Regulation of 9 September 2005 No. 1218 concerning the construction and operation of gas-fuelled passenger ships


Chapter 1
General provisions

§ 1 Scope of application

(1) This Regulation and its appendices apply to Norwegian-registered, gas-fuelled passenger ships built on the date of or after the entry into force of this Regulation, and pursuant to:
   a) Regulation of 15 September 1992 No. 695 concerning the construction of passenger ships, cargo ships and barges; or
   b) Regulations of 28 March 2000 No. 305 concerning surveys, construction and equipment of passenger ships engaged on domestic voyages; or
   c) Regulations of 5 January 1998 No. 6 concerning the construction, equipment and operation of high-speed craft used as passenger craft or cargo craft.

(2) This Regulation also applies to ships that are converted to gas-fuelled passenger ships.

(3) For gas-related matters that are not regulated in this Regulation, the following shall apply:
   a) Classified ships shall comply with the DNV rules currently in force for gas-fuelled engine installations or the equivalent rules of another recognized classification society.
   b) Unclassified ships shall comply with the DNV rules currently in force for gas-fuelled engine installations.

Amended by regulation of 29 June 2007 No. 1006 (in force on 1 July 2007).

§ 2 Definitions

For the purposes of this Regulation, the following definitions shall apply:

(1) Accepted: Equipment accepted by the Norwegian Maritime Directorate on the basis of approval or type approval by:
   a) a recognized classification society;
   b) another public or private institution;
   c) another public/private institution specified by name; or
   d) the administration of a country that has ratified the SOLAS Convention.

(2) Recognized classification society: A classification society with which the Ministry has entered into an agreement pursuant to section 41 of the Ship Safety and Security Act:
   a) Det Norske Veritas (DNV)
   b) Lloyd's Register of Shipping (LRS)
   c) Bureau Veritas (BV)
   d) Germanischer Lloyd (GL)
   e) American Bureau of Shipping (ABS)

(3) Built:
   a) the ship is at a stage of construction where the keel is laid; or
   b) the construction of a specific ship can be established as having commenced; or
   c) the parts of the ship that have been put together comprise at least 50 tons or constitute 1% of the calculated weight of the building material, whichever is less.

(4) Semi-confined space: An area where the natural ventilation conditions are notably different from the conditions on open decks due to the arrangement of structures such as decks, flooring, windbreaks or bulkheads so that gas can accumulate.
Design explosion event: An explosion event that represents, in accordance with the defined acceptance criteria, an unacceptable risk, and that consequently serves as a basis for the design and operation of gas-fuelled passenger ships and their preparedness for emergencies, calculated on the basis of the gas cloud that may be formed.

6. DSB: Directorate for Civil Protection and Emergency Planning.

7. Explosion-protected (Ex-protected) electrical equipment: Classification of electrical equipment based on the explosive atmosphere in which the equipment is intended for use.

8. Explosion hazardous space: A space where any gas pipe and equipment that may contain gas in a liquid or gaseous state pass through, or where such gas pipes end, in which there is a risk of a gas leak that may cause an explosion hazardous atmosphere to develop.

9. Explosion pressure relief: Measures taken to prevent the explosion pressure of a container or an enclosed space from exceeding the maximum overpressure the container or space is designed for, by releasing the overpressure through the explosion pressure relief opening.

10. EMC: Electromagnetic compatibility.

11. Gas-fuelled passenger ship: Any ship that is required to have a passenger certificate or passenger ship safety certificate pursuant to the provisions of Chapter VIII of the Act of 9 June 2003 No. 7 relating to Public Control of the Seaworthiness of Ships, etc., and which uses liquid and/or compressed gas as a source of fuel for propulsion and/or power generation.

12. Gas free: To empty, inert and vent bunker tanks and piping to avoid an explosion hazardous atmosphere in gas pipes or tanks. Inerting must be performed with e.g. nitrogen, CO₂ or argon prior to venting.

13. Gas lock: An enclosed space between explosion hazardous and explosion safe areas to prevent the ingress of gas to an explosion safe area.

14. Gas engine room: A room with a gas engine for propulsion and/or power generation.

15. Gas engine: Any engine, turbine or fuel cell fuelled by gas.


17. IMO: International Maritime Organization.

18. Cold box: Gas-tight protection made of stainless steel or equivalent material around pipe and valve arrangements from bunker tanks.

19. LEL: Lower explosion limit.

20. NEK: Norwegian Electrotechnical Committee, the Norwegian national committee of the International Electrotechnical Commission (IEC).

21. Passenger ship: A ship that can carry more than 12 passengers and which is required to have official permission to carry passengers.

22. Reliability/vulnerability assessment: An analysis that evaluates the probability of a functional failure, including an evaluation of any weaknesses of the system/equipment, on the basis of the design of the system/equipment, design calculations, arrangements, operational parameters, etc.

23. Risk: Expression of the danger that an undesired event represents to persons, to the environment or to material property. The risk is expressed by the probability and consequences of an accident.

24. Safety management system: International Safety Management system as described in the ISM Code, which is implemented in the Regulations of 23 December 1999 No. 1529 concerning a Safety Management System for passenger ships.

25. Safety and response system: A system in which the safety and response function shall be activated if an undesired event occurs.


28. Accidents: Uncontrolled events that may entail the loss of human life, personal injuries, environmental damage or the loss of assets and financial interests.

29. Discharge source: Any valve, detachable pipe joint, pipe packing, compressor or pump seal in the gas fuel system.

30. Open deck: A deck that is open on both ends, or is open on one end and equipped with adequate natural ventilation that is effective over the entire length of the deck through permanent openings distributed in the side panels or in the deck above.

Amended by regulation of 29 June 2007 No. 1006 (in force on 1 July 2007).

§ 3

Duties

The company, the master and others who have their work on board shall perform their duties in accordance with the Ship Safety and Security Act and the supplementary provisions laid down in this Regulation.

Amended by regulation of 29 June 2007 No. 1006 (in force on 1 July 2007).
§ 4
Exemptions

(1) The Norwegian Maritime Directorate may, in individual cases and upon written application, grant exemptions from the requirements of this Regulation. There must be special reasons that make the exemption necessary, and it must be justifiable in terms of safety. Exemptions must not contravene international agreements to which Norway has acceded.

(2) The Norwegian Maritime Directorate may upon written application accept alternative solutions to the requirements of this Regulation. Documentary proof through a risk analysis pursuant to § 7, to the effect that alternative solutions maintain a safety level equivalent to the requirements set forth in this Regulation, shall be provided.

§ 5
Safety management system

(1) Any gas-fuelled passenger ship to which this Regulation applies shall have a safety management system that satisfies the requirements of the regulation currently in force concerning a safety management system for passenger ships.

(2) The company shall ensure that a safety management system is established and maintained at the company’s onshore organization and on the individual gas-fuelled passenger ships, and that audits are requested and performed pursuant to the applicable regulation concerning safety management.

§ 6
Documentation

(1) The documentation that is required pursuant to this Regulation is in addition to other documentation that shall be submitted pursuant to the currently applicable documentation lists prepared by the Norwegian Maritime Directorate.

(2) For classed ships, gas-related documentation shall be submitted pursuant to the document list of the classification society in question and shall be approved by the classification society in question prior to submission to the Norwegian Maritime Directorate. For unclassed ships, gas-related documentation shall be submitted to the Norwegian Maritime Directorate pursuant to the documentation list of the DNV.¹

(3) Drawings representing the area classification of explosion hazardous spaces and areas pursuant to § 10 shall be submitted.

(4) A risk analysis shall be prepared for approval by the Norwegian Maritime Directorate as early as possible. The analysis shall be prepared pursuant to the provisions of § 7 and Appendix 1.

(5) The Norwegian Maritime Directorate may require additional documentation and practical tests to verify that the technical arrangements and systems function as intended.

¹ I. Pt. 6, Ch. 13, Sec. 1, C "documentation" and E "operation and maintenance manuals"

§ 7
Risk analysis

(1) A risk analysis shall be performed for the ship pursuant to recognized methods, cf. Appendix 1. The risk analysis shall be performed through the identification of undesired events, an evaluation of the probability that they may arise and the associated consequences.

(2) The risk analysis shall ensure a comprehensive safety assessment of the ship’s gas concept and the selected solutions. The analysis shall be presented as early as possible during the planning phase.

(3) If the ship’s working language is not Norwegian, the Norwegian Maritime Directorate may require the analysis to be prepared in English.

(4) The safety level of a gas-fuelled passenger ship shall at least be equivalent to the safety level of a new diesel-powered ship. This shall be documented by the analysis.

(5) The risk analysis shall cover the ship’s gas-related systems and their influence on the ship and its surroundings in the event of an unwanted event. The analysis shall include the following sub-analyses as described in Appendix 1:

a) concept analysis;
b) emergency preparedness analysis; and

c) explosion analysis.

The risk analysis may be prepared as a combined publication or as separate sub-analyses.

(6) If any changes are made to the design, equipment or procedures during construction or after the ship is placed in service, the risk analysis shall be updated.

(7) For passenger high-speed craft under planning that are to be fuelled by gas, the risk analysis shall be performed with a special focus on hull strength, speed and ingress damage in the event of collision. The safety level shall comply with the fourth paragraph.
§ 8

Requirements for the approval of equipment

(1) Equipment that is required pursuant to this Regulation which has been fitted on board after the entry into force of this Regulation and which is covered by the Regulations of 29 December 1998 No. 1455 concerning marine equipment (the Marine Equipment Regulations), shall be approved by a Notified Body in accordance with the Marine Equipment Regulations and be wheel-marked.

(2) Equipment not covered by the Marine Equipment Regulations shall be accepted.

(3) Electrical equipment shall comply with the relevant provisions of the regulation currently in force concerning electrical equipment (FEU) issued by the DSB. For Ex-protected electrical equipment, refer to § 19.

§ 9

General functional and operational requirements

(1) Any equipment related to gas installations on board shall be designed to withstand a load that corresponds to the ship hitting an unyielding object head on reaching vertically along the entire height of the ship at 2/3 of its operational speed, without resulting in a consequential accident on board because of a gas discharge.

(2) It shall be allowed for a kinetic energy in the event of a collision that shall be no less than:

\[ E = \frac{1}{2}(\Delta + m)v^2 \]

where:

- \( \Delta \) = the ship’s displacement in tons, being the mean value of the light ship weight and the displacement when fully immersed
- \( m \) = additional mass in tons for ships due to trailing masses of water, equals 0.1 \( \Delta \)
- \( v \) = collision speed in metres per second, equals 2/3 of the operational speed, minimum 10 knots (5.1 m/s).

(3) Calculations displaying the ship’s deformation length in the event of a collision must be prepared, in order to calculate the forces gas installations will be exposed to. Such calculations shall be submitted to the Norwegian Maritime Directorate.

(4) In addition, the facility shall be designed to withstand a side collision corresponding to 2g.

(5) For vessels covered by the Regulations of 5 January 1998 No. 6 concerning the construction, equipment, and operation of high-speed craft used as passenger craft or cargo craft, the installations shall be designed to withstand a “collision load” as well as other loads as described in Chapter 4 of the International Code of Safety for High-Speed Craft, adopted by resolution MSC.97(73), as subsequently amended (HSC Code 2000).

(6) Any gas-fuelled passenger ship that is not a high-speed craft shall be equipped with an emergency source of electrical power that satisfies the requirements of Appendix 1, Chapter II-1, Part D of the Regulation of 28 March 2000 No. 305 concerning surveys, construction and equipment of passenger ships engaged on domestic voyages. The emergency source of power shall in addition have the capacity to control a gas ventilation arrangement as well as the ventilation of explosion hazardous spaces. This also applies to passenger ships in trade areas 1 and 2.

(7) For ships in trade area 2 or a lesser trade area,¹ the Norwegian Maritime Directorate may, upon written application, grant exemptions from the requirement for an emergency source of power if the ship has two fully redundant engine rooms for propulsion and power supply, separated by at least two water-proof and fire-proof compartments, the combined length of which equals L/4, provided the generators of each engine room satisfy the provisions of Regulation II-1/D/3.2 to 3.5 of the Appendix to the Regulation mentioned in paragraph (6).

(8) High-speed craft shall satisfy the requirements for emergency power sources of the International Code of Safety for High-Speed Craft, adopted by resolution MSC.97(73), as subsequently amended (HSC Code 2000).

(9) An explosion in an explosion hazardous space shall not:

a) damage the accommodation so that passengers or crew are injured;

b) cause damage to any space other than where the incident occurs;

c) damage the ship in such a way that there is an ingress of water below the main deck, either by direct or progressive flooding;

d) damage life-saving equipment or evacuation arrangements;

e) disrupt the proper functioning of fire-fighting equipment located outside the explosion-damaged space; or

f) damage equipment or systems in other areas which may affect the ship’s propulsion or power supply.

(10) A propulsion engine shall withstand the stress it is subjected to on changing to full speed ahead to full speed astern.

(11) Quality and safety requirements for fuel gas shall at least be equivalent to the requirements set by gas engine suppliers to guarantee 100% engine capacity.

(12) Gas-related equipment and systems that have not previously been used and tested on board ships, as well as new gas fuels with compositions that do not comply with the requirements of the eleventh paragraph, shall have been tested at land-based facilities, in laboratories or in the field, and documentary proof to the effect that such equipment and systems are justifiable in terms of safety for the use on board passenger ships shall be provided. The Norwegian Maritime Directorate may require a risk analysis in this regard.
Chapter 2
Arrangement and design of explosion hazardous spaces and areas

§ 10
Area classification

(1) The following spaces on board the ship shall be classified as Zone 1:
   a) tank spaces/cold box;
   b) ventilation shafts; and
   c) bunkering stations.
(2) The following spaces shall be classified as Zone 2:
   a) gas engine rooms
(3) Other areas shall be assessed in each individual case.¹,²

¹ Pursuant to recommendations of IEC 60079-10.
² For open or semi-enclosed areas on the open deck, the explosion hazardous area shall normally be assumed to extend as follows:
   (1) At least 3 metres from the gas tank safety valve exhaust outlets. The expanse of zones from the outlets of gas tank safety valves shall be assessed especially in relation to tank volume, and shall be stipulated pursuant to submitted documentation of area classification, cf. § 6, third paragraph.;
   (2) 3 metres from gas tank openings, gas pipe flanges, or openings to explosion hazardous spaces.
   (3) 3 metres from ventilation exhaust openings from spaces where any gas compressors, gas pumps or similar equipment are present, and from ventilation exhaust openings from pipe ducting and gas engine rooms.
   (4) 2.4 metres from the outer surface of a gas carrying installation where such a surface is exposed to the weather.

§ 11
Gas engine rooms

(1) Gas engine rooms shall be designed in such a way as to the greatest possible extent minimize the damage to the space and its equipment in the event of an explosion.
(2) If the ship has two or more gas engines for propulsion with associated control systems and engines and power generation systems with appurtenant distribution and wiring, they shall as a general rule be located in separate spaces, so that fire or explosion in any one space does not entail the loss of necessary propulsion, control and electrical power supply for safe operation.
(3) Gas engine rooms shall be constructed with explosion pressure relief leading to a safe area where people or equipment cannot be damaged in the event of an explosion. Explosion pressure relief to adjacent spaces may be accepted.
(4) Gas engine rooms shall be planned with a minimum of electrical equipment. Auxiliary systems, such as pumps, etc. that are connected to gas engines and that do not require placement in the gas engine room, shall be located in spaces that are not explosion hazardous.
(5) Auxiliary systems where gas may leak directly into the system medium (lubricating oil, cooling water) shall be safeguarded against gas leaks and equipped with a gas alarm.
(6) There shall be no direct access from the accommodation to gas engine rooms or other explosion hazardous spaces. If access is via another engine room that is not classified as explosion hazardous, but the room has auxiliary equipment and potential electrical ignition sources, the access shall be safeguarded with a gas lock, the doors of which shall be self-closing.
(7) Unauthorized persons shall be prevented by physical means from accessing explosion hazardous spaces or equipment and arrangements that are connected to the gas system.
(8) Fixed potential mechanical ignition sources¹ are not permitted in gas engine rooms, with the exception of what is required for the gas engines and the associated shaft system.
(9) Bulkheads, hulls and decks in gas engine rooms, and any explosion ducts and pressure relief spaces, shall be designed for the maximum explosion pressure relief that can arise for the solution in question according to the explosion analysis.
(10) The design overpressure that the gas engine room shall withstand, shall be determined on the basis of the explosion analysis. The analysis shall take the geometry and design of the gas engine room into account, including the explosion pressure relief, as well as the air-gas mixture ratio (design explosion event).

¹ Pursuant to recommendations set out by EN 1834-1:2000.
§ 12

Tank spaces/bunker tanks

(1) It shall be possible to close all the inlet and outlet valves on bunker tanks (with the exception of safety valves) from the control room, the bridge and locally. A defect in the control system shall trigger an alarm. In the event of an emergency shutdown, the gas piping system shall be depressurized to the gas mast.

(2) Bunker tanks for compressed gas shall be physically protected against overfilling by an early warning alarm for pressure. The maximum filling pressure shall trigger the alarm and automatically close the filling valves as well as provide pressure relief to the gas mast. The maximum filling shall not exceed the maximum filling pressure according to the gas supplier's and classification society's recommendations.

(3) Bunker tanks for liquid gas shall be physically protected against overfilling by an early warning alarm and an alarm for the maximum level. The maximum level shall trigger an automatic shutdown of the filling valves, as well as provide pressure relief to the gas mast. The automatic shutdown system shall be arranged so that it is always operative when the tank is being filled. The maximum level shall not exceed 95% of the tank volume.

(4) The early warning alarm and shutdown system for bunker tanks for compressed or liquid gas shall be independent of each other.

(5) It shall be possible to empty, purge gas and vent bunker tanks with gas piping systems. Procedures shall be prepared for this. Inerting shall be performed with for instance nitrogen, CO₂ or argon prior to venting to avoid an explosion hazardous atmosphere in tanks and gas pipes, cf. Appendix 2.

(6) When a tank system is non-operational, the other tank systems shall have adequate capacity for the supply of power to the ship and propulsion to a port.

(7) The access to the collecting unit from bunker tanks shall be designed so as to prevent a ccess during normal operation. Access to the collecting unit shall not be permitted until the atmosphere has been checked and determined safe.

(8) The ship’s control stations shall be warned of operational or functional defects in the mechanical ventilation of the collecting unit from bunker tanks and ventilation shafts. This alarm shall apply to fans and airflow, cf. § 14.

(9) Bunker tanks shall be placed as close as possible to the centreline.

§ 13

Bunkering stations

(1) Special safety measures shall be taken when bunkering. The safety measures shall appear from the bunkering procedure that shall be approved by the Norwegian Maritime Directorate.

(2) If several bunkering models will be utilized, such as fuel trucks, tank installations or tankers/lighters, a bunkering procedure for each bunkering model shall be prepared. Matters concerning communication and responsibility shall be clearly defined.

(3) The bunker manifold shall have a remote-controlled valve arrangement, cf. § 12, first paragraph.

(4) The bunkering system shall be protected against operator errors during bunkering. This shall be documented in the risk analysis.

(5) Reference is made to the regulations currently in force laid down by the DSB for such installations.

§ 14

Ventilation

(1) The ventilation system for explosion hazardous spaces shall be separated from the other ventilation on board.

(2) Air intakes and exhausts in explosion hazardous spaces shall be located at a safe distance from each other to prevent mixture of the airflows.

(3) The ventilation capacity of gas engine rooms shall be at least 30 air changes of the room's gross volume per hour. Ventilation failure, reduced air circulation and operational errors shall trigger an alarm.

(4) There shall be negative pressure ventilation in all explosion hazardous spaces. If the gas engine room is located above the main deck, positive pressure ventilation may be accepted as an equivalent solution, following an application.

(5) The air intake in all explosion hazardous technical rooms shall have replaceable filters to prevent dust and moisture.

(6) The ventilation shall function at all temperatures the ship will be operating in.

(7) Ventilation ducts to and from explosion hazardous spaces shall be designed to withstand the maximum pressure build-up in the event of a design explosion event.

(8) Non-explosion hazardous machinery spaces, generator rooms and control panel rooms shall have positive pressure ventilation with an air supply from a gas-safe area. Additionally, assessments shall be made to determine whether non-explosion hazardous spaces adjacent to explosion hazardous spaces shall be provided with ventilation. Ventilation failure shall trigger an alarm.
§ 15

Gas piping arrangement

(1) Ships with one gas engine room shall have two separate supplies of fuel to gas engines therein.
(2) The gas supply to gas engines shall be carried in double piping in gas engine rooms. Other equivalent solutions for the fuel gas piping arrangement, which are part of the gas engine’s fixed arrangement, may be considered by the Norwegian Maritime Directorate in each individual case.
(3) Gas piping shall not be led through other engine rooms. Alternatively, double gas piping may be approved, provided the danger of mechanical damage is negligible, the gas piping has no discharge sources and the room is equipped with a gas alarm.
(4) Gas piping with valve arrangements shall be positioned at least 760 mm from the ship side.
(5) Gas piping shall be protected against mechanical damage and the piping shall be capable of assimilating thermal expansion without developing substantial tension.

§ 16

Gas detection systems

(1) All spaces that are defined as explosion hazardous shall be monitored by a fixed gas detection system. The gas detection system shall be type approved for hydrocarbon gas and use in explosion hazardous spaces.
(2) The number and location of the gas detectors shall be assessed in each individual case by the Norwegian Maritime Directorate. The size, gas sources and ventilation of the explosion hazardous space will form part of the assessment. A combination of line detectors and point detectors may be used in the same room.
(3) Gas detectors shall have alarm limits of 20% and 40% of the LEL, except for gas detectors located in the exhaust duct for the engine-room ventilation, where the alarm limits shall be 5% and 10% of the LEL. Alarm limits of 5% and 10% of the LEL may also be considered in other locations, where the exchange ratio is high and where a quick dilution of the gas concentration can be expected.
(4) Assessments shall be made to determine whether non-explosion hazardous spaces adjacent to explosion hazardous spaces shall be provided with gas detection.

§ 17

Gas engines, regulation and control

(1) It shall be possible to trigger the emergency shutdown of an individual gas engine, as well as the shutdown of the gas supply to gas engine rooms, manually from the bridge, control room, and locally near the gas engine room.
(2) If the gas engine room ventilation is non-operational, the engine’s control system shall prevent the engine from starting. A manual override of the engine-start lockout shall be possible.
(3) Gas engines shall be safeguarded against exceeding the maximum RPM (revolutions per minute) and against re-ignition after the shutdown.

§ 18

Fire protection

(1) The gas engine room shall be fitted with a fixed primary water-based extinguishing system. It shall be possible to activate the system from the bridge, control room and locally from a safe location outside the gas engine room.
(2) Bulkheads and decks surrounding explosion hazardous spaces and ventilation ducts leading to such spaces shall be insulated to a fire integrity of A-60.

§ 19

Electrical systems

(1) Generators in explosion hazardous spaces shall be brushless and insulation monitored by alarms in the event of earth faults.
(2) All electrical equipment, including hand-held/portable equipment, in explosion hazardous spaces and areas, as well as communication equipment, shall be Ex-protected pursuant to the recommendations of IEC 60079-14, in relation to the nature of protection, temperature class and gas group for the zone and gas type in question. The equipment shall be adapted to the exterior environmental conditions to be expected.
(3) Electrical equipment and installations in non-explosion hazardous spaces shall meet the requirements of Regulations of 28 March 2000 No. 305 and the regulation issued by the DSB concerning maritime electrical installations (FME) currently in force. This also applies to passenger ships in trade areas 1 and 2.
(4) The ingress protection degree (IP)² for generators shall comply with the supplier’s recommendations for the area/location in question. Water-cooled generators shall have minimum IP 44, and air-cooled generators minimum IP 22.
(5) There shall be an equalization connection between the bunker supplier and the bunkering station on the ship when a flammable gas/liquid is transferred.
(6) EMC documentation shall appear from a final survey document in accordance with IEC 60533 Annex B. Reference is otherwise made to the regulation issued by the DSB concerning maritime electrical installations (FME) currently in force.
(7) Cable penetrations shall satisfy the requirements regulating the dispersion of gas.

1 Summarized in NEK 420: 2003.
2 IP (ingress protection): Standardized designation for degrees of protection provided by enclosures for electrical equipment and instruments, described, inter alia, in International Standard: IEC 60529.

Chapter 3
Testing and control of gas-related equipment and arrangements before ships are placed in service

§ 20
General provisions
(1) The implementation of testing and control pursuant to this Chapter is the responsibility of the company.
(2) Procedures shall be prepared for inspections and tests of all systems on board, including a plan for the 80-hour long-term test of equipment and arrangements that have not undergone a factory acceptance test pursuant to the rules of the classification society. Data from the long-term test shall be submitted to the Norwegian Maritime Directorate.
(3) All technical gas-related equipment and arrangements shall be tested in accordance with specifications given in drawings documentation and manuals.
(4) It shall be documented that all the requirements of this Chapter have been met before the ship is placed in service.

§ 21
Gas engine tests
(1) The following functions and procedures for gas engine systems shall be tested on board:
   a) engine-start lockout initiated by a ventilation stop in the engine room; and
   b) other safety functions for the gas engine systems and their arrangements.
(2) If the ship has redundant engine rooms, cf. § 11, second paragraph and § 9, seventh paragraph, it shall be tested whether each engine room can maintain manoeuvrability, ventilation and power generation.
(3) “Black-out” tests and tests of the ability of the machinery to withstand maximum load changes. The tests shall be performed for each individual engine and in the relevant operational modes.
(4) The machinery’s regulating control capability at low loads shall be tested to verify critical levels.
(5) A “crash stop” test, changing from full speed ahead to full speed astern.

§ 22
Bunker tanks
(1) Tanks and the associated gas piping and valve arrangements shall be leak tested before they are filled with gas.
(2) Pressure control valves and pressure relief valves shall be tested.
(3) Emergency shutdown initiated by the maximum permitted filling in bunker tanks shall be tested.
(4) It shall be tested whether the valve operations for the shutoff of fuel and venting function as intended.
(5) Bunker tanks shall be pressure tested with water and dried out with hot air or hot nitrogen before they are placed in service. This shall be documented.
(6) Bunker tanks for liquid gas shall be cooled with nitrogen filling before the first bunkering takes place.

§ 23
Gas piping
Leak testing of all gas piping with an inert gas, such as nitrogen, CO₂ or argon, shall be performed.
§ 24  
**Bunkering stations**

(1) The bunkering station’s connections and valve arrangements shall be tested pursuant to the supplier’s procedures upon filling of liquid nitrogen at liquid gas facilities.

(2) Leak tests shall be performed at actual temperatures, and the overfilling protection, emergency shutoff valves in the event of interrupted filling, emptying of bunker tanks and purging of gas shall be tested.

(3) It shall be verified whether the equalization connection between the bunker supplier and the bunkering station/storage tanks complies with the regulations currently in force issued by the DSB.

§ 25  
**Ventilation**

(1) The requirements for the testing and control of ventilation apply to all explosion hazardous spaces.

(2) The design of the ventilation system shall be tested so that gas pockets do not form.

(3) The ventilation capacity shall be measured and controlled.

(4) The ventilation system’s interlocking functions in relation to the engine systems and engine rooms shall be tested.

§ 26  
**Gas detection system**

(1) The gas detection system shall be tested by exposing each individual detector to calibration gas, and by verifying that data has been registered on the right channel and with the right concentration level.

§ 27  
**Electrical systems**

Thermophotography may be required if the Norwegian Maritime Directorate or the DSB considers it to be necessary. This shall be considered prior to the entry into service.

Chapter 4  
**Training**

§ 28  
**Training**

(1) The training described in this Section comes in addition to other training that is required in order to serve on board passenger ships.

(2) The training shall comply with the guidance currently in force prepared by the Norwegian Maritime Directorate.

(3) All crew members constituting the minimum safe manning on a gas-fuelled passenger ship shall have completed the general basic training, Category A, for gas-related safety, operation and maintenance, before assuming duties on board.

(4) The part of the crew that are directly responsible for the operation of gas-related equipment on board shall also receive special training, deck officers, Category B, and engineer officers, Category C.

(5) The training plan/curriculum shall include all three categories (A, B and C), and shall be approved by the Norwegian Maritime Directorate.

(6) Documentation of completed training shall be kept on board.

(7) Crew members who have been away from the ship for a continuous period of more than six months shall complete a specially arranged internal refresher course before they assume duties on board. Documentation of completed internal courses shall be kept on board.
Chapter 5
Operation

§ 29
Maintenance

(1) A special maintenance manual shall be prepared for the gas supply system on board.

(2) The manual shall include maintenance procedures for all technical gas-related installations, and shall comply with the recommendations of the suppliers of the equipment. The intervals for and the extent of the replacement of gas valves shall be established. The maintenance procedure shall specify who is qualified to carry out maintenance.

(3) A special maintenance manual shall be prepared for electrical equipment that is installed in explosion hazardous spaces and areas. The inspection and maintenance of electrical installations in explosion hazardous spaces shall be performed in accordance with IEC 60079-171.

(4) Any personnel that shall carry out inspections and maintenance of electrical installations in explosion hazardous spaces, shall be qualified pursuant to IEC 60079-17, item 4.2.

1 Summarized in NEK 420: 2003 Part 3.

§ 30
Special provisions for maintenance and repair work

(1) Safety functions and procedures as mentioned in § 21, first paragraph shall be tested regularly in accordance with the equipment supplier’s recommendations.

(2) A function test of the gas detector system and control of the gas detector calibration shall be carried out pursuant to the supplier’s recommendations, at least once per year.

(3) To identify minor gas leaks in explosion hazardous spaces, a short shutdown of the ventilation shall be carried out at regular intervals. Alternatively, leak tests may be performed locally with an electronic measuring device.

(4) Before maintenance work is commenced, bunker tanks and associated gas piping systems shall be emptied and purged of gas to the extent necessary. A procedure shall be prepared for shipyard visits which shall include the checklists of Appendix 2.

(5) If the purging of gas shall be carried out at a shipyard, a procedure for such purging of gas shall be prepared in collaboration with the shipyard.

(6) Where hot and cold work shall be carried out in explosion hazardous spaces and areas, the gas piping system of such areas and spaces shall be purged of gas. At least two persons shall be present in an explosion hazardous space and area at all times, and one of these two persons shall have been assigned and instructed to act as fire watch.

(7) A permit shall be issued for hot and cold work in explosion hazardous spaces and areas. The permit shall include information of the time at disposal until the pressure in the bunker tanks rises to the opening pressure for the safety valves. A permit form for hot and cold work in explosion hazardous spaces and areas, cf. Appendix 2, shall be completed in each individual case and approved by the master, the chief engineer officer and/or the company.

Chapter 6
Concluding provisions

§ 31
Entry into force

This Regulation enters into force on 15 September 2005.

Amended by regulation of 29 June 2007 No. 1006 (in force on 1 July 2007, previously § 32).
Appendix 1

Performance of a risk analysis for the construction and operation of gas-fuelled passenger ships

§ 1 Guidelines

1. The analysis shall be carried out through the identification of undesired events and an evaluation of the probability that they may arise and the associated consequences.
2. The analysis shall ensure a comprehensive and overall safety assessment of the entire gas-fuelled ship concept.
3. The analysis shall be performed in accordance with recognized procedures and methods, and with updated software. The guidelines for planning, performing and using risk analyses may, for example, be found in Requirements for risk analyses Norwegian Standard NS 5814. The international standard IEC 60300-3-9 Risk Analysis of Technological Systems provides similar guidelines. The methods that are described in the standards and guidelines deal with the most commonly used risk analysis methods.
4. A co-ordinator should be appointed, who will be responsible for follow-up and communication between the parties in question during the preparation of the risk analysis.

The guidelines for this standard have been published in SINTEF report no. STF75A91021.

§ 2 Methods

1. The risk analysis shall describe the methods and computer programs, as well as the national or international standards that are used.
2. The data sources, data and calculations used for the preparation of the analysis shall be specified and documented.

§ 3 General risk analysis requirements

The risk analysis shall be prepared by an enterprise that can document its knowledge of and experience from the preparation of risk analyses, as well as its knowledge of the ship’s design and technical and operational systems.

1. The risk analysis for gas-fuelled passenger ships shall satisfy the requirements set forth in § 7 of this Regulation and specified in this Appendix, as well as the requirements for the risk analysis mentioned in other Sections.
2. The analysis shall document that any gas explosion shall be controlled so that people are not injured and the equipment and ship are not damaged, cf. § 9 of this Regulation.
3. The scope of the analysis can be reduced if a satisfactory risk level for identical designs and systems with the same gas type has been previously documented to the Norwegian Maritime Directorate.
4. In addition to technical functional failure and similar, the element of human error shall also be included in the analysis.
§ 4

Sub-analyses

1. Concept analysis
   The concept analysis shall include all the ship’s arrangements and systems, and their placement in relation to each other, as well as any redundancy. The analysis shall include a reliability/vulnerability assessment in which human error, structural restrictions, functional and system failures, etc., are taken into account. Any supplier of gas installation equipment and systems on board shall be subjected to such a vulnerability analysis. The results of the entire concept analysis shall act as a guide for the selection of design solutions for ships and equipment, so that the applicable functional requirements are met. The risk reducing and consequence reducing measures shall only include matters relating to gas operation. The measures shall be identified and summarized in the analysis. The description shall indicate which structural and operational measures are required to be implemented to achieve a level of safety that is at least as high as that of diesel-powered ships.

2. Emergency preparedness analysis
   This analysis shall be carried out on the basis of accidents and design explosion events that may arise on board. The ship’s safety functions and safety and response systems and the crew’s positions and duties in an alarm situation shall be used as a basis for the emergency preparedness analysis. The emergency preparedness analysis shall set out any specific emergency preparedness measures related to gas operation. The results of the emergency preparedness analysis shall be incorporated in the ship’s emergency preparedness plan.

3. Explosion analysis
   The explosion analysis shall determine the probability of the formation of an explosive gas mixture, the probability of ignition of the gas, as well as the consequences of any explosions. The analysis shall indicate whether the ship satisfies the requirements set out in § 9, ninth paragraph and § 11, second paragraph of this Regulation. The analysis shall, inter alia, confirm the dimensions of explosion panels/ducts/hatches in explosion hazardous spaces and the strength of explosion hazardous spaces. The maximum pressure shall be calculated on the basis of a design explosion event. The explosion pressure relief to open air or to pressure relief spaces shall be included in the calculation.

Guidelines for a vulnerability analysis are, for example, given in the book System Reliability Theory; Models, Statistical Methods and Applications (ISBN 0-471-4713).
Appendix 2

Preparations for hot and cold work in explosion hazardous spaces and areas

Contents:
1. Checklist for purging of gas
2. Gas measurement results
3. Checklist for equipment and emergency preparedness
4. Permit for hot and cold work

1. CHECKLIST FOR PURGING OF GAS

a) Description of the work to be performed and whether it is hot or cold work:

b) Spaces and gas piping systems to be purged of gas:

c) Measuring instruments last calibrated:

d) Gas concentration measured in space ______ Oxygen content measured in space ______ (Ventilation to be stopped for at least 10 minutes before the space is measured.)

e) Which master gas piping valve(s) are shut off?

f) Gas supply line to engine room purged of gas

g) Gas piping from bunkering station to bunker tank purged of gas

h) Gas piping to gas mast shut-off and purged of gas

i) Bunker tank purged of gas/emptied

j) Area around bunker tank/shaft purged of gas

Comments:

Check box: YES ☐ NO ☐

Place/date _____________ Master _______________ Chief engineer officer _______________
2. GAS MEASUREMENT RESULTS

Gas measurement of explosion hazardous spaces/areas shall be performed before a hot or cold work permit is issued.

<table>
<thead>
<tr>
<th>Explosion hazardous space</th>
<th>% (LEL) HC</th>
<th>% (vol) HC</th>
<th>% oxygen</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

Place/date ___________  Master ___________  Chief engineer officer ___________
3. CHECKLIST FOR EQUIPMENT AND EMERGENCY PREPAREDNESS

Check box:

a) At least two persons are present at all times in explosion hazardous spaces/areas, and at least one of them is assigned and instructed as fire watch
b) Powder extinguishers are in place
c) Fire hose(s) under pressure are ready
d) Gas measuring instrument is in place
e) Approved communication equipment is in place
f) Description of equipment and emergency preparedness from shipyard:

________________________________________________________

Comments:

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

Place/date  Master  Chief engineer officer
4. PERMIT FOR HOT AND COLD WORK IN EXPLOSION HAZARDOUS SPACES AND AREAS

Ship’s name and call signal ____________________________________________________
Company/management company ________________________________________________
Shipyards/place where the work shall be performed _______________________________

Permit applies to hot/cold (delete as appropriate) work in the following space/area:
___________________________________________________________________________
___________________________________________________________________________

This permit for hot/cold work requires the following documents to be provided and signed:

Check box

- a) Checklist for purging of gas
- b) Gas measurement results (shall not exceed 1% of the LEL)
- c) Checklist for equipment and emergency preparedness

NOTE: If this permit is issued without the bunker tanks and associated gas piping systems having been emptied and purged of gas, the validity of this permit shall be restricted to the time available before the opening pressure is reached for the bunker tanks’ safety valves.

Safety valve opening pressure: _____ Time available _____
Permit is valid for: ______ hours from date ______ time _______

Comments:
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

___________________________________________________________________________

Place/date ____________ Master ____________ Chief engineer officer

When the purging of gas is performed at a shipyard, the shipyard’s operations/safety manager shall be familiar with and sign this permit.

Place/date ____________ Shipyard’s manager

GUIDELINES

Training of crews on gas-fuelled passenger ships

Gas-related training
1. Training in general
   The training on gas-fuelled passenger ships is divided into the following categories:
   Category A: Basic training for crew members constituting the minimum safe manning
   Category B: Supplementary training for deck officers
   Category C: Supplementary training for engineer officers
2. Category A
The goal of the Category A training is to provide crew members constituting the minimum safe Manning with a basic understanding of the gas in question as a fuel, the technical properties of liquid and compressed gas, explosion limits, ignition sources, risk reducing and consequence reducing measures, and the rules and procedures that must be followed during normal operation and in emergency situations.

The general basic training required for the basic safety crew is based on the assumption that the crew does not have any prior knowledge of gas, gas engines and gas systems.

The instructors should include one or more of the suppliers of the technical gas equipment or gas systems, alternatively other specialists with in-depth knowledge of the gas in question and the technical gas systems that are installed on board.

The training shall consist of both theoretical and practical exercises that involve gas and the relevant systems, as well as personal protection while handling liquid and compressed gas.

Practical extinguishing of gas fires shall form part of the training, and shall take place at an approved safety centre.

3. Categories B and C

Deck and engineer officers shall have gas training beyond the general basic training. Category B and Category C training shall be divided technically between deck and engineer officers. The company’s training manager and the master shall determine what comes under deck operations and what comes under engineering. This must appear from the curriculum, which shall be approved by the Norwegian Maritime Directorate, as mentioned in § 28 of this Regulation.

Those ordinary crew members who are to participate in the actual bunkering work, as well as gas purging, or are to perform work on gas engines or gas installations, etc., shall participate in all or parts of the training for Category B/C.

The company and the master are responsible for arranging such training based on an evaluation of the concerned crew member’s job instructions/area of responsibility on board.

The instructors used for such supplementary training should be the same as outlined for Category A.

All gas-related systems on board shall be reviewed. The ship’s maintenance manual, gas supply system manual and manual for electrical equipment in explosion hazardous spaces and zones, as mentioned in § 29 of this Regulation, shall be used as a basis for this part of the training.

This Regulation and Appendices 1 and 2 shall be reviewed. Appendix 1 concerning risk analysis shall be emphasized, and the risk analysis and sub-analyses shall be available to course participants during training.

If the ship's own crew will be performing technical maintenance of gas equipment, the training for this type of work shall be documented.

The master and the chief engineer officer shall give crew members constituting the minimum safe Manning on board their final clearance prior to the entry into service of the ship. The clearance document shall only apply to gas-related training, and it must be signed by both the master/chief engineer officer and the course participant.

The clearance document for gas-related training may be integrated in the ship's general training programme, but it must be clearly evident what is regarded as gas-related training and what is regarded as other training.

The training requirements related to the gas system shall be evaluated in the same manner as other training requirements on board at least once a year. The training plan shall be evaluated at regular intervals.