
Ship Inspection and Audit Techniques

Ship Structural Integrity Inspection

Hull – the primary structural component that provides buoyancy and overall strength to a vessel. The hull is composed of transverse and longitudinal elements that work together to resist hydrostatic pressure, wave loads, and impact forces. In inspection, the hull is examined for deformation, cracking, corrosion, and weld integrity. For example, a mid-ship hull girder may show signs of excessive deflection after a heavy cargo load, indicating possible overstress.

Hull girder – the longitudinal structural system formed by the deck, bottom plating, and internal framing. It acts as a beam that carries bending moments induced by waves and cargo distribution. Inspectors assess the girder by measuring plate thickness, checking for buckling, and evaluating the condition of stiffeners. A common challenge is detecting hidden cracks in the inner layers of the girder where visual access is limited.

Deck – the horizontal platform that forms the upper surface of the hull and supports equipment, cargo, and crew. Decks are typically constructed from longitudinal deck plating supported by deck beams and girders. During inspection, the deck is checked for corrosion pits, deck seam failures, and fatigue cracks, especially near deck-to-hull connections.

Bulkhead – a vertical partition that divides the hull into watertight compartments. Bulkheads are essential for maintaining stability and preventing the spread of flooding. Inspection focuses on the integrity of bulkhead seams, the condition of transverse framing, and the presence of corrosion at the junction of bulkheads with deck and hull plating. A compromised bulkhead, such as one with a cracked transverse frame, can reduce the vessel's survivability in case of hull breach.

Side shell plating – the outermost layer of the hull that forms the sides of the vessel. This plating is subject to external corrosion, impact, and fatigue. Inspectors measure plating thickness using ultrasonic testing and look for signs of blistering, pitting, or delamination. In practice, a vessel operating in tropical waters may develop aggressive under-water fouling that accelerates side shell corrosion.

Bottom plating – the lower portion of the hull that lies beneath the waterline. It experiences the highest hydrostatic pressure and is prone to corrosion, especially from stray electrical currents (electro-galvanic corrosion). Inspection includes checking for coating degradation, cathodic protection system performance, and any signs of plate thinning. A typical challenge is identifying localized thinning caused by stray current without removing the coating.

Stiffener – a structural element, usually a plate or bar, that reinforces hull plating against buckling and local deformation. Stiffeners can be transverse (frames) or longitudinal (stringers). Their condition is verified by measuring dimensions, checking welds, and detecting corrosion at connections. For instance, a longitudinal

stiffener that has lost thickness due to corrosion may compromise the overall buckling resistance of the hull.

Frame – a transverse structural member that provides shape and support to the hull. Frames are spaced at regular intervals and work together with longitudinal members to form a rigid framework. Inspection of frames involves checking for cracks, corrosion, and proper alignment. Misaligned frames can lead to uneven stress distribution, increasing the risk of fatigue failure.

Stringer – a longitudinal stiffener that runs fore-to-aft, often located between decks or within the hull girder. Stringers enhance resistance to longitudinal bending and shear. During inspection, stringers are examined for corrosion, weld quality, and attachment to bulkheads. A broken stringer can significantly reduce the longitudinal strength of the vessel.

Deck plating – the steel plates that form the deck surface. Deck plating must be sufficiently thick to support loads from cargo, machinery, and personnel. Inspection includes thickness measurement, detection of cracks, and evaluation of coating condition. A common issue is deck plating fatigue near hatch coamings where repeated loading occurs.

Coating – the protective layer applied to steel surfaces to prevent corrosion. Coatings may include primers, intermediate paints, and topcoats. The effectiveness of a coating system is assessed by visual inspection for blistering, cracking, and delamination, as well as by measuring coating thickness. Inadequate coating maintenance can lead to rapid corrosion, especially in high-salinity environments.

Cathodic protection – an electrochemical technique used to control corrosion by making the hull a cathode of an electrochemical cell. This is achieved through sacrificial anodes or impressed current systems. Inspectors verify the operation of cathodic protection by measuring potentials, checking anode condition, and confirming that current densities are within the recommended range. Failure of the cathodic protection system is a frequent cause of accelerated hull corrosion.

Weld – the joint that binds metal components together. In ship structures, welds are critical for transferring loads between plates, stiffeners, and frames. Inspection of welds includes visual examination for cracks, porosity, and undercut, as well as non-destructive testing (NDT) methods such as ultrasonic testing or radiography. Poor weld quality can be a primary source of structural failure.

Weld seam – the line where two plates are joined by welding. Seam integrity is essential for maintaining the continuity of the hull. Inspectors assess seam geometry, the presence of reinforcement, and the quality of the weld bead. A common challenge is detecting hidden cracks within the weld root, which may require advanced NDT techniques.

Fillet weld – a type of weld used to join two surfaces at a right angle, typically found at the intersection of plates and stiffeners. Fillet weld quality is evaluated by checking the weld throat size, penetration, and absence of defects. Inadequate fillet welds can reduce the load-carrying capacity of the connection.

Spot weld – a localized weld used to join overlapping plates, often in thin-sheet applications. Spot welds are inspected for proper size, spacing, and lack of cracks. Failure of spot welds can lead to local buckling of plating.

Fatigue – the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. Fatigue is a major concern for ships that experience repeated wave loading and cargo operations. Inspectors look for fatigue cracks, especially at high-stress concentration areas such as hatch coamings, welds, and stiffener junctions. Detecting fatigue damage early requires detailed visual inspection and sometimes NDT methods like magnetic particle testing.

Stress – the internal force per unit area within a material that resists external loads. In ship structures, stress analysis is performed to ensure that stresses remain below allowable limits. Inspectors may compare measured strain (using strain gauges) with calculated stress values to verify structural integrity. Excessive stress can accelerate fatigue and lead to permanent deformation.

Strain – the deformation of a material relative to its original dimensions, often measured as a change in length per unit length. Strain gauges attached to structural members provide real-time data on how components respond to loads. In inspection, strain measurements help validate design predictions and identify areas of unexpected loading.

Allowable stress – the maximum stress that a material can safely sustain under specified conditions, as defined by classification societies or engineering standards. This value incorporates safety factors to account for uncertainties in material properties, loading conditions, and inspection reliability. Inspectors verify that measured stresses do not exceed allowable limits.

Factor of safety – the ratio of the material's strength to the applied stress, providing a margin to prevent failure. A typical factor of safety for ship structures ranges from 1.5 To 2.0, Depending on the component and classification rules. During inspection, the factor of safety is considered when evaluating the significance of observed defects.

Classification society – an organization that establishes technical standards for the design, construction, and maintenance of ships, and conducts surveys to verify compliance. Examples include ABS, DNV, Lloyd's Register, and Bureau Veritas. Inspectors must be familiar with the specific rules and survey requirements of the relevant society, as they dictate inspection frequencies and acceptance criteria for defects.

Survey – a systematic examination of a ship's condition conducted by a qualified surveyor. Surveys can be routine (annual, intermediate), special (pre-delivery, after repair), or condition-based (based on observed deterioration). The survey report documents findings, recommendations, and any required corrective actions.

Non-destructive testing (NDT) – techniques used to evaluate the integrity of a material or structure without causing damage. Common NDT methods for ship inspection include ultrasonic testing (UT), radiographic

testing (RT), magnetic particle testing (MT), and visual inspection (VT). Each method has specific applications; for example, UT is widely used to measure plate thickness and detect internal flaws.

Ultrasonic testing (UT) – an NDT method that uses high-frequency sound waves to detect internal defects and measure material thickness. In ship inspection, UT probes are applied to hull plating to locate corrosion pits, cracks, and to verify that thickness remains above minimum requirements. Calibration of the ultrasonic instrument is essential to obtain accurate readings.

Radiographic testing (RT) – an NDT technique that employs X-rays or gamma rays to produce images of internal structures. RT is particularly useful for detecting weld defects such as porosity, cracks, and incomplete penetration. The method requires strict safety protocols due to radiation hazards.

Magnetic particle testing (MT) – an NDT method that detects surface and near-surface discontinuities in ferromagnetic materials by applying a magnetic field and observing the pattern of magnetic particles. MT is effective for identifying surface cracks in welds and plates, especially in areas where ultrasonic access is limited.

Visual inspection (VT) – the most common inspection technique, involving direct observation of the ship's components. VT is used to identify corrosion, coating failures, deformation, and obvious cracks. Proper lighting, cleaning of surfaces, and use of magnification tools enhance the reliability of visual assessments.

Corrosion – the electrochemical degradation of metal caused by exposure to seawater, oxygen, and other environmental factors. Types of corrosion relevant to ship structures include uniform corrosion, pitting, crevice corrosion, and stress corrosion cracking. Inspectors monitor corrosion rates by tracking thickness loss and evaluating coating performance.

Uniform corrosion – a general, even loss of material across a surface. While it may appear less severe than localized forms, uniform corrosion can lead to significant thickness reduction over time. Regular thickness surveys help detect uniform corrosion before it reaches critical levels.

Pitting corrosion – localized, small-diameter cavities that penetrate into the metal surface. Pits can act as stress concentrators and initiate cracks. Inspection of pitting requires close-up visual examination and often the use of ultrasonic probes to assess pit depth.

Crevice corrosion – corrosion that occurs in confined spaces where the electrolyte becomes stagnant, such as under gaskets, bolts, or in lap joints. Crevice corrosion can be aggressive and difficult to detect. Inspectors need to disassemble components where feasible to examine hidden crevices.

Stress corrosion cracking (SCC) – the growth of cracks caused by the combined influence of tensile stress and a corrosive environment. SCC is a serious concern for high-strength steels used in ship structures. Detection often involves NDT methods like ultrasonic or magnetic particle testing, as the cracks may be surface-breaking but very fine.

Fatigue crack growth – the propagation of a crack under cyclic loading. The rate of growth depends on the stress intensity factor range and material properties. Inspectors track crack length over successive inspections to predict remaining life. In practice, a crack that has reached a critical length may require immediate repair or part replacement.

Residual stress – stresses that remain in a material after it has been subjected to manufacturing processes such as welding, forming, or machining. Residual stresses can affect fatigue performance and may lead to unexpected failure. NDT techniques like X-ray diffraction can measure residual stress, though this is less common in routine ship inspection due to equipment constraints.

Hull deformation – permanent change in the shape of the hull caused by excessive loads, impact, or structural failure. Deformation may be observed as bow-down, sagging, or hogging. Measuring deformation involves using laser scanning, plumb lines, or simple visual references. Significant deformation often indicates that the hull girder has been overstressed.

Hogging – upward bending of the hull's mid-section caused by wave action where the bow and stern are supported by wave crests while the mid-section is over a trough. Hogging induces tensile stress on the deck plating and compressive stress on the bottom plating. Inspection after severe hogging events focuses on the deck and bottom plating for signs of cracking.

Sagging – downward bending of the hull's mid-section when the bow and stern are over a trough and the mid-section is supported by a wave crest. Sagging creates tensile stress on the bottom plating and compressive stress on the deck. Similar to hogging, sagging inspections target the deck and bottom for cracking.

Impact damage – physical damage resulting from collision with another vessel, floating object, or docking structure. Impact damage may manifest as dented plates, cracked frames, or displaced stiffeners. Immediate inspection after an impact event is crucial to assess structural integrity and determine repair requirements.

Hull fracture – a catastrophic break in the hull structure, often resulting from a combination of corrosion, fatigue, and overload. Prevention relies on regular inspection, thickness monitoring, and timely repair of identified defects. Historical cases, such as the Liberty ships, illustrate the consequences of insufficient structural monitoring.

Load line – a marking on the hull indicating the maximum permissible draft under specific conditions, as required by the International Convention on Load Lines. While not a structural term per se, the load line helps inspectors assess whether the vessel is operating within safe loading limits that affect structural stress.

Deadweight tonnage (DWT) – the total weight a ship can safely carry, including cargo, fuel, provisions, and crew. Knowing DWT is essential for evaluating load distribution and its impact on structural stresses. Inspections may involve verifying that cargo stowage plans align with structural capacity.

Structural analysis – the process of calculating stresses, strains, and deflections in a ship's structure using engineering methods such as finite element analysis (FEA). Inspectors may use analysis results to prioritize inspection areas, especially where high stress concentrations are predicted.

Finite element analysis (FEA) – a computational technique that divides a complex structure into smaller elements to predict how it will react to loads. FEA models of a ship's hull girder can identify critical zones that warrant closer inspection. The accuracy of FEA depends on the quality of input data, including material properties and boundary conditions.

Material property – characteristics of a material such as yield strength, tensile strength, and fracture toughness. Accurate knowledge of material properties is necessary for assessing whether a component meets design specifications. In older vessels, material records may be incomplete, posing a challenge for inspectors.

Yield strength – the stress at which a material begins to deform plastically. Structural components are typically designed to operate below the yield strength to avoid permanent deformation. Inspectors must ensure that any observed deformation does not indicate yield has been exceeded.

Ultimate tensile strength (UTS) – the maximum stress a material can withstand before fracture. While ships are not designed to reach UTS under normal operating conditions, knowledge of UTS is useful for evaluating the severity of a discovered crack.

Fracture toughness – a material's ability to resist crack propagation. Materials with high fracture toughness are more tolerant of flaws. In ship inspection, low fracture toughness can make even small cracks dangerous, especially in low-temperature environments.

Temperature effect – the influence of ambient and seawater temperature on material behavior. Low temperatures can increase brittleness, making steel more susceptible to brittle fracture. Inspectors must consider temperature when evaluating the risk of crack growth, particularly for vessels operating in Arctic regions.

Cold-worked steel – steel that has been strengthened through plastic deformation at low temperatures. While it offers higher strength, it may have reduced ductility, affecting crack resistance. Inspection of vessels built with cold-worked steel requires close attention to crack detection.

Weld heat-affected zone (HAZ) – the area of base metal whose microstructure and properties are altered by the heat of welding. The HAZ may experience reduced toughness and increased susceptibility to cracking. Inspectors evaluate the HAZ by reviewing welding procedures and performing NDT on adjacent material.

Weld reinforcement – additional material added to a weld to increase its cross-sectional area and improve load-carrying capacity. Proper reinforcement is required by classification rules for certain critical joints. Lack of reinforcement can be identified during visual inspection of weld profiles.

Weld toe – the junction where the weld bead meets the base metal surface. This area is prone to stress concentration and fatigue cracking. Inspectors often look for cracks initiating at the weld toe, especially in fillet welds.

Weld root – the deepest part of a weld joint, typically at the interface of the two base metals being joined. Root defects, such as lack of fusion, can compromise the strength of the joint. Detection may require radiographic or ultrasonic testing.

Weld pass – each individual application of filler material during a multi-pass welding operation. The number of passes affects the heat input and residual stress distribution. Inspectors review welding records to ensure appropriate pass sequencing for critical joints.

Heat input – the amount of energy supplied to the material during welding, usually expressed in kilojoules per millimeter (kJ/mm). Excessive heat input can increase the HAZ size and promote grain growth, reducing toughness. Monitoring heat input is part of quality control during construction and repair.

Pre-heat – the practice of heating the base material before welding to reduce thermal gradients and prevent cracking. Pre-heat requirements are specified for thicker sections and certain steel grades. Inspectors verify that pre-heat temperatures were achieved and documented.

Post-weld heat treatment (PWHT) – a controlled heating process applied after welding to relieve residual stresses and improve material properties. PWHT is essential for certain high-strength steels. Inspection may involve checking temperature logs and verifying that the treatment was performed according to specifications.

Weld defect – any imperfection in a weld that reduces its performance, such as cracks, porosity, lack of fusion, or undercut. Classification societies classify defects by severity, ranging from minor to critical. Inspectors must accurately identify and classify defects to determine acceptability.

Critical weld – a weld that carries significant loads or is located in a high-stress area, where failure would have severe consequences. Critical welds require more rigorous inspection and tighter acceptance criteria. Examples include welds at hatch coamings, bulkhead junctions, and longitudinal stiffener attachments.

Hatch coaming – the raised frame surrounding a hatch opening, providing structural support and sealing. Coamings are subject to cyclic loading from deck traffic and water pressure differentials. Inspection of hatch coamings often reveals fatigue cracks at the weld toe, requiring timely repair.

Shipyard – the facility where vessels are constructed, repaired, and maintained. Shipyard practices influence the quality of construction and the prevalence of defects. Inspectors may visit shipyards to assess welding procedures, material handling, and quality assurance processes.

Repair welding – the process of restoring damaged or deteriorated structural components by adding new material. Repair welding must adhere to the same standards as original construction, including pre-heat,

heat input control, and post-weld treatment. Inspectors evaluate repair quality by reviewing welding records and performing NDT on the repaired area.

Structural repair – any corrective action taken to restore the integrity of a ship's structure, which may include plate replacement, stiffener reinforcement, or bulkhead rebuilding. Repair planning involves assessing the extent of damage, selecting appropriate materials, and ensuring compliance with classification rules.

Plate replacement – the removal of corroded or cracked steel plates and installation of new plates. This process may involve cutting out damaged sections, fitting new plates, and welding them in place. Inspection after plate replacement focuses on weld quality, plate alignment, and coating continuity.

Stiffener reinforcement – the addition of new stiffeners or the strengthening of existing ones to increase load-carrying capacity. Reinforcement may be required when original stiffeners have deteriorated or when vessel loading has increased beyond original design assumptions.

Bulkhead strengthening – the installation of additional plates, ribs, or reinforcement members to improve the strength of a bulkhead. This is often performed when bulkheads have been identified as weak points during structural analysis.

Survey schedule – a planned timetable dictating the frequency of various inspections, such as annual, intermediate, and special surveys. The schedule is determined by classification society rules, vessel age, operating environment, and past inspection findings. Adherence to the survey schedule is essential for maintaining certification.

Condition-based monitoring (CBM) – a maintenance strategy that uses real-time data from sensors (e.G., Strain gauges, corrosion probes) to assess structural health and schedule inspections only when needed. CBM can reduce unnecessary downtime but requires reliable data acquisition and analysis.

Corrosion probe – a device inserted into a small hole in the hull to monitor the rate of metal loss over time. Probes provide direct measurements of corrosion rate, helping to predict future thickness loss. The data from corrosion probes informs maintenance planning and inspection intervals.

Strain gauge – a sensor that measures deformation of a structural member, typically expressed as microstrain. Strain gauges can be permanently installed on critical locations to monitor stress changes during operation. The collected data helps validate design assumptions and detect abnormal loading.

Hull stress monitoring system – an integrated network of strain gauges, load cells, and data loggers used to continuously track the structural response of a ship. Such systems are common on high-value vessels like offshore support ships, where structural integrity is paramount. Inspectors may review system calibration records and data trends during audits.

Deformation measurement – the process of quantifying changes in geometry, such as hull curvature or deck

levelness. Techniques include laser scanning, photogrammetry, and the use of plumb lines. Accurate deformation measurement is critical for identifying permanent bending or sagging that may affect vessel performance.

Laser scanning – a non-contact method that captures a dense point cloud of a ship's surface, enabling precise measurement of geometry and detection of deformations. Laser scanning data can be compared against design models to identify deviations. The technology is increasingly used for large-scale inspections.

Photogrammetry – the use of photographs taken from multiple angles to reconstruct three-dimensional geometry. Photogrammetry offers a cost-effective alternative to laser scanning for documenting hull condition and detecting deformations.

Plumb line survey – a traditional method where a weighted line is hung from a fixed point to assess vertical alignment of the hull. Deviations from a true vertical indicate hogging or sagging. While simple, the method provides valuable data when combined with more advanced techniques.

Hull plating thickness – the measured distance between the inner and outer surfaces of a hull plate. Thickness is a key indicator of remaining structural life. Thickness measurements are performed using ultrasonic testing, calibrated gauges, or direct measurement after removal of coating.

Minimum allowable thickness – the lowest thickness stipulated by classification societies or regulatory authorities, below which the plate must be repaired or replaced. This value varies by location (e.g., Side shell versus bottom plating) and by vessel type. Inspectors compare measured thickness against this threshold to determine compliance.

Coating system – the combination of primer, intermediate, and topcoat paints applied to protect steel surfaces. Different coating systems are selected based on service environment (e.g., Marine, arctic, high-temperature). Inspection of coating systems includes checking for proper surface preparation, application thickness, and adhesion.

Surface preparation – the process of cleaning and roughening a steel surface before coating application. Proper preparation removes rust, old coating, and contaminants, and creates a profile for coating adhesion. Common methods include abrasive blasting (SA 2.5 To SA 3) and hand sanding. Inspectors verify preparation by visual inspection and, when needed, by measuring surface roughness.

Coating adhesion test – a test that evaluates the bond strength between the coating and the substrate, often performed using pull-off or tape methods. Poor adhesion can lead to coating delamination and accelerated corrosion. Results of adhesion tests are documented in maintenance records.

Coating thickness gauge – an instrument used to measure the dry film thickness of paint systems, typically using magnetic or ultrasonic principles. Regular thickness checks ensure that the coating meets specification and provides adequate protection.

Bottom paint – a specialized coating applied to the hull’s underwater portion, designed to resist fouling, corrosion, and marine growth. Bottom paint may contain biocides and anti-fouling agents. Inspectors assess bottom paint condition by checking for blistering, loss of coverage, and fouling levels.

Above-water paint – coating applied to the hull’s exposed portions, primarily for corrosion protection and aesthetic purposes. Above-water paint is less aggressive than bottom paint but still requires regular inspection for cracking, chalking, and loss of gloss.

Cathodic protection monitoring – the practice of regularly checking the voltage potential between the hull and reference electrodes to ensure the cathodic system is functioning correctly. Monitoring may involve handheld potential meters or permanent data loggers. Deviations from target potentials may indicate anode depletion or system failure.

Galvanic anode – a sacrificial metal element (commonly zinc, aluminum, or magnesium) that corrodes preferentially to protect the hull. Anodes are attached to the hull and gradually dissolve. Inspectors track anode consumption and replace them before they are exhausted.

Impressed current cathodic protection (ICCP) – a system that supplies a controlled electrical current from an external source to the hull, using inert anodes and a rectifier. ICCP allows precise control of protection levels but requires regular maintenance of the power supply and rectifier. Inspectors verify rectifier operation and anode condition.

Stray current corrosion – corrosion caused by unintended electrical currents, often from onboard electrical systems, welding equipment, or shore power connections. Stray currents can create localized aggressive corrosion. Detecting stray current corrosion involves measuring potential differences and inspecting for pitting near electrical equipment.

Hull inspection checklist – a standardized list of items to be examined during a structural survey. The checklist includes visual checks, thickness measurements, coating assessments, weld inspections, and documentation of findings. Using a checklist ensures consistency and completeness of the inspection process.

Inspection report – the formal document that records the findings of a survey, including observed defects, measurements, photographs, and recommended corrective actions. The report may be submitted to the shipowner, classification society, and flag state authorities. Accuracy and clarity in the report are vital for subsequent decision-making.

Defect classification – the process of categorizing identified flaws based on severity, location, and impact on structural integrity. Classification societies typically use categories such as “acceptable,” “repairable,” and “critical.” Proper classification determines whether a defect can be deferred or requires immediate attention.

Repair tolerance – the allowable deviation from design dimensions after a repair. Tolerances are defined by

classification rules to ensure that repaired structures still meet strength requirements. Inspectors verify that repairs stay within these limits.

Non-conformity – any deviation from prescribed standards, specifications, or procedures identified during inspection. Non-conformities must be documented, investigated, and corrected. Persistent non-conformities may lead to increased survey frequency or loss of certification.

Corrective action – the steps taken to address a identified defect or non-conformance. Corrective actions may include repair, reinforcement, replacement, or modification of procedures. Inspectors track corrective actions to ensure they are completed satisfactorily.

Preventive maintenance – scheduled activities aimed at preserving structural condition and preventing the occurrence of defects. Examples include regular coating renewal, cathodic protection checks, and routine thickness surveys. Effective preventive maintenance reduces the likelihood of costly emergency repairs.

Risk assessment – the systematic evaluation of potential hazards associated with structural defects, considering likelihood and consequence. Risk assessments guide prioritization of repairs and allocation of resources. For instance, a small crack in a high-stress area may be deemed high-risk despite its size.

Structural health monitoring (SHM) – the use of sensors, data analytics, and predictive models to continuously assess the condition of a ship's structure. SHM systems can detect early signs of fatigue, corrosion, and overload, enabling proactive maintenance. Implementation of SHM requires integration with ship management systems and thorough validation.

Shipyard quality assurance (QA) – the set of procedures and controls applied during construction or repair to ensure that work meets design specifications and standards. QA includes welding procedure qualification, material certification, and inspection documentation. Inspectors may audit shipyard QA programs to verify compliance.

Welding procedure specification (WPS) – a documented set of parameters that defines how a particular weld is to be performed, including filler material, heat input, shielding gas, and pre-heat requirements. Compliance with the WPS is mandatory for critical welds. Inspectors review WPS records and compare actual welding parameters to ensure conformity.

Welding procedure qualification record (WPQR) – a test record that demonstrates the suitability of a welding procedure for a specific material and thickness. The WPQR includes test coupon results, mechanical property tests, and NDT findings. Classification societies require a valid WPQR for each welding process used on the vessel.

Material test certificate (MTC) – a document provided by the steel supplier confirming the chemical composition and mechanical properties of the material. Inspectors verify that the MTC matches the material specifications used in construction. Missing or inaccurate MTCs can raise questions about compliance.

Design code – the set of rules and standards governing ship structural design, such as the International Association of Classification Societies (IACS) Unified Requirements, ABS Rules, or DNV Rules. Understanding the applicable design code is essential for interpreting inspection findings and determining acceptable limits.

Load case – a specific combination of forces and moments applied to a ship's structure for analysis purposes. Typical load cases include still water loading, wave bending, cargo weight distribution, and impact loads. Inspectors may reference load case results to assess whether observed deformations are within expected ranges.

Service life – the anticipated operational lifespan of a vessel or its components before major overhaul or replacement is required. Service life is influenced by design, material quality, operating environment, and maintenance practices. Inspection data contribute to estimating remaining service life.

Life-extension program – a systematic approach to prolonging a vessel's service life through targeted repairs, upgrades, and enhanced maintenance. Life-extension programs rely on detailed inspection data, structural analysis, and risk assessments to justify continued operation.

Structural fatigue assessment – an evaluation of the vessel's susceptibility to fatigue failure, often performed using fracture mechanics or S-N curve methods. The assessment considers load spectra, material properties, and existing defects. Inspectors may recommend additional monitoring or repairs based on the fatigue assessment outcome.

Fatigue life prediction – the estimation of the number of load cycles a component can endure before a crack initiates, based on material fatigue data and stress analysis. Accurate prediction helps schedule inspections and preventive measures. Variability in loading conditions and material quality introduces uncertainty into predictions.

Fatigue monitoring – the practice of regularly measuring and recording parameters that influence fatigue, such as stress ranges, crack growth rates, and operating profiles. Fatigue monitoring may involve installing strain gauges at critical locations. Data from fatigue monitoring inform maintenance decisions.

Structural repair standard – a set of guidelines defining acceptable repair methods, materials, and workmanship. Classification societies publish repair standards that must be followed to maintain vessel certification. Inspectors verify that repairs adhere to the applicable standard.

Repair welding qualification – the process of demonstrating that repair welds meet required quality and performance criteria, often through test coupons and NDT. Repair welding qualification ensures that the repaired area regains its intended strength.

Inspection frequency – the interval at which specific components are examined, determined by classification rules, vessel age, and operating conditions. For high-risk areas like hatch coamings, inspection frequency

may be increased to semi-annual surveys.

Surveyor qualification – the credentials and experience required for a person to conduct ship structural inspections. Surveyors typically hold certifications from classification societies and must demonstrate proficiency in NDT methods, structural analysis, and regulatory requirements.

Regulatory authority – the governmental body responsible for enforcing maritime safety standards, such as the flag state administration or the U.S. Coast Guard. Regulatory authorities may require additional inspections or impose restrictions based on survey findings.

Flag state – the country under which a vessel is registered. The flag state sets the regulatory framework for vessel inspection, certification, and compliance. Inspectors must be familiar with the flag state's specific requirements, which may differ from those of classification societies.

Port State Control (PSC) – inspections conducted by a foreign port authority to verify that visiting vessels comply with international conventions. PSC officers may focus on structural integrity, especially if previous surveys have identified critical defects. Findings from PSC can lead to detention or mandatory repairs.

International Maritime Organization (IMO) – the United Nations agency responsible for setting global maritime safety and environmental standards. IMO conventions, such as SOLAS and MARPOL, indirectly influence structural integrity through requirements for load lines, watertight integrity, and pollution prevention.

Load line certificate – a document confirming that a vessel's load line marks are in compliance with IMO regulations. While primarily concerned with buoyancy, the load line also reflects structural considerations, as excessive loading can overstress the hull.

Watertight integrity – the ability of a vessel's hull and bulkheads to prevent water ingress. Maintaining watertight integrity depends on the condition of hull plating, bulkhead seams, and hatch closures. Structural inspections often focus on ensuring that watertight compartments remain intact.

Hatch seal – the gasket and locking mechanism used to close a hatch opening, providing a watertight barrier. Inspectors examine hatch seals for wear, compression loss, and proper alignment. Faulty hatch seals can compromise watertight integrity, especially during heavy seas.

Closing mechanism – the hardware that secures a hatch or deck opening, such as bolts, clamps, or hydraulic locks. The condition of the closing mechanism is checked for corrosion, proper torque, and functional movement. Failure of the mechanism may lead to unintended opening under load.

Structural deformation monitoring – the ongoing observation of hull shape changes using fixed reference points, sensors, or periodic surveys. Monitoring helps detect progressive sagging or hogging trends that may indicate overstress or material degradation.

Hull girder stress monitoring – the measurement of stresses within the hull girder using strain gauges or load cells. Data are compared against design stress limits to assess the safety margin. Anomalous stress readings may prompt detailed inspections or load redistribution.

Ship stability – the vessel's ability to return to an upright position after being inclined by external forces. Stability is linked to structural integrity because loss of bulkhead strength or excessive hull deformation can alter the center of gravity and affect stability. Inspectors consider stability implications when evaluating structural defects.

Damage control – the set of procedures and equipment used to mitigate the effects of hull breaches, flooding, or fire.