# RULES
# FOR THE CLASSIFICATION OF SHIPS

*Part 9 – MACHINES*
*January 2025*

*Amendments No. 2*
**January 2026**

**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 22nd December 2025 and shall enter into force on 1 January 2026

# 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 January 2025, as last amended by Amendments No. 1 edition July 2025.

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.

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 108<br>Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS PROT 1988)<br><br>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 81<br>Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto |
| **Resolutions:** | MSC.532(107) |
| **Circulars:** | MSC.1/Circ.1425, MSC.1/Circ.1662 |

**International Association of Classification Societies (IACS)**

| | |
|---|---|
| **Unified Requirements (UR):** | A3 (Rev.1 2019), F29 (Rev. 6, 2005), M2 ( 1971), M3 (Rev. 7, Feb 2024), M9 (Corr. 2, 2007), M10 (Rev. 5, 2024), M11 (1972), M12 (1972), M16 (Rev. 1, 2005), M26 (Corr. 1, 2005), M28 (1978), M42 (Rev.6, Mar 2022), M44 (Corr. 1, Feb 2022), M51 (Corr. 1, Oct 2018), M53 (Rev. 5, May 2023), M56 (Corr.3, Sep 2025), M60 (Rev.1, Nov 2021), M61 (Rev.3, Feb 2024), M63 (Rev.1, Jan 2023), M66 (Corr. 1, Oct 2021), M67 (Rev. 2, 2015), M71 (Corr.1, 2016), M72 (Rev.23 Apr 2023), M73 (Rev.2, May 2023), M74 (Rev. 2, June 2021), Z26 (2015), M77 (Rev. 4, Feb 2023), M79 (Rev. 1, Feb 2020), M80 (2019), M81 (Rev.1, July 2023), M84 (Feb 2024) |
| **Unified Interpretations:** | SC76 (1985), SC94 (Rev. 2, 2016), SC133 (1998), SC189 (2004), SC228 (2008), SC242 (Rev.2, 2020), SC246 (Rev.1, 2015) |

**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

# TABLE 1 – REVIEW OF AMENDMENTS

This review comprises amendments in relation to the Rules for the Classification of Ships, Part 9 – Machines, edition January 2025, as last amended by Amendments No. 1 edition July 2025.

| *ITEM* | *DESCRIPTION OF THE AMENDMENTS* |
|---|---|
| **SECTION 2 – INTERNAL COMBUSTION ENGINES** | |
| Head 2.3 | Existing Head 2.3 has been amended to include requirements contained in IACS UR M10, Rev.5, Nov 2024. |
| **SECTION 4 – GEARS, REVERSIBLE AND FLEXIBLE COUPLINGS** | |
| Head 4.2 | Existing Head 4.2 has been amended to include corrections contained in IACS UR M56, Corr.3, Sep 2025. |
| **ANNEX E – ANCHOR HANDLING WINCHES** | |
| | New Annex has been provided due to inclusion of requirements contained in Resolution MSC.532(107) and Circular MSC.1/Circ.1662. |

# 2 INTERNAL COMBUSTION ENGINES

■ **Head 2.3 – CRANKCASE** has been partly changed and should be read as follows:

## 2.3 CRANKCASE

### 2.3.1 General

**2.3.1.1** The mating surfaces of the frame parts forming the engine crankcase shall be close-fitting, oil-tight and gas-tight. The frame parts (bed plates, columns, cylinder blocks, etc.) shall be fixed together by means of calibrated pieces.

**2.3.1.2** For the purpose of the present head, the following definitions apply:

- Low-Speed Engines means I.C engines having a rated speed of less than 300 rpm.
- Medium-Speed Engines means I.C engines having a rated speed of 300 rpm and above, but less than 1400 rpm.
- High-Speed Engines means I.C engines having a rated speed of 1400 rpm and above.

*NOTE: For equivalent devices for high-speed engines, refer to UI SC 133.*

### 2.3.2 Protection of internal combustion engines against crankcase explosions

**2.3.2.1** Crankcase construction and crankcase doors are to be of sufficient strength to withstand anticipated crankcase pressures that may arise during a crankcase explosion taking into account the installation of explosion relief valves required by 2.3.3. Crankcase doors are to be fastened sufficiently securely for them not be readily displaced by a crankcase explosion.

**2.3.2.2** Additional relief valves are to be fitted on separate spaces of crankcase such as gear or chain cases for camshaft or similar drives, when the gross volume of such spaces exceeds 0.6 m3.

**2.3.2.3** Scavenge spaces in open connection to the cylinders are to be fitted with explosion relief valves.

**2.3.2.4** Crankcase explosion relief valves are to comply with 2.3.3.

**2.3.2.5** Ventilation of crankcase, and any arrangement which could produce a flow of external air into the crankcase, is in principle not permitted except for engines fuelled with gas or low-flashpoint fuel, where this might be necessary to maintain the gas concentration in the crankcase below LEL provided that:

.1 It is demonstrated that the risk connected with a crankcase explosion is not increased by the ventilation system.

.2 The operation of the ventilation system is monitored.

.3 The automatic safety actions to be activated and / or the risk mitigation measures to be implemented in case of detection of a ventilation failure are specified by the engine manufacturer and justified in the safety concept of the engine.

*NOTE: LEL means the Lower Explosive Limit, as defined in IEC 60079-10-1 (February 2021) standard, paragraph 3.6.12. The lowest applicable LEL of all possible gas or low flashpoint fuels, fuel vapours or mixture is to be considered.*

Crankcase ventilation pipes, where provided, are to be as small as practicable to minimise the inrush of air after a crankcase explosion.

When forced extraction of crankcase atmosphere is provided, the crankcase pressure level is not to influence the reliable function of measurement and safety devices (such as oil mist detection) in the crankcase.

To avoid interconnection between crankcases and the possible spread of fire following an explosion, crankcase ventilation pipes and oil drain pipes for each engine are to be independent of any other engine.

**2.3.2.6** For engines fuelled with gas or low flashpoint fuel a detailed evaluation regarding the safety of crankcase is to be carried out justifying that:

.1 either the gas concentration in the crankcase remains below the LEL without specific measures, or

.2 the risk of a crankcase explosion is reduced through specific measures (see, for example, 2.3.2.5 or 2.3.2.23).

**2.3.2.7** Lubricating oil drain pipes from the engine sump to the drain tank are to be continuously submerged at their outlet ends.

**2.3.2.8** A warning notice is to be fitted either on the control stand or, preferably, on a crankcase door on each side of the engine. This warning notice is to specify that, whenever overheating is suspected within the crankcase, the crankcase doors or sight holes are not to be opened before a reasonable time, sufficient to permit adequate cooling after stopping the engine.

**2.3.2.9** Oil mist detection arrangements (or engine bearing temperature monitors or equivalent devices) are required:

.1 for alarm and slow down purposes for low-speed I.C. engines of 2250 kW and above or having cylinders of more than 300 mm bore

.2 for alarm and automatic shutoff purposes for medium- and high-speed I.C. engines of 2250 kW and above or having cylinders of more than 300 mm bore

Oil mist detection arrangements are to be of a type approved by classification societies and tested in accordance with IACS UR M67 *Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment* and comply with 2.3.2.10 to 2.3.2.21. Engine bearing temperature monitors or equivalent devices used as safety devices (see note below) have to be of a type approved by classification societies for such purposes.

*NOTE: Engine bearing temperature monitors or equivalent devices are defined as follows:*

*a) For crosshead engines:*
*The wording "engine bearing" of the term "engine bearing temperature monitors or equivalent devices" includes at least journal and connecting rod bearings and the crosshead bearings.*

*b) For trunk piston engines:*
*"Engine bearing temperatures monitors" may be accepted as an alternative to the oil mist detector only when the temperature of all bearings, including the piston pin bearings, are monitored.*

*c) The expression "equivalent devices" includes measures applied to engines where specific design features to preclude the risk of crankcase explosion are incorporated, subject to satisfactory justifications.*

*d) The examples of acceptable "temperature monitors or equivalent devices" are as follows:*
*.1) a temperature monitoring system of the bearing concerned*
*.2) a bearing oil outlet temperature monitoring system*
*.3) a splash oil temperature monitoring system*
*.4) measures applied to engines where specific design features to preclude the risk of crankcase explosions are incorporated, subject to satisfactory justifications.*

**2.3.2.10** The oil mist detection system and arrangements are to be installed in accordance with the engine designer's and oil mist detection system manufacturer's instructions/recommendations. The following particulars are to be included in the instructions:
.1 Schematic layout of engine oil mist detection and alarm system showing location of engine crankcase sample points and piping or cable arrangements together with pipe dimensions to detector.
.2 The manufacturer's maintenance and test manual.
.3 Information relating to type or in-service testing of the engine with engine protection system test arrangements having approved types of oil mist detection equipment.

**2.3.2.11** A copy of the oil mist detection equipment maintenance and test manual required by 2.3.2.10 is to be provided on board ship.

**2.3.2.12** Oil mist detection and alarm information is to be capable of being read from a safe location away from the engine.

**2.3.2.13** Each engine is to be provided with its own independent oil mist detection arrangement and a dedicated alarm.

**2.3.2.14** Oil mist detection and alarm systems are to be capable of being tested on the test bed and board under engine at standstill and engine running at normal operating conditions in accordance with test procedures that are acceptable to the classification society.

**2.3.2.15** Alarms and shutdowns for the oil mist detection system are to be in accordance with UR M35 and UR M36 and the system arrangements are to comply with UR M29 and UR M30.

**2.3.2.16** The oil mist detection arrangements are to provide an alarm indication in the event of a foreseeable functional failure in the equipment and installation arrangements.

**2.3.2.17** The oil mist detection system is to provide an indication that any lenses fitted in the equipment and used in determination of the oil mist level have been partially obscured to a degree that will affect the reliability of the information and alarm indication.

**2.3.2.18** Where oil mist detection equipment includes the use of programmable electronic systems, the arrangements are to be in accordance with individual classification society requirements for such systems.

**2.3.2.19** Plans showing details and arrangements of oil mist detection and alarm arrangements are to be submitted for approval in accordance with Annex A table 2 item 26.

Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate (if applicable), supported by a confirmation from the oil mist detection system manufacturer, from the crankcase and the spaces mentioned in 2.3.2.2, is to be provided to the *Register* for reference purposes only.

As an alternative to the evidence of studies, an oil mist inlet test may be performed on a running engine. Test conditions such as setup, records or engine loads are to be agreed upon between engine designer, oil mist detector (OMD) manufacturer and respective class society. The test engine is to be chosen to demonstrate OMD arrangement suitability to cover a specified range of engine types and configurations. To allow a repeatable and comparable test, an oil mist generator as described under IACS UR M67 Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment is to be used.

**2.3.2.20** The equipment together with detectors is to be tested when installed on the test bed and on board ship to demonstrate that the detection and alarm system functionally operates. The testing arrangements are to be to the satisfaction of the classification society.

**2.3.2.21** Where sequential oil mist detection arrangements are provided the sampling frequency and time is to be as short as reasonably practicable.

**2.3.2.22** Where alternative methods are provided for the prevention of the build-up of oil mist that may lead to a potentially explosive condition within the crankcase details are to be submitted for consideration of individual classification societies. The following information is to be included in the details to be submitted for consideration:

.1 Engine particulars – type, power, speed, stroke, bore and crankcase volume.

.2 Details of arrangements prevent the build up of potentially explosive conditions within the crankcase, e.g. bearing temperature monitoring, oil splash temperature, crankcase pressure monitoring, recirculation arrangements.

.3 Evidence to demonstrate that the arrangements are effective in preventing the build up of potentially explosive conditions together with details of in-service experience.

.4 Operating instructions and the maintenance and test instructions.

**2.3.2.23** Where it is proposed to use the introduction of inert gas into the crankcase to minimise a potential crankcase explosion, details of the arrangements are to be submitted to the classification society for consideration.

# 4 GEARS, REVERSIBLE AND FLEXIBLE COUPLING

■ **Head 4.2 – GEARING** has been partly changed regarding requirements for Hardness ratio factor *Zw*, and should be read as follows:

## 4.2 GEARING

### 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: $b$ +2$m_n$);
$d$ – 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≤ $h_{ao}$ ≤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;
$\alpha_n$ – normal pressure angle at reference cylinder [°];
$\alpha_t$ – transverse pressure angle at reference cylinder [°];
$\alpha_{tw}$ – transverse pressure angle at working pitch cylinder [°];
$\beta$ – helix angle at reference cylinder [°];
$\beta_b$ – helix angle at base cylinder [°];
$\nu_{40}$ – kinematic viscosity of lubricating oil at 40°C [mm²/s];

$\nu_{50}$ – kinematic viscosity of lubricating oil at 50°C (if $\nu_{40}$ is unknown) [mm²/s];

$\varphi$ – angle of twist, due to torsion, for the driving shaft at full load for dual tandem gears [°];

$\rho_{ao}$ – tooth fillet radius factor of the tool (basic rack)

ISO recommendation: $\rho_{ao}$ =0,38

DIN recommendation: 0,25≤$\rho_{ao}$ ≤0,45;

$\sigma_{FE}$ – bending endurance limit;

$\sigma_{Hlim}$ – endurance limit for contact stress [N/mm²]

$\sigma_{t1}$, $\sigma_{t2}$ – normal circumferential shrink fit stress (if a gear is connected to the shaft by a shrinkfit) [N/mm²];

$\varepsilon_\alpha$ – transverse contact ratio;

$\varepsilon_\beta$ – overlap ratio;

$\varepsilon_\gamma$ – 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 $\varepsilon_\alpha$ 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, $K_\gamma$**

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

$K_\gamma$ 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 $K_\gamma$ 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, $K_\gamma$=1,00
- 4 planetary gears, $K_\gamma$=1,20
- 5 planetary gears, $K_\gamma$=1,30
- 6 planetary gears and over, $K_\gamma$=1,40

For dual tandem gears: $K_\gamma = 1+0{,}2/\varphi$

**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 $\beta \le 30°$
- 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 $\varepsilon_\beta \ge 1$

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

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 ($\beta$=0°) and for helical gears ($\beta$>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 $\frac{v \cdot z_1}{100}\sqrt{\frac{u^2}{1+u^2}} \le 0{,}2$ 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 $\varepsilon_\beta<1$ 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 ($\beta=0°$), in accordance with a);

$K_{v\beta}$ – $K_v$ value for helical gears ($\beta>0°$), 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 $K_A$, $K_\gamma$, $K_v$, $K_{H\beta}$
- 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 $\sigma_F$ and the permissible root stress $\sigma_{FP}$ shall be calculated separately for the pinion and the wheel.

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

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

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];

$\alpha_{Fen}$ – 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].

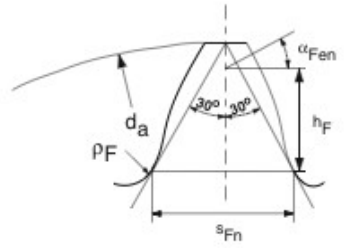


**Fig. 4.2.2.12-1**
Dimensions of $h_F$, $s_{Fn}$ and $\alpha_{Fen}$ for external gear

For the calculation of $h_F$, $s_{Fn}$ and $\alpha_{Fen}$, 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

$\rho_F$ – 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 $\rho_F$ the procedure outlined in the reference standard *ISO 6336-3:2019* is to be used.

**Helix angle factor, $Y_\beta$**

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, $Y_\beta$ 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 $\varepsilon_\beta$ 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:

$Y_B = 1$ 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:

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

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

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 $\sigma_{FP}$ is determined from the formula:

$$\sigma_{FP1,2} = \frac{\sigma_{FE1,2} \cdot Y_{d1,2} \cdot Y_N}{S_F} Y_{\delta relT} \cdot Y_{RrelT1,2} \cdot Y_x \quad [\text{N/mm}^2]$$

(4.2.2.13-1)

**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, $\sigma_{FE}$**

For a given material, $\sigma_{FE}$ 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.

$\sigma_{FE}$ 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 $\sigma_{FE}$ 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, $\sigma_{FE}$ 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 $\sigma_{FE}$.

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)

$\rho'$ – slip-layer thickness, mm, from the following table

**Table 4.2.2.12-1**
Slip-layer thickness

| Material | | $\rho'$ [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 $\rho'$ 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 | $4{,}299 - 3{,}259(R_z + 1)^{0,00}$ | nitrided steels |

where:

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

$\sigma_B$ – 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 $\sigma_H$ at the operating pitch circle, or at the inner point of single pair contact is calculated from the formula:

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

where:

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

$Z = Z_B \cdot Z_H \cdot Z_E \cdot Z_\varepsilon \cdot Z_\beta$ 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 ($\beta$=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 $\nu_1$, $\nu_2$ on the contact stress. It is calculated as follows:

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

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 $189{,}8\sqrt{\text{N/mm}^2}$ .

**Contact ratio factor, $Z_\varepsilon$**

Factor $Z_\varepsilon$ accounts for the influence of the transverse contact ratio $\varepsilon_\alpha$ and the overlap ratio $\varepsilon_\beta$ on the specific surface load of gears. It is calculated as follows:

a) For spur gears ($\beta$=0°):

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

b) For helical gears ($\beta$>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, $Z_\beta$**

Factor $Z_\beta$ 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 $\sigma_{HP}$ shall be evaluated according to formula:

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

(4.2.2.15-1)

**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, $\sigma_{Hlim}$**

For a given material, $\sigma_{Hlim}$ is the limit of repeated contact stress which can be permanently endured. The value of $\sigma_{Hlim}$ 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 $\sigma_{Hlim}$ 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 $\sigma_{Hlim}$, 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:

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

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 $\sigma_{Hlim}$<850 N/mm$^2$, then take $C_{ZL}$ = 0,83

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

where:

$\nu_{40}$ – 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·$\sigma_{Hlim}$, for 850≤ $\sigma_{Hlim}$ ≤ 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

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

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

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

where:

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

$R_{zH}$ – equivalent roughness [µm]

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

If $R_{zH}$ > 16 then $R_{zH}$ = 16 µm

If $R_{zH}$ < 3 then $R_{zH}$ = 3 µm

$\rho_{red}$ – 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.

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

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

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

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.

# ANNEX E - ANCHOR HANDLING WINCHES AND ASSOCIATED LOOSE GEAR

## 1 GENERAL

**1.1** This Annex shall apply to anchor handling winches, and loose gear utilized with the anchor handling winches.

Anchor handling winch means any winch for the purpose of deploying, recovering and repositioning anchors and mooring lines in subsea operations.

Loose gear means an article of ships equipment by means of which a load can be attached to a lifting appliance or an anchor handling winch but which does not form an integral part of the appliance or load.

**1.2** Anchor handling winches installed on or after 1 January 2026 shall be designed, constructed, installed and tested to the satisfaction of the *Register*.

Anchor handling winches installed before 1 January 2026 shall be tested and thoroughly examined by *Register*, based on the requirements of this Annex no later than the date of the first renewal survey on or after 1 January 2026.

*NOTE: The expression installed on or after 1 January 2026, means:*

1. *for ships the keel of which is laid or which is at a similar stage of construction on or after 1 January 2026, any installation date on the ship; or*
2. *for ships other than those specified in .1, including those constructed before 1 January 2009, a contractual delivery date for anchor handling winches, or in the absence of a contractual delivery date, the actual delivery date of the anchor handling winches to the ship on or after 1 January 2026.*

**1.3** All anchor handling winches, regardless of installation date, and all loose gear utilized with anchor handling winches, shall be operationally tested, thoroughly examined, inspected, operated and maintained, based on the requirements of this Annex of the Rules.

**1.4** While all reasonable steps shall be taken to maintain anchor handling winches and loose gear to which this regulation applies in working order, malfunctions of that equipment shall not be assumed as making the ship unseaworthy or as a reason for delaying the ship in ports, provided that action has been taken by the master to take the inoperative anchor handling winch into account in planning and executing a safe voyage.

## 2 DEFINITONS

For the purpose of this Annex, the following definitions apply:

1. **Brake holding** force is the maximum force for which the winch brake is designed.
2. **Brake holding** capacity is the maximum line pull that the winch brake can withstand without slipping of the brake.
3. **Maximum line pull** is the maximum sustained force the winch is capable of pulling.
4. **Static bollard pull** is the maximum sustained pulling force a vessel is capable of generating at maximum power (i.e. 100% maximum continuous rating (MCR)) and zero forward speed.
5. **A wire** means a dedicated line (wire rope, synthetic rope or chain cable) used for the handling of anchors by means of an anchor handling winch. The wire may include connecting loose gear.
6. **Chain stopper** is a device used for securing and holding a section of wire, thereby relieving the load on the winch drum.
7. **Competent person** means a person possessing the knowledge and experience required for the performance of duties specified in these Annex.
8. **Inspection means** an assessment carried out by a responsible person to ascertain if the anchor handling winches or associated loose gear are in good working condition for continued safe use.
9. **Responsible person** means a person appointed by the master or company as defined in SOLAS regulation IX/1, as appropriate, possessing the knowledge and experience required for the performance of duties specified in these Annex.
10. **Certified** means that the anchor handling winches or associated loose gear have been verified and documented as compliant to the satisfaction of the *Register*.
11. **Maintenance** means any activity carried out by a responsible person to keep the anchor handling winches or associated loose gear in good working condition for continued safe use.
12. **Operational testing** means a test carried out by a responsible person to verify the correct functioning of a component or operation of the anchor handling winches and/or associated loose gear.
13. **Load test** means a test in excess of the maximum line pull, carried out in the presence of a competent person in order to check the structural integrity of the anchor handling winches and their attachment to and adequacy of their supporting structure.

14. **Thorough examination** means a detailed assessment carried out by a competent person in order to determine whether or not the anchor handling winches or associated loose gear are in compliance with the applicable requirements of the *Register*.

# 3 ANCHOR HANDLING WINCHES

## 3.1 DESIGN, CONSTRUCTION AND INSTALLATION

### 3.1.1 General

Anchor handling winches and associated equipment should be designed, constructed and installed in accordance with the requirements of *Register* or standards acceptable to the *Register* which provide an equivalent level of safety. In addition to the above, anchor handling should also comply with the additional guidance specified under paragraphs 3.1.2 to 3.1.8 below.

### 3.1.2 Speed control and handling

**3.1.2.1** The anchor handling winches should be capable of hoisting and lowering in a controlled manner, and should be provided with adjustable speed control between the minimum and maximum speeds.

**3.1.2.2** The winch operating controls should be designed to pay out the wire by moving the control lever away from the winch operator and heave in by pulling the control lever towards the operator. All operating controls should be permanently marked with signs indicating their purpose and the operating direction.

**3.1.2.3** The winch operating controls should be of the "hold-to run" type, which will cause the hoisting or lowering motion to automatically stop when the control lever is released by the operator.

### 3.1.3 Tension control

Anchor handling winches should be equipped with tension control to ensure that the system is not overloaded in the event that the anchor being handled gets stuck, entangled or is exposed to similar situations.

### 3.1.4 Overload alarm and monitoring

**3.1.4.1** Winches should be provided with continuous load monitors and an audible and visual overload alarm.

**3.1.4.2** The overload alarm should be programmable for lower levels of load.

### 3.1.5 Control stations

**3.1.5.1** The main control station should be placed in a position on the bridge which has a clear view of the deck area. Operators should be able to visually monitor anchor handling winches and associated equipment and, if the view is obstructed, cameras or video monitoring devices may be used for this purpose.

**3.1.5.2** The anchor handling winch may be controlled from more than one position provided that an arrangement to prevent more than one position from exercising control at any one time is fitted.

**3.1.5.3** Each control station should be provided with:

.1 means for two-way communication with the main control station;
.2 an arrangement to prevent inadvertent actuation;
.3 adequate protection of personnel; and
.4 sufficient illumination

*NOTE The minimum lighting level is at least 320 Lux.*

### 3.1.6 Spooling device

Anchor handling winches should be equipped with remotely operated spooling devices.

### 3.1.7 Emergency release

**3.1.7.1** Anchor handling winches should be designed to facilitate emergency release of the load on the wire in a safe and controlled manner, both under normal as well as dead-ship conditions.

**3.1.7.2** The controls for actuation of the emergency release should be placed at the main control station. Emergency release function may also be available at the local control station.

**3.1.7.3** Emergency release control should be protected against unintentional activation.

**3.1.7.4** The design and operation of the emergency release should take into consideration restrictions on the pay-out speed of the wire due to inertia and any restrictions due to onboard arrangements.

**3.1.7.5** Instructions for the operation of the emergency release should be clearly displayed at the navigation bridge and locally at the winch.

**3.1.7.6** After an emergency release, the complete anchor handling winch system should be inspected for signs of damage or deterioration. Any identified damage or deterioration should be rectified before the anchor handling winch is put back into service.

### 3.1.8 Associated anchor handling equipment

#### 3.1.8.1 Chain stopper

**3.1.8.1.1** Anchor handling vessels should be equipped with chain or wire stoppers (hereafter referred to as chain stoppers).

**3.1.8.1.2** A chain stopper should be equipped with an audible alarm which is activated when the stopper is either being engaged or disengaged.

**3.1.8.1.3** A chain stopper should be equipped with an emergency release that is functional in all conditions, including dead-ship situations.

**3.1.8.1.4** Emergency release of chain stopper should include disengaging of pins and other equipment that may prevent releasing the wire or cause the wire to get stuck/entangled during release.

**3.1.8.1.5** Emergency release of the chain stopper should be designed for remote operation in order to minimize the risk of injury to personnel.

**3.1.8.1.6** The emergency release mechanism of the chain stopper should be protected against unintentional activation.

**3.1.8.1.7** Instructions for the operation of the emergency release should be clearly displayed at the navigation bridge and locally at the emergency release control mechanism.

3.1.8.1.8 After an emergency release, the chain stopper system should be inspected for signs of damage or deterioration. Any identified damage or deterioration should be rectified before the chain stopper is put back into service.

## 3.2 TESTING AND THOROUGH EXAMINATION

### 3.2.1 Commissioning test

**3.2.1.1** For anchor handling winches to which this Annex applies, a commissioning test should be carried out according to the manufacturer's instructions and the requirements of a *Register*, or with applicable national or international standards acceptable to the *Register* and which provide an equivalent level of safety. The commissioning test should include the following:

.1 Function tests at light load to verify the correct working of the winch and its controls over the full operating range.
.2 An overload test to verify the capacity and integrity of the anchor handling winch, the attachment of the winch to ship and the adequacy of the ship's supporting structure.
.3 Test of emergency release and residual holding force in the wire. The test should be performed with the wire attached to an onshore strong point, or an anchor on the seabed or a similar arrangement.
.4 Residual brake holding force after emergency release should be verified by test.
.5 Function test of the whole winch system including static bollard pull test and brake holding capacity test. Where it is not practicable to verify the brake holding capacity by testing, the same may be demonstrated through calculations.

**3.2.1.2** After repairs, modifications or alterations of a major character, anchor handling winches are to be tested in accordance with 3.2.1.1.1, 3.2.1.1.2 and 3.2.1.1.5. If the emergency release system is affected by these repairs, modifications or alterations of a major character, the anchor handling winches are to be additionally tested in accordance with 3.2.1.1.3 and 3.2.1.1.4.

**3.2.1.3** Repairs, modifications or alterations of a major character are those which:

.1 change the rated wire pull of the anchor handling winch;
.2 affect the strength, stability or service life of the anchor handling winch;
.3 affect the primary load bearing structure of the anchor handling winch; or
.4 modify the functionality of the anchor handling winch or any part thereof which may affect its strength or safety or structural integrity.

**3.2.1.4** Anchor handling winches that are not designed for towing do not need to undergo the bollard pull test in 3.2.1.1.5. Functional testing other than the static bollard pull test is still required.

### 3.2.2 Periodical testing

Anchor handling winches and associated equipment should be operationally tested annually and five-yearly according to the manufacturer's recommendation and the requirements or recommendations of a *Register* which is authorised by the Administration in accordance with the provisions of regulation XI-1/1. The annual test should include function tests of all equipment. The *Register* should witness the five-yearly test.

### 3.2.3 Thorough examination

**3.2.1.1** Anchor handling winches and associated equipment should be subject to a thorough examination to the satisfaction of the *Register* during annual surveys required by SOLAS regulations I/7 for passenger ships and I/10 for cargo ships, before re-entering service after any structural repairs or modifications of major character and after load testing.

**3.2.3.2** If on completion of a thorough examination, the competent person considers the anchor handling winch to be unsafe for operation or not in compliance with the applicable requirements of the *Register*, then that anchor handling winch should be taken out of service until any deficiency is rectified to the satisfaction of a competent person. The anchor handling winch should be clearly marked "not to be used" and the status should be recorded as outlined in 3.2.4. While out of service, the relevant actions for inoperative anchor handling winches as outlined under section 5 of these Annex should be followed.

### 3.2.4 Records of testing and thorough examination

Records of thorough examination and testing may be documented in any convenient form, provided each entry includes the necessary information, is clearly legible and is authenticated by the competent person. The relevant classification society or equivalent forms for documenting the thorough examination and testing should be considered for use.

## 3.3 DEMONSTRATION OF COMPLIANCE

**3.3.1** Before being put into use for the first time, anchor handling winches installed on or after 1 January 2026 should be certified by the *Register* in accordance with this Annex requirements with the recommended scope for demonstration of compliance of anchor handling winches comprising the following:

.1 a plan appraisal of the anchor handling winch and foundation connections;
.2 verification of materials;
.3 survey, testing and examination during fabrication;
.4 verification of component certificates including its loose gear; and
.5 testing and thorough examination when installed on board.

**3.3.2** Anchor handling winches installed before 1 January 2026 should be certified by the *Register* in accordance with this Annex requirements no later than the date of the first renewal survey on or after 1 January 2026.

**3.3.3** Existing anchor handling winches with valid certificates under another international instrument acceptable to the *Register* and issued before 1 January 2026 should be considered compliant with this Annex requirements.

**3.3.4** Demonstration of compliance certified as per paragraphs 3.3.1.and 3.3.2 should be recorded in accordance with paragraph 3.2.4.

## 3.4 NAMEPLATE

**3.4.1** Anchor handling winches should be provided with a permanently affixed name plate which should include at least the following information:

.1 details of the manufacturer (name, address);
.2 model name/number;
.3 serial number;
.4 date of manufacture and date of installation;
.5 details of power supply;
.6 details of wire (e.g. length, diameter);
.7 maximum brake holding capacity, metric tons;
.8 maximum line pull, metric tons;
.9 maximum static bollard pull, metric tons;
.10 placeholder for the classification society's surveyor's stamp;
.11 drum size; and
.12 winch speed.

**3.4.2** Detailed specifications of anchor handling winches, such as the following information, can be included in other documentation, e.g. anchor handling winches' operation/maintenance manual on board:

.1 date of manufacture and date of installation;
.2 details of power supply;
.3 details of wire (e.g. length, diameter);
.4 maximum brake holding capacity, metric tons;
.5 maximum line pull, metric tons;
.6 maximum static bollard pull, metric tons;
.7 placeholder for the classification society's surveyor's stamp;
.8 drum size; and
.9 winch speed.

**3.4.3** It should be ensured that the documentation on board can be unambiguously related to the actual winch, i.e. by referring to the unique serial number.

## 3.5 MAINTENANCE, INSPECTION AND OPERATIONAL TESTING

### 3.5.1 General

**3.5.1.1** Maintenance, inspection, operational testing and their respective intervals should be in accordance with the manufacturer's recommendations, industry standards and guidelines or *Register* requirements and recommendations acceptable to the *Register*, considering factors such as the operational profile of the ship and the anchor handling winch.

**3.5.1.2** All anchor handling winches and associated equipment should be considered vulnerable to marine environmental conditions which may lead to significant and accelerated deterioration and corrosion, and the inspection and maintenance regime should be implemented accordingly.

**3.5.1.3** The inspection and maintenance of anchor handling winches and associated equipment may involve working at height, enclosed space entry and other hazards. These hazards should be considered when developing the relevant procedures for undertaking such tasks, including safe access.

**3.5.1.4** Examples of items requiring particular attention may include:

.1 corrosion and damage of primary structural members, such as winch frames and bedplates, drums, foundations and foundation connections, including welds and bolts;
.2 wear, corrosion and damage of mechanical components including hydraulic/pneumatic cylinders, pins, winch drums, chain wheels, wire-spooling and guide systems, clutches, bearings, rollers, shafts, gears, bearings and brakes;
.3 correct setting and functioning of safety, protection and limiting devices;
.4 condition and correct functioning of the anchor handling winch as a whole and, in particular, the piping/hoses, hydraulic arrangements, spooling devices, motors, and electrical and control systems;
.5 corrosion and damage to all means of safe access to the anchor handling winch, including attached maintenance platforms and extensions, with particular attention to support brackets and welds; and
.6 certification and identification of all wires.

**3.5.1.5** Damaged, broken, worn or corroded wires, including their terminations connecting loose gear, should be inspected and discarded according to manufacturers' recommendations, relevant industry standards, international standards or requirements of *Register*.

**3.5.1.6** If on the completion of an inspection, the responsible person considers the anchor handling winch to be unsafe for operation or not in compliance with the applicable requirements of the *Register*, then that anchor handling winch should be taken out of service until any deficiency is rectified to the satisfaction of a competent person. The anchor handling winch should be clearly marked not to be used and the status should be recorded in accordance with 3.2.4. While out of service, the relevant actions for inoperative anchor handling winches as outlined under section 5 of this Annex should be followed.

### 3.5.2 Maintenance manual

**3.5.2.1** A maintenance manual for an anchor handling winch should be provided by the manufacturer. Where maintenance manuals for existing anchor handling winches are not available from the manufacturer, these may be provided by competent third parties.

**3.5.2.2** The maintenance manual should, as a minimum, include the following for each anchor handling winch:

.1 description of the required inspection regime and maintenance schedules specific to the anchor handling winch, checklists and a list of key tools or other items for use when carrying out inspections and maintenance;
.2 instructions for routine repairs/maintenance;
.3 technical maintenance information;

.4 information on recommended lubricants, oil and filter change;
.5 information on bearing maintenance, if applicable;
.6 lists of replaceableparts/components, as well as theinspection/maintenance/replacement procedures for these parts/components;
.7 lists of sources of spare parts;
.8 model forms for records of inspections and maintenance;
.9 operational test procedures, as well as the pre/post-operational test inspection procedures;
.10 list of components requiring particular attention during inspections, as well as the inspection/maintenance procedures for these components;
.11 recommended intervals for replacement and overhaul of components and equipment;
.12 information on the preservation of the coating and corrosion protection system; and
.13 information regarding special inspection and maintenance in cases where the anchor handling winch is not operated for long periods of time.

### 3.5.3 Records of maintenance and inspection

**3.5.3.1** Records of the routine inspection and maintenance of anchor handling winches or their components or parts should be maintained and kept on board.

**3.5.3.2** The records and particulars of inspection and maintenance may be documented in any convenient form, provided each entry contains the necessary information, is clearly legible and is authenticated by a responsible person. Any recommendations of the manufacturer for such inspection and maintenance records should be used.

## 3.6 OPERATIONS

### 3.6.1 General

**3.6.1.1** Personnel operating anchor handling winches and their associated equipment should be qualified, familiarized with the equipment and be authorized by the master.

**3.6.1.2** All personnel involved in an anchor handling winch operation should understand their role during the operation and, in particular, the signals that may be required to commence, coordinate or stop the operation.

**3.6.1.3** Personnel involved in anchor handling winch operations should be equipped with appropriate personal protective equipment for the task.

**3.6.1.4** Anchor handling winch operations should be planned, supervised and carried out so that any identified risks are minimized.

**3.6.1.5** Procedures and instructions should relate to the specific type of anchor handling winch and should be provided in the operations manual.

**3.6.1.6** Due consideration should be given to any limiting operational conditions, such as the ship's motion/inclination, environmental conditions including sea state, maximum wind speeds including wind gusts, ice and snow accretion, as well as limitations of the anchor handling winch, such as maximum line pull, maximum brake holding capacity, etc.

**3.6.1.7** Effective communication should be established among ship's personnel as well as other ships/offshore units involved in the anchor handling winch operation.

**3.6.1.8** Safe means of access to anchor handling winches and the work area should be established. Safe areas for the personnel involved should be available.

**3.6.1.9** When developing plans and procedures for anchor handling winch operations, consideration should be given to prevention of accidents or incidents due to the wires striking any person or other structures in close proximity.

**3.6.1.10** Procedures and measures for the safe operation of anchor handling winches should take account of applicable international and national instruments and best practices for occupational safety and health.

**3.6.1.11** Personnel operating the anchor handling winch should consult the operations manual for any specific instructions related to the anchor handling operations.

**3.6.1.12** Periodic drills for emergency release and emergency brake operation should form part of the planned maintenance schedule.

### 3.6.2 Operations manual

**3.6.2.1** An operations manual for the anchor handling winches should be provided by the manufacturer. Where operations manuals for existing anchor handling winches are not available from the manufacturer, these may be provided by competent third parties.

**3.6.2.2** The operations manual should, as a minimum, include the following for each anchor handling winch:

.1 design, operational and environmental limitations;
.2 compatible loose gear, if any;
.3 safety instructions; and
.4 operating procedures, including emergency procedures, if any.

**3.6.2.3** For anchor handling winches installed before 1 January 2026, their operations manual should be developed with original manufacture, design and build data, and take into account any modifications since installation. Where original data or modification data is not available, the operations manuals should be developed on the current operational procedures and practices.

# 4 LOOSE GEAR

## 4.1 DESIGN AND MANUFACTURING

Loose gear utilized with anchor handling winches to which this Annex apply should be designed and manufactured in accordance with requirements as stated in the *Rules for technical supervision of sea-going ship,s Part 19 – Lifting Appliances*, 2.7 or a recognized code or standard.

## 4.2 PROOF TEST AND THOROUGH EXAMINATION

**4.2.1** All loose gear in use with anchor handling winches and associated equipment to which this Annex applies should have documentary evidence of a proof test and be retested after repairs, modifications or alterations of major character acceptable to the *Register*.

### 4.2.2 Thorough examination

**4.2.2.1** Loose gear should be subject to thorough examination to the satisfaction of the *Register*:

.1 after any proof test; and
.2 annually.

**4.2.2.2** If on completion of a thorough examination, the competent person considers the item(s) of loose gear to be unsafe for operation or not in compliance with the applicable requirements of the *Register*, then that loose gear should be taken out of service until any deficiency is rectified to the satisfaction of a competent person. The loose gear should be clearly marked "not to be used" and the status should be recorded as detailed in sub-section 4.7. While out of service, the relevant actions for inoperative loose gear as outlined under section 5 of these Annex should be followed.

## 4.3 DEMONSTRATION OF COMPLIANCE

**4.3.1** Before being put into use for the first time, the loose gear utilized with anchor handling winches which comply with this Annex requirements should be certified to meet the provisions in section 4.

**4.3.2** The existing loose gear utilized with anchor handling winches and associated equipment to which this Annex requirements apply, with valid certificates under another international instrument acceptable to the *Register* and issued before 1 January 2026, should be considered compliant with S this Annex requirements.

## 4.4 MARKING

**4.4.1** Loose gear should be clearly and permanently marked with its unique identification (serial no.), safe working load (SWL) and any additional marks required for safe use.

**4.4.2** If there is insufficient space for the marking on the loose gear other than the SWL, the omitted information should be included in the certificate or be provided by other suitable means.

## 4.5 OPERATION

The personnel involved in anchor handling winch operations which utilize loose gear should be qualified, familiarized with the equipment and be authorized by the master.

## 4.6 MAINTENANCE AND INSPECTION

**4.6.1** Maintenance and inspections at respective intervals should be in accordance with the manufacturer's recommendations, industry standards and guidelines or classification society requirements and recommendations acceptable to the *Register*, considering factors such as the operational profile of the ship, anchor handling winch and the loose gear.

**4.6.2** All loose gear should be considered vulnerable to marine environmental conditions which may lead to significant and accelerated deterioration and corrosion, and the inspection and maintenance regime should be implemented accordingly.

**4.6.3** Hazards particular to the inspection and maintenance of loose gear should be considered when developing the relevant procedures for undertaking such tasks.

**4.6.4** Loose gear should be inspected by a responsible person before each use.

**4.6.5** Examples of aspects requiring particular attention may include:

.1 wear, corrosion, damage and correct functioning of the loose gear;
.2 damaged, worn or corroded chains, including their terminations;
.3 certification, identification and marking of loose gear; and
.4 physical or chemical degradation, including degradation due to the exposure to the environment.

**4.6.6** If on completion of an inspection the responsible person considers the loose gear to be unsafe for operation or not in compliance with the applicable requirements of the *Register*, then the loose gear should not be used until any deficiency is rectified to the satisfaction of a competent person. The loose gear should be clearly marked "not to be used" and the status should be recorded. While out of service, the relevant actions for inoperative loose gear as outlined in section 5 should be followed.

## 4.7 RECORDS OF INSPECTION, MAINTENANCE, TESTING AND THOROUGH EXAMINATION

### 4.7.1 Records of thorough examination and testing

**4.7.1.1** A record of thorough examination and evidence of proof testing of loose gear should be maintained and kept on board.

**4.7.1.2** Records of thorough examination and testing may be documented in any convenient form, provided each entry includes the necessary information, is clearly legible and is authenticated by the competent person. Forms issued by the *Register* or any equivalent forms for documenting the thorough examination and testing should be considered for use.

### 4.7.2 Records of inspection and maintenance

**4.7.2.1** Records of the routine inspection and maintenance of loose gear should be maintained and kept on bord.

**4.7.2.2** The records and particulars of inspection and maintenance may be documented in any convenient form, provided each entry contains the necessary information, is clearly legible and is authenticated by a responsible person. Any recommendations of the manufacturer for such inspection and maintenance records should be used.

# 5 INOPERATIVE ANCHOR HANDLING WINCHES, ASSOCIATED EQUIPMENT AND LOOSE GEAR

The following actions should be taken by the Master to mitigate risks posed by inoperative anchor handling winches and associated loose gear and wire:

.1 take the inoperative anchor handling winches, associated equipment and wire into account in planning and executing a safe voyage;
.2 prevent the operation of inoperative anchor handling winches and associated loose gear and equipment;
.3 prevent uncontrolled movement of inoperative anchor handling winches or associated loose gear and equipment using appropriate restraining and preventing arrangements, if required;
.4 store inoperative wires and loose gear separately from in-service wires and loose gear and mark it as being inoperative; and
.5 record the particulars of anchor handling winches or loose gear, associated equipment and wire that is inoperative as detailed in paragraph 3.2.4 and/or 4.7.1 until necessary repairs have been completed and it has been tested or proof tested, as necessary, and thoroughly examined.