Guideline No.F-06 (201510)

F-06 Marine CO_2 Fire Extinguishing System

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Foreword

This Guideline is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

This Guideline is published and updated by CCS and can be found through http://www.ccs.org.cn. Comments or suggestions can be sent by email to ps@ccs.org.cn.

Historical versions and release date:

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Marine CO2 Fire Extinguishing System

1 Application

1.1 The Guideline applies to the fixed marine gas fire-extinguishing system required in 10.4.1.1.1 of Chapter II-2 of the modified Convention on the Safety of Life At Sea (SOLAS) (1974).

1.2 The fixed marine CO_2 fire-extinguishing system applies to the following international navigation ships and places required in Chapter II-2 of SOLAS Convention:

1.2.1 Type-A machinery space for oil burning boiler, oil burning unit, turbine, enclosed steam-engine, and internal combustion engine (10.5 of Chapter II-2 of SOLAS Convention);

1.2.2 Place for storing flammable liquid (10.6.3 of Chapter II-2 of SOLAS Convention);

1.2.3 Cargo space of the passenger ship of 1000 GT or more (10.7.1.1 of Chapter II-2 of SOLAS Convention)

1.2.4 Cargo space of the cargo ship of 2000 GT or more (10.7.1.3 of Chapter II-2 of SOLAS Convention);

1.2.5 Space for carrying dangerous goods (10.7.2 of Chapter II-2 of SOLAS Convention);

1.2.6 Liquid cargo pump room of the liquid cargo ship (10.9.1.1 of Chapter II-2 of SOLAS Convention);

1.2.7 Vehicle and roll-roll shipment space (20.6.1.1 of Chapter II-2 of SOLAS Convention).

2 Basis for approval and inspection

2.1 Chapter II-2 of Amendment (2000) of *Convention on the Safety of Life at Sea* (SOLAS Convention) (1974)

2.2 Chapter 5 of *International Code for Fire Safety Systems(FSS CODE)*

2.3 Amendment of MSC.206 (81) International Code for Fire Safety Systems (FSS CODE)

2.4 Section 2 "*Fixed Gas Fire-extinguishing System*", Chapter 2, Part Six of *Rules for Classification of Sea-going Steel Ship (2009)*.

3 Terms and definitions

3.1 Low pressure carbon dioxide fire extinguishing system:

The fire extinguishing system with carbon dioxide extinguishing agent stored at -18℃~-20℃.

3.2 Filling rate for cylinder: The ratio of the carbon dioxide mass and the volume of the cylinder,

expressed in kg/l.

3.3 Remote control release station: The station used for release control of carbon dioxide extinguishing agent, which is of pneumatic control generally. The remote control release station is provided with two cylinder starting sets, one for starting the selector valve installed on the carbon dioxide pipeline, and the other for starting the carbon dioxide cylinder set.

4 Plans and technical documents

4.1 When applying for CCS type approval, the applicant should submit the following plans and technical documents to the product inspection unit assigned by CCS:

(1) Main components diagram (carbon dioxide cylinder, cylinder valve, release valve, release device, check valve, and three-way valve);

(2) Schematic diagram of carbon dioxide system ;

(3) List of physical and chemical properties of main component materials;

(4) Technical conditions for product inspection and acceptance;

(5) Product type/factory test program;

(6) Instructions on product installation, application, and maintenance.

4.2 When applying for CCS product inspection, the applicant should submit the following plans and technical documents to the plan approval unit assigned by CCS:

(1) Piping layout of the carbon dioxide fire extinguishing system (carbon dioxide cylinder set, and remote control release station)

(2) Calculation book of the fire extinguishing dose of the carbon dioxide fire extinguishing system and pipe network.

5 Materials and components

5.1 The materials and components of the product should be controlled as per relevant requirement of current regulations of CCS.

5.2 The following outsourced parts should also be provided with the CCS marine product certificate, and meet the expected application requirement:

(1) Starting cylinder;

(2) Check valve;

(3) Seamless steel tube and connecting pipe (between the cylinder valve of the carbon dioxide cylinder and the collecting tube).

6 Design and technical requirements

6.1 Control device

6.1.1 Automatic audible and visual alarm device for release of carbon dioxide should be provided in the roll-roll shipment space or the place where any person works, comes in or goes out. The audible alarm should be located at a place so that the alarm can be heard in the whole protected area while all machines are working, and be differentiated from other audible alarms by sound pressure or tune adjustment.

6.1.2 The release alarm should be started automatically, for example, by opening the door of the remote control release station. After the audible and visual alarm is released, sufficient time should be provided for personnel to evacuate from the dangerous area, but in any circumstance, the alarm time should be 20 s ahead of that for carbon dioxide release. Such alarm is not required at common cargo space or those small spaces (for example, the compressor room and paint room) provided with only partial release devices.

6.1.3 Two separate control devices should be provided to release the carbon dioxide to the protected space. One is used to open the release valve (namely, to open the valve on the pipeline used to transport the carbon dioxide gas to the protected space), and the other is used to open the cylinder valve to release the carbon dioxide from the cylinder. The operation sequence should be indicated on the operation manual to guarantee the safe release of carbon dioxide.

6.1.4 Both of the control devices should be placed in the same release box (generally the remote control release station). Prominent mark should be provided on specific position of such box. If the release box is locked normally, the key to open the box should be put into a box with glass panel that is placed at a prominent position near the release box.

6.2 Dosage of the carbon dioxide extinguishing agent

6.2.1 The requirement on the dosage of the carbon dioxide extinguishing agent is as follows:

Requirement on the dosage of the carbon dioxide extinguishing agent Table 1

	Space	**Free carbon dioxide gas volume**
1	Shipment space	It should be at least 30% of the total volume of max. cargo space (unless otherwise specified)
2	Machinery space	It should be at least the bigger of the following two values: (1) 40% of the total volume of the max. machinery space under protection, with calculation range limited to the horizontal plane of the engine room casing. On the above horizontal plane, the horizontal area of the engine room casing is equal to or less than 40% of the horizontal area from the top of the double bottom to the lowest part of the engine room casing;

		(2) 35% of the total volume of the max. machinery space under protection (including the engine room casing).
		For cargo ship of less than 2000 GT, it should be at least the bigger of the following two values: (1) 35% of the total volume of the max. machinery space under protection, with calculation range limited to the horizontal plane of the engine room casing. On the above horizontal plane, the horizontal area of the engine room casing is equal to or less than 35% of the horizontal area from the top of the double bottom to the lowest part of the engine room casing; (2) 30% of the total volume of the max. machinery space under protection (including the engine room casing).
3	If there is an air starting cylinder in the engine room	The free air volume in the cylinder should be calculated as the additional volume of the fire extinguishing agent.
4	For the cargo pump room of the liquid cargo ship with cargo oil flash point of not more than 60℃	It should be at least 45% of the total volume of the cargo pump room (including the volume of the engine room casing).
5	For the cargo pump room of the liquid cargo ship with cargo oil flash point of more than 60℃	It can be treated as the machinery space if the cargo oil pump is placed separately at one space.
6	For the shipment space used to carry motor vehicles with fuel tank containing self-use fuel that can be sealed from an external position	It should be at least 45% of the total volume of such max. shipment space that can be sealed.
7	Closed roll-roll shipment space	It should be at least 45% of the total volume of the max. shipment space.

6.2.2 The volume of the free carbon dioxide gas should be calculated based on 0.56 m^3/kg.

6.3 Carbon dioxide pipeline and layout

6.3.1 The pipeline used to transport the carbon dioxide gas to the protected space should be provided with a release valve, and the space connected with the pipeline should also be marked clearly.

6.3.2 Each connecting pipe between the cylinder valve of the carbon dioxide cylinder and the collecting tube should be provided with a check valve.

6.3.3 The main between the collecting tube and distribution valve chest should be provided with a pressure gage of 24.5 MPa.

6.3.4 The carbon dioxide pipe between the Type-A machinery space and cargo pump room should be sufficient in size and nozzle quantity, so that 85% of the total volume of the carbon dioxide required can be sprayed into the protected space in 2 min.

6.3.5 The diameter of the carbon dioxide pipe between the Type-A machinery space and cargo pump room should be determined according to the total volume of the carbon dioxide to be transported. For the max. volume of carbon dioxide transported via relevant pipe diameter, see Table 2.

6.3.6 The pipeline used for carbon dioxide transportation should be seamless steel tube. For min. wall thickness, see Table 3.

Pipe flow volume and inner diameter **Table 2**

Max. total volume of carbon dioxide flowing in the pipe (kg)	Inner diameter of the pipe (mm)	Max. total volume of carbon dioxide flowing in the pipe (kg)	Inner diameter of the pipe (mm)
60	15	2400	80
100	20	3300	90
135	25	4750	100
275	32	6800	114
500	40	9500	127
1100	50	15250	152
1600	65		

Min. wall thickness of the carbon dioxide pipeline **Table 3**

External diameter of the pipe (mm)	**Pipe wall thickness (mm)**	
	Main in front of the distribution valve chest	**Branch pipe between the distribution valve chest and the protected compartment**
21.3 ~ 26.9	3.2	2.6
30.0 ~ 48.3	4.0	3.2
51.0 ~ 60.3	4.5	3.6

63.5 ~ 76.1	5.0	3.6
82.5 ~ 88.9	5.6	4.0
101.6	6.3	4.0
108.0 ~ 114.3	7.1	4.5
127.0	8.0	4.5
133.0 ~ 139.7	8.0	5.0
152.4 ~ 168.3	8.8	5.6

6.3.7 The diameter of the carbon dioxide pipe connected to the shipment space should not be less than 20 mm. The diameter of the branch pipe connected to the nozzle should not be less than 15 mm.

6.3.8 Compressed air purge tube joint should be provided on the collecting tube or distribution valve chest.

6.3.9 For vehicle space and enclosed shipment space of the roll-on roll-off ship, the pipeline arrangement should guarantee that 2/3 of the carbon dioxide gas can be injected into such space in 10 min.

6.3.10 If the valve arrangement forms a closed pipe section in the pipeline segment, such closed pipe section should be provided with pressure release valve with outlet connected to the exposed deck.

6.3.11 All carbon dioxide pipes, accessories and nozzles in the protected space should be made with materials with melting temperature of higher than 925℃. The pipeline and relevant accessories should be provided with sufficient supports.

6.4 Carbon dioxide container and assembly

6.4.1 Carbon dioxide container should be seamless steel cylinder, with the following contents marked clearly and permanently on the cylinder body:

(1) Container weight, volume, hydraulic test pressure, test date, factory number and inspection mark;

(2) The container body should be printed with prominent color with the words "Carbon Dioxide (or CO_2)", and the mark mentioned above should be printed in white for verification;

6.4.2 The container filling ratio should be in line with the container strength, which should not exceed 0.67 kg/L generally;

6.4.3 The cylinder valve should be provided with a piece of steel or copper pipe with diameter of

10~12mm and oblique section at the tail, which should be extended to the bottom of the container;

6.4.4 The cylinder valve should be provided with a safety diaphragm or other type of safety device, and the safety diaphragm should be broken automatically when the pressure reaches 18.6±1 MPa. Relevant technical test documents should be provided for other type of safety device to prove that the fire extinguishing agent can be released at the same pressure mentioned above;

6.4.5 After the safe diaphragm is broken, the fire extinguishing agent released from the cylinder valve should be led to the atmosphere of the outdoor open deck via the exhaust pipe. However, if the carbon dioxide cylinder storage space is provided with a special power ventilation system, by which ventilation can be carried out at least 6 times per hour and the storage space temperature can not exceed 45℃, as well as temperature alarm device, the above-mentioned exhaust pipe may not be required;

6.4.6 The cylinder valve should be made with cast bronze or other proper materials;

6.4.7 The carbon dioxide cylinders should be grouped as per the protected compartment, and the quantity of those in each group should not exceed 12 if the release device is to be started manually.

6.5 Low-pressure carbon dioxide extinguishing system

6.5.1 The volume of the carbon dioxide in the fire extinguishing system, time for releasing it to the protected space, nozzle position in the protected space and alarm device started by the fire extinguishing system should meet relevant requirements of the high-pressure carbon dioxide system.

6.5.2 The container, refrigeration equipment, control equipment and other equipment of the fire extinguishing system should lie at the space meeting the requirement of the high-pressure carbon dioxide system.

6.5.3 The container and relevant equipment should meet the following requirements:

(1) The rated liquid carbon dioxide should be stored in the container with working pressure of 1.8~2.2 MPa, and the normal liquid filling quantity in the container should not exceed 95% of the container volume, so as to provide sufficient vapor space to allow the liquid to expand at max. storage temperature (such expansion rate is bigger than that obtained at the setting of the pressure release valve);

(2) The design, manufacturing and test of the container should meet the requirement on pressure container in Chapter 6, Part Three of *CCS Rules for Classification of Sea-Going Steel Ships*, and the design pressure adopted should not be less than the setting value of the safe valve. In addition, the following devices should be provided:

① Pressure gage;

② High-pressure alarm: Sound an alarm at the pressure of 2.2 MPa;

③ Low-pressure alarm: Sound an alarm at the pressure of 1.8 MPa;

④ Safety diaphragm;

⑤ Fire extinguishing agent filling branch pipe with check valve;

⑥ Exhaust pipe;

⑦ Liquid carbon dioxide level instrument installed on the container (remote control fluid level gauge should be provided at the place with carbon dioxide release remote control);

⑧ 2 safety valves, the arrangement of which should guarantee that when one valve is closed, the other should turn on the container. The setting pressure of the safety valve should not be less than 2.2 MPa, and the discharge of the each valve should guarantee that the pressure increase in the container should not exceed 20% of the setting pressure when the steam generated is released under ignition. The steam released from the safety release valve should be exhausted to the atmosphere;

6.5.4 Thermal insulation layer should be provided for container filled with carbon dioxide permanently and the delivery pipe, so that the safety valve can be prevented from operating when the ambient temperature is 45℃ and the reset pressure is equal to the starting pressure of the refrigeration equipment in 24h after the refrigeration equipment loses power. The thermal insulation materials and lining should meet the expected application requirement especially with respect to the fireproof performance and mechanical property of the materials, as well as the protection against water vapor intrusion.

6.5.5 The refrigeration equipment should meet the following requirements:

(1) The container should be provided with 2 special completely-independent automatic refrigeration equipment, with each containing one compressor and prime motor, evaporator and condenser;

(2) The refrigeration equipment should meet relevant requirement of CHAPTER FIVE of *CCS Rules for Classification of Sea-Going Steel Ships*, and the refrigeration capacity and automatic control of each equipment should guarantee the temperature of the carbon dioxide container does not exceed the required one when the seawater temperature and ambient temperature reach 32℃ and 45℃ respectively after 24 h of continuous operation;

(3) When one of the refrigeration equipment fails, the other one should be started automatically, which should be provided with local manual control device;

(4) The power of each electric refrigeration equipment should be supplied by the bus bar of the main switchboard via independent feeder;

(5) The cooling water of the refrigeration equipment should be provided at least by 2

cooling water pumps, one of which is used for standby. The standby pump can be used for other purpose, but it should not affect the water supply of other essential equipment on the ship when being used for cooling water supply. The cooling water should be taken from two sea connections, which should be preferably located on the larboard and starboard respectively.

6.5.6 The pipeline and accessories should meet the following requirements:

(1) The pipe, valve and accessories should meet relevant requirement of Chapter Three of *CCS Rules for Classification of Sea-Going Steel Ships*, and the design pressure should not be less than the design pressure of the carbon dioxide container;

(2) If the medium pressure in any pipe section separated by the check valve may exceed the design pressure of any part in such section, safety valve should be provided;

(3) The pipe system design should guarantee that the carbon dioxide can flow to the release nozzle in the form of liquid, and the pressure at the nozzle end should not be less than 1.0 MPa;

6.5.7 Visual and auditory alarm should be provided at the fire control station and in the marine engineer compartment, and triggered in the following circumstance:

(1) The pressure in the container reaches the lower or higher alarm limit specified in 6.5.3(2);

(2) Any refrigeration equipment fails;

(3) The liquid in the container reaches the min. allowable liquid level.

6.5.8 The release control measures of the low-pressure carbon dioxide extinguishing system should meet the following requirements:

(1) The release of the carbon dioxide extinguishing system should be started manually;

(2) If any automatic regulating equipment is provided to release the carbon dioxide to the protected space, such equipment should also be regulated manually;

(3) If such fire extinguishing system protects more than one space, equipment should be provided to control the carbon dioxide release volume, such as the autotimer or accurate fluid level gauge at the control position.

7 Selection of typical samples

During type test, the complete unit, including the carbon dioxide cylinder set, remote control release station, release valve, collecting tube and release alarm device, should be tested. In addition to the complete unit test, each type of component should be selected for function test, tightness test, and strength test.

8 Type test items

8.1 Cylinder valve

8.1.1 Valve body hydraulic intensity test: The test pressure is 24.5 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.1.2 Safety diaphragm bursting test: Bursting pressure is 18.6±1 MPa.

8.1.3 Final assembly hydraulic pressure tightness test: The test pressure is 19.6 MPa, and there is no pressure drop after pressure maintaining for 5 min.

8.1.4 Air cylinder body hydraulic intensity test: The test pressure is 22.1 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.1.5 Cylinder assembly body airtightness test: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.2 Release valve

8.2.1 Valve body hydraulic intensity test: The test pressure is 22.1 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.2.2 Valve assembly body airtightness test: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.2.3 Air cylinder body hydraulic intensity test: The test pressure is 22.1 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.2.4 Air cylinder assembly body airtightness test: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.3 Tee conversion valve

8.3.1 Valve body hydraulic intensity test: The test pressure is 22.1 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.3.2 Valve assembly body airtightness test: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.4 Check valve

8.4.1 Valve body hydraulic intensity test: The test pressure is 11.8 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.4.2 Valve assembly body airtightness test: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.5 Release device

8.5.1 Valve body hydraulic intensity test: The test pressure is 17.7 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

8.5.2 Valve assembly body airtightness test: The test pressure is 11.8 MPa, and there is no bubble generated after being immersed in the water for 1 min.

8.6 Pneumatic remote control release

8.6.1 Low temperature test: It should work normally after a test at -30±3℃ for >0.5 h.

8.6.2 Dry heat test: It should work normally after a test at 55±2℃ for >0.5 h.

8.6.3 Impact test: It should work normally after a test at 50 m/s2 for 11 ms.

8.6.4 Impact test: It should work normally after the axial impacts for 1000±10 times at 50 m/s2 for 16 ms.

8.6.5 Inclining test: It should work normally with longitudinal inclination of ±10° in the front and back for at least 15 min and transverse inclination of ±22.5° in the left and right for at least 15 min.

8.6.6 Sway test: It should work normally with pitching of ±10° for at least 30 min and rolling of ±22.5 for at least 30 min.

8.6.7 Vibration test: It should work normally with frequency of 2~13.2 Hz and displacement of ±1 mm as well as frequency of >13.2~80.0 Hz and acceleration of ±0.7 g.

8.8 Salt mist test: The surface should be free of verdigris after a test at 35±2℃ for 48 h.

8.6.9 Shell waterproof test: It should work normally with IP×2 after a test for at least 10 min.

8.6.10 Function test: The pressure in the starting air cylinder should not be less than 2.47 MPa, the linked audible and visual alarm can be started normally after the remote control release station door is opened, the release handle should be manually turned on steadily and reliably, and the time delay of the delayer should be ≥20 s after the release handle is manually turned on.

8.7 Assembly test

Airtightness test after connection of carbon dioxide cylinder and cylinder valve: The test pressure is 14.7 MPa, and there is no bubble generated after being immersed in the water for 1 min.

Hydraulic pressure tightness test on connecting pipe between cylinder valve and check valve: The test pressure is 17.7 MPa, and there is no pressure drop after pressure maintaining for 5 min.

Collecting tube hydraulic intensity test: The test pressure is at least 11.8 MPa, and there is no

wetting or leakage on the surface after pressure maintaining for 5 min.

8.8 Joint system debugging test

8.8.1 The carbon dioxide storage containers should be filled as required, the starting cylinder should be filled with driving gas, and the pressure should not be less than 2.47 MPa;

8.8.2 After the release handle is opened manually, each part should operate steady and reliably, the linked audible and visual alarm can work normally, the time delay of the delayer should not be less than 20 s, each part and pipe connection should be sealed properly without any leakage or bubble, the release valve should be opened normally, and all the cylinder valves of the carbon dioxide cylinders should be opened normally.

8.8.3 Pipeline unblocking test: All the pipelines and nozzles should be subject to compressed air blow-through test to check whether the carbon dioxide release pipeline is unblocked.

9 Unit/batch inspection

9.1 10% of the safety diaphragms should be selected for bursting test with bursting pressure of 18.6±1 MPa.

9.2 Collecting tube hydraulic intensity test: The test pressure is at least 11.8 MPa, and there is no wetting or leakage on the surface after pressure maintaining for 5 min.

9.3 The cylinder valve, release valve, tee conversion valve, check valve and release device should be subject to hydraulic pressure strength test and airtightness test.

9.4 Joint system debugging test

9.4.1 The carbon dioxide storage containers should be filled as required, the starting cylinder should be filled with driving gas, and the pressure should not be less than 2.47 MPa.

9.4.2 After the release handle is opened manually, each part should operate steady and reliably, the linked alarm can work normally, the time delay of the delayer should not be less than 20 s, each part and pipe connection should be sealed properly without any leakage or bubble, the release valve should be opened normally, and all the cylinder valves of the carbon dioxide cylinders should be opened normally.