

LCS-1 Freedom Reduced Manning Study Report

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FOREWORD

This report describes the results of the first spiral of a study conducted by the NAVAIRWARCENWPNDIV Fire Science and Technology Office, to review the suitability of the Lockheed Martin Littoral Combat Ship (LCS-1 Freedom) design to obtain permission to operate helicopters with fewer personnel than required by the NAVAIR 00-80R-14 NATOPS U.S. Navy Aircraft Firefighting and Rescue Manual. The study, conducted from April through June 2006, included a survey of LCS ship personnel, a visit and inspection of LCS ship facilities, and preliminary LCS ship data and program review.

This first spiral of the study effort primarily addressed the suitability of LCS ship facilities, as-built. Several concerns are noted and preliminary recommendations included to address them. Further work is required prior to completion of the assessment and final recommendation. A fire party response plan must be developed and the concept proved in a facility mock-up with live fire tests.

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CONTENTS

Introduction.....	3
Scope	3
Evaluation Results.....	4
References.....	20

Figures:

1. Starboard AFT AFFF Hose Reel Mounted High on Bulkhead	5
2. Area Between STBD AFT Reel and Flight Deck Access Door	5
3. Starboard AFT AFFF Hose Reel Looking FWD. Note piping blocking hose payout.....	6
4. TRIGON Operating Console Obstructing Flight Deck Access Door	7
5. Example of Hose Roller Guide Assembly Mounted to a Reel. Suggested assemblies would mount cantilever off ship's frame to guide hose over obstructions and through door openings	8
6. Starboard AFT Saltwater Discharges Pointing Up Will Likely Result in Kinked Hose When Charged and Pulled.....	9
7. Port Flight Deck Access Vestibule Looking AFT. Note narrow walkway created by piping obstruction.....	10
8. Port Flight Deck Access Vestibule Looking FWD. Note hazard of ladder way when attempting to pass piping obstruction	11
9. PORT AFT AFFF Hose Reel. Note payout is NOT in direction of flight deck.	12
10. PORT AFT Saltwater Discharge with Mission Module Corner Pad on Deck. Tight clearance between discharge and module will likely cause hose to kink when charged	13
11. Area Between Ladder Well and Bulkhead is the Suggested Location for a Hose Tray in PORT Flight Deck Access Vestibule	14
12. 1-1/2" Piping Running Up, Overhead, and Back Down to Feed STBD FWD Hose Reel from Opposite Side of AMZ	16
13. Lower Portion of 1-1/2" Piping Feeding STBD FWD Reel. Note numbers of bends in runs that will lead to a reduction in pressure at reel.....	17
14. PORT Flight Deck Access Door is Blocked by Open Fuel Station Door.....	18
15. General Arrangement of Mission Bay and Hangar Bay	20

INTRODUCTION

Chapter 9 of the *Navy Aviation Crash Firefighting and Rescue Manual* (NATOPS 00-80R-14) currently requires a minimum of nine (9) personnel on standby on, or adjacent to, the flight deck during flight operations on aviation-capable ships (Reference 1) to fill the following positions:

- Scene Leader (1)
- Hotsuitmen (2)
- Dedicated AFFF hose team (3)
- Collateral duty AFFF hose team (3)
- Total 9 personnel

Additionally, background assistance personnel will be required to bring five-gallon AFFF containers to the scene and monitor their use at eductor locations, changing out pails when necessary.

The reduced manning posture of some new ship programs makes it difficult for new ships to comply with the current NATOPS requirement. The disadvantages of reduced manning are two fold. First, typically very few members of the crew are trained specifically for aviation firefighting. Crew members receive basic firefighting training, which includes some basic hose handling and brief hands-on exercises against propane fires. Second, smaller crew sizes correspond to a reduction in the number of personnel responding to an emergency. These two disadvantages could potentially contribute to loss of life and ship, unless properly addressed. The current (proposed) trend towards "optimizing" manning levels includes multitasked, multi-trained personnel with limited commitment to "non-active" work assignments (dedicated standby with no other duties during that time period), permits personnel to perform general ship duties during flight operations and then respond quickly to an emergency as part of a fully trained firefighting team.

SCOPE

Each class of ship will be evaluated to determine if the ship design and size, the anticipated crash/fire threat and the crew size and collaborative duties permit a reduced flightdeck firefighting manning posture and initial response. If this evaluation supports a reduced staffing concept, development of a response plan and training requirements will then be developed. Evaluation of the ships ability to support a reduced manning concept will be conducted in four stages:

1. GO/NO-GO Questionnaire: Lessons learned from Seafighter reduced staffing concept testing has resulted in a set of questions to be used as a go/no-go test. The questionnaire will be filled out by Navy engineers during an interview with Navy and contractor stakeholders.
2. White Paper Study: If the results of the ship's questionnaire indicate there is a possibility for using a reduced manning firefighting concept, then a study will provide the data needed to prepare the ship-specific firefighting response plan, fire tests, and to gather data for future use in ATGPAC/LANT training programs.
3. Ship-specific Firefighting Response Plan: Based on Task 2 findings, a response plan with specific procedures will be developed for each ship.

4. Fire Testing: Fire testing for LCS reduced manning concept will draw from lessons learned during Seafighter testing. Testing will occur at NAWCWD on the Carrier Deck Firefighting Test Facility. A series of no less than 9 tests will be carried out to test concept viability using LCS crew as firefighters to account for a variety of fuselage orientations and weapons load-outs. Tests will be accomplished using a helicopter simulator with timed response scenarios which will be used to evaluate and optimize response plans; these tests will be conducted without JP-8 fire. Once optimized, response plan scenarios will be conducted with live JP-8 fuel fires to both assure an effective plan and to provide real condition training for the fire teams.

This report summarizes the findings for the Stage 1 and the partial findings to date for Stage 2. The NAVAIR Fire Protection Team made two trips to the ship yard in Marinette Wisconsin, during 25-27 April and 9-11 May 2007, to meet with members of the ships Gold Team and SupShips personnel. These trips also included an in-depth aboard ship survey of LCS-1 Freedom. During these visits interviews with the ships crew and SupShips were conducted to complete the questionnaire, ships layout, and design were examined and measurements were collected.

EVALUATION RESULTS

The NAVAIR Fire Protection team found several conditions in the ship design that inhibited efficient and effective flightdeck firefighting capabilities even with a complete NATOPS 00-80R-14 Chapter Nine flight deck staffing. The team has identified some changes or additions to ship installations and space assignments that could drastically improve the emergency response capabilities to the flight deck. The Team believes that these changes are reasonable, relatively minor and should not interfere with other ship operations. This will need to be confirmed with the rest of the LCS team. For reference at the end of this report, Figure 15 shows the layout of the LCS mission bay and hangar bay (mission module box locations are not shown).

1. Starboard aft AFFF Hose Reel in Hangar: This hose reel is positioned high on the bulkhead with the Trigon control panel mounted between the hose reel and the flightdeck access door (Figures 1 and 2).

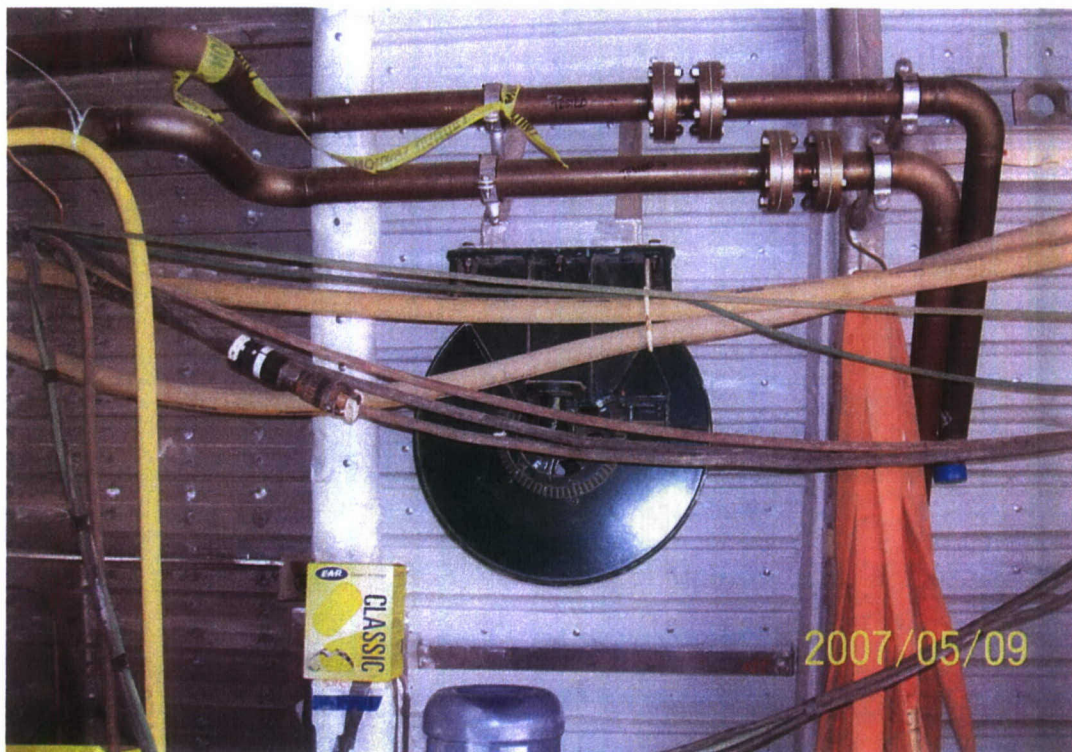


FIGURE 1. Starboard AFT AFFF Hose Reel Mounted High on Bulkhead.



FIGURE 2. Area Between STBD AFT Reel and Flight Deck Access Door.

In this configuration it will be difficult for the hose team to pull heavy charged fire hose over the panel without hose couplings hanging up on and potentially damaging the Trigon System. There is also a three-inch diameter pipe in front of the hose reel that would impede direct feeding of hose off of the reel (Figure 3).

Flaking out hose on the hangar deck may help these situations, but would require hose to be played out in the primary personnel travel route from the interior of the ship to the flightdeck. The looping of the hose would also require one person to remain in the hangar as hose is being pulled to feed the hose through tight spots caused by the Trigon control panel which blocks full access through the door (Figure 4).



FIGURE 3. Starboard AFT AFFF Hose Reel Looking FWD. Note piping blocking hose payout.



FIGURE 4. TRIGON Operating Console Obstructing Flight Deck Access Door.

Hose would also need to be rolled back onto the reel during any Trigon operations moving aircraft in or out of the hangar.

The proposed correction for this situation is to install hose roller guides on the framing between the hose reel and the door. These four sided roller guide assemblies would be similar to those mounted to the hose reel shown in Figure 5.

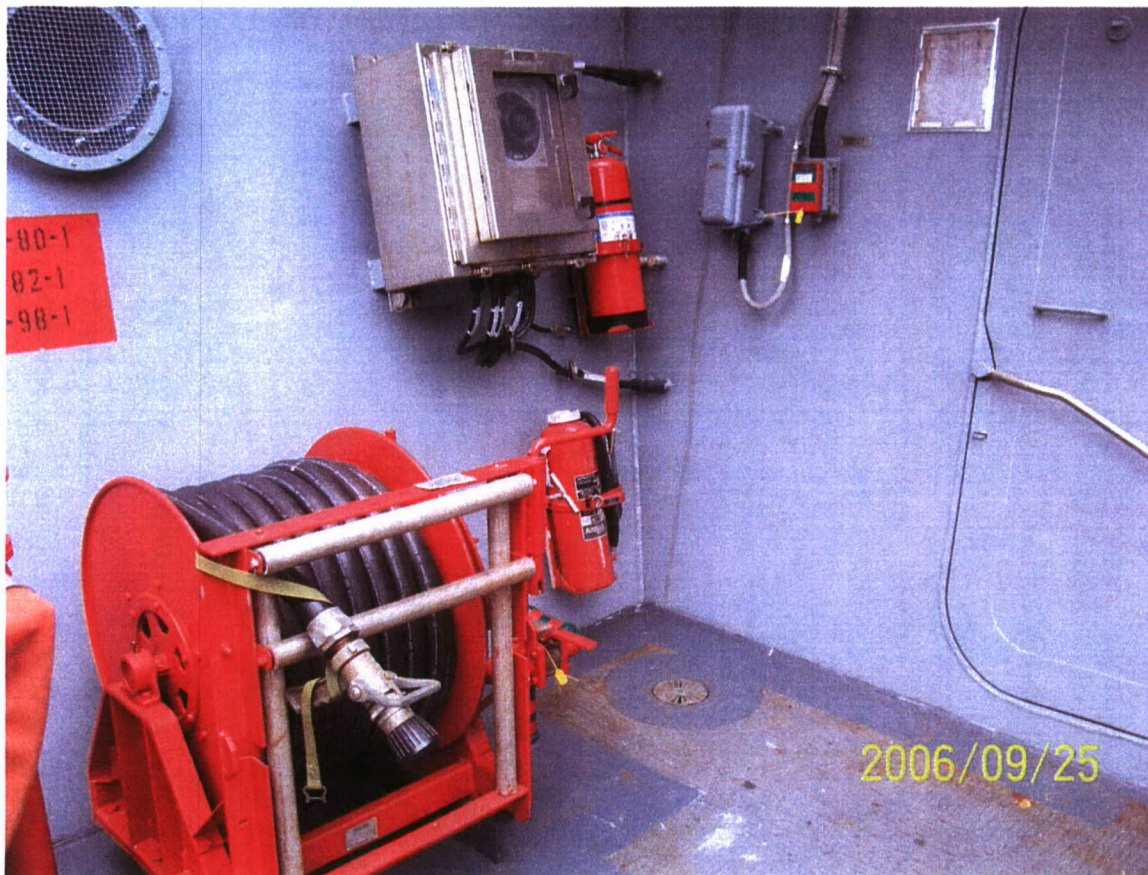


FIGURE 5. Example of Hose Roller Guide Assembly Mounted to a Reel. Suggested assemblies would mount cantilever off ship's frame to guide hose over obstructions and through door openings.

However, the proposed guide assemblies would only need to be large enough to fit a nozzle and thus could be smaller than that shown. The proposed guide assemblies would need to be designed such that they could be mounted cantilever off the frames in the subject area. This will permit the hose nozzle to be positioned at the door during flight operations. A single person will be able to immediately grab the nozzle as they exit the door and pull hose being fed off of the reel without the need to wait for a second person. Exact roller design and placement will be determined in collaboration with the LCS design team.

2. Starboard aft saltwater connection: This hose connection is pointing up (Figure 6); it is required to point down or horizontal to prevent kinking of hose. (per NVR: Part 5, Chapter 4, Section 3, Paragraph 1.7, "Fireplugs shall be positioned so that the valve hand wheel is approximately 1.8 m (6 ft) above the deck with the hose end downward").

Use of this connection with 150 feet of 1 ½" soft hose line and an AFFF eductor will be required to provide protection and firefighting for incidents involving armed aircraft. Due to the need for a rapid response with this hoseline and the design of the ship, including the placement of the Trigon Control Panel, flaking of hose onto the hangar deck during flight operations would be required. This played out hose would need to be on the deck in the primary path of travel from the ships interior to the flight deck and would need to be moved during Trigon operations.



FIGURE 6. Starboard AFT Saltwater Discharges Pointing Up Will Likely Result in Kinked Hose When Charged and Pulled.

The proposed correction for this situation is to correct the position of the saltwater connection to point down. In addition, installation of a hose tray in lieu of a camelback rack between ship frames approximately 3 feet above the deck, with direct access to the door of the flight deck, would permit one person to grab the hose nozzle and pull hose through the door feeding directly off of the tray. A structural fire apparatus hose fold can be utilized to assure proper playing out of hose off of the tray. The NAVAIR Fire Protection Team can provide guidance to the ships crew and to the training schools on this hose fold. Exact hose tray design and placement will be determined in collaboration with the LCS design team.

3. Port flight deck access vestibule: The fuel oil tank vent water vent/overflow plumbing is directly in the path of travel for firefighting teams from the hangar to the flight deck (Figures 7 and 8).

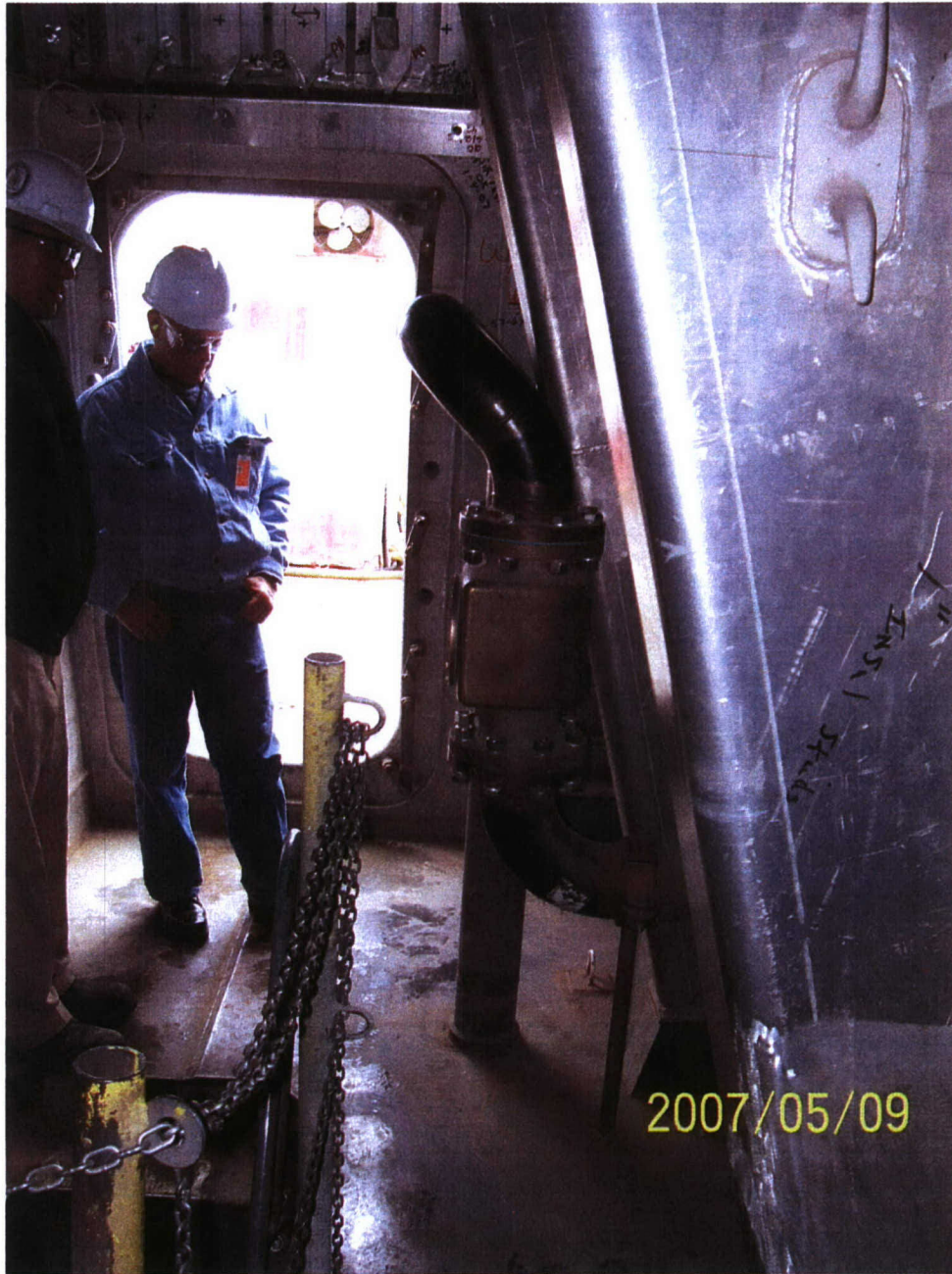


FIGURE 7. Port Flight Deck Access Vestibule Looking AFT. Note narrow walkway created by piping obstruction.

Traversing this path is difficult under normal conditions. With the added bulk of proximity suits with SCBA, while pulling hose, this path becomes a serious safety concern, due both to the difficulty of traversing this space without damaging fragile proximity suits as well as the hazard of falling into the adjacent ladder well while negotiating around bulkhead frames and plumbing installations

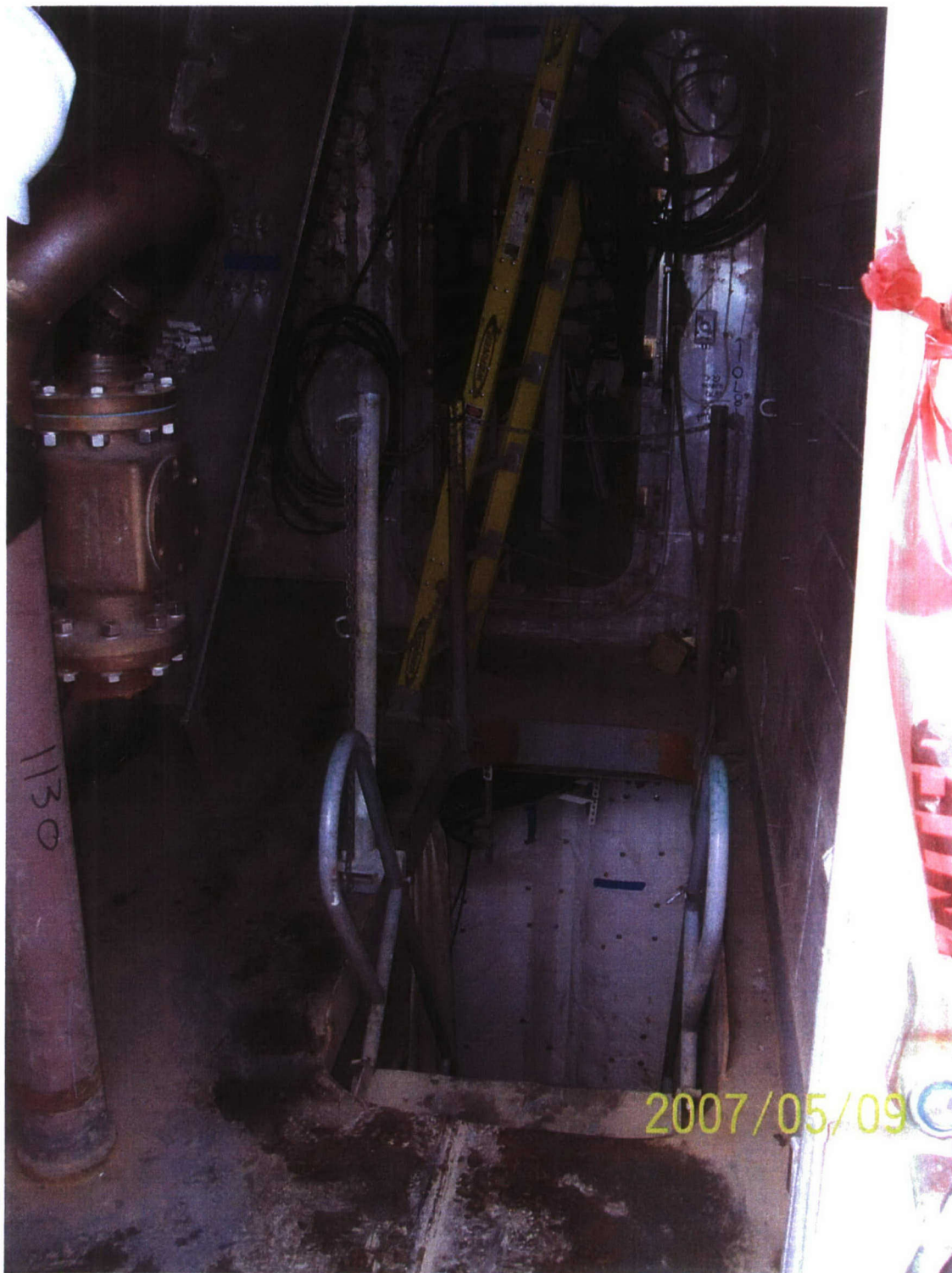


FIGURE 8. Port Flight Deck Access Vestibule Looking FWD. Note hazard of ladder way when attempting to pass piping obstruction.

The proposed correction for this situation is to reposition vent piping close to the skin of the ship and out of way of vestibule traffic to open this path of travel to an acceptable width.

4. Port aft AFFF Hose Reel in Hangar: This hose reel is positioned low on the bulkhead with the barrel of the reel parallel to the port bulkhead, thus feeding hose inboard rather than aft toward the flight deck (Figure 9).

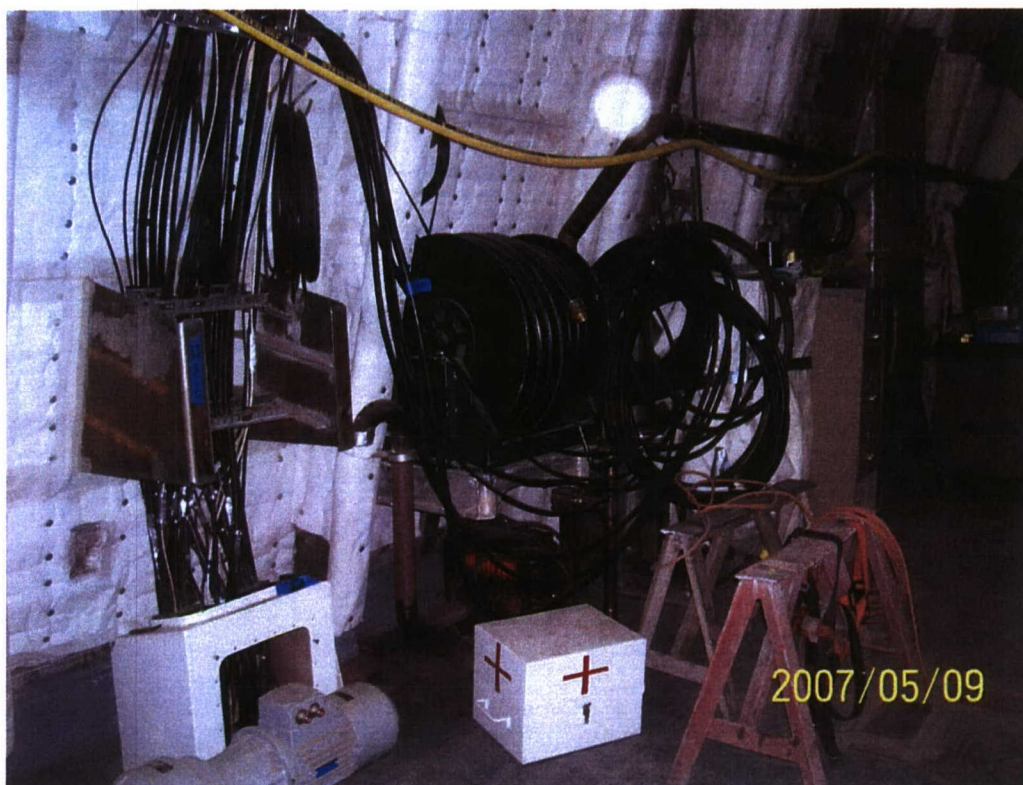


FIGURE 9. PORT AFT AFFF Hose Reel. Note payout is NOT in direction of flight deck.

In this configuration it will be difficult for the hose team to pull heavy charged fire hose over at a right angle, requiring a minimum of two personnel and a slower response time to deploy the hose. Flaking out hose on the hangar deck may help this situation, but would require hose to be played out in a primary personnel travel route from the interior of the ship to the flight deck. This travel route is already narrowed due to the placement of Mission Module Containers. The looping of the hose would also require one person to remain in the hangar as hose is being pulled to feed the hose through tight spots caused by the mission containers, doorways and ladder from the first deck.

The proposed correction for this situation is to install the hose reel higher on the bulkhead and turned 90° so that hose feeds aft off of the reel similar to the installation of the aft starboard reel. Installation of hose roller guides on the framing between the hose reel and the exterior flight deck door will also eliminate the difficulties of pulling hose through the two doors and around the access trunk ladder. This will permit the hose nozzle to be positioned at the door during flight operations. A single person will be able to immediately grab the nozzle as they exit the door and pull hose being fed off of the reel without the need to wait for a second person. Exact reel placement and roller design and placement will be determined in collaboration with the LCS design team.

5. Port aft saltwater connection: Use of this connection with 150 feet of 1 ½" soft hose line and an AFFF eductor will be required to provide protection and firefighting for incidents involving armed aircraft. Due to the need for a rapid response with this hoseline and the design of the ship, including the placement of the mission container, flaking of hose onto the hangar deck during flight operations would be required. This played out hose would need to be on the deck in a

primary path of travel from the ship's interior to the flight deck. This travel route is already narrowed due to the placement of Mission Module Containers. Another problem with this location is that the hose connection port on the valve points forward, potentially causing a charged hose to kink against the Mission Module Container (Figure 10).



FIGURE 10. PORT AFT Saltwater Discharge with Mission Module Corner Pad on Deck. Tight clearance between discharge and module will likely cause hose to kink when charged.

The proposed correction for this situation is to install in the vestibule in the gap between the bulkhead and starboard edge of the ladder well, a hose tray along the inboard bulkhead in the access trunk (Figure 11).

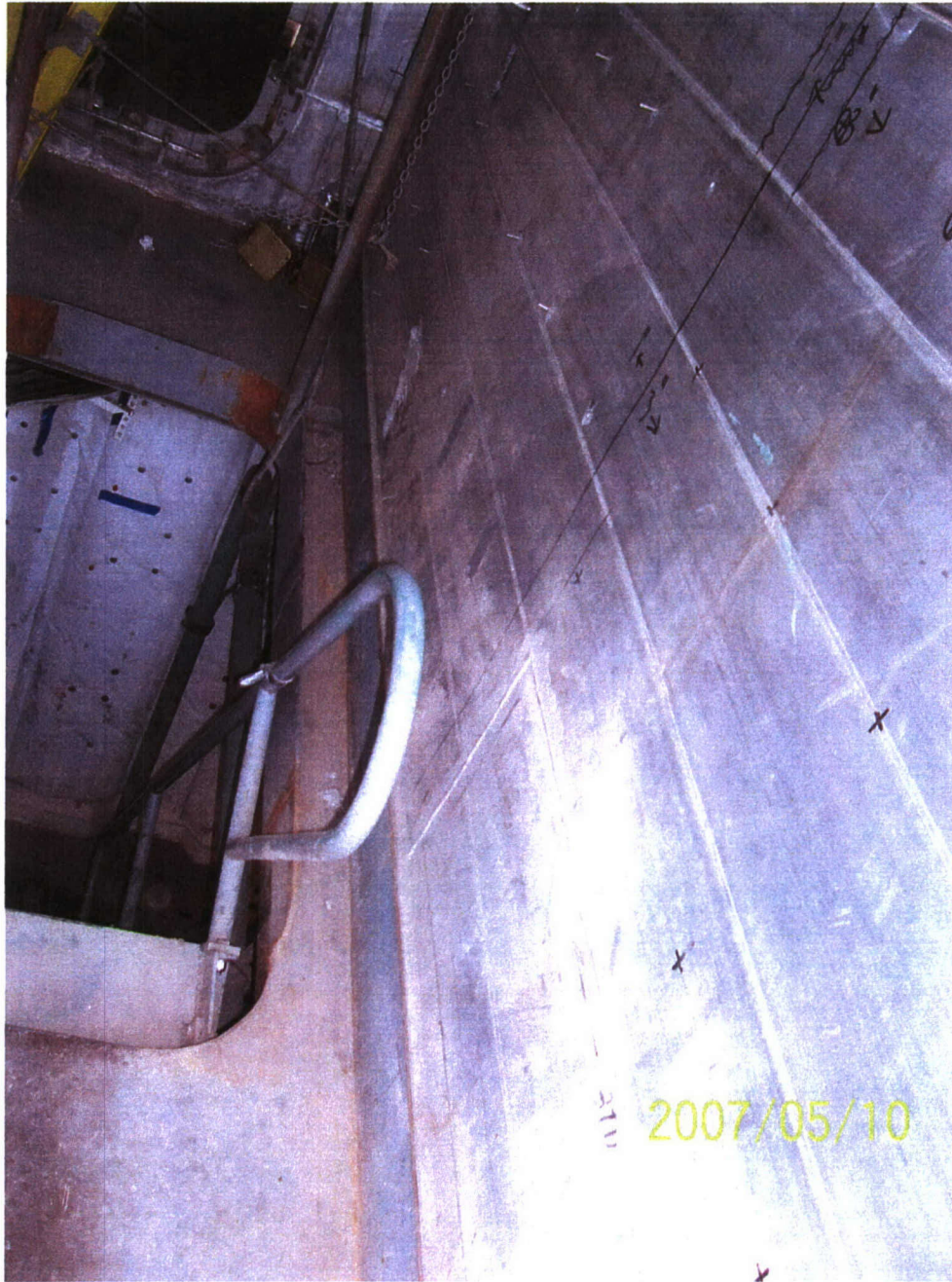


FIGURE 11. Area Between Ladder Well and Bulkhead is the Suggested Location for a Hose Tray in PORT Flight Deck Access Vestibule.

The hose would be connected as needed to the saltwater connection during flight operations and disconnected after flight operations have been suspended so that the door can be closed. This arrangement would permit one person to grab the hose nozzle and pull hose through the door feeding directly off of the tray. A structural fire apparatus hose fold can be utilized to assure proper playing out of hose off of the tray. The NAVAIR Fire Protection Team can provide guidance to the ships crew and to the training schools on this hose fold. Exact hose tray design and placement will be determined in collaboration with the LCS design team.

In order to correct the problem of kinked hose against the Container, the valve could be turned so that the hose connection port points toward the nearby starboard hatch.

6. Crash and Salvage Locker access: The crash locker is located at the forward starboard side of the hangar deck. Access to the locker and travel to the flight deck with firefighting apparel and equipment will be impeded by the narrow travel paths created by placement of the aviation mission container. Travel paths on both sides of the container provide less than 20 inches of clearance. This is a tight traverse during an emergency carrying gear that may get hung up and damaged on ship structures. This is also the primary means of travel from the ships interior to the hangar and flight deck. Two-way travel in this space would not be possible.

One proposed correction for this situation is to switch the locations of the Crash and Salvage Locker and the Aviation Workshop. This would provide closer and easier "emergency" access to the locker. The Aviation Workshop should not have a need for this type of quick access. Because the current Aviation Workshop space is larger than the current Crash and Salvage Locker, some workshop activities may be able remain within that space if necessary. Details of these arrangements can be made jointly with the DCC and Aviation Integration Team.

A second proposed correction is to insert the tool/equipment cabinets/lockers in the Aviation Module Zone (AMZ). This cabinet would hold rescue and firefighting tools and equipment that would normally be kept in the Crash and Salvage locker until required during an incident (spare SCBA bottles, forcible entry tools, etc.).

7. Saltwater Line AFFF Eductor Concentrate Supply: Saltwater hose lines with eductors and AFFF concentrate will be required for weapons cooling in the event of an incident involving an armed aircraft. To provide adequate AFFF flow until the Background Assistance is able to provide a continuous delivery of concentrate pails, a minimum of four pails would need to be stored at the connection location both port and starboard. This procedure also requires one additional person per saltwater hose line prior to deployment of the line to provide a continuous flow of AFFF to the eductor by moving the eductor tube from one pail to the next as they drain down (approximately every 105 seconds with 3% AFFF).

The proposed correction for this situation is to provide a "portable" 20-30 gallon AFFF concentrate tank at each saltwater connection. This portable tank can be placed in position and the eductor down tube can be placed in the tank during flight operations (and removed following flight ops stand down). This would provide an immediate deployment capability and sufficient continuous flow of AFFF without the need for a person to staff this position once the line has been charged (7-10.5 minutes of flow with 3% AFFF). Size, design and placement of the tanks can be coordinated with the ship design team.

8. AFFF Station and Saltwater Connection Supply Piping: All Hangar Deck and Flight Deck AFFF and saltwater connection piping that were viewed during the evaluation aboard Freedom were found to be predominantly small diameter piping (1.5") with long runs and many elbows, all generating significant friction loss (Figures 12 and 13).

There is concern that this plumbing will not provide the required minimum nozzle pressure of 70 psi while flowing that is required per NVR Part 5, Chapter 4, Section 3, Paragraph 3.3.2. Inadequate flow will obviously provide insufficient firefighting and weapons cooling capability.

The proposed correction to this situation is to conduct flow tests of each component (AFFF hose reels, saltwater hose lines, flight deck flushdeck system and hangar overhead sprinkler system) to assure proper flow and make adjustments to the piping supply system as needed to meet minimum flow requirements.



FIGURE 12. 1-1/2" Piping Running Up, Overhead, and Back Down to Feed STBD FWD Hose Reel from Opposite Side of AMZ.



FIGURE 13. Lower Portion of 1-1/2" Piping Feeding STBD FWD Reel. Note number of bends in runs that will lead to a reduction in pressure at reel.

9. Flight Deck Helo Fueling Station Door/Hangar to Flight Deck Access Door Interface: When the Fueling Station door is in its fully open position, it overlaps onto the personnel access door, preventing it from being opened as can be seen in Figure 14.



FIGURE 14. PORT Flight Deck Access Door is Blocked by Open Fuel Station Door.

This is a primary access route to the flight deck for hose teams. Since fueling operations have potential for fuel spills and related fires, this needs to be corrected.

The proposed correction for this situation is the installation of the hold back device that will secure the fueling station door in an open position that does not block the personnel door, perhaps limited to a 90° swing.

10. Flight Deck Access Doors: Per NVR, Part 5, Chapter 4, Section 3, Paragraph 3.3.2, and per Air-Capable Aviation Ship Facilities Bulletin 1J, paragraph. 18.2.1-A., if hose reels are located in

the deckhouse, 100 mm (4-inch) diameter, fixed light viewing ports in accordance with drawing, NAVSHIPS No. 805-1400056 and a positive means of securing the door in the open position need to be provided. At the time of the evaluation, the doors had viewing ports but no hold open devices had been installed. Because of the angle of the superstructure bulkhead, these doors would naturally swing all the way open and rest in the open position on the bulkhead. However, wind conditions may blow this door closed if not secured.

The proposed correction for this situation is to confirm that positive hold open devices are installed.

11. AMZ hose reel: The hose reel located on the starboard, forward bulkhead in the AMZ is provided specifically to protect the AMZ from internal fire and also from extension of fire from the flight deck and other spaces into the AMZ. The location of this hose reel makes it difficult to access while the Aviation Mission Module is in place. The limited space will require an additional person to feed hose off of the reel around obstacles while the hose is being advanced by the nozzleman. This prevents this from being a one person initial response as intended. Use of this hose reel at this location is further complicated as this is the primary route of traffic to and from the flight deck to interior ship spaces. This hose reel is particularly critical on this ship during Flight Operations to provide protection for the AMZ from spread of fuel and fire from the flight deck under the roll-up bay door due to the absence of a drainage trough which would normally prevent the majority of spilled fuel from flowing into the AMZ or against the hangar door seal.

The proposed correction for this situation is to relocate the AFFF hose reel further aft past the aft end of the mission module such that the hose can pay clearly out into the AMZ with interference with the module.

12. Evacuation of injured personnel from the flight deck. Because both flight deck access doors have limited/difficult passage (Trigon control panel on the starboard side and the ladder well on the port side), as well as the limited space traversing around the aviation mission module in the AMZ, evacuation of injured flight crew or crash responders to internal ship spaces is significantly impacted. Assisted walking or passage of litters will be very difficult at best through these three choke points. Even provided that injured persons can be maneuvered through these spaces, they will be subjected to possible additional injury while being guided over and around obstacles. In addition, the extended time that will be required to perform this maneuver will further expose the AMZ to lengthy smoke and fire exposure through the opened doors.

One potential correction for this situation is to use the port side door, if not blocked by debris or incident related hazards (fuel, fire, smoke), for transport of injured personnel down the well ladder to the deck below and on to internal ships spaces. Before this solution can be accepted, the route from this space to the medical spaces must be fully evaluated.

Based on the questionnaire results and ship survey, the Team has determined that if satisfactory corrections can be made to the twelve items listed above there is a reasonable expectation that the NATOPS required manning may, with further study and testing, be safely relaxed under certain launch and recovery scenarios. The Team recommends completion of Stage 2 and consideration of a "tiered" staffing requirement based on the specific hazard associated with the flight operations profile: armed helos, unarmed helos, UAV, maintenance turnups, etc. An in-depth understanding is also needed of the availability and response times of on-duty ships company, air detachment personnel and "off-duty" personnel to best be able to define the critical response in the first two to three minutes of an incident on the flight deck.

A white paper study will be performed next to prepare for testing, data collection, and reduced manning plan validation. The NAWCWD team will obtain the data needed to prepare the ship-specific fire fighting plan, the fire testing plan, and data for future use in ATGPAC/LANT training programs. Once the white paper is prepared, it will be forwarded to the LCS Program Office for approval and funding.

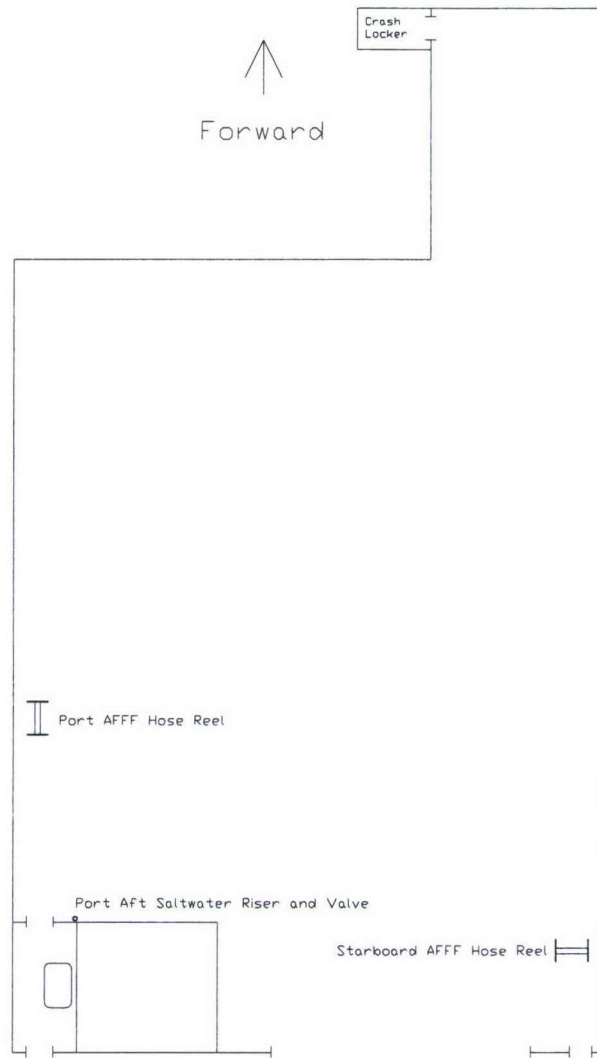


FIGURE 15. General Arrangement of Mission Bay and Hangar Bay.

REFERENCES

1. Navy Aviation Crash Firefighting and Rescue Manual (NATOPS 00-80R-14).