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NVIC 09-00 Change 1

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NAVIGATION AND VESSEL INSPECTION CIRCULAR NO. 09-00, Change 1

SUBJ: CH-1 TO NVIC 09-00; CARBON DIOXIDE FIRE EXTINGUISHING SYSTEM SAFETY

1. PURPOSE. This document revises Navigation and Vessel Inspection Circular (NVIC) No. 09-00 and includes the guidance of the Occupational Safety and Health Administration (OSHA) promulgated in Title 29, Code of Federal Regulations (CFR) section 1915.506 of Federal Register dated Wednesday, September 15, 2004 (69 F.R. 55705) to prevent an accidental discharge of an installed carbon dioxide fire extinguishing system within protected spaces on board a commercial vessel during shipyard periods or dockside repairs.

2. ACTION. Officers in Charge, Marine Inspection, are encouraged to bring this Circular to the attention of appropriate individuals in the marine industry within their zones. Coast Guard personnel should become familiar with this circular and apply the safety procedures, as necessary, in their regular work activities while on board U.S. flagged vessels equipped with a fixed carbon dioxide fire extinguishing system. This NVIC is available on the World Wide Web at: http://www.uscg.mil/hq/g-m/nvic/ . The Coast Guard will distribute it by electronic means only.

3. DIRECTIVES AFFECTED. This change to NVIC 09-00 supersedes and replaces enclosure (1) of NVIC 09-00 and adds enclosures (2), (3) and (4).

4. BACKGROUND. NVIC 09-00 was published to provide information on Coast Guard approved installed carbon dioxide fire extinguishing systems. These systems are very effective for the protection of shipboard machinery spaces and cargo holds however, the concentration of carbon dioxide needed to extinguish fires exceeds the level to which humans can be safely exposed. There have been a number of casualties where crew members and inspectors have died as the result of an inadvertent operation or malfunction of an installed

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carbon dioxide system while the system was being serviced or tested. The casualties occurred as a result of varying root causes; however, most of them could have been avoided if the personnel involved were more familiar with the design and operation of approved carbon dioxide systems and had followed pre-planned safety precautions.

5. DISCUSSION. During shipyard periods or dockside repairs the potential of injuries or death due to an accidental discharge of carbon dioxide greatly increases due to the large number of ship's crew and shipyard workers located within the protected spaces who may be unfamiliar with the escape routes of the vessel. Also, repair equipment located throughout the ship could slow evacuation, and the removing of deck plates or moving of machinery may block the direct path to an escape route. The OSHA final rule requires employers to provide a means to prevent a carbon dioxide system onboard a commercial vessel from discharging during a shipyard period or to ensure that employees are trained to recognize system alarms and the location of the evacuation routes. The purpose of this Circular is to alert marine industry personnel of the risks involved with carbon dioxide fire extinguishing equipment:

   a. to recommend basic safety guidelines whenever system testing or servicing are being performed;

   b. to provide guidance on the installation of a positive means to prevent an accidental discharge during shipyard periods or dockside repairs;

   c. to provide guidance to vessel owners and shipyard employers with the training of their personnel to ensure their safety when working in a space protected by a carbon dioxide fire extinguishing system.

6. IMPLEMENTATION. The OSHA guidance for Fire Protection in Shipyard Employment goes into effect on December 14, 2004. Owners and operators of vessels inspected under Title 46 CFR, Subchapter's I, H, K and T equipped with a fixed carbon dioxide fire extinguishing system can either provide a positive means to prevent an accidental discharge from the carbon dioxide system or develop vessel specific training on carbon dioxide systems safety with the shipyard employer during shipyard or dockside repair periods. Internet release authorized.

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Assistant Commandant for Marine Safety,
Security and Environmental Protection

Encl: (1) Information on Carbon Dioxide Fire Extinguishing Systems
(2) Recommendations to isolate Carbon Dioxide Fire Extinguishing Systems
(3) Training Recommendations for Carbon Dioxide System Safety
(4) Safety Procedures for Fixed Carbon Dioxide Extinguishing Systems

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Enclosure (1) to NAVIGATION AND VESSEL INSPECTION CIRCULAR NO 9-00, CH-1

INFORMATION ON CARBON DIOXIDE FIRE EXTINGUISHING SYSTEMS

1. INTRODUCTION. This enclosure provides information on fixed carbon dioxide fire extinguishing systems commonly installed on commercial vessels. The information is general in nature and is intended to educate commercial vessel owners and operators as well as the vessel's crew on how carbon dioxide systems operate and extinguish shipboard fires.

2. HEALTH HAZARDS OF CARBON DIOXIDE. Carbon dioxide is a colorless, odorless gas when it is at atmospheric pressure. When used in fire extinguishing systems, the gas is liquefied and either stored in DOT approved cylinders at a high pressure or in a large refrigerated American Society of Mechanical Engineers (ASME) approved pressure vessel at a lower pressure. At 70° F (21° C), high-pressure carbon dioxide cylinders are under a pressure of approximately 850 psi (5860 kPa). Refrigerated low-pressure systems maintain their supply of carbon dioxide at 0° F (-18° C), at a pressure of 300 psi (2069kPa). When released into the protected space, each pound of carbon dioxide liquid expands to form approximately nine cubic feet (0.254 cubic meters) of carbon dioxide gas at ambient temperature. Carbon dioxide gas is 1.5 times heavier than air of the same temperature and settles at the lower areas of a space after discharge.

Carbon dioxide gas is present in the atmosphere at a concentration of approximately 0.03 %. Shipboard fire extinguishing systems are designed for a minimum concentration of 34 %. If humans are exposed to elevated levels of carbon dioxide, an increase in respiration rate will happen when the concentration of carbon dioxide exceeds 3 %. The increase in breathing rate will continue until a level of approximately 6 to7% is reached. A carbon dioxide concentration of 6 to 7% is considered the maximum level that humans can be exposed to without harmful effects. Exposure to concentrations approaching 9 to10% will cause a rapid decrease in the breathing rate, resulting in unconsciousness and ultimately death.

Because the concentration of carbon dioxide required for a fixed fire extinguishing systems is well above that required to cause serious injury or death to humans, spaces that are protected by such systems must be evacuated before the extinguishing agent is released. Careful attention must also be paid to areas where carbon dioxide could be inadvertently discharged. On marine systems, the agent storage containers are typically located in a separate storage room outside the protected spaces, and the extinguishing gas is piped to the protected spaces. If a malfunction occurs that releases carbon dioxide into the storage room or if a leak occurs in another intermediate area, dangerous concentrations of carbon dioxide could result.

When carbon dioxide is discharged, part of the liquid forms a vapor while some of the liquid converts to snow or dry ice. The temperature of the dry ice is around -110° F (-79° C). If the dry ice comes into skin contact it may result in a "frost-burn" type injury. Personnel should be instructed not to handle any residual snow or dry ice which might remain after a system discharge.

3. SYSTEM TYPES. When fixed carbon dioxide systems are installed and maintained in accordance with their Coast Guard approved design manuals and system drawings, they are considered very safe and reliable. Testing and maintenance of fixed carbon dioxide fire extinguishing systems generally occur during shipyard periods, which increase the potential risk to the personnel working within the protected space(s). Problems have occurred when the systems are improperly tested or are field modified or incorrectly returned to operation after servicing. A summary description of the common type of carbon dioxide systems installed on board commercial vessels is provided below:

Small engineered carbon dioxide systems are commonly found within the engine room of vessels inspected under 46 CFR Subchapter T and K and within paint lockers and other spaces of subchapter I and H vessels. These systems consist of a bottle, a nozzle and a detector that activates the discharge of the carbon dioxide. Most small engineering suppression systems are automatic and are normally activated when the temperature of the space exceeds the setting of a heat detector. The heat detector will open a valve on the container allowing the carbon dioxide to discharge to extinguish the fire.

The large carbon dioxide systems that are installed on board subchapter I and H vessels consist of two manual pull cables or two pressure operated controls from a remote release station. The remote releasing controls function only to release the system. When the controls are operated, the system discharge cannot be terminated from the remote release station. Fixed carbon dioxide extinguishing systems that are less than 300 pounds may only have one manual pull handle to activate the system.

For the safety of the occupants of the protected spaces, a time delay device and a pre-discharge warning siren are required to provide personnel within the space time to evacuate. Both of these devices are located in the system between the manifold and the stop valve and they are activated when the cylinder control is operated. The time delay is a carbon dioxide pressure-operated device that is installed in the manifold to cause a delay of at least 20 seconds before the agent is released. The evacuation time is based on normal vessel operations and is not adjusted to increase the time to evacuate a space occupied by shipyard workers. Note that on vessels where multiple hazards are protected, the warning sirens will only sound in the affected space.

There are two types of large carbon dioxide systems; High Pressure Systems and Low Pressure Systems. The high pressure system consists of a bank of cylinders connected to a common manifold. The common cylinders sizes of the high pressure systems are 50, 75 and 100 pounds. The manifold connects to the discharge piping and nozzles in the protected space. These systems are generally installed for the protection of spaces such as paint lockers, generator rooms, main and auxiliary machinery spaces and cargo holds.

On high pressure systems, one remote control operates the discharge heads on the pilot cylinders. Most systems have two pilot cylinders that provide the primary gas pressure to release the remainder of the cylinders connected to the manifold. Operation of the remote release causes the discharge of the carbon dioxide in the pilot cylinders into the manifold. The pressure builds up in the manifold and backfeeds into the other connected cylinders, causing their discharge.

There is no other way to release the main cylinder bank. The manifold holds the carbon dioxide until the other remote release is operated to open the manifold stop valve. When the stop valve is opened, the agent in the manifold is released into the discharge piping. The normally closed stop valve is located on the discharge side of the cylinder manifold. Both manual controls must be operated to discharge the system. Thus, if one control is accidentally operated the carbon dioxide may fill the manifold, but will not pass the normally closed stop valve.

On systems where more than one space is protected by a common system, multiple stop valves or selector valves are installed on the manifold to admit the agent to the protected spaces. When the system controls are operated, one discharges the cylinders into the manifold, and the other opens only the stop valve to the space where the fire is located. The stop valves for the unaffected spaces remain in the closed position to prevent the inadvertent discharge of carbon dioxide into these areas.

There are many variations between manufacturers in the design of their high-pressure systems and approved releasing controls. Some systems use only pull cables, which mechanically open the agent pilot cylinders, while others may use remote pressure operated controls, where gas pressure from small releasing cylinders cause the pilot cylinder valves and system stop valve to open. Almost all systems use two main agent cylinders as pilot cylinders. The pilot cylinders are operated by direct connection to the remote releasing controls. The pilot cylinders and stop valves must also be capable of local manual control in the event the remote controls do not function properly. The remainder of the cylinders connected to the manifold can only be released by the pilot cylinder gas pressure backfeeding from the manifold.

The low pressure system consists of a large storage tank that is kept at 0° F by a refrigeration system. A manually operated tank shutoff valve and a master valve are installed on the discharge manifold. The tank shutoff valve is normally locked open except during system servicing. The master valve is normally closed and is operated by the remote manual release stations. One or more selector or stop valves are installed in the discharge piping downstream of the master valve. The selector valves direct the carbon dioxide flow into the correct protected spaces. Each selector valve is operated by a remote manual release control. Low pressure systems have two manual controls at each remote release station. One control opens the master valve, permitting carbon dioxide pressure to flow into the manifold up to the selector valves. Operation of the second control typically supplies pressure to the warning sirens in the affected space, pressure operated switches to stop ventilation fans and fuel pumps and the pre-discharge time delay.

After the time delay cycle is completed, the gas pressure is then applied to the operating mechanism of the selector valve, causing it to open and discharge carbon dioxide into the protected space. Because low-pressure systems are usually designed for the protection of multiple spaces, the quantity of agent discharged will vary between the protected spaces.

The pneumatic timer for each selector valve also includes a discharge timer which keeps the selector valve open for a pre-determined length of time and then automatically closes the selector valve. To permit discharge of the system in case of failure of the normal control devices, both the master valves and the selector valves are equipped with devices which by-pass the normal operating mechanisms and directly cause discharge of carbon dioxide into the protected space. Over the years, various control arrangements have been used for low pressure systems. Many variations can be found still in service; it is therefore essential for the service technicians to fully understand the operation of the system before beginning work.

Enclosure (2) to NAVIGATION AND VESSEL INSPECTION CIRCULAR NO 9-00, CH-1

RECOMMENDATIONS TO ISOLATE CARBON DIOXIDE FIRE EXTINGUISHING SYSTEMS

1. INTRODUCTION. The OSHA Final Rule provides vessel owners and operators and shipyard employees with two methods to protect the safety of the shipyard workers and vessel crew members from an accidental carbon dioxide extinguishing system discharge during a shipyard or dockside maintenance period. The first method is to physically isolate the carbon dioxide system or to use other positive means to prevent a system discharge. The second method is for the employer to ensure that the employees (shipyard workers and contractors) are trained to recognize the discharge alarms and the location of the escape routes from the each space protected by an extinguishing system. This enclosure provides information on how a vessel owner and operator can install a positive means to isolate a carbon dioxide system to meet the OSHA requirement.

For the purpose of meeting the OSHA requirement the Coast Guard will accept the installation of an isolation valve as a positive means to isolate a fixed carbon dioxide system during a shipyard or dockside maintenance period. The isolation valve is to be a type which a vessel crew member can easily determine if the valve is open or closed. This type of valve could either be a butterfly valve, ball valve, a rising stem gate valve or other type of valve that has a visual means to identify if the valve is open or closed. The valve has to have a means to secure it in both the open or closed position. The isolation valve may be preferable to other methods of securing the system especially where operation of only a single valve or handle causes a release of carbon dioxide. In addition, the valve provides a quick method of returning the system to operation if it is needed in response to a fire. The Coast Guard will consider other methods of isolating a system that will protect against an accidental discharge and enable the vessel's crew quickly return the system to operation without the use of tools other than a wheel wrench.

For a fixed carbon dioxide extinguishing systems that requires the operation of two valves or pull handles to activate a discharge the system can be secured with the installation of a method to lock and secure the pull handles or valve handles to prevent their operation will be acceptable. For this type of system that have both a local and remote control stations all means to activate a discharge must be provided with a method for locking and securing. The means of locking and securing the valves or pull handles must be designed to allow a quick method of returning the system to operation if needed for a fire and prevent an accidental discharge.

2. HIGH PRESSURE SYSTEMS. For vessels that have high pressure fire extinguishing systems the isolation valve will be installed in the discharge piping downstream of the pilot and stop valves. The isolation valve will be located within the carbon dioxide storage locker. For automatic carbon dioxide extinguishing systems for the paint locker, emergency generator space or any space protected by an automatic carbon dioxide system the isolation valve will be located in the discharge pipe immediately after the cylinders.

A copy of the key used to secure/un-secure the lock on the isolation valve or the pilot and stop valve handles will be located next to or as close as possible to the valve or control station in a break glass type enclosure. The break glass type enclosure will be clearly marked "CO2 System Lock Key". Vessel fire plans are to be updated to show the location of the isolation valve and the break glass type enclosure.

3. LOW PRESSURE SYSTEMS. For low pressure systems the tank's stop valve can be used to isolate the system provided the crew can easily determine if the valve is open or closed and it can be secured in both the open or closed position. If the existing stop valve cannot accomplish that then it will be replaced by a valve which can or an isolation valve will be installed on the discharge side of the system after the tank's stop valve. This type of valve could either be a butterfly valve, ball valve, a rising stem gate valve or other type of valve that has a means to identify if the valve is open or closed. The valve has to have a means to secure it in both the open or closed position.

A copy of the key used to secure/un-secure the lock on the isolation valve or the stop and manifold valves will be located next to the valve or control station in a break glass type enclosure. The break glass type enclosure will be clear marked "CO2 System Lock Key". Vessel fire plans are to be updated to show the location of the isolation valve and the break glass type enclosure.

4. SMALL-ENGINEERED SYSTEMS. This type of carbon dioxide fire extinguishing system is not large enough to incorporate an isolation valve. While these systems are much smaller than the systems found on the larger commercial vessels they can be just as dangerous if an accidental discharge occurs. It is recommended that owners and operators of vessels with this type of extinguishing system have a service technician temporarily disconnect and remove the carbon dioxide bottle from the system during a shipyard period.

5. PLAN REVIEW. All updated plans for carbon dioxide extinguishing systems are to be submitted in accordance with the Marine Safety Center plan submittal process.

6. INSTALLATION TESTING. Each system must be approved for operation by the cognizant Officer in Charge, Marine Inspections at the local Coast Guard Marine Safety Office, Marine Safety Unit, Activity or Sector.

Enclosure (3) to NAVIGATION AND VESSEL INSPECTION CIRCULAR NO 9-00, CH-1

TRAINING RECOMMENDATIONS FOR CARBON DIOXIDE SYSTEM SAFETY

1. INTRODUCTION. Per the OSHA requirements for the hazards of fixed extinguishing systems on board vessels the employer must either physically isolate the system or provide training to employees (shipyard workers and contractors) so they are aware of the dangers of a carbon dioxide system as well as the discharge alarms and escape routes of the space. This enclosure provides recommendations for owners and operators of vessels that do not have a fixed extinguishing system isolation valve to help ensure that shipyard employees and contractors are aware of the dangers of a carbon dioxide system, know to evacuate when a discharge alarm is activated and know the location of escape routes.

2. TRAINING RECOMMENDATIONS. Both training and planning are very important aspects to preventing an accidental discharge of carbon dioxide. Most accidents related to the testing and servicing of carbon dioxide systems are attributable to personnel errors. It is therefore critical that all persons on board a vessel with a carbon dioxide extinguishing system are fully knowledgeable in its operation, the potential dangers and the escape routes from the protected spaces. The following outlines the basic safety information the vessel representative is to provide to the shipyard employer or contractors to facilitate the training of the shipyard workers and contractors on carbon dioxide safety prior to any start of work:

- Carbon Dioxide Systems – A description of the type of system installed on board the vessel (high pressure or low pressure system). List the spaces within the vessel that are protected by a carbon dioxide system. A description of the safety precautions to prevent an accidental discharge including if the system has or does not have an isolation valve installed.

- Carbon Dioxide Discharge Alarms – The type of sound a discharge alarm makes to help avoid confusion among the shipyard workers and contractors if an alarm sounds.

- Evacuation – The safety information will include the amount of time shipyard workers and contractors will have to evacuate the space once the Carbon Dioxide Discharge Alarm sounds. The brief will also inform the shipyard workers and contractors on where they should evacuate to be safe from the affects of the carbon dioxide.

- Escape Route – Due to the different internal arrangements of commercial vessels the safety information should include the location of all of the escape routes from each of the protected spaces.

- Training Verification – The vessel's representative and the shipyard representative will coordinate the documentation of the training of each of the shipyard workers and the contractors working on board the vessel.

Enclosure (4) to NAVIGATION AND VESSEL INSPECTION CIRCULAR NO 9-00, CH-1

SAFETY PROCEDURES FOR FIXED CARBON DIOXIDE FIRE EXTINGUISHING SYSTEMS

1. INTRODUCTION. This enclosure contains recommended procedures to protect the safety of the vessel's crew and the shipyard personnel from an accidental discharge. Located at the end of this enclosure are safety check lists for the testing and servicing of carbon dioxide systems. Vessel masters, port engineers and marine inspectors are encouraged to utilize these safety check lists to help prevent an accidental discharge.

2. SHIPYARD AND DOCKSIDE MAINTENANCE PERIOD. The isolation valve will always be closed and secured during a shipyard or dockside maintenance period. The valve will be closed and secured by a designated vessel officer or vessel representative who is familiar with the system. A log book entry will be made in the vessel's log book noting the time, date and reason why the isolation valve for the extinguishing system was closed. A "lock out" tag will be affixed to the carbon dioxide extinguishing control station noting the status of the system. The valve will be open and secured open at the end of the shipyard period or during ship trials by a designated vessel officer or vessel representative. After the valve has been opened a note in the log book noting the time and date the valve was opened will be made. In addition the "lock out" tag will be removed from the carbon dioxide extinguishing control station.

Pull handle locks will always be secured and locked during a shipyard or dockside maintenance period. They will be closed and secured by a designated vessel officer or vessel representative who is familiar with the system. A log book entry will be made in the vessel's log book noting the time, date and reason why the pull handles for the extinguishing system were locked. A "lock out" tag will be affixed to both the local and the remote carbon dioxide extinguishing control stations noting the status of the system. The system will be open at the end of the shipyard period or during ship trials by a designated vessel officer or vessel representative. After the system has been opened a note in the log book noting the time and date the system was returned to operation will be made. In addition the "lock out" tag will be removed from the carbon dioxide extinguishing control station(s).

The designated vessel officer or vessel representative will also ensure that the storage locker for the carbon dioxide extinguishing system bottles or tank is secured so no unauthorized personnel can enter the space.

While safety training is not required for vessels that have an isolation valve or lock installed on their carbon dioxide extinguishing system, it is recommended that the training be conducted for the vessel's crew, shipyard workers and contractors to ensure that they are aware of the location of the escape routes, the sound the discharge siren makes and where they should evacuate to.

For vessels that do not have an isolation valve or pull handle locks installed, carbon dioxide extinguishing system safety training will always be conducted for all shipyard and contractor employees prior to any shipyard or dockside maintenance period.

3. SYSTEM TESTING AND SERVICING. Whenever a carbon dioxide system is taken out of operation for testing and servicing strict safety precautions must be followed to prevent the possibility that individuals performing or witnessing the activities, as well as the personnel located within the protected spaces, are placed at a higher risk. The service technicians should be able to demonstrate to the satisfaction of the vessel's master, designated vessel officer or vessel representative previous experience with carbon dioxide extinguishing systems, and in particular must be knowledgeable with the specific components and equipment used on the installed system. Factory training or approval as a factory authorized service agent by the manufacturer of the system is recommended. In addition, it is recommended that the vessel representative, master or the company's port engineer work closely with service technicians, shipyard safety officers and marine inspectors to plan and coordinate the maintenance and/or testing of a carbon dioxide system during an inspection or shipyard period to prevent an accidental discharge.

The following paragraphs offer general safety recommendations to avoid accidental exposure to personnel and maintain vessel safety. Because each carbon dioxide system is engineered for the particular vessel on which it is installed, the vessel's crew should review the manufacturer's operating and maintenance manual and become familiar with the system's safety procedures and devices.

a. FIRE SAFETY PRECAUTIONS. If a fire were to start in a protected space during the time that the carbon dioxide system is disabled in order to conduct system testing or servicing, the fire may be able to grow, causing significant damage to the vessel and placing the lives of the people on board in jeopardy. It is strongly recommended that the vessel's master or the vessel's port engineer ensure that adequate fire safety precautions are taken to detect and extinguish a fire during carbon dioxide system servicing or testing.

b. SYSTEM ISOLATION. Prior to any work being done to prepare the system for testing or servicing, the isolation valve or pull handle locks, if installed, shall be closed and secured by the service technician under the supervision of the vessel port engineer or by a designated member of the crew who is fully knowledgeable of the system and safety procedures. A log book entry will be made in the vessel's log book noting the time, date and reason why the extinguishing system was secured. A "lock out" tag will be affixed to both the local and remote carbon dioxide extinguishing control stations noting the status of the system.

c. ESCAPE ROUTE. During a system test and servicing, the service technicians, vessel crew members and marine inspectors routinely enter the carbon dioxide storage room to inspect and to work on the system. If a valve or component on the manifold fails, the storage room could rapidly fill with carbon dioxide. Because systems are sized to protect areas much larger than the storage room, the release of even one cylinder could form a lethal concentration. To facilitate rapid evacuation, the door or hatch to the storage room should be secured in the open position even if the door opens out or has a kick away escape plate whenever service technicians, vessel crew members and marine inspectors are working within the space.

d. CONDITION OF THE SYSTEM. The service technicians should evaluate the physical condition of the equipment and should also carefully observe the installed configuration of valves and control heads. It is possible that previous service work may have installed the control heads incorrectly on the pilot cylinders or connected the releasing controls to the wrong stop valves. Any non-standard components should be carefully scrutinized. Rust and corrosion of the cylinders may indicate the potential for leakage or rupture if they are disconnected and moved. The cylinder brackets and piping supports should be checked to see that the equipment is properly restrained and will not fall during testing. Any improperly installed equipment must be evaluated for its potential to release the system before testing begins. Check the labeling and arrangement of all controls and stop valves to verify that the protected space is correctly identified and the controls are properly matched to the correct devices.

e. SYSTEM DESIGN. If the system protects multiple spaces, be aware of the possibility of split discharges. In some instances, stop valve failures or crossed releasing controls have resulted in the discharge of carbon dioxide into the wrong protected space. As a precaution, personnel must be evacuated from all of the protected spaces during a testing or servicing evolution, not just the space being tested. This consideration is particularly important for low pressure systems, where the agent storage tank typically remains connected to the discharge piping during testing. High pressure systems where the cylinders are disconnected from the manifold during testing do not pose a similar risk.

f. HIGH PRESSURE SYSTEM. Disconnect all high-pressure cylinders from the manifold if the system distribution piping is to be pressure tested, or if an actuation test will be performed. Generally the system piping will be visually checked to ensure that there are no internal obstructions. The servicing agency may also blow air or gas from a small carbon dioxide cylinder through the piping to verify that the nozzles are clear. The actuation sequence of the system may also be tested by flowing a small quantity of carbon dioxide into the control piping to verify operation of the alarms and pressure switches.

   Because the valves on the carbon dioxide cylinders are pressure-operated, the introduction of this small amount of gas pressure into the manifold could cause the complete discharge of the system. Also note that the warning sirens are directly connected to the manifold. If the piping to the siren is pressurized it could also discharge the system.

g. LOW PRESSURE SYSTEMS. Verify that the tank shutoff valve is closed. If the shutoff valve is also utilized to isolate the system it must be verified that it is secured during testing. A small quantity of carbon dioxide is released into the manifold prior to conducting the service tests. It is important to verify that the mechanically operated tank shutoff valve is completely closed after the manifold has been filled with the test pressure. This valve should be carefully examined to ensure that it is properly assembled and installed such that it can be completely closed for testing purposes.

h. COMMUNICATIONS. Before conducting the testing or servicing of the system, determine that a means of communication is available to summon help if it is needed. Confirm that the means of communication is operable and effective throughout the areas where personnel will be stationed. The service technicians should have their own set of radios and it is strongly suggested that a member of the crew with a ship's radio be present whenever servicing is performed.

i. SYSTEM OPERATION. Determine what shipboard equipment will be disabled or operate when the system is tested. Carbon dioxide systems are typically fitted with pressure operated switches located on the manifold to shut down operating equipment that could prevent the fire from being extinguished. Usually this includes ventilation fans and fuel pumps. In some cases, the extinguishing system may secure the generators, in which case electrical power and lighting will be lost. There also may be power-operated doors that are closed, which could affect a ready escape from the area. Before conducting an operational test, it is vital to check with the chief engineer or designated vessel representative to determine what equipment will be shut down by the testing. It may be necessary to have the ship's electrician disconnect the interlock circuits before beginning the test.

j. EVACUATION. Generally, extinguishing systems are tested and serviced in port while other maintenance activities are being performed on the vessel. During these maintenance activities, timely evacuation from the protected spaces may be hindered by temporary equipment stowed in the passageways, or because the work is being performed in the bilges or in other restricted locations. Therefore, all personnel are to be evacuated from the protected spaces before any testing is performed on high pressure or low pressure systems. Consideration should also be given to areas where the carbon dioxide could leak. Because it is heavier than air, the gas will travel to the lower levels of the vessel.

Shipyard personnel and contractors may enter and remain within a protected space during the servicing of the fixed fire extinguishing system if the system has a positive means to prevent a discharge and it is isolated as per paragraph b of this enclosure.

In cases where the fixed extinguishing system does not have positive means to prevent an accidental discharge but the agent storage tank or high pressure cylinders are completely disconnected from the manifold the need to keep personnel out of the protected space during servicing should be evaluated on a case by case basis by the shipyard employer or contractor and the vessel's designated officer or representative. Items to be evaluated include but are not limited too are the number of personnel who will be working within the protected spaces, the condition of the space(s) (location of tools and equipment) to hinder evacuation if an accidental discharge occurs and if there is an effective means of communication between the vessel and shipyard representatives and service technician to ensure that a system will not be reconnected with personnel located within the protected space(s).

Prior to allowing the vessel's crew, shipyard personnel or contractors into the protected space during servicing the designated vessel officer or representative, the service technician and the shipyard representative or contractor will confirm that the system is completely disconnected. It will be noted in the log book that the fixed fire extinguishing system is completely disconnected from the manifold and that shipyard or contract personnel were allowed to work within the protected spaces. The vessel's crew, shipyard personnel or contractors will be evacuated from the space before the storage tank or high pressure cylinders are reconnected.

If it is absolutely necessary to have personnel in the protected spaces during testing or servicing, when the bottles or storage tank are connected to the system and there is no positive means to secure the system, only trained personnel wearing self contained breathing apparatus (SCBA) should be permitted. This should only be done on very rare occasions when there is a great need to complete essential work or to maintain the operation of the engineering plant. Despite taking all precautions when servicing a system, there is always a possibility of a component malfunction that could result in a system release into the protected spaces. If there is an accidental release, the SCBA may be needed for escape, or could be necessary to rescue persons overcome by the carbon dioxide. An adequate number of SCBA should be provided for all personnel located within the protected spaces. Before any testing or servicing has begun, the SCBA should be verified functional, and the involved test personnel should be instructed on how to use the equipment.

Coast Guard personnel will remain outside of the protected spaces during the testing of a high or low pressure fixed fire extinguishing system. Coast Guard personnel may enter and remain within a protected space during the servicing of the fixed fire extinguishing system if the system has a positive means to prevent a discharge and it is documented as per paragraph b of this enclosure. Coast Guard personnel may also enter and remain within a protected space during the servicing of the system when the bottles or storage tank(s) are not connected to the system's manifold.

k. PREVENT RE-ENTRY. Establish and implement a plan to prevent personnel entry into the protected spaces until testing or servicing is completed and the spaces have been determined to be safe for human occupancy. There have been cases where personnel have entered the protected spaces without knowing that a test was in progress. There have also been cases where persons have entered the protected space immediately after testing was performed not realizing the atmosphere inside the space was hazardous. It is recommended that readily apparent warning notices be posted at each entrance to the protected spaces until the testing is completed.

l. ACCIDENTAL DISCHARGE. If an accidental release occurs, immediately evacuate and do not re-enter the spaces affected until they have been ventilated and tested for an adequate oxygen concentration. If a release occurs, go immediately to a space that is not connected to the area where the carbon dioxide was released. It is preferable to evacuate to an on-deck open area. Do not allow anyone to re-enter the protected space without

wearing an SCBA. Seek prompt medical attention for anyone exposed to the discharge, even if they appear to have recovered and are breathing normally. Both oxygen and carbon dioxide meters must be used to ensure the space is habitable before re-entry. Specifically test low-lying areas such as the bilges.

m. SYSTEM VERIFICATION. Before the system has been placed in operation, the service technician and a designated ship's officer will make sure that all components are properly reconnected.

Any of the ship's circuits that were disconnected during the testing must be re-connected and functionally tested when the testing is completed to ensure the extinguishing system is fully operable. For high pressure extinguishing systems, verify that all control heads are correctly re-installed. If the rod in the control head is not correctly positioned when the head is replaced onto the cylinder, it will cause the system to discharge when the lock nut is tightened. Most equipment requires the pilot cylinder control heads to be connected to the pull cables in only one configuration to be operable. Because the control heads are not marked "open" or "closed," a factory manual should be used to verify that all of the control equipment is correctly re-installed, and the system is left in an operable condition.

Gas pressure-operated valves should be checked to ensure that the releasing lines are connected to the correct valve port. It is particularly important to verify that stop valves are connected to the remote release controls for the space protected. Coast Guard regulations require all valves to be marked to indicate the spaces that are protected. On systems that protect multiple spaces, there is one agent supply connected to a manifold with multiple stop valves or selector valves that direct the flow of carbon dioxide to the protected spaces. If the remote releasing controls for the protected spaces are not connected to the correct stop valves, the agent will discharge into the wrong area if a fire occurs. If this happens, there may be no warning to the occupants, and a lethal concentration of agent could be rapidly reached, depending on the difference in volume between the two areas.

Once the system is ready to be placed back into operation, the isolation valve will be opened by the service technician under the supervision of the vessel representative or a designated member of the crew who is fully knowledgeable of the system and safety procedures. To document that the system is operational, a log book entry will be made in the vessel's log book noting the date and time the system was returned to service.

CARBON DIOXIDE SYSTEM TESTING AND SERVICING SAFETY CHECKLIST

VESSEL NAME_____

DATE OF TEST AND/OR SERVICE_____

MANUFACTURER OF SYSTEM_____

LOCATION OF PROTECTED SPACES_____

NAME OF VESSEL REPRESENTATIVE_____

NAMES OF TECHNICIANS_____

☐ The service technician(s) have demonstrated to the satisfaction of the vessel's representative, master or designated ship's officer an adequate level of experience with this manufacturer's equipment.

☐ An approved system drawing and a factory manual are available for use during the testing and servicing, and are understood by the technicians.

☐ The isolation valve, if installed, is closed and secured. A note identifying the date and time the isolation valve was closed has been made in the vessel's log book. The "lockout" tag has been placed at the control station for systems with an installed isolation valve.

☐ The pull handle locks, if installed, are secured. A note identifying the date and time the pull handles were locked has been made in the vessel's log book. The "lockout" tag has been placed at the control station for systems with pull handle locks.

☐ If required the Fixed Carbon Dioxide Extinguishing System Safety Training of shipyard personnel or contractors has been conducted and documented.

☐ Radios or other means of communication are readily available for the service technicians to contact the bridge. The radios have been tested from the both the cylinder room and the protected space and are operable.

POST-TESTING/SERVICING CHECK LIST

☐ After the testing is completed, verify that the system has been returned to service. All releasing controls are properly installed. All of the pilot cylinder heads and stop valve controls are in the correct or "set" position.

☐ All manual pull cables have been checked to verify that the proper stop valve has been co-ordinated with the correct remote release control.

☐ All system release labels and warnings have been verified correct.

☐ All electrical circuits disconnected for testing have been re-connected and verified functional.

☐ All piping connections between the cylinder discharge heads and the manifold have been verified to be correctly tightened.

☐ The isolation valve, if installed, is open and secured. A note identifying the date and time the isolation valve was opened has been made in the vessel's log book.

☐ The pull handles locks are open. A note identifying the date and time the system was returned to operation has been made in the vessel's log book.

☐ The "lockout" tag has been removed at the control station for systems with an installed isolation valve or locks.