MICROSOFT WORD / V. 2013 / I-ET-3010.00-5425-260-P4X-003_0.DOCX

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SUMMARY

1 SCOPE

This Technical Specification (TS) establishes the mandatory requirements for the design of CO_2 firefighting system that shall be installed in the Offshore Units for firefighting protection for fire at the outlet of vent post ducts and outlet of flammable atmospheric vent ducts. The purpose of this system is the fire extinguishing.

The CO_2 Fire Fighting System supplier shall incorporate all these TS requirements to guarantee the supply and assembly of a reliable, safe and functional firefighting system.

Detailing Design of CO_2 Fire Fighting System shall be developed in accordance with the requirements herein established. Petrobras decides to approve or not any proposal for deviation.

2 ABBREVIATION AND DEFINITIONS

The following abbreviation are applicable:

- CCR: Central Control Room;
- PLC: Programmable Logic Controller;
- CSS: Control and Safety System;
- FGS: Fire and Gas System;
- IACS: International Association of Classification Societies
- I/O: Input/Output of CSS;
- IMO: International Maritime Organization
- P&ID: Piping and Instrumentation Diagram;
- SOS: Supervision and Operation System;
- TS: Technical Specification.

The following definitions are applicable:

- CO_2 header: Piping systems that receives CO_2 gas from flexible hoses connected to the CO_2 storage cylinders and conducts gas to main header.

- Main header: Piping system that interconnects all CO_2 headers and from which gas is conducted to protected system (vent post ducts and atmospheric flammable vent ducts systems).

- Design Concentration: Concentration of extinguishant, including a safety factor, required for system design purposes.

- Rate of Application: The minimum design rate of application shall be based on the quantity of carbon dioxide and the maximum time to achieve design concentration to extinguish fire and minimum time to cooldown the outlet duct.

3 APPLICABLE REGULATION, CODES AND STANDARDS

During the design, installation and tests of CO_2 fixed firefighting system the following rules and guidelines shall be applied. In case of any conflict between them, Petrobras shall be consulted for a definition.

- IMO - SOLAS: Convention for the Safety of Life at Sea – 1974 and Amendments in Force.
- IMO - FSS Code: International Code for Fire Safety Systems.
- NFPA 12: Standard for Carbon Dioxide Extinguishing Systems.
- Brazilian Regulatory Standards NR-17 and NR-37.
- I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING.
- I-ET-3010.00-5400-947-P4X-004 - LIFE SAVING EQUIPMENT.
- Requirements of Classification Society of the Unit, including the Unified Interpretations (UI) and Unified Requirements (UR) issued by IACS

4 TECHINICAL REQUIREMENTS

4.1 General

4.1.1 CO_2 fixed firefighting for vent systems shall be designed, installed, and tested in accordance with NFPA 12 and all IMO-SOLAS applicable requirements.

4.1.2 Location of cylinders, instruments, valves, firefighting equipment, and activation devices of the system shall be according to ergonomic requirements (NR-17 Brazilian Regulatory Standard) in order to ensure a safe and effective system inspection, mounting, maintenance and operation.

4.1.3 All components of the system shall be suitable for operating in a marine environment.

4.1.4 All systems and equipment used for firefighting on Offshore Units shall be approved by a recognized institution, designed and tested according to recognized codes/standards. Certifying requirements for the CO_2 firefighting system materials shall be in accordance with the Classification Society requirements. Each protected system shall have an acceptance teste in full compliance with NFPA 12.

4.2 System Components

4.2.1 The CO_2 fixed firefighting system shall comprise the following components, but not limited to:

- CO_2 local storage cylinders battery.
- CO_2 header, main header, piping distribution system, valves, hoses, connections, and nozzles of discharge.
- Mechanical supports and fixtures.
- Controls, cables, instruments, temperature sensors and signaling devices.

4.3 CO_2 Local Storage Cylinders Battery

4.3.1 The CO_2 local storage cylinders battery shall comprise a high-pressure cylinder's battery, ready for use, sized to provide CO_2 for the protected vent system. It shall be installed in a sheltered place (compartment or locker), with access doors, and not exposed to the environmental conditions. Facilities and space for the cylinders weighting and for the replacement shall be provided.

4.3.2 All the local CO_2 storage cylinders battery covered by this TS shall be provided with backup batteries ready for use. It shall be possible the battery selection (main and backup) through manual key installed near the local CO_2 batteries.

4.3.3 The CO_2 cylinders shall be of seamless steel and constructed to withstand high pressure. The CO_2 cylinders shall be provided with internal dip tubes to ensure that discharge takes place in the liquid phase.

4.3.4 The CO_2 cylinders shall be fitted with valves that, under normal conditions, are held closed by the gas pressure itself. On the top of the valves shall be fitted the discharge heads, whose purpose will be to open the valves to discharge the CO_2. The cylinders shall be supplied only with valves to specific functions, i.e. master cylinders with pilot valves and slave cylinders with slave valves.

4.3.5 Flexible hose and connectors shall be used for linking up the cylinder's valves with the CO_2 header. For each cylinder there shall be a check valve installed on the CO_2 header to avoid a back flow of gas in case of hose rupture or connection failure.

4.3.6 Pilot cylinders shall be used for discharging of cylinders required by the system to be protected. The pilot valves shall be electrically operated from the Unit Control and Safety System (FGS) by an electric solenoid and also to allow the actuation by a hand operated mechanical control, independent of electric power. The electrical actuation of these valves shall be made from manual push buttons integrated in FGS. For the vent protections the actuation by CSS HMIs shall be possible. This control shall be according to NFPA 12 - chapter 9: Marine Systems.

4.3.7 The electric solenoid shall be energized to open the pilot valve. The reset of these valves shall be only locally by means of hand mechanical control and only after switching off power to the solenoid valve.

4.3.8 In each cylinder battery there shall have at least 2 master cylinders with pilot valve.

4.3.9 Whenever directional valves are used, It shall be guaranteed, through interlocking, that the directional valve opens prior to the pilot valve.

4.3.10 A pressure transmitter shall be provided to check pressure increase at the main header and also detect a discharge failure.

4.4 CO_2 Distribution System

4.4.1 The CO_2 distribution system shall comprise a CO_2 header, main header, pilot valves, lockout valves, directional valves (if applicable), distribution piping, fittings and nozzles. The system shall be designed in such a way to assure that the CO_2 will be discharged only into the required protected vent system.

4.4.2 In cases of a CO_2 fixed firefighting system is used to protect more than one vent system, each system to be protected by CO_2 shall be provided with a corresponding directional valve installed at the discharge piping of the system. This valve shall be designed to permit the operation through either a solenoid valve or manual activation (without electrical energy). The solenoid valve shall be energized to open the directional valve.

4.4.3 It shall not be permitted pneumatic activation of directional valves. The electrical signal from FGS shall open the directional valve. Any pneumatic power to open directional valves, even partially, will not be accepted.

4.4.4 Directional valves shall be supplied with limit switch that shall monitor the CO_2 discharge and show indication at SOS HMIs. The reset of these valves shall be only locally by means of hand mechanical control and only after switching off power to the solenoid valve. These limit switches can be used to provide an electrical interlocking described in 4.3.9.

4.4.5 A lockout valve (hand operated valve) shall be provided to avoid a discharge during maintenance of the protected system. The valve shall be provided with means to lock the valve on closed and on open position. During normal operation the valve shall be locked open and, during maintenance shall be locked close.

4.4.6 Lockout valve shall be placed between the main header and discharge nozzles. Whenever directional valve exists, lockout valve shall be located upstream the directional valve and shall have its position, opened and closed, monitored at CSS HMIs.

4.4.7 The CO_2 nozzles installed in the protected system shall be sized and positioned so as to regulate and distribute the application of the CO_2 and to ensure the designed discharge flow rate.

4.5 Control and Signaling Devices

4.5.1 Vent post of cargo tanks, including slop tanks and offspec tanks, and atmospheric flammable vents shall be provided with remote manual local actuation (by pushbutton and mechanical devices) and automatic activation by temperature detectors.

4.5.2 The remote manual actuation (by pushbutton switches), the operation signaling, and the CO_2 firefighting system monitoring shall be executed by FGS system.

4.5.3 For all protected systems, the CO_2 discharge shall be initiated either by remote manual actuation, by means of pushbutton switches located in the vicinity to the protected system and also be initiated by mechanical manual actuation, by means

of clearly identified directional valve and pilot valve levers. All these controls shall be according to NFPA 12 - chapter 9: Marine Systems.

4.5.4 Two pushbuttons shall be provided for each point of actuation to allow manual remote activation. The pushbuttons shall be specified as normally open, press to close, non-retentive type with return by spring. The two pushbuttons shall be installed inside individual enclosures, clearly identified. The enclosure shall be of “lift and push the button” type, colored safety yellow with safety red color stripe, painted diagonally. The electrical cables and related multicables of each push-button shall be independent in order to avoid unpredicted release of CO_2 due to common cause failure.

4.5.5 It shall be foreseen a local reset function at the CO_2 local storage (Local Panel) to permit the restart of the logic for a new discharge after the end of a CO_2 release. It shall be permitted the reset action if only one pushbutton for a protected system is activated. The reset function shall never abort or interrupt the release of CO_2 if this operation has been effectively started (directional and pilot valves opened). The purpose of the reset function is to restart the logic for a new discharge after the end of a CO_2 release or after an eventual undesired operation of only one of the commands pushbuttons

4.5.6 It shall be foreseen signaling at CCR indicating the effective CO_2 discharge. This indication shall be originated from a pressure transmitter, with a logic indication that following has occurred in the same order: no pressure detected, pressure detected, no pressure detected. The pressure transmitter shall be installed downstream of the directional valve, whenever it exists.

4.5.7 All CO_2 system components (signaling, pushbuttons etc.) and the control circuits shall be monitored to check integrity, continuity and short-circuit through PLC I/O cards. Fail signaling shall be activated at CCR (SOS HMIs).

4.5.8 To avoid unpredicted release of CO_2 due to common cause and reduce the risk of a non-intentional release of CO_2 the following shall be followed:

4.5.8.1 The electrical cables and related multicables of each push-button shall be independent and each one directed to different junction boxes. This avoids accidental actuation due to a cable failure such as a rupture or junction box maintenance.

4.5.8.2 The solenoids of the pilot and directional valves shall be connected to exclusive junction boxes, i.e, junction boxes containing only directional valves and other junction boxes containing pilot valves. This prevents accidental actuations of both directional and pilot valves during a maintenance of a junction box.

4.5.8.3 As an extension of item 4.5.8.2, multicables shall also not mix signals for directional valves with signals for pilot solenoid valves, even for different spaces.

4.5.8.4 Cables for directional solenoid valve and the cable of its respective limit switch for open position indication shall be directed to different junction boxes. Since

there is an interlocking between directional valve actuation with its position, both cannot be accidentally actuated during a maintenance of a junction box.

4.5.8.5 The solenoids of the pilot and directional valves and its respective pushbuttons shall be connected to different I/O cards (discrete inputs) to avoid unpredicted release of CO_2 due to common cause failure.

5 ADDITIONAL REQUIREMENTS

5.1 The racks of CO_2 cylinders shall be arranged in such a manner as to allow fast and easy access for operation, inspection, and maintenance of the system, including changing of cylinders.

5.2 The space around the cylinder's racks shall be provided with at least 1.0 m wide and 2.1 m high. Means for weighting and replacing the cylinders shall be provided in the vicinity of the CO_2 cylinders.

5.3 It shall be installed outside of all spaces (compartments or lockers) with local CO_2 storage battery of cylinders an autonomous breathing apparatus, duly conditioned, in each access of the space.

5.4 In case of any line spec break, it shall be located downstream the last possible valve or device that could block the CO_2 flow.

5.5 CO_2 piping shall not be welded to its supports. It shall be fixed by U-Bolt Clamps or similar.

5.6 As a minimum required documentation, certificates approved by Brazilian Maritime Administration (DPC) shall be provided.

6 CO_2 BATTERIES SIZING

6.1 Calculation of CO_2 amount required for firefighting for each protected system covered by this TS shall be according to NFPA 12 Standard. The performance standard of the system shall consider the design concentration, rate of application and duration of discharge to extinguishing fire and cooldown to avoid reignition.

6.2 Duration of discharge: The minimum time duration of CO_2 application shall be increased to compensate for any hazard condition that would require a longer cooling period to ensure complete extinguishment. Where there is a possibility that metal or other material can become heated above the ignition temperature of the fuel, the effective duration of discharge shall be increased to allow adequate cooling time.

6.3 Sizing methodology and design calculation results shall be submitted for Class Society and for Petrobras approvals.

7 ANNEX I - TYPICAL P&ID OF CO2 FIXED FIREFIGHTING SYSTEM FOR VENT SYSTEMS – SNUFFING SYSTEM

Annex I is the typical P&ID of the system that shall be followed on the Design. On the Detailing Design phase this P&ID shall be detailed according to design technical information (Tag numbers, piping, valves, and accessories specifications).

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