Naval Facilities Engineering Command
200 Stovall Street
Alexandria, Virginia 22332-2300

HYPERBARIC FACILITIES MAINTENANCE MANUAL

NAVFAC MO-406

JULY 1990

SNDL DISTRIBUTION

(10 Copies each):

FA46 PWCLANT
FB54 PWCPAC

FKN1 EFD
FT104 PWCCNET

HQ U.S. AIR FORCE
Engineering And Services Center
Tyndall AFB, FL 32403

U.S. ARMY
Office Chief of Engineers
Washington. D.C. 20314 (DAEN-MPO)

(2 Copies each):

C58M	NAVSCOLEOD
FA6	NAS LANT
FA7	NAVSTA LANT
FA18	NAVPHILBASE LANT
FB7	NAS PAC
FB21	NAVPHIBASE PAC
FB30	NAVSHIPREPFAC
FB45	TRIREFFAC
FB48	NAVSUPPFAC
FH3	NAVHOSP
FH5	LAB COMNAVMEDCOM
FH7	NAVMEDRSCHINSTITUTE
FH15	NAVENPVNTMEDU
FH18	NAVAEROSPMEDINST
FH31	NAVMEDCLINIC
FKN11	NAVCIVENGRLAB
FKP1E	NAVUSEAWARENGSTA
FKP4B	NAVEODTECHCEN
FKP6D	NAVXDIVINGU
FKP7	NAVSHIPYD
FKQ6B	NAVCOASTSYSCEN
FKQ6C	NAVOCEANSYSCEN
FKQ6E	DTNSRDC
FKQ6G	NUSC
FT10	NAVAVSCOLSCOM
FT38	NAVSUBTRACENPAC
FT44	NAVDIVESALVTRACEN
FT54	NAVSUBSCOL
FT99	NAVSPECWARCEN

FOREWORD

This Hyperbaric Facilities Maintenance Manual (HFMM) was prepared to assist NAVFAC organizational level management, maintenance and operating personnel responsible for shore based man-rated hyperbaric facilities. The intent of the HFMM is to provide guidance and reference information necessary to properly maintain hyperbaric facilities which fall under the purview of the NAVFAC SCA. Included in the HFMM are maintenance and operating guidelines, reference information, recommended maintenance procedures, sample forms, sample procedures, and inspection guidelines. Although NAVFAC (CHESDIV FPO-1H) has assumed responsibility for maintaining and publishing the HFMM, it is emphasized that this is a "fleet" manual. As such, NAVFAC shore based man-rated hyperbaric facility managers, maintenance and operating personnel are strongly encouraged to provide input (e.g., changes, additions, deletions) to "their" manual.

Additional information or suggestions that will improve this manual are invited and should be submitted through appropriate channels to the Naval Facilities Engineering Command, (Attention: Code 163), 200 Stovall Street, Alexandria, VA 22332-2300.

This publication has been reviewed in accordance with the Secretary of the Navy Instruction 5600.16A and is certified as an official publication of the Naval Facilities Engineering Command.

D.B. Campbell
Assistant Commander for
Public Works Centers and Departments

ABSTRACT

Guidance document to assist activity personnel in maintaining, repairing, and operating shore based man-rated hyperbaric systems which fall under the purview of the NAVFAC System Certification Authority (SCA). Provides maintenance guidelines to facility managers and technicians for establishing an activity level maintenance system. Provides guidance for conducting component level repairs. Criteria provided for the conduct of inspections and tests on hyperbaric systems and components. Overview of NAVFAC certification requirements and guidance on maintaining certification records and certification procedures. Guidelines provided for the safe operation of hyperbaric facilities.

CHANGE CONTROL SHEET

Document all changes, page replacements, and pen and ink alterations posted in this manual.

Amendment No.	Amendment Date	Post Date	Posted By (Last Name)

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

CHAPTER 1 INTRODUCTION, SCOPE AND ORGANIZATION

1.1. PURPOSE OF THE MANUAL

1.1.1 Single Guidance Document. It is the purpose of this manual to provide a document which offers specific guidance and direction with respect to the maintenance of shore-based hyperbaric facilities. This manual is intended to assist activity managers and technicians in the maintenance, operation and system certification aspects of NAVFAC hyperbaric facilities. Pertinent areas of concern are either addressed directly by this manual or specific direction is provided concerning other applicable references and directives.

1.1.2 Operational Guidelines. This manual provides guidelines to responsible activity personnel for the safe operation of NAVFAC hyperbaric facilities. Applicable guidance documents and Navy instructions which must be followed are addressed. Recommended guidelines and sample formats for the development of operating procedures (OPs) and emergency procedures (EPs) are provided.

1.1.3 Alteration and Overhaul Guidelines. Guidance is provided for activity personnel in planning overhauls and alterations to hyperbaric facilities. Further, guidance is provided with respect to applicable concerns such as recommended maintenance frequencies, typical work to be performed, and availability of support assistance (e.g., PWC, EFD).

1.1.4 Certification Guidelines. An overview of the Navy certification program as it is accomplished within NAVFAC is provided. Specific guidance on certification procedures and the maintenance of records is provided. Also, certification requirements for the inspection and testing of hyperbaric systems are addressed in detail.

1.1.5 Maintenance Guidelines. This manual provides hyperbaric system maintenance guidelines to activity maintenance managers and maintenance technicians. Specifics addressed by this manual, with respect to these maintenance guidelines, are outlined in the following subparagraphs.

a. Describes how a maintenance system can be established at the activity level to help ensure the safe and reliable operation of the hyperbaric facility. This maintenance system shall fulfill the requirements of both scheduled and unscheduled maintenance.

b. The maintenance system presented in this manual, if followed, will satisfy the maintenance and documentation requirements for continued NAVFAC certification.

C. Provides guidance to identify maintenance actions, frequencies and procedures for typical hyperbaric systems and components.

d. Provides guidance to determine test and acceptance criteria for work accomplished on hyperbaric systems and addresses the quality assurance (QA) guidance necessary to establish required QA procedures in support of maintenance documentation requirements.

1.2 SCOPE AND INTENT OF MANUAL

1.2.1 General Areas Covered in Manual. This Hyperbaric Facilities Maintenance Manual is broken down into the following major categories:

a. Introduction, Scope and Organization.
b. Operation
c. Maintenance, Repair, Alterations and Overhauls.
d. Certification
e. Material Control and Provisioning

Other areas of major concern, such as testing, inspection and safety, are addressed in conjunction with the above major categories.

1.2.2 Intended Users of Manual. This manual is primarily intended for use by hyperbaric facility managers, system operators and maintenance technicians. Others who may find this manual of benefit include the host activity Public Works Office, facility planners and design agencies.

1.2.3 Backaround. Prior to the issuance of this manual there was no established NAVFAC maintenance system which specifically addressed man-rated hyperbaric facilities. Maintaining these facilities at a high level of confidence with respect to the safety of occupants and system operators is of paramount concern. Due to the life-critical nature of such facilities and the unique components and materials used in these systems, maintenance guidelines specifically tailored for hyperbaric man-rated facilities have been developed and are detailed herein. This manual delineates a NAVFAC maintenance system for hyperbaric facilities including planning, procedures and required documentation for components, equipment, pressure vessels and systems.

1.3 ORGANIZATION

1.3.1 NAVFACENGCOM Organization. The Naval Facilities Engineering Command (NAVFAC) and its Engineering Field Division, Chesapeake Division (CHESDIV), are responsible for the acquisition, and maintenance of fixed shore based and fixed sea bottom man-rated hyperbaric systems. NAVFAC and CHESDIV further provide guidance on the repair, alteration, maintenance and operations of these hyperbaric systems. Additionally, NAVFAC (Code 04B) is directly responsible for certification of the hyperbaric facility. As such, acquisition, maintenance, repair and alterations on these systems fall under the same policies and procedures established for all NAVFACENGCOM facilities. Therefore, to operate or acquire hyperbaric facilities, it is necessary to understand the NAVFACENGCOM organization and the various instructions and procedures governing acquisition, maintenance and operation.

NAVFACENGCOM is a systems command under the office of Naval Operations (OPNAV) and is organized into regional Engineering Field Divisions (EFD's). These EFD's provide technical and administrative guidance as well as the review authority for operation, maintenance and construction of shore facilities. EFD's interface with the various shore activities primarily via the host activity Public Works Department (PWD) or Public Works Center (PWC) and provide technical guidance to the shore facility line organization on all matters regarding shore facilities. Figure l-l, Shore Command Line Organizational Relationship to NAVFACENGCOM, represents a typical shore facility line organization and the NAVFAC organization showing typical organizational ties. Specifically, many hyperbaric facilities belong to commands which are tenants of another host shore activity. As such, a formal host-tenant relationship exists between the host and tenant activity defining the level of support between the two activities. Acquisition, maintenance, repair and alterations to the hyperbaric facilities may come under the authority and responsibility of the host command PWC or PWD as defined by various NAVFACENGCOM instructions. Personnel responsible for the operation of shore based hyperbaric facilities should ensure they become familiar with the local Public Works organization and determine the nature of the formal relationship that exists between all hosts and tenants. The authority to perform construction, alterations or repairs to these systems may or may not rest with the facility commanding officer depending on the work that is to be accomplished.

1.3.2 Activity Maintenance Organization. To operate hyperbaric systems safely and to maintain system certification, each activity responsible for the operation of hyperbaric facilities must maintain and provide a record of maintenance actions conducted on the respective facility. As such, each

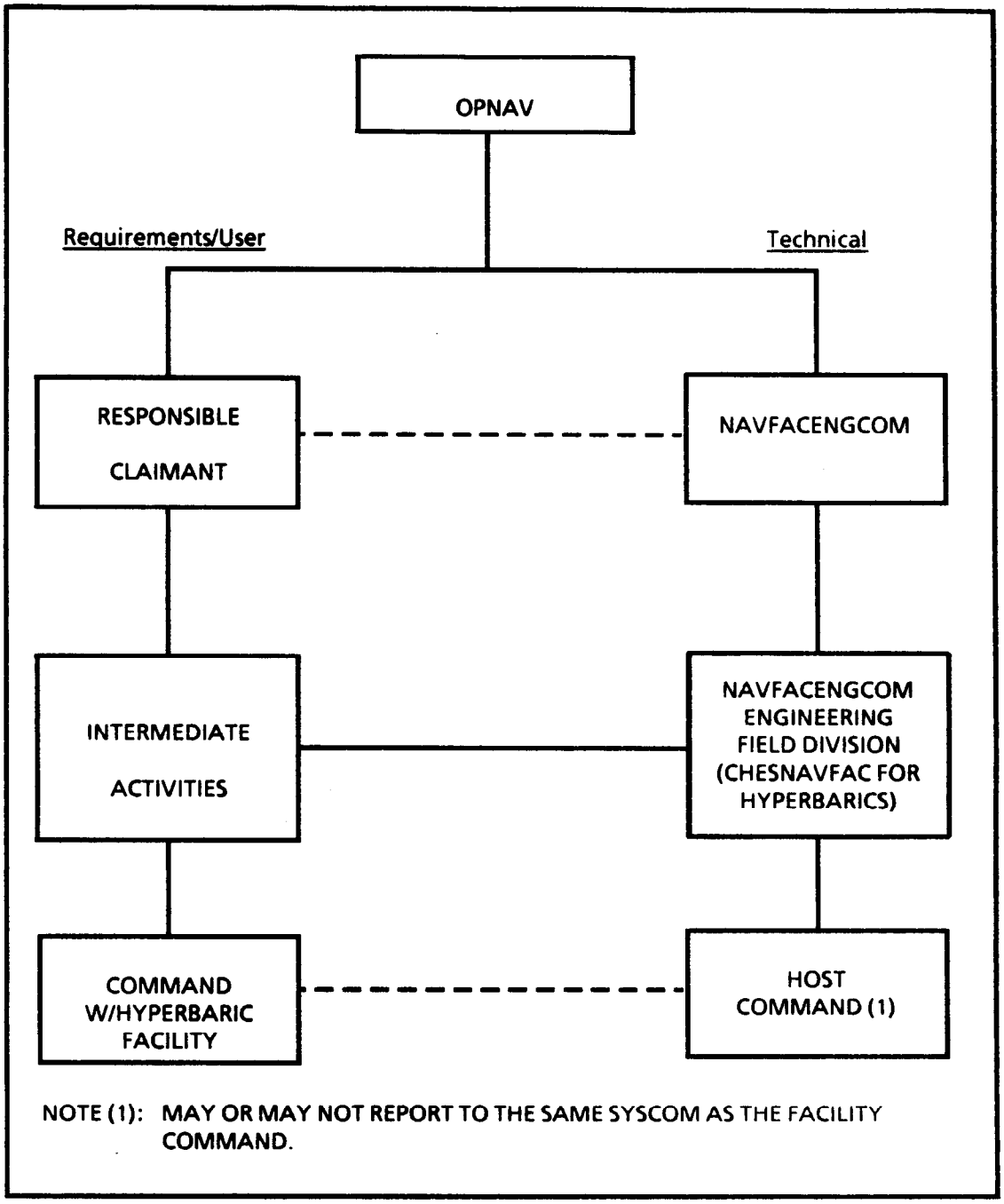


Figure 1-1
Shore Command Line Organizational Relationship to NAVFACENGCOM (Typical)

activity must provide a maintenance program and organization which 1) ensures that adequate maintenance is performed, and 2) documents these maintenance actions. How the command organization is to be established for the conduct of maintenance is dependent on many factors such as hyperbaric system size and complexity, personnel manning, personnel qualifications, mission, availability of outside maintenance, funding availability and contracting ability. Each activity should analyze the particular mission requirements for their hyperbaric facility, determine the maintenance requirements, define the maintenance resource (funding, personnel, and equipment) available to the command, and then develop an organization to ensure the accomplishment of maintenance.

At most commands hyperbaric facility maintenance should be conducted through a mix of many assets such as:

a. Divers assigned to the command.
b. Other command maintenance personnel.
c. Contract maintenance personnel.
d. Public Works maintenance personnel.
e. Any other qualified maintenance organization (shipyards, SIMAs, Navy Laboratories, etc.).

The complexity of the maintenance tasks required on hyperbaric systems prohibits staffing, funding and providing equipment assets suitable for performing all possible types of maintenance within most commands. The maintenance organization established should reflect the various maintenance activities required to maintain a safe certifiable system and establish the normal sources selected to perform these actions. Only after this is done can the spare parts systems, funding requirements, maintenance procedures, maintenance program and special equipment assets be identified to support hyperbaric facility maintenance requirements.

1.3.3 Activity Certification Organization. Each command responsible for maintenance and operation of hyperbaric systems must have personnel assigned who are knowledgeable with the NAVAL FACILITIES ENGINEERING COMMAND Certification Program. The command has the responsibility to ensure the system remains certified. To do this, some organizational responsibilities must be clearly defined. The command must establish an organization which provides for and meets the requirements of the NAVFACENGCOM certification program. The command organizational structure should define the responsibility for ensuring: 1) that system certification is maintained, and 2) that an adequate maintenance program and supporting records are kept in the command. An appropriate command certification instruction and personnel responsibilities for the certification effort should be formally designated in writing. The certification organizational responsibilities should be carefully thought out so as to support the maintenance organization and system certification program intent without causing undue system down times and maintenance costs. Personnel with certification

responsibilities must ensure that all maintenance actions are performed within the established quality control guidelines and that maintenance records in support of certification are adequately completed, reviewed and maintained on file. When setting up the maintenance organization, the command should perform an analysis of 1) the hyperbaric system maintenance and certification requirements, and 2) the assets available to perform these requirements. A suitable maintenance organization with assigned responsibilities can then be established to effectively control and accomplish hyperbaric facility maintenance.

CHAPTER 2 OPERATING OF SHORE-BASED HYPERBARIC FACILITIES

2.1 GUIDANCE DOCUMENTS

2.1.1 U.S. Navy Diving Manual, Volumes 1 & 2, NAVSEA Publications 0994-LP-001-9010 and 9020. This manual contains limited guidance concerning maintenance and general guidance on operational procedures for diving and hyperbaric chamber systems. Information in the U.S. Navy Diving Manual which is pertinent to shore-based hyperbaric facilities includes: hyperbaric physics, hyperbaric physiology, operations planning, diver-carried equipment maintenance, medical emergency procedures and equipment, recompression chamber treatment tables, recompression chamber operation, and general recompression chamber maintenance guidelines.

2.1.2 U.S. Navy Diving and Manned Hyperbaric Systems Safety Certification Manual, NAVSEA TM SS521-AA-MAN-010. This instruction is a set of guidelines for the designer and/or builder of a U.S. Navy Diving and Manned Hyperbaric System, which includes any noncombatant submersible, in or on-bottom habitat, diving system, diving equipment, or hyperbaric facility, that is intended for use by Navy or government personnel. Areas addressed include: system certification process; design, construction, fabrication and assembly guidelines; testing, quality assurance, operability and maintainability guidelines; system certification surveys; and tenure of certification. Additional information is provided in the appendices to SS521-AA-MAN-010 on: categorization of scope of certification materials and components; design parameters for diving systems; design parameters for implodable and explodable items: general guidelines for atmospheric evaluation of manned diving systems; general guidelines for cleaning breathing gas systems: general guidelines for diving system handling systems; and general guidelines for re-entry control.

2.1.3 Certification Certificate. The Certification Certificate is the document which each facility must obtain from the NAVFAC System Certification Authority (SCA) prior to conducting diving or manned hyperbaric operations with a particular system/facility. The certification certificate is issued by the NAVFAC SCA after: the system technical documentation has been reviewed to ensure that materials have been procured, fabricated, installed, cleaned and tested properly: the SCA has conducted an onsite survey to verify design compliance; and a successful operational demonstration "dive" of the system to its certifiable limits is witnessed by the SCA or an authorized representative of the SCA.

2.1.4 Instructions and Documents. There are numerous applicable instructions and documents which provide direction and guidance with respect to the maintenance of shore-based hyperbaric facilities. These instructions and documents include both government and civilian sources. A current reference library of these instructions and documents (primarily codes, standards and specifications) is necessary to properly maintain, repair, operate and provision any hyperbaric facility. Appendix A, of this manual, contains a listing of these applicable instructions and documents.

2.1.5 Operating and Emergency Procedures. Operating procedures (OPs) and emergency procedures (EPs) are locally prepared documents. Prior to their use, however, they shall be approved by the NAVFAC SCA. OPs and EPs contain written instructions and checklists that provide the occupants and operators of a hyperbaric facility with a detailed safe sequence of operations for all normal and emergency operating modes/profiles. Appendix B provides specific guidance concerning the requirements and development of OPs and EPs.

2.1.6 Hyperbaric Facility Manuals. Operating and Maintenance (O&M) manuals are developed by the builder of the system or the command. Updates to O&M manuals are handled by the command directly or under contract as part of the facility acquisition. O&M manuals contain information for facility operation and maintenance and/or provide specific reference to the source documents required. O&M manuals shall include, but not be limited to the following: a system layout showing piping, valves, and controls; wiring and control diagrams with data to explain detailed operation and control of each component; a control sequence describing start-up, operation and shutdown; a detailed description of the function of each principal component of the system; the procedure for lining up and starting: the procedure for operating; shutdown instructions; installation instructions: maintenance and overhaul instructions: lubrication schedule including type, grade, temperature range, and frequency; safety precautions; diagrams, and illustrations; test procedures; performance data; and parts lists. The manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances provided.

2.1.7 AIG 239 Messages. These are "Diving Advisory" messages which are sent to all commands with an assigned U.S. Navy diving locker (AIG 239). Message topics include: interim change's to the diving manual, equipment and component deficiencies, procurement guidance for components and consumables, diver and chamber operator training, maintenance criteria for components and systems, potential safety hazards, and operational guidance. Commands not on distribution for AIG 239 messages can request copies from NAVSEA OOC.

2.1.8 As-Built Drawings. Every man-rated hyperbaric facility must maintain a set of system level drawings which reflect the "as-built" condition. These drawings should include as a minimum: material lists, operating pressures for major components and piping, flow directional arrows, and reference to applicable cleaning and testing procedures.

2.2 CERTIFICATION REQUIREMENTS. Hyperbaric facility maintenance for man-rated systems requires effective control of work performed, from the standpoint of material safety. Such control is achieved by the establishment of certification requirements for hyperbaric facilities which strictly monitor and track materials installed, fabrication and installation procedures used, and personnel qualifications of the individuals performing the work. Chapter 4 of this manual discusses the certification process for man-rated hyperbaric facilities and applicable requirements in detail.

2.3 MATERIAL PROVISIONING AND CONTROL. Detailed information and guidance with respect to material control and provisioning is provided in Chapter 5 of this manual.

2.4 USER DOCUMENTATION REQUIREMENTS. Facility users have a requirement to maintain adequate documentation to certify, operate and maintain the facility. All or part of the following documentation may be required to continue operations at a specific hyperbaric facility.

2.4.1 Hyperbaric Construction Contract Documentation. For hyperbaric construction contracts, including modifications to existing facilities, the following documentation may be required to be prepared and submitted by the activity performing the work:

a. Drawings and Manuals.
   (1) As-built system drawings.
   (2) Hyperbaric facility manuals.
   (3) Equipment and component technical manuals.

b. Material Traceability Records.
   (1) Copies of purchase documents.
   (2) Vendor's certificates of material and equipment certifying compliance with applicable specifications and containing detailed chemical, physical, and test data.
   (3) Receipt inspection records.
   (4) Builder conducted chemical or physical tests on material or equipment.

c. Construction Records.
(1) Copies of all work procedures, including welding procedures.
(2) Welding procedure qualification records and approval documents.
(3) Welder qualification records (welder lists and test results).
(4) Installation, storage, and handling procedures.
(5) In-process inspection records.
(6) Welding Joint Record Cards.
(7) Mechanical Joint Record Cards.
(8) Mapping Plan and Weld/Mechanical Joint ID.

d. Quality Assurance Records.
(1) Builder's Quality Assurance Plan.
(2) Qualification records of nondestructive test personnel.
(3) Non-destructive test reports and data.
(4) Records of all installation inspection checks.

e. Cleanliness.
(1) Copy of cleaning specification(s) used.
(2) Vendor's certification of cleanliness of items supplied in a clean condition.
(3) Inspection records verifying that items cleaned by the builder meet approved cleanliness criteria.
(4) Storage inspection recordsverifying compliance with storage cleanliness requirements.
(5) Records of system cleaning flushes.
(6) Air sample analysis reports verifying compliance with approved air standards.

f. System Testing.
(1) System test plan.
(2) Copies of test procedures for tests conducted.
(3) Signed-off system test procedure data sheets for strength, tightness, and drop tests.

g. Functional Testing.
(1) Functional test plan.
(2) Copies of test procedures for tests conducted.
(3) Signed-off functional test procedure data sheets for tests conducted.

2.4.2 Activity Generated Documentation. The following documentation may be required to be generated and maintained by hyperbaric facility personnel. CHESDIV (Code FPO-1H) will provide guidance and assistance, when necessary, for initial development.
a. Operating Procedures (OPs).
b. Emergency Procedures (EPs).
c. Procedural Guides, Pre-Survey Outline Booklet (PSOB).
d. Re-entry Control Procedures (REC).

e. Parts Lists.
f. Training Booklets (TABS).
g. Training Materials.
h. Maintenance Check-off Sheets.
i. Maintenance Procedures.
j. Quality Assurance Documentation.
k. Hyperbaric Facility Manuals (Includes O&M).
l. Scope of Certification (SOC).

NOTE: See Glossary for descriptions.

2.5 MAINTENANCE AND OPERATIONS SCHEDULING.

2.5.1 Coordination of Onerations with Maintenance Planning. A major concern of any hyperbaric facility is the coordination of operations and maintenance. Maintenance must be planned so that it does not interfere with scheduled hyperbaric operations or with periods when the facility is in a duty status (e.g., standby chamber).

To ensure proper coordination of operations and maintenance, commands shall develop and maintain cycle, quarterly, and weekly maintenance schedules. The quarterly maintenance schedule will be used to clearly show the planned operational periods. The level of detail on these schedules is dependent upon the complexity of the facility, but as a minimum shall list major systems, equipments and components. These schedules are addressed in further detail in Chapter 3.

Two documents which will further assist in operations and maintenance planning are:

- Red Tag Log
- Re-Entry Control (REC) Log

These two logs will provide for more detailed tracking of the maintenance and operational status of systems, equipments and components. Commands shall include a line item on all operating procedures (OPs) verifying that the Red Tag Log and REC Log have been reviewed and that no conditions exist which would interfere with scheduled system operations. Details of red tag and reentry control procedures are addressed in Chapter 4 and Appendix C.

2.6 HAZARD CATEGORIES

2.6.1 General. Modernman-rated hyperbaric facilities and the associated support systems are designed to be fail-safe (Note: Some older existing facilities do not meet this design criteria). In cases where a system malfunction would endanger the lives of the Pressure Vessel for Human Occupancy (PVHO) occupants or divers, a stand-by system, either active or passive, is incorporated in the

design. Stand-by systems are independent of the primary system in all details, including power source and other support utilities. Further, primary and stand-by systems are located in different areas of the facility so that an incident which causes primary system malfunction will not cause stand-by system malfunction. To accomplish this fail- safe design, each of the functional systems and subsystems (including components and operating procedures) are analyzed in accordance with MIL-STD-882, System Safety Program Requirements. Hyperbaric facility managers shall ensure that their man-rated systems and the respective procedures meet the requirements of MIL-STD-882.

2.6.2 Hazard Categories. All systems, equipments, components and procedures shall be-evaluated and assigned a hazard category (HAZCAT) per MIL-STD-882. The HAZCAT is based upon the potential hazard to occupants or divers and/or systems associated with the loss of pressure boundary integrity and/or loss of functional operation. It is emphasized that the facility occupants/divers are the personnel to which this HAZCAT analysis program is directed.

2.6.3 Hazard Category Criteria. In the analysis of a structural (excessive leak) and/or functional failure of a system, equipment or component the following hazard category evaluation criteria is used (Figure 2-1 refers):

a. HAZCAT I. Occupant/Diver fatality or injury is probable. No failure management or maintenance action planned.

b. HAZCAT II. Occupant/Diver injury is imminent. Failure management and maintenance planned and required.

c. HAZCAT III. Occupant/Diver injury is not possible. Failure management and maintenance planning required to continue hyperbaric/diving operations.

d. HAZCAT IV. Occupant/Diver injury is not possible. Failure management and maintenance planning not required to continue hyperbaric/diving operations. Maintenance repairs to be made at a convenient time.

2.6.4 HAZCAT Guidelines. Generally, most of the components within a specific system are all the same HAZCAT. Since HAZCAT I designation means a malfunction endangers the lives of occupants/divers and no failure action is planned-- stricter material selection and control, fabrication and installation procedures, quality control and testing is required on HAZCAT I items. Likewise, HAZCAT II items have more stringent requirements than HAZCAT III and HAZCAT IV items. The following guidelines are provided to assist in the determination of HAZCAT designations:

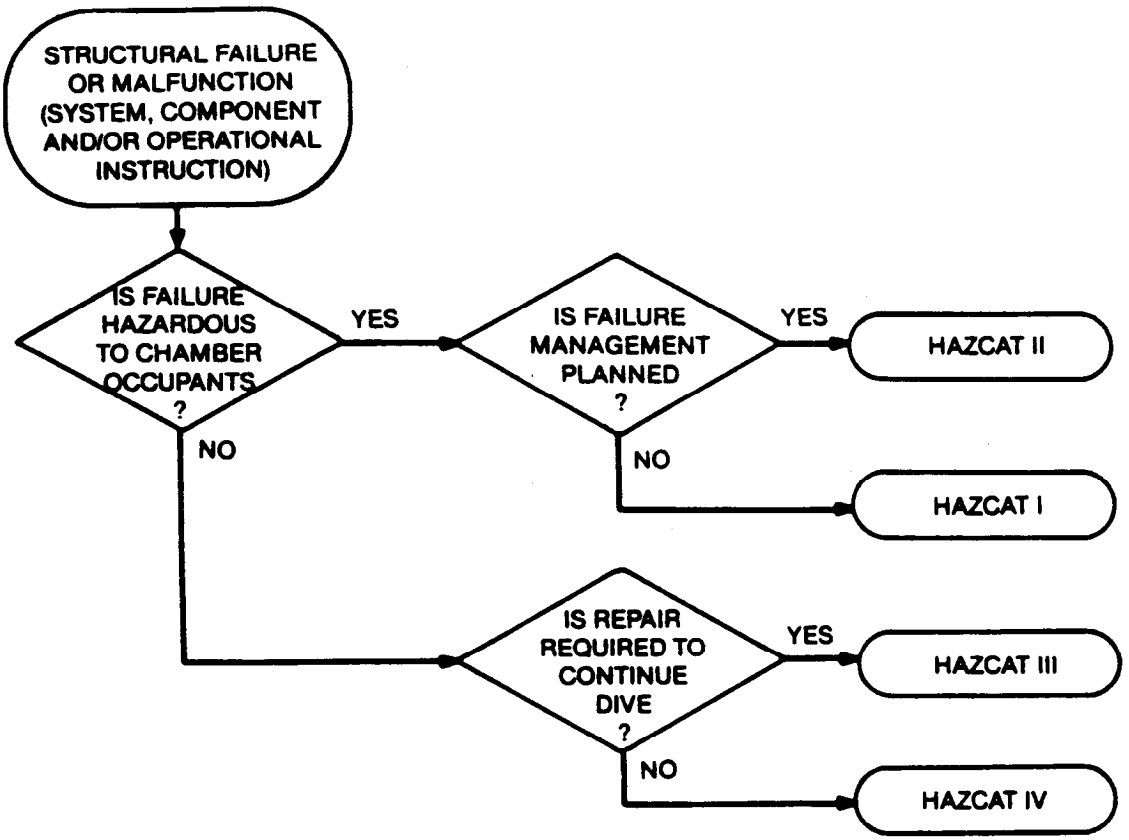


Figure 2-1
Hazard Category Decision Tree

a. HAZCAT I items include the pressure boundary surrounding the occupants/divers up to the first pressure piping stop valves. HAZCAT I items, dependent upon the design, may also include other system piping and components. For example, if no completely independent stand-by system exists then all piping and components would be HAZCAT I.

- Pressure vessel (of occupants/divers).
- Pressure vessel viewports.
- Pressure vessel penetrator fittings.
- Any other item or component which meets the definition for HAZCAT I in paragraph 2.6.3.

b. HAZCAT II items include the systems, equipments and components which provide life support to the occupants/divers and for which a completely independent standby system exists.

- Primary Air Systems
- Stand-by Air Systems
- Vent Systems
- BIBS Systems (O_2 AIR, OVERBOARD DUMP)
- Electrical Lighting
- Communications Systems
- Any other item or component which meets the definition of HAZCAT II in paragraph 2.6.3.

C. HAZCAT III items include the systems, equipments and components providing support to the occupants/divers, which are not life critical, but for which action is required to continue the dive.

- Monitoring Systems
- Flood and Drain Systems for Wet Complexes
- Any other component which meets the definition of HAZCAT III in paragraph 2.6.3.

d. HAZCAT IV items include all systems, equipments and components which are not HAZCAT I, II and III, and for which repairs can be made at a convenient time.

- Medical Lock Pressurization and vent System (excluding lock pressure boundaries)
- Chamber Sanitary Flushing System

2.7 REPORTING REQUIREMENTS

2.7.1 SCA Reports. The following are excerpts from SS521-AA-MAN-010 addressing required reports to the System Certification Authority (SCA):

a. Operating Limits. The diving system shall operate within the certified operational limits specified as part of the requirements for sustaining certification. Operation outside of the authorized operational limits without a valid waiver will result in termination or suspension of system certification. Any

violation shall be reported to the SCA stating the cause or justification.

b. Unusual Situations. The SCA shall be advised of any situation which may prevent the system from maintaining its intended operational capability. These may include, but are not limited to, excursions below certified depth or above certified pressure, physical damage, grounding, entanglements, fires, and emergency ascents or depressurizations and casualties resulting in injury or death. It is not intended that these emergency situations include failures which only temporarily interrupt the operational ability of the system and are corrected by routine repairs. Further, a report shall be submitted containing an evaluation of the extent of damage, proposed repair methods, and probable cause of the emergency (e.g., personnel error, operations, systems, component failures, etc.).

2.8. PERSONNEL TRAINING

2.8.1 Introduction. Personnel involved with the operation and maintenance aspects of man-rated hyperbaric facilities shall, as a minimum, be properly indoctrinated in the areas set forth by this paragraph. It is the responsibility of the command to develop indoctrination procedures which adequately address these specific areas:

a. Operating Personnel.
   (1) System operating manuals.
   (2) System operating procedures.
   (3) System emergency procedures.
   (4) System drawings and schematics.
   (5) System safety precautions.
   (6) Tag-out procedures.
   (7) Reentry control procedures.
   (8) HAZCAT management and maintenance requirements/ procedures.

b. Maintenance Personnel.
   (1) System maintenance manuals.
   (2) System drawings and schematics.
   (3) System safety precautions.
   (4) Equipment and component technical documentation references.
   (5) Maintenance planning and scheduling.
   (6) Maintenance procedures.
   (7) Certification requirements.
   (8) Maintenance and certification documentation.
   (9) Tag-out procedures.
   (10) REC procedures.
   (11) HAZCAT management and maintenance requirements/procedures.

(12) Cleaning procedures.
(13) Personnel qualifications requirements for conducting repairs, inspection and testing.

2.8.2 Personnel Training and Qualifications. Personnel involved in the welding and inspection of man-rated hyperbaric facilities require specific training and qualifications. Commands using in-house personnel to perform these functions shall ensure that the individuals concerned meet the following requirements:

a. Welders: Trained and qualified per one of the following:
(1) MIL-STD-248 (SHIPS) "Welding and Brazing Procedures and Performance Qualification"
(2) ASME Boiler and Pressure Vessel Code, Section IX, "Welding, Brazing Qualification"
(3) ANSI/ASME B31.1, "Power Piping", Section V
(4) NAVSHIPS 0900-001-7000, "Fabrication and Inspection of Brazed Piping Systems"

b. Inspectors: Trained and qualified per one of the following:
(1) ANSI/ASME B31.1, "Power Piping", Section VI
(2) ASME Boiler and Pressure Vessel Code, Section V, "Nondestructive Examination"
(3) NAVSHIPS 0900-001-7000, "Fabrication and Inspection of Brazed Piping Systems"

2.9 FACILITY PRE-DIVE PLANNING

2.9.1 Pre-Dive Planning Events. Facility pre-dive planning for man-rated hyperbaric complexes is an important part of conducting safe operations. Involves ensuring that maintenance has been completed and properly performed, and that personnel are properly indoctrinated and briefed prior to conducting manned hyperbaric or diving operations. The following events should be part of pre-dive planning for all man-rated hyperbaric or diving operations:

a. Operating and maintenance personnel advised of operating requirements and responsibilities/assignments clearly defined per a prepared dive plan (scenario/protocol/dive bill).

b. Maintenance requirements scheduled to be performed consistent with the operating schedule.

c. Maintenance performed, properly inspected and documented.

d. Operating and emergency procedures reviewed and verified adequate.

e. Operating personnel review assignments and applicable operating procedures. For long duration dives this shall include watch-section pre-dive operational dry runs as a unit.

f. Repair supply stocks, supporting HAZCAT failure management and maintenance planning, inventoried and verified ready for installation if needed.

g. Clearing of outstanding RECs and proper removal of red tags on equipment and components.

h. Detailed brief/indoctrination for occupants/divers.

i. Detailed brief of all personnel prior to commencement of hyperbaric/diving operations.

2.10 REFERENCE MATERIALS

To assist facility managers and maintenance personnel in the identification of applicable reference materials, Appendix A is provided.

CHAPTER 3 MAINTENANCE OF HYPERBARIC FACILITIES

3.1 DEFINITION OF TYPES OF MAINTENANCE

3.1.1 Maintenance Types. Maintenance, in the most general terms, involves all actions required to keep the hyperbaric facility in a condition which will allow the safe operation of the facility for all mission requirements. For NAVFAC man-rated hyperbaric facilities, maintenance consists of the following maintenance types:

- o General Maintenance
- o Repairs
- o Alterations
- o Overhauls

Each of these maintenance types is defined in the paragraphs that follow.

3.1.2 General Maintenance. General maintenance includes all maintenance that is routine in nature and which does not involve the fabrication of materials. Included under general maintenance are actions such as calibration, replacement of soft goods, lubricant renewal, painting, filter replacement, system and component inspections, cleaning, sampling of oil and air, and testing.

General maintenance consists of two sub-elements which are addressed in detail under Section 3 of this chapter:

- o Scheduled Maintenance
- o Unscheduled Maintenance

3.1.3 Repairs. Repairs are maintenance actions which require the fabrication of piping or components, and for which there is no deviation from the original design. Included under repairs are actions such as: replacement of piping, component replacement involving welding, machining of parts or components, cladding, stud replacement and weld repairs. It is emphasized that repairs do not involve deviation from the original design. Therefore, the replacement of a valve with the valve of a different manufacturer which meets the original design specifications, constitutes a repair. Should the replacement valve not meet the original design specifications, or should such specifications not exist as is the case with some older facilities, then the valve change would be treated as an alteration.

3.1.4 Alterations. An alteration is an approved permanent change from the as-certified design, material, configuration or performance. This includes any change which affects the pressure containing capability of the system and non-physical changes such as an increase or decrease in the maximum allowable working pressure. Included under alterations are actions such as: rerouting of piping, material changes to piping or components, component additions or deletions, and component replacements which change performance characteristics.

It is emphasized that alterations require approval from the NAVFAC SCA prior to making the changes to the facility. This prior approval includes the review of the proposed alteration(s) to verify that the submitted drawings and supporting documentation comply with applicable standards, specifications and authoritative requirements documents.

Alterations should not be confused with departures from specifications. Departures are temporary approved changes which do not require the update of associated system documentation and drawings. Alterations are permanent approved changes to the facility, which do require the update of system documentation and drawings.

3.1.5 Overhauls. Overhaul maintenance consists of those maintenance actions performed during a designated period, normally every three to six years. During an overhaul period major maintenance actions are accomplished such as: compressor rebuilding, storage flasks refurbishment/replacement, major piping system changes, and pressure vessel modifications. Additionally, outstanding repair actions, pending alterations and outstanding departures from specification may be included in the overhaul "package" depending on available funding.

The major concern of the hyperbaric facility manager, with respect to an overhaul, will be funding for the maintenance work to be conducted. Both O&MN and Special Project Funds are normally involved, so advanced planning and close liaison with the major claimant by the command are necessary.

3.2 APPROVAL OF MAINTENANCE ACTIONS

3.2.1 Maintenance Notification Approval Requirements. This section provides guidance concerning the proper notification and subsequent approval of maintenance performed on man-rated hyperbaric facilities. Notification and approval is dependent upon the HAZCAT of the system/component involved. Table 3-1, Maintenance Notification and Approval Requirements for Man-Rated Hyperbaric Facilities, shall be complied with if required by the SCA during certification of the facility.

TABLE 3-1
Maintenance Notification and Approval Requirements
for NAVFAC Man-Rated Hyperbaric Facilities

HAZCAT LEVEL PER MIL-STD-882	HAZCAT I			HAZCAT II			HAZCAT III		
MAINTENANCE TYPE	Notify SCA	APPROVAL		Notify SCA	APPROVAL		Notify SCA	APPROVAL	
		SCA	Facility Mgr.		SCA	Facility Mgr		SCA	Facility Mgr.
General Maintenance	No	No	Yes	No	No	Yes	No	No	Yes
Repairs	Yes	No	Yes	Yes	No	Yes	No	No	Yes
Alterations	Yes*	Yes*	_ _ _ _ _	Yes*	Yes	_ _ _ _	Yes	Yes	Yes
Overhauls	Yes*	Yes*	_ _ _ _ _	Yes *	Yes	_ _ _ _ _	Yes	No	Yes

* - In advance of implementing modifications(s)
NOTE 1 - Performance of all maintenance requires use of qualified personnel.
NOTE 2 - Records must be maintained on file by the facility for all maintenance actions performed.
NOTE 3 - The Facility Manager is that individual designated in writing by the command, who is responsible for the maintenance and safe operation of the hyperbaric facility.

3.3 GENERAL MAINTENANCE

3.3.1 Introduction. This section defines the two elements of general maintenance, scheduled maintenance and unscheduled maintenance, and outlines the objectives for each. General maintenance concepts are also briefly addressed.

3.3.2 Scheduled Maintenance. Scheduled maintenance is all maintenance which is scheduled and performed on equipment, components and systems prior to anticipated failure or operational degradation below acceptable standards/criteria. Scheduled maintenance actions are the minimum required to maintain equipment in a fully operable condition, and within specifications. When performed according to schedule, these scheduled maintenance actions will provide the means to identify parts requiring replacement prior to failure and are, therefore, preventive in nature. Scheduled maintenance is intended to prevent equipment, component and system failures which might otherwise result in repeated unscheduled (corrective) maintenance actions.

The primary objective of scheduled maintenance is to provide for managing and conducting maintenance in a manner which will ensure maximum operational readiness of the man-rated hyperbaric facility. Therefore, scheduled maintenance shall be established to meet the following intermediate objectives:

a. Achievement of specific maintenance standards, specifications and criteria including manufacturer's recommended maintenance.

b. Effective use of available manpower and material resources in maintenance and maintenance support.

c. Documenting of information relating to maintenance and maintenance support actions.

d. Improvement of maintainability and reliability of systems, equipments and components by provision of documented maintenance information for analysis.

e. Identification and reduction of the cost of maintenance and maintenance support in terms of manpower and material resources.

f. Provide the means to properly schedule, plan, manage, and track maintenance.

g. Collect data on which to base improvements in design and spare parts support.

On applicable equipment, components and systems, commands are encouraged to make use of the Planned Maintenance System (PMS)

delineated by OPNAVINST 4790.4A. PMS is an established scheduled maintenance program which provides detailed maintenance procedures and periodicity of performance for many of the equipments, components and systems that are found in shore-based hyperbaric facilities.

3.3.3 Unscheduled Maintenance. Unscheduled maintenance is maintenance which is necessitated by equipment, component or system failure or degradation below acceptable standards/criteria. Unscheduled maintenance is, therefore, corrective in nature.

For man-rated hyperbaric facilities it is required that all equipments, components and systems be analyzed and their hazard category (HAZCAT) identified, per the guidance in Chapter 2, Section 6, prior to the conduct of manned operations. This HAZCAT identification determines the planning and provisioning of unscheduled maintenance. Items identified as HAZCAT I do not require provisions for unscheduled maintenance since their failure would be, by definition, not repairable without aborting the dive. HAZCAT II items, those for which failure would endanger the lives of the occupants/divers, are repairable. HAZCAT II items shall have maintenance procedures available to initiate immediate repairs including the availability of spare parts. HAZCAT III items are those which do not endanger the lives of the occupants/divers but repair in order to continue the dive. HAZCAT III items require available maintenance procedures including the availability of spare parts, should the command desire to continue the dive profile. Although the maintenance procedures for HAZCAT II and HAZCAT III items may be the same as those used for scheduled maintenance of the same items, the difference is that spare parts must be physically located at the hyperbaric facility which are ready for installation and readily accessible.

The primary objective of unscheduled maintenance for man- rate hyperbaric facilities is to provide for maintenance management and support in a manner which will ensure maximum safety of the occupants/divers and continued operation of the facility. Therefore, unscheduled maintenance will be established to meet the following intermediate objectives:

a. Identification of the HAZCAT for all systems, equipments and components.

b. Failure management planning for correction of HAZCAT II items (HAZCAT III items at command option).

c. Spare parts provisioning for all HAZCAT II items (HAZCAT III items at command option).

d. Scheduled maintenance performance on all spare parts for HAZCAT II items (HAZCAT III items at command option).

e. Establishment of a system to ensure that spare parts for HAZCAT II items are accessible if needed (HAZCAT III items at command option).

f. Documenting of information related to unscheduled maintenance actions.

g. Provide the means to schedule, plan, manage and track unscheduled maintenance that is not failure management related.

h. Provide for the collection of data from unscheduled maintenance actions on which to base improvements in equipment design, spare parts support, maintenance procedures and operational procedures.

3.3.4 General Maintenance Concents. The successful performance of general maintenance on man-rated hyperbaric facilities is predicated on the achievement of proper support in the following areas:

- o Operating and Maintenance Technical Documentation.
- o Supply Support (Repair Parts, Lubricants, Replacement Elements, etc).
- o Maintenance Planning.
- o Maintenance Funding.
- o Maintenance Performance and Documentation.
- o Operating and Maintenance Indoctrination.

3.4 SCHEDULED MAINTENANCE SYSTEM

3.4.1 Maintenance System Requirements. A maintenance system, for all NAVFAC man-rated hyperbaric facilities/systems, will be established at the command level to meet the objectives outlined in Section 1, paragraph 1 of this chapter. Commands are encouraged, but not required, to use the Planned Maintenance System (PMS) delineated by OPNAVINST 4790.4A, either in whole or in part. Use of the PMS will meet or exceed all maintenance objectives put forth in this manual. Commands not using PMS will maintain equipments in accordance with existing procedures such as manufacturer's technical manuals, technical bulletins, etc., and shall comply with the maintenance objectives of this manual.

Maintenance systems for NAVFAC man-rated hyperbaric facilities systems shall, as a minimum, provide the following:

a. Define requirements for conducting scheduled maintenance.

b. Scheduling and monitoring of maintenance performance through the use of cycle, quarterly, and weekly schedules.

c. Comprehensive maintenance procedures (e.g., PMS, technical manuals, technical bulletins, etc.).

d. Maintenance Check-off Sheets which include the materials, tools, personnel and procedures required to properly perform the maintenance.

e. Documentation of the equipment conditions found while conducting maintenance (can be incorporated into and recorded on the Maintenance Procedure Check-off Sheets). Commands using PMS will use the Maintenance Data System (MDS).

3.4.2 Maintenance Periodicity. All equipment maintenance actions shall be assigned periodicity codes which reflect how often they are to be performed. The following periodicity codes shall be used:

W - Weekly	24M - Every 24 Months
M - Monthly	36M - Every 36 Months
Q - Quarterly	60M - Every 60 Months
S - Semiannually	72M - Every 72 Months
A - Annually	

NOTE: Should the need arise, commands may use other periodicity codes (e.g., 18M - Every 18 months, 2W - Every 2nd week, etc.).

For maintenance actions which do not have regular performance periods the following codes shall be used:

*R - Situation Requirement ("As Required")
U - Unscheduled Maintenance

NOTE:* - Situation Requirements are used as scheduling reminders for equipments such as compressors, which require maintenance either periodically or after a fixed number of operational hours (i.e., annually or every 600 hours, the more frequent is followed).

Each maintenance action will be assigned a title, periodicity code and number which uniquely identifies that maintenance action (E.g.: #1 L.P. Compressor Filter, A-l; Operate and Leak Test Piping Valves, M-2). Additional guidance on maintenance requirements and periodicity is provided in Section 6 of this chapter.

3.4.3 Scheduling and Monitoring Maintenance.

a. Cycle Schedule. This schedule shall list scheduled maintenance for all equipments during a complete maintenance cycle. This cycle will be established by the command and may be set to coincide with major events such as an overhaul period or a certification tenure period. No prescribed format is required for this cycle schedule, however, the format provided in Figure 3-1 is recommended. The hyperbaric facility manager shall be directly responsible for maintaining this cycle schedule.

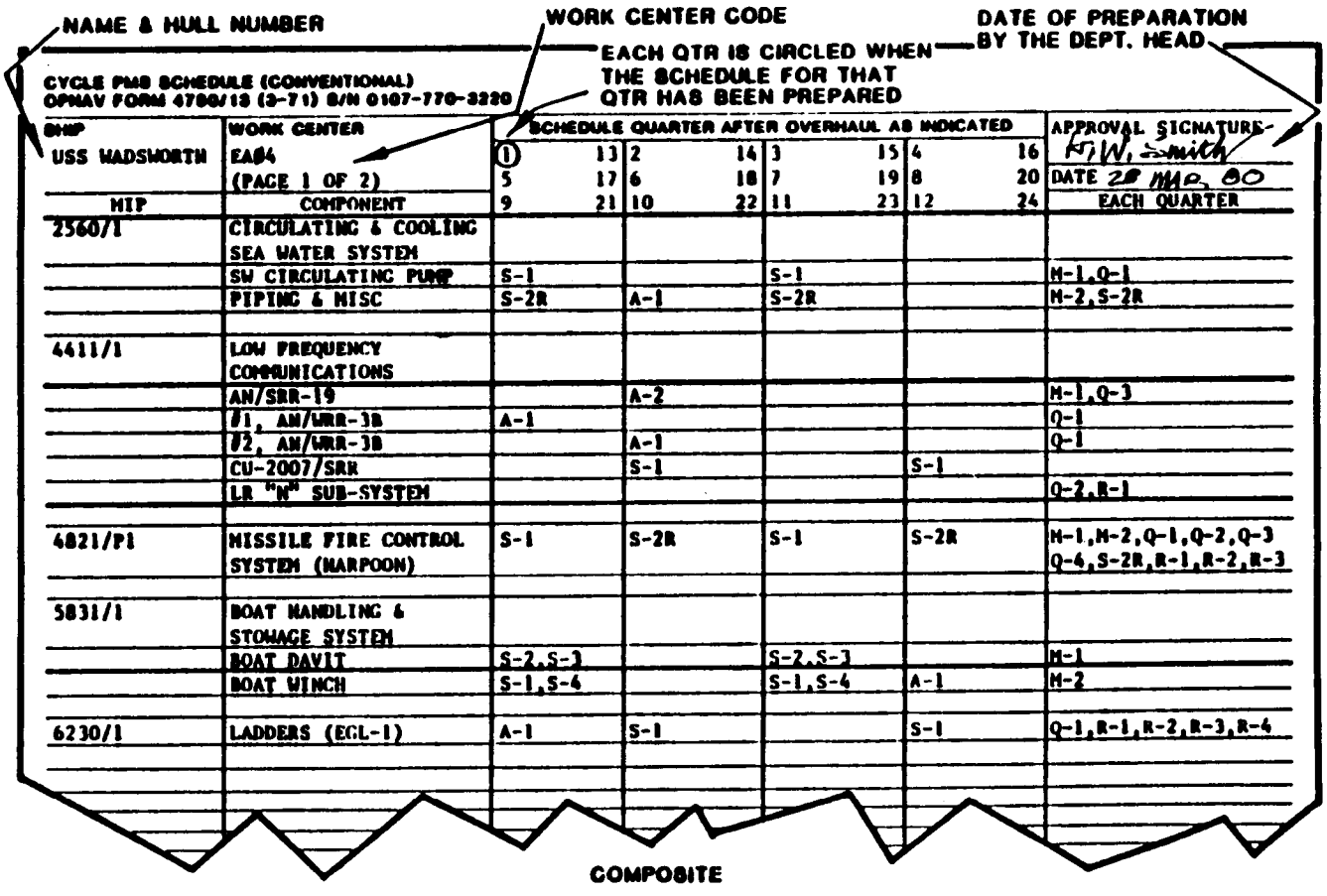


Figure 3-1 Cycle Schedule

b. Quarterly Schedule. This schedule shall list scheduled maintenance for the quarter and shall be used to monitor maintenance performance. Additionally, this schedule will reflect periods during which the hyperbaric facility/system is scheduled for operational use or in a duty status (e.g., standby chamber). Figure 3-2 shows a completed Quarterly Schedule. This schedule format shall be used for scheduling maintenance and shall be kept on file as a maintenance record a minimum of 5 years or the end of the cycle. Daily and weekly maintenance actions shall be noted on the line directly under the maintenance action ID #. Note that completed maintenance actions are simply crossed-out with an "X". Rescheduled maintenance actions are "circled" and then rescheduled. If the rescheduled action can be performed during the same quarter then the identifying code is moved to a suitable week and an arrow shows where it was rescheduled from. If the rescheduled action cannot be performed during the same quarter, then the identifying code is placed in the rescheduled column for scheduling on the next quarterly schedule. This schedule shall be updated weekly.

c. Weekly Schedule. This schedule shall list scheduled maintenance for the week and shall be used to monitor accomplishment. Figure 3-3 shows a completed Weekly Schedule. This schedule format shall be used for weekly maintenance scheduling and shall be kept on file a minimum of one year. Note that completed and rescheduled actions are handled the same way as on the Quarterly Schedule.

d. Maintenance Procedure Check-Off Sheets. These sheets will be prepared for each maintenance action. The intent is to provide personnel performing the maintenance action with a checklist to follow which includes: materials and tools needed, personnel requirements, and the specific procedures to be followed in a check-list format. Figure 3-4 shows a sample Maintenance Check-Off Sheet in the required format. The person conducting the maintenance action shall initial the accomplishment of each step in the procedure as it is accomplished. Equipment/component conditions and problems encountered while performing maintenance will be noted on the back of the maintenance procedure check-off sheet. These sheets will be stapled to the Weekly Schedule at the end of each week and maintained on file a minimum of one year.

3.5 UNSCHEDULED MAINTENANCE SYSTEM

3.5.1 General. Unscheduled maintenance on man-rated hyperbaric facilities can occur during two situations as follows:

a. Facility not conducting a manned dive.
b. Facility conducting a manned dive.

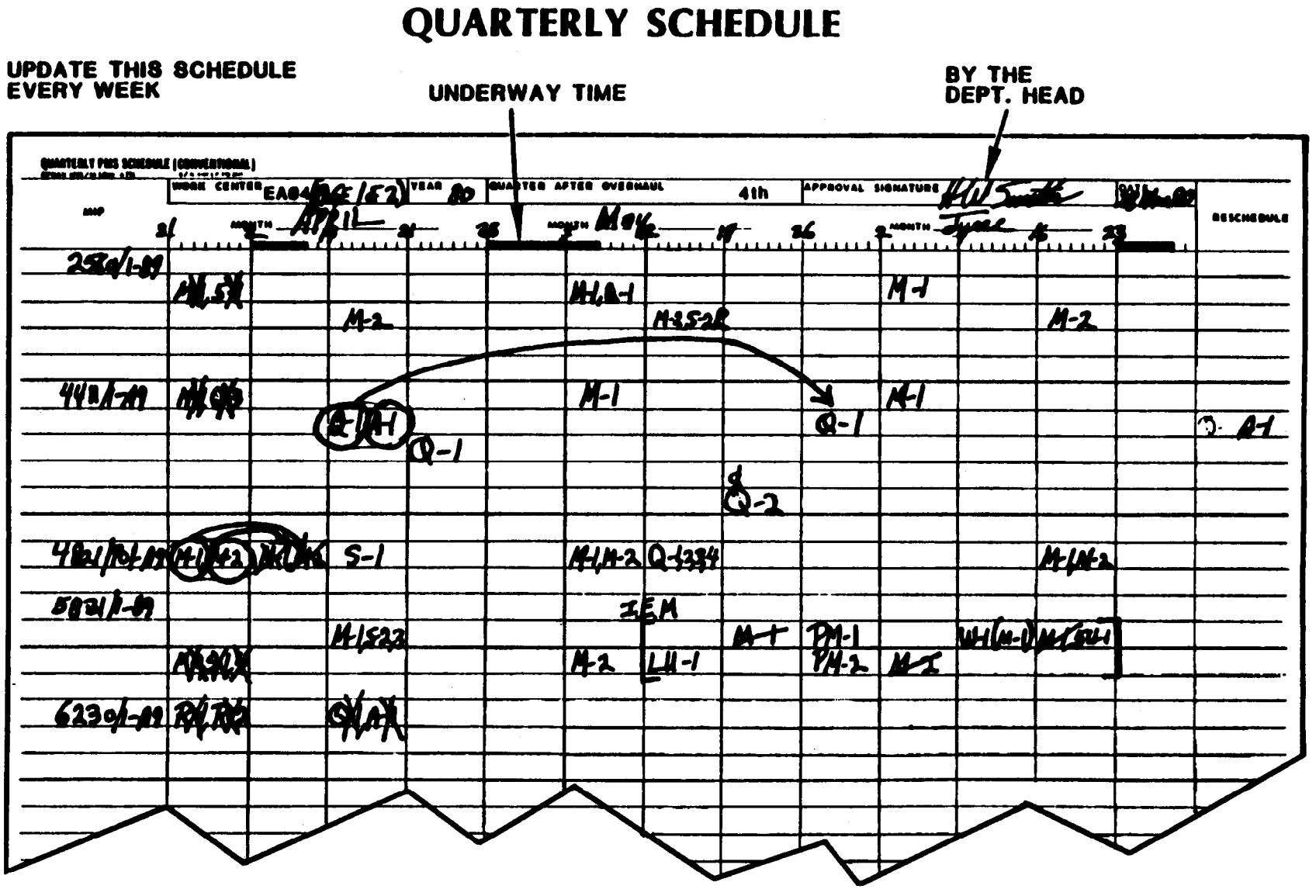


Figure 3-2 Quarterly Schedule

WEEKLY SCHEDULE

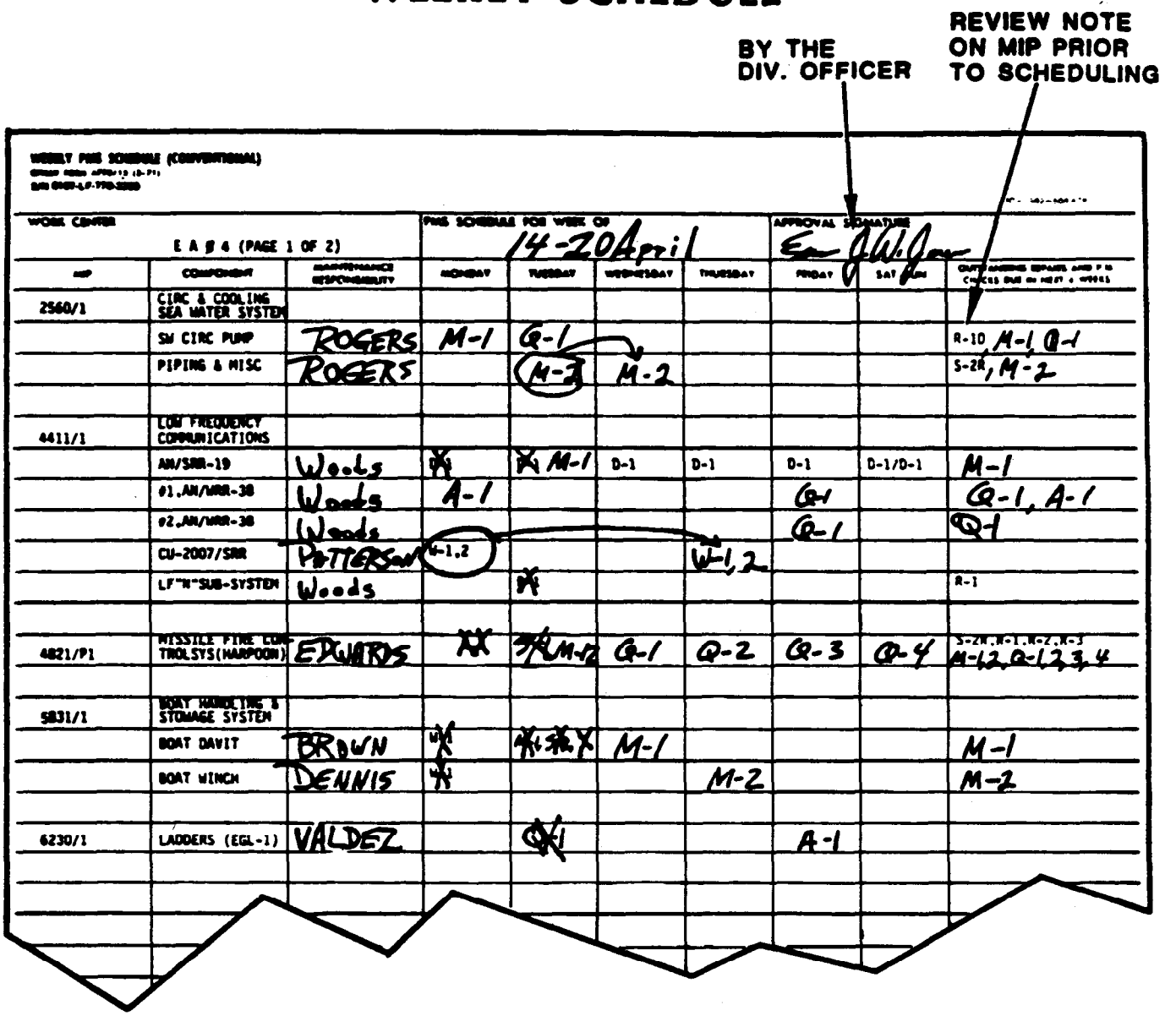


Figure 3-3
WEEKLY SCHEDULE

FACILITY: NRRO, Charleston, S.C.	SYSTEM: Engine Driven Air Compressor	MAINT.CODE: W-1

MAINTENANCE DESCRIPTION: Inspect oil levels and rotate idle compressor by hand.

PERSONNEL REQUIREMENTS: Qualified Hyperbaric Maintenance Technician or U.S. NAVY Diver.

SAFETY PRECAUTIONS: Shore activities comply with Safety Precautions for Shore Activities, NAVMAT P-5100 Series.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

MATERIALS

1. Rag. wiping
2. Tag. safety
3. Oil, MIL-9000, Symbol 9250
4. Oil, MIL-L-17332, Symbol 2190-TEP

PROCEDURE

NOTE: Idle is defined as not having been operated in the past 7 days.

Preliminary

_____ a. De-energize/deactivate starting circuit/system and tag "Out of Service."

1. Inspect Oil Levels; Rotate Idle Compressor Crankshaft By Hand.

_____ a. Inspect compressor crankcase oil level. Proper level is half full in indicator sight glass. If replenishment is required, use oil symbol 2190-TEP.

_____ b. Remove engine oil level dipstick and inspect oil level. Proper level is at full mark on dipstick. If replenishment is required, use oil symbol 9250.

_____ c. Clean and reinstall dipstick.

_____ d. Rotate compressor crankshaft by hand; inspect for free and easy movement.

_____ e. Remove safety tag and energize/activate starting circuit/system.

MAINTENANCE SUPERVISOR'S SIGNATURE:	Date:

Figure 3-4
MAINTENANCE PROCEDURE CHECK-OFF SHEET

When unscheduled maintenance is identified and the facility does not have a manned dive in progress, then the required maintenance will be treated as scheduled maintenance. The maintenance action will be scheduled maintenance periodicity code preceded by a "U" (i.e., US-2). Unscheduled maintenance identified while the facility has a manned dive in progress is dependent upon the HAZCAT of the equipment involved as previously discussed in Section 3, paragraph 2, of this chapter. Further guidance on managing and conducting such maintenance is provided in the paragraphs that follow.

3.5.2 Manned-Operations Failure Management Planning (FMP). As previously discussed in Chapter 2, Section 6, failure management planning (FMP) is required for HAZCAT II items. Such planning requires the integration of the following:

- Emergency procedures.
- Maintenance control.
- Maintenance procedures.
- Spare parts availability.

Further, failure management planning (FMP) involves:

- Analyzing HAZCATs.
- Review of emergency procedures.
- Review of maintenance control mechanism & responsibilities.
- Establishment of approved maintenance procedures.
- Review of spare parts availability **&** maintenance.
- Personnel indoctrination & Training.

3.5.3 Manned-Operations Failure Management Maintenance (FMM). FMM involves the actual implementation of the FMP. The following steps outline the procedures for conducting FMM.

a. Step 1 in FMM is the initiation of the applicable emergency procedure (s). When the chamber occupants have been isolated from the immediate danger, the secondary life-support system is known to be functioning properly, and the situation is firmly under control the unscheduled maintenance can be initiated.

b. Step 2 in FMM is the control of maintenance operations. This involves strict liaison between the Dive Watch Supervisor and the Maintenance Supervisor. The Dive Watch Supervisor is responsible for ensuring that the system is lined up so that maintenance can be conducted, re-entry control initiated and tag-out procedures followed. The Maintenance Supervisor is responsible for providing the maintenance check-off sheets and ensuring that the proper materials, tools and people are ready to conduct the maintenance. Prior to conducting the maintenance action the Maintenance Supervisor must receive an approved REC sheet signed by the Dive Watch Supervisor.

c. Step 3 in FMM is conducting the actual maintenance action. The maintenance shall be conducted in accordance with approved procedures and performed as quickly as possible consistent with performing proper maintenance.

d. Step 4 in FMM is proper removal of the equipment tags and close out of the REC.

NOTE: For HAZCAT III maintenance actions that are initiated during a dive these same FMM procedures shall be applied.

3.6 MAINTENANCE DOCUMENTATION REQUIREMENTS

3.6.1 General. In addition to the maintenance scheduling and procedural documentation previously discussed in this chapter maintenance documentation requirements exist for the following:

a. Work Orders for maintenance and repair work performed by other activities.
b. Re-Entry Control.
c. Quality Assurance (QA).
d. Design Changes and Drawing Updates.
e. Testing and Inspection.
f. Fabrication and In-Process Procedures.
g. Material Identification and Control.

5. Each of these areas is addressed in detail in Chapters 4 and

3.7 GENERAL MAINTENANCE PRACTICES

3.7.1 Cleaning Practices and Sampling Procedures. The purpose of this section is to provide procedural guidance for the proper cleaning of man-rated hyperbaric life support systems. Cleaning practices involve a wide variety of actions to ensure safe and reliable performance of the systems during their intended operations. Generally, cleaning practices can be divided into two categories:

a. In-place piping systems which are best processed for cleaning in their installed locations(s).

b. Components/equipments which are easily removed from the piping system for cleaning in a clean room environment.

The safe and reliable operation of man-rated hyperbaric life support systems requires that appropriate system cleanliness levels be achieved and maintained. Every manrated hyperbaric system/facility which is certified, or in pursuit of certification,

must have approved cleaning process procedures. These cleaning procedures shall be promulgated as a command instruction. Additionally, system drawings are required to have cleaning, provisions noted on the drawings (NAVFAC DM-39 refers).

NAVFAC Design Manual DM-39, Section 12, contains a list of cleaning standards and specifications commonly used for breathing gas and oxygen piping systems. Although these cleaning standards and specifications contain accurate criteria for cleaning, most do not specify the procedural steps to be followed. The paragraphs that follow are organized into two procedural categories and list the recommended cleaning, testing, and inspection procedural steps in their required sequence. It is reasonable to expect that some situations may arise where an acceptable end product may be reached through deviations from these established procedural sequences. Any deviations from these procedural sequences will require a departure from specification/waiver in accordance with established procedures.

In-Place Piping Systems, Cleaning and Testing Sequence:

a. Preparation of flushing, drying and testing scheme and approval.
b. Component removal, system preparation and inspection.
*c. Pre-flush with cleaning agent (e.g., PCA, TSP, NID) to remove hydrocarbons.
*d. Hydrostatic test with Grade B water (see glossary).
e. Flush with cleaning agent to remove hydrocarbons.
f. Inspect for hydrocarbon removal.
g. Rinse with Grade B water.
h. Inspect for particulate level and Grade B water conformance.
i. Dry.
j. Remove test equipment and re-assemble system.
k. Inspect valve seat tightness.
l. Inspect system tightness.
*m. Perform drop test/extended tightness test.
n. Perform gaseous contaminants check.

NOTE:* - Not required for re-cleaning of gas systems which have not been modified.

Component/Equipment, Cleaning and Testing Sequence:

a. Pre-cleaning (degreasing/steam cleaning/sandblasting).
b. Disassembly.
c. Cleaning with solvents (ultrasonic/manual).
d. Inspect for hydrocarbon removal.
e. Rinse with Grade B water (rinse/flush).
f. Inspect for particulate level and Grade B water conformance.
g. Dry.
h. Particulate inspection verification.
i. Re-assembly.
j. Test/Adjust/Calibrate as required.

k. Packaging
l. Identification/Labeling.

WARNING: Some cleaning standards and specifications list trichloroethylene and methyl chloroform as cleaning agents-- NAVFAC DM-39 specifically prohibits the use of these two agents for cleaning man-rated hyperbaric systems.

3.7.2 Gas Sample Analysis. Every six months or after cleaning, hydrotesting, and assembly, a gas sample shall be taken from each system that contains gases that will be breathed by chamber occupants and analyzed for trace contaminants. Trace contaminants and their maximum limits shall be in accordance with Table 3-2 or "Limits for Atmospheric Constituents, 90-day Limit" (Table E-2), Appendix E, Diving System Environmental Control, SS521-AA-MAN-010. Test reports shall be completed.

TABLE 3-2
STANDARD FOR AIR IN HYPERBARIC FACILITIES

Parameter	Limit
Oxygen	20-22% by volume
Carbon dioxide	1000 ppm maximum
Carbon monoxide	20 ppm maximum
Total hydrocarbons other than methane	25 ppm maximum
Particulates and oil mist	5 mg/m3 maximum
Odor and taste	Not objectionable

NOTE: These standards are applied to nonsaturation air dives and are measured at standard temperature and pressure. During normal gas other than methane analysis, hydrocarbons are first converted to methane and analyzed methane value is then subtracted from this result to give the value for unknown hydrocarbons. Unknown hydrocarbons should not exceed 25 ppm.

3.8. EQUIPMENT AND COMPONENT MAINTENANCE PRACTICES

3.8.1 General. This section addresses specific maintenance practices to be used as a base line for the development of maintenance procedures for man-rated hyperbaric facilities. These maintenance practices address the requirements and

recommended minimum frequency of performance for equipments and components under the following major areas:

a. Air Source (Compressors, air storage flasks).
b. Piping System (Piping, valves, regulators, filters, reliefs, etc.).
c. Recompression Chamber (Valves, BIBS, hatches, lighting, etc.).

Detailed recommended maintenance procedures for each of the maintenance practices addressed by this section are provided in Appendix D.

3.8.2 Breathing Gas Supply Equipment Maintenance Practices

a. Engine Driven Air Compressor.
(1) Weekly:
(a) Sample and inspect lubricating oil.
(b) Inspect oil level and rotate compressor crankshaft by hand.

(2) Monthly:
(a) Inspect/clean air coolers, fan, hoses and fittings.
(b) Inspect/renew discharge air filter.
(c) Test operate compressor, lift relief valves(s) by hand, and test air inlet and discharge valves.
(3) Quarterly:
(a) Inspect receivers, coolers and piping for external corrosion, and sound and tighten foundation bolts.
(4) Semiannually or Per Manufacturers Recommended Number of Operating Hours (first to occur):
(a) Renew oil in compressor crankcase
(b) Clean compressor air intake filter.
(c) Inspect drive belt tension.
(d) Renew oil in engine crankcase and clean fuel sediment bowl.
(e) Measure spark plug and breaker point gap.
(f) Clean engine air filter.
(5) Annually:
(a) Test operate the compressor and inspect air system piping under full working pressure.
(b) Test all relief valves for proper lifting pressure.
(6) Per Cycle (Normally 3 to 4 Years):
(a) Test over-temperature shut down device.
(b) Disassemble compressor and inspect internal parts for wear.

b. Electric Driven Air Compressor.
   (1) Weekly:
      (a) Sample and inspect lubricating oil.
      (b) Inspect compressor oil level and rotate compressor crankshaft by hand.
   (2) Monthly:
      (a) Inspect/clean air coolers, fan, hoses and fittings.
      (b) Inspect/renew discharge air filter.
      (c) Test operate compressor, lift relief valve(s) by hand, and test air inlet and discharge valve(s).
   (3) Quarterly:
      (a) Inspect receivers, coolers and piping for external corrosion, and sound and tighten foundation bolts.
   (4) Semiannually or Per Manufacturers Recommended Number of Operating Hours (first to occur):
      (a) Renew oil in compressor crankcase.
      (b) Clean air compressor air intake filter.
      (c) Inspect drive belt tension.
   (5) Annually:
      (a) Test operate the compressor and inspect air system piping under full working pressure.
      (b) Test all relief valves for proper lifting pressure.
   (6) Per Cycle (Normally 3 to 4 years):
      (a) Test over-temperature shut down device.
      (b) Disassemble compressor and inspect internal parts for wear.

c. Compressed Gas Storage Flasks.

(NOTE: Inspect and test IAW MO-324, Hyperbaric Facility Support Pressure Vessels)

   (1) Every 24 Months:
      (a) Inspect compressed gas flasks.
   (2) Every 72 Months:
      (a) Strength test compressed gas flasks.

3.8.3 **Pi**ping System Maintenance Practices.

a. Air System Piping.
   (1) Monthly:
      (a) Operate air system valves.
   (2) Quarterly:
      (a) Inspect piping and inspect/operate valves, including leak test.
      (b) Inspect/Renew filter elements and clean filter sump(s).
      (c) Inspect/Renew cartridge(s) in air purifier(s).
      (d) Strength test hose 5 to 9 years old from date of manufacture.

(3) Semiannually:
(a) Take air analysis sample(s) [See recompression chamber maintenance practices].
(b) Calibrate pneumofathometer and scuba charging gauges.
(4) Annually:
(a) Test relief valves.
(b) Test reducers and test pressure piping of air system at maximum operating pressure.
(c) Calibrate piping system gauges.
(d) Strength test scuba charging hose(s).
(5) Every 24 months:
(a) Inspect Hyperbaric Facility Support Pressure Vessels. Internally and externally inspect all piping system pressure vessels (filters, moisture separators, etc.) with an internal diameter greater than three inches and a MAWP greater than 250 psig per NAVFAC MO-324.
(6) Every 72 months:
(a) Inspect and strength test all piping system pressure vessels (filters, moisture separators, etc.) with an internal diameter greater than three inches per NAVFAC MO-324.

b. Oxygen System Piping.
(1) Monthly:
(a) Operate oxygen system valves.
(b) Operate and inspect oxygen regulator.
(2) Quarterly:
(a) Inspect piping including leak test.
(b) Inspect flexible hoses and fittings, including leak test.
(3) Annually:
(a) Strength test hoses 5 to 9 years old from date of manufacture [Dates checked during quarterly inspections].

3.8.4 Recompression Chamber Maintenance Practices.
a. Recompression Chamber.
(1) Monthly:
(a) Visually inspect and lubricate door gaskets.
(b) Visually inspect viewing port gaskets in place.
(c) Visually inspect viewports.
(d) Clean and inspect chamber, and test chamber communications system.
(e) Inspect and clean circuit breaker/fuse panel supplying chamber electricity.
(f) Clean, inspect and sterilize breathing apparatus (BIBS masks). [Also performed after every use.]
(g) Operate chamber valves through complete turning

(h) Test emergency lighting and inspect/replace

battery(s).

(2) Quarterly:
   (a) Lubricate chamber door hinges and associated moving parts (e.g., door dogs, spider worm gear, etc.).

(3) Semiannually:
   (a) Air analysis sample(s). [HPAC and AIR SYSTEM.]
   (b) Comparison check of Roylyn gauges.
   (c) Inspect electrical wiring and lighting.

(4) Annually:
   (a) Inspect and test chamber relief valve(s).

(5) Every 24 Months:
   (a) Pressure test per U.S. Navy Diving Manual.

3.9 MISCELLANEOUS GENERAL MAINTENANCE GUIDANCE

3.9.1 Lubricants and Sealants. Maintenance personnel must ensure that lubricants and sealants introduced into the hyperbaric facility are suitable for use in high pressure air and oxygen environments. Lubricants and sealants used shall be selected from the tables listed in NAVFAC DM-39, Chapter 12.

3.9.2 Chamber Painting. Only steel chambers are painted. Aluminum chambers are normally a dull, uneven grey color and corrosion products can be easily recognized. Painting an aluminum chamber will hide and further encourage corrosion. Steel chambers shall be painted as delineated per NAVFAC DM-39, Chapter 8. (Note: MIL-E-17970 and MIL-E-17972 have both been superseded by DOD-E-24607).

3.9.3 Piping Color Code and Labeling. Hyperbaric facility piping and tubing must be color coded and labeled to indicate contents, function, direction of flow and possible hazards. Piping color code and labeling shall comply with the requirements of NAVFAC DM-39 Chapter 5.

CHAPTER 4. CERTIFICATION REQUIREMENTS FOR MAN-RATED HYPERBARIC FACILITIES

4.1 INTRODUCTION AND OVERVIEW

4.1.1 Purpose. This NAVFAC Hyperbaric Systems Maintenance Manual is issued to comply with applicable certification policy and provides maintenance personnel with guidance for the administration of certification documentation associated with hyperbaric system maintenance. Certification documentation guidance includes, but is not restricted to, operation, maintenance, repair, and modification of a certified diving system or manned hyperbaric facility.

4.1.2 Introduction. System certification, as it applies to man-rated hyperbaric facilities, is a systematic process for providing maximum assurance that the system is materially and procedurally adequate to safely operate within the intended mission profile. This chapter contains guidelines for maintenance personnel involved in this certification process for shore-based hyperbaric facilities. The intent of this document is to provide practical certification guidance in amplification of the requirements of SS521-AA-MAN-010.

4.1.3 Background. The certification process and the assignment of responsibilities through the unit level are defined by NAVFACINST 9940.1 and amplified by NAVFACINST 5420.19. The two principals involved are the system sponsor and the NAVFAC SCA. The system sponsor may be identified as a commanding officer, officer in charge, or program manager of a command or activity that supports, operates, or develops Deep Submergence Systems.

The system sponsor is responsible for ensuring that his system is certified in accordance with the established certification procedures. The NAVFAC SCA is responsible for ensuring an adequate certification review process, but is not responsible for upgrading the sponsor's system to, or maintaining it in a certified condition. The SCA will, however, answer the sponsor's questions and conduct impartial technical reviews of the system and associated documentation to determine if it is adequate and safe.

SS521-AA-MAN-010 constitutes the procedural and technical guidance for the prosecution of certification. It provides guidelines to help the sponsor decide what type of supporting documentation should be provided for materials, testing, and system operation. of primary concern to the sponsor is an understanding of the steps required to have the system certified. System

Certification is achieved by following a logical sequence of events which will be addressed in detail later in this chapter.

4.1.4 General. The Naval Facilities Engineering Command (NAVFAC), via the chain of command, has been assigned the responsibility for the development, promulgation, and implementation of procedures and criteria by which personnel safety of man-rated hyperbaric facilities is to be evaluated. These procedures and criteria are known as the Deep Submergence System Certification Program. NAVFAC has system certification responsibilities for all Navy shore-based manned hyperbaric and deep ocean simulation pressure chamber complexes; these include all permanently installed shore-based recompression and decompression chambers, diving pressure tanks and pressure vessels that are used for testing manned equipment, which is a permanent part of a shore facility. It should be mentioned that systems belonging to industrial and educational institutions may also be included since they must be certified if leased by the government for use by Navy or government personnel. Additionally, NAVFAC provides assistance to other services and government agencies when requested.

Objectives. The objective of the system certification process is to verify that these systems provide acceptable levels of personnel safety throughout the specified operating range when used in accordance with approved operating and maintenance procedures. The system certification process is concerned with establishing maximum reasonable assurance of the recovery of personnel without injury, and the deliberate avoidance of conditions that could imperil the lives and well-being of operating personnel.

b. Procedure. System certification is a methodical, independent review of the facility/system documentation and hardware. This review is conducted to verify that system elements have been designed and constructed with proper materials; assembled, cleaned, and performance-tested in accordance with accepted engineering practices; and that the operating and maintenance manuals provide sufficient information to allow the system to be operated safely. This independent review and effective control of design, fabrication, testing, construction, inspection, maintenance, and operation is necessary because of the complexity of the systems involved and the immediate impact on personnel safety. System certification is the final Navy check to ensure that no recognizable unsafe conditions exist in the system prior to manned operations.

4.2. SYSTEM CERTIFICATION PROCESS

4.2.1 Process Summary. The certification of any man-rated hyperbaric facility is based on a very simple premise-ensure

that the system is safe. This involves the consideration and review of the following: system mission; approved system design; fabrication and assembly procedures and process; quality assurance procedures and documentation; system testing; system operability; and system maintenance. since each of these areas of consideration can be further broken down into several individual events and procedures, our simple premise evolves into a much more complex and interrelated process.

The certification process has three basic requirements: (1) proper use of materials, (2) proper workmanship, and (3) traceable documentation to validate materials used and work performed. To assist commands in the pursuit and maintenance of certification, SS521-AA-MAN-010 provides a program management procedure as follows:

- o Prepare milestone chart.
- o Develop proposed certification scope.
- o Collect/maintain data to support system adequacy and submit for review.
- o Collect/maintain and verify technical documentation and submit for review.
- o Develop and verify OPs, EPs, and system schematic drawings and submit for review.
- o Request and schedule a survey by the SCA.
- o Correct system discrepancies.

A flowchart of these major certification events is provided as Figure 4-1. Each of these events is addressed in detail below.

4.2.2 Milestone Event Schedule. The first task facing the sponsor and command is preparation of a Certification Milestone Event Schedule. The milestone schedule is a list of all the sequential events in the certification process with estimated dates of completion. A completed Certification Milestone Event Schedule is shown in Figure 4-2. The sponsor enters completion dates (best estimate) for the items applicable to his system and forwards it to the SCA for review. Following approval by the SCA, the sponsor maintains the schedule to provide himself and the SCA with a current status of the certification process. If changes are required, the SCA must be advised to allow adequate time for proper planning and scheduling. Time allowance for documentation submissions, technical reviews and deficiency corrections should be considered when preparing the milestone event schedule to assure a timely completion of the system certification process prior to the desired certification date.

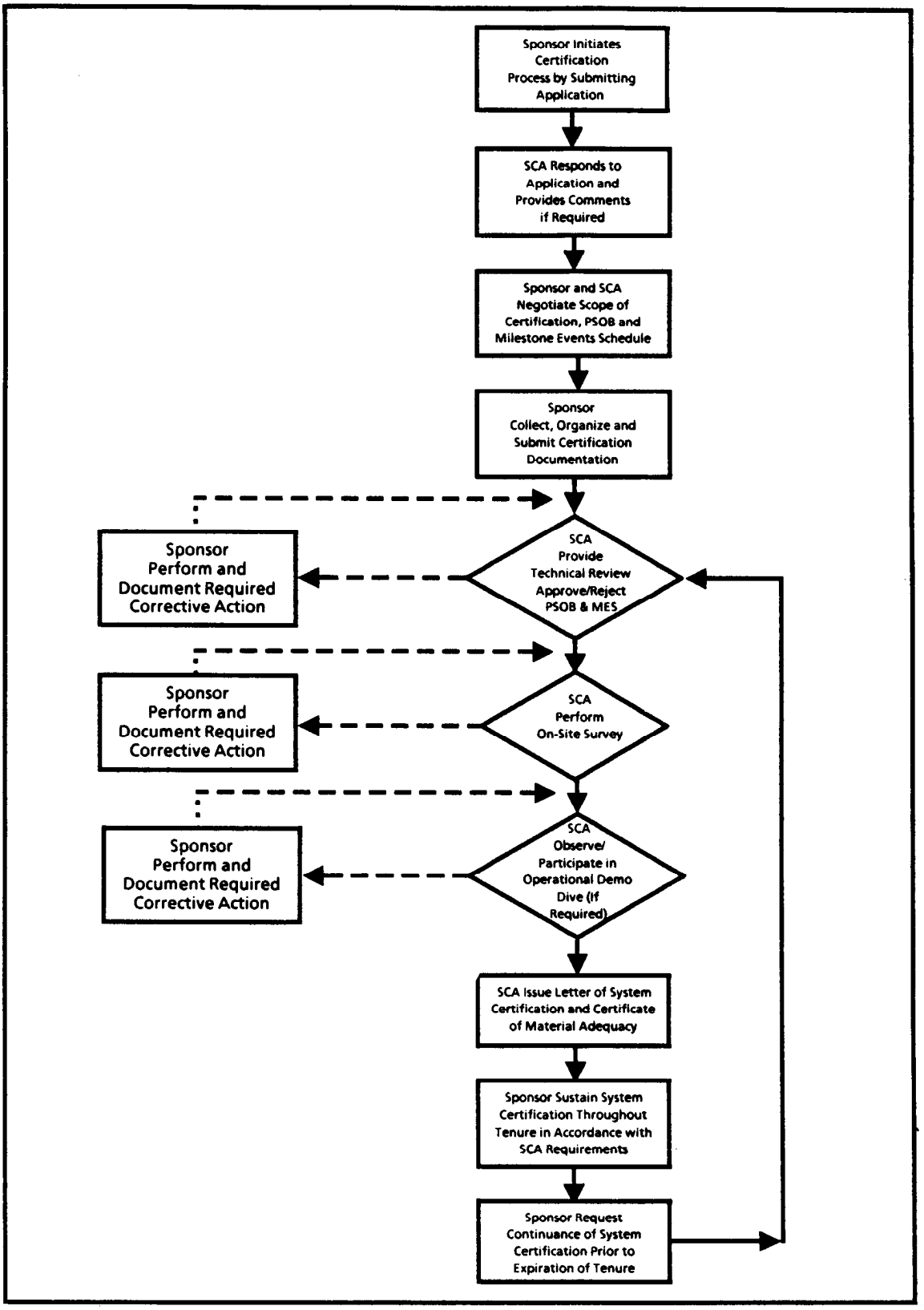


Figure 4-1
Flowchart, System Certification Milestone Events

SYSTEM _____ INITIAL SUBMISSION DATE _____

SCA APPROVAL _____ REVISION _____ DATE _____

Instructions: For each event applicable to the applicant's system, enter the date of completion in the appropriate box of the 24-month/week grid provided.

Event																								
Design Review Information																								
Scope of Certification (SOC)																								
Presurvey Outline Booklet (PSOB)																								
Summary Description of System																								
Design Parameters																								
Subsystem Descriptions																								
Design Analysis																								
System Drawings																								
Operability and Maintainability Procedures																								
Justification of Materials																								
Toxic and Flammable Materials Data																								
Atmosphere Analysis																								
Hyperbaric Chamber Vaccuum Data																								
Hazard Analysis																								

Figure 4-2
Certification Milestone Event Schedule

SYSTEM_____ INITIAL SUBMISSION DATE_____

SCA APPROVAL_____ REVISION_____ DATE_____

Instructions: For each event applicable to the applicant's system, enter the date of completion in the appropriate box of the 24-month/week grid provided.

Event																								
Fabrication Procedures																								
Work Procedures																								
Process Instructions																								
Welding Procedures																								
Brazing Procedures																								
Assembly Procedures																								
Cleaning Procedures																								
Quality Assurance Procedures/Data																								
Design and Drawing Control Data																								
Material Control Data																								
Fabrication and Manufacturing Control Data																								
Cleaning Control																								

Figure 4-2 (Continued)
Certification Milestone Event Schedule

SYSTEM_____ INITIAL SUBMISSION DATE_____

SCA APPROVAL_____ REVISION_____ DATE_____

Instructions: For each event applicable to the applicant's system, enter the date of completion in the appropriate box of the 24-month/week grid provided.

Event																								
Testing and Inspection Control																								
Test Plan																								
Individual Test Procedures																								
Test Procedure Index																								
Test and Inspection Results																								
Re-entry Control Data																								
Operating Records																								
Maintenance Records																								
Correct Discrepancies																								
On-Site Survey																								
Correct Discrepancies																								
Certification Dive																								
Receipt of Certification																								

Figure 4-2 (Continued)
Certification Milestone Event Schedule

4.2.3 System Certification Scone. The next step in the certification process is the development of a certification scope, or scope of certification (SOC), for the system. The scope, developed by the sponsor and command, is a list of those subsystems required to ensure the safety and well-being of the system occupants and divers. Systems which pertain to diving systems and hyperbaric complexes are defined in Chapter 2 of SS521-AA-MAN-010.

The scope also includes a list of the operating, emergency, and maintenance procedures for those subsystems, as well as any emergency or back-up systems required to rescue and return the occupants to safety after a noncatastrophic accident. In addition, the scope should include the criteria and justification for establishing the limits of the certification scope. The sponsor must look at each of the systems within his facility and evaluate the effects of specific failure which could occur during a mission. The SCA will provide assistance if the sponsor is not sure whether a system should be included within the scope. There is no rigid format for presenting the scope, however, the SOC usually includes a list of subsystems with detailed descriptions and a system schematic (or drawings) that clearly show the boundaries of the system that are within the scope. The most important consideration is that the certification scope be clearly and explicitly defined. The sponsor should submit the scope to the NAVFAC SCA for review and approval.

4.2.4 Maintenance of Certification Documentation. When the certification scope and the PSOB have been approved, the sponsor shall assemble the documentation necessary to support the request for certification or recertification. SS521-AA-MAN-010 contains guidelines as to the documentation required. However, there are many diving and chamber systems in service that predate the requirements for certification. Many of the components of these systems have evolved in service and their capabilities and limitations have not been documented to the extent and in the form required by SS521-AA-MAN-010. Major concerns with systems of this nature include: are components presently safe in their intended mode of operation, has component integrity been compromised, have components been mismatched, and have the actual composite capabilities and limitations been recognized? Documentation which the sponsor of this type of system should gather to substantiate these aims include operating records, maintenance records, fabrication records, test data, reentry control records, modification records, and repair work documents, Any documentation in addition to those listed above that provides information as to the replacement of components, repair of a component, and the operating and testing of components/systems should also go into the sponsor's file of certification documentation.

The sponsors of newly developed and constructed diving and chamber systems must provide the documentation required by SS521-AA-MAN-010. This consists of the various design, construction,

fabrication; assembly, and quality assurance documents required by chapters 2 through 6 of SS521-AA-MAN-010.

Procedural adequacy is as important to achieving certification as material adequacy. The sponsor should also collect the typical documents that are used in the day-to-day operation of the hyperbaric facility. These documents include the system drawings that define all of the functional components in the system: the operating and emergency procedures used to line up, operate, and correct anticipated malfunctions; and the operation and maintenance manual(s) for the system. Also included are the test procedures used to test the entire system or any repaired components within the system, the cleaning procedure used for systems and components requiring specialized levels of cleanliness, and the maintenance procedures used to repair and replace components. The OPs, EPs and schematic drawings must be verified by the activity sponsor and submitted to the System Certification Authority for review and approval before an onsite survey can be scheduled. The documents or drawings that the sponsor provides must be up to date and reflect the system as it exists. However, the condition of the documentation should not delay the pursuit of certification.

Following is a representative sample of the types of support documentation necessary to verify system adequacy:

- System schematic and drawings.
- Material list.
- Fabrication procedures.
- Personnel qualifications.
- Fabrication documentation.
- Fabrication testing records.
- Cleaning records.
- Quality assurance documentation.
- Design specifications.
- Operational test plan.
- Air/gas purity samples.
- Calibration records.
- Maintenance plan.
- Operating and emergency procedures.
- Reentry control procedure.

When the sponsor has all of the supporting documentation assembled, and the facility/system is operational, he can request an on-site survey by the SCA. However, before requesting the survey, the system should be reviewed in detail by the command and any known discrepancies should be corrected. Many of these discrepancies may be small items such as a missing nameplate or a missing handwheel on a valve. Such known discrepancies should be corrected before the survey to lessen the number of discrepancy cards (paragraph 4.2.6. below refers) written during the survey by the NAVFAC SCA. The correction of a subject discrepancy card will require much more effort and documentation after the survey than

if it had been corrected prior to the survey. Appendix E, Do and Don't Summary of Common Diving and Recompression Chamber Discrepancies, and Appendix G, Hyperbaric Facility Inspection and Audit Guide, are provided to assist commands in conducting in-house inspections and audits.

4.2.5 On-Site Survey. The sponsor contacts the SCA and requests scheduling of an on-site survey. The SCA sets a date and then the SCA, or an authorized representative, visit the sponsor's system. The certification files and supporting recordable evidence are reviewed and the system is inspected to ensure that the hardware complies with the documentation. During the course of the survey, discrepancy cards are prepared for items found to be less than satisfactory. The discrepancy may be classified as category IA, IB, IC, or II, depending on severity. All IA discrepancies must be corrected before manned use of the system, and all IB discrepancies must be corrected before the system is certified. All IC discrepancies (normally applicable to documentation and drawings) will be assigned a deadline date to be corrected by. IC discrepancies that exceed the assigned date(s) will be automatically classified IB. However, the assigned deadline date(s) can be modified by the SCA, upon request and proper justification, prior to expiration of the deadline date. Discrepancies that are classed category II (desirable) may be corrected at the sponsor's option and do not delay his pursuit of certification or recertification.

4.2.6 Operational Demonstration. When the IA and IB discrepancies have been corrected, the SCA may request an operational demonstration of the system. This exercise takes the system to its operational limits to the satisfaction of the SCA. After a successful demonstration of the facility the sponsor is granted certification.

4.2.7 Tenure of Certification. System certification is not granted for the entire design life of the equipment. In general, the time period for which system certification will initially be granted (tenure of system certification) is based on the operating and test histories of related systems. The tenure of certification may be negotiated to coincide with planned events such as overhaul or refurbishment. The granting of system certification by the System Certification Authority (SCA) does not automatically ensure that system certification will remain effective for the full stated period. System certification shall be terminated as a result of the following per SS521-AA-MAN-010:

- Expiration of tenure of certification.
- Major Repair.
- Overhaul.
- Broaching of the scope of system certification.
- Recognition of the existence of an unsafe condition.
- Expiration of a lease contract.

4.2.8 Continuance and Recertification. Prior to the expiration of the initial period of certification the facility/system certification may be extended or renewed by either continuance or recertification, as applicable.

Continuance of system certification is the extension by the SCA of the system certification period beyond that initially granted. This is normally considered to accommodate continued use of systems that have had no changes to the basic design, scope of system certification, or general operating characteristics. It is emphasized that continuance of system certification, if desired, must be requested prior to the expiration date of the current certification period.

Recertification is certification of system adequacy for a facility prior to expiration of the certification tenure. The applicant shall validate the system scope of certification, provide recordable evidence as requested by the SCA, and fulfill any other requirements deemed necessary by the NAVFAC SCA. Recertified systems are normally granted a tenure of certification for the same length of time as the initial certification. It is emphasized that should a command allow the certification of a facility or system to naturally expire or be terminated due to the reasons noted in the previous paragraph then an initial certification of the system is required. Such an initial certification is inherently more difficult than obtaining continuance or recertification.

4.2.9 Sustaining Certification. Achieving certification for a system does not end the process. The sponsor is responsible for sustaining the system's certification. The SCA may revoke the certification of the system for failure to adhere to the appropriate guidelines. The sponsor should ensure that he stays within the certified operational limits of the system and that he promptly notifies the SCA of any situation that could cause him to exceed those limits. The scheduled maintenance developed for the system must be followed and the maintenance records kept up-to-date. Whenever the sponsor intends to alter or modify the certified system or the supporting documentation, he must notify the SCA before taking any action and then send the SCA all the documentation (e.g., design calculations, drawings, etc.) necessary to properly evaluate the effects of the proposed alterations. The SCA must approve specified modifications to certified systems prior to making the change (Table 3-1 refers). The SCA must also be notified when any unsafe or emergency conditions exist that prevent the sponsor from operating the system within its intended mission profile, when these conditions cannot be corrected by simple maintenance, repair or "replacement-in-kind" (refer to Appendix G for definition) of material. Additionally, the SCA must be notified of contamination to any system within the scope of certification. An important consideration in sustaining certification is the use of proper repair parts. The use of an

unauthorized replacement part can invalidate the certification of the system. A material identification and control (MIC) system should be established and rigidly adhered to. The MIC program provides for the tracking of system piping and components from procurement to installation in the system, which enables all concerned to verify the materials installed. Chapter 5 addresses the MIC program in specific detail.

4.3 QUALITY ASSURANCE

4.3.1 Definition. Quality Assurance (QA) is a system for the establishment and review of quality control procedures, records and production actions, which provides adequate proof and confidence that work accomplished and/or material manufactured will perform as designed, and that there is documentary evidence to this effect.

4.3.2 Quality Assurance Requirements. As a minimum, QA for man-rated hyperbaric facilities will include provisions to maintain such facilities in accordance with specific requirements and provide supporting recordable evidence, in the following areas:

a. Design and Drawing Quality Control.
   - o System for Approval of Design/Drawing Changes.
   - o Drawing Control Procedures for Updating All Points Issue and Use.
   - o Maintenance of Design Information and Technical Data and Installation

b. Material Identification and Control.
   - o Procurement Procedures.
   - o Receipt Inspection and Identification Marking Procedures.
   - o Material Documentation and Storage Procedures.
   - o Material Control Procedures During Fabrication and Installation.

c. Fabrication and In-Process Quality Control.
   - o Personnel Qualification Records (welders, inspectors).
   - o Approved Fabrication Procedures.
   - o Fabrication Inspection Procedures.
   - o Fabrication Documentation Records

d. Testing and Inspection Quality Control.
   - o Test Plan.
   - o Test Criteria and Requirements.
   - o Test and Inspection Procedures.
   - o Test and Test Inspection Records

e. Facility Work Management Quality Control.

- o Reentry Control Procedures.
- o Reentry Control Log and Records.
- o Tag-Out Procedures.
- o Maintenance System.
- o Maintenance Procedures.
- o In-House Quality Control Inspections and Documentation Audits.

4.3.3 Summary and Responsibilities. Quality Assurance is a program as outlined in the paragraph above. Quality Control consists of the specific procedures and records which are implemented to support the Quality Assurance Program. It is the responsibility of the Hyperbaric Facility Manager to ensure that a suitable QA Program is established, implemented and maintained.

4.4 DESIGN AND DRAWING QUALITY CONTROL. Instructions and guidance shall be established which assure that current design drawings are promptly distributed to maintenance and manufacturing personnel and that only current drawings are used. The drawing control system shall require approval of design changes, including material substitutions, before such changes are incorporated into the finished product. The drawing control system shall, require approval of design changes, including material substitutions, before such changes are incorporated into the finished product. Also the drawing control system shall require removal of obsolete drawings and change requirements from all points of issue and use. The control system should also provide control over supplemental specifications, process instructions, production engineering instructions, industrial engineering instructions, and work instructions that either implement the design or supplement design drawings. Design information, technical data and drawings will be maintained to reflect and support the current as-built condition of the hyperbaric facility.

4.5 MATERIAL IDENTIFICATION AND CONTROL. Proper identification and control of materials must be maintained from procurement through installation in man-rated hyperbaric facilities. This includes all materials and consumables: piping, components, equipments, repair parts, soft goods, lubricants, welding filler material, penetrations, etc. These procedures must ensure that materials used conform to the applicable physical, chemical, or other technical requirements. A means of keeping track of the identity of tested and approved materials must be established. Additionally, controls must be in-place to prevent the inadvertent use of unapproved materials. Chapter 5, Material Control and Provisioning, provides further guidance.

4.6 FABRICATION AND IN-PROCESS QUALITY CONTROLS

4.6.1 General and Purpose. Fabrication and in-process quality, control applies to work performed on the facility whether it is in conjunction with initial construction, alterations, overhauls or repairs. The purpose of these controls is to provide procedures for ensuring that: the personnel performing the work are qualified, approved processes are followed, proper inspection of the work is conducted, and the work is properly documented.

4.6.2 Personnel Qualifications. Personnel conducting fabrication and in-process work often requires qualifications to do so (e.g., welders, inspectors). Chapter 2, Section 8 provides guidance concerning these requirements.

4.6.3 Approved Fabrication Procedures. The initial step in conducting any fabrication or in-process effort is to develop, procedures for conducting the work. These procedures shall be developed so that they comply with applicable codes, standards and specifications. When developed and formally prepared all such procedures shall be approved by the hyperbaric facility manager. With respect to hyperbaric facilities, fabrication procedures are required for:

- Man-rated chamber welding.
- Life-critical pipe welding.
- Life-critical pipe fabrication.
- Life-critical component fabrication.
- Life-critical pressure vessel welding.

4.6.4 Fabrication Inspection Procedures. Standards and codes require that periodic inspections of fabrication efforts be conducted. These inspections include Visual Testing (VT), Penetrant Testing (PT), Ultrasonic Testing, Magnetic Particle Testing (MT), and Radiographic Testing (RT) methods. Fabrication procedures will include applicable inspection checks, and approved inspection procedures must be established to conduct these checks.

4.6.5 Fabrication Documentation Records. Fabrication efforts must be documented properly. As a minimum, the information listed below must be recorded and kept on file.

a. Fabrication record number.
b. Date(s) fabrication performed.
C. Identification of components, equipments and piping joints within the scope of work.
d. Description of work.
e. Fabrication procedures used.
f. Inspection procedures used.
g. Drawing reference.
h. Standard/Code/Specification references.
i. Person(s) performing work.

j. Inspector(s).
k. Verification signatures of lead fabrication person and all inspectors.
l. Notes (include applicable REC number, departures, etc.).

4.7 TESTING AND INSPECTION QUALITY CONTROL

4.7.1 Test Plan. A test plan shall be developed for the facility which clearly defines all required testing within the certified boundaries. This test plan shall include as a minimum:

a. Test criteria requirements.
b. Test frequencies and requirements for conducting (e.g., initial installation, annually, after repairs, etc.).
c. Flow diagram similar to Figure 4-3, which shows all tests required in support of certification.
d. Test and inspection procedures index.

4.7.2 Test Criteria and Requirements

a. Hyperbaric Facility Support Pressure Vessels (Strength, Leak and Operational). The primary guidance document for test criteria and requirements for pressure vessels is provided by NAVFAC MO-324, Inspection and Certification of Boilers and Unfired Pressure Vessels. By definition, pressure vessels include manned chambers and all hyperbaric facility support pressure vessels (e.g., flasks, filters, separators, etc.) with an internal diameter of three inches or greater. NAVFAC MO-324 references the following codes for the conduct of inspection and testing of unfired pressure vessels:

- ASME Boiler and Pressure Vessel Code (Section VIII, Divisions I and II).
- ANSI/NB-23, National Board Inspection Code.
- NFPA National Fire Codes (See Appendix A for applicable NFPA codes).

When there is a conflict between NAVFAC MO-324 and any of the above codes, NAVFAC MO-324 shall govern. Additionally, the U.S. Navy Diving Manual (Volume I, Appendix D) requires a pressure test on every U.S. Navy recompression chamber as follows:

- When initially installed.
- When moved and reinstalled.
- At two-year intervals at a given location.

b. Piping Systems (Strength, Leak and Operational). The guidance document for test criteria and requirements for piping systems is ANSI/ASME B31.1, Power Piping. These criteria and requirements apply to:

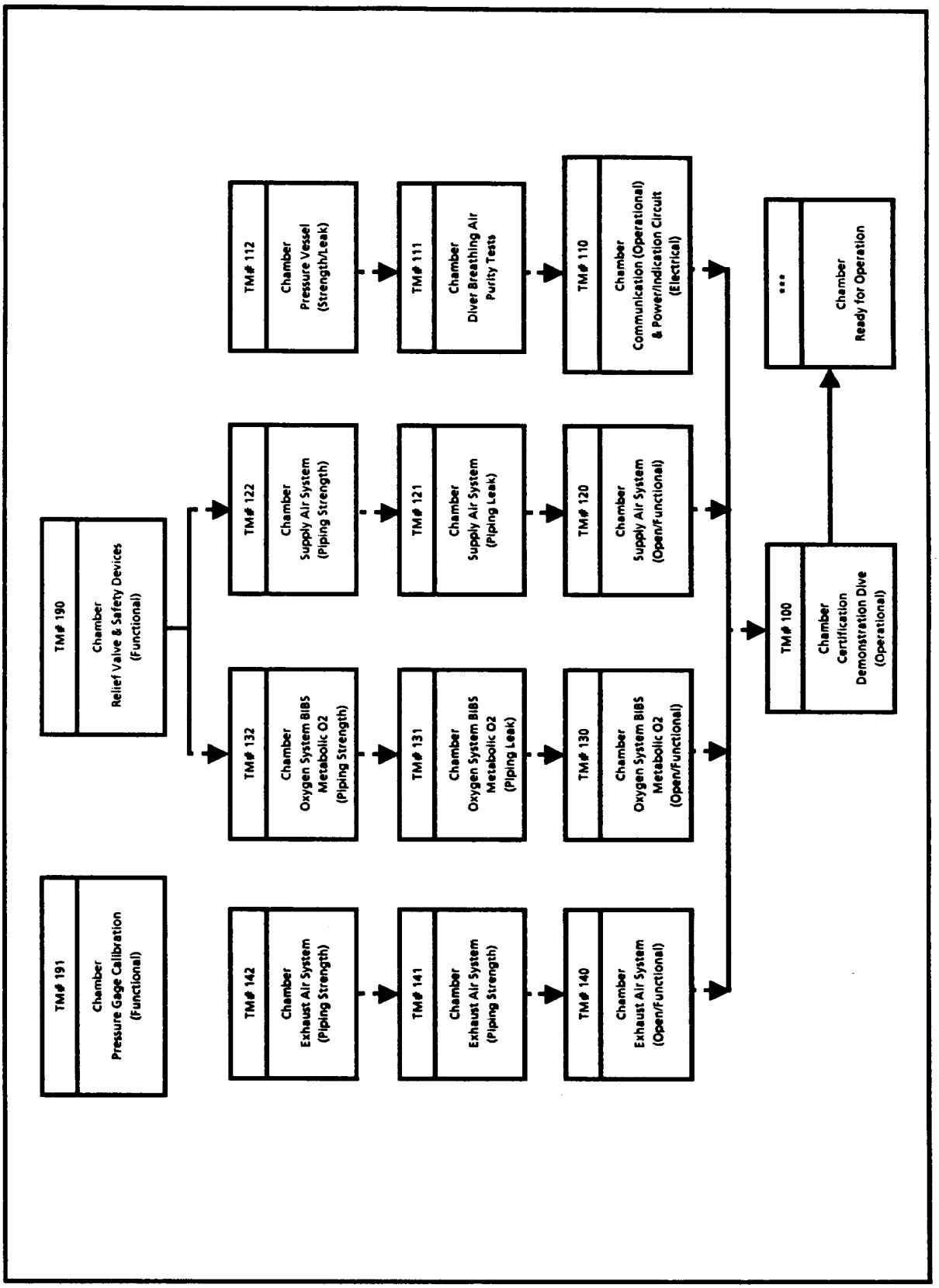


Figure 4-3
Recompression Chamber Test Plan Flow Diagram

Figure 4-3
RECOMPRESSION CHAMBER TEST PLAN FLOW DIAGRAM

- HAZCAT I and II air piping systems.
- HAZCAT III and IV air piping systems.
- Oxygen piping systems.
- Fire extinguishing piping systems.
- Life support items not covered under pressure vessels (e.g., small diameter in-line filters, etc.).

c. Viewports. The guidance document for test criteria and requirements for hyperbaric chamber viewports is ANSI/ASME PVHO-1, Safety Standard for Pressure Vessels for Human Occupancy.

d. Electrical Systems. The guidance documents for test criteria and requirements for hyperbaric facility electrical systems are NFPA 99, Health Care Facilities, and NFPA 70E, Electrical Safety Requirements for Employee Work Places. These test criteria and requirements apply to:

(1) Emergency generators supply power to the chamber.
(2) All life criteria electrical circuits.
(3) Chamber lighting circuits and/or fiber optics.
(4) Chamber atmosphere monitoring and control circuits.
(5) Fire protection and alarm circuits.
(6) Communications circuits.

Inspection and testing of NAVFAC hyperbaric facility electrical systems will be conducted semiannually, except as follows:

- Emergency generators, 30 days.
- Batteries for communications and emergency lighting, 7 days when temperature exceeds 90 degrees (F).

Prior to chamber operations, all electrical circuits shall be functionally tested and high voltage systems checked for continuity.

e. Non-Destructive Testing/Examination. The following NDT/NDE documents shall be used as the governing guidance for pressure containing systems:

(1) Pressure Vessels.
  (a) Radiography.
    - ASME Code, Section V, Non-Destructive examination.
    - MIL-STD-453, Inspection, Radiographic.
  (b) VT, UT, PT and MT.
    - ASME Code, Section V, Non-Destructive Examination
    - MIL-I-6866B, Inspection, Penetrant Method of.
    - MIL-I-6868E, Inspection, Process, Magnetic Particle.

(2) Piping Systems (see paragraph 2.6).
(a) Radiography.
o ANSI/ASME B31.1, Power Piping.
(b) T, UT, PT and MT.
o ANSI/ASME B31.1, Power Piping.

4.7.3 Test and Inspection Procedures. Commands shall develop test and inspection procedures for critical tests conducted on hyperbaric facilities. These procedures shall comply with applicable code requirements and contain the following as a minimum:

a. Procedure title and reference number.
b. Test/Inspection description and scope.
C. Applicable references (e.g., codes, standards, specifications, drawings, etc.).
d. Safety precautions.
e. System pre-test line-up procedures.
f. Test and Inspection procedures in sufficient detail to allow proper performance and safe conduct.
g. Recording of test data.
h. System post-test shut-down procedures.
i. Signature verification for inspectors and test director.

4.7.4 Test and Inspection Records. Records of tests and inspections conducted on the hyperbaric facility shall be maintained on file by the hyperbaric facility manager. Test and inspection records shall be retained until superseded by subsequent re-testing or until permanent removal of the system/equipment/component(s) involved.

4.8 FACILITY WORE MANAGEMENT QUALITY CONTROL

4.8.1 General. The proper control and management of work performed on manned hyperbaric facilities is necessary to ensure continued material adequacy of the installed systems, equipments and components. Facility work management quality control consists of the following areas:

a. Re-Entry Control Procedures and Records.
b. Tag-Out Procedures.
c. Maintenance System and Procedures.
d. Maintenance Records.
e. In-House Quality Control Inspections and Documentation Audits.

4.8.2 Re-Entry Control (REC) Procedures and Records. REC is a system for maintaining positive control of work performed within the certification boundaries of the facility. The REC system provides for monitoring and documenting the following:

a. Who authorized and accepted the RECs.
b. Why work was required.
c. What work was accomplished, including materials and components used, re-test requirements, tests performed and test data.
d. Who did what work.
e. When and where the work was accomplished, including the work boundaries.

When any maintenance or work is performed which breaches the certification boundaries of the facility a REC must first be initiated by the REC supervisor. This is accomplished by completing a REC sheet, obtaining authorization from the facility manager (or designated representative), and noting the REC in the REC Log. The necessary work or maintenance can now be performed on the facility. Upon completion, the REC sheet is completed and all applicable maintenance check-off sheets, inspection records, testing records, and fabrication records are attached to, or placed in a file folder with, the REC sheet. The REC can then be closed out by the REC supervisor by placing the REC sheet and associated documents in the REC file drawer and completing the REC Log entry. Appendix C provides additional guidance concerning REC instructions and record forms.

4.8.3 Taa-Out Procedures. Tag-out procedures are used to identify equipments and components which 1) are in need of maintenance/repair, or 2) define REC boundaries and are not to be operated while the REC is open (i.e., work in progress). Commands shall develop suitable tag-out procedures which meet the following requirements:

a. Command instruction which clearly defines Tag-Out procedures to be used for the hyperbaric facility.

b. Tag-Out Log in which to record the location, reason for the tag, person initiating the tag-out, and current status of the equipment/component.

C. Tags which are easily identifiable and are marked with the Tag-Out Log reference number and the reason for the tag-out.

4.8.4 Maintenance System and Procedures. *Refer to Chapter 3.

4.8.5 Maintenance Records. *Refer to Chapter 3.

4.8.6 In-House Quality Control Inspections and Documentation Audits. Periodic inspections and audits should be conducted by the facility manager to ensure that maintenance is being

performed properly, the system is in good overall condition, and that documentation records are complete and accurate. To accomplish this, it is recommended that an inspection guide similar to Appendix F be used.

CHAPTER 5 MATERIAL CONTROL AND PROVISIONING

5.1 MATERIAL PROVISIONING REQUIREMENTS

5.1.1 Stocking Levels. An important part of the safe operation and maintenance of a manned hyperbaric facility is having adequate levels of spare parts and consumables in stock. Previously, in Chapter 3, requirements and guidance concerning the provisioning of spare parts and consumables was addressed, with emphasis on the availability of spare parts for failure management. This section will provide additional guidance with respect to the provisioning of maintenance materials for hyperbaric facilities.

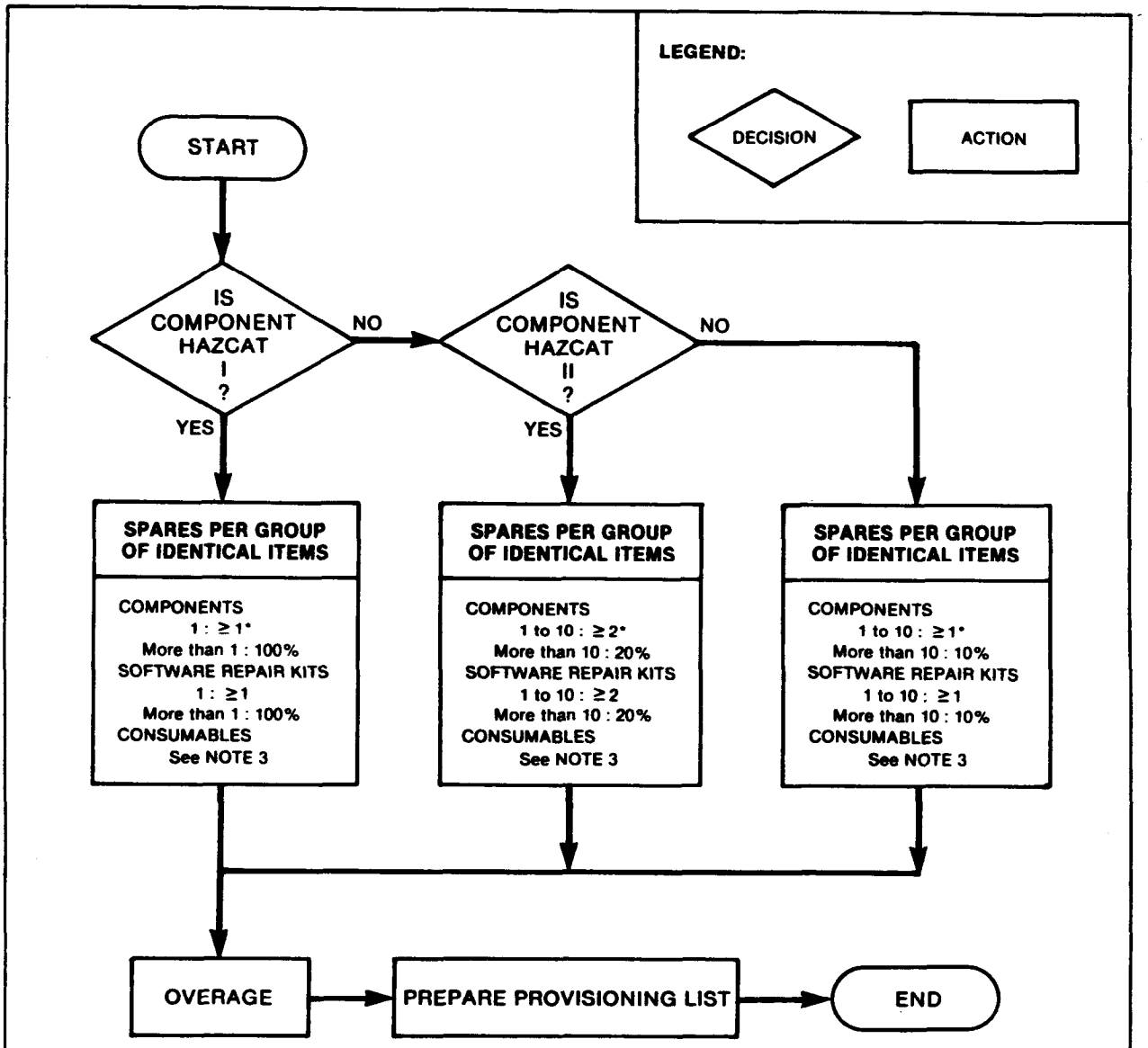
The following minimum provisioning requirements are necessary to conduct safe hyperbaric and diving operations. Facility managers and other responsible personnel should verify compliance with these requirements on a regular basis.

Consumables. Sufficient consumables shall be available (e.g., filter elements, CO_2 absorbent, lubricants, etc.) to operate the facility for twice the duration of the maximum operating profile. Prior to conducting operations consumables will be checked to verify availability and, where applicable, expiration dates.

b. Mandatory Spare Parts and Repair Kits. For all HAZCAT II systems, components, and equipments (Chapter 3, Section 3 refers) required spare parts and software repair kits shall be available at the facility and ready for immediate installation to conduct mandatory repairs. This includes one (1) twenty foot length of every size piping installed in the system.

c. Gas Supplies. Available gas supplies (e.g., compressors, storage flasks) shall be capable of meeting the pressure and duration requirements of the U.S. Navy Diving Manual. For systems not addressed by the U.S. Navy Diving Manual the minimum required gas supply shall be established by the NAVFAC SCA.

To assist commands in establishing provisioning requirements for components, software repair kits and consumables, Figure 5-1, NAVFAC Recommended Provisioning Decision Tree for Hyperbaric Facilities, is provided. Commands shall develop and maintain a list of provisioning items required to support the hyperbaric facility. As a minimum this provisioning list shall contain the following:



NOTES:

1. Major items excluded but software repair kits and consumables required.
   TYPICAL: Chamber, Compressor, Air Dryer and Purifier

2. Consumables: Filters, Lubricants, Fan Belts, Fuels, etc.

3. Overage (user judgement of)
   a. Amount and type of consumables
   b. Increase in number of spares due to:
      (1) Remote location
      (2) Excess time required to acquire components
      (3) Amount of use of components
      (4) Increased knowledge of component life due to increased knowledge of facility

Figure 5-1
NAVFAC RECOMMENDED PROVISIONING DECISION TREE FOR HYPERBARIC SYSTEMS

- o Item description.
- o Ordering information and/or stock number.
- o Minimum stocking level of the item.
- o Amount of item held in stock.
- o Location of item stock.

5.2 MATERIAL IDENTIFICATION AND CONTROL

5.2.1 Purpose. This section provides guidance for the establishment of a Material and Identification Control (MIC) system, that will ensure the installation of correct materials in life-critical systems of manned hyperbaric facilities.

5.2.2 General. MIC applies to all components, equipments, piping, repair kits, soft goods and consumables, which are intended for installation into the certified boundaries of the hyperbaric facility. MIC shall address the following areas:

a. Receipt Inspection and Marking.
b. Material Storage.
C. Material Control During Fabrication and Installation.

5.2.3 Receipt Inspection and Marking.

a. Receipt Inspection. Materials will be visually inspected to ensure that they are free from exterior damage and are in good condition (e.g., the valve handle turns). Vendor's shipping document(s), and any supporting vendor Objective Quality Evidence (OQE) documentation, shall be checked against command purchasing documents to verify that the materials ordered are the materials received. Materials found suitable for subsequent use in the facility will be assigned a unique identification number. Procedures will be established, by the command, to provide for tracking of this I.D. number back to the vendor shipping document and the command purchasing document (s). Supporting material documentation will be maintained on file for a minimum of 3 years or for the duration of installation of the applicable material (i.e., If the material is in the system, then retain the documentation on file).

b. Marking. MIC marking is required on all parts that form the pressure boundary of a completed assembly (e.g., valve body and bonnet, or any other removable pressure boundary part) This marking provides traceability of installed material to objective quality evidence (OQE). Material consumed in the construction process must have its identity attested to by recorded data such as fabrication/installation records (e.g., welding rods).

c. Method of Marking. Markings shall be applied in accordance with MIL-STD-792 and as stated in this paragraph.

Alternate marking methods are permissible provided such method is an available option delineated by applicable specifications or drawings.

(1) Markings shall be legible.
(2) Markings shall be so located as to not affect the form, fit or function of the item.
(3) Markings will be permanent whenever the type, size and condition of the material permits.
(4) Piping will be marked 1 inch from each end.
(5) Small uninstalled items whose type or condition preclude the use of permanent markings shall be identified as follows:
    (a) Package in two "clean" clear bags (i.e., double bag) and label the bag with the required traceable I.D. number.
    (b) Items with the same I.D. number (e.g., same lot of fittings, o-rings) may be packaged for storage in the same bag.
    (c) Items removed from the bag for installation shall be documented by recording the I.D. number on the applicable REC sheet.
(6) Marking number format is at the discretion of individual commands. Sequential three digit numbers preceded by the year the material is received is recommended (e.g., MIC-86-001, MIC-86-002, etc.). All MIC marking numbers shall be preceded by "MIC" to identify the purpose of the marking.

5.2.4 Material Storage.

a. Cleaning. Prior to storage, items such as valves, fittings, hoses, gauges, etc., shall be cleaned per approved cleaning procedures (OQE cleaning documentation from vendor is acceptable).

b. Storage. Materials shall be stored in a suitable area specifically designated for the storage of life-critical components and materials. Access to such storage area shall be controlled to prevent inadvertent tampering with these materials.

5.2.5 Material Control During Fabrication and Installation. Materials requiring installation only and which have permanent MIC I.D. numbers require no special attention other than following approved installation and REC procedures. Materials requiring additional control awareness are:

Piping. Prior to cutting, MIC I.D. markings shall be placed one (1) inch from the cut on both sides of the cut.

b. Soft Goods and Consumables. Record the MIC I.D. number from the bag or container onto the REC sheet (This applies to O-rings, filter elements, CO_2 absorbent, repair-kits, small, fittings, etc.).

c. Welding Filler Material. Inspector shall record the type filler material used during fabrication/repair, on the fabrication inspection sheet and on the REC sheet.

APPENDIX A

REFERENCE INSTRUCTIONS AND DOCUMENTS

APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

REFERENCE INSTRUCTIONS AND DOCUMENTS

APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

This APPENDIX is categorized into the following major areas:

- Design Manuals
- Commercial Codes and Documents
- Commercial Specifications
- Government/Military Instructions
- Government/Military Standards
- Government/Military Specifications
- Technical Manuals
- Handbooks

The primary purpose(s) of each instruction and document listed is noted by an "x" under the appropriate column to assist commands in the identification of applicable references.

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Design Manuals							
NAVFAC DM-3.5	Compressed Air & Vaccuum Systems		X		X	X		X
NAVFAC DM-4	Electrical Engineering		X		X	X		
NAVFAC DM-8	Fire Protection Engineering		X		X	X		X
NAVFAC DM-12	Electronic Facilities Engineering		X		X	X		
NAVFAC DM-24	Land Operational Facilities		X					
NAVFAC DM-39	Hyperbaric Facilities	X	X	X	X	X	X	X
NAVFAC MO-324	Inspection and Certification of Boilers and Unfired Pressure Vessels				X	X	X	
NAVFAC TS-15401	Plumbing		X	X	X	X		X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Commercial Codes and Documents							
ANSI C-2	National Electrical Safety Code		X	X	X	X		X
ANSI/ASME B31.1	Power Piping		X	X	X	X	X	X
ANSI/ASME PVHO-1	Safety Standard for Pressure Vessels for Human Occupancy		X	X	X	X		X
ANSI/NB-23	National Board Inspection Code		X	X	X	X	X	X
ASME CODE SECTION II	Material Specification		X	X	X	X		
ASME CODE SECTION V	Non-Destructive Examination				X	X		
ASME CODE SECTION VIII	Boiler and Pressure Vessel Code (Divisions I and II)		X	X	X	X	X	X
ASME CODE SECTION IX	Welding Qualifications				X	X		X
AWS D1.5	Structural Welding Code, Aluminum		X	X	X	X		
NFPA 13	Installation of Sprinkler Systems		X	X	X	X		
NFPA 50	Bulk Oxygen Systems		X	X			X	X
NFPA 51	Oxygen - Fuel Gas Systems		X	X			X	X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
NFPA 53M	Fire Hazards in Oxygen Enriched Atmosphere		X			X		
NFPA 56F	Nonflammable Medical Gas System		X	X		X		X
NFPA 70	National Electrical Code		X	X				
NFPA 70E	Electrical Safety Requirements for Employee Workplaces					X		X
NFPA 70L	Inspection of Electrical Installations				X			X
NFPA 701	Fire Tests, Textiles					X		
NFPA 99	Health Care Facilities (Supersedes NFPA 3M, 56A, 56B, 56C, 56D, 56E, 56G, 56HM, 56K, 76A, 76B, and 76C)		X	X		X	X	X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Commercial Specifications							
ANSI B-16.5	Steel Pipe Flanges and Flange Fittings		X	X				
ANSI B-36/10	Welded and Seamless Wrought Steel Pipe		X	X				
ANSI B-36.19	Stainless Steel Pipe		X	X				
ASTM B-61	Steam or Valve Bronze Castings		X	X				
ASTM B-62	Composition Bronze or Ounce Metal Casting		X	X				
ASTM A-120	Pipe, Steel, Black, and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless Superseeds Fed Spec WW-P-406		X	X				
ASTM B-209	Aluminum & Aluminum-Alloy Sheet & Plate		X	X				
ASTM B-210	Aluminum - Alloy Drawn Seamless Tubes		X	X				
ASTM B-221	Aluminum & Aluminum-Alloy Extruded Bar, Rod, Wire Shape and Tube		X	X				
ASTM B-247	Aluminum-Alloy Die and Hand Forgings		X	X				
ASTM B-271	Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
ASTM-A-312	Seamless and Welded Austenitic Stainless Steel Pipe		X	X				
ASTM-A-325	High-Strength Bolts for Structural Steel Joints		X	X				
ASTM-A-336	Steel Forgings, Alloy, for Pressure and High Temperature Parts		X	X				
ASTM-A-350	Forgings, Carbon and Low-Alloy Steel, Requiring Notch Toughness Testing for Piping Components		X	X				
ASTM-A-352	Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts Suitable for Low Temperature Service		X	X				
ASTM-B-402	Copper-Nickel Alloy Plate and Sheet for Pressure Vessels		X	X				
ASTM-F-436	Hardened Steel Washers		X	X				
ASTM-B-466	Seamless Copper-Nickel Pipe and Tube		X	X				
ASTM-A-490	Heat-Treated Steel Structural Bolts, 150 KSI Minimum Tensile Strength		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Instructions							
ASTM-A-516	Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service		X	X				
ASTM-A-537	Pressure Vessel Plates, Heat Treated, Carbon-Manganese-Silicon Steel		X	X				
ASTM-A-543	Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum		X	X				
ASTM-A-563	Carbon and Alloy Steel Nuts		X	X				
ASTM-E-604	Test Method for Dynamic Testing of Metallic Materials		X			X		
BUSHIPS 9230.12	Oxygen and Nitrogen Piping Systems, Cleaning, and Inspection of			X	X	X		X
CHARLESTON NAVAL S.Y. P.I. 0558-839-701	Life Support Systems: Cleaning and Inspection Procedures/Test Criteria/Maintenance			X	X	X		X
NAVFAC INST 11320.19	Fire Extinguishers for Diver Recompression Chambers		X				X	
SS521-AA-MAN-010	Diving & Manned Hyperbaric Systems Safety Certification Manual	X	X	X	X	X	X	X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
NAVSEA INST 3150.1	Navy Diving Program	X						
NAVSEA INST 4855.6	Metrology and Calibration Program	X						
NAVSEA INST 4855.9	Operation and Certification Requirements for Fleet Mechanical Instrument and Calibration Activities				X	X	X	
NAVSEA INST 10560.1	Compressed Gas Storage Cylinders Used in Underwater Breathing Apparatus; Periodic Examination, Inspection and Test of					X		X
NAVSEA INST 10560.2	List of Diving Equipments Which are Service Approved or Authorized for Navy Use; Promulgation of		X					
OPNAV INST 5100.23	Navy Occupational Safety and Health (NAVOSH) Program Manual (Supersedes NAVMED 6260.2A)						X	X
OPNAV INST 5100.8F	Navy Safety and Occupational Health Program Implementationof (Supersedes NAVMED 6260.2)	X						
OPNAV INST 3150.27	Navy Diving Program	X						
MINSY P.I. 0558-839E	Life-Support Gas System: Cleaning Inspection Procedures/Testing Criteria			X	X	X		X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Standards							
MIL-STD-17B-1	Mechanical Symbols		X					
MIL-STD-101B	Color Code for Pipelines and for Compressed Gas Cylinders			X			X	X
MIL-STD-109B	Quality Assurance Terms & Definitions				X			
FED-STD-162A	Hose, Rubber, Visual Inspection Guide for					X		
FED-STD-209B	Clean Room and Work Station Requirements, Controlled Environment		X	X	X			X
MIL-STD-248C	Welding and Brazing Procedures and Performance Qualifications			X		X		
MIL-STD-271E	Nondestructive Testing Requirements for Metals		X			X		
MIL-STD-278E	Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels in Ships of the United States Navy			X				
MIL-STD-410D	Nondestructive Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic, and Ultrasonic)					X		

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-STD-438E	Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service		X					
MIL-STD-453C	Inspection, Radiographic			X		X		
MIL-STD-454J	Standard General Requirements for Electronic Equipment	X						
DOD-STD-480A	Configuration Control--Engineering Changes, Deviations, and Waivers	X			X			
MIL-STD-767C	Cleaning Requirements for Special Purpose Equipment, Including Piping System			X				X
MIL-STD-777D	Schedule of Piping, Valves, Fittings and Associated Piping Components for Naval Surface Ships		X					
MIL-STD-792D	Identification Marking Requirements for Special Purpose Components			X	X			X
MIL-STD-882B	System Safety Program Requirements	X						
MIL-STD-889B	Dissimilar Metals		X					
MIL-STD-1246A	Product Cleanliness Levels and Contamination Control Program				X			

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-STD-1247B	Markings, Functions, and Hazard Designations of Hose, Pipe and Tube Lines for Aircraft, Missile and Space Systems			X				X
MIL-STD-1330C	Cleaning and Testing of Shipboard Oxygen and Nitrogen Gas Piping Systems			X		X		X
MIL-STD-1359A	Cleaning Methods and Procedures for Breathing Oxygen Equipment			X				X
MIL-STD-1622	Cleaning of Compressed Air Systems			X				X
MIL-STD-1627B	Bending of Pipe or Tube for Ship Piping Systems			X				X
MIL-STD-1630	Oxygen System and Component Cleanliness; Servicing and Certification Requirements for			X	X			X
MIL-STD-1688	Fabrication, Welding, and Inspection of HY 80/100 Submarine Applications			X		X		
MIL-STD-1693A	Fabrication Welding and Inspection of Hyperbaric Chambers and other Critical Land-Based Structures			X	X			X
MIL-STD-45662	Calibration System Requirements	X			X			

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Specifications							
QQ-N-281D	Nickel-Copper Alloy Bar, Rod, Plate Sheet, Wire, Forgings, and Structural and Special Shaped Sections		X	X				
QQ-N-286E	Nickel-Copper-Aluminum Alloy, Wrought		X	X				
QQ-N-288	Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings		X	X				
BB-N-411C	Nitrogen Technical			X				X
P-C-437B	Cleaning Compound, High Pressure (Steam) Cleaner			X				X
QQ-C-465B	Copper-Aluminum Alloys (Aluminum Bronze) (Copper Alloy Numbers 606, 614, 630, 632M and 642); Rod, Flat Products with Finished Edges, Shapes and Forgings		X	X				
O-F-499D	Flux, Brazing (Silver Alloy, Low-Melting Point)			X				
O-S-642F	Sodium Phosphate, Tribasic, Anhydrous; Dodecahydrate; and Monohydrate; Technical			X				X
TT-P-645A	Primer, Paint, Zinc, Chromate, Alkyd Type		X	X				X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
QQ-B-650B	Brazing Alloys, Copper, Copper-Zinc, and Copper-Phosphorus			X				
QQ-B--654A	Brazing Alloys, Silver			X				
QQ-B-655C	Brazing Alloys, Aluminum and Magnesium, Filler Metal			X				
TT-I-735A	Isopropyl Alcohol			X				X
QQ-S-763D	Steel Bars, Wire, Shapes, and Forgings, Corrosion-Resisting		X					
BB-O-925A	Oxygen, Technical, Gas and Liquid		X				X	
BB-A-1034A	Air, Compressed, for Breathing Purposes		X				X	
MIL-P-1144D	Pipe, Corrosion-Resistant, Stainless Steel, Seamless or Welded			X				
BB-H-1168B	Helium, Technical		X				X	
MIL-F-1183H	Fittings, Pipe, Cast Bronze, Silver-Bronze, General Specification for Tube and Pipe		X	X	X			
MIL-T-1368C	Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded		X	X				
MIL-H-2815F	Hose Assemblies, Rubber, Diver's Breathing Air and Gas Supply		X				X	

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-V-2961C	Valves, Pressure Reducing, for Gas Service (sizes 1/4 to 2 inches IPS)			X				
MIL-C-5501F	Caps and Plugs, Protective, Dust and Moisture Seal			X				
MIL-F-5509D	Fittings, Flared Tube, Fluid Correction		X	X				
MIL-I-6865B	Inspection, Radiographic					X		
MIL-I-6866B	Inspection, Penetrant Method of					X		
MIL-I-6868E	Inspection, Process, Magnetic Particle					X		
MIL-B-7883B	Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum, and Aluminum Alloys			X				
MIL-P-11970C	Potassium Permanganate, Technical					X		
MIL-T-15301D	Tanks, Pressure, 600 PSI Gage Working Pressure, Naval Shipboard Use		X					
MIL-I-15379B	Inhalator, Diver's, for Administering Helium-Oxygen During Decompression		X				X	
MIL-C-15726E	Copper-Nickel Alloy, Rod, Flat Products and Forgings		X	X				
MIL-S-16216J	Steel Plate, Alloy, Structural, High Yield Strength		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-T-16420K	Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706)		X	X				
MIL-B-16541B	Bronze, Valve: Castings		X	X				
MIL-D-16791F	Detergents, General Purpose (Liquid, Nonionic)			X				X
MIL-E-17970C	Enamel, Nonflaming (Dry), Chlorinated Alkyd Resin, Soft White, Semigloss, Formula No. 124/158 (Use DOD-E-24607)			X				X
MIL-E-17972C	Enamel, Nonflaming (Dry), Clorinated Alkyd Resin, Bulkhead Gray, Semigloss, Formula No. 126/58 (Use DOD-E-24607)			X				X
MIL-R-19558A	Regulator, Air, Demand, Diver's		X					
MIL-C-20159C	Copper-Nickel Alloy Castings		X	X				
MIL-S-21952C	Steel (HY-80 and HY-100) Bars, Alloy		X	X				
MIL-V-22549D	Valves, Angle, Relief, for Gas and Oxygen Service (sizes 2 inches IPS and below); Naval Shipboard		X	X				
MIL-F-22687B	Valves, Ball, Naval Shipboard, for Air, Nitrogen, Helium, or Hydraulic Service (sizes 2-1/2 inches IPS and below)		X	X				
MIL-S-23008C	Steel Castings, Alloy, High Yield Strength		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-S-23009B	Steel Forgings, Alloy, High Yield Strength (HY-80 and HY-100)		X	X				
MIL-S-22698B	Steel Pipe and Shapes, Weldable Ordinary Strength and Higher Strength: Hull Structural		X	X				
MIL-B-23921	Bronze-Nickel-Aluminum Castings for Sea-Water Service (Use MIL-B-24480)		X	X				
MIL-B-24059	Bronze-Nickel-Aluminum: Rod, Flat Products with finished edges, shapes and Forgings (Use QQ-C-465B)		X	X				
MIL-T-24107A	Tube, Copper (seamless) (Copper numbers 102, 103, 108, 120, 122, and 142)		X					
MIL-V-24109A	Valves, Globe, Angle, Quick Change Cartridge, Trim, High Pressure (H.P.) Hydraulic and Pneumatic (sizes 1/8 - 1-1/4 inches)		X					
MIL-S-24113A	Steel Plates, Carbon Manganese-Heat Treated by Normalizing or Quenching and Tempering (See MIL-S-22698)		X					
MIL-V-24272B	Valve Manifolds, High Pressure Gas Reducing		X					
MIL-V-24287	Stud, Bolt-Stud, Bolts, Nuts, Alloy Steel to 700 DEG F and Fatigue Application		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-V-24336	Valves, Pressure Reducing, for Oxygen		X					
MIL-V-24394	Valves, Automatic, Shut-Off, for Gas Service (sizes 1/4 - 2 inches IPS)		X					
MIL-V-24439A	Valves, Oxygen, Helium, and Helium-Oxygen Mixture, High Pressure for Gas Service		X					
MIL-B-24480A	Bronze, Nickel-Aluminum Castings for Sea Water Service		X	X				
MIL-D-24542A	Diving Outfit, Lightweight						X	
MIL-H-25579E	Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure			X				
DOD-E-24607	Enamel, Interior Nonflaming (Dry), Chlorinated Alkyd Resin Semigloss		X	X				X
MIL-H-26626B	Hose Assembly, Nonmetallic Tetrafluoroethylene, Oxygen		X	X				
MIL-O-27210E	Oxygen, Aviator's Breathing, Liquid and Gas		X				X	
MIL-H-27267B	Hose Tetrafluoroethylene, High Temperature, Medium Pressure		X	X				
MIL-F-27272A	Fittings, Tetrafluoroethylene Hose, High Temperature, Medium Pressure, General Requirements for		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
MIL-T-27730A	Tape, Antiseize, Polytetrafluoroethylene, with Dispenser			X				X
MIL-C-81302D	Cleaning Compound, Solvent, Trichlorotrifluoroethane (PCA, FREON 113)			X				X
MIL-R-83248A	Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant		X	X				

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Technical Manuals							
NAVSEA 0900-000-1000	Ship Hulls Fabrication Welding and Inspection			X		X		
NAVSEA 0900-001-7000	Fabrication and Inspection of Brazed Piping Systems			X		X		
NAVSEA 0900-006-3010	Hull Structure Production and Repair Welds, Ultrasonic Inspection Procedures and Acceptance Standards			X	X	X		
NAVSEA 0900-01609010	Fabrication, Welding, and Inspection of HY 80/100 Submarine Hulls			X	X	X		
NAVSEA T.M.*/ CH-262	Lubricating Oils, Greases, Hydraulic Fluids and Lubrication Systems (old NSTM Chap. 9450)							X
NAVSEA T.M.*/ CH-504	Pressure, Temperature, and Other Mechanical Electromechanical Measuring Instruments (old 9870)		X			X		X
NAVSEA T.M.*/ CH-505	Piping Systems (old 9480)		X			X		
NAVSEA T.M.*/ CH-551	Compressed Air Plants (old 9490)		X			X	X	X
NAVSEA 0994-001-9010	U.S. Navy Diving Manual, Volume I	X	X				X	X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
NAVSEA 0994-001-9020	U.S. Navy Diving Manual, Volume II	X	X				X	X
NAVSEA 0987-002-3010	Oxygen Gas System Inplace and Onsite Calibration of Pressure Instruments					X		X
NAVSEA 0987-022-3011	Inplace and Onsite Calibration of Pressure Instruments in Oxygen Gas Systems					X		X
NAVSEA S6560-AB-MMD-010/ EV EQP	Cleaning and Phosphate Coating Instructions High Pressure Air Flasks Used in Diving Air Systems			X				X
NAVSEA S9505-AF-MMA-010	Submarine Non-Nuclear Piping Systems Test Manual					X		
NAVSEA S9592-AG-MMO-010	Diver's Intercommunication Set, Operation and Maintenance Instructions						X	X
NAVSHIPS 0994-014-5010	(Painting)		X	X				X

REFERENCE INSTRUCTIONS AND DOCUMENTS APPLICABLE FOR NAVFAC HYPERBARIC SYSTEMS

Number	Title	Program Mission	Design	Fabrication and Assembly	Quality Assurance	Testing and Inspection	Operability	Maintenance
	Handbooks							
MIL-HDBK-406	Contamination Control Technology, Cleaning Materials for Precision Precleaning and Use in Clean Rooms and Clean Work Stations			X	X			X
MIL-HDBK-407	Contamination Control Technology, Precision Cleaning Methods and Procedures			X	X			X
MIL-HDBK-249	Metals and Alloys, Rapid Onsite Indentification of (recommended procedures for chemical spot testing)				X	X		

APPENDIX B

OP AND EP DEVELOPMENT GUIDELINES

OP AND EP DEVELOPMENT GUIDELINES

1. Procedural Guide (PG) Matrix

The first step in developing Operating Procedures (OPs) and Emergency Procedures (EPs) is determining the operations required to be supported (eg., Chamber Treatment Operations, Scuba Operations, Chamber PN02 Test Operations, etc.). After the required operations have been defined, then a determination can be made concerning the OPs and EPs needed to support each of the required operations. The recommended way to accomplish the above is to develop a Procedural Guide (PG) Matrix which clearly shows the OPs/EPs supporting each required operation. Table B-1, Sample Procedural Guide Matrix for Recompression Chamber and Scuba Operations, is provided to demonstrate how this is accomplished. The OPs/EPs needed to support each operation are noted by simply placing an "X" in the appropriate column (Table B-l refers).

2. Operating Procedure Development

When writing OPs for a hyperbaric system or equipments, the procedure must be developed in sufficient detail to cover all functional components involved in the system or equipment operation. The procedure must ask those questions which require specific data effecting lineup. In addition, the procedure must safely take the system from a shutdown configuration to an operating condition and back to shutdown while minimizing the hazards to personnel and damage to hardware. The following five sections are recommended as format guidelines for an operating condition and back to shutdown while minimizing the hazards to personnel and damage to hardware. The following five sections are recommended as format guidelines for an P development. In some cases, the sections will not apply and can be deleted, but they should be considered during the OP writing phase.

(1) Pre-Dive General Information
- (a) Type of dive
- (b) Which dive station (s) to be set up or manned
- (c) Which specific support equipment is to be used
- (d) Which compressors and air/oxygen storage flasks are to be used
- (e) Standby and primary gas supplies
- (f) Which chamber to use (if more than one)

(2) System Shutdown Verification
- (a) Check that every component in the system is in the shutdown configuration.

Table B-1
Sample Procedural Guide (PG) Matrix
Recompression Chamber and Scuba Operations

OP/EP No.	Title	Chamber Treatment Operations	Chamber PN02 Test Operations	Scuba Operations
OP-1	Air System-Chamber	X	X	X
OP-2	Oxygen System-Chamber	X	X	X
OP-3	Chamber Treatments	X		X*
OP-4	PN02 Tests		X	
OP-5	Scuba Operations			X
OP-6	Scuba Small Boat Procedures			X **
OP-7	Scuba Charging			X
EP-1	Scuba Diving EP			X
EP-2	Chamber Fire-Internal	X	X	
EP-3	Chamber Fire-Vicinity External	X	X	
EP-4	Chamber Pressurization-Uncontrolled	X	X	
EP-5	Chamber Pressure Loss-Uncontrolled	X	X	
EP-6	Chamber Contaminated Atmosphere	X	X	

Notes: * Ensures OP and personnel available
**** Applies only if diving from small boat**

(b) Check and record gas/air pressures
(c) Verify gas analysis
(d) Diving equipment pre-dive checks

(3) System Lineup
(a) In a specific order line up system
(b) This is normally a small number of components
(c) Ask specific questions, which when answered, specify alternative lineups
(d) Verify pressures and component operations

(4) Dive Operation Evolutions
(a) Cover all procedures that could require action/ accomplishment during a dive, such as:
- shifting gas banks
- shifting to standby

(5) System Shutdown
(a) In a specific order, shut down the system
(b) System shutdown should be the condition which:
- minimizes component operations
- leaves the system safe when shut down
- renders the system safe if left shut and other systems placed on-line
- renders the hyperbaric/diving system (s) safe if the system is not required and left in a shutdown condition

The format of operating procedures is at command discretion. However, each OP shall contain a space for the initials of the person accomplishing each action in the OP, and the signature of the diving supervisor and facility manager/diving officer indicating that they have reviewed the OP. A sample OP is provided as attachment (1) to this appendix.

3. Emergency Procedure Development.

The purpose of EPs is to provide guidelines and instructions to operating personnel which will eliminate personnel injury or equipment damage due to abnormal system conditions. Each EP addresses a specific emergency situation and identifies the actions required to respond to the situation.

EP corrective actions consist of a sequence of logical steps to address the casualty. In general, STEP 1 alerts all operators and divers of an imminent or existing emergency situation. STEP 2 takes initial positive actions which will protect the occupants/divers or transfer them to a safe environment. Subsequent steps provide for follow-up actions to control and/or isolate the malfunctioning component, equipment or system. Emergency situations usually encountered can be

identified within the following hazardous conditions:

(1) Fire
    (a) Within the system
    (b) Vicinity of system

(2) Fault within pressure boundary
    (a) Uncontrolled pressurization
    (b) Uncontrolled pressure loss

(3) Contamination of breathing media

The format of emergency procedures is at command discretion. Unlike OPs, EPs require no signatures/initials during implementation since such action would detract from response to the situation. In lieu of this, it is mandatory that all operating personnel be well trained in emergency procedure execution. EP Training is the direct responsibility of the Hyperbaric Facility Manager for Chamber Operations and the assigned senior diver (by diving qualification) for diving operations. A sample EP is provided as attachment (2) to this appendix.

SAMPLE OPERATING PROCEDURE
OP-3

CHAMBER TREATMENT

This OP is approved by the NAVFAC SCA for use on the recompression chamber located at NRRO, Charleston, S.C.

Hyperbaric Facility Manager _____ Date _____

SYSTEM: Recompression Chamber

STEP: 1. General

This procedure guide is to be used in administering emergency treatment for Decompression Illness. The procedures contained herein cover treatment for military members not assigned to this command, members of this command, and humanitarian treatment provided civilian divers. Because this procedure covers all possibilities for treatment, not all steps of the procedural guide will be applicable for every condition and individual steps may be marked as Not Applicable (N/A), as appropriate. This procedure shall be completed for each Chamber Treatment Operation.

STEP: 2. Associated Procedures

(a) OP 1: Air System -- Chamber
(b) OP 2: Oxygen System -- Chamber

STEP: 3. System Parameters

The following operational capabilities/parameters are effective for recompression chamber treatment:

(a) Maximum Chamber Pressure	100 psi
(b) Minimum Personnel Requirements	Diving Supervisor Qualified Outside Tender Qualified Inside Tender Gas King
(c) Treatment Tables	As set forth in the U.S. Navy Diving Manual, Volume 1.

Attachment (1)

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 4. Warnings, Cautions, and Notes

WARNING

1. These procedures shall be performed only by personnel properly trained to use them. Only a Diving Medical Officer may change or modify the procedures. Since these procedures cover symptoms ranging from pain to life threatening disorders, the degree of medical expertise necessary to carry out treatment properly will vary. Certain procedures, such as starting intravenous fluid lines and inserting chest tubes, require special training and should not be attempted by untrained individuals. Most treatment tables can be executed without consultation with a Diving Medical Officer, although one should always be contacted if possible. Two treatment tables, however, require special consideration. Treatment Table 4 is a long, arduous table that requires constant evaluation of the stricken diver. Treatment Table 4 should be performed without consultation with a Diving Medical Officer only in extreme emergencies where every effort to contact a Medical Officer has failed . Treatment Table 7 is a new table that allows prolonged treatment at 60 feet for severely ill patients. TREATMENT TABLE 7 REQUIRES DECISIONS TO BE MADE BASED ON THE PATIENT'S CONDITION THROUGHOUT THE TREATMENT AND SHOULD NOT BE DONE UNLESS A DIVING MEDICAL OFFICER IS EITHER ON SCENE OR IN CONTACT WITH THE TREATMENT FACILITY.

NOTE

1. Experience has shown that symptoms of severe decompression sickness or gas embolism may occur following seemingly innocuous dives. This fact combined with the many operational scenarios under which diving is done means that, occasionally treatment of severely ill individuals will be required where qualified medical help is not immediately on scene. This makes it incumbent upon the Diving Supervisor to ensure that every member of a diving team:

   1. Is thoroughly familiar with all recompression procedures,
   2. Knows where the nearest recompression facility is,
   3. Knows how to get in contact with a qualified Diving Medical Officer if one is not on scene.

   Modern communications allows access to expertise anywhere in the world from even the remotest areas.

NOTES: _____

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 4. Warnings, Cautions, and Notes (continued)

Emergency consultation is available 24 hours a day from:

Navy Experimental Diving Unit (NEDU)
Panama City, FL 32407
Commercial: (904) 234-4351
Autovon: 436-4351

or

Naval Medical Research Institute (NMRI)
Bethesda, MD 20814
Commercial: (202) 295-1839
Autovon: 295-1839

STEP: 5. Chamber Pre-Dive Procedures

Item	Component/Description	Location	Procedure	Check	Note
1.	Chamber Recall Bill		Implement personnel recall.		
2.	Assignment of Personnel		Assign personnel to complete required OPS and to duties for treatment.		
3.	**OP-1**	Per OP	Conduct OP-1 to verify that Chamber Air System is lined up to supply		
4.	**OP-2**	Per OP	Conduct OP-2 to verify that Chamber Oxygen System is lined up to supply chamber		

NOTES: _____

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 5. Chamber Pre-Dive Procedures (continued)

Item	Component/Description	Location	Procedure	Check	Note
5.	Flame Retardant Clothing	Chamber	Verify at least three (3) in chamber.		
6.	Flame Proof Blankets	Chamber	Verify at least three (3) in chamber.		
7.	Medical Kits	Chamber	Verify that medical kit(s) are ready for use and in chamber.		
8.	Chamber Lighting	Chamber	Test chamber electric lights to verify proper operation (leave lights on).		
9.	Chamber Lighting	Chamber	Hook-up and test chamber commmunications between inside and outside tenders.		
10.	Chamber Inner Lock Equipment	Chamber	Verify inner lock equipped with: (a) Bucket (b) Mattress in flame proof cover (c) Minimum of three (3) sets of ear protectors with pin holes. (d) Battle lantern (e) Mallet.		
11.	Chamber Outer Lock Equipment	Chamber	Verify outerlock equipped with: (a) Bucket (b) Minimum of (1) set of ear protectors with pin holes.		

NOTES: _____

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 5. Chamber Pre-Dive Procedures (continued)

Item	Component/Description	Location	Procedure	Check	Note
12.	Chamber Interior	Chamber	Verify chamber interior is clean and clear of all debris.		
13.	Chamber BIBS/Air	Chamber	Verify BIBS/Air System is operational by breathing on each BIBS mask		
14.	Chamber BIBS/Oxygen	Chamber	Verify BIBS/Oxygen System is operational by breathing on each BIBS mask.		
15.	Chamber Outside Tender Station	Chamber	Verify outside tender station equipped with: (a) U.S. Navy Diving Manual (b) Chamber Log (c) Four (4) Stop Watches		
16.	Step 5 Completion [Sign/ Date Prior to Continuing Procedure]	---	Dive Sup: _____ Sign/Date _____		

STEP: 6. Chamber Treatment

1.	Neurological Evaluation	Chamber	Upon arrival of patient, conduct pretreatment exam per U.S. Navy Diving Manual (Volume I, Appendix J)		

NOTES: _____

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 6. Chamber Treatment (continued)

Item	Component/Description	Location	Procedure	Check	Note
2.	Treatment	Chamber	Upon decision to treat, conduct operations per U.S. Navy Treatment Tables. Comply with Step 4 WARNING #1 when conducting treatment. See Step 4 Note #1 for emergency medical consultation phone numbers.		

STEP: 7. Chamber Post-Dive Procedures

1.	Patient Post-Treatment	Chamber Vicinity	Carry out patient post-treatment procedures per U.S. Navy Diving Manual (Volume I, Chapter 8).		
2.	Chamber Equipment and Cleaning	Chamber	Upon completion/ termination of chamber treatment, clear the chamber and repeat the following items of STEP (a) Item 5 (b) Item 6 (c) Item 7 (d) Item 8 (e) Item 9 (f) Item 10 (g) Item 11 (h) Item 12		

NOTES:

SAMPLE OPERATING PROCEDURE OP 3: CHAMBERTREATMENT

STEP: 7. Chamber Post-Dive Procedures (continued)

Item	Component/Description	Location	Procedure	Check	Note
3.	Chamber Standby Condition [In The Event of Recurrent Illness]	Chamber	On completion of treatment the Chamber Air System and Chamber Oxygen System will remain lined up to supply the Chamber for at least 24 hours, in the event of recurrent illness. Close outer lock door.		
4.	Chamber Shut-Down	Various	When appropriate, conduct system shut-down procedures per OP-1 and OP-2 respectively.		
5.	3150's	---	Complete 3150's for all patients and inside tenders.		

NOTES: _____

SAMPLE OPERATING PROCEDURE OP 3: CHAMBER TREATMENT

STEP: 8. Verification/Review of Completed OP

OP Completed: _____

Dive Supervisor (Print Name) Signature Date

Reviewed: _____

Hyperbaric Facility Manager/ Diving Officer (Print/Type) Signature Date

WHEN BOTH SIGNATURES ARE OBTAINED, FILE THIS OP TOGETHER WITH ASSOCIATED OPs AND 3150's (copies), AND RETAIN FOR THREE(3) YEARS.

NOTES: _____

SAMPLE EMERGENCY PROCEDURE
EP-6

CHAMBER CONTAMINATED ATMOSPHERE

This EP is approved by the NAVFAC SCA for use on the recompression chamber located at NRRO, Charleston, S.C.

Hyperbaric Facility Manager Date

Step	Operator	Component	Description	Location
1.	Dive Supervisor	Communica-tions	Alert all personnel of casualty	Chamber
2.	Inside Tender	BIBS AIR (02-See NOTE)	Chamber occupants go on BIBS AIR **NOTE** If depth is 60 ft or less dive supervisor may direct use of 02	Chamber
3.	Gas King	Air Supply	Shift from primary to stand by air	Various
4.	Outside Tender	Air Supply	Ventilate Chamber until. atmosphere is restored	Chamber
5.	Outside Tender	Exhaust	Decompress chamber as directed by dive supervisor	Chamber

Attachment (2)

APPENDIX C

SAMPLE MAN-RATED HYPERBARIC FACILITY
REENTRY CONTROL (REC) PROCEDURES

SAMPLE RAN-RATED HYPERBARIC FACILITY REENTRY CONTROL (REC) PROCEDURES

This document is intended to be used as a baseline in the development of reentry control procedures. It is not intended as a replacement for existing procedures which have been found to be acceptable by NAVFAC. The provided procedure and REC sheet format is only one example of a suitable REC program -- other formats are acceptable.

NRRO
INST 9080.1
January 1986
NRRO INSTRUCTION 9080.1

From: Commanding Officer, NRRO

To: Hyperbaric Facility Manager

Subj: Man-Rated Hyperbaric Facility Reentry Control Procedure

Ref: (a) SS521-AA-MAN-010, U.S. Navy Diving and Manned Hyperbaric Systems Safety Certification Manual
(b) Approved Hyperbaric Facility Cleaning Procedure
(c) ASME Chapter VIII, Division II

Encl: (1) REC Procedure Sequence
(2) REC Sheet
(3) REC Log (sample page)

1. Purpose. To promulgate the procedures to be utilized for controlling reentry into recompression chamber systems which require material and cleanliness control in order to accomplish and subsequently maintain NAVFAC system certification.

2. Discussion.

a. Reference (a) provides guidance requiring that reentry control procedures be established for recompression chamber systems. This instruction is issued to supplement specified requirements of reference (a).

b. The term "Certified System" with regard to this instruction is inclusive of all pressure hull fittings, including penetrators, hatches, and viewports within each pressure hull and each breathing gas or other piping system within the total system as defined by the Scope of Certification.

c. Material control for replacement of repair parts in a "Certified System" is regulated by the material schedule contained in the "as-built" drawings and by the requirements of reference (a).

d. Hydrostatic or gas tightness testing pressures shall be in accordance with the "as-built" drawings and the guidelines of reference (c).

e. Requirements and procedures for cleaning breathing gas piping and hose systems, system gauges, and subsequent testing of these systems, along with gas contaminant testing of the breathing gas systems and pressure hulls shall be in accordance with guidelines of references (b) and (c).

3. Action.

a. Once a certifiable system has been successfully pressure-tested, cleaned, and cleanliness verified in accordance with the requirements of references (a), (b) and (c), no reentry to that system shall be accomplished without strict compliance to the REC procedure sequence included as enclosure (1).

b. Reentry shall be requested and documented on the REC sheet included as enclosure (2). Smooth originals of each REC sheet shall be maintained on file by the hyperbaric facility manager in numerical serial file order.

c. A complete record of all REC actions approved and completed shall be maintained in the REC log by the hyperbaric facility manager. A sample REC log page is included as enclosure (3). REC log serial numbers shall include the current year followed by the sequential number for that year (e.g., 84-0001, 84-0002, etc.)

d. Should additional areas of the system become accidentally contaminated during a REC maintenance action, or should additional or unforeseen work necessitate change to the original REC, the original REC sheet shall be cancelled, and a revised sheet submitted under the original REC number with a numerical revision (e.g., 84-0001A). The smooth original shall be brought up to date as of the revision, and plainly marked at the top of each page "CANCEL due to REVISION ___." A cancelled REC shall be maintained on file. A complete explanation shall be written in the NARRATIVE section, item 14. An entry explaining the circumstances of the revision is NOT required on the new REC sheet unless space item 3 permits.

e. The hyperbaric facility manager shall approve or disapprove all REC requests.

4. Responsibilities.

a. The hyperbaric facility manager is responsible for the execution of this instruction. When a certified system must be reentered, he shall:

(1) assign a qualified REC supervisor (REC SUP). Note : He may assign himself as REC SUP,
(2) set the work limit boundaries within the certification limits,

(3) screen each REC sheet request prior to submission for approval,

(4) assign a REC number from the REC log and make the required entries in the REC log,

(5) at the completion of the REC, have the smooth REC sheet prepared, dated, and signed. File the smooth REC sheet in the REC sheet serial file.

b. The REC supervisor (REC SUP) shall:

(1) initiate and maintain the rough working copy of each REC sheet.

(2) directly supervise all details of the reentry and be physically present during any and all work accomplished in relation to the REC, other than work accomplished in the cleanroom or contracted to an industrial concern if covered by test reports or other official documentation.

Commanding Officer

MAN-RATED HYPERBARIC FACILITY REENTRY CONTROL PROCEDURE SEQUENCE

1. Hyperbaric facility manager assigns qualified REC SUP and REC number.

2. Hyperbaric facility manager and REC SUP review work requirements.

3. REC SUP completes items 1 through 10 on REC sheet.

4. REC SUP submits REC sheet to hyperbaric facility manager for screening.

5. Hyperbaric facility manager approves/disapproves REC.

6. REC SUP Tag's Out and Secures isolation boundaries.

7. REC Maintenance Action is accomplished. REC SUP supervises and is present for entire procedure, other than laboratory work or work contracted and which is covered by test reports.

8. REC SUP submits completed (rough) REC sheet to hyperbaric facility manager.

9. Hyperbaric facility manager has smooth REC sheet completed, signs, and files signed smooth REC sheet.

10. Hyperbaric facility manager completes REC log entry.

*NOTE: Hyperbaric facility manager may delegate his responsibilities for REC in writing to qualified personnel.

Enclosure (1)

SAMPLE REENTRY CONTROL SHEET

REC No.: _____ **REV** No. : _____

REC Supervisor: _____

Associated RECs: _____

1. System to be entered:
   _____
2. System Drawing No. _____
3. Justification for REC in detail:
4. Isolation boundaries by piping number and valve number, etc.:
5. Steps to be taken to preclude contamination of any portion of system temporarily sealed:
6. Other systems affected:
7. Applicable maintenance procedures:
8. NDT requirements:
9. Pressure testing requirements:
10. Cleaning/testing requirements:
11. Signature of REC SUP:
    _____(submit to hyperbaric facility manager for screening and correction.)

Approved: _____
Hyperbaric Facility Manager

12. REC SUP tag out and secure isolation boundaries: _____

13. Reentry start time and date: _____/_____

14. Narrative of work and testing accomplished. Attach any test result sheets or documentation as additional pages to smooth REC sheet.

15. Completion time and date: _____/_____

_____
REC Supervisor Date

_____
Hyperbaric Facility Manager Date

Sample REC Log Page

FACILITY							
REC No.	REV	System Reentered	REC SUP (Print Name) (Signature)	DATES			REMARKS (Include any associated RECs)
				Issue	Start	Completion	

APPENDIX D

DO AND DON'T SUMMARY OF

COMMON DIVING AND RECOMPRESSION CHAMBER SYSTEM DISCREPANCIES

DO AND DON'T SUMMARY OF COMMON DIVING AND RECOMPRESSION CHAMBER SYSTEM DISCREPANCIES

Appendix D contains the following:

- "Do and Don't" Summary of Common Diving and Recompression Chamber System Discrepancies

This "Do and Don't" summary is provided to assist commands in conducting in-house indoctrination and training of personnel involved with chamber/diving system maintenance and operation. Commands are encouraged to incorporate this document into the command indoctrination/training program.

"DO AND DON'T" SUMMARY OF COMMON DIVING AND RECOMPRESSION CHAMBER SYSTEM DISCREPANCIES

Pressure Gages	
DO	**DON'T**
o Have gages calibrated at least once a year or if a Roylyn gage, compared every six months. o Have gages tagged to show when next calibration or comparison is due. o Have an isolation valve in line with each gage as close to chamber hull or source as possible. o Have each gage adequately supported.	o Mount gages against a panel without provisions for a back-mounted blowout plug to be effective. o Forget to replace all of the mounting hardware after gage calibration. o Remove a gage for calibration without filling out a reentry form and capping off the line to protect it from contamination. o Use a gage where the maximum system operating pressure is more than 75 percent of the gage scale.

Oxygen System	
DO	**DON'T**
o Use approved material, fittings, and fabrication procedures for oxygen system. o Keep all oxygen cylinders securely clamped in place. o Ensure that BIBS manifolds are adequately supported. o Repair or replace BIBS regulators that free flow. o Inspect for oxygen leaks from valve packing stems and seats. o Do ensure that NO SMOKING signs are prominently displayed.	o Use unapproved whips open to contamination. o Leave unattached whips open to contamination. o Run oxygen lines so that they contact other piping, electrical cables, brackets, etc. o Keep deteriorated BIBS masks in manned or enclosed spaces. Vent overboard to weather if possible.

General	
DO	DON'T
o Have and follow reentry control procedures for maintenance, ripouts, repairs, authorized modifications, etc. o Prepare and submit a presurvey outline booklet (PSOB) and a certification milestone event schedule after applying for certification. o Have operating and emergency procedures that reflect the system by identifying all valve and gage numbers, etc., are realistic, understandable and current.	o Forget to keep system drawings updated, including the bills of material, when approved modifications and changes are made. o Neglect to add new components to the maintenance system. o Fail to specify what systems, equipment, and components are considered to be within the scope (boundary) of certification.

Air System	
DO	DON'T
o Ensure that the air purity meets the requirements specified for diving. o Install filters as close to the compressors as practical to prevent contaminating long runs of piping. o Label, color code, and indicate directions of flow on system piping components. o Clean, hydro and leak test all piping systems. Record date and sign all results and keep on file. o Marry strength member with appropriate snap-shackle end connections to SCUBA charging whips and hoses to prevent them from lashing about if the hose parts or becomes disconnected during use.	o Leave air hoses and SCUBA charging whips uncapped when not in use. Have protective caps attached to hose storage stations for use in keeping contaminants out of unused lines. o Fail to install pressure relief valves downstream of all regulators so that in case of regulator leakage or failure, system components cannot be overpressurized. o Install underrated components in the piping system. o Fail to hydratest HP flasks, volume tanks, moisture separators, and filters within the prescribed time period. Record the date of the test and the test pressure on each component tested.

Air System (Continued)	
DO	DON'T
o Ensure that new piping systems meet the material requirements for air systems. o Allow at least two threads to project beyond nuts or threaded flanges on bolt-assembled components. Cut off excess bolt length where not required. o Provide for blowdown of air supply filters every hour of compressor operation, or as recommended by manufacturer. o Use only approved air system filters.	o Rerate air systems without insuring that all components have design operating pressure ratings equal to, or in excess of, the new pressure, otherwise remove them from the system. o Assume backup air supply is adequate as to quantity and quality. Provide calculations and air sample test results. o Operate system with missing valve handwheels. o Install filters backwards. Check the flow directions shown on the filter or manufacturer's specification.

Recompression Chamber	
DO	DON'T
o Have chamber relief valve setting and date of test shown on valve. o Conduct chamber pressure tests with air per the U.S. Diving Manual. o Have chamber relief valve gage valve installed and wired open and warning plate Installed. o Ensure that doors and door dogs operate smoothly without binding, misalignment or interference. Effect a seal quickly and at low pressure.	o Have relief valve exhaust directed towards personnel. o Leave the deck plates loose so that they could possibly accumulate a static electric charge that on discharge could serve as an ignition source. Bolt them down. o Have primary chamber support system that requires more than three (3) minutes to pressurize inner chamber lock to 165 fsw. o Neglect medical locks. Keep them clean and leak-tight. Keep special wrenches required for operation at the locks.

Recompression Chamber (Continued)	
DO	DON'T
o Make provisions for emergency lighting of both the inside and the outside of the chamber. Battle lanterns dedicated for use by directing through viewports and control area are acceptable. o Check for cut or worn door gaskets and replace, if required. o Check drain valve penetrations (if installed) for signs of corrosion. o Have all valves that require operation accessible to the operator. o Have additional medical support telephone numbers posted in the vicinity of the chamber, such as EDU, Panama City 904-234-4335/51 (Autovon 436-4351) and NMRI, Bethesda 202-295-1839 (Autovon 295-1839).	o Store or permit unknown, unauthorized, or flammable materials in the chamber. o Splice speaker wires unless they are in a box. Attach them to terminal strips or solder them to the speaker lugs. o Fail to keep chamber bilges clean and dry. o Drape electrical wire and cables across the outside of the chamber. Have them supported properly or enclosed. o Have outdated copies of treatment tables posted or available. Ensure tables reflect the latest changes.

APPENDIX E

SAMPLE FORMS

SAMPLE FORMS

DROP TEST RECORD | **FILE NO.:**

FACILITY:	**PROCEDURE NO.:**	**REV.:**
JOB NO.:	**LEAD SHOP/WORK CENTER:**	

1	SYSTEM/COMPONENT TO BE TESTED:		
2	DIAGRAM OF TEST AREA (DESCRIPTIVE OR DIAGRAMMATIC):		
3	TEST MEDIUM:	SOURCE OF TEST MEDIUM:	
4	REQ'D TEST PRESSURE (PSIG):	INITIAL TEST PRESSURE (PSIG):	
5	SEA WATER TEMP °F AT START:	SEA WATER TEMP °F AT FINISH:	
6	COMPARTMENT AIR TEMP °F AT START:	COMPARTMENT AIR TEMP °F AT FINISH:	
7	TEST PRESSURE GAGE RANGE (PSIG):	ACCURACY (±F PSIG):	**DATE CHECKED:**
8	ALLOWABLE PRESS DROP _____ % IN _____ HRS/DAYS	FINAL PRESSURE AT END OF TEST:	
9	FINAL PRESS DROP CORRECTED FOR TEMP °F CHANGE:		
10	TEST RESULTS: **0 SAT 0 UNSAT**		

INSPECTED BY	**DATE**
APPROVED BY	**DATE**
REVIEWED BY	**DATE**

COPY TO:

HYDROSTATIC/PNEUMATIC TEST RECORD

FILE NO.			
FACILITY	PROCEDURE NO.	REV.	DATE
JOB NO.	LEAD SHOP/WORK CENTER		

1	SYSTEM/COMPONENT TO BE TESTED:		
2	DIAGRAM OF TEST AREA (DESCRIPTIVE OR DIAGRAMMATIC) INCLUDING GAGS AND BLANKS INSTALLED:		
3	SOURCE OF PRESSURE:	CAPACITY (GPM/CPM):	
4	TEST MEDIUM:	SOURCE OF TEST MEDIUM:	
5	REQ'D TEST PRESSURE (PSIG):	ACTUAL TEST PRESSURE (PSIG):	
6	TEST RIG RELIEF VALVE SETTING (PSIG):	CAPACITY (GPM)	DATE CHECKED
7	PRIMARY PRESSURE GAGE RANGE (PSIG):	ACCURACY (± PSIG)	DATE CHECKED
8	BACKUP PRESSURE GAGE RANGE (PSIG):	ACCURACY (± PSIG)	DATE CHECKED
9	REQUIRED TEST TIME MIN/HRS:	ACTUAL TEST DURATION MIN/HRS:	
10	ALLOWABLE LEAKAGE RATE:	ACTUAL LEAKAGE RATE:	
11	TEST RESULTS: 0 SAT 0 UNSAT		
12	VERIFY GAGS AND BLANKS REMOVED:		
13	RESTORE SYSTEM/COMPONENT TO NORMAL OR AS REQUIRED FOR SUBSEQUENT TEST.		

INSPECTED BY	DATE
APPROVED BY	DATE
REVIEWED BY	DATE

COPY TO:

THICKNESS MEASUREMENT REPORT

FILE NO.

FACILITY:	JOB NO.	PLAN/DRAWING NO.	REV.	DATE

SYSTEM	COMPONENT(S)	TYPE OF MAT.	MIL SPEC	MATERIAL 0 PIPE 0 PLATE 0 CASTING 0 OTHER

THICKNESS

DESIGN MATERIAL	LOWEST ACCEPTABLE	ACTUAL	0 ACCEPTED 0 REJECTED

ULTRASONIC EQUIPMENT

INSTRUMENT (Model) SER. NO.	TYPE TRANSDUCER	SIZE	FREQ.	ACCURACY + ( ) % - ( ) %	COUPLANT

INSPECTION AREA SKETCH:

REMARKS:

INSPECTOR/ID	DATE	INSPECTOR/ID	DATE	SUPERVISOR/ID	DATE

COPY TO:

TORQUE/CONTROLLED ASSEMBLY REPORT

FILE NO.

FACILITY	JOB NO.	REC NO.	DATE
LEAD SHOP/WORK CENTER	SYSTEM		
FASTENER MATERIAL	SIZE	TYPE	REFERENCE FOR MATL.
O NEW O REUSED	INSPECTION REFERENCE(S)		
TORQUE REQUIRED	REFERENCE FOR TORQUE		

MISC. REFERENCES

TORQUE SEQUENCE SKETCH	INSTALLATION PROC.
	ANTI-SEIZE MATERIAL
	SEALING COMPOUND
	TORQUE DEVICE RANGE
	CAL DUE DATE
	RUNNING TORQUE
	FINAL TORQUE (Required & Running Torque)
	THREAD ENGAGEMENT

PARTS REPAIRED

GASKET/O-RING DATA		OTHER PARTS REPLACED
SPECIFICATIONS		REF.
REF.		
NSN/COMMERICAL STOCK NO.	EXP. DATE	
		SEALING SURFACE FINISH IAW
LOCKWIRED IAW		REASSEMBLY COMPLETED IAW
MICROMETER SERIAL NO.		BLUE CHECK RESULTS

REMARKS

The **person designated to sign** for an action verifies based on personal observation, and certifies by his signature, that the action has actually been performed in accordance with specified requirements.	PERFORMED/DATE
	QA INSP. WITNESSED/DATE

FLEXIBLE HOSE INSPECTION REPORT

*See Attached for Defect Code

FILE NO.

FACILITY	WORK CENTER	SYSTEM(S)	DATE

	HOSE ASSEMBLY	FACILITY ID NO.	HOSE		LGTH.	WORKING PRESS	FITTING TYPE	DEFECT CODE*	DATE		SHOP INFORMATION	MATERIAL AVAIL.
			TYPE	SIZE					MFG.	INSTALL.		
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												

INSPECTOR (Signature)	INSPECTOR (Signature)	SUBMITTED	APPROVED BY

PAGE _____ OF _____

FLEXIBLE HOSE INSPECTION REPORT (ATTACHMENT)

INSPECTION REQUIREMENTS (DEFECTS)
ALL FLEXIBLE HOSE ASSEMBLIES SHALL BE INSPECTED FOR THE FOLLOWING DEFECTS:

1. EVIDENCE OF LEAKAGE AT FITTING ENDS.

2. DISCOLORATION OF FITTINGS. (THIS COULD INDICATE POSSIBLE RUSTING OF WIRE REINFORCEMENT OF HOSE)

3. SLIPPAGE OF HOSE OUT OF FITTING.

4. SEALER NOT VISIBLE.

5. CRACKING OF OUTER RUBBER COVER.

6. SOFT SPOTS OR BULGES ON HOSE BODY.

7. RUBBER COVER RUBBED THIN BY CHAFING OR ABRASION.

8. DAMAGED FITTING.

9. LARGE AREA OF HOSE COVERED WITH PAINT.

10. STEEL SEGMENTED SOCKETS IN SEA WATER SYSTEMS.

11. FITTED FITTINGS, OR LOOSE OR SHIFTED BANDS OR RETAINING RINGS.

12. MIS-BATCHED HOSE AND FITTINGS.

13. HANGERS BROKEN, DISTORTED OR DAMAGED.

14. ADDITIONAL HANGERS REQUIRED.

15. TWISTED OR DEFLECTED.

16. IMPROPER CLEARANCE.

17. IMPROPER BEND RADIUS.

18. FREE LENGTH OF HOSE NOT CORRECT.

19. NO DATE OF HOSE MANUFACTURE.

20. NO INSTALLATION DATE. (METAL TAG)

21. NO HOSE IDENTIFICATION.

22. HOSE HAS EXCEEDED SERVICE LIFE. REPLACE.

23. IMPROPER HOSE INSTALLED.

HOSE ASSEMBLY REPORT FILE NO.

FACILITY _____ SERIAL NO. _____

ASS'Y NO. _____ SYSTEM _____ ASS'Y DATE _____

PLAN NO. _____ J. O. _____

TYPE HOSE _____ FREE LENGTH OF HOSE ADEQUATE _____

SYSTEM _____ FITTING X-RAY REQ'D _____ YES _____ NO

SPRINGS AND SPACERS INSTALLED _____ PROPER CLEARANCE _____

ASSEMBLY PC. NO. _____

END SEALED _____ FITTINGS ETCHED _____

ASSEMBLED BY _____ DATE HOSE MF'D _____

FLUSHED & HYDRO TESTED _____ PSI _____

WITNESSED AND CERTIFIED BY SUPERVISOR _____

FACILITY INSPECTOR _____ DATE _____

NOTES:

FABRICATION TAG ATTACHED _____ TAGGED BY _____

DELIVERED TO _____ DATE _____

WELDING INPROCESS CONTROL—NONDESTRUCTIVE TEST INSPECTION REPORT

FILE NO.

FACILITY	WORK CENTER	REC NO.	DATE
JOB DESCRIPTION	PLAN NUMBER	JOINT ID NUMBER	☐ ORIGINAL ☐ REPAIR NO.
SYSTEM	COMPONENT	LOCATION	

WELDING SPECIFICATION DATA

WELD PROCEDURE	TECH. NO.	POSITION WELDING				ACCESSIBILITY	
		☐ HFP ☐ VFP	☐ VERT ☐ HORZT	☐ FLAT ☐ OVHD	☐ OTHER:	☐ RESTRICTED ☐ UNRESTRICTED	
JOINT DESIGN	☐ MODIFIED BY WELD PROCEDURE	WELD CUR RNG.	SHIELD GASS	FLOW RATE	PRE-HEAT	INTER-PASS	POST-HEAT

BASE MATERIAL SPECIFICATION DATA

NOUN NAME	MATERIAL TYPE	SIZE	SCH.	THICKNESS	MIL-SPEC	MIC NUMBER
CANOPY SEAL BACKING RING						

WELDING MATERIAL SPECIFICATION DATA

FILLER MATERIAL	FILLER TYPE	SIZE	MIL-SPEC	MIC NUMBER
INSERT				
BARE WIRE				
ELECTRODE				

INPROCESS CONTROL INSPECTION DATA

FABRICATION STANDARD	CLASS	INSPECTION STANDARD	ACCEPTANCE STANDARD	CLASS

FIT-UP	ROOT OPNG	BEV ANGLE	LAND WD	SKT DP	DIAM CLR	☐ ACCEPT ☐ REJECT	INSPECTOR NAME/ID	DATE

WELD LEVEL	WELDER ID	QUAL EXP DATE	PHT INTPS	PRO-CESS	AMP / VOLT	TYPE INSP	INSP MTHD	INSP TEMP	DATE	INSPECTOR NAME/ID	ACPT REJ
END PREP											
TACK											
ROOT PASS											
INTERM. LAYER(S)											
FINAL											

INSPECTION PROCEDURE(S)	WELD COMPLETION DATE/TIME	FINAL WELD DIM.	FINAL SURFACE CONDITION
			☐ AS WELDED ☐ MACHINED ☐ GROUND ☐ OTHER

REMARKS/NOTES

☐ ACCEPT ☐ REJECT	SHOP SUPERVISOR/ID	DATE	LOCAL GOVERNMENT INSPECTOR	DATE

NON-DESTRUCTIVE TESTING QUALIFICATIONS

FACILITY

DATE: _____

CERTIFICATION:

1. Certified this date in accordance with standards as indicated below.
2. Certification for all standards expire three years from above date or upon termination of current employment, whichever occurs
3. Certification card number _____ issued.

METHOD	LEVEL QUALIFIED	LIMITATIONS	STANDARD	SIGNATURE OF EXAMINER

NDT EXAMINER NUMBER _____

APPROVAL SIGNATURE _____

NAME (LAST, FIRST, MIDDLE)	SSN	WORK CENTER

NON-DESTRUCTIVE TESTING RADIOGRAPHIC (RT) TECHNIQUE RECORD AND INSPECTION REPORT

FILE NO.

FACILITY	JOB NO.	REC NO.	DATE

JOB DESCRIPTION	JOINT ID NO.	PLAN NO.

SYSTEM	COMPONENT	LOCATION OF WORK

SPECIMEN COMPONENT PRE-EXPOSURE DATA

SPECIMEN COMPONENT TYPE	MAT. TYPE	PIPE SIZE	THICKNESS	JOINT DESIGN
			TM' _____ TM _____	☐ INSERT ☐ BK RING ☐ OTHER:

REINFORCEMENT	WELD LEVEL	SURFACE FINISH
OUTSIDE _____ TOTAL INSIDE _____ ONE SIDE _____	☐ ROOT ☐ OTHER _____ ☐ FINAL ☐ REPAIR NO. _____	☐ AS WELDED ☐ GROUND ☐ OTHER ☐ AS CAST ☐ MACHINED

EXPOSURE REQUIREMENT DATA

INSPECTION STANDARD/CLASS	RT COVERAGE REQUIRED	PENETRAMETER
	☐ 60° ☐ 100° ☐ 360° ☐ OTHER: _____	SIZE _____ MAT'L _____ ☐ SOURCE SIDE ☐ FILM SIDE

QUALITY LEVEL REQ'D	SPECIMEN THICKNESS	SHIM MAT. THICKNESS	EXPOSURE TECHNIQUE
	TS' _____ TS _____		☐ DOUBLE WALL ESP. SINGLE VIEW ☐ DOUBLE WALL EXP. DOUBLE VIEW ☐ SINGLE WALL EXPOSURE

EXPOSURE EQUIPMENT DATA

	MANUFACTURER KVP	FOCAL SPOT SIZE	KV AND MA USED	SCREENS USED
X-RAY				_____FRONT _____MIDDLE _____BACK

	ISOTOPE USED	INTENSITY (CURIES)	PHYSICAL DIMEN	FILTER MASKING USED
ISOTOPE				☐ NO ☐ YES TYPE _____

	MANUFACTURER	TYPE	SIZE	LOADED	FILM PROCESSING
FILM				☐ SINGLE ☐ DOUBLE	☐ MANUAL ☐ AUTOMATIC TIME _____ TEMP _____

EXPOSURE DATA (RADIOGRAPHIC INTERPRETATION SHEET ATTACHED)

SOURCE TO FILM DISTANCE (SFD) AND EXPOSURE TIME

LOC	SFD	TIME	LOC	SFD	TIME	LOC	SFD	TIME

RADIOGRAPHER

ASSISTANT RADIOGRAPHER(S)

FINAL REVIEW

	RADIOGRAPHIC FILM INTERPRETER/ID	DATE	SHOP SUPERVISOR/ID	DATE
☐ ACCEPT ☐ REJECT				

	RADIOGRAPHIC FILM INTERPRETER/ID	DATE	GOVERNMENT INSPECTOR	DATE
☐ ACCEPT ☐ REJECT				

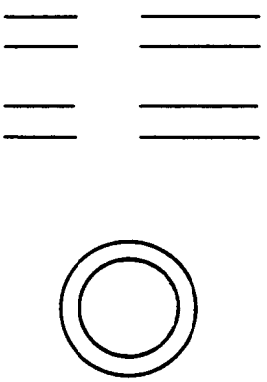
COPY TO.

RADIOGRAPHIC INTERPRETATION SHEET

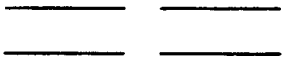
FILE NO.

RADIOGRAPHIC SHOOTING SKETCH DRAWING

PIPING



PLATE



STANDARD RADIOGRAPHIC TECHNIQUE USED

THE BELOW INFORMATION SHALL BE INDICATED ON APPLICABLE SKETCH:

a. Type of joint design.

b. Weld level radiographed

c. Source orientation direction and distance of off-set.

d. Penetrameter and shim placement.

e. Film and location marker placement

f. Indicate orientation of piping or component

g. Indicate if joint is between piping and component; or fitting.

RADIOGRAPHIC INTERPRETATION DATA

ACCEPTANCE STANDARD/CLASS

WELD PROCESS ☐ TIG ☐ MAA ☐ COMBINED

FILM TO BE VIEWED ☐ SINGLE WALL ☐ DOUBLE WALL

AREA	T-HOLE	FILM DENSITY			INDICATION DESCRIPTION																	DESCRIPTION AND SIZE OF INDICATIONS	DISPOSITION OF WELD OR COMPONENT		DISPOSITION OF RADIOGRAPHIC TECH.	
LOCATION MARKERS	VISABLE T-HOLE	DENSITY LIGHTEST AREA OF INTEREST	DENSITY DARKEST AREA OF INTEREST	DENSITY OF THE SHIM IMAGE	CRACK: TYPE	SLAG/OXIDE	POROSITY	INCOMP PENETRATION	LACK OF FUSION	MELT THROUGH	BURN THROUGH	OXDTN/LOSS OF PURGE	CRATER PIT	TUNGSTEN INCLUSION	ROOT SUR CONCAVITY	ROOT SUR CONVEXITY	UNDERCUT	ROOT SUR C/L CREASE	IMCOPT INSERT MELT.	BK-RING ROOT EDG COND	OTHER:		ACCEPT	REJECT	ACCEPT	REJECT

REMARKS:

TEST AND INSPECTION FORM-OTHER THAN NDT

		FILE NO.
FACILITY	JOB NO.	DATE
	LEAD SHOP	REC NO.

DESCRIPTION OF ITEM

DESCRIPTION OF TEST AND/OR INSPECTION COMMENTS

COMMENTS

SHOP/FIELD Q.A. INSPECTOR	DATE
FACILITY REPRESENTATIVE	DATE

COPY TO:

MAINTENANCE SCHEDULES

Maintenance Cycle, Quarterly and Weekly schedules may be developed locally using a suitable format meeting the requirement of Chapter 3 of this manual, or, the following PMS schedules may be used and ordered from standard stock.

Cycle PMS Schedule: FSN 0107-LF-770-3200

Quarterly PMS Schedule: FSN 0107-LF-770-3241

Weekly PMS Schedule: FSN 0107-LF-770-3260

EFFECTIVE DATE OF PROCEDURE:

FACILITY:	SYSTEM:	MAINT. CODE
MAINTENANCE DESCRIPTION:		
PERSONNEL REQUIREMENTS:		
SAFETY PRECAUTIONS:		
TOOLS, PARTS, MATERIALS, TEST EQUIPMENT:		
PROCEDURE:		
MAINTENANCE SUPERVISOR'S SIGNATURE:		DATE:

Sheet 1 of 1

EFFECTIVE DATE OF PROCEDURE:

FACILITY:	SYSTEM:	MAINT. CODE
MAINTENANCE DESCRIPTION:		
PERSONNEL REQUIREMENTS:		
SAFETY PRECAUTIONS:		
TOOLS, PARTS, MATERIALS, TEST EQUIPMENT:		
PROCEDURE:		
MAINTENANCE SUPERVISOR'S SIGNATURE:		DATE:

Sheet .of

EFFECTIVE DATE OF PROCEDURE:

FACILITY:	SYSTEM:	MAINT. CODE
MAINTENANCE DESCRIPTION:		
PROCEDURE:		
MAINTENANCE SUPERVISOR'S SIGNATURE:		DATE:

Sheet of

OPERATING PROCEDURE OP- :

This OP is approved by the NAVFAC SCA for use on recompression chamber located at

_____

Hyperbaric Facility Manager **Date**

Sheet of

OPERATING PROCEDURE OP :					
STEP:					
Item	**Component/Description**	**Location**	**Procedure**	**Check**	**Note**

NOTES: _____

EMERGENCY PROCEDURE
EP-

This EP is approved by the NAVFAC SCA for use on _____

_____

_____ _____
Hyperbaric Facility Manager Date

Step	Operator	Component	Description	Location

EMERGENCY PROCEDURE
EP-

Step	Operator	Component	Description	Location

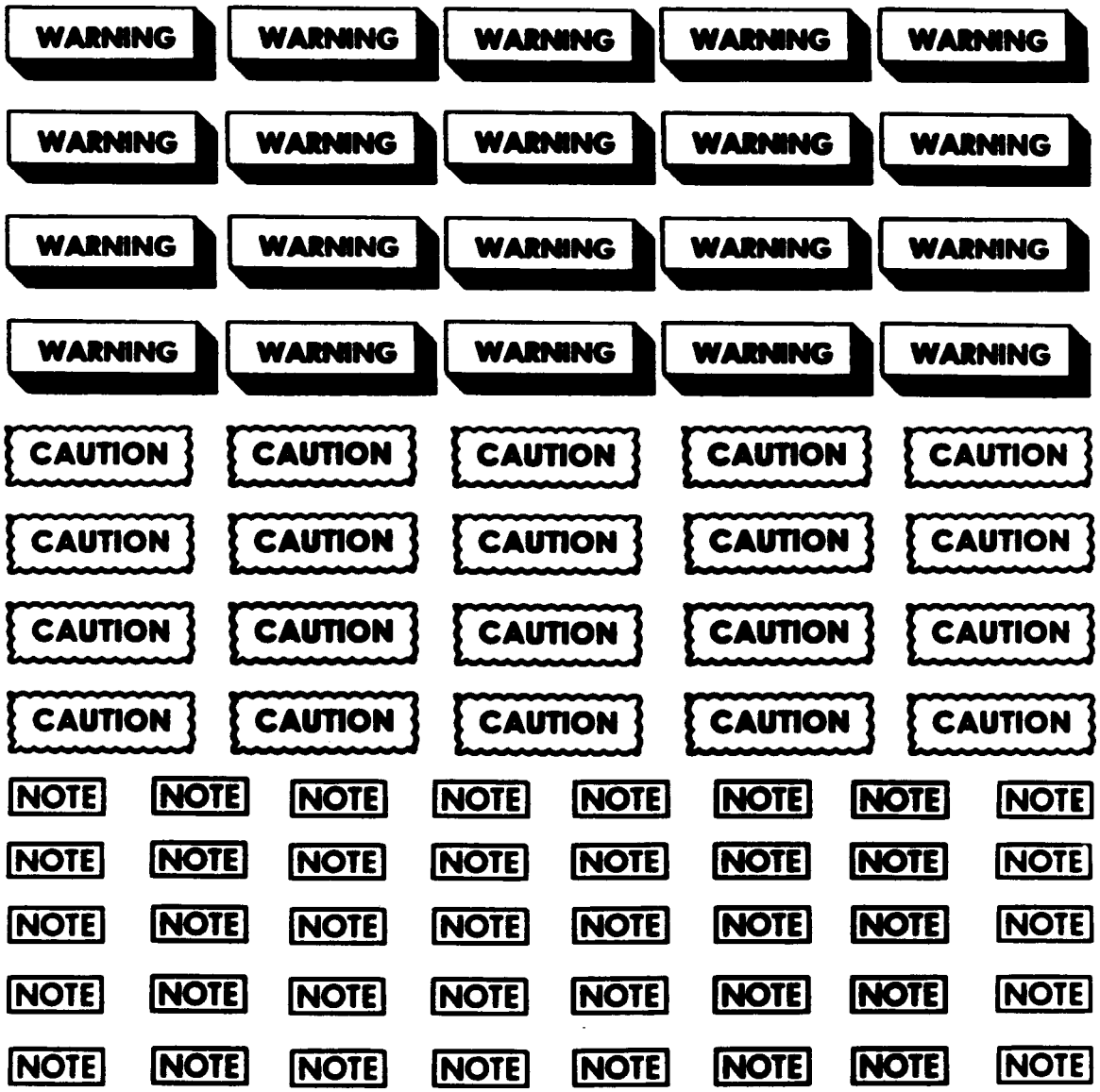
DEFINITION OF WARNING, CAUTION AND NOTE

The safety notices associated with the following symbols should be given special attention when they appear in maintenance, operating and emergency procedures.

WARNING — CONCERNS AN OPERATING PROCEDURE OR PRACTICE THAT, IF NOT STRICTLY OBSERVED, CAN RESULT IN INJURY TO PERSONNEL OR LOSS OF LIFE.

CAUTION — CONCERNS AN OPERATING PROCEDURE OR PRACTICE THAT, IF NOT STRICTLY OBSERVED. CAN RESULT IN DAMAGE TO OR DESTRUCTION OF EQUIPMENT.

NOTE — CONCERNS AN OPERATING PROCEDURE OR CONDITION THAT NEEDS HIGHLIGHTING.



MATERIAL RECEIPT CONTROL RECORD

FACILITY		DATE
MATERIAL NOMENCLATURE	HAZCAT LEVEL ☐ I ☐ II ☐ III ☐ IV	MIC NO./ID NO.
REQ. NUMBER	JULIAN DATE	NUMBER RECEIVED
NSN/COMMERCIAL STOCK NO.	VENDOR AND VENDOR'S MARK	

ACCEPTABLE CERTIFICATION DOCUMENTS FURNISHED (SIGNATURE AND DATE)
☐ YES ☐ NO

INSPECTION REQUIRED

ENTER APPROP. CODE X — RECORDS REQUIRED O — RECORDS NOT REQ'D.	MT	PT	RT	UT	VIS	CHEM	PHYS	SPOT CHECK	HDNS	DIMEN
	___	___	___	___	___	___	___	___	___	___

INSPECTION RESULTS/REMARKS AND SIGNATURE AND DATE

DISPOSITION	CLEANING REQUIREMENTS	STORAGE AREA
☐ ACCEPT ☐ REJECT		
DOWNGRADE	SIGNATURE AND DATE	
☐ GENERAL STOCK ☐ REJECT TO SOURCE		

CLEANING AND AIR ANALYSIS DATA SHEET

File No.:

Facility:	REC. Number:	Date:
System:	Procedure Ref:	
Description:		

Solvent Hydrocarbon Analysis

Solvent Used: ☐ TSP ☐ PCA (FREON 113) ☐ NID ☐ OTHER _____

Cleaning Certification: ☐ Vendor _____ ☐ Lab _____

Hydrocarbons at 3.42 MICRONS (5.0 PPM By Wgt. Allowable): _____ PPM

Particulate Analysis

Sample Size _____ ML Surface Area _____ SQ. FT.

PARTICLES

MICRONS	ALLOWABLE	ACTUAL
0-149	Unlimited	_____
150-230	10	_____
231-320	3	_____
321-410	2	_____
411-500	1	_____
501- UP	0	_____

FIBERS*

MICRONS	ALLOWABLE	ACTUAL
0-149	Unlimited	_____
150-500	10	_____
501-1,000	1	_____
1,000- Up	0	_____

*A Fiber is defined as a particle whose length to width ratio is 10 to 1 or greater.

Component Hydrocarbon Presence: Visual ☐ Sat ☐ Unsat Ultraviolet Lamp ☐ Sat ☐ Unsat

Purge Gas Analysis

Dew Point (-40° F MAX) _____ °F

Fluorocarbon Solvent (5.0 ppm by volume allowable) _____ ppm

Gas Tightness Test

Gas: ☐ AIR ☐ He ☐ HeOx ☐ N2 ☐ 90% N2/10% O2

System Pressure _____ psig Temperature _____ °F

Test Results: ☐ Sat ☐ Unsat

Gas Analysis

Pressure (100 ± 10 psig)_____psig, Temp. (75 ± 10 °F) _____°F, Soak Time (2 Hrs./Min.) _____Hrs.

Trace Gases (PPM By Volume — Surface Equivalent Values)

Gas	Allowable	Actual
Carbon Dioxide	1000	_____
Carbon Monoxide	20	_____
Total Hydrocarbons -Less Methane	25	_____
Oil Mist & Vapor	5 (mg/m³)	_____

Gas	Allowable	Actual
Odor	Not Objectionable	☐ Sat ☐ Unsat
Particulates	Not Detectable -Except as noted in Oil Mist & Vapor	☐ Sat ☐ Unsat

Oxygen Content (20 to 22% By Volume): %

Remarks:

Attached Analysis Reports: ☐ Solvent Hydrocarbon, ☐ Particulate, ☐ Purge Gas, ☐ Gas Analysis Report

Verified by: _____ Reviewed by: _____

NOTE: Criteria listed apply to hyperbaric/diving systems except saturation systems.

PRESSURE VESSEL INSPECTION REPORTS AND CERTIFICATES

The following forms shall be used in the inspection and testing of unfired pressure vessels installed in hyperbaric facilities. NAVFAC MO-324, Inspection & Certification and Boilers and Unfired Pressure Vessels, refers.

Data Record Sheet - Boilers (includes unfired pressure vessels)
NAVFAC Form 9-11014/40 (9-69)
NSN 0105-003-9010

Inspection Report - Boilers (includes unfired pressure vessels)
NAVFAC Form 9-11014/41 (3-67)
NSN 0105-004-0000

Inspection Certificate for Boilers - Unfired Pressure Vessels
NAVFAC Form 9-11014/32 (3-67)
NSN - 0105-003-000

APPENDIX F

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Appendix F is organized into the following major areas:

- System Fabrication and Installation
- Air Piping System
- Recompression Chamber
- SOC, PSOB, Drawings, PG, OPs and EPs
- Maintenance and Testing

This Hyperbaric Facility Inspection and Audit Guide is provided as a "tool" to assist commands in conducting in-house inspections and audits.

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: SYSTEM FABRICATION AND INSTALLATION	Sat	Unsat	Remarks
1. Are the components used in the system, such as air compressors, filters, chamber gages, etc., on approved system drawings or is documented approval for their use from NAVFAC available?			
2. Are the piping, fittings, valves, unions, and gaskets used in the fabrication of the compressed gas system IAW ANSI/ASME B31.1 Power Piping?			
3. Was system welding conducted IAW approved commercial specifications?			
4. Are welded joints 2 1/2 inches or less butt or socket welded? NAVFAC DM-39, page 39-178.			
5. Are welded joints greater than 2 1/2 inches butt welded? NAVFAC DM-39, page 39-178.			
6. Are welding fabrication records available which document the fo!lowing: a. Joint identification? b. Joint design? c. Base material type? d. Filler material type? e. Fit-up? f. Welding procedure? g. Heat treatment? h. Welder identification?			

Command/Facility:	Date Conducted:		
Area: SYSTEM FABRICATION AND INSTALLATION (Continued)	Sat	Unsat	Remarks
i. Inspection results? j. Disposition of weld? k. Repairs of weld? I. Inspection results? m. NDT test and inspection personnel identification? n. Record forms or joint cards? 7. Do flexible hose assemblies meet the requirements of NSTM 9480, part 5; or if for oxygen service, are they of an approved type? 8. Is documentation available, dated, and signed showing that the installed system has successfully completed a hydrostatic test to 150 percent of maximum design working pressure? 9. Has system been cleaned and inspected for hydrocarbon removal and particulate level IAW an approved cleaning procedure? 10. Has the system been checked for cleaning agent removal IAW approved cleaning procedures. 11. Are lines adequately supported with pipe clamps and are they protected from external forces when in an exposed run? NAVFAC DM-39, page 39 - 176. 12. Does all tubing of the same nominal diameter have the same pressure rating? Does tubing meet requirements for a safety factor of 4 times the working pressure? NAVFAC DM-39, page 39-173.			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: AIR PIPING SYSTEM	Sat	Unsat	Remarks
1. Have air purity sample(s) been taken in the last six monthsand if so was the air quality satisfactory? 2. Are all air systems filtered before reaching the occupant/divers? 3. Have all system gages been calibrated within the last 12 months? 4. Are all gages adequately supported and provided with isolation valves? 5. Are all valves and functional components identified with a label plate bearing the system designation number as it appears on the drawings an din the OPs and EPs? 6. Are all lines, piping runs, and valve handwheels color-coded, identified, and supplied with flow direction arrows? NAVFAC DM-39, HYPERBARIC FACILITIES, page 207a. 7. Are there dust caps/bags on charging connections, manifold outlets, and divers air hoses when not in use? 8. Are primary and secondary air systems clearly defined? Are NAVFAC approved OPs and EPs available? 9. Are all permanently installed air flasks within the 6/12 year hydro test requirements of NSTM 9490.17 and .181?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: AIR PIPING SYSTEM (Continued	Sat	Unsat	Remarks
10. Are all components that trap condensed water provided with drain valves (filters, air receivers, flasks, moisture separators, moisture traps, divers air manifolds, etc.)? 11. Are compressor air intake lines piped to the weather and provided with an air intake filter? 12. Are air receivers (volume tanks) and pressure vessels designed in compliance with MIL SPECS, ASME standards, or other recognized specifications/standards? 13. Have volume tanks (air receivers: LP) been given a hydrostatic test to one and one-half times the working pressure within the last six years? NSTM 9490.176. 14. Is there relief valve protection downstream from all pressure reducing stations? 15. Is the relief valve set at 110 percent of design pressure and tagged with the date, pressure setting, and name of test activity? 16. Are HP air flasks stowed so that easy access for inspection and bleeding off accumulated moisture can be accomplished? 17. Does the air manifold(s) have a pressure gage and gage isolation valve? 18. Are reducing stations provided with an emergency bypass?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: AIR PIPING SYSTEM (Continued)	Sat	Unsat	Remarks
19. Are relief valves installed so that they cannot be isolated by valves from the system they are installed to protect? (Except chamber relief valves.) 20. Is the primary air system capable of supporting the maximum number of divers for the most imposing dive specified in the PSOB? (Pressure and flow) 21. Is the secondary air system capable of supporting the maximum number of divers on an emergency ascent assuming worst-case decompression obligation? 22. Is there a back pressure regulator installed between the compressor outlet and the accumulator so that the compressor is always working against a back pressure? U.S. Navy Diving Manual, page 6-57. 23. Are installed high pressure moisture separators within the three-year hydro test requirements of NSTM 9490.181? 24. Is a hose record log maintained? U.S. Navy Diving Manual, page 6-36. 25. Are filters, moisture separators, check valves, and valves installed so that the gas flow direction is in the direction of the flow arrows or inlet and outlet legends marked on the device?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: SOC, PSOB, Drawings, PC, OPs and EPs	Sat	Unsat	Remarks
1. Does the certification scope adequately define the boundaries and specify in-scope and out-of-scope equipment? 2. Has the PSOB for the facility been submitted to and approved by NAVFAC? 3. Are system drawings for all equipment, within the Scope of Certification, up-to-date and do they identify all functional components by type, material, part number, etc. and are designation numbers shown? 4. Has a procedural Guide (PG) Matrix been developed which reflects the OPs/EPs needed to support required operations? 5. Do operational procedures (OPs) and Emergency Procedures (EPs) exist for system line-up and operation and are they NAVFAC-approved? SS521-AA-MAN-O10. 6. Do the operating procedures state the pressures the flasks are to be charged to and the minimum pressure to take them down to?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: RECOMPRESSION CHAMBER	Sat	Unsat	Remarks
1. Have all Roylyn gages had a comparative check within the last 6 months and all other gages calibrated within the past year? 2. Are recompression treatment tables readily available to the chamber and up-to-date? 3. Are the NEDU and NMRI 24-hour phone watch numbers posted for use in requesting medical consultation or other assistance? U.S. Navy Diving Manual, page 8-21. 4. Is there a ball-type gage valve between the chamber and relief valve, lock-wired open and a warning posted? 5. Is relief valve set at 110 psi and tagged with pressure setting, date set and testing activity? 6. Are valve handwheels color-coded and identified, lines color-coded and labeled and proved with flow direction arrows? NAVFAC DM, HYPERBARIC FACILITIES, page 207a. 7. Are all gages labeled and proved with isolation valves? 8. Has chamber been pressure-tested within the last two years? U.S. Navy Diving Manual, Appendix D, page D-14. 9. Are the exhaust ports guarded to prevent injury during decompression and venting, and are they free from sharp edges and burrs?			

Command/Facility:	Date Conducted:		
Area: RECOMPRESSION CHAMBER (Continued)	Sat	Unsat	Remarks
10. Is the air system capable of pressurizing the chamber innerlock to 165 FSW in three minutes or less? U.S. Navy Diving Manual, Appendix D, page D-3. 11. Are viewports free of chips, cracks, discoloration, excessive air-bubbling, or other defects? 12. Are the acrylic viewports less then 10 years old? PVHO-1 13. Does the gage mounting allow for “blow-out plug” operation? 14. Do the chamber medical kits contain required equipment and supplies? U.S. Navy Diving Manual, page 8-48. 15. Is the interior wiring properly supported and adequately protected so that it cannot be damaged or used for handholds? 16. Doe primary and secondary communications systems in both inner and outer locks work properly? 17. Are inner and outer lock door gaskets free of cracks, deterioration and excessive adhesive on gasket butt joint? 18. Are all door dogs in good condition and functioning properly? 19. Do inner and outer lock doors operate easily and seal properly.			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: RECOMPRESSION CHAMBER (Continued)	Sat	Unsat	Remarks
20. Are aural protectors present in the chamber and do they have equalization holes drilled in each ear piece? U.S. Navy Diving Manual, Appendix D, page D-7. 21. Does the medical lock, if present, operate properly? 22. Are mattress and bedding flameproof and is unauthorized or flammable material excluded? U.S. Navy Diving Manual, Appendix D, page D-13. 23. Are the primary and secondary air systems clearly defined and do they meet the requirements of Appendix D, U.S. Navy Diving Manual? 24. Are the BIBS masks provided with separate isolation valves (one valve per mask)? 25. Are sufficient oxygen bottles on station and can standby bottles be readily connected or removed from the system while oxygen is in use? 26. Are oxygen fittings, pipes, and hoses of approved material and have approved fabrication procedures been used? 27. Are chamber bilges and medical lock clean and dry? 28. Are drain plugs, if installed, free from signs of corrosion? 29. Are deck plates properly secured?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: RECOMPRESSION CHAMBER (Continued)	Sat	Unsat	Remarks
30. Are all valves, including exterior oxygen control valves for inner and outer locks readily accessible?			
31. Has an air sample been taken from the chamber interior to ensure that no undesirable offgassing is occurring?			
32. Are fire fighting equipment buckets, with stainless steel covers, or portable air-charged water extinguishers in the chamber during use? NAVFAC DM-39, page 39-257.			
33. Does the primary air system have sufficient air to pressurize both locks of the chamber twice to 165 feet and ventilate throughout the treatment? U.S. Navy Diving Manual, Appendix D, page D-3.			
34. Does the secondary air system have sufficient air to pressurize both locks of the chamber once to 165 feet and ventilate for one hour? U.S. Navy Diving Manual, Appendix D, page D-3.			
35. Is emergency lighting available for operators and to illuminate inside the chamber?			
36. Are interior lamps provided with the proper wattage bulbs to prevent overheating?			
37. Is chamber wiring, interior and exterior, of approved type, properly installed and in good condition?			
38. Are the chamber oxygen BIBS operating properly with adequate flow rates and no leaks?			

HYPERBARIC FACILITY INSPECTION AND AUDIT GUIDE

Command/Facility:	Date Conducted:		
Area: MAINTENANCE AND TESTING	Sat	Unsat	Remarks
1. Is a scheduled maintenance system established for the facility which includes cycle, quarterly and weekly scheduling of maintenance?			
2. Are planned dives and duty-status periods (e.g., “duty chamber”) noted on the quarterly maintenance schedule.			
3. Have Maintenance Procedure Check-Off Sheets been developed for scheduled maintenance?			
4. Are maintenance schedules and procedures being maintained on file (cycle and quarterly schedules--minimum 5 years, weekly schedules and maintenance procedure check-off-sheets--minimum one year)?			
5. Have REC procedures been established?			
6. Are REC procedures being followed and a REC log kept?			
7. Have “Tag-Out” procedures been established?			
8. Are “Tag-Out” procedures being followed and a “Tag-Out” Log kept?			
9. Have Material Identification and Control (MIC) procedures been established?			
10. Do MIC procedures provide for: a. Receipt Inspection b. Identification Marking			

Command/Facility:	Date Conducted:		
Area: MAINTENANCE AND TESTING (Continued)	Sat	Unsat	Remarks
c. Material Documentation and Storage d. Material Control During Fabrication/Installation 11. Has a Test Plan for system and component level testing been developed? 12. Does the Test Plan include test criteria and periodicity of tests? 13. Have test and inspection procedures been developed to support the Test Plan? 14. Are test and test inspection records maintained on file? 15. Has the facility been analyzed to determine the HAZCAT of components, equipments and systems? 16. Do maintenance procedures exist for HAZCAT II components in support of failure management planning/maintenance? 17. Are spare parts available for HAZCAT items IAW NAVFAC recommendations? 18. Is scheduled maintenance performed on HAZCAT II spare parts and are HAZCAT II spare parts readily accessible if needed?			

GLOSSARY

GLOSSARY

Accessibility to Vital Equipment. The ability to reach, read, and/or operate vital equipment and devices.

Accident. A happening that is not expected, foreseen, or intended under normal operating conditions.

AIG 239. Diving/hyperbaric safety and information messages.

Air Analysis Sample. Occupant/diver breathing air source is required to be checked for purity at intervals not to exceed six months.

Alteration. An approved change from the as-certified design, material, configuration, or performance.

Applicant/Sponsor. The agency/organization that is making application for System Certification or Recertification of a hyperbaric facility. For facilities being developed, the Applicant/Sponsor will normally be that Agency/Organization tasked with development. For existing facilities, the Applicant/Sponsor will normally be that element within the organization chain responsible for operation and maintenance.

Appurtenance. An accessory added to a major component (i.e., viewport, hatch, support rail, connector, piping, etc.).

Arc-Strike. Any inadvertent change in the contour of the finish weld or adjacent base material resulting from an arc of heat generated by the passage of electrical energy between the surface of the finished weld or base material and a current source such as welding electrodes or magnetic inspection prods.

As-Built Drawings. Drawings which reflect the current configuration of the hyperbaric facility. These drawings include detailed material lists and reference applicable fabrication, installation, cleaning and testing procedures.

Audit. The analysis and evaluation of procedures, methods, and reports necessary to determine compliance with existing requirements.

Bending Stress. Primary stress at a particular location on the pressure hull which is proportional to the applied or induced moments and is proportional to distance from the centroid of a solid section. The effects of discontinuities and concentrations are excluded. An example of a primary bending stress is the stress in the central portion of a flat head due to pressure.

Boundaries. The specific limitations on the physical area involved in work and testing accomplished on a specific Re-Entry or Job Order.

Boundary. That line point, or location identified as the border between controlled and uncontrolled areas. For purposes of this manual, it has the following connotations according to the type of system involved:

(1) Piping/Mechanical - the last disturbed joint.
(2) Electrical - the circuit disconnect point or points.
(3) Isolation Point - that system component nearest to the work area which is operated to regulate or shut off the flow of fluid or to de-energize an electrical circuit, as applicable, to the portion of the system being worked on.

Breathing Gas Supply Equipment. Equipment that is used to compress, condition, mix or store, breathing gas.

Casting. Defined as a component formed by pouring molten metal into a mold or by forming by a centrifugal method.

Casualty. A serious accident resulting in physical injury to the occupants/divers, or damage to equipment.

Catastrophe. Any great or sudden disastrous malfunction which gravely jeopardizes the safety of the hyperbaric facility or its occupants/divers.

Certification Authority. The code within NAVFAC, NAVFAC (04B), that has been delegated, through the Navy chain of command, the responsibility to conduct the certification process for shore-based facilities.

Certification Certificate. The document attesting to the System Certification granted by the SCA.

Certification Scope. A list promulgated by separate letter for each system concerned, defining those systems, equipments, components, maintenance, and operational procedures needed to preserve the physical well-being of the hyperbaric facility personnel. (SOC)

Coamings. The structure surrounding holes in, and extending through one or both sides of, the pressure hull structure.

Continuity of DSS Certification. A status defined by those procedures, tests, and inspections required when hardware is renewed or replaced within the Certification Boundary, as well as the periodic checks or inspections required to assure continued satisfactory material and procedural adequacy for certification.

Contractor Submittals. Drawings and documentation pertaining to materials, fabrication procedures, installation procedures, personnel qualifications, cleaning procedures and records, and testing procedures and records, which are required to document work performed by contractors on certified facilities.

Controlled Assembly. Proper assembly of a component in accordance with detail drawing(s), including material and clearance readings, verified by a second witness, usually the QA inspector.

Controlled Material. Any material which the commanding officer, hyperbaric facility manager or SCA determined must be controlled/identified throughout the manufacturing/repair process, including installation, in order to meet the specifications required of the end product. Controlled material shall be placed in segregated storage and shall be identified by material markings and applicable quality assurance documentation.

Controlled Task. Any work which the commanding officer, hyperbaric facility manager or SCA determined must be controlled throughout the manufacturing/repair process, including installation, in order to meet the specifications required of the end product.

Construction Specifications. The document which details the specific requirements which must be met during construction and modification of hyperbaric facilities with respect to materials used, processes followed, personnel qualifications, cleaning levels, testing and documentation.

Crack. A linear rupture of metal under stress.

Critical Defect. A defect that judgment and experience indicate could result in hazardous or unsafe conditions for individuals using or maintaining the product.

Defect. Any nonconformance of the unit or product with specified requirements.

Departure from Specification. A lack of compliance with any authoritative document, plan, procedure, instruction, etc.

Departure from Specification Approval. A device by which responsible authority grants administrative and/or technical approval of a departure from specifications.

Design Operating Pressure. The maximum pressure at which a structure, system, or component operates under normal service conditions.

Designer. The individual or organization responsible for the final configuration and successful culmination of a design for a hyperbaric facility, including tests.

Documentation. The records of objective evidence establishing the requisite quality of the material, component, or work accomplished. Documentation should be traceable from the item to the records and filed in an auditable manner.

Emergency. A sudden unexpected malfunction, or other set of circumstances in the hyperbaric facility operation, which requires immediate attention.

Emergency Procedures. Written procedures used to safely recover from conditions which endanger hyperbaric facility occupants/divers.

Equipment and Component Manuals. Manufacturers technical manuals for equipments and components.

Field Calibration Activity (FCA). An activity located at organizational and intermediate maintenance facilities in which calibration is performed by specially trained personnel utilizing NAVFAC approved standards, procedures, and equipment. The standards used by the FCA are submitted to a higher echelon laboratory for calibration.

Fire Resistant. A material that will immediately self-extinguish when the source of ignition is removed, when tested in an atmosphere representative of its intended use environment.

Forging. A component formed by hammering or pressing a piece of heated metal to form a shape.

Foundation. That permanently installed part of a hyperbaric facility which serves exclusively to transmit the weight of the facility onto natural ground.

Functional Test Plans and Specifications. The test plan and specifications used to conduct functional tests of the hyperbaric facility to demonstrate that it will perform properly under all designed operating conditions.

Government Furnished and Certified Material or Equipment (GFE or GFM). Material procured by NAVFAC letter to the original certifying activity, identifying component by serial number, mold number, etc.

Grade B Water. Filtered to 25 microns absolute, maximum chloride ion, 1ppm; maximum conductivity, 20 micromhos/cm; pH less than 8.0; visual clarity; no turbidity, oil or sediment.

Heat Resistant. A material that does not give off noxious fumes at its operating temperature or at any temperature below 200 degrees Fahrenheit and which is not degraded with respect to performing its intended function when exposed to a temperature of 400 degrees Fahrenheit for five minutes.

Homogeneous Lot. A group of items that have common heat, batch, or vendor trace-ability number as well as size and description, from the same source, received in the same shipment or under the same contract number. (Pipe fittings that do not bear a heat number must be in a single shipment under one contract.)

Hyperbaric Facility. A complex, for operation at pressures above atmospheric, in which the magnitude and rate of change of the pressure and the composition and temperature of the confined atmosphere and/or water can be accurately controlled.

Implodable Item. Any item containing a noncompensated compressible volume which has the potential for failure under external pressure.

Incomplete Penetration. Lack of penetration of the weld through the thickness of the joint, or penetration which is less than specified.

In-Process Inspection. Inspection performed during the manufacturing or repair cycle in an effort to prevent defects from occurring and to inspect the characteristics and attributes that are not capable of being inspected at the final inspection.

Inserts Components welded into the pressure envelope or other area by some type of butt joint and which may be the same or of greater thickness than the surrounding structure. Inserts reinforce the structure at openings or areas of high stress.

Inspection Record. Record data showing the results of an inspection with appropriate identifying information on the characteristics inspected and item inspected.

Inspector. Government personnel qualified as required by this manual to accept or reject materials or workmanship from specified test results.

Interchangeability. The commonality between plans, machinery components, record;, etc., required by specifications.

Life Critical System. Any system whose catastrophic failure while under pressure could jeopardize the lives of the occupants.

Life-Support Equipment. Those items required to provide a safe habitat for all personnel within the chamber and its associated locks or compartments.

Life Support System. A system that provides and monitors a liveable environment or that provides a breathing mixture suitable and safe for use by occupants/divers under pressure.

Linear Indication. Indication greater that 1/16" long, revealed by non-destructive test inspection, whose length is equal to or greater than three times its width.

Man-Rated Hyperbaric Facility. A hyperbaric facility that will be occupied by men for any reason whatsoever.

Maintainability The probability (when maintenance action is initiated under-stated conditions) of restoring a system to the specified operational conditions within a specified total downtime.

Maintenance Procedure. A written procedure for conducting maintenance which includes the required materials, tools, personnel qualifications, technical references and detailed procedural actions.

Maintenance System. A system for scheduling, monitoring and documenting maintenance actions.

Material Adequacy. The design of and the materials used in the hyperbaric facility have been performance tested in accordance with accepted engineering principles and proved for the safety of the occupants and operators of the satisfaction of the SCA by the applicant/sponsor.

Material Identification and Control (MIC) Number. A number assigned to a certified material which provides traceability to Objective Quality Evidence.

Maximum Operating Pressure. The highest pressure that can exist in a system or subsystem under normal operating conditions. This pressure is determined by such influences as pump or component shutoff pressures, pressure regulating valve lockup (no flow) pressure, and maximum pressure at the system source.

Maximum System Pressure. Maximum system pressure is the highest pressure that can exist in a system or subsystem during any condition. Normal, abnormal, and emergency operation and casualty conditions shall be considered in determining the maximum system pressure. In any system with relief valve protection, the nominal setting of the relief valve shall be taken as the maximum system pressure. (Relief Valve accumulation may be ignored.)

Milestone Event Schedule. A list of sequential events in the certification process, with estimated completion date.

Minor Defect. A defect that does not materially reduce the usability of the unit or product for its intended purpose or that is a departure from established standards that has no significant bearing on the effective use or operation of the unit.

NAVFAC. Naval Facilities Engineering Command, Department of the **Navy.**

New Mechanical Joint. A joint in which either the flange or the union is replaced. A new mechanical joint requires 150 percent hydrostatic test of normal operating pressure.

Normal Operating Pressure. The approximate pressure at which an essentially constant pressure system operates when performing its normal function. This pressure is used for the system basic pressure identification.

Nominal Pipe Size, (NPS). Nominal Pipe Size means the same as Iron Pipe Size (IPS), where piping materials are involved. Where tubing is involved, NPS is the actual measured outside dimension and its related actual wall thickness as required by the applicable tubing specification.

Non-destructive Testing/Examination (NDT/NDE). All methods of testing/examination used to detect or measure the significant properties or performance capabilities of material, parts assemblies, equipment, or structures which do not impair the serviceability of the parts tested.

Nonhomogeneous Lot. A group of items of the same size, color, and configuration that have either the same material markings (other than heat, batch, or traceability number) or the same ordering number (i.e., stock number, part number, catalog number), but were not received from the same source, in the same shipment or under the same contract number.

Objective Quality Evidence. Any statement of fact pertaining to the quality of a product or service based on tests that can be fully verified. Evidence must be expressed in terms of specific quality requirements or characteristics. These characteristics are identified in drawings, specifications, and other documents that describe the item, process, or procedure.

(a) Tests can be based on heat, batch, continuous cast or pour, or other manufacturing processes, provided the manufacturer can prove that the test sample was representative of the material supplied.

(b) Material supplied shall bear a unique marking: and the report of supporting test quantitative data shall bear an identical marking.

O&M Manual(s). Contain facility information such as: system layout of piping, valves, controls: wiring and control diagrams; a control sequence describing start-up, operation and shut down; a description of the function of principal system equipments and components; lubrication schedules; test procedures, performance data; and parts lists.

Operating Procedures. Approved written instructions and checklists for conducting system line-up, operation and shutdown, in a safe sequence.

Operator. The person who physically controls the operating parameters of the hyperbaric facility: e.g., depth, pressure, gas flow rate, gas composition, etc.

Parts List. Describe the part size, applicable specifications, and ordering information.

Penetration (Penetrator). The assembly, component, cable, shaft, packing gland, seal, or other device which penetrates the hyperbaric chamber or other pressure-resisting structure.

Porosity. Gas pockets or voids in weld metal.

Pre-Survey Outing Booklet (PSOB). A check list that identifies those areas to be reviewed by NAVFAC as part of the certification procedure for a specific hyperbaric facility.

Procedural Adequacy. The procedures used in the operation and maintenance of the hyperbaric facility are suitable and sufficient to provide for the safety of the occupants and operators of the system before, during, or after any credible operation/emergency evolution. The procedures must be proved satisfactory to the SCA by the applicant.

Procedure Qualification. An action by which test assemblies are prepared in accordance with a proposed procedure and evaluated either by destructive or nondestructive tests or both.

Procedural Guides. Written instructions, checklists, and maintenance guides that provide the occupants and operators with a detailed safe sequence of operations of the hyperbaric facility in all its various designed normal and emergency operating modes.

Procurement Document. The written communication to a supplier that describes what is to be supplied and what requirements must be met;

Proper Vendor Documentation. Documentation traceable to source material in question, by Serial Number, Lot Number, etc.

Quality Assurance Documentation. Quality Control, records, and all production actions that will provide adequate proof and confidence that work performed or material manufactured will perform as designed and that there is documentary evidence to this effect.

Quality Control Procedures. The procedures used for supervision and inspection on the lo& that prevents improper workmanship and/or materials-from being produced or installed.

Random Sampling. The procedure used to select items from an inspection lot so that each item in the lot has an equal chance of being included in the sample.

Recordable Evidence. All recorded information, including operational and maintenance procedures, that can be used as proof that the hyperbaric facility has been designed, constructed of the proper materials, fabricated, assembled, and performance tested in accordance with acceptable engineering principles.

Re-Entry. Includes any and all work and testing within the scope of certification, including penetration of the pressure hull from the first breaching through final grooming, testing, and return to final operation.

Re-Entry Control (REC). Provides positive control of those elements required to maintain the certification established by the SCA.

Re-Entry Control Procedures. The procedures used to implement REC (see Appendix C).

Re-Made Mechanical Joint. A flanged or union joint that is taken apart for access or work. Bolt replacement is considered a Re-Made Joint. Re-Made Joints require 100 percent hydrostatic or operational test, depending on the specific system requirements.

Repair. A restoration or replacement to the original condition that does not change the original design material, configuration, or performance, using procedures previously approved.

Replacement-In-Kind (R-I-K). R-I-K of a component is defined as the identical component if the identical component is still in manufacture. In the event the identical component is no longer in manufacture, the replacement component must meet all the requirements of the original component as follows:

Components and piping replaced and new components required for modifications shall be selected and inspected in accordance with the pressure requirements of ANSI B31.1 and for service at the pressure, temperature flow, and as specified for the gases and liquids contained as indicated per the approved design specifications. The acceptability of pressure containing components is based upon ANSI B31.1, paragraph 104.7, "Pressure Design of other Containing Components". The following extract from the paragraph is the basis of judgment, "...Pressure containing components not covered by the standards listed in Table 126.1 and for which design formulas or procedures are not given in this code, may be used where the design of similarly, proportioned and sized components have been proven satisfactory by successful performance under comparable service conditions..." In addition, components shall be those commonly used in the diving industry.

Sampling Plan. A statement of the acceptable quality level, the level of inspection, the sample size or sizes to be used, and the associated acceptance and rejection criteria.

Scope. See Certification Scope.

Scope of Certification (SOC). See Certification Scope.

Segregated Storage Area. A clearly marked, dry, clean storage area that contains separate boxes, bins, shelves roped-off areas for segregation of different types of Controlled Materials from each other. Each separate storage area within the Segregated Storage Area will be clearly marked to allow only that specific type of Controlled Material. Access to this area will be strictly controlled by the Hyperbaric Facility Manager.

Superstructure. That part of a hyperbaric facility, above the foundation, which supports the hyperbaric chamber(s) and life-support components of the facility.

Survey. To examine, inspect, and review in detail all items falling within the certification scope to determine their material adequacy and procedural adequacy.

Survey Team. The personnel representing the SCA to perform the on-site certification survey of the hyperbaric facility.

System. All components, piping, and fittings, including electrical and mechanical items which together form and contribute to the operation of an integrated functional arrangement. The "system" as used herein is not limited to piping only unless "piping" is specified. Any part that receives the fluid, controls the fluid, or is controlled by the fluid is included"

System Certification. The procedure including application, independent technical review, survey, and approval to ensure the adequacy of the hyperbaric facility to safely perform over its operational/emergency spectrum. System certification is a combination of two major areas of review; material adequacy and procedural adequacy. (This replaces the older term "material certification.")

System Structure Integrity Fittings. For purposes of this instruction, shall include inserts, electrical/mechanical penetrations, liners, packing glands, stuffing tubes, flanges, seals, and fasteners.

System Tenure. Time period for which system certification or recertification will be granted.

Test-Equipment (Calibration). For purposes of this instruction, test equipment will be interpreted as comprising all general purpose equipment (standard measuring instruments), special testing equipment, including such classes as checkout equipment, acceptance equipment, inspection equipment, gauges, and associated accessories.

Traceability. A positive means of identifying material to its objective quality evidence. Refined as the ability to identify material and provide quality (for each applicable item or component) from point of fabrication/installation as a part of the ship through a controlled procedure back to material receipt records, by means of fabrication records and/or markings on material. Receipt records need not identify each individual piece to a unique record but must provide objective evidence of quality.

Training Booklets (TABS). Instructional guides for indoctrination of personnel.

TSP. Trisodium Phosphate. A common cleaning agent.

Wet Chamber. A hyperbaric chamber that may be flooded with fresh or salt water to simulate actual diving conditions.

Working Standards (Calibration). These standards comprise a wide variety of equipment used throughout the laboratory in support of all measurements performed in the laboratory. These standards are used day by day in performing calibrations.

Index