times the diameter of the intermediate shaft, in all other cases. The mechanical properties of material of the wheel shaft and intermediate shafts and their differences shall be taken into consideration.

4.2.3.2 Shafts, pinions and gear wheels of propulsion gears for ships strengthened for navigation in ice shall be designed for a torque exceeding the main engine designed torque, determined by means of the factor K_i (see the *Rules for the classification of ships, Part 7 - Machinery installation*, item 8.7.1).

The requirements of this item do not apply to the installations protected against torque overload.

4.2.4 Lubrication

4.2.4.1 The toothing and sleeve bearings of the main propulsion gears shall be provided with forced lubrication. The possibility of oil pressure governing shall be provided. Provision shall be made for a safety device excluding the oil pressure rise above the permissible value.

4.2.4.2 Lubricating oil shall be delivered to the toothing through sprayers. The sprayers shall provide the oil is fed in form of fanned-out compact jet with the adjacent jets being overlapped.

The sprayers shall be so arranged that, while running ahead or astern, the oil is captured in the toothing.

Oil supply to and withdrawal from the bearings and sprayers shall be so arranged that there is no oil foaming or emulsification.

A possibility of oil entraining by wheel or pinion of the largest diameter from the gear sump under the conditions mentioned in 1.5.1 shall be prevented.

6 DECK MACHINERY

■ **Item 6.2.1** has been amended and should be read as follow:

6.2.1 General requirements and definitions

6.2.1.1 For the purpose of these Rules, the following definitions and explanations have been adopted:

.1 **Main steering gear** is the machinery, rudder actuator(s), steering gear power units, if any, ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.

.2 **Auxiliary steering gear** is the equipment other than any part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear, but not including the tiller, quadrant or components serving to the same purpose.

.3 **Steering gear power unit** is:

.3.1 in case of electric steering gear an electric motor and its associated electrical equipment;

.3.2 in case of electrohydraulic steering gear an electric motor and its associated equipment and connected pump;

.3.3 in case of other hydraulic steering gear a driving engine and connected pump.

.4 **Steering gear control system** is the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables. Steering gear control system is also understood to cover "the equipment required to control the steering gear power actuating system".

.5 **Power actuating system** means the hydraulic equipment provided for supplying power to turn the rudder stock, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. The power actuating systems may share common mechanical components, i.e. tiller, quadrant and rudder stock, or components serving to the same purpose.

.6 **Rudder actuator** means the component which converts directly hydraulic pressure into mechanical action to move the rudder.

.7 **Maximum ahead service speed** means the greatest speed which the ship is designed to maintain in service at sea at her deepest sea going draught.

.8 **Redundancy** is the ability of a component or system to maintain or restore its function when one failure has occurred. Redundancy can be achieved for instance by installation of more units or alternative means for performing a function.

9. **Maximum working pressure** means the maximum expected pressure in the system when the steering gear is operated under the operational conditions specified in 6.2.2.1.2.

.10 **Hydraulic locking** means all situations where two hydraulic systems (usually identical) oppose each other in such a way that it may lead to loss of steering. It can either be caused by pressure in the two hydraulic systems working against each other or by hydraulic "by-pass" meaning that the systems puncture each other and cause pressure drop on both sides or make it impossible to build up pressure.

6.2.1.2 Unless expressly provided otherwise, every ship shall be provided with a main steering gear and an auxiliary steering gear to the satisfaction of these Rules. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative.

6.2.1.3 All the steering gear components and the rudder stock shall be of sound and reliable construction to the satisfaction of this part of the Rules. Special consideration shall be given to the suitability of any essential component which is not duplicated. Any such essential component shall, where appropriate, utilise antifriction bearings such as ball-bearings, roller-bearings or sleeve-bearings which shall be permanently lubricated or provided with lubrication fittings.

6.2.1.4 The design pressure for calculations to determine the scantlings of piping and other steering gear components subjected to internal hydraulic pressure shall be at least 1.25 times the maximum working pressure to be expected under the operational conditions specified in 6.2.2.1.2, taking into account any pressure which may exist in the low-pressure side of the system. At the discretion of the *Register*, fatigue criteria shall be applied for the design of piping and components, taking into account pulsating pressures due to dynamic loads.

6.2.1.5 Relief valves shall be fitted to any part of the hydraulic systems which can be isolated and in which pressure can be generated from the power source or from external forces. The setting of the relief valves shall not exceed the design pressure. The valves shall be of adequate size and so arranged as to avoid an undue rise in pressure above the design pressure.

6.2.1.6 The electrical power circuits and the steering gear control systems with their associated components, cables and pipes required by these Rules shall be separated as far as practicable throughout their length.