



Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N. Y. 10001

HYDROSPACE INFORMATION REPORT

AIR 1063

Issued 4-15-69
Revised

GENERAL ENVIRONMENTAL REQUIREMENTS FOR DEEP SUBMERSIBLE VEHICLES AND SUBMARINES

1. PURPOSE

It is intended that this Hydrospace Information Report (HIR) set down general environmental requirements for the design, development, evaluation and testing of submarines and deep submersible vehicles. This document sets forth the environmental limits within which submarines and deep submersible vehicles, related components, and associated equipment should operate satisfactorily and reliably. The detailed performance and test requirements for a particular submarine or deep submersible vehicle, related components, and associated equipment shall be as defined in the detailed specification.

2. SCOPE

The scope of this HIR is to specify general oceanographic environments. Specific environmental requirements shall be specified in a detail specification. Specific requirements are in the state of constant flux because the ocean environment is constantly changing and the changes occur not only on a seasonal basis but also monthly, weekly, daily, and in some cases even hourly.

This HIR is to be used as a guide only.

3. CLASSIFICATION

The deep submersible vehicles and submarines shall be classified as follows:

3.1 Type

- Type I - Manned
- Type II - Unmanned
- Type A - Combatant
- Type B - Non-Combatant

3.2 Classes

Operating Depths: All classes include operation of vehicles and equipment at the air-sea interface and water-bottom interface.

- Class 1 0 - 1000 ft
- Class 2 0 - 2000 ft
- Class 3 0 - 3000 ft
-
- Class 36 0 - 3600 ft

4. APPLICABLE DOCUMENTS

The following documents listed below should be utilized as a guide only.

4.1 Specifications

- 4.1.1 MIL-T-18404 (WEP), "Torpedoes, Environmental Requirements General Specification For." Amendment 1, 2 March 1965.
- 4.1.2 MIL-I-16910 (SHIPS), "Interference Measurement, Electro-Magnetic Methods and Limits."
- 4.1.3 MIL-E-16400, "Electronic Equipment Naval Ship and Shore, General Specification Navy."
- 4.1.4 MIL-E-22403, "Environmental Requirements and Tests for Torpedo MK 45, Mods and 1 Components and Assemblies."
- 4.1.5 MIL-E-5272C, "Environment Testing, Aerospace and Associated Equipment General Specification For."
- 4.1.6 MIL-S-23012, "A Submarine Intercommunication System."
- 4.1.7 MIL-S-17422, "Ship Control Consoles and Combination Equipments Naval Shipboard Use."
- 4.1.8 MIL-T-5422, "Testing, Environmental, Aircraft Electronic Equipment."
- 4.1.9 MIL-S-901, "Mechanical Shock of Shipboard Equipment."

4.2 Standards

- 4.2.1 MIL-STD-167 (SHIPS), "Mechanical Vibrations of Shipboard Equipment," 20 December 1954.
- 4.2.2 Fed Test Method, STD-151, "Metals; Test Methods".
- 4.2.3 MIL-STD-202, "Test Methods for Electronic and Electrical Component Parts."
- 4.2.4 MIL-STD-740, "Airborne and Structure-borne Noise Measurements and Acceptance Criteria of Shipboard Equipment."
- 4.2.5 MIL-STD-810, "Environmental Test Methods for Aerospace and Ground Equipment."
- 4.2.6 MS33586, "Metals, Definition of Dissimilar."

4.3 Publications

- 4.3.1 BUMED INST 6270.3B Threshold Limit Values for Toxic Materials.
- 4.3.2 SAR-304, Special Navy Aeronautical Requirements, General Design Information for Informal Aircraft Proposals.
- 4.3.3 P-2452, Navy Navexos, Admiral Stephan Report by Deep Submergence Systems Review Group, 4 Volumes, prepared 1 March 1964.

SAE Technical Board rules provide that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform, to or be guided by any technical report, in formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

4.3.4 Publication No. NS 250000-9006, Stock No. 0283-013-4800, Chapter 9006, Submarines.

4.3.5 Publication No. NS250120-1, Stock No. 0283-026-3005, Shipbuilding and Boatbuilding Contract Manual, Change 3.

5. GENERAL ENVIRONMENTAL REQUIREMENTS

This section presents the general environmental requirements under which the vehicle will be stored, transported, handled and operated.

5.1 Definitions - For the purpose of this document, the following definitions will apply:

5.1.1 Vehicle: A deep submersible or submarine in an assembled state with its related components, or associated equipment.

5.1.2 Related Components: Assemblies, sub-assemblies and parts which comprise the vehicle.

5.1.3 Associated Equipment: That equipment appended to the vehicle for carrying, launching, supporting, and for assisting purposes.

5.1.4 Vehicles, Related Components and Associated Equipment Condition

5.1.4.1 Inert Storage: The condition of the vehicle, related components and associated equipment, when stored, transported or handled, assembled or not, and not ready for immediate operation.

5.1.4.2 Ready, Non-operating: The condition of the vehicle, related components and associated equipment, when prepared (fueled and checked out), issued, transported and handled.

5.1.4.3 Operating: The condition of the vehicle, related components and associated equipment, when operating or present at the environmental sea condition.

5.2 General - Natural On-Land, On-Ship and at Air-Sea Interface - The environmental requirements for non-operating and operating conditions listed in paragraphs 5.1.4.2 and 5.1.4.3 are presented in this section as well as air-sea interface which is one of never ending action and interaction as it is constantly affected by the winds, mass water movement, waves, ice formation and general meteorological conditions. This is the ever-changing, often violent and frequently unpredictable part of the ocean environment which plays a key role in the success or failure of any surface support in underwater mission. Components as well as the entire system must be protected from the natural and artificial environments encountered during their manufacture and long-term deployment.

5.2.1 Corrosion Contribution Environments

This section presents important mechanisms involved in the corrosive deterioration of vehicle and submarine systems hardware excluding mechanical deterioration. The vehicles must be preserved during handling and storage prior to operational use and also at air-sea interface. Corrosion assumes many insidious forms and is defined as any type of chemical deterioration caused by or contributed to

by the environment. Thus, reactions of vehicle materials with environment, such as the rusting or oxidation of steels, the pitting of aluminum, electrolytic reaction between dissimilar metallic substances, may be broadly categorized as corrosion.

5.2.1.1 Important Corrosion Mechanisms Affecting Vehicle Systems Hardware - Nearly all corrosion involves some degree of chemical interaction between a material and its environment. Although often subtle, corrosion is always costly and often irresistible when neglected. In visualizing the corrosive mechanism it is very convenient to think of highly processed articles as containing amounts of free energy. The total energy content is the energy resulting from refining, drawing, forming, rolling, welding, heat treating, and other processes to which the material has been subjected. The most natural form for the materials present is, of course, their original, or natural state, such as metallic ores. The free energy which has been added by fabrication processes may be considered as the potential of the material to revert to its natural, or lower, free-energy state. All that is normally required to initiate and carry out this reversion is an electrolyte, supplied by environment in the form of water, oxygen, or other chemical oxidizers and during fabrication in the form of processing and cleaning residues. The very natural tendency of a high-energy level material to become converted to a lower-energy level material does not imply that corrosion cannot be prevented or at least greatly reduced in rate. However, this fundamental tendency is perhaps the biggest factor impeding preventive measures.

Important specific types of corrosion that can affect the reliability of a vehicle system and its related ship support equipment and facilities include the following:

Galvanic Corrosion: Corrosion caused by the contact of two dissimilar metals in an electrolyte.

Stress Corrosion: Corrosion initiated at points of stress concentration.

Intergranular Corrosion: Preferential corrosion of grain boundaries of a metal or alloy.

Local Cell: Corrosion caused by difference of potentials on the surface of a metal, such as general surface corrosion or pitting.

Concentration Cell: One form of localized corrosion, resulting from differences of concentration of electrolyte.

Aeration (Oxygen) Cell: Corrosion due to differences in oxygen concentration at different electrodes of the same material, such as waterline attack crevice corrosion, etc.

Miscellaneous and Fracting Corrosion: Corrosion by two contacting surfaces.

Several of the above mechanisms produce corrosion products which are not readily recognizable. In addition, these are likely to attack areas which may be difficult or impossible to inspect.

5.2.1.2 Atmospheric Contributions To Corrosion



Water, the most universal solvent, is also the most common cause of corrosion. Transported by the atmosphere in the form of rain, spray, fog, or water vapor, water may in turn carry a wide variety of dissolved corrosive contaminants that are likely to initiate deterioration wherever deposited. Table 1 indicates corrosive agents commonly found in rain water.

Although deterioration caused by water usually occurs to metallic substances, the combination of moisture with other compounds in the air affects nonmetals. Ozone and water, for example, can have a marked effect on glass fibers as well as on the plastics.

5.2.1.3 Galvanic Corrosion - The possibility of galvanic action between dissimilar metals is too well known to require further elucidation as is the knowledge that the potential of any one metal or alloy differs widely depending on the environmental conditions. But it bears repeating that the potential of a metal in the electromotive force series is only a rough guide to its galvanic behavior in any specific environment and that its potential is reversible.

5.2.1.4 Localized Corrosion - A metal may develop pits or blisters at local areas, or it may be attacked selectively at grain boundaries or along slip planes. In the case of a two-phase alloy, one phase or constituent may be attacked selectively, while the other is relatively resistant. The occurrence of localized corrosion often makes it difficult to evaluate the true extent of the damage. Localized corrosion can result from conditions of exposure, as well as from the metallurgical structure of the material.

5.2.1.5 Stress-Corrosion Cracking - An insidious and catastrophic type of corrosion even in mild environments affects high-strength metals when used at high stress levels. This threat of disastrous failures from stress-corrosion cracking in high-strength vehicle components has been recognized; a number of comprehensive programs have investigated the phenomenon.

The application of tensile stress to a material is not a requirement for the initiation and propagation of intergranular corrosion. However, in certain materials the rate of penetration of intergranular corrosion is accelerated by increasing stress. Although the stress-corrosion mechanism is not yet completely known, it is hypothesized that the stress concentration at the roots of the localized corrosion paths results in mechanical rupturing of the metal in these regions. The rupturing exposes more anodic, clean metal which is unprotected by films, and results in increased current flow and accelerated corrosion.

The corrosivity of a chemical medium cannot be used as an indication of its capability of promoting stress-corrosion cracking. Many rather corrosive solutions do not cause cracking. Environments most conducive to stress-corrosion cracking are those which produce highly localized attack without significant general surface corrosion. Examples of environments known to cause stress-corrosion cracking in some of the more common metals and alloys

are listed in Table 2.

The factors that influence or contribute to stress-corrosion cracking may arise in any or all of the sequences that the metal encounters during conversion from its original to final form. Heat treating, quenching, fabrication, welding and other assembly operations, surface finishing, and other production processes may affect either the metallurgical structure and mechanical properties of the alloy, or result in the development of harmful residual stresses in the finished product. The alloys are exposed to a variety of conditions during these operations, and it is important to consider what their effect will be on the stress-corrosion cracking properties of the materials.

Further potentially critical conditions can develop during transportation and storage of finished hardware. Careless handling may result in damage which introduces additional stresses and provides sites for the start of corrosion. Finally, the finished vehicles are subject to a variety of environments, such as exposure to cyclic wetting and drying in humid or salt air locations during long-time sea-borne storage.

Stress-corrosion cracking is not to be confused with the increased general corrosive attack that is sometimes observed when a material is under stress; neither is it to be confused with other types of localized attack such as pitting, galvanic attack, or intergranular corrosion. Also, stress-corrosion cracking is not limited to metals or even to crystalline materials. Cracking failures of methylmethacrylate plastics in alcohol, polyvinyl chloride plastics in water, or glass in humid air can also be considered example of stress corrosion.

5.2.1.6 Intergranular Corrosion - Intergranular corrosion is a form of localized attack that is often confused with stress-corrosion cracking; however, stress is not required for intergranular corrosion. The selective attack follows the grain boundaries in a metal and can seriously reduce its structural strength. The attack is associated with a less resistant zone at or adjacent to the grain boundaries. This less resistant zone can be related to alloy composition, heat treatment, and in some instances to contamination of the surface from external sources. When related to alloy composition or to heat treatment, the attack may occur at all the grain boundaries. The depth of penetration through the boundaries is usually uniform.

Although attacks resulting from stress-corrosion cracking often follow grain boundaries, they are basically related to the stress pattern in the metal. In some instances, therefore, stress-corrosion cracks proceed across the grains rather than following grain boundaries.

5.2.1.7 Miscellaneous And Fretting - It should not be assumed that severe corrosion conditions at coastal areas are solely the result of salt air. The heavy use of fertilizers, air-borne contaminants, temperature changes, and many other factors make any area a potential problem.