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Vol. 1

NAVFAC(CHESDIV) STANDARDS AND CRITERIA PROGRAM: PHASE 1A

by

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INTRODUCTION

Purpose

This paper is published in two volumes. The first, describes some of the hardware, systems and techniques needed to design, construct, install and maintain a Fixed Ocean Facility (FOF). The second documents the need for standards and criteria to serve as accurate, reliable guidelines in using these techniques and equipment. Both volumes are submitted to the Ocean Engineering and Construction Project Office (FPO-1) of the Chesapeake Division (CHESDIV) of the Naval Facilities Engineering Command (NAVFAC) in satisfaction of the requirements for Phase 1A of the NAVFAC Standards and Criteria Program.

Background

The NAVFAC Standards and Criteria Program was initiated by assignment to various Navy laboratories to define areas of technology (AT's) applicable to the development of FOF's and to identify specific aspects of each for which standards and criteria should be developed. For Phase 1A FOF's were restricted to unmanned structures supported by or attached to the sea floor and situated on the surface, in the water column or on the bottom of the open ocean. Harbor and coastal facilities were excluded except for Fleet moors in deep water or exposed positions, and the interface requirements of in-shore extensions of the FOF. Power and utility systems were considered an integral part of the FOF.

Standards were sought primarily to aid designers, engineers and technicians by controlling variety in engineering materials and practices. Criteria were needed to serve as a set of bounds on physical and performance parameters by which operational decisions could be made.

Each AT was defined by grouping areas of expertise matching a technical requirement for development of an FOF. For example, the Naval Undersea Center (NUC) defined and assumed responsibility for four AT's including Bottom Navigation Systems, Recovery Systems, Remote Work Systems and Search/Relocation Systems. NUC shared responsibility for a fifth AT, Cable Protection/Immobilization, with the Civil Engineering Laboratory (CEL). CEL dealt with near-shore operations extending from on-shore through the surf zone to working diver depths of 130 feet; NUC covered deep-sea operations and methods that cannot be implemented by divers. The experience that NUC engineers drew upon in defining these AT's is exemplified by the bibliography concluding the first volume of this report.

The AT's defined by NUC were assigned to this laboratory and designated Assigned Areas of Technology (AAT's). Presently, NUC is responsible for five, including that shared with CEL, but others may be added in the future. Among the new AT's identified during the preparation of this paper are Maneuvering, Underwater Vision Enhancement Techniques, Energy/Power Systems, Site Survey and Cable Inspection and Repair. NUC has requested that it be assigned the last two AT's, for which it has experience and expertise.

All NUC AAT's have been classed in the category of Work Elements and Associated Systems; these include the tasks or work functions entailed in the development of FOF's,

and the supporting systems used to accomplish the tasks. The scope of each AAT can be defined as follows:

"Bottom Navigation Systems" includes the methods and equipment used to navigate below the sea surface or in proximity to the ocean bottom for a variety of ocean engineering and construction missions. The following specific items fall within this AAT:

- Methods for navigation on or above the sea floor
- Equipment mounted on or suspended above the sea floor
- Methods and equipment used by divers, submersibles, towed and tethered vehicles and surface platforms
- Navigation by comparison of bottom topography with charts
- Use of grid networks placed on the sea floor
- Use of transponder nets
- Use of optical and acoustic systems
- Accuracy and error analysis techniques
- Parametric descriptors defining performance characteristics.

"Search/Relocation Systems" covers the methods and equipment for search/relocation of FOF's and points on the ocean floor, as well as marking of FOF components or sites for relocation. The following specific items are included in this AAT:

- Search systems
- Search patterns
- Optical, RF and acoustic methods of marking FOF's or sites for relocation
- Methods of making FOF's more compatible with relocation techniques by enhancing the detectability of the target.
- Parametric descriptors defining performance characteristics in terms of target strength.

"Remote Work Systems" includes the methods and equipment for performing work in the ocean, remote from a surface platform. These topics are included:

- Manned and unmanned vehicles
- Tools and manipulator systems
- Methods and equipment to be considered in the design of FOF's to increase compatibility with remote work systems for inspection, maintenance, repair and recovery
- Methods and equipment used for stabilizing platforms for work functions
- Physical and performance characteristics of remote work systems, vehicles, tools and manipulators.

"Recovery Systems" covers the methods and equipment that may be needed for some phase of FOF recovery. The following topics are included:

Methods and equipment for recovery of FOF's for removal, maintenance or repair

Methods and equipment that may be included in the design of FOF's to permit recovery (e.g., releases, grapnel lines, etc.)

Devices for recovery of structures

Attachment hardware.

"Cable Protection/Immobilization" includes methods to protect bottom-laid and suspended cable systems from damage during their design life. Also included are methods of immobilizing or restraining movement of cable throughout an entire cable system or in portions of a system. The AAT addresses these specific points:

Equipment and hardware used to protect and immobilize cable systems

Specific methods and equipment used by remote work systems to accomplish these tasks.

Information relating to each AAT was organized in two Technology Breakdown Structures (TBS's), one detailing the hardware and equipment comprising the AAT, the other outlining the parametric descriptors that quantitatively describe the hardware and its performance. Additionally, the Technology Interface Requirements (TIR's) of each AAT were summarized to identify the other AT's that depend upon the AAT as well as those that it depends upon. For example, Remote Work Systems rely upon Bottom Navigation Systems and affect the operation of Recovery Systems. Moreover, the operation of all systems is affected to some degree by environmental parameters such as weather, which may also constitute a TIR. The TIR summaries use terminology developed in the Parametric Descriptor TBS to define the specific elements of the interrelated AT's that impact upon the AAT or are affected by it.

For each AAT the TBS's and TIR summaries were developed using graphic displays and accompanying narrative correlated by a numerical outline. For example, in the first AAT, Bottom Navigation Systems, the topic "Navigation Sonar" appears in the graphic display for the Hardware/Equipment TBS and carries the number 2.2.1.1. The reader will find a textual explanation for this topic following the same number in the narrative. This scheme has been followed throughout the first volume, which presents TBS's and TIR summaries for the four NUC AAT's.*

The TBS's and TIR summaries were developed in detail to ensure that each AAT would be completely defined and to permit program participants to write Point Papers identifying all areas for which standards and criteria are needed (S/C areas). It was the purpose of the TBS's and TIR summaries to specify all topics that might be grouped to form S/C areas. Then, Point Papers were written to define the S/C areas in terms of the parametric

*CEL has assumed responsibility for reporting the TBS's and TIR Summary for the fifth AAT, Cable Protection/Immobilization, incorporating NUC's input on deep-sea operations. Therefore, this paper presents only the publications from which NUC's input was drawn and, in the second volume, the Point Papers written by NUC for this AAT.

descriptors developed in the TBS's. Additionally, the Point Papers determined the S/C areas' applicability to the development of FOF's, indicated the standards and criteria needed, identified RDT&E programs that might affect the S/C area and recommended a program to develop the standards and criteria needed. When relevant RDT&E programs could be identified, the Point Papers defined their scope and impact and named the principal investigators, citing their administrative codes and telephone numbers. Presently, 19 Point Papers have been written; they are presented in the second volume of this report.

The Hardware/Equipment TBS's, Parametric Descriptor TBS's and TIR Summaries, and the Point Papers written using them, constitute the documentation deliverables for Phase 1A of the NAVFAC(CHESDIV) Standards and Criteria Program.

Organization

The first volume of this paper consists of four major sections, each of which presents the TBS's and TIR Summary for an AAT. To facilitate reference, tabbed dividers call out each AAT, and running heads identify each subsection. A bibliography of publications used in defining the AAT's concludes the volume.

The second volume presents the Point Papers, grouped by the AAT to which they apply. In this volume also, tabbed dividers call out the AAT's.

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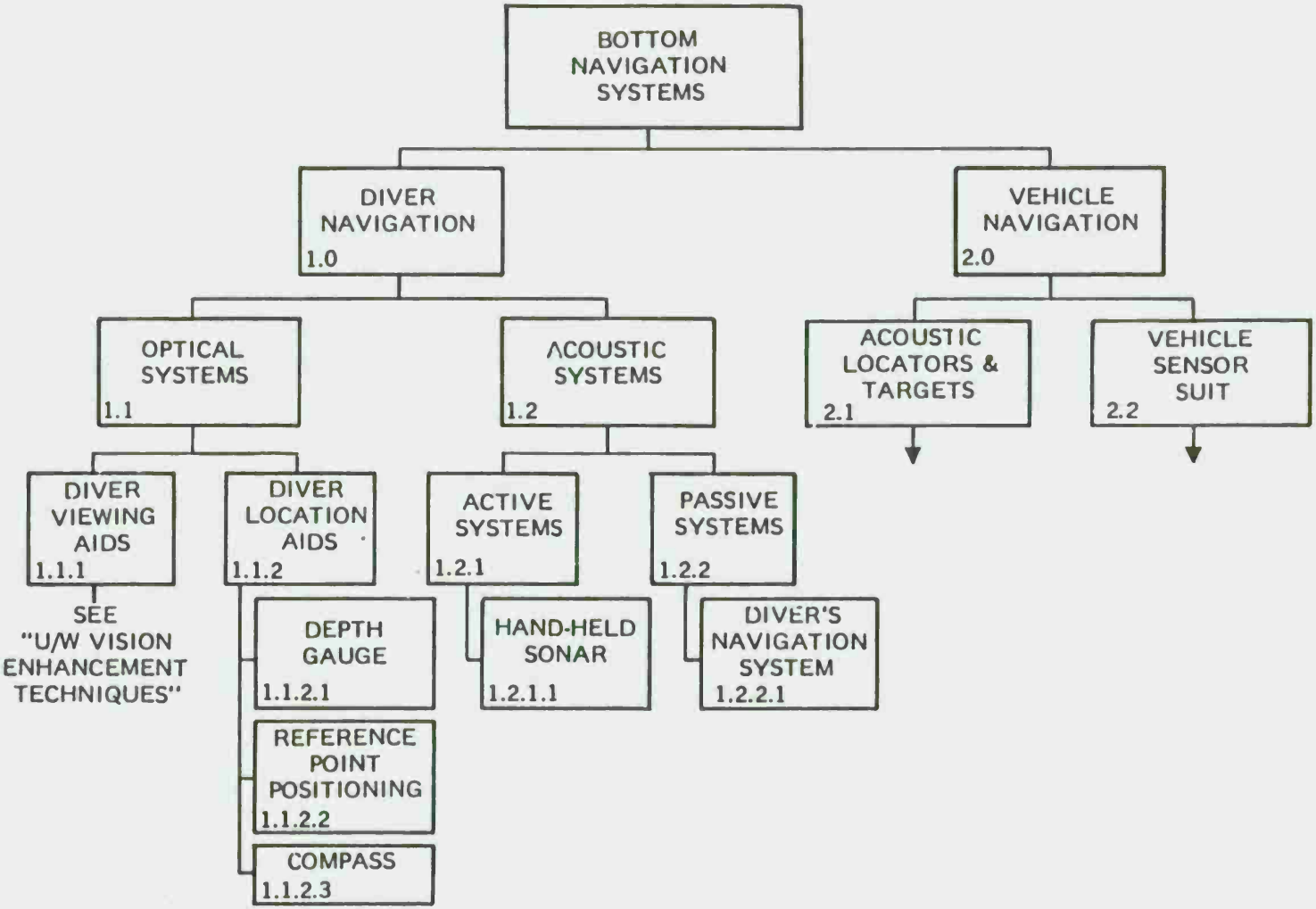
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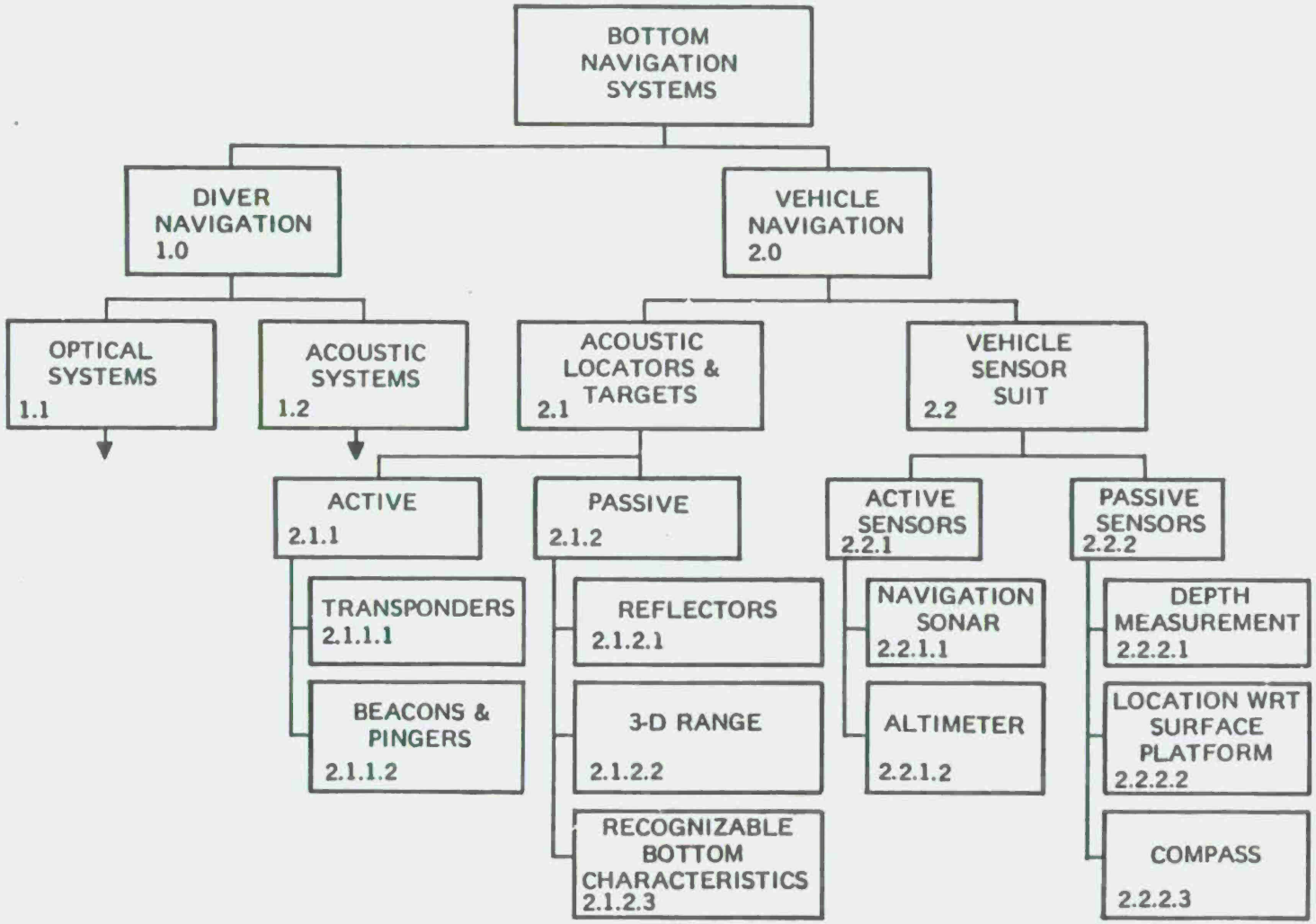
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BOTTOM NAVIGATION SYSTEMS

Bottom navigation, as defined here, applies to underwater navigation of work systems, divers or Fixed Ocean Facilities (FOF's) for the purpose of installation, maintenance or repair of an FOF. It is limited to relatively small areas (maximum 50-mile radius), and is differentiated from search in that search involves seeking a specific, previously determined point, or previously installed FOF; navigation involves determining the location of a work system, diver or FOF with respect to an arbitrarily chosen fixed point. Surface navigation techniques are specifically excluded.

1.0 Diver Navigation

Diver navigation systems comprise the hardware that aids a diver in locating specific spots on the ocean bottom. These systems support construction and maintenance of FOF's in relatively shallow water. Within the operational limitations of diving equipment they are not affected by depth. This section excludes vehicles designed for diver propulsion.

1.1 Optical Systems

Optical systems are diver navigation systems that depend on optical visibility; they improve visibility or present a visual readout which in turn requires clear water.

1.1.1 Diver Viewing Aids

DEFN – Those devices specifically designed to improve a diver's capability to see underwater. Full details are presented as a TIR.

1.1.2 Diver Location Aids

DEFN – Diver location aids are those which give a diver information as to where he is, such as X, Y position and depth. This section is limited to devices which do not utilize acoustic signals in any way.

USAGE – Used to give a diver three-dimensional orientation.

1.1.2.1 Depth Gauge

DEFN – A device which tells a diver how far below the surface he is. The devices provide a readout corresponding to the water pressure present at a given depth.

PROPERTIES – Usually attach to diver's wrist for easy viewing; essential tool in diving due to potential danger in remaining too deep for too long.

1.1.2.2 Reference Point Positioning

DEFN – A diver location aid that enables a diver to know range and bearing to a point on the surface or enables a surface installation to know range and bearing to a diver beneath the surface.

1.1.2.3 Compass

TIR

1.2 Acoustic Systems

Acoustic systems are diver navigation devices that emit or receive acoustic signals to aid a diver in navigating his way toward a specific site or target. These systems are active or passive. They are especially useful in dark or turbid water.

1.2.1 Active

DEFN – Acoustic diver navigation devices that emit acoustic signals to aid in diver location.

USAGE – Most appliable to movement toward a passive object or toward an object tagged with a transponder.

1.2.1.1 Hand-Held Sonar

DEFN – An acoustic device that acts in a similar manner to a shipboard sonar system, enabling a diver to move toward a specified object.

PROPERTIES – Small and portable; provides range and bearing information.

1.2.2 Passive

DEFN – Those acoustic diver navigation devices that do not emit acoustic signals, but listen for acoustic signals.

USAGE – Especially useful in vicinity of objects or sites which have been tagged with pingers or C. W. beacons.

1.2.2.1 Diver Navigation System (DNS)

DEFN – An NUC-developed, hand-held device which locates active acoustic sources by triangulation (three hydrophones).

PROPERTIES – Lightweight, small and portable; provides bearing wrt diver by means of a pointer; can select one of several listening frequencies for movement toward a specific beacon.

2.0 Vehicle Navigation

Vehicle navigation systems include the various devices and sensors available for navigating a subsurface, remotely controlled, unmanned vehicle. This section covers three-dimensional navigation below the surface. Both acoustic targets and vehicle sensors are included.

2.1 Acoustic Locators and Targets

Those acoustic devices which provide vehicle navigation assistance by reflecting back sound or emitting sound upon acoustic interrogation, or by emitting sound on a continual basis.

2.1.1 Active

DEFN – Acoustic targets that emit acoustic signals upon interrogation or emit acoustic signals continuously.

2.1.1.1 Transponders

DEFN – Active markers that emit acoustic signals only when interrogated by another acoustic signal from the surface.

PROPERTIES – Well-suited for objects that will be implanted for long periods of time before relocation because of low battery drain during off periods. Offer unique marker identification by the pattern of the transponder's signal or its frequency.

2.1.1.2 C. W. Beacons and Pingers

DEFN – Active markers that emit a continuous acoustic signal regardless of interrogation. C. W. beacons differ from pingers in that beacons are not pulsed.

PROPERTIES – High power requirement, hence relatively short life; unique marker identification by frequency of signal; provide very strong acoustic target.

2.1.2 Passive Acoustic Markers

DEFN – Acoustic markers that respond to acoustic interrogation only by reflecting sound rather than by emitting an acoustic signal.

USAGE – Aid relocation by providing a target for acoustic interrogation signals.

2.1.2.1 Reflectors

DEFN – Passive markers that are designed to reflect sound in an optimum manner. The shape of the reflector (e.g., right angle, parabolic) determines the amount of reflectance.

PROPERTIES – Provide a more definitive target than an object not specifically designed as a reflector; thus they are easier to "see" acoustically.

2.1.2.2 3-D Range

DEFN – An underwater range containing a number of hydrophones that provide sufficient information to obtain three-dimensional triangulation data on objects passing through the range. It could conceivably be used for FOF positioning or array installations.

2.1.2.3 Recognizable Bottom Characteristics

DEFN – Bottom characteristics that because of acoustic qualities, physical structure or physical shape, are readily recognizable. The utilization of these features will rely on the use of such aids as maps and charts, bottom profiles or previous knowledge of bottom constituents.

2.2 Vehicle Sensor Suit

DEFN – The equipment on vehicles that aids in their navigation underwater. The sensors suit as a whole provide three-dimensional positioning data. Such equipment provides a remote-vehicle operator with sufficient information to guide the vehicle to a work site and position it for performing work.

2.2.1 Active Sensors

DEFN – Those portions of the vehicle sensor suit that emit signals to perform their navigation function.

USAGE – Provide obstacle-avoidance information, range and bearing to specific targets, and height above bottom.

2.2.1.1 Navigation Sonar

DEFN – Small, specially designed navigation sonar units whose sensors are located on remotely controlled vehicles but whose processing readouts are at the surface for operator use.

PROPERTIES – Small, special-purpose; provides range and bearing data to selected targets/objects; provides obstacle-avoidance information.

2.2.1.2 Altimeter

DEFN – A device that provides a remote operator with data on the height of a vehicle above the ocean bottom by bouncing acoustic signals off the bottom; essentially a fathometer whose sensors are located some distance below the surface.

2.2.2 Passive Sensors

DEFN – Those portions of the vehicle sensor suit that receive their inputs from sensors other than self-emitted signals.

USAGE – Passive sensors give information on the vehicle's depth, heading (direction) and location wrt (with respect to) the surface support ship.

2.2.2.1 Depth Measurement

DEFN – A depth gauge that responds to pressure; its sensor is on the vehicle and its readout is on the surface ship.

PROPERTIES – Provides real-time depth measurement. Note that this differs from the altimeter function.

2.2.2.2 Location Wrt Surface Ship

DEFN – A device that gives the operator the X, Y position of a remote vehicle wrt the operator's position (surface ship). This, coupled with depth, slant range data and altimeter readouts, provides the operator with complete three-dimensional positioning information.

2.2.2.3 Compass

TIR

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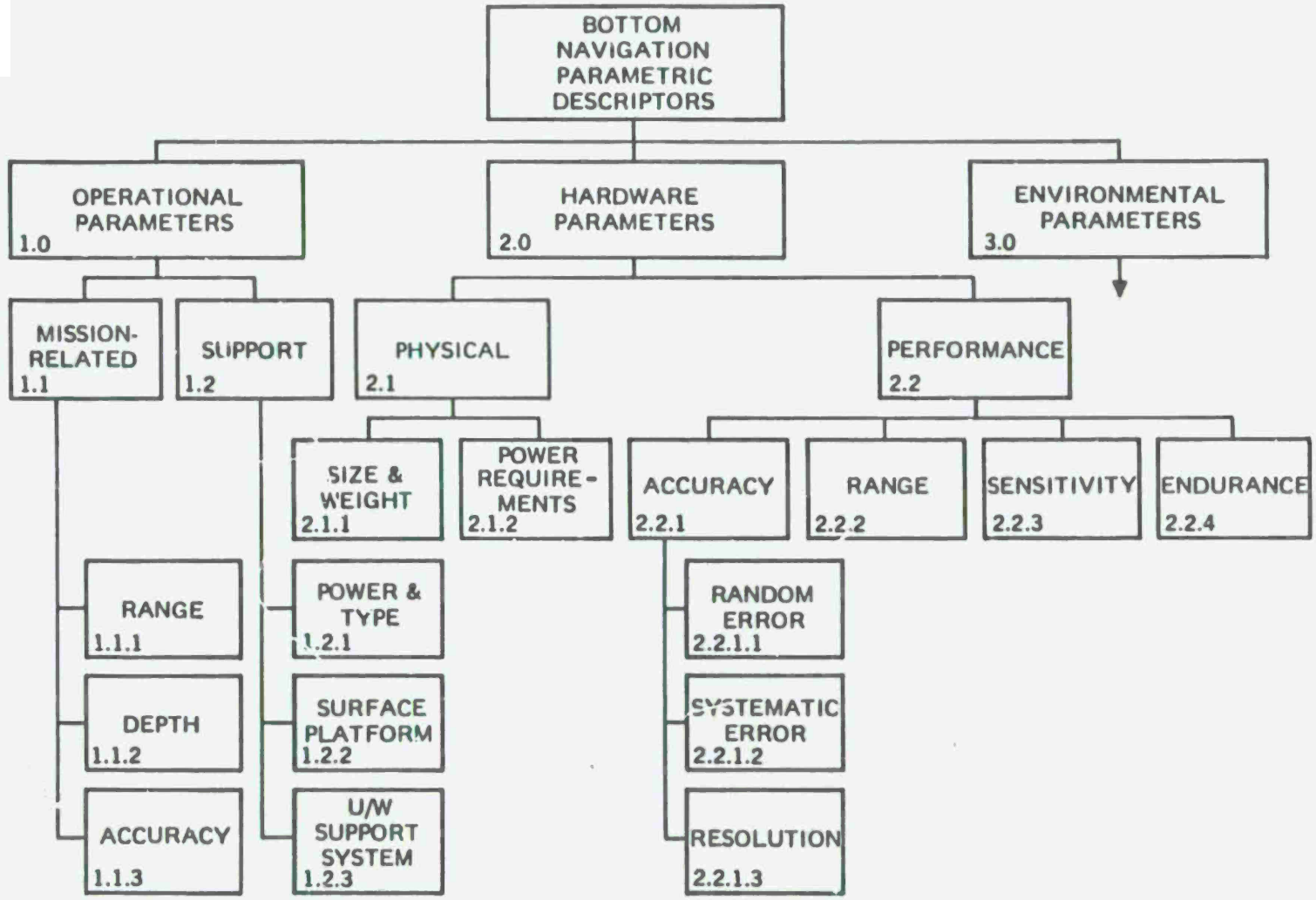

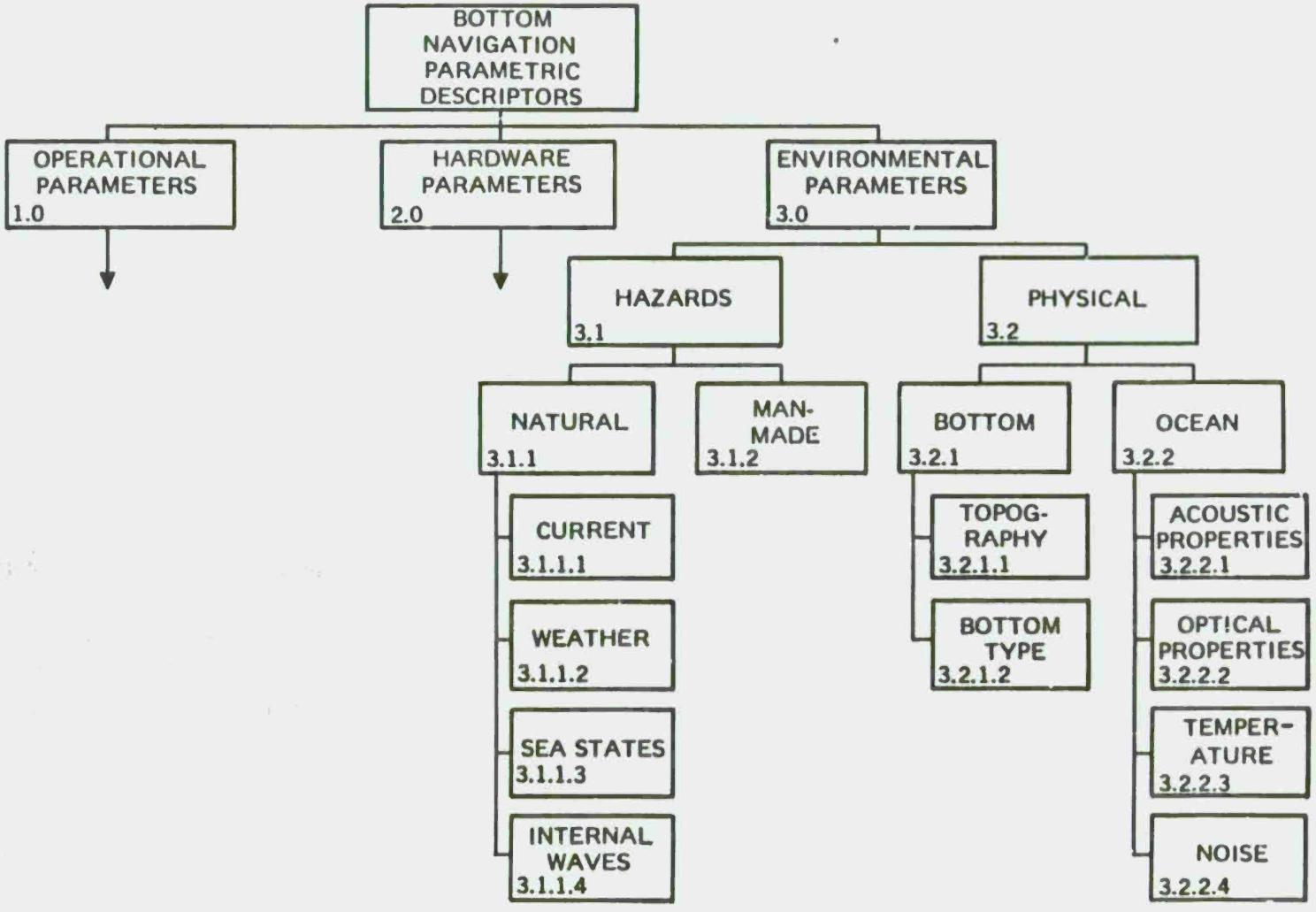
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1.0 Operational Parameters

DEFN – Operational parameters are the numerically identifiable characteristics that adequately describe the essence of operational planning and execution for an AAT. These parameters are limited to those characterizing task-requirement items that are independent of hardware or methods considerations or the operating environment.

1.1 Mission-Related

DEFN – These parameters include numerical data that describe the status of the FOF and the operations required. This category of information should be sufficient to completely describe the actual tasks to be done on the FOF or in conjunction with the operation.

1.1.1 Range

DEFN – Range is the distance between the navigation sensor suit and the FOF.

INPUT/DEPENDENCE – Range information requires the use of an active sensor and is a function of power output and frequency.

1.1.2 Depth

DEFN – Depth as an operational parameter refers to the depth of the ocean floor in the navigational area.

INPUT/DEPENDENCE – The depth in the navigational area influences the type of navigational system required for a given mission, e.g., its power output.

1.1.3 Accuracy

DEFN – Accuracy describes how close the navigation package can guide a vehicle between two points.

INPUT/DEPENDENCE – The accuracy required on a given navigation mission influences the type of navigation system required for that mission.

1.2 Support-Related

DEFN – These parameters include numerical data that describe all vital support functions and equipment required to support the operational mission.

1.2.1 Power and Type

DEFN – The electrical input, including voltage, current and frequency, required to power the navigational equipment.

INPUT/DEPENDENCE – The power and type are dependent upon the type of navigation equipment being utilized.

1.2.2 Surface Platform

DEFN – A surface vessel capable of supporting the navigational package safely in its operational environment.

INPUT/DEPENDENCE – The capabilities of the surface platform are dependent on the size and complexity of the navigational package.

1.2.3 U/W Support Systems

DEFN – An underwater platform capable of supporting a navigational sensor suit safely in its operational environment.

INPUT/DEPENDENCE – The underwater support system is dependent on its surface platform, the physical parameters of the navigational sensor suit and the mission to be performed.

2.0 Hardware Parameters

DEFN – Hardware parameters are those numerically identifiable characteristics that adequately describe the essence of a hardware item or system to specify its use in accomplishing a NAVFAC mission requirement.

2.1 Physical

DEFN – Physical parameters describe the critical dimensions or qualities of a hardware item sufficiently to specify its use and methods of application.

2.1.1 Size and Weight

DEFN – The size and weight of the navigational package. Such parameters describe on-board receiving and processing equipment as well as sensors mounted on or below a surface platform.

INPUT/DEPENDENCE – Size and weight of a navigational package influence the size of a surface ship or underwater support system required to handle the package.

2.1.2 Power Requirements

DEFN – Power requirement parameters specify the type of power needed to operate a particular piece of navigational equipment.

INPUT/DEPENDENCE – Power requirements depend on the type of navigational equipment in use.

2.2 Performance Parameters

DEFN – Performance parameters are generally accepted numerical values (such as sensitivity, receiver gain, contrast, etc.) that describe the ability of a hardware item to perform its sensing function.

2.2.1 Accuracy

DEFN – Accuracy is the inverse of the Circular Probability Error (CPE). The CPE is an ideal number determined by prediction analysis.

INPUT/DEPENDENCE – Accuracy depends directly on random error, systematic error and resolution.

2.2.1.1 Random Error

DEFN – Random error in bottom navigation depends on component random errors, which are caused by signal-to-noise ratio, bandwidth and other environmental and system parameters.

2.2.1.2 Systematic Error

DEFN – Errors that do not usually change sign or magnitude from one measurement to the next.

INPUT/DEPENDENCE – Systematic errors depend on a variety of predictable human errors, mistakes, and oversights in such things as calibration, hardware design and data reading/recording. Examples of systematic errors in bottom navigation systems are incorrect transducer depth, failure to account for ocean current and read-out bias.

2.2.1.3 Resolution

DEFN – Resolution is the minimum linear or angular separation of two distinguishable bottom locations.

INPUT/DEPENDENCE – Resolution is a direct function of frequency; however, it is an inverse function of range.

2.2.2 Range

DEFN – Range is the distance between the receiver and an FOF.

2.2.3 Sensitivity

DEFN – Sensitivity is the minimum energy that will produce a detectable output from a given sensor.

2.2.4 Endurance

DEFN – Endurance is the length of time the navigational package can operate without replacement of its energy source.

INPUT/DEPENDENCE – Endurance is dependent on the power requirements of the navigational package.

3.0 Environmental Parameters

DEFN – Environmental parameters include values or characteristics of the operating environment which have a direct effect on the use or performance of a system and, therefore, must be known or understood for effective operation.

3.1 Hazards

DEFN – Hazards are characteristics that are inherent in the environment and tend to degrade the performance of a system.

3.1.1 Natural

DEFN – Natural hazards are phenomena such as currents or a deep scattering layer which endanger the equipment or tend to prevent it from accomplishing a task.

3.1.1.1 Currents

DEFN – Currents are a naturally occurring phenomenon in the ocean; they are movements of water in one direction on the surface, in the water column or on the bottom of the ocean.

INPUT/DEPENDENCE – When suspended sensors are used as part of a navigation system, strong currents can have a severe influence on the effectiveness of the sensors in completing the mission.

3.1.1.2 Weather

DEFN – Weather parameters include storms, wind velocity, temperature, etc. Operational hazards are created by inclement weather.

INPUT/DEPENDENCE – Weather is usually a major factor in determining the success or failure of a mission.

3.1.1.3 Sea State

DEFN – The conditions of the sea as it relates to wave height and spray.

INPUT/DEPENDENCE – The degree to which sea state affects navigation depends largely upon the type of support platform used.

3.1.1.4 Internal Waves

DEFN – Internal waves refer to waves within the water column.

INPUT/DEPENDENCE – Internal waves influence signal degradation.

3.1.2 Man-Made

DEFN – Man-made hazards include obstacles to hardware performance that are not naturally occurring phenomena. This category includes intentional actions such as trawler fishing or active sonar interference as well as accidental or unintentional actions such as dumping debris or discarding cables.

3.2 Physical

DEFN – Physical parameters include those characteristics of the environment which have a definite effect on performance of a specific mission.

3.2.1 Bottom

DEFN – Bottom refers to the physical characteristics of the sea floor.

INPUT/DEPENDENCE – Bottom characteristics depend to some extent on bottom currents and type of soil, but mostly on geologic activity.

3.2.1.1 Topography

DEFN – Topography refers to the physical features of the sea floor including man-made objects.

INPUT/DEPENDENCE – Topographical characteristics are used for navigation with respect to a known bottom profile.

3.2.1.2 Bottom Type

DEFN – Bottom type refers to the type of material on the bottom such as sand, clay, mud, etc.

INPUT/DEPENDENCE – The type of bottom is an input to the navigation system because different bottom types reflect acoustic signals in different manners.

3.2.2 Ocean

DEFN – Ocean refers to those oceanographic properties which can effect acoustic and optical wave propagation.

INPUT/DEPENDENCE – Oceanographic conditions such as thermoclines, subsurface ducts and internal waves influence signal degradation.

3.2.2.1 Acoustic Properties

DEFN – Acoustic properties are environmental conditions that effect the propagation of acoustic waves in the ocean.

INPUT/DEPENDENCE – Acoustic properties of seawater are largely inputs to such aspects of propagation as signal degradation caused by attenuation and doppler shift, and noise and propagation discontinuities caused by thermoclines, ducts, etc. Such acoustic properties are dependent upon weather, time of year, internal waves and other environmental factors.

3.2.2.2 Optical Properties

DEFN – Optical properties are those environmental conditions which affect the propagation of optical energy in the ocean.

INPUT/DEPENDENCE – Optical properties of seawater are inputs to optical signal degradation during propagation. These properties are dependent upon weather, biological activity in the water column, surface sea state and other environmental factors.

3.2.2.3 Temperature

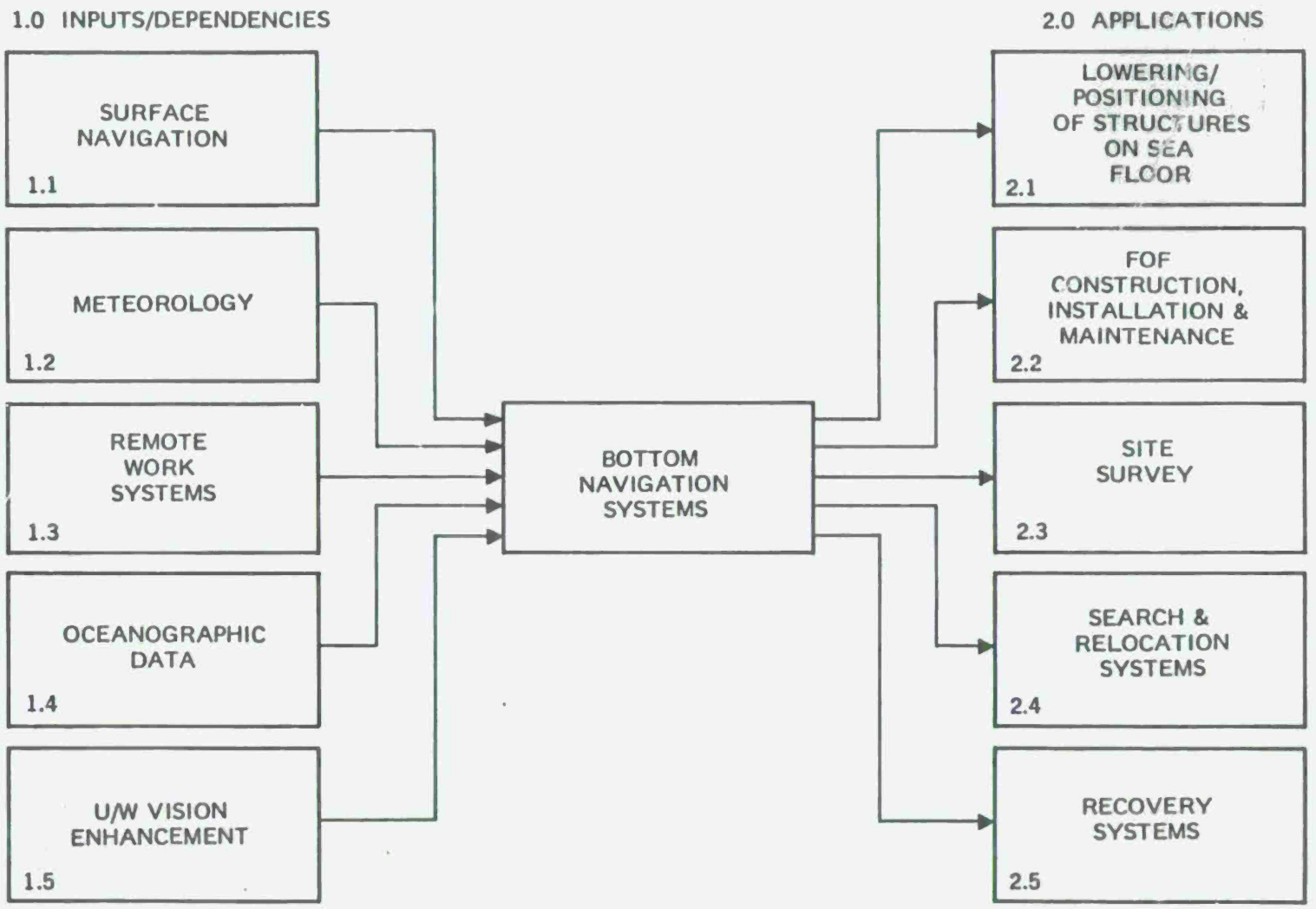
DEFN – Temperature refers to the temperature of the water.

INPUT/DEPENDENCE – Temperature, salinity and depth influence acoustic propagation to a varying extent.

3.2.2.4 Noise

DEFN – Noise is a term for any unwarranted signals.

INPUT/DEPENDENCE – Seawater noise has three basic components: (1) ambient noise due to molecular motion or man-made noise, e.g., surface shipping; (2) reverberation caused by incident sound pulses reflecting or scattering off objects, particles or molecules; and (3) biological noise resulting from the motion or acoustic output of living organisms in the sea. Optical noise is due to light scattering off particles and molecules in seawater.


1.0 INPUTS/DEPENDENCIES
SURFACE NAVIGATION
1.1
METEOROLOGY
1.2
REMOTE WORK SYSTEMS
1.3
OCEANOGRAPHIC DATA
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SITE SURVEY
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SEARCH & RELOCATION SYSTEMS
2.4
RECOVERY SYSTEMS
2.5

1.0 Inputs/Dependencies

1.1 Surface Navigation

DEFN – Surface navigation is the process of guiding a surface ship toward a specific location or direction. Surface navigation systems also allow a surface ship to know its exact coordinates at any location.

IMPACT – Bottom navigation is dependent on surface navigation for information as to exact surface location. A mission requiring bottom navigation systems must begin from a specific surface site.

1.2 Meteorology

DEFN – Meteorology (weather) defines the environmental conditions of a given surface site.

IMPACT – Since bottom navigation systems are directly supported from surface platforms, bad surface weather can be a serious detriment to mission completion. Thus, it is important to monitor weather trends.

1.3 Remote Work Systems

DEFN – Remote work systems are undersea platforms or equipment that can perform a work task and are controlled from the surface.

IMPACT – Bottom navigation systems depend on remote work systems in instances in which navigation sensors are attached to work systems (e.g., vehicles).

1.4 Oceanographic Data

DEFN – Oceanographic data describe ocean water properties at a certain ocean site. Of special importance to bottom navigation are acoustic and optical seawater properties.

IMPACT – Poor seawater conditions can greatly impair the performance of a bottom navigation system. Thus, oceanographic data must be monitored.

1.5 Underwater Vision Enhancement

DEFN – Underwater vision enhancement devices aid undersea divers in seeing better in seawater. Examples are back-scatter reduction lights, low-light goggles, and polarization enhancement devices.

IMPACT – Diver navigation is greatly improved by the use of these viewing aids in dark or turbid water.

2.0 Applications

2.1 Lowering/Positioning of Structures on Sea Floor

DEFN – The process of implanting structures or equipment on the sea floor.

DEPENDENCIES – The positioning process depends upon bottom navigation for accuracy in placement of a structure.

2.2 FOF Installation and Maintenance

DEFN – FOF installation and maintenance depend on bottom navigation in that a work system must be positioned to perform its work task.

2.3 Site Survey

DEFN – Site survey is the process of investigating an ocean location with the intent of using that location as a site for FOF installation.

DEPENDENCIES – Site survey depends on bottom navigation in that a surveying system's position must be accurately known to fully study or map a site.

2.4 Search/Relocation Systems

DEFN – Search/relocation systems are acoustical and optical systems whose purpose is to search for objects on the sea floor.

DEPENDENCIES – Search systems depend on bottom navigation system for guidance of a subsurface search sensor to a specific location.

2.5 Recovery Systems

DEFN – Recovery systems are mechanical systems that are designed to connect to and recover objects mounted or lying on the sea floor.

DEPENDENCIES – Recovery systems depend on bottom navigation for positioning the recovery device, whether it is attached to a vehicle or is a separate entity.

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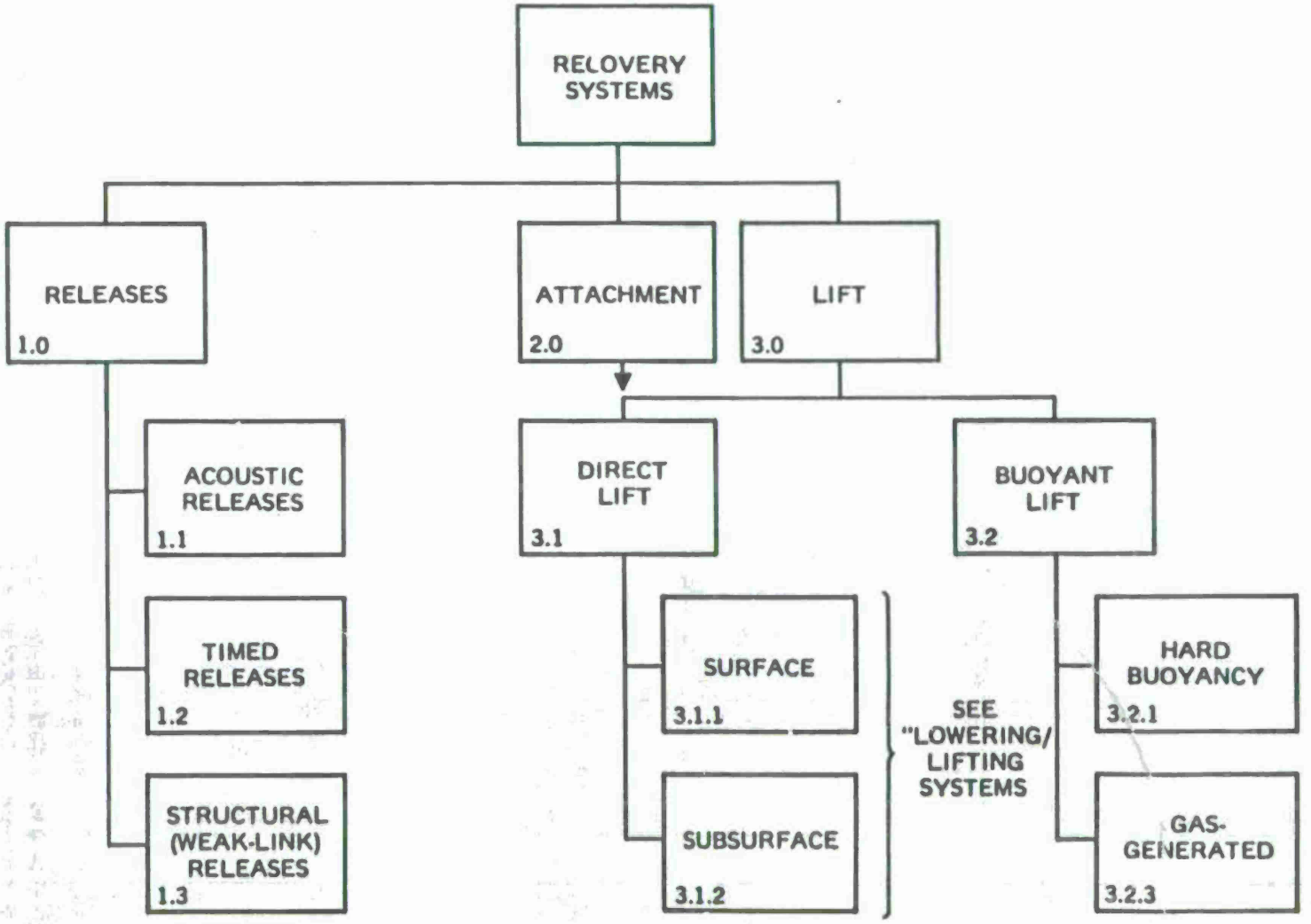

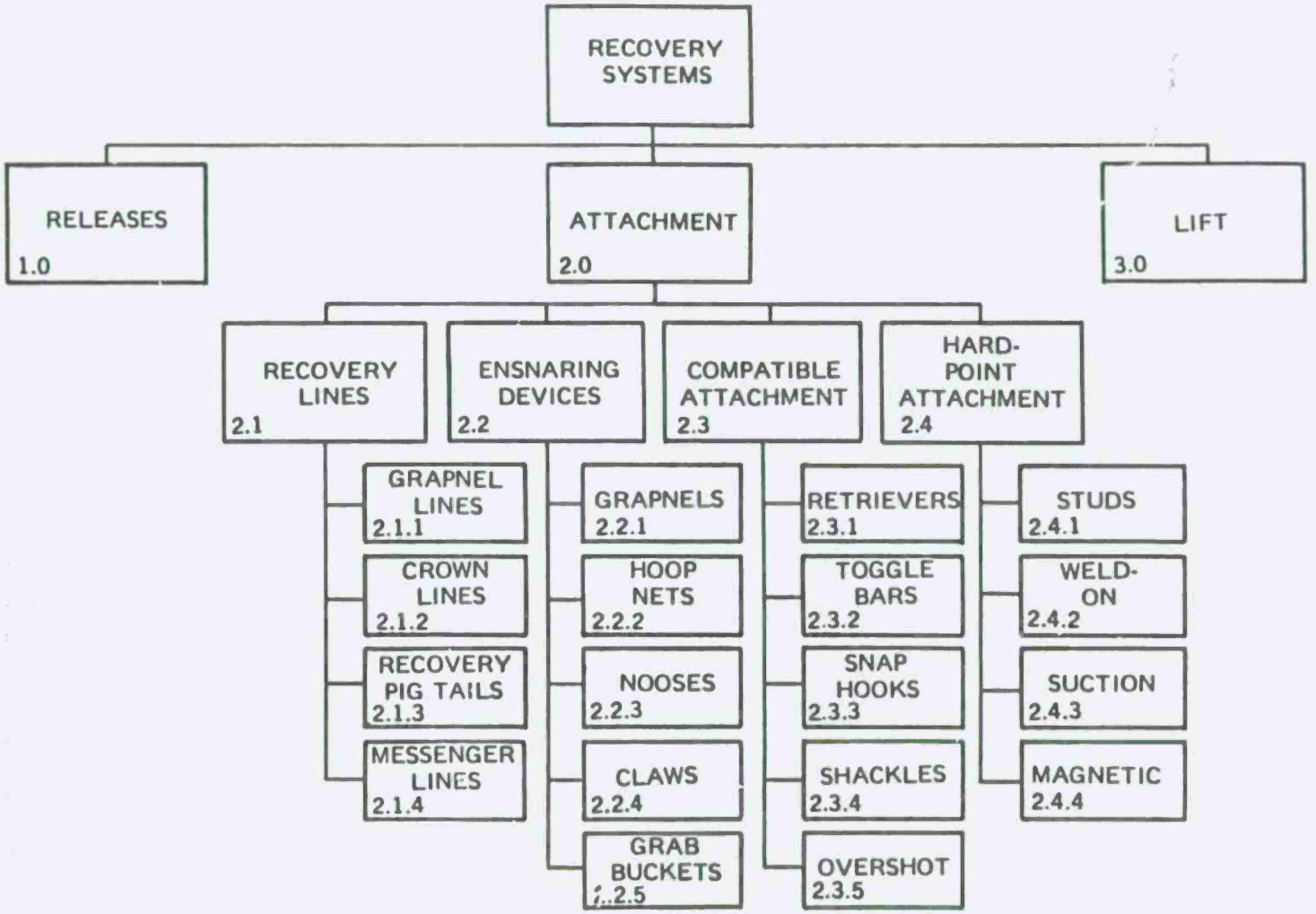
RECOVERY SYSTEMS
RELEASES 1.0
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RECOVERY LINES 2.1
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RECOVERY SYSTEMS

Recovery systems, as defined in this situation, include the equipment used in recovery of bottom-mounted or bottom-tethered FOF's or FOF components. Specifically excluded are the recovery of surfaced or floating FOF or FOF components and diver recovery methods.

1.0 Releases

Releases are devices used in anchor or tether lines to free an underwater object from its restraint during recovery. They can also be used, if necessary, to release lift lines during the lift phase of recovery or salvage operations.

1.1 Acoustic Releases

Acoustic releases are electronic devices that actuate on command from an acoustic signal transmitted through the water from a remote signal source. The signal source can be located at the surface or in deep water on a submersible vehicle. Most acoustic releases require a signal of specified frequency and programmed, coded pulse length to prevent release by extraneous noise.

1.2 Timed Releases

Timed releases are automatically actuated after a specified length of time by some sort of timing or clock mechanism. The mechanisms include electrical or mechanical timers, dash-pot timers and devices that separate as a result of electrolysis of a magnesium link mounted in close proximity to a steel surface. Timed releases may vary from precision, short-term timers to inaccurate, long-term timing devices.

1.3 Structural (Weak-Link) Releases

Structural releases contain a low-strength element that will break or shear away when a predetermined load has been exceeded. The low-strength element is always the weakest point in the mechanism, thus preventing damage from overload to the remainder of the anchoring or lifting system.

2.0 Attachment

Attachment includes the equipment employed in making an attachment to an object, and the methods of making an attachment for the specific purpose of recovery. Attachments for tasks other than recovery (e.g., construction, mooring, etc.) are excluded. Equipment beyond the scope of the actual attachment device (e.g., manipulators, vehicles, etc.) is excluded.

2.1 Recovery Lines

Recovery lines are used to assist in making an attachment prior to a recovery or lift operation. They may include synthetic rope, wire cable or chain.

2.1.1 Grapnel Lines

DEFN – A line, wire or chain attached to the FOF structure and laid out across the ocean floor for sufficient length to be hooked by a grapnel on a towed drag line, allowing a bight to be retrieved to the surface.

2.1.2 Crown Lines

DEFN – A line, wire or chain sufficiently strong to lift the FOF. The line is attached to the FOF lift point and buoyed off at the surface or near surface.

2.1.3 Recovery Pig Tails

DEFN – A short line, wire or chain that is attached to the FOF lift point and can be used to attach a recovery line. A pig tail differs from a grapnel line in that the pig tail is shorter than the depth of water and usually incorporates a special attachment point on its free end.

2.1.4 Messenger Lines

DEFN – A messenger line is attached to a lift point and latching device on an FOF and is sufficiently long to reach the surface. The messenger line is a light line not capable of being used for lift; it guides and transfers a heavier lift line to the attaching device on the FOF.

2.2 Ensnaring Devices

Ensnaring devices are recovery devices that are not dependent upon lift fittings mounted on the recovery object but function by ensnaring or circling the object itself.

2.2.1 Grapnels

DEFN – A hook-shaped device at the end of a drag line.

USAGE – Designed to capture or hook onto a line, wire or chain lying on the ocean floor.

2.2.2 Hoop Nets

DEFN – A net with a hoop and purse strings to draw it tight about the recovery object.

USAGE – Dropped over objects to be recovered; used to recover several pieces of debris or one piece of irregular size and shape; however, all pieces to be recovered must be larger than the mesh size of the net.

2.2.3 Nooses

DEFN – A loop of wire, line or chain.

USAGE – Used to ensnare the object to be recovered and then drawn up tight around it.

2.2.4 Claws

DEFN – A rigid, moveable structure designed to ensnare an envelope of specific size and shape.

2.2.5 Grab Buckets

DEFN – A rigid device used to envelop items on the bottom including the surrounding bottom.

PROPERTIES – May be structured as a closed box for small objects or a large, hay-rake device for bigger components.

2.3 Compatible Attachment Devices

Compatible attachment devices comprise equipment made specifically to interface with a predesigned lift point.

2.3.1 Retrievers

DEFN – A device lowered by a lift line and used to assist in connecting the lift line to the recovery object.

USAGE – May carry an overshot or similar device for attachment to a pig tail, and may winch itself down on a lightweight messenger line or follow a taut messenger line.

2.3.2 Toggle Bars

DEFN – A device dependent for its operation on having an opening available in the structure to be recovered.

USAGE – Attached by inserting the toggle into the hole and pivoting a cross bar behind the opening, preventing the toggle from being extracted.

2.3.3 Snap Hooks

DEFN – A hook with a retaining catch so that when a line, shackle, or pad eye is engaged in the hook, release is prevented.

USAGE – Used as standard rigging device fitting.

2.3.4 Shackles

DEFN – A coupler including a moveable pin inserted to form a closed link through the attachment hole.

USAGE – Couples fittings such as a pad eye, eye splice or chain.

2.3.5 Overshot

DEFN – An overshot device is used in conjunction with a messenger line and is a device designed to capture and lock onto a conical spear device at the end of a pig tail attached to the recovery object.

USAGE – Used in conjunction with a messenger line; the overshot is lowered from the surface on a heavy lift line and is used to attach the heavy line to the object.

2.4 Hard-Point Attachment

Hard-point attachments include all devices that are rigidly attached to a structural component of an FOF, for attaching lift lines, marker buoys, messenger lines, etc.

2.4.1 Studs

DEFN – Smooth or threaded rods positioned perpendicular to the structural surface.

USAGE – Serve as the primary attachment device or are used to secure plates, pad eyes or other devices to the structure.

2.4.2 Weld-On

DEFN - Devices attached to the underwater structure by automatic welding techniques such as thermite mixes.

2.4.3 Suction

DEFN -- Devices that use the ambient water pressure to affect an attachment by creating a low-pressure region between the attachment device and the structure to be recovered.

2.4.4 Magnetic

DEFN – Devices using permanent or electromagnets for recovery.

USAGE – Suitable for recovery of ferrous objects only.

3.0 Lift

Lift of objects is concerned with the methods of applying a lift force to an object for the specific task of recovery. The tools and techniques for applying the lift force are described, and the functional and operational characteristics are defined. Detailed hardware descriptions of lift equipment is not germane to the specific requirement of applying a lift force, and such descriptions are excluded.

3.1 Direct Lift

Direct lift systems apply a lifting force from the surface or subsurface. They include floating platforms and lift devices mounted on those platforms. Detailed information on the platforms and direct lift devices is covered as a TIR; additionally, they are treated in another AAT, "Lowering/Lifting Systems."

3.2 Buoyant Lift

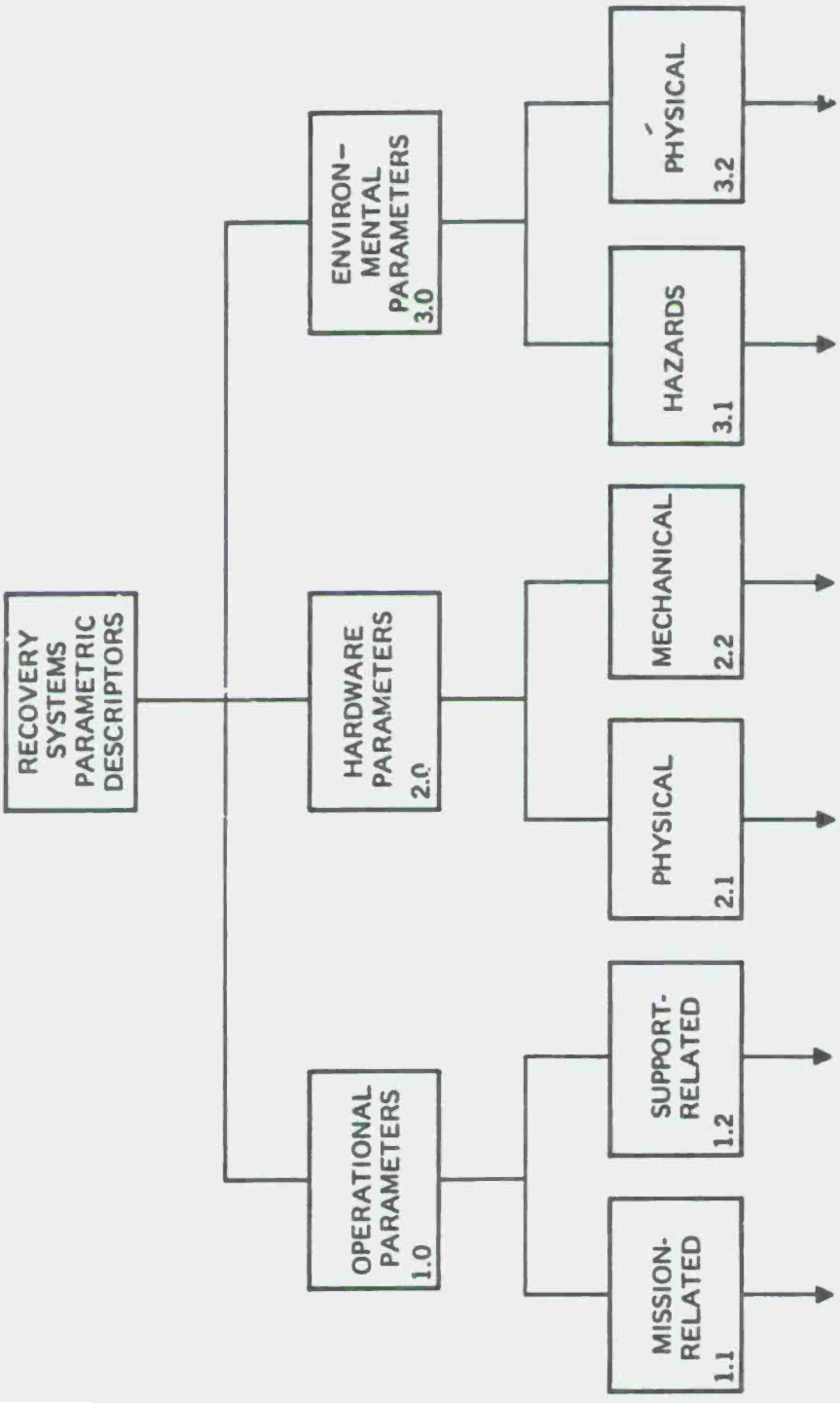
Buoyant lift systems employ a buoyant device that is either an integral part of the FOF or separate from it to provide a lifting force to the FOF.

3.2.1 Hard Buoyancy

DEFN – Systems with fixed displacement that experience only slight buoyancy changes with increasing depth down to their hydrostatic crush points. Typical buoyant materials in this category include various types of foam materials, rigid pressure-vessels and low-density fluids.

3.2.2 Gas-Generated Buoyancy

DEFN – Systems that derive buoyancy by displacing seawater with a gas. The gas may be provided by compressing air, by a chemical reaction with hydrazine or lithium hydride to produce hydrogen, by boiling gas off a cryogenic liquid, or by the electrolysis of seawater to produce hydrogen. To provide buoyancy at a specified depth, the gas must be supplied at a pressure in excess of the ambient pressure at that depth.



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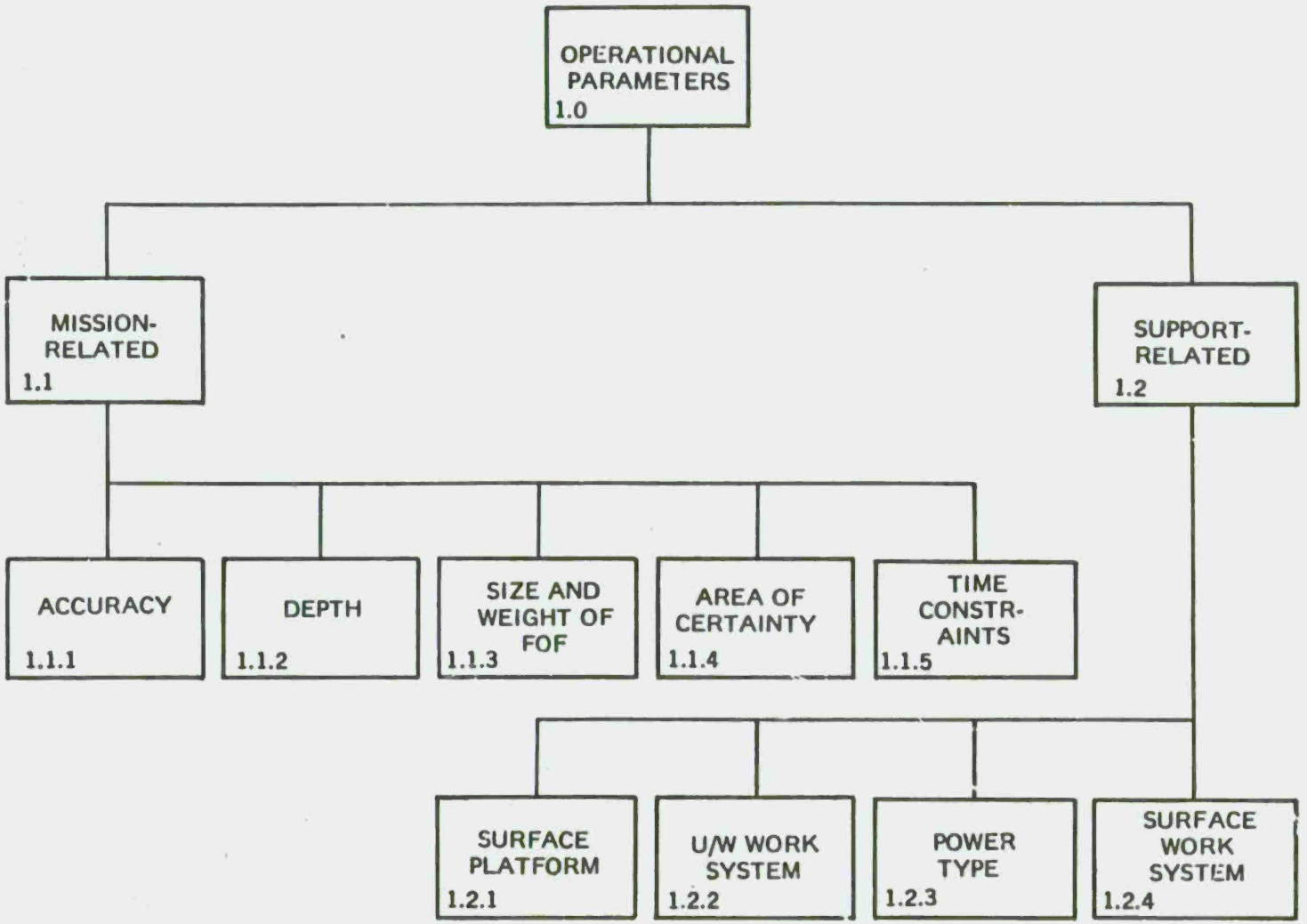
OPERATIONAL PARAMETERS
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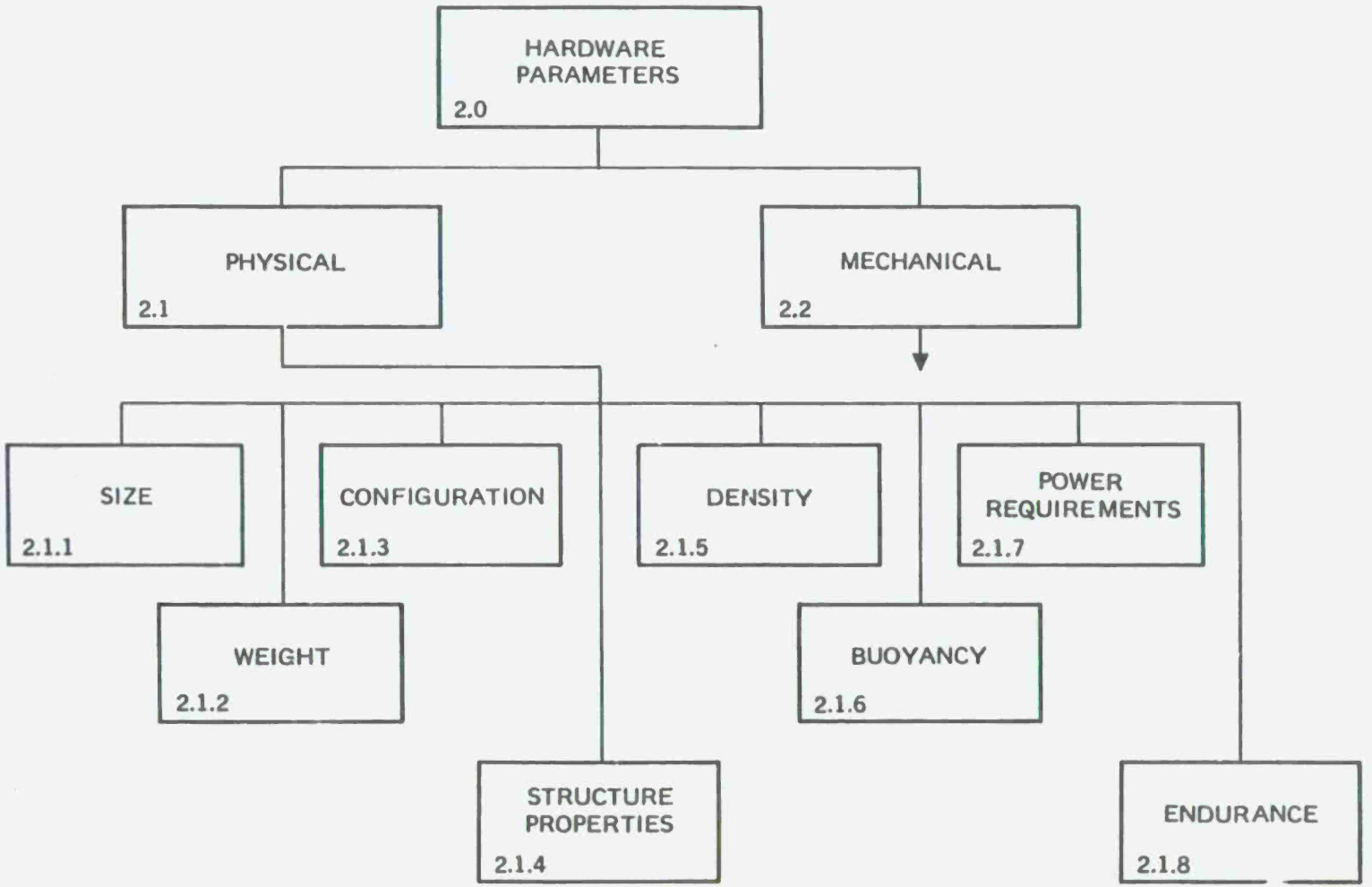
HARDWARE PARAMETERS
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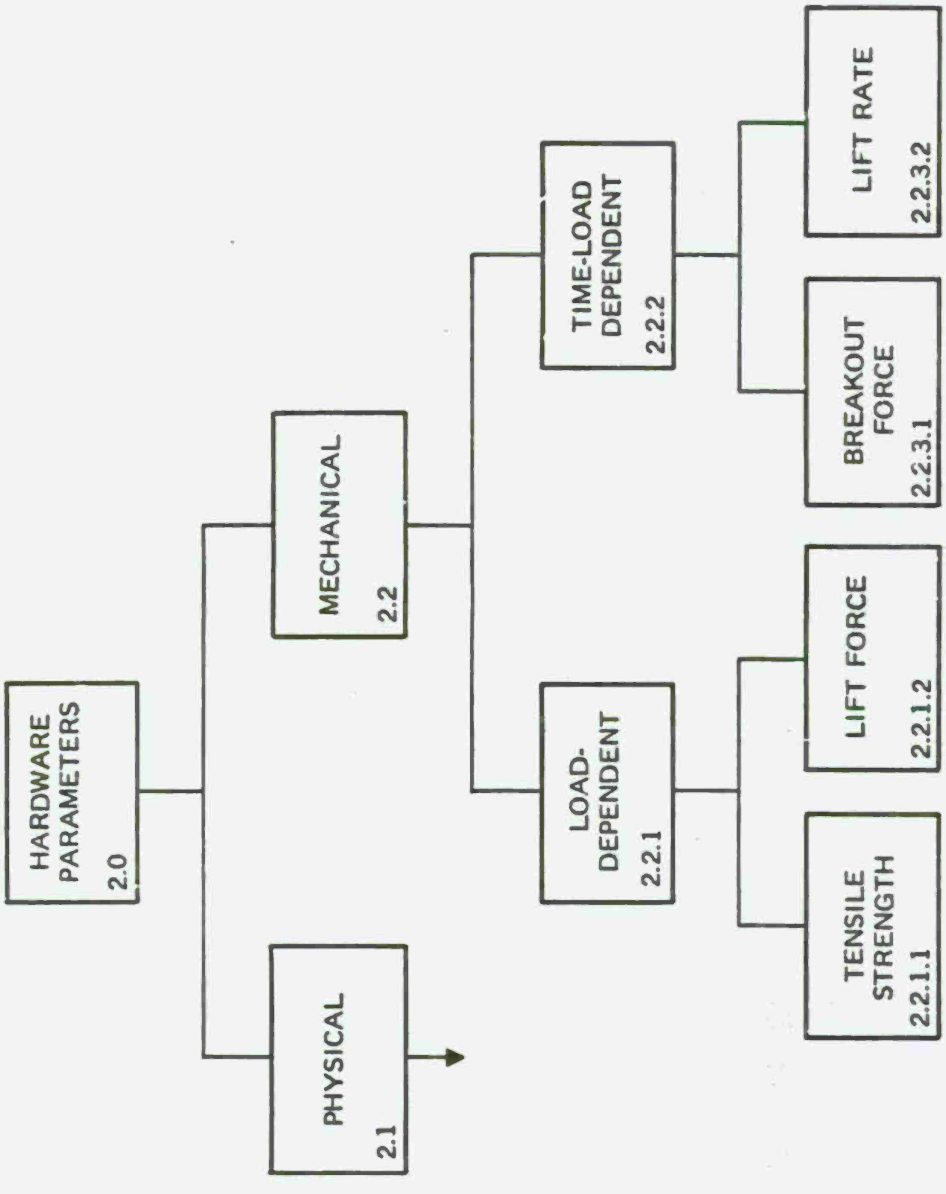
HARDWARE PARAMETERS 2.0
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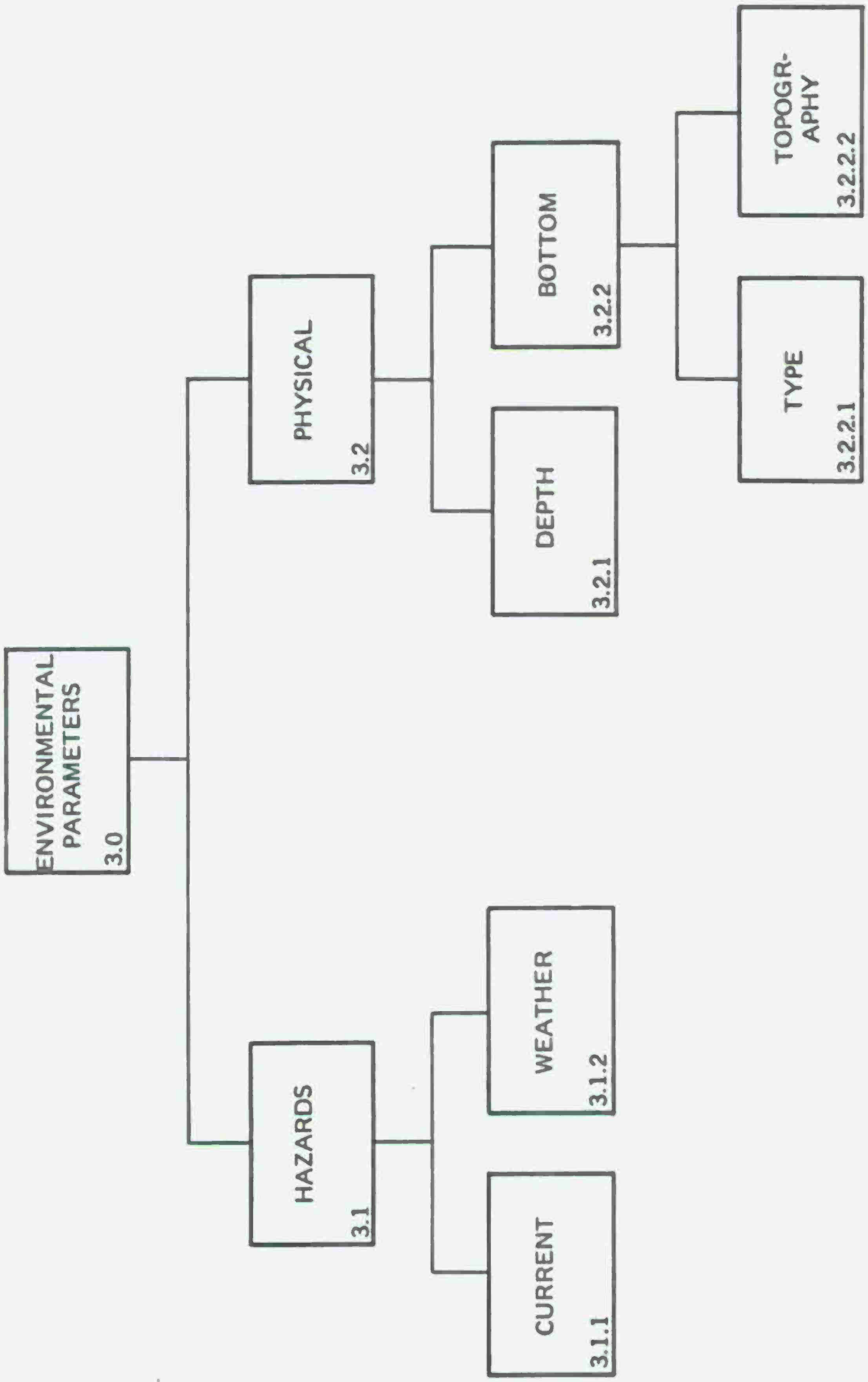
ENVIRONMENTAL PARAMETERS 3.0
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1.0 Operational Parameters

DEFN – Operational parameters are those numerically identifiable characteristics which adequately describe the essence of operational planning and execution for an AAT. These parameters are limited to characterizing task requirement type items which are independent of hardware or methods considerations or the operating environment.

1.1 Mission Related Parameters

DEFN – These parameters include numerical data which describe the status of the FOF and the operations required. This category of information should be sufficient to completely describe the actual tasks to be done on the FOF or in conjunction with the operation.

1.1.1 Accuracy

DEFN – Accuracy is a measure of how close a recovery mission comes to relocating the exact position of an FOF.

INPUT/DEPENDENCE – The accuracy required for a given recovery mission influences the type of recovery system to be used.

1.1.2 Depth

DEFN – Depth refers to how deep the FOF to be recovered is located.

INPUT/DEPENDENCE – The depth of an object to be recovered influences the type of recovery system required to complete the mission.

1.1.3 Size & Weight of FOF

DEFN – These parameters describe the physical characteristics of the FOF.

INPUT/DEPENDENCE – The size and weight of the FOF will influence the type of recovery system to be used for a specific mission.

1.1.4 Area of Certainty

DEFN – The area of certainty implies how well the location of an FOF to be recovered is known in advance of the start of a mission. The probability of a successful recovery is enhanced by a complete definition of an FOF's location.

INPUT/DEPENDENCE – The area of certainty depends on previous data, maps, markers, etc.

1.1.5 Time Constraints

DEFN – Time constraints for a given mission refer to the maximum time allowed for mission completion.

INPUT/DEPENDENCE – Time constraints can contribute to the overall urgency of a recovery mission, which in turn makes demands upon operator time and efficiency, equipment reliability, economic factors, etc.

1.2 Support-Related

DEFN – These parameters include numerical data which describe all the vital support functions and equipment required to support the operational mission.

1.2.1 Surface Platform

DEFN – The surface platform is a surface ship capable of safely supporting the recovery equipment.

INPUT/DEPENDENCE – The size and weight of the recovery equipment and its associated deck-handling equipment and the size and weight of the FOF will determine the type and size of the surface platform.

1.2.2 Underwater Work System

DEFN – The underwater work system is that portion of the recovery equipment that attaches to the FOF to effect the recovery.

INPUT/DEPENDENCE – Depending on the size, weight and configuration of the FOF, this could be anything from a simple grapnel line to a system similar to NUC's CURV III.

1.2.3 Power & Type

DEFN – Power and type denote the electrical inputs (including voltage, current and frequency) and the hydraulic flow rate required to operate the recovery equipment.

INPUT/DEPENDENCE – The power and type is dependent on the recovery equipment used.

1.2.4 Surface Work System

DEFN – Surface work systems include the surface recovery equipment and tools needed to support the overall recovery mission. Included would be the crane, winch, rigging materials, welding equipment, machine tools, etc.

INPUT/DEPENDENCE – The surface work system and equipment is dependent on the mission requirements, surface platform available and the complexity of the recovery.

2.0 Hardware Parameters

DEFN – Hardware parameters are those numerically identifiable characteristics which adequately describe the essence of a hardware item or system to specify the use of that item or system to accomplish a NAVFAC mission requirement.

2.1 Physical Hardware Parameters

DEFN – Physical parameters describe the critical dimensions or qualities of a hardware item sufficiently to specify the utilization and methods of application of the hardware.

2.1.1 Size

DEFN – Size refers to the physical size of the FOF.

INPUT/DEPENDENCE – The size of the FOF to be recovered will influence the size of the surface support platform.

2.1.2 Weight

DEFN – Weight refers to the weight of the FOF in air and in water.

INPUT/DEPENDENCE – The weight of the FOF will determine the capabilities of the recovery equipment.

2.1.3 Configuration

DEFN – Configuration refers to the general shape of the FOF.

INPUT/DEPENDENCE – The configuration of the FOF will influence the type of recovery equipment to be used.

2.1.4 Structure Properties

DEFN – Structure properties include the type of material and construction of the FOF.

INPUT/DEPENDENCE – Structure properties give an indication of how strong the FOF is and, therefore, an indication of the best means to recover the FOF.

2.1.5 Density

DEFN – Density refers to the density of the FOF to be recovered.

INPUT/DEPENDENCE – The density of the FOF will determine the capabilities of the recovery equipment.

2.1.6 Buoyancy

DEFN – Buoyancy refers to the amount of buoyancy of the FOF.

INPUT/DEPENDENCE – Buoyancy of the FOF will determine the capabilities of the recovery equipment.

2.1.7 Power Requirements

DEFN – Power requirements include the amount and type of power required by the recovery system.

INPUT/DEPENDENCE – The power requirement influences the choice of the surface platform that must supply the power.

2.1.8 Endurance

DEFN – Endurance is the length of time any part of the recovery system can be operated without replenishment of its energy source.

INPUT/DEPENDENCE – Endurance is dependent upon the specific recovery system used and its power source.

2.2 Mechanical Performance

DEFN – Mechanical performance parameters are numerical values that describe the actual mechanical capabilities of hardware based on operational experience.

2.2.1 Load-Dependent

DEFN – Load-dependent forces are forces related only to the weight of the FOF.

INPUT/DEPENDENCE – Load-dependent forces define the steady-state capabilities of the recovery system.

2.2.1.1 Tensile Strength

DEFN – Tensile strength is the greatest longitudinal stress (as pounds per square inch) the recovery line can bear without tearing apart.

INPUT/DEPENDENCE – The tensile strength defines the capability of the recovery line.

2.2.1.2 Lift Force

DEFN – Lift force is the steady-state force that must be applied to recover an FOF.

INPUT/DEPENDENCE – The lift force specifies the steady-state strength of the recovery system.

2.2.2 Time-Load Dependent

DEFN – Time-load dependent forces are forces that change with time.

INPUT/DEPENDENCE – Time-load dependent forces specify the dynamic capabilities of the recovery system.

2.2.2.1 Breakout Force

DEFN – Breakout force is the force necessary to break the FOF free from the bottom sediment and begin to raise it from the ocean floor.

INPUT/DEPENDENCE – Breakout force specifies the dynamic capability of the recovery system.

2.2.2.2 Lift Rate

DEFN – Lift rate is the rate in unit length per unit time that the lift cable is moved.

INPUT/DEPENDENCE – The lift rate is determined by the tensile strength of the lift line and the weight of the FOF.

3.0 Environmental Parameters

DEFN – Environmental parameters include values or characteristics of the operating environment that have a direct effect on the use or performance of a system and, therefore, must be known or understood for effective operation.

3.1 Hazards

DEFN – Hazards are characteristics inherent in the environment that tend to impede the performance of a system.

3.1.1 Natural

DEFN – Natural hazards are natural phenomena such as currents or a deep scattering layer that present a hazard to the equipment or tend to prevent the equipment from accomplishing a task.

3.1.1.1 Currents

DEFN – Currents are a naturally occurring phenomenon in the ocean. Currents are movements of water in one direction, on the surface, in the water column or on the bottom of the ocean.

INPUT/DEPENDENCE – Strong currents can have a severe influence on the completion of the recovery mission.

3.1.1.2 Weather

DEFN – Weather parameters include storms, wind velocity, temperature, etc. Operational hazards are created by inclement weather.

INPUT/DEPENDENCE – Weather is usually a major factor in determining the success or failure of a recovery mission.

3.1.2 Man-Made

DEFN – Man-made hazards include obstacles to hardware performance that are not naturally occurring phenomena. These include intentional actions such as trawler fishing or active sonar interference as well as accidental or unintentional actions such as dumping debris or discarding cables.

3.2 Physical

DEFN – Physical parameters include those characteristics of the environment that have a definite effect on performance of a specific mission.

3.2.1 Depth

DEFN – Depth refers to the depth of the ocean floor at the recovery site.

INPUT/DEPENDENCE – The depth at the recovery site influences the type of recovery system required for a given mission.

3.2.2 Bottom

DEFN – Bottom denotes the physical characteristics of the sea floor.

INPUT/DEPENDENCE – Bottom characteristics are dependent to some extent on bottom currents and type of soil, but mostly on geological activity.

3.2.2.1 Type

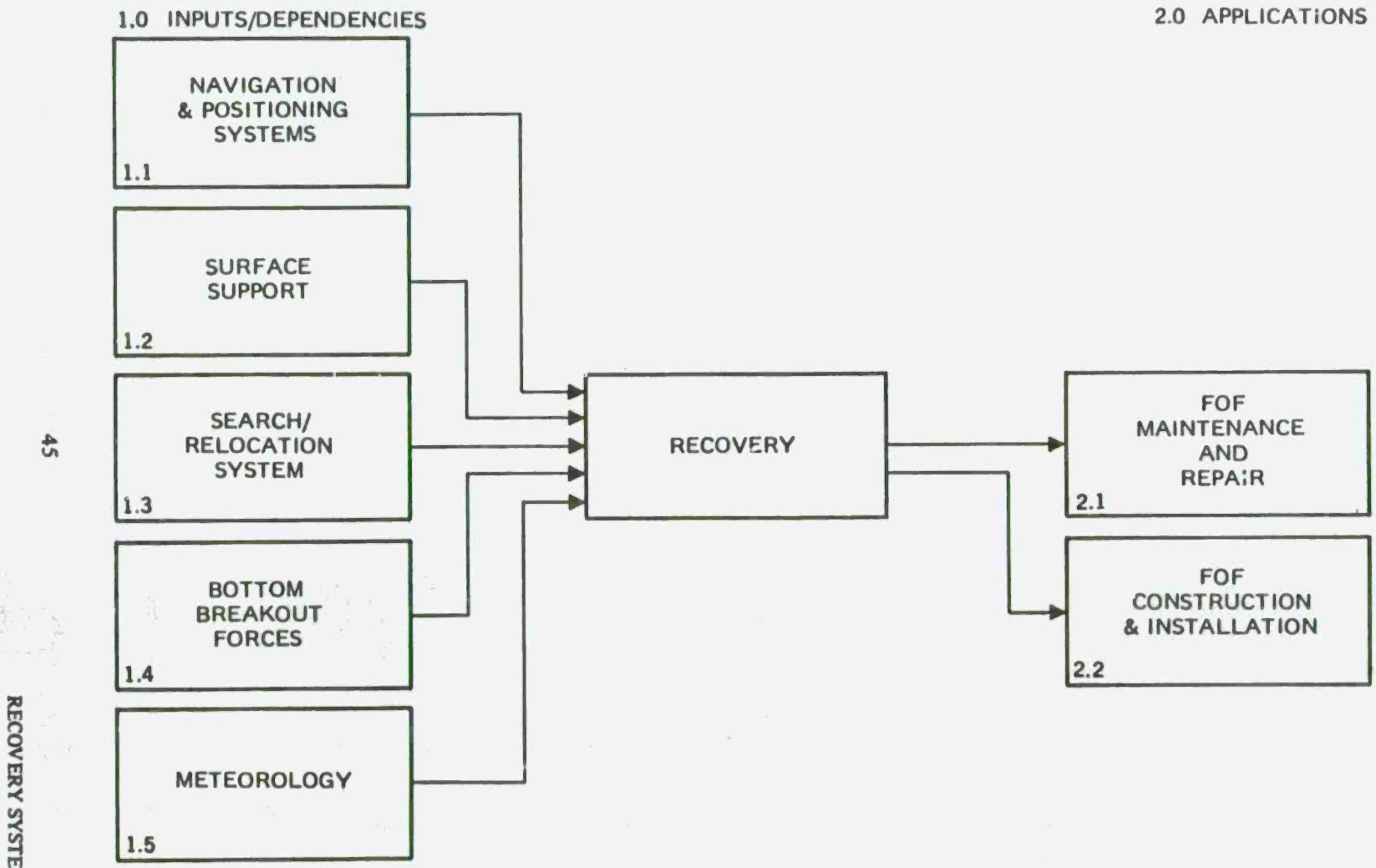
DEFN – Bottom type refers to the type of material on the bottom, such as sand, clay, mud, etc.

INPUT/DEPENDENCE – Bottom type influences the type of FOF and the break-out forces necessary to recover it.

3.2.2.2 Topography

DEFN – Topography refers to the physical features of the sea floor, including man-made objects as well as natural objects.

INPUT/DEPENDENCE – Topography influences recovery in that obstacles present a hazard in recovery operations.


1.0 INPUTS/DEPENDENCIES
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RECOVERY
FOF MAINTENANCE AND REPAIR
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FOF CONSTRUCTION & INSTALLATION
2.2

1.0 Inputs/Dependencies

1.1 Navigation & Positioning Systems

DEFN – Those systems which are employed to determine the position and location of both the surface platform and the underwater work system with respect to the object to be recovered.

IMPACT – Without the ability to station keep with the surface support craft, which is dependent on surface navigation, recovery will be difficult or impossible.

1.2 Surface Support

DEFN – Surface support includes the surface support vessel and all such systems there on which are vital to the operation of a recovery system. This includes such things as power sources, lifting and handling gear, and sea keeping ability.

IMPACT – A surface support system is essential to carrying out recovery operations by currently employed methods.

1.3 Search Relocation System

DEFN – Those systems used to locate, detect and classify the object to be recovered.

IMPACT – A search system will be required to accomplish recovery operations if the object to be recovered is not adequately marked.

1.4 Bottom Breakout Forces

DEFN – Breakout forces are forces that resist lift forces on an object due to adhesion or suction between the ocean bottom and the object. This is a time-dependent function.

IMPACT – Breakout forces will have a direct effect on the selection of lift equipment.

1.5 Meteorology

DEFN – As applied to this TIR, meteorology is limited to the effects and prediction of prevailing weather conditions at an operating site.

IMPACT – Weather conditions at an operating site will have an effect on the type of recovery equipment to be used and the planning of the time frame of the operation.

2.0 Applications

2.1 FOF Maintenance & Repair

DEFN – All operations performed on an existing FOF to keep the FOF in a desired status or return it to a desired status.

DEPENDENCE – In many cases the maintenance or repair of a FOF depends on the ability to recover either the entire FOF or at best selected components of the FOF.

2.2 FOF Construction & Installation

DEFN – Applications of recovery to construction of an FOF is limited to on-site construction or assembly or designing for compatibility with recovery equipment.

DEPENDENCE – The on-site construction or assembly of an FOF may depend on the ability to recover assembly fixtures once the various components are placed and joined together. During construction the ability to recover an FOF can be enhanced by building recovery fixtures into the FOF.

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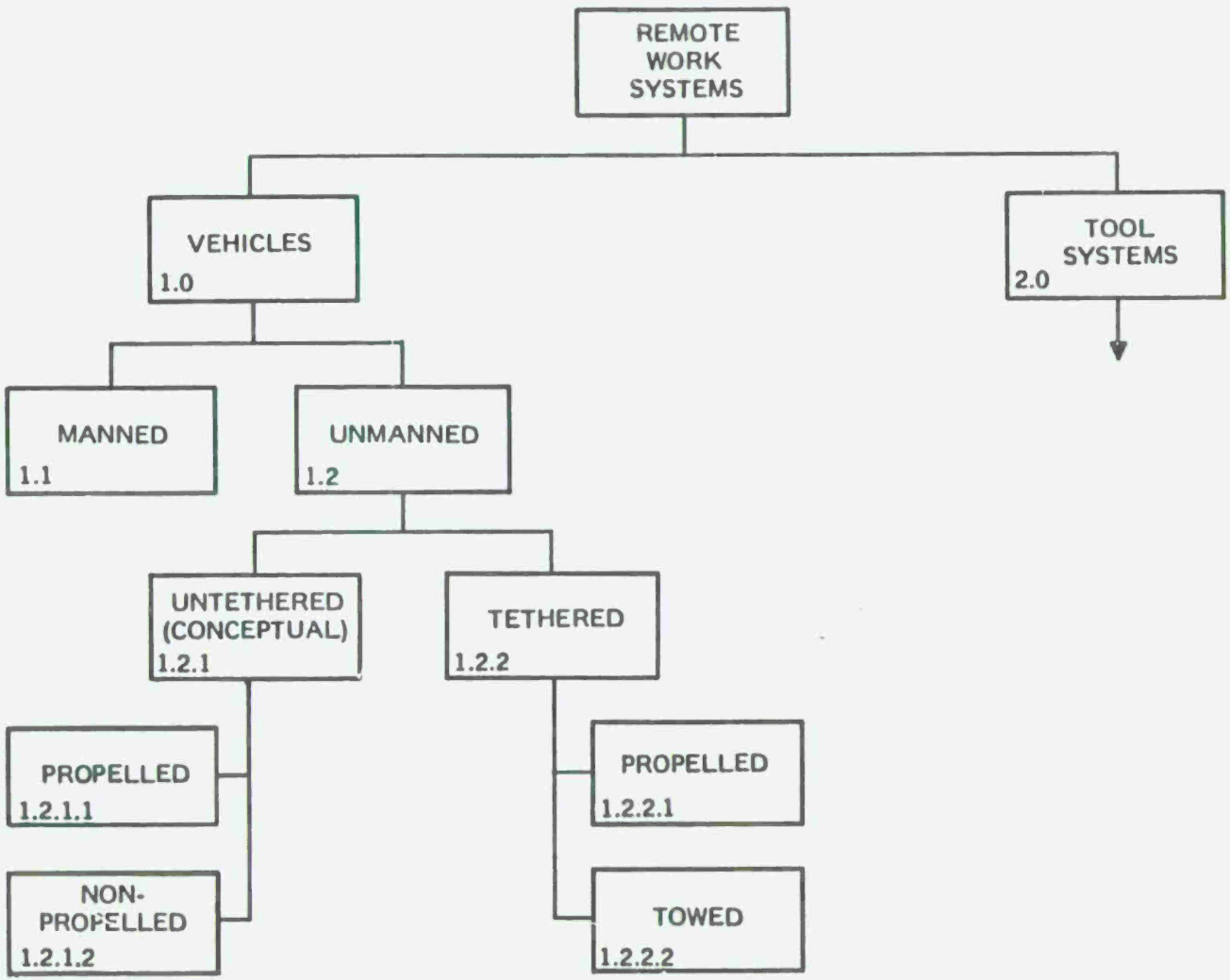

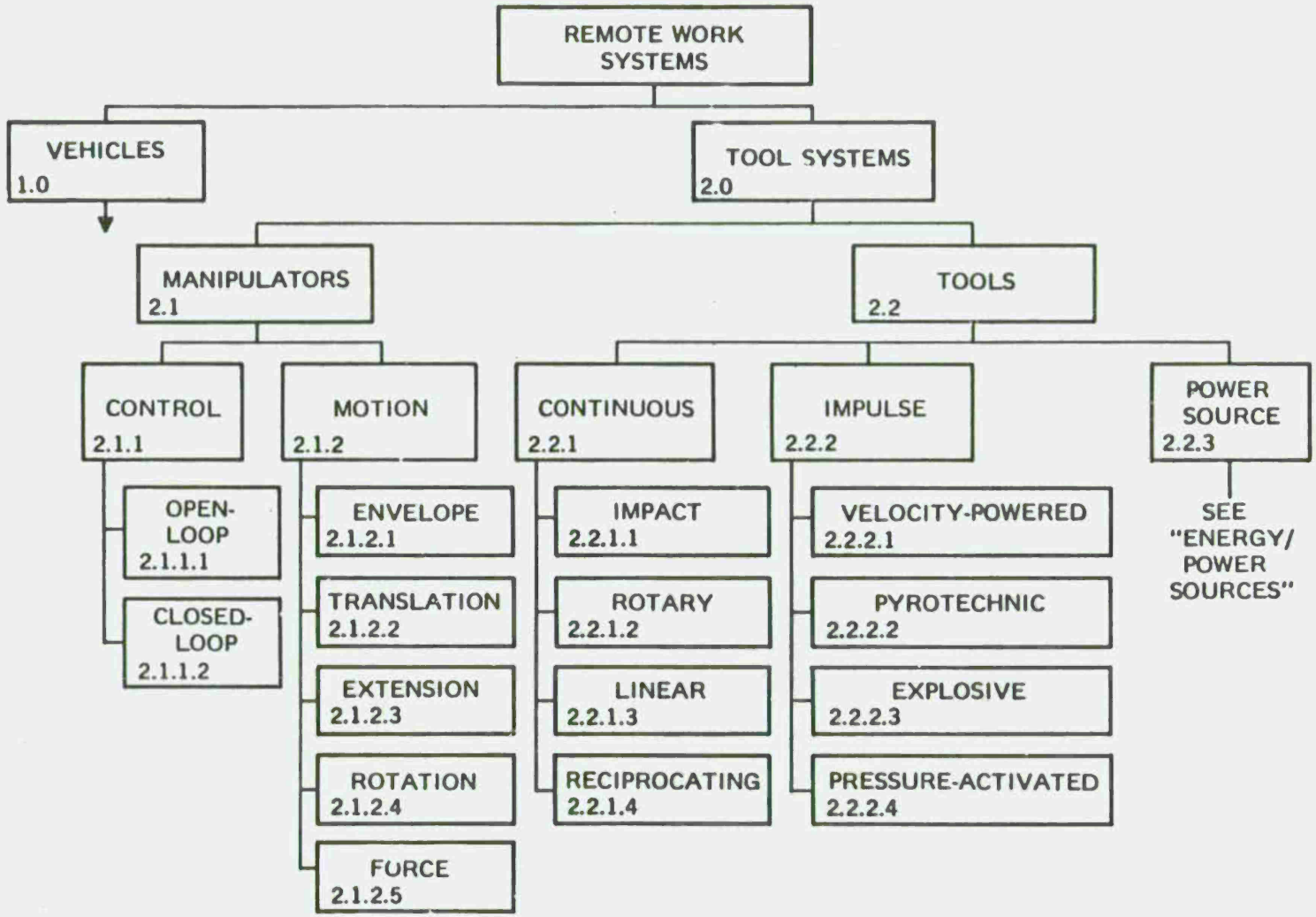
REMOTE WORK SYSTEMS
VEHICLES 1.0
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REMOTE WORK SYSTEMS

Remote work systems include the methods and equipment for performing work in the ocean, remote from a surface platform.

1.0 Vehicles

Vehicles, as defined here, include all submersible vehicles that are employed to deliver or carry remote work systems for installation, maintenance or repair of FOF's. Vehicle operational characteristics and functional capabilities are described in sufficient detail to clarify their impact on FOF installation, maintenance or repair. Detailed vehicle system descriptions and vehicle design parameters are specifically excluded from this section; however, some of this information is covered as a TIR.

1.1 Manned

Manned submersible vehicles are specifically excluded at this time.

1.2 Unmanned Vehicles

Unmanned vehicles are those that do not require or do not have as a part of their design a life-support system for operation. Therefore, it may be assumed that all man-machine interfaces occur at the surface in a normal one-atmosphere environment.

1.2.1 Untethered Vehicles

Untethered vehicles are unmanned vehicles that do not have or do not require a mechanical link between the vehicle and the surface operating/control station. They include remotely controlled vehicles that rely on an acoustic or other environmental transmission link for control of the vehicle and telemetering of data.

1.2.1.1 Propelled

DEFN – Propelled vehicles have a power source and thrust capability for accomplishing a mission profile.

1.2.1.2 Nonpropelled

DEFN – Free-running vehicles may or may not have an onboard power source but are incapable of exerting a thrust for propulsion or maneuvering of the vehicle.

1.2.2 Tethered

DEFN – Tethered vehicles, as defined here, include all submersible vehicles that are mechanically linked to a surface support and control station. The power supply of such vehicles may be supplied from the surface through the tether or on board the vehicle.

1.2.2.1 Propelled

DEFN – Submersible vehicles having as a part of their design thrust-producing components for applying traversing and maneuvering forces.

1.2.2.2 Towed

DEFN – Vehicles having no thrust-producing machinery except for control surfaces; they rely on the forces produced by the tether for traversing and maneuvering.

2.0 Tool Systems

Tool systems, as defined here, include equipment used to perform specific underwater work tasks including fine-positioning and orientation of an actuating device or component, applying force to the actuating device or component and the specific end function capabilities. Items such as tool design, power source and type of power are treated as a TIR.

2.1 Manipulators

Manipulators, as defined here, include equipment that is used to fine-position or apply a force to an end-function tool. It is the interface between a vehicle used to deliver the work system to the work site, and a specific end-function tool, such as a claw, cutting torch or the like, used to perform the end function. Manipulators may also be those devices used in applying a force to position components of an FOF.

2.1.1 Control

Manipulators applied to undersea usage are generally mounted at some distance from the operator and, therefore, require remote control. The manipulator-control circuitry directs or guides the manipulator arm to perform its required work functions. The controls in some instances act as a data link between the manipulator and control console. Command and control signals to the arm may be transmitted over a multiple-lead hard-wire system or through coaxial cable multiplexing telemetry circuits.

2.1.1.1 Open-Loop

DEFN – Open-loop manipulators have no provision for feedback to the operator. That is, the operator must rely on a secondary device, such as a TV system, to determine the condition of the manipulator being operated.

2.1.1.2 Closed-Loop

DEFN – Closed-loop manipulators have a feedback system as a part of their design. The feedback provides information to the operator for improved positioning or force control of the manipulator.

2.1.2 Motion

DEFN – To locate the terminal device, or tool, three translational degrees of freedom or motion are required. These are in the X, Y and Z planes. Orientation of the terminal device also requires three degrees of freedom or series rotation about three mutually perpendicular axes. The terminal device also has one operational motion. Therefore, a true manipulator has a minimum of seven motions or degrees of freedom.

2.1.2.1 Envelope

DEFN – The manipulator envelope is generated by circumscribing a volume with the manipulator at maximum and minimum extension. It therefore establishes the volumetric limits within which a work tool can be utilized.

2.1.2.2 Translation

DEFN – The motions controlling the gross movement of the manipulator, usually associated with the shoulder actuators.

2.1.2.3 Extension

DEFN – The motions controlling the reach of the arm, usually governed by the elbow and wrist actuators.

2.1.2.4 Rotation

DEFN – The motions that control the terminal-device orientation. These motions result from actuation of the wrist azimuth actuator and the wrist rotary actuator.

2.1.2.5 Force

DEFN – The motion and load resulting from operation of the terminal-device jaws.

2.2 Tools

Tools are devices providing an end-function work capability to facilitate a mechanical operation. There orientation and control is provided by other components of the tool system, usually the manipulators.

2.2.1 Continuous

Continuous tools are those provided with continuing energy from an external power source, allowing work operations to proceed over a finite period of time. Normally, they receive power from hydraulic, pneumatic or electric energy sources.

2.2.1.1 Impact

DEFN – Tools that impart an impact or shock pulse to the work piece to develop a high energy level for a short period of time. Powered hammers and nut-torquing wrenches are examples of impact tools.

2.2.1.2 Rotary

DEFN – Tools using rotary motion to perform a work function. Tools normally operate at several hundred RPM or higher and can be classified as high-speed or low-speed. Drilling or tapping are low-speed functions and grinding or wire brushing are high-speed functions.

2.2.1.3 Linear

DEFN – Tools performing a work function utilizing a linear motion to apply a mechanical force. The hydraulic-mechanical energy transfer is usually obtained through the use of hydraulic actuators or cylinders and is considered to be a low speed function. Spreader bars, jacks, and cable cutters are typical examples.

2.2.1.4 Reciprocating

DEFN – Tools utilizing an oscillatory motion to impart energy to the work task. The rate of oscillatory motion is considerably greater than that associated with linear tools. Chipping hammers or reciprocating synthetic line-cutting tools are examples.

2.2.2 Impulse

Impulse tools are those using a closed energy source that does not provide continuous power to a tool, but rather provides power for a single work operation. Energy is applied by an instantaneous explosive pulse or by a more sustained shock pulse of varying length. Devices may be expendable or include a provision for reloading the energy cartridge.

2.2.2.1 Velocity-Powered

DEFN – Velocity-powered tools derive their energy from power-charged cartridges that utilize the instantaneous generation of gas to impart a high-velocity impulse to the work component. Actuation is usually initiated with a firing pin or squib device. Stud-drivers or cable-cutters are in this category.

2.2.2.2 Pyrotechnic

DEFN – Pyrotechnic tools obtain their energy from a mixture of propellant materials and various types of metallic particles. The energy thus generated may be used for cutting or welding operations, depending on the formulation. Actuation is initiated with an electrical squib. Pyronol cutting torches are an example of pyrotechnic tools.

2.2.2.3 Explosive

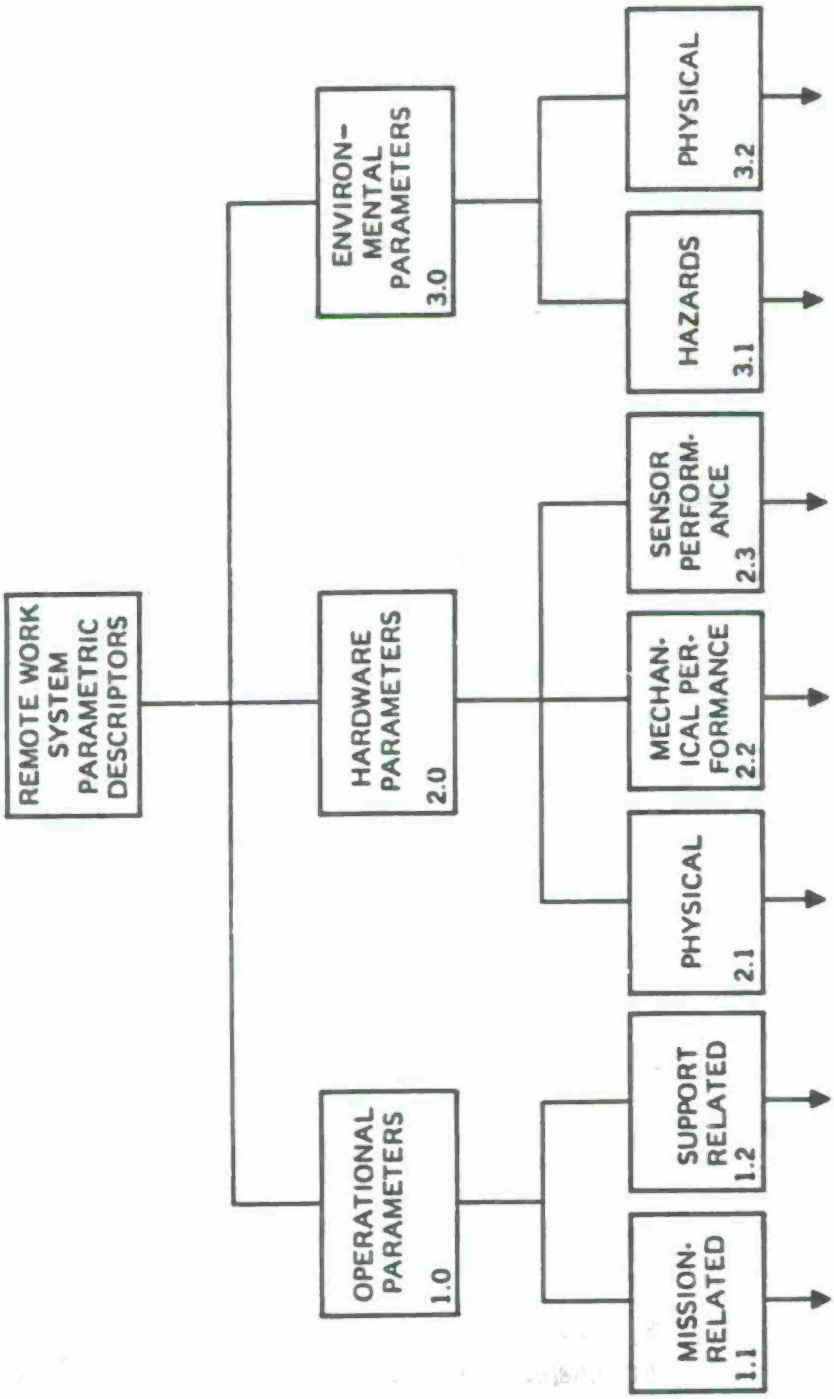
DEFN – Explosive devices utilize the detonation of stored chemical energy to accomplish a work function. The explosive energy is used directly rather than imparting the energy to some other mechanical tool component. Included under this category are explosive compounds for blasting, punching or cutting, as well as mechanical devices such as explosive bolts used for release or jettisoning operations. Detonation is initiated with blasting caps or squibs.

2.2.2.4 Pressure-Activated

DEFN – Pressure-activated tools utilize the implosive energy resulting from opening a one-atmosphere pressure-housing to subsurface pressures, usually below continental shelf depths, providing a pressure differential for tool actuation.

2.2.3 Power Source

DEFN – Energy or power sources are treated as a TIR for this AAT; they will be dealt with in detail under another AAT, "Energy/Power Systems."



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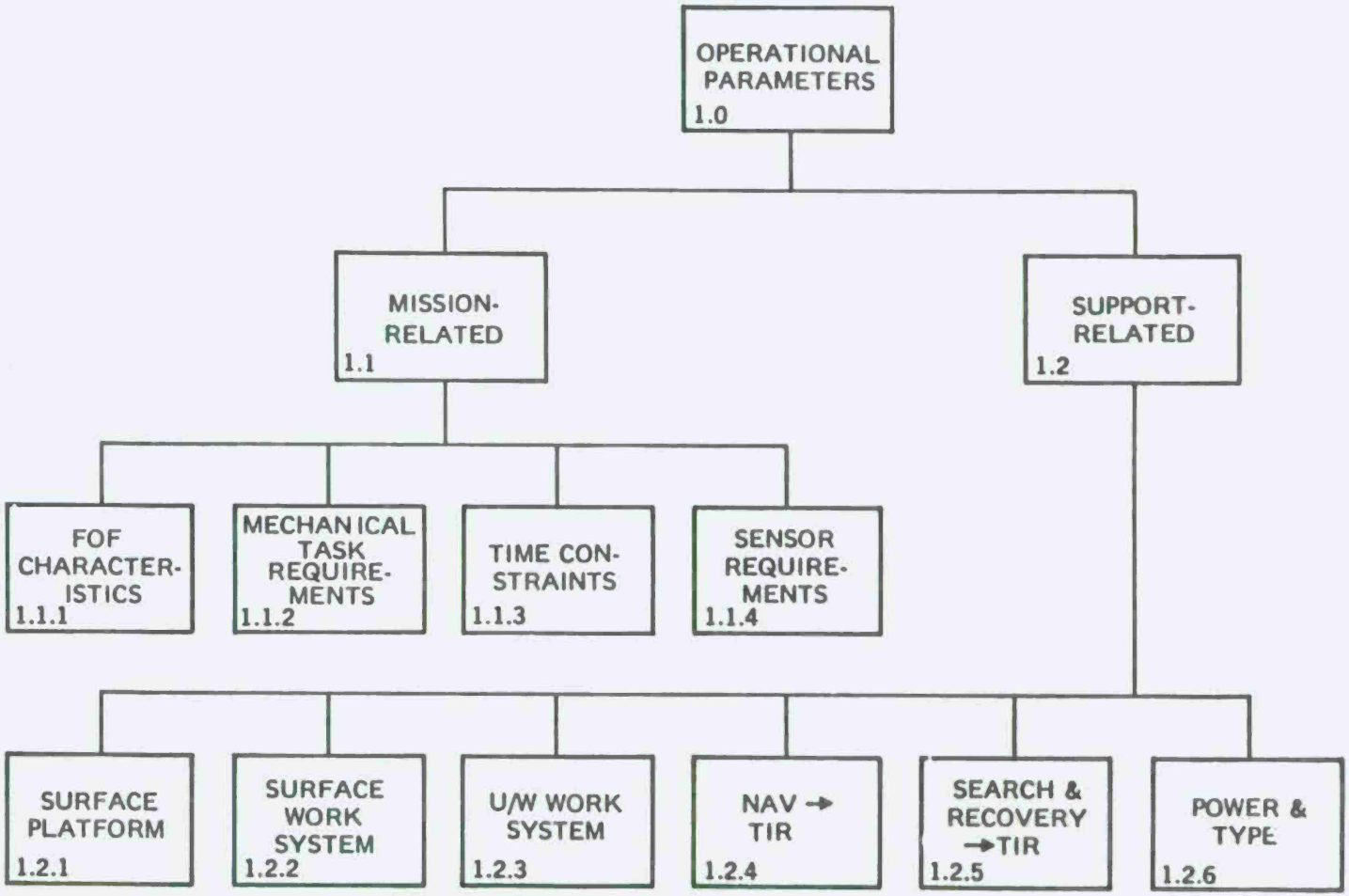
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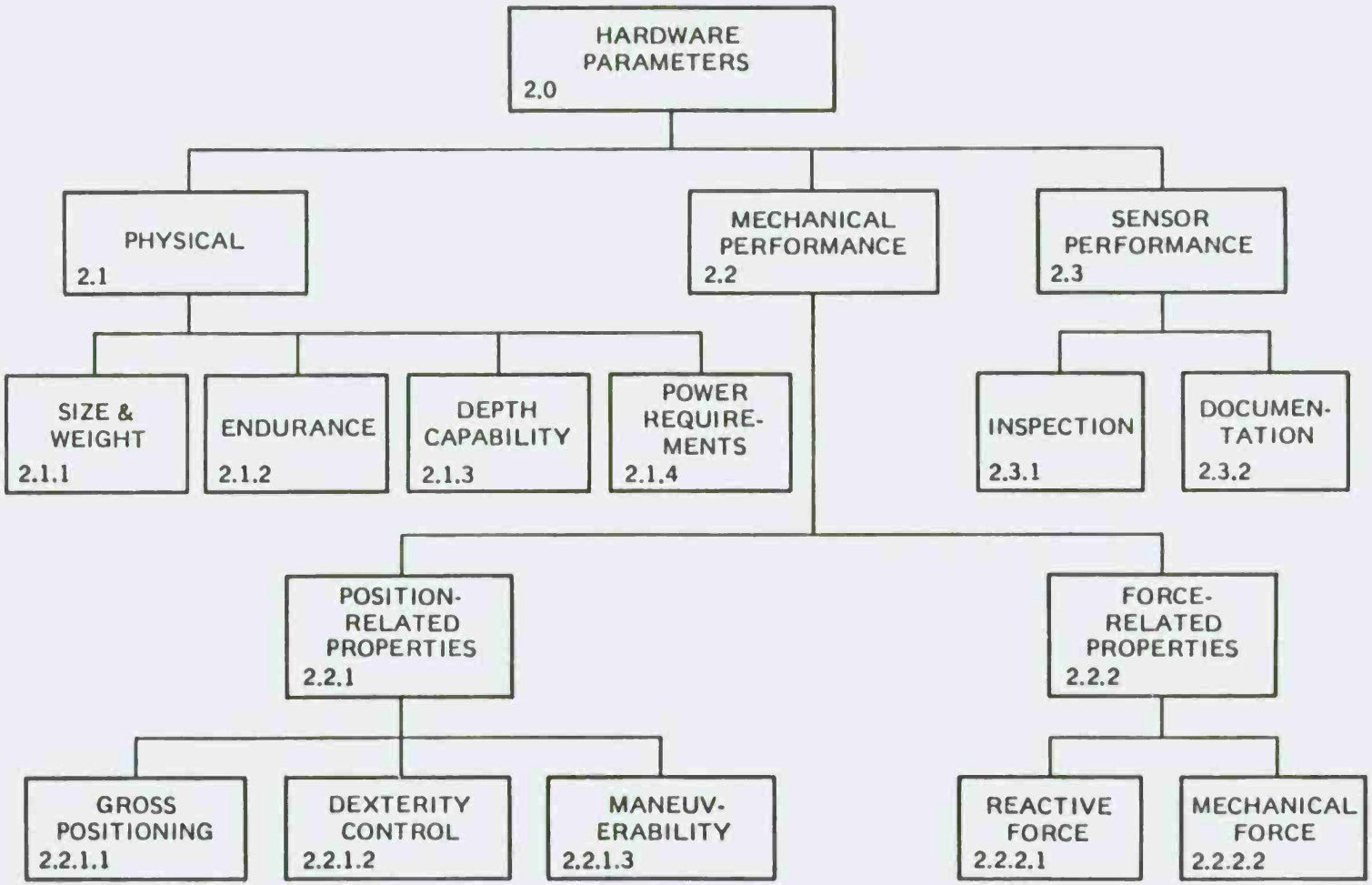
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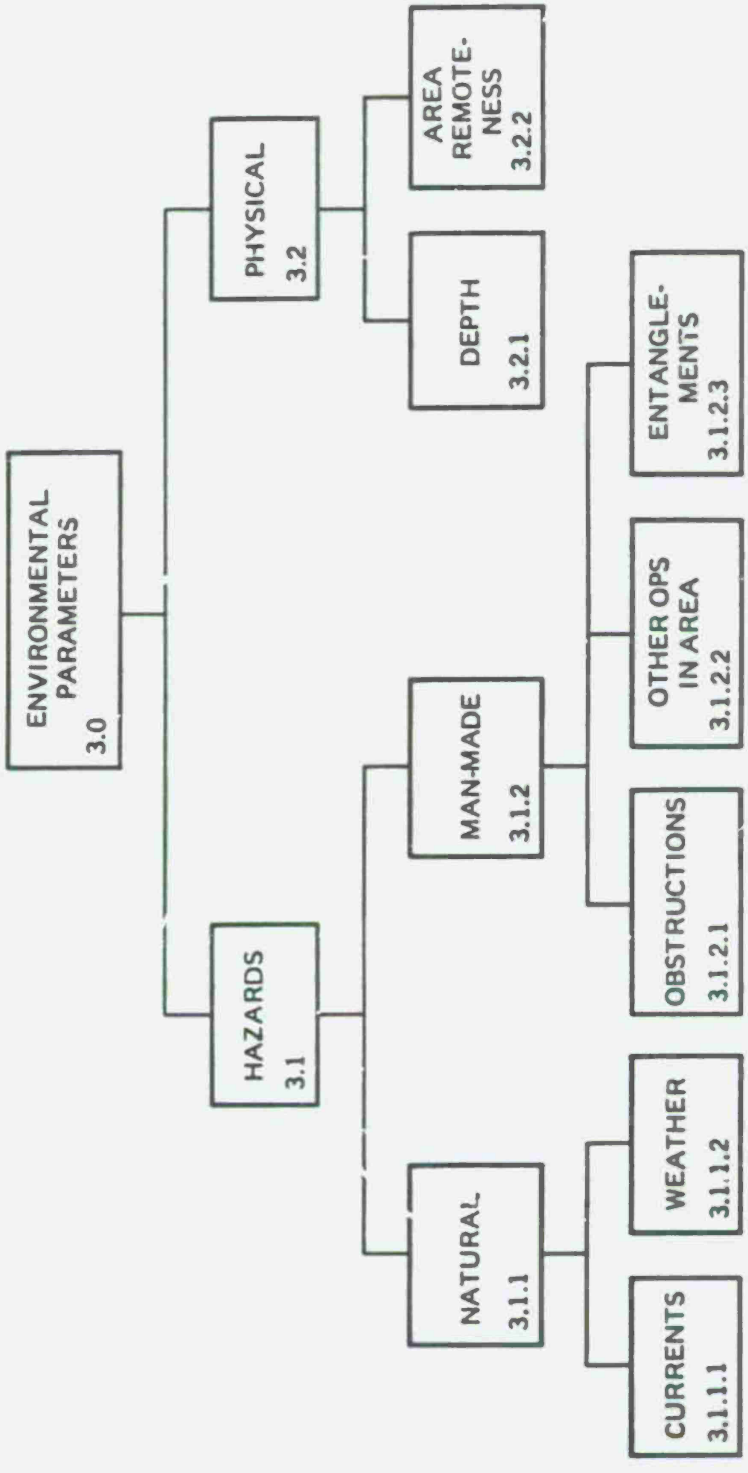
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1.0 Operational Parameters

Operational parameters are numerically identifiable characteristics that adequately describe the essence of operational planning and execution for an AAT. These parameters are limited to those characterizing task-requirement items that are independent of hardware or methods or the operating environment.

1.1 Mission-Related

These parameters include numerical data that describe the status of the FOF and the operations required. This category of information should be sufficient to completely describe the actual tasks to be done on the FOF or in conjunction with the operation.

1.1.1 FOF Characteristics

DEFN – The FOF characteristics are established in quantitative terms in order to determine the magnitude and scope of the mission and its related operations. Included are FOF size, weight, structural description, power requirements, etc. These characteristics are the initial specifications needed to establish the work systems needed and the extent of their mission.

INPUT/DEPENDENCE – These characteristics are dependent upon the FOF type, construction, location and intended use.

1.1.2 Mechanical Task Requirements

DEFN – The mechanical task requirements are basically those parameters that define the extent of the work task. The requirements include such data as the loads to be worked, number and type of tools needed, and the extent of the support required.

INPUT/DEPENDENCE – These requirements are dependent upon a detailed survey of the work site, an adequate description of the FOF and a comprehensive mission scenario with well-defined objectives.

1.1.3 Time Constraints

DEFN – All work missions have some type of time constraint as a result of emergency conditions, weather restrictions, total acceptable mission costs or the like. These time constraints have a major impact on determining the total mission scope and the work systems needed.

INPUT/DEPENDENCE – These constraints are dependent upon mission objectives and economic factors.

1.1.4 Sensor Requirements

DEFN – In any type of work operation, a number of sensors are required to provide feedback information to the equipment operator. Included may be the use of TV, lights, hydrophones for audio monitoring, and load or force feedback instrumentation. These sensor parameters must be established to adequately define the work suit.

INPUT/DEPENDENCE – Sensor requirements are dependent upon the mission scenario and the work systems to be utilized.

1.2 Support-Related

These parameters include numerical data which describes all of the vital support functions and equipment required to support the operational mission.

1.2.1 Surface Platform

DEFN – Parameters that describe the surface platforms necessary to accomplish the work mission and support the work equipment. Included are platform type, size, propulsion, living accommodations, etc.

INPUT/DEPENDENCE – Surface platform parameters are dependent upon a thorough knowledge of mission requirements and the work scenario or sequence to be followed.

1.2.2 Surface Work System

DEFN – Those parameters that outline the surface work equipment and tools needed to support the overall work task. Included would be the crane and rigging materials, welding equipment, machine tools, air supplies, hand tools, etc.

INPUT/DEPENDENCE – The surface work-system and equipment is dependent on the mission requirements, surface platform available and the complexity of work to be accomplished.

1.2.3 Underwater Work System

DEFN – Parameters that define the underwater work system and its capabilities. The requirements and capabilities of the underwater platform (vehicle), manipulator and individual tools are established in conjunction with the mission requirements and work tasks to be accomplished.

INPUT/DEPENDENCE – The underwater work system is dependent upon its support platform, working vehicle and the extent of the work to be done.

1.2.4 Navigation

DEFN – Both surface and bottom navigation are TIR to Remote Work Systems.

1.2.5 Search and Relocation

DEFN – Search and relocation are important aspects of any mission prior to beginning any work task. Both are TIR to Remote Work Systems.

1.2.6 Power Type

DEFN – The type of power available to support a work mission can be a significant factor. On-board ship's power is needed for battery charging, powering instruments and sensors; and for unmanned vehicle propulsion, etc. Each tool and manipulator has its own specific requirements.

INPUT/DEPENDENCE – The power characteristics are dependent upon the surface support platform utilized and upon the work system requirements.

2.0 Hardware Parameters

Hardware parameters are numerically identifiable characteristics that adequately describe the essence of a hardware item or system to specify the utilization of that item or system to accomplish a NAVFAC mission requirement.

2.1 Physical

Physical parameters describe the critical dimensions or qualities of a hardware item sufficiently to specify the utilization and methods of application of the hardware.

2.1.1 Size & Weight

DEFN – To adequately determine support requirements for a specific work mission, the size and weight of all work system components must be established, including the submersible vehicle, manipulator and tools.

INPUT/DEPENDENCE – Size and weight are dependent upon the mission to be accomplished and the tools specified to perform the task.

2.1.2 Endurance

DEFN – Endurance is the length of time any part of the work system can be operated without replenishment of its energy source. This will vary from an indefinitely long period for surface-powered, unmanned vehicles to a very short period for one-shot, velocity-powered tools.

INPUT/DEPENDENCE – Endurance is dependent upon the specific work system being used and its respective power source.

2.1.3 Depth Capability

DEFN – The maximum operating depth that each work system can be utilized. Gas-powered tools are restricted to shallower depths, while pressure-compensated hydraulic systems can usually be utilized to maximum ocean depths.

INPUT/DEPENDENCE – Depth capability is dependent upon tool construction and the energy source used for power.

2.1.4 Power Requirements

DEFN – Power requirements parameters are those that specify the type of power needed to operate a specific work system, such as pneumatic, hydraulic or electrical power. Also specified are details such as; flow rate, flow volume, voltage, current, etc.

INPUT/DEPENDENCE – Power requirements are dependent on tool design characteristics and the extent of the work mission.

2.2 Mechanical Performance

Mechanical performance parameters are numerical values based on operational experience that describe the actual mechanical capabilities of hardware.

2.2.1 Position-Related Properties

DEFN – Mechanical performance parameters that are concerned with the spatial location and position of the various work system subcomponents.

INPUT/DEPENDENCE – Position-related properties are dependent on the type of work system to be used and the accuracy required to complete the mission.

2.2.1.1 Gross Positioning

DEFN – The parameters for gross positioning include primarily a quantitative definition of the accuracy needed in placing and locating the overall work system in relation to the object to be worked on.

INPUT/DEPENDENCE – Gross positioning is dependent upon the surface support platform available, maneuverability of the submersible vehicle and external forces such as bottom currents.

2.2.1.2 Dexterity Control

DEFN – The parameters for dexterity control relate to establishing the accuracy, movement rates, torque values, repeatability, working envelope, etc., for the manipulator arms or specialized work tools.

INPUT/DEPENDENCE – Dexterity is dependent upon which submersible vehicle is used and upon the manipulator construction, control system, actuators, etc.

2.2.1.3 Maneuverability

DEFN – These parameters are TIR to the AAT "Maneuverability."

2.2.2 Force-Related Properties

DEFN – Parameters dealing with the mechanical forces required to perform a work task.

INPUT/DEPENDENCE – Force-related properties are dependent upon the work system being utilized and on the magnitude and scope of the work task to be accomplished.

2.2.2.1 Reactive Force

DEFN – Opposition forces resulting from the application by the work system of a force, or push, to a work object.

INPUT/DEPENDENCE – Reactive forces are dependent upon the size, weight, thrust and mechanical power of the work system submersible vehicle and its tools.

2.2.2.2 Mechanical Force

DEFN – Parameters for mechanical force include the thrust, loads and forces applied to the work object by the manipulator arm or the various work tools.

INPUT/DEPENDENCE – Mechanical forces are dependent upon the power of the various work systems.

2.3 Sensor Performance

Sensor performance parameters are generally accepted numerical values (such as sensitivity, receiver gain, contrast, etc.) that describe the ability of a hardware item to perform its sensing function.

2.3.1 Inspection

DEFN – Inspection sensor parameters are numerical values designating the performance capabilities of inspection equipment such as TV cameras.

INPUT/DEPENDENCE – Inspection sensor performance is dependent upon the submersible vehicle utilized and upon water conditions.

2.3.2 Documentation

DEFN – Documentation sensor parameters designate the numerical values of performance for the documentary photo cameras and their related lighting systems.

INPUT/DEPENDENCE – Documentation sensor performance is dependent upon water conditions, lighting conditions, film type, etc.

3.0 Environmental Parameters

Environmental parameters include values or characteristics of the operating environment that have a direct effect on the utilization or performance of a system and, therefore, must be known for effective operation.

3.1 Hazards

Hazards are characteristics inherent in the environment that tend to impede the performance of a system.

3.1.1 Natural

Natural hazards are phenomena, such as currents or a deep scattering layer, that present a hazard to the equipment or tend to prevent the equipment from accomplishing a task.

3.1.1.1 Currents

DEFN – Includes hazards caused by above-average bottom currents reacting against the work system.

INPUT/DEPENDENCE – Hazard to the work mission is dependent upon the current velocity, duration, etc.

3.1.1.2 Weather

DEFN – Operational hazards are created by inclement weather conditions. These hazards have their primary influence upon the surface support for the work mission, which in turn has an indirect effect upon the below-surface work system. Weather parameters include sea state, wind velocity, etc.

INPUT/DEPENDENCE – Weather-related hazards affect a work mission to a degree largely dependent upon the type of support platform that is being used.

3.1.2 Man-Made

Man-made hazards include obstacles to hardware performance that are not naturally occurring phenomena. These include intentional actions such as trawler fishing or active sonar interference as well as accidental or unintentional actions such as bottom debris or discarded cables.

3.1.2.1 Obstructions

DEFN – Obstructions are large or small man-made objects on the sea floor or in mid-water that would impede the performance of a work task. These include ship hulks, dumped debris, buoys, platforms, etc.

INPUT/DEPENDENCE – Data on obstruction location and size is input to the mission scenario, so that these hazards can be taken into account during work operations.

3.1.2.2 Other Operations in Area

DEFN – Other operations taking place in the same general area where an FOI work mission is in progress can constitute a major hazard. Anchor lines and ships in near proximity are apt to endanger the remote work system.

INPUT/DEPENDENCE – Planning for a work mission must take into account other nearby operations or shipping.

3.1.2.3 Entanglements

DEFN – The hazard of entanglement with bottom structures, debris, cables or drifting synthetic lines constitutes a major concern to any work mission and must be considered during project planning.

INPUT/DEPENDENCE – Planning for hazard-avoidance during work operations is highly dependent upon an adequate site-survey prior to beginning the work task.

3.2 Physical

Physical parameters include characteristics of the environment that have a definite effect on performance of specific mission.

3.2.1 Depth

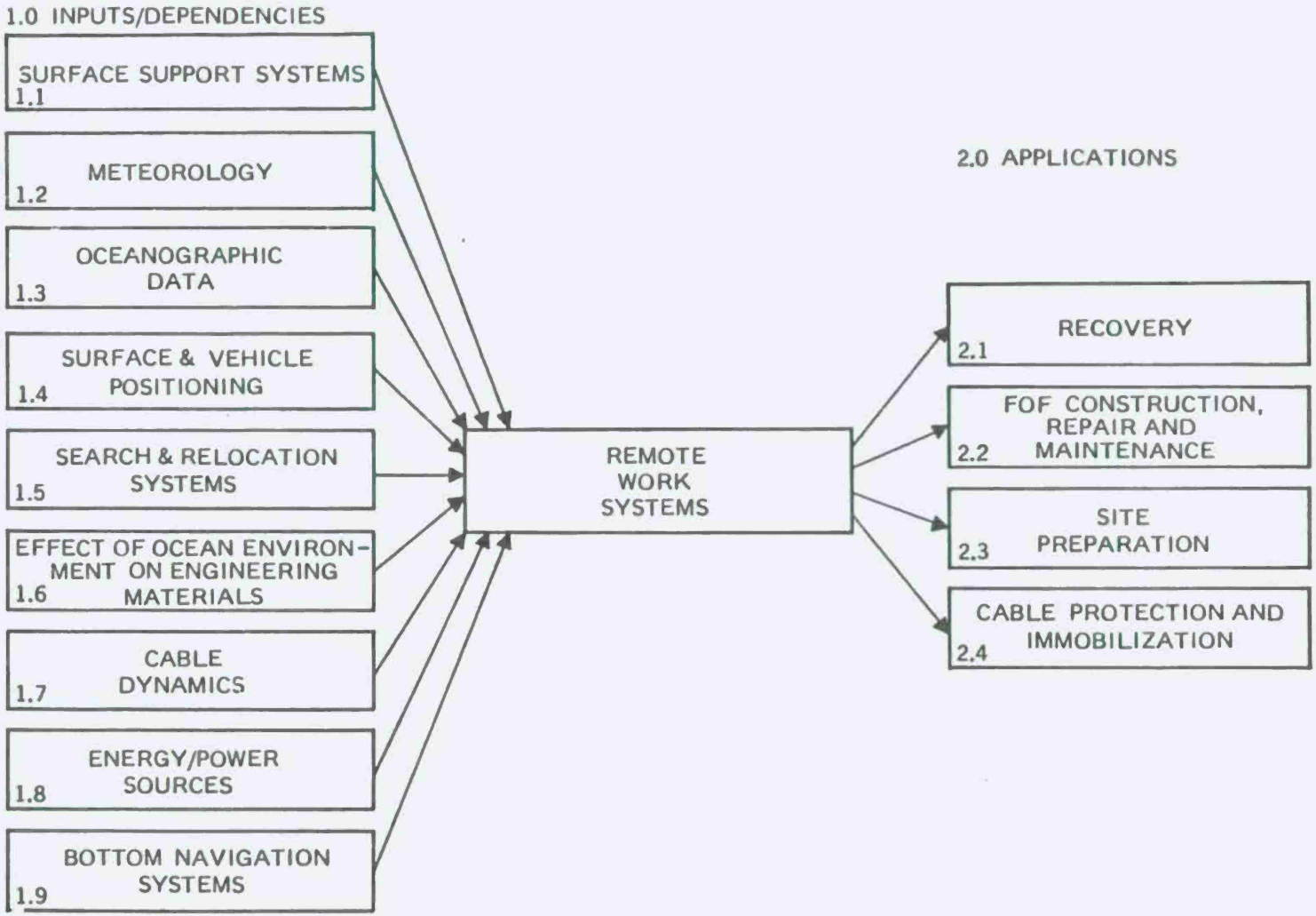
DEFN – The depth of water in which a work task will be performed has a direct effect upon all hardware used in a work mission and is a major factor in establishing the support and equipment needed.

INPUT/DEPENDENCE – Accurate information from site surveys is required as an input prior to the mission.

3.2.2 Area Remoteness

DEFN – Parameters adequately describing the work area and its proximity to support or backup equipment constitute a primary input to initial program planning. Considerably greater support is required in remote areas.

INPUT/DEPENDENCE – These parameters are dependent upon an adequate site-survey.



1.0 Input/Dependencies

1.1 Surface Support Systems

DEFN – All the systems required on the ocean's surface to provide support to a remote work system, including surface support ships, power, handling and rigging equipment, tools, etc.

IMPACT – The ability of an underwater work system to accomplish its assigned task is directly related to the platform it is working from and the technical support available.

1.2 Meteorology

DEFN – The determination of atmospheric conditions in local and distant areas to predict future weather conditions at the operating site.

IMPACT – Weather forecast is vital to any underwater work or construction mission, to establish when conditions will allow operations to proceed.

1.3 Oceanographic Data

DEFN – Include measurements of the ocean conditions that affect the underwater work mission; such as depth, current, sea state, bottom soil mechanics, water temperature, etc.

IMPACT – Oceanographic data is required to determine ocean conditions that will have a major impact upon a work system's ability to perform so that these factors can be incorporated into the operation's planning.

1.4 Surface & Vehicle Positioning

DEFN – The capability of the surface platform and submersible vehicle to establish and maintain their positions relative to the work site.

IMPACT – The remote work system must be properly positioned with respect to the FOF or work object to accomplish its assigned task.

1.5 Search & Relocation Systems

DEFN – The systems used to find or relocate the work site prior to deploying the remote work system to perform its assigned tasks.

IMPACT – Adequate search and relocation equipment is required to rapidly locate the work site so that the mission can commence.

1.6 Effect of Ocean Environment on Engineering Materials

DEFN – Data on engineering materials are utilized during the design of underwater remote work systems to promote maximum reliability and keep the deteriorating effects of seawater to a minimum.

IMPACT – Reliability of work equipment is a major concern during field operations. The proper use of engineering materials during design and construction of underwater equipment increases reliability considerably.

1.7 Cable Dynamics

DEFN – The forces and displacements caused in a cable due to hydrodynamic loads on a suspended cable.

IMPACT – If cable dynamic forces are sufficient to pose a threat to the mechanical integrity of the cable or cause excessive displacement, immobilization will be required.

1.8 Energy/Power Sources

DEFN – The energy or power sources external to the remote work system that supply the energy for direct operation of the work system or for recharging system components such as batteries. Energy source may be electrical, hydraulic or pneumatic.

IMPACT – The correct energy input for each work system must be provided to properly power the tools during a work mission.

1.9 Bottom Navigation Systems

DEFN – Those navigation systems used for locating the FOF operational site and determining the orientation of the remote work system prior to beginning operations.

IMPACT – Before beginning any work mission the site must be located and the work system positioned in the proper attitude.

2.0 Applications

2.1 Recovery

DEFN – Remote work systems are utilized for the clearing, preparation and attachment to an FOF prior to the raising and recovery of the unit.

DEPENDENCIES – The recovery of any FOF or its related equipment is largely dependent upon the ability of the selected underwater work system to adequately prepare the FOF before its recovery begins.

2.2 FOF Construction, Repair and Maintenance

DEFN – The construction, repair or maintenance of an underwater FOF by employing a remotely operated work system.

DEPENDENCIES – The ability to construct, repair or maintain an underwater FOF is dependent upon the dexterity, power, load handling and general capability of the work tools.

2.3 Site Preparation

DEFN – The preparation of an underwater site or FOF prior to beginning construction or recovery operations.

DEPENDENCIES – Site preparation is dependent upon adequate tools for seafloor stabilization, grading or clearing, as well as tools for debris-clearing or FOF preparation.

2.4 Cable Protection and Immobilization

DEFN – The protection and immobilization of deep-water communications cables.

DEPENDENCIES – Cable protection is dependent upon tools, trenching equipment and the like, that can work in deep water.

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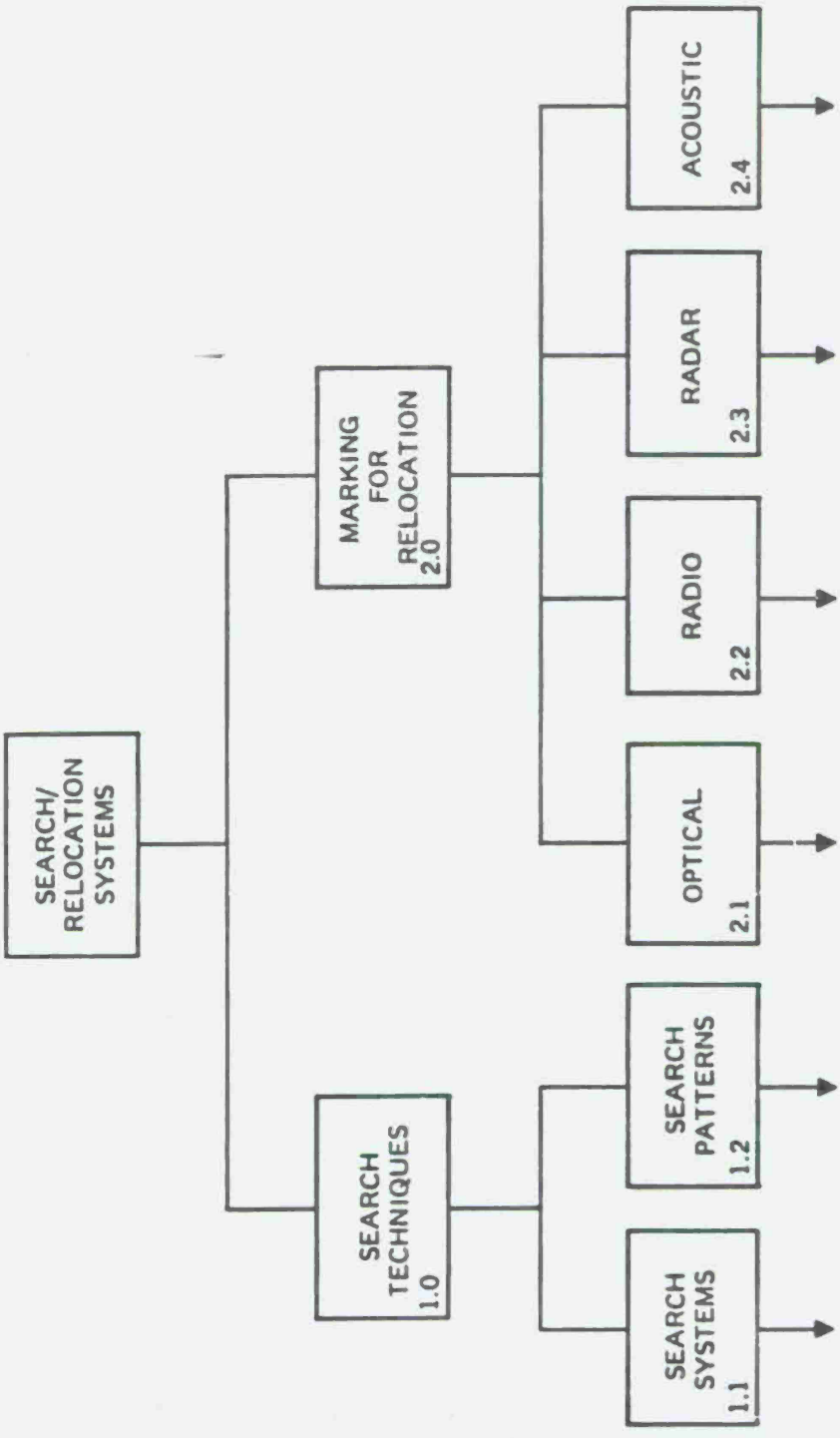

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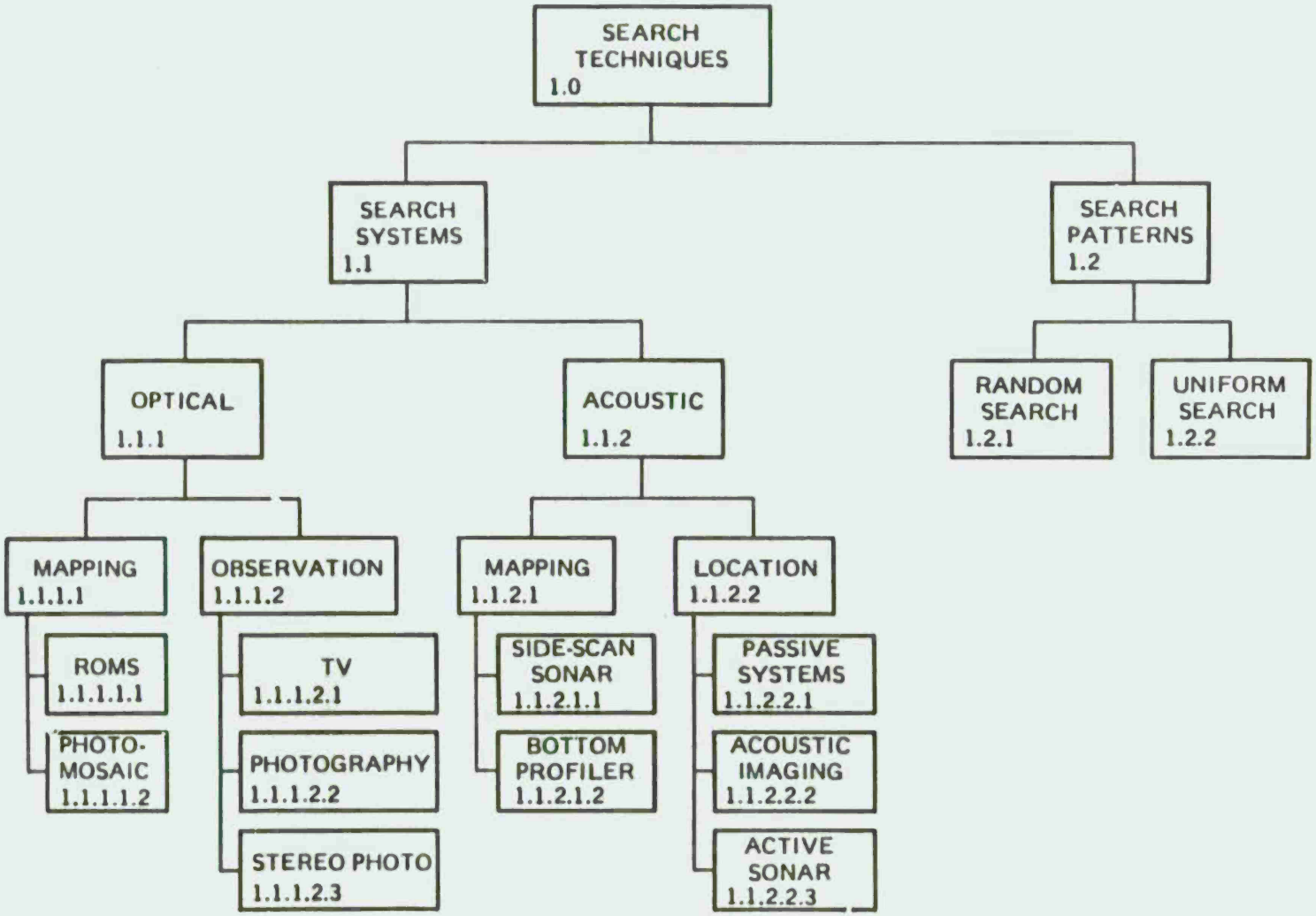
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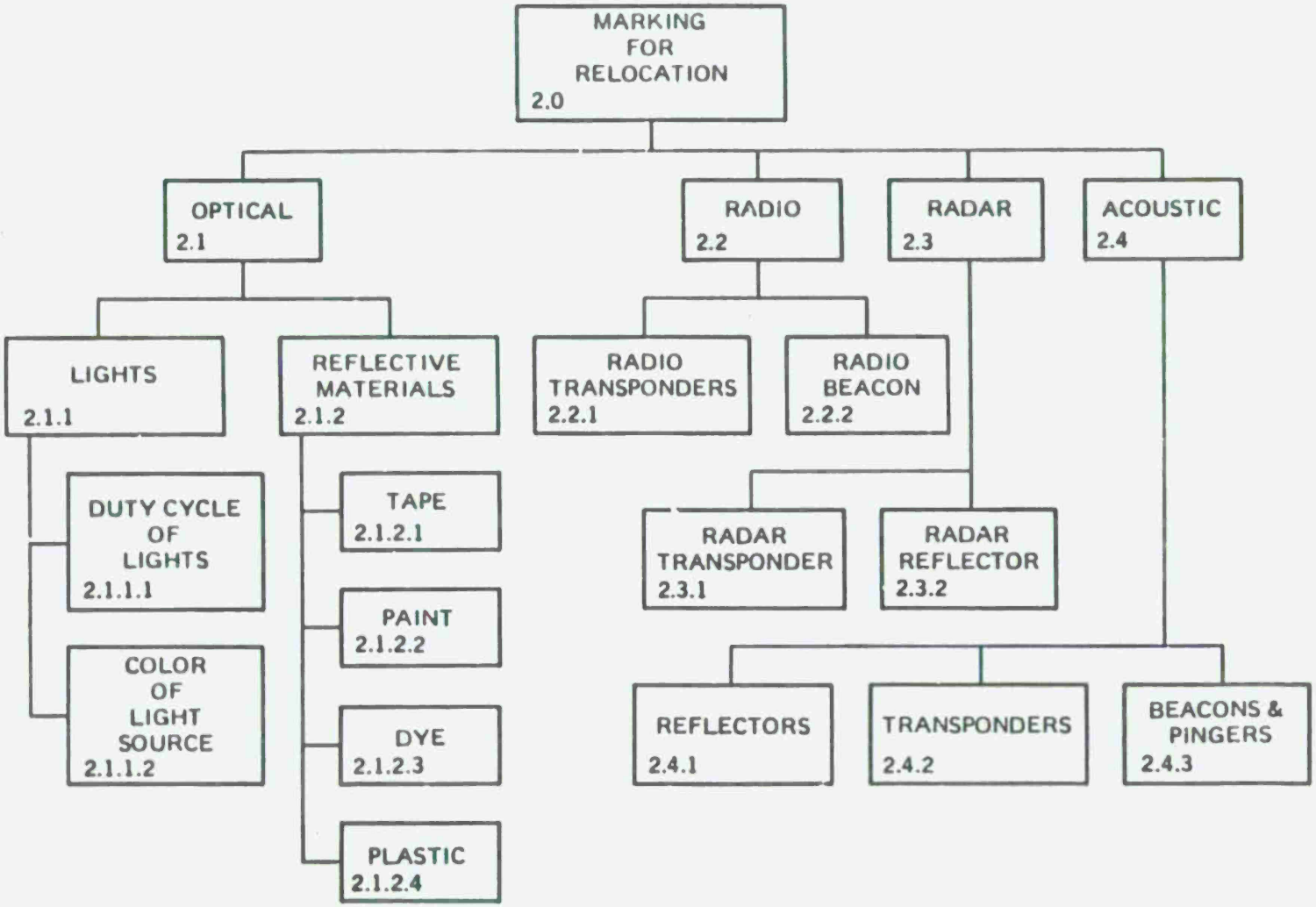
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2.4.1
TRANSPONDERS
2.4.2
BEACONS & PINGERS
2.4.3

SEARCH

The mission of search, as defined in this AAT, is concerned with the localization and location of objects on the sea floor or in the water column. It is confined to relatively small area search (less than a circle of ten-mile radius), and is limited to unmanned systems, i.e., diver search techniques are excluded. Hardware and equipment descriptions in this AAT exclude supporting technology such as surface search, support ship, and large-area localization or navigation. These supporting technologies are treated as T!R's.

1.0 Search Techniques

Search techniques include the general methods of prosecuting a search mission, as well as the hardware and equipment available to accomplish the tasks involved in limited-area, underwater search. This area does not include diver operated systems. It does include both surface operated and submerged, unmanned search systems.

1.1 Search Systems

Search systems comprise the hardware and equipment needed to conduct a search mission.

1.1.1 Optical Search Systems

Search systems whose signals and sensor response are all at visible light wavelengths. This section discusses underwater optical search systems and their uses for mapping and observation. Such systems are most useful in clear water.

1.1.1.1 Mapping

DEFN – Optical search systems whose primary function is to map the ocean bottom. Both photographic and optical imaging techniques are employed.

USAGE – To provide a picture-type map of the bottom, especially to indicate bottom topography. Search for objects on the bottom is greatly enhanced by these devices as well.

1.1.1.1.1 ROMS (R & D impact)

DEFN – The Remote Optical Mapping Systems (ROMS) being developed at NUC uses a gated underwater laser that scans the bottom in strips with high-power pulses of light. The received light is processed and presented as an essentially real-time bottom map. The laser and receiver are contained in a towed fish that maintains a set altitude above the ocean bottom.

PROPERTIES – Provides detailed optical bottom maps in real time, location of bottom-mounted objects, improved object/target recognition.

1.1.1.1.2 Photomosaic

DEFN – The process of sequentially taking a number of still pictures of the ocean bottom and piecing them together into a single large photograph or map of the bottom. The underwater camera must be maintained at a constant depth to preserve fidelity of bottom features. Not a real-time technique.

PROPERTIES – Provides a large, detailed photographic bottom map with high resolution if water is clear. Color photography provides improved bottom object recognition and classification.

1.1.1.2 Observation

DEFN – Optical search systems employed for observation are essentially an eye in the sea.

USAGE – Observation of bottom topography, features or objects especially useful in site surveys. Observation also important feature of vehicles and work systems.

1.1.1.2.1 TV

DEFN – TV camera/systems designed or converted for use underwater. Such systems are enclosed in pressure-tolerant, airtight housings to prevent camera damage. Cameras can be attached to a surface ship and towed/tethered at deep depth or bottom-mounted.

PROPERTIES – Improved detailed site survey, close-up object recognition and classification, and work system support, all in real time.

1.1.1.2.2 Photography

DEFN – Film cameras designed or converted for underwater use. Both color and black-and-white cameras are used. Such systems are not real-time.

PROPERTIES – Improved bottom object identification due to potential for color and high resolution.

1.1.1.2.3 Stereophoto

DEFN – Optical search systems that use two cameras or one camera with appropriate optics to create a stereoscopic photograph or TV picture and hence provide three-dimensional information.

PROPERTIES – Well-suited for improved bottom topography detail or in situations in which an operator presence is required. Stereo head-coupled TV developed at NUC is such a system.

1.1.2 Acoustic Search Systems

Acoustic search systems utilize acoustic sensors and signals for either mapping or object location. Some of these systems provide a visual readout while others provide simply an audible output.

1.1.2.1 Mapping Systems

DEFN – Acoustic search systems that provide a visual readout in the form of a map of the ocean bottom. Acoustic signals are emitted from a height above the bottom and hydrophones are used for signal pickup. Returned signals are processed into maps.

PROPERTIES – Not dependent on water clarity; resolution generally not as good as optical mapping.

USAGE – Bottom mapping, bottom object recognition and classification.

1.1.2.1.1 Side-Scan Sonar

DEFN – Acoustic mapping systems that scan a swath of ocean bottom on each side of a towed capsule. The capsule contains sending and receiving transducers; processing to produce a map is done on the surface.

PROPERTIES – Maps only off to the side of capsule; ROMS maps both off to the side and beneath the capsule, provides a near real-time map of bottom; more useful for wide-area search than optical systems; provides higher resolution than bottom profile systems.

1.1.2.1.2 Bottom Profiler

DEFN – Those acoustic search systems which provide bottom depth information continuously, usually in the form of a chart in depth vs. time. Bottom profilers are essentially fathometers with a continuous readout.

PROPERTIES – Provides depth information directly below surface ship only, are considerably simpler systems than side-scan sonar, useful for locating prominent changes in bottom topography.

1.1.2.2 Location

DEFN – Acoustic systems that provide only location information, i.e., something is there. Such systems provide an audible output or a visual readout; a few have both.

USAGE – Primary usage is target/object location and, in some cases, classification. In the case of acoustic imaging, observation is another use.

1.1.2.2.1 Passive Systems

DEFN – Acoustic location systems that only listen for acoustic sources. Readouts are aural (headphones) or PPI scope presentation.

PROPERTIES – A simple system for use in locating objects marked with pingers or beacons; for example, swimmer-defense passive sonars can detect very weak acoustic signals generated by biological organisms. Passive systems provide only bearing information, not range.

1.1.2.2.2 Acoustic Imaging

DEFN – Acoustic systems that send out an acoustic signal employ a hydrophone array and electronically process the returned sound into an image of the target. Such systems are very sophisticated and require much signal-processing equipment in order to be real-time.

PROPERTIES – Large hydrophone arrays required for good resolution. Theoretically best acoustic viewing method; provides object-recognition independent of water conditions.

1.1.2.2.3 Active Sonar

DEFN – Acoustic systems that emit sound, usually in short, high-power pulses and present the returns both aurally and on a PPI scope or video display.

PROPERTIES – Well-suited for interrogating transponder-type markers; provide both range and bearing information but give little information on object-classification.

1.2 Search Patterns

Search patterns addressed the specific problem of employing search hardware and equipment to accomplish a search mission. This area is concerned with methods and techniques and excludes hardware descriptions – except as the search patterns affect the use of search hardware.

1.2.1 Random Search

DEFN – Search patterns that establish arbitrary areas to be searched. Areas of high interest may be covered completely; however, interstitial areas or adjoining areas of low interest may be disregarded.

1.2.2 Uniform Search

DEFN – Search patterns that are developed in a geometrical fashion so that the area searched is surrounded by a single continuous perimeter, and all areas within the perimeter are searched.

2.0 Marking for Relocation

This category is concerned with the methods and techniques of marking FOF's, components thereof and FOF sites prior to installation for the purpose of later relocation.

Hardware and equipment descriptions include limited-area marking devices for bottom-mounted, midwater or surface markers. These markers are concerned only with bottom-mounted or bottom-tethered FOF's.

2.1 Optical

Optical markers are ones that can be seen; they float on the surface or are bottom-mounted for viewing by underwater television cameras. Such markers are either lighted or reflective.

2.1.1 Lights

DEFN – Visual markers that indicate location of an FOF or a previously surveyed FOF site and have some of artificial light source on them.

USAGE – To mark, primarily on the surface, a site or facility that must be relocated from a great distance, especially at night. Also to provide FOF obstacle-avoidance information for surface vessels.

2.1.1.1 Duty Cycle of Lights

DEFN – Differentiation of those markers that contain flashing lights versus those whose light source is on continuously.

PROPERTIES – Easier to see flashing light, especially at night. Battery life is considerably extended by using flashing lights rather than continuous lights.

2.1.1.2 Color of Light Source

DEFN – Differentiation of those markers that have colored lights from those having white ones.

PROPERTIES – Different colors are easier to see under certain conditions, provide unique identification for a marker, and are well-suited for indicating different portions of an FOF (port, starboard) to facilitate obstacle-avoidance and relocation.

2.1.1 Reflective Materials

DEFN – Visual markers whose ability to be sighted is enhanced by some reflective material.

USAGE – To mark, primarily on the surface, a site or facility that is to be relocated from a short distance.

2.1.2.1 Tape

DEFN – Markers of which some portion is covered with a reflective tape.

PROPERTIES – Incident light on marker causes bright reflection for improved location of marker, color usually bright for easy recognition.

2.1.2.2 Paint

DEFN – Those markers of which some portion is covered with colored and/or fluorescent paints.

PROPERTIES – Reflective paint and/or bright colored paint provide improved visual contrast, color and/or color combinations or patterns provide unique marker identification.

2.1.2.3 Dye

DEFN – Markers that eject or are in some way surrounded by a readily visible, colored dye mixed with surface water.

PROPERTIES – Bright-colored dye provides improved visual contact, especially from the air, since dye can cover a wide ocean-surface area.

2.1.2.4 Plastic

DEFN – Markers constructed of or coated with a bright-colored plastic.

PROPERTIES – Generally bottom-mounted and corrosion-resistant; used for relocation by underwater TV or vehicle.

2.2 Radio

Radio markers are devices that use radio waves to determine location.

2.2.1 Radio Transponders

DEFN – An active device that transmits a signal in response to interrogation by a signal from an interrogator transmitter/receiver. By accurate measurement of the travel time of the interrogator signal, distance between the interrogation transmitter and the transponder can be determined.

USAGE – For near-shore operations two or more transponders set up at known locations will provide an accurate location for implantation or relocation of an FOF.

2.2.2 Radio Beacon

DEFN – A device that transmits radio signals. Its bearing can be found using direction-finding equipment, and it can be located using two or more direction-finders located at same distance from one another.

USAGE – When mounted on a buoy attached to an FOF a radio beacon will provide a means of relocating the FOF. When combined with a radio transponder, it permits bearing and distance to an FOF to be determined.

2.3 Radar Markers

Radar markers are devices that use radar signals to determine location.

2.3.1 Radar Transponder

DEFN – A device similar to a radio transponder that receives an interrogation signal and sends a signal to the interrogator's receiver. The received signal is visually displayed on a Plan Position Indicator (PPI) scope, which gives distance as well as bearing to the transponder.

USAGE – When mounted on a buoy attached to an FOF, a radar transponder provides an accurate method of relocation. Since the transponder is an active device, the signal shown on the PPI scope is stronger than that returned by a passive reflector. This is advantageous during stormy conditions when rain clutter is a problem.

2.3.2 Radar Reflector

DEFN – A radar reflector is a passive device (i.e., it requires no power) that is specially constructed to reflect radar signals.

USAGE – When mounted on a buoy attached to an FOF, a radar reflector provides a target used in relocating the FOF. Since this is a passive device the reflected signal is not as strong as the signal returned by a transponder, especially when the signal is blanketed by rain clutter.

2.4 Acoustic Markers

Acoustic markers are designed to respond to acoustic interrogation or to emit an acoustic signal that could be easily received by a system sensor. They are usually bottom-mounted.

2.4.1 Reflectors

DEFN – Passive markers that are designed to reflect sound in an optimum manner. The shape of the reflector (e.g., right angle, parabolic) determines the amount of reflectance.

PROPERTIES – Provide a more definitive target than an object not specifically designed as a reflector; thus they are easier to "see" acoustically.

2.4.2 Transponders

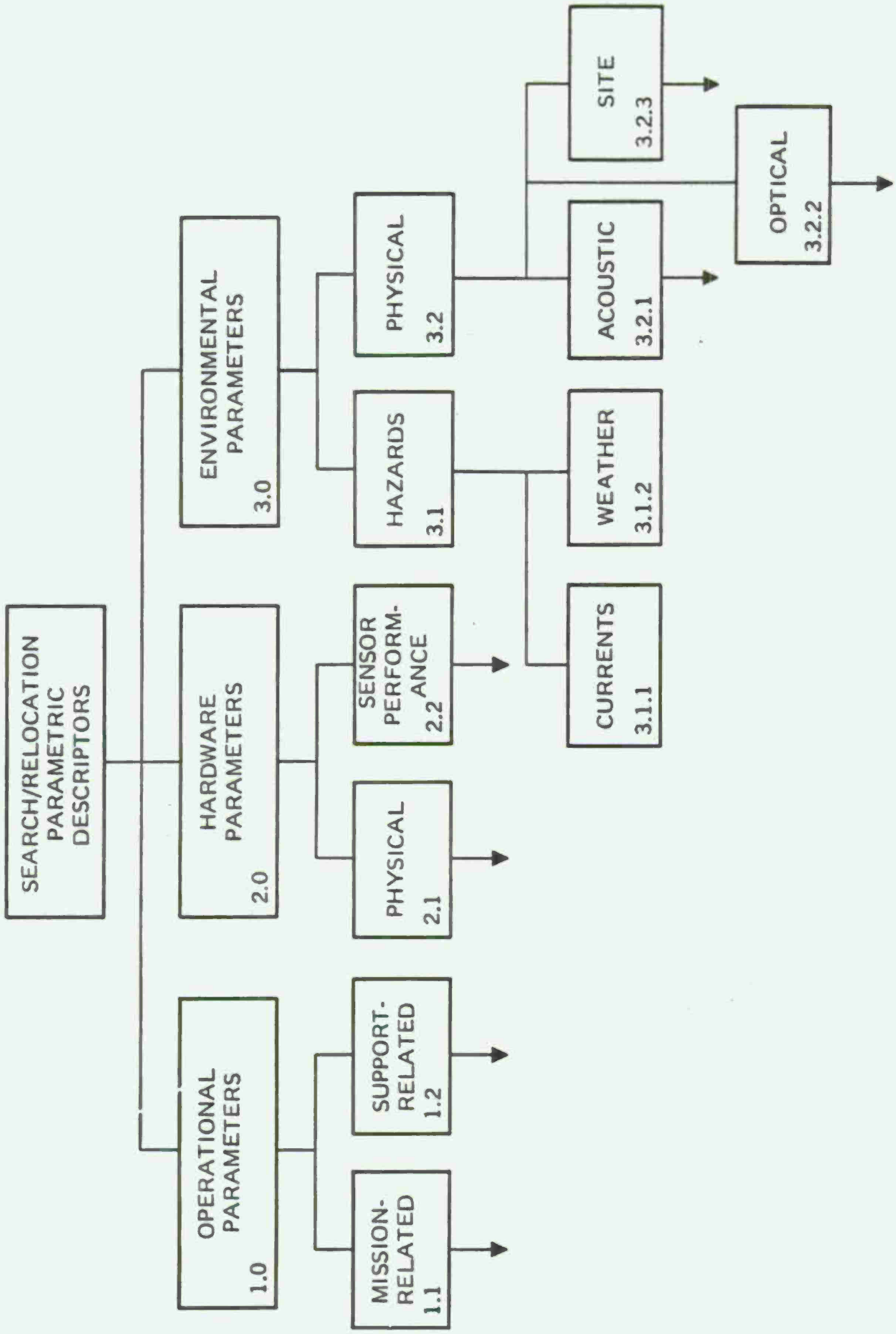
DEFN – Those active markers which emit acoustic signals only when interrogated by another acoustic signal from the surface.

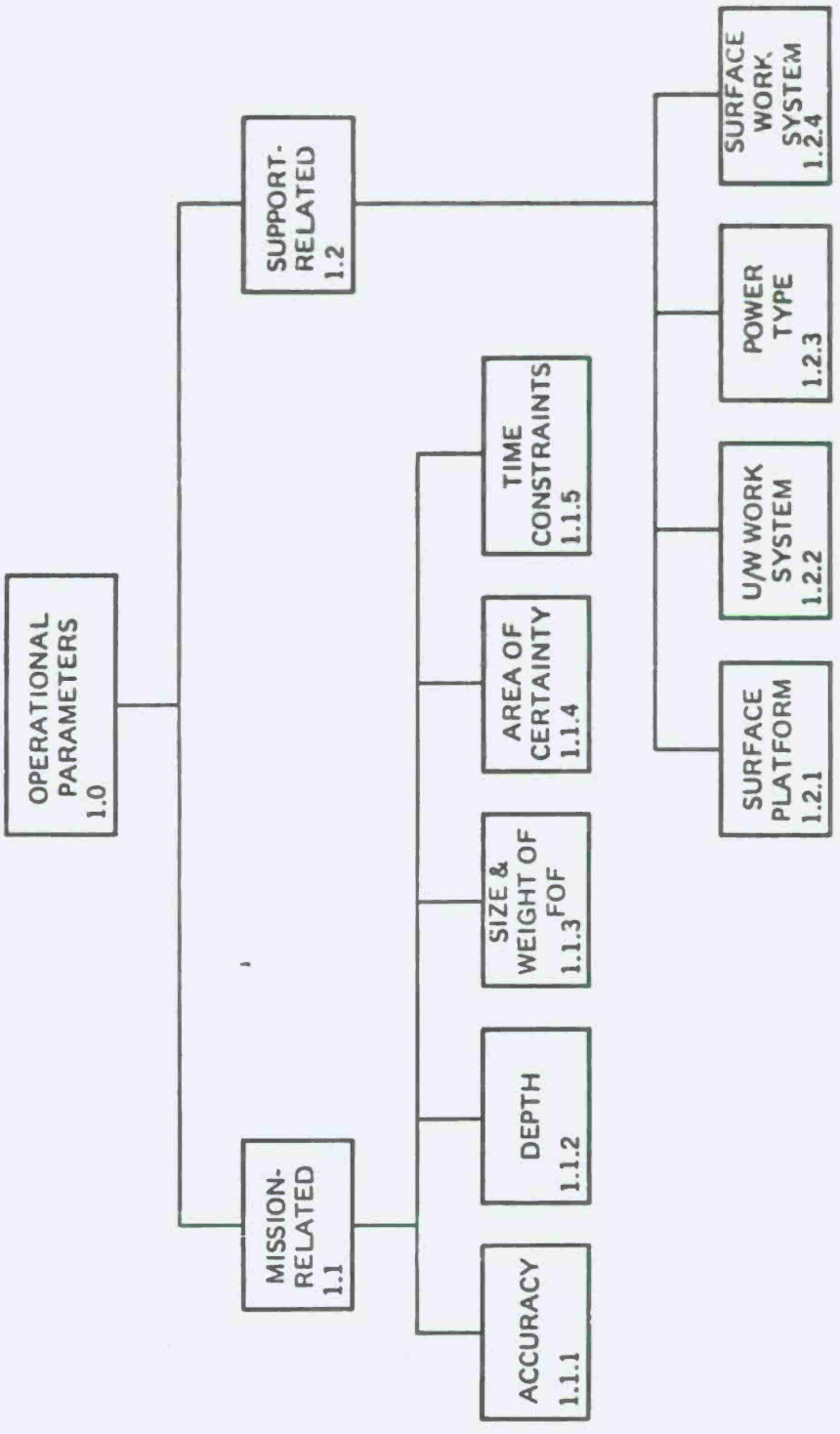
PROPERTIES – Well-suited for objects that will be implanted for long periods of time before relocation because of low battery-drain during off periods. Unique marker identification can be achieved by the pattern of the transponder's signal or its frequency.

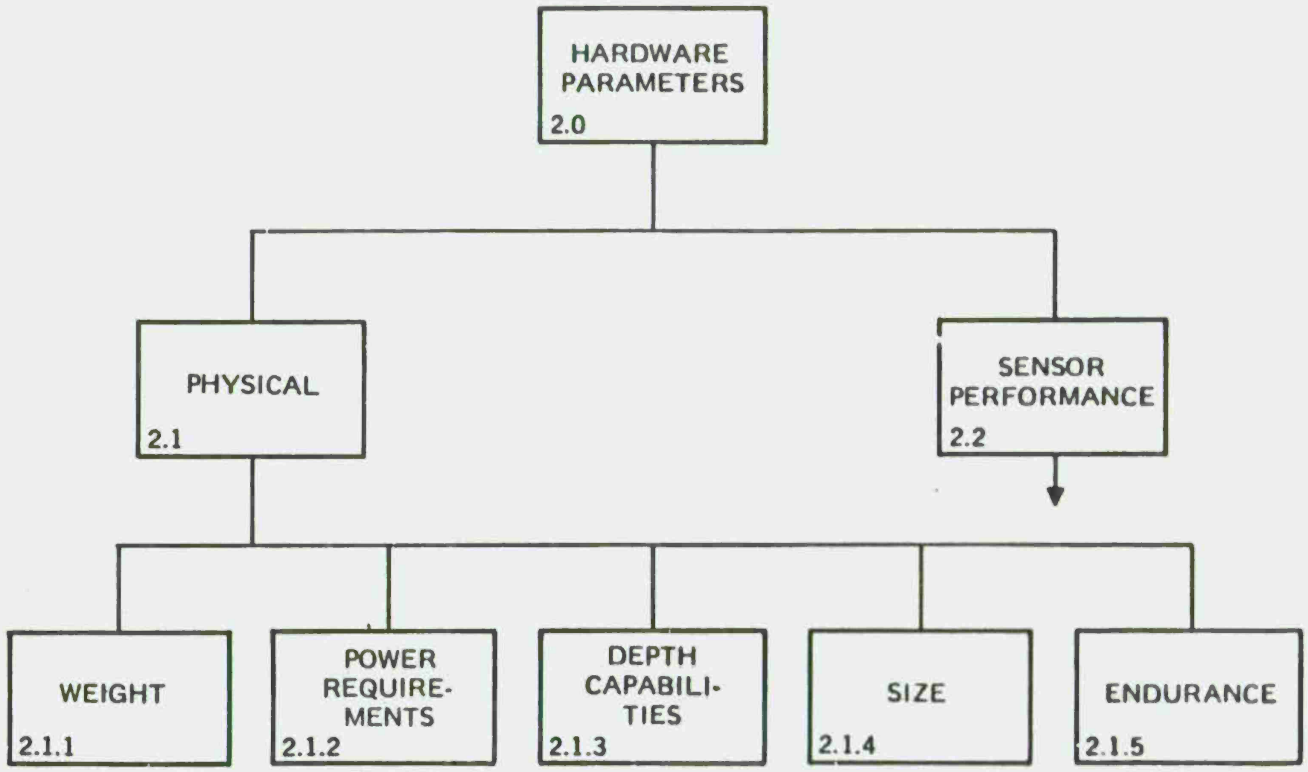
2.4.3 Beacons & Pingers

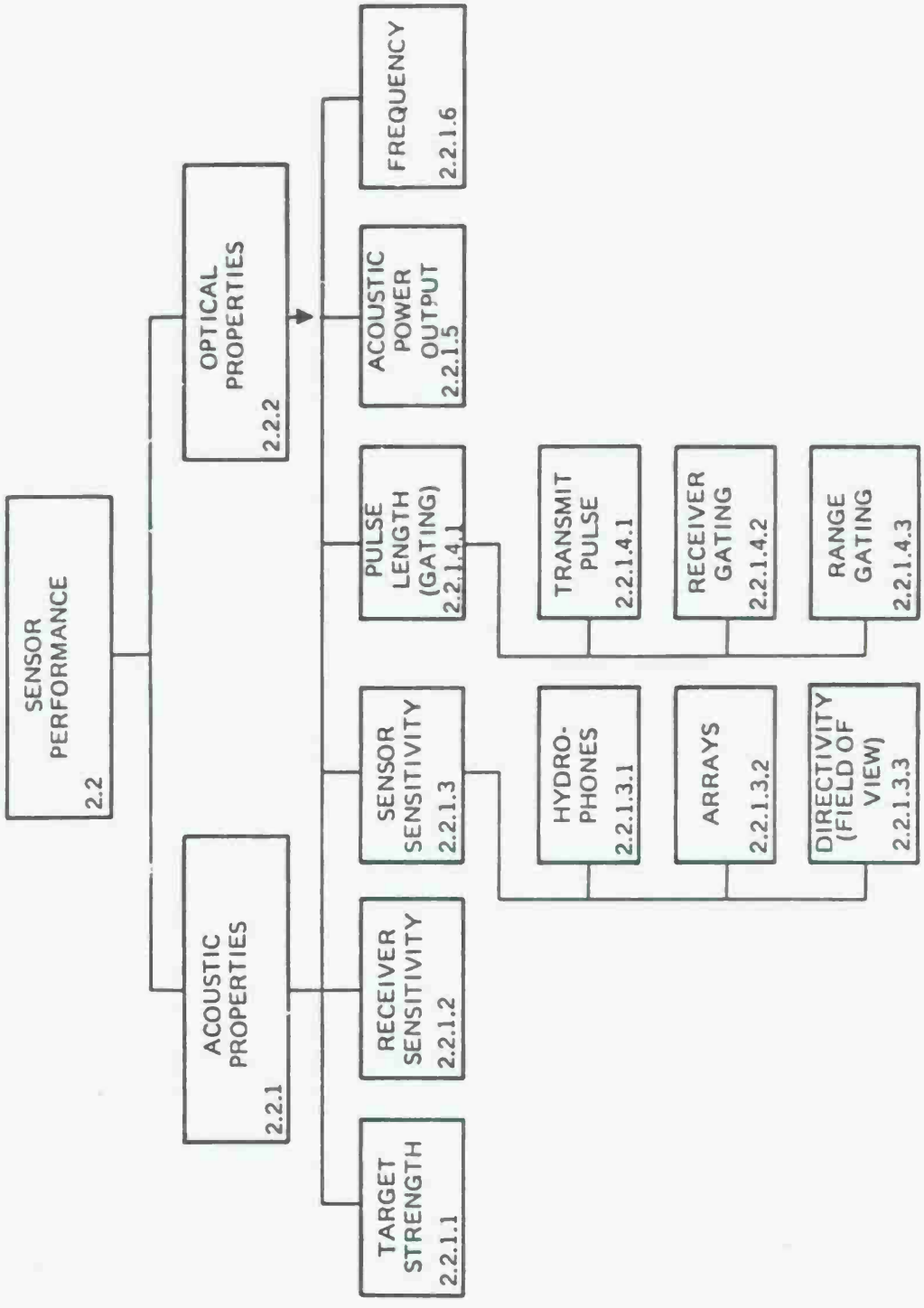
DEFN – C. W. beacons and pingers emit continuous acoustic signals regardless of interrogation. C. W. beacons differ from pingers in that beacons are not pulsed.

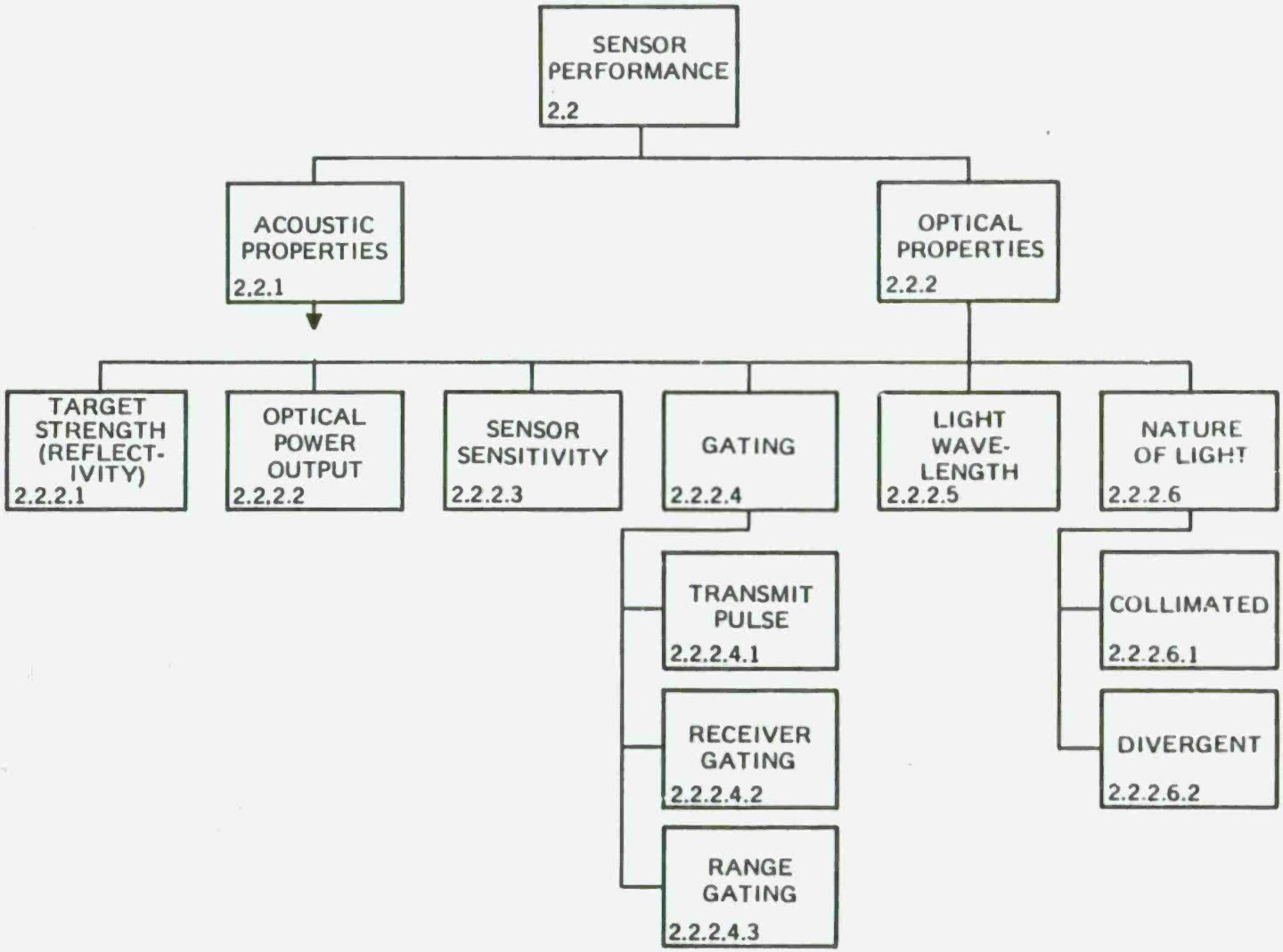
PROPERTIES – Well-suited for objects that are to be relocated relatively soon after original implantation due to power supply limitations; different ping patterns and frequency of beacon signals can provide unique marker identification; provide very strong acoustic targets.

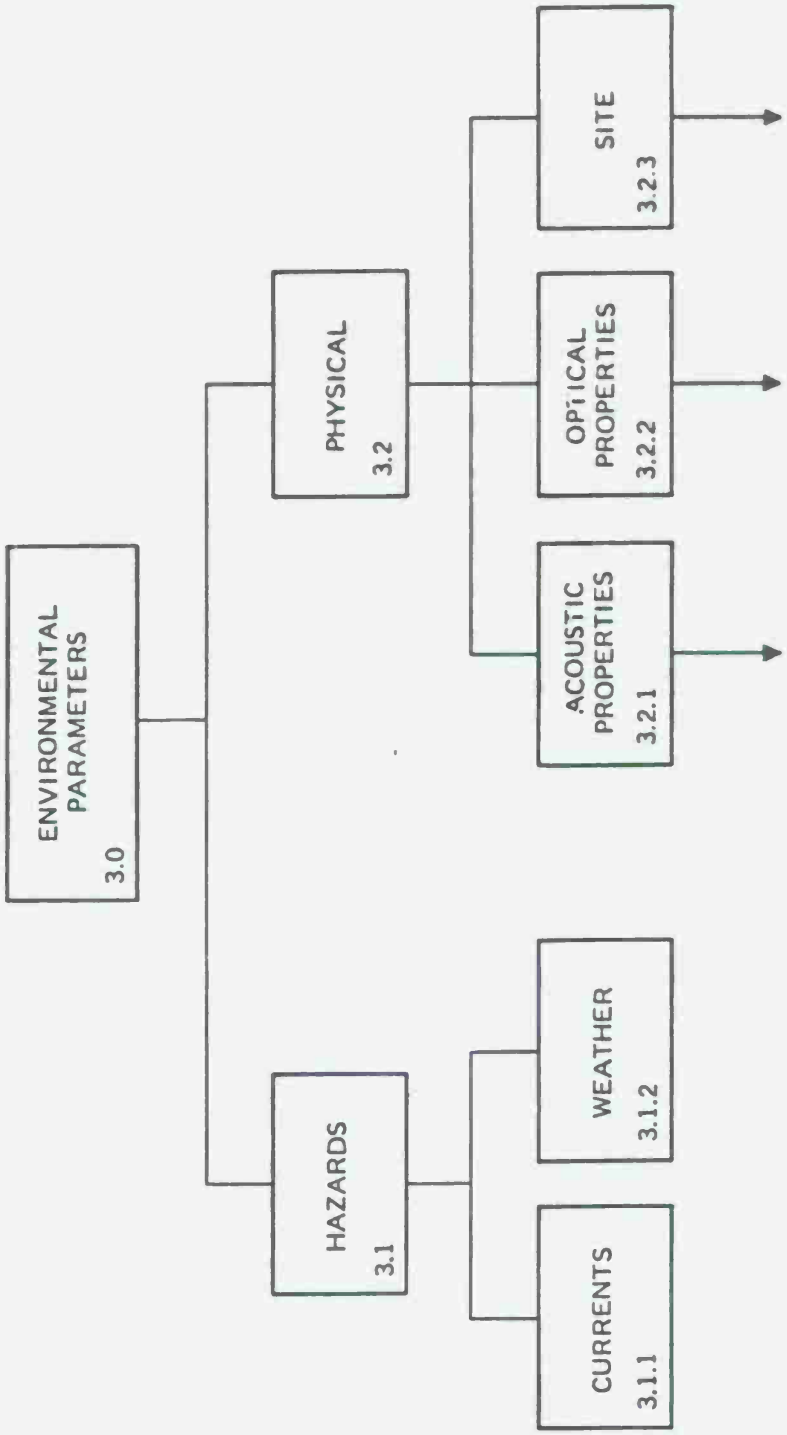

SEARCH/RELOCATION PARAMETRIC DESCRIPTORS
OPERATIONAL PARAMETERS 1.0
HARDWARE PARAMETERS 2.0
ENVIRONMENTAL PARAMETERS 3.0
MISSION-RELATED 1.1
SUPPORT-RELATED 1.2
PHYSICAL 2.1
SENSOR PERFORM-ANCE 2.2
HAZARDS 3.1
PHYSICAL 3.2
CURRENTS 3.1.1
WEATHER 3.1.2
ACOUSTIC 3.2.1
OPTICAL 3.2.2
SITE 3.2.3

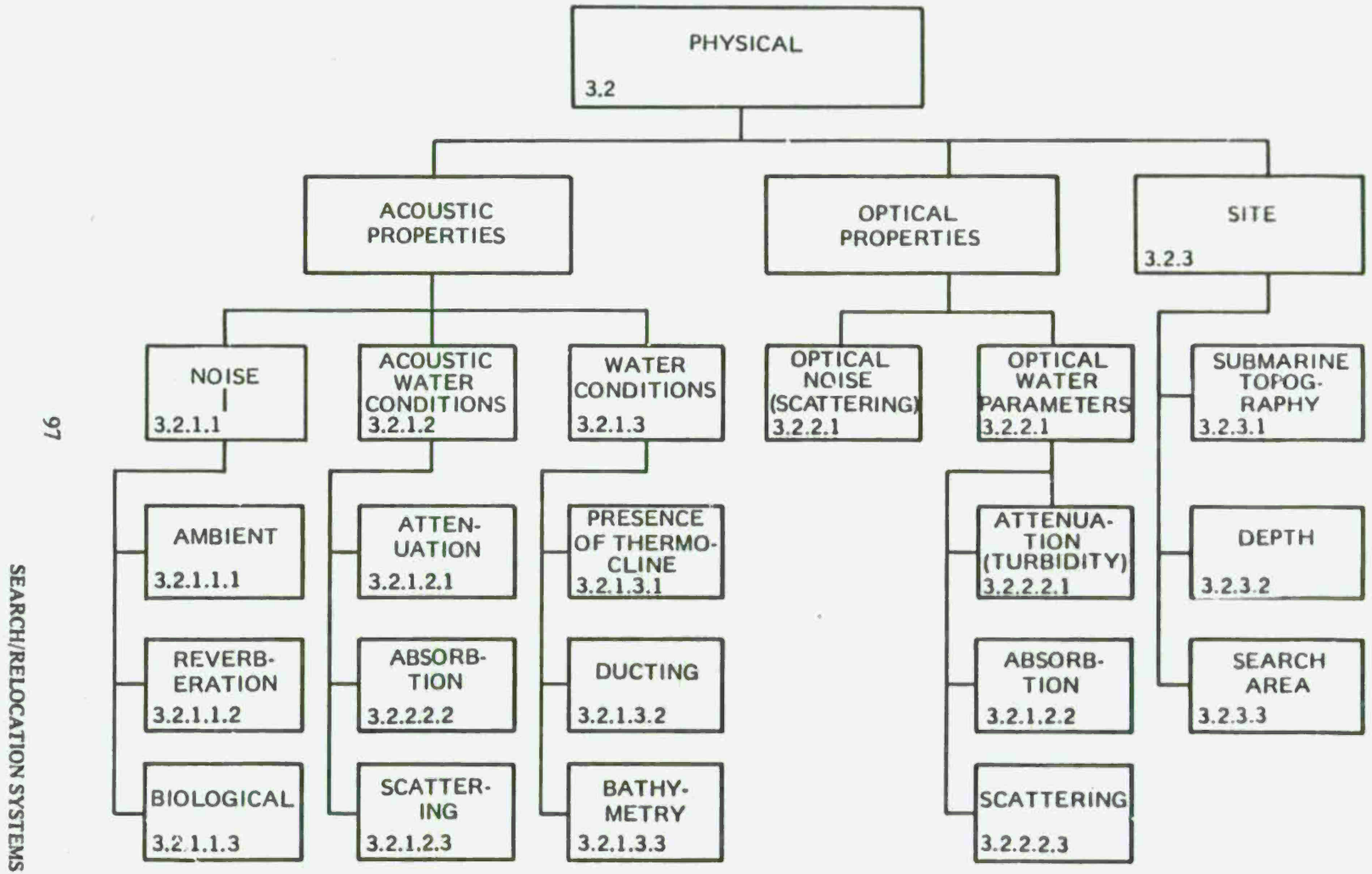

OPERATIONAL PARAMETERS 1.0
MISSION-RELATED 1.1
ACCURACY 1.1.1
DEPTH 1.1.2
SIZE & WEIGHT OF FOF 1.1.3
AREA OF CERTAINTY 1.1.4
TIME CONSTRAINTS 1.1.5
SUPPORT-RELATED 1.2
SURFACE PLATFORM 1.2.1
U/W WORK SYSTEM 1.2.2
POWER TYPE 1.2.3
SURFACE WORK SYSTEM 1.2.4


HARDWARE PARAMETERS
2.0
PHYSICAL
2.1
SENSOR PERFORMANCE
2.2
WEIGHT
2.1.1
POWER REQUIRE-MENTS
2.1.2
DEPTH CAPABILI-TIES
2.1.3
SIZE
2.1.4
ENDURANCE
2.1.5


SENSOR PERFORMANCE 2.2
ACOUSTIC PROPERTIES 2.2.1
OPTICAL PROPERTIES 2.2.2
TARGET STRENGTH 2.2.1.1
RECEIVER SENSITIVITY 2.2.1.2
SENSOR SENSITIVITY 2.2.1.3
PULSE LENGTH (GATING) 2.2.1.4.1
ACOUSTIC POWER OUTPUT 2.2.1.5
FREQUENCY 2.2.1.6
HYDRO-PHONES 2.2.1.3.1
ARRAYS 2.2.1.3.2
DIRECTIVITY (FIELD OF VIEW) 2.2.1.3.3
TRANSMIT PULSE 2.2.1.4.1
RECEIVER GATING 2.2.1.4.2
RANGE GATING 2.2.1.4.3


SENSOR PERFORMANCE
2.2
ACOUSTIC PROPERTIES
2.2.1
OPTICAL PROPERTIES
2.2.2
TARGET STRENGTH (REFLECT-IVITY)
2.2.2.1
OPTICAL POWER OUTPUT
2.2.2.2
SENSOR SENSITIVITY
2.2.2.3
GATING
2.2.2.4
LIGHT WAVE-LENGTH
2.2.2.5
NATURE OF LIGHT
2.2.2.6
TRANSMIT PULSE
2.2.2.4.1
RECEIVER GATING
2.2.2.4.2
RANGE GATING
2.2.2.4.3
COLLIMATED
2.2.2.6.1
DIVERGENT
2.2.2.6.2


ENVIRONMENTAL PARAMETERS
3.0
HAZARDS
3.1
CURRENTS
3.1.1
WEATHER
3.1.2
PHYSICAL
3.2
ACOUSTIC PROPERTIES
3.2.1
OPTICAL PROPERTIES
3.2.2
SITE
3.2.3


PHYSICAL
3.2
ACOUSTIC PROPERTIES
OPTICAL PROPERTIES
SITE
3.2.3
NOISE
3.2.1.1
ACOUSTIC WATER CONDITIONS
3.2.1.2
WATER CONDITIONS
3.2.1.3
OPTICAL NOISE (SCATTERING)
3.2.2.1
OPTICAL WATER PARAMETERS
3.2.2.1
SUBMARINE TOPOG-RAPHY
3.2.3.1
AMBIENT
3.2.1.1.1
REVERB-ERATION
3.2.1.1.2
BIOLOGICAL
3.2.1.1.3
ATTEN-UATION
3.2.1.2.1
ABSORB-TION
3.2.2.2.2
SCATTER-ING
3.2.1.2.3
PRESENCE OF THERMO-CLINE
3.2.1.3.1
DUCTING
3.2.1.3.2
BATHY-METRY
3.2.1.3.3
ATTENUA-TION (TURBIDITY)
3.2.2.2.1
ABSORB-TION
3.2.1.2.2
SCATTERING
3.2.2.2.3
DEPTH
3.2.3.2
SEARCH AREA
3.2.3.3

1.0 Operational Parameters

Operational parameters are numerically identifiable characteristics that adequately describe the essence of operational planning and execution for an AAT. These parameters are limited to characterizing task requirement items that are independent of hardware or methods considerations or the operating environment.

1.1 Mission-Related

These parameters include numerical data that describe the status of the FOF and the operations required. This category of information should be sufficient to completely describe the actual tasks to be done on the FOF or in conjunction with the operation.

1.1.1 Accuracy

DEFN – Accuracy refers to how close a search mission comes to relocating an exact position or object.

INPUT/DEPENDENCE – The accuracy required on a given search mission influences the type of search system required for that mission.

1.1.2 Depth

DEFN – Depth as an operational parameter refers to the depth of an object to be relocated. This differs from the environmental parameter depth given in section 3.2.3.2.

INPUT/DEPENDENCE – The depth of an object or site to be relocated or searched for influences the type of search system required to complete a given mission, e.g., power output.

1.1.3 Size of FOF

DEFN – This parameter describes the size of an object (FOF) which is to be relocated on a given task.

INPUT/DEPENDENCE – The size of the object to be found influences the required resolution of a search system for a specific mission. Size also implies a certain accuracy for that mission.

1.1.4 Area of Certainty

DEFN – The area of certainty implies how well the exact location of an object to be relocated is known in advance of the start of a mission. Clearly, the probability of a successful relocation is enhanced by a complete definition of an object's location.

INPUT/DEPENDENCE – Area of certainty depends on previous data, maps and markers, i.e., any device that helps to pinpoint a specific ocean location.

1.1.5 Time Constraints

DEFN – Time constraints for a given mission refer to the maximum time allowed for mission completion.

INPUT/DEPENDENCE – Time constraints can influence the overall urgency of a search mission, which in turn implies operator time and efficiency, equipment reliability, etc.

1.2 Support-Related

These parameters include numerical data that describe all of the vital support functions and equipment required to support the operational mission. For search missions, surface support is required only for the use of undersea vehicles or suspended sensors forming part of the search systems.

1.2.1 Surface Platform

DEFN – The surface platform is the surface ship required to support a vehicle used for search and relocation missions.

INPUT/DEPENDENCE – The capabilities of the surface platform are dependent on the complexity and size of the vehicle requiring support.

1.2.2 Power and Type

DEFN – Any vehicle requiring support requires a certain amount and type of power; for example, 4000 watts of 12 volts DC or a certain flow rate of hydraulic fluid.

INPUT/DEPENDENCE – The power and type required on the surface platform is dependent on the requirements of the vehicle used on a specific task.

2.0 Hardware Parameters

Hardware parameters are numerically identifiable characteristics that adequately describe the essence of a hardware item or system to specify the utilization of that item or system to accomplish a NAVFAC mission requirement.

2.1 Physical Hardware Parameters

Physical parameters describe the critical dimensions or qualities of a hardware item sufficiently to specify the utilization and methods of application of the hardware.

2.1.1 Size and Weight

DEFN – These terms denote size and weight of search system hardware. Such parameters describe both on-board receiving and processing equipment as well as any sensors mounted on or below a surface platform.

INPUT/DEPENDENCE – Size and weight of a specific search system influence the size of a surface ship required to handle the system.

2.1.2 Power Requirements

DEFN – Power Requirements of a search system are simply the amount and type of power required to operate a specific search system.

INPUT/DEPENDENCE – Search system power requirements dictate the amount and type of power that must be available aboard the ship carrying that specific search system.

2.1.3 Depth Capabilities

DEFN – The depth capability of a search system is either the maximum depth at which it can operate (in the case of a vehicle or sensor placed below the surface) or the maximum depth that it can adequately resolve.

INPUT/DEPENDENCE – The depth capabilities of a search system indicate its usefulness for a given mission.

2.1.4 Endurance

DEFN – Endurance is the length of time a search system can operate continuously without replenishment of its energy source.

INPUT/DEPENDENCE – A search system's endurance can depend on its innate construction or its type of energy source; it must be considered in conjunction with the time constraints of a given mission (sec. 1.1.5).

2.2 Sensor Performance

Sensor performance parameters are generally accepted numerical values (such as sensitivity, receiver gain, contrast, etc.) that describe the ability of a hardware item to perform its sensing function.

2.2.1 Acoustic Properties

DEFN – Acoustic properties are hardware properties that affect the generation or reception of sound waves in ocean water. Acoustic parameters of the ocean are treated in section 3.2.1.

INPUT/DEPENDENCE – These properties depend solely upon the type of acoustic search system in use and the nature of the target under search. The interrelationship of some of these properties is given by the sonar equation (in logarithmic form):

$$DT = SL - 2TL + TS - NL$$

where

DT = Detection threshold, which is determined by receiver sensitivity and sensor (hydrophone) sensitivity;

SL = source level, which includes acoustic power output, pulse length, array directivity, hydrophone efficiency, etc;

2TL = two-way transmission loss, which takes into account seawater attenuation and the frequency of the acoustic wave (see Section 3.2.1);

TS = target strength; and

NL = noise level, which includes both ambient noise and reverberation.

2.2.1.1 Target Strength

DEFN – Target strength is a measure of the reflectivity of an object when sound energy is incident on the object; it increases with reflectivity.

INPUT/DEPENDENCE – Target strength can be a function of the following characteristics of an object:

- size
- material
- shape
- density.

2.2.1.2 Receiver Sensitivity

DEFN – Receiver sensitivity refers to the minimum receiver-input signal-level that produces a usable receiver output. For example, a sonar receiver must receive a certain input voltage level from hydrophones to detect the presence of a signal.

INPUT/DEPENDENCE – Receiver sensitivity is a function of front end noise, receiver gain and component selection.

2.2.1.3 Sensor Sensitivity

DEFN – Sensor sensitivity is the minimum acoustic energy that will produce a detectable output from a given sensor. For example, a certain hydrophone's sensitivity may be X dyne/cm^2 (sound pressure level), thus producing Y volts output, where Y is the minimum receiver sensitivity (sec. 2.2.1.2).

INPUT/DEPENDENCE – Sensor sensitivity can be a function of the following:

- the construction of a hydrophone itself (efficiency, etc.)
- the number of hydrophones in a given array (sensitivity increases with the size of an array)
- the phasing (and hence directivity) of a hydrophone array: higher directivity means more sensitivity in a specific direction.

2.2.1.4 Pulse Length (Gating)

DEFN - Pulse length is the width in time of an acoustic pulse of energy, and, hence, the size of an acoustically illuminated volume of seawater. Pulse length is a component of source level.

INPUT/DEPENDENCE – Several different types of puising or gating schemes are used in acoustics to cut down on either backscatter or reverberation:

- transmit pulse gating: variation in the length of a transmitted acoustic pulse
- receiver gating: The receiver is turned on only when the transmitted pulse is returning from a target, thus reducing reverberation noise.
- range gating: the technique of turning on a receiver at a time corresponding to a specific distance (range) from the receiver's sensor, thus reducing backscatter or reflections from targets at different ranges.

2.2.1.5 Acoustic Power Output

DEFN – Acoustic power output is a measure of the sound pressure level emitted from a hydrophone. Acoustic power is a component of source level.

INPUT/DEPENDENCE – Acoustic power output is influenced by hydrophone efficiency, array directivity (for cases other than omnidirectional hydrophones), and electrical power supplied to the hydrophone input.

2.2.1.6 Frequency

DEFN – Frequency refers to the frequency of transmitted or received acoustic energy in seawater.

INPUT/DEPENDENCE – The frequency of an acoustic signal depends on the generation of that signal and any doppler shift induced by the motion of the acoustic energy in seawater. Frequency is an input to transmission loss: the higher the acoustic frequency, the more the signal attenuation (see section 3.2.1.2).

2.2.2 Optical Properties

DEFN – Optical properties are hardware properties that affect the generation or reception of optical energy in ocean water.

INPUT/DEPENDENCE – These properties depend solely upon the type of optical search system in use and the nature of the target under search.

2.2.2.1 Target Strength

DEFN – Target strength is a measure of the optical reflectivity of an object.

INPUT/DEPENDENCE – Target strength can be a function of the following characteristics of an object:

- size
- color
- outer (exposed) material
- shape.

2.2.2.2 Receiver Sensitivity

DEFN – Receiver sensitivity refers to the minimum receiver input signal level that produces a usable receiver output. For example, an optical search system receiver must receive a certain input voltage level from a photomultiplier tube to detect the presence of a signal.

INPUT/DEPENDENCE – Receiver sensitivity is a function of front end noise, receiver gain and, in some cases, alignment and quality of optical components.

2.2.2.3 Sensor Sensitivity

DEFN – Sensor sensitivity is the minimum optical energy that will produce a detectable output from a given sensor. For example, a certain photomultiplier tube's sensitivity may be X foot-candles, thus producing Y volts output, where Y is the minimum receiver sensitivity (see section 2.2.2.6).

INPUT/DEPENDENCE – Sensor sensitivity can be a function of these:

- the conversion efficiency of optical energy to electrical signals
- the field-of-view of the sensor
- the alignment and quality of "front end" optics.

2.2.2.4 Gating

DEFN – Gating refers to the length of transmitted or received pulses of optical energy. This gating implies a volume of seawater that can be illuminated by a given pulse of energy.

INPUT/DEPENDENCE – Several different types of gating schemes are used in optics to reduce optical backscatter in seawater:

- transmit pulse gating is done to illuminate only a small volume of seawater;
- receiver pulse gating allows the receiver to be on only when the transmitted pulse returns; and
- range gating allows the receiver to be turned on only at a time corresponding to a specific range from an optical sensor.

2.2.2.5 Optical Power Output

DEFN – Optical power output is a measure of the amount of optical energy emitted into seawater from a light source. Such measurement is usually thought of as intensity.

INPUT/DEPENDENCE – Optical power output is a function of conversion efficiency from electrical to optical power, the amount of electrical power input, and the directivity of the light, i.e., whether the light is collimated as with lasers, or divergent as with most underwater lights.

2.2.2.6 Light Wavelength

DEFN – Wavelength (or frequency) in this case refers to the color of light generated or received in seawater.

INPUT/DEPENDENCE – Wavelength in seawater is dependent on the generation of the signal. Seawater has differing optical transmission characteristics for different optical wavelengths, however (see section 3.2.2.1).

3.0 Environmental Parameters

Environmental parameters include values or characteristics of the operating environment that have a direct effect on the utilization or performance of a system and, therefore, must be known or understood for effective operation.

3.1 Hazards

Hazards are those characteristics which are inherent in the environment and tend to impede the performance of a system.

3.1.1 Currents

DEFN – Currents are naturally occurring phenomena in the ocean. Currents are movements of water in one direction on the surface, in the water column or on the bottom of the ocean.

INPUT/DEPENDENCE – When vehicles or suspended sensors are used as part of a search system, strong currents can have a severe influence on the effectiveness of vehicles or sensors in completing the mission.

3.1.2 Weather

DEFN – Weather can be a hazard to a search mission for obvious reasons.

INPUT/DEPENDENCE – Weather is usually the major factor in determining the success or failure of a given mission.

3.2 Physical

Physical parameters include those characteristics of the environment that have a definite effect on performance of a specific mission.

3.2.1 Acoustic Properties

DEFN – Acoustic properties are environmental properties that affect the propagation of acoustic waves in the ocean.

INPUT/DEPENDENCE – Acoustic properties of seawater are largely inputs to such aspects of propagation as signal degradation caused by attenuation and doppler shift and noise, and propagation discontinuities caused by thermoclines, ducts, etc. Such acoustic properties are dependent upon weather, time of year, internal waves and other environmental factors.

3.2.1.1 Noise

DEFN – Acoustic noise is an all-encompassing term for any unwanted signals in the acoustic frequency range (0 - 500 kHz).

INPUT/DEPENDENCE – Seawater noise has three basic components:

- ambient noise due to molecular motion in the sea water, etc., or due to man-made noise, e.g., surface shipping;
- reverberation, caused by incident sound pulses reflecting or scattering off objects, particles or molecules in the water column or on the ocean bottom; and
- biological noise resulting from the motion or acoustic output of living organisms in the sea. Snapping shrimp, for example, are a particularly potent source of biological acoustic noise.

3.2.1.2 Acoustic Water Parameters

DEFN – Acoustic water parameters are those that provide definite numbers describing the "goodness" of acoustic propagation at a given spot in the ocean.

INPUT/DEPENDENCE – The following parameters result, generally, in the degradation of an acoustic signal:

- Attenuation: Attenuation, the diminishing of acoustic wave amplitude, increases with frequency; hence, ocean acoustic signals are generally of very low frequency. Attenuation is made up of absorption (acoustic energy being absorbed into objects, particles, molecules, etc.) and scattering (the divergence of an acoustic wave by collisions with particles and molecules in the water column).
- Doppler: Doppler shifts are generated by the motion of acoustic energy through seawater. The result of doppler is a shift in the transmitted frequency.

3.2.1.3 Water Conditions

DEFN – Water conditions denote oceanographic properties that can affect acoustic wave propagation but are not expressly intended to describe sound propagation only.

INPUT/DEPENDENCE – Oceanographic water conditions include the following:

- Discontinuities in the water column, such as thermoclines, subsurface ducts and internal waves. These have an input effect to signal degradation.
- Bathymetry: The salinity, temperature and depth (STD) measurements influence acoustic propagation to a varying extent. The three together allow calculation of sound velocity at a given point in the ocean.

3.2.2 Optical Properties

DEFN – Optical properties are environmental properties that affect the propagation of optical energy in the ocean.

INPUT/DEPENDENCE – Optical properties of seawater are, in general, inputs to optical signal degradation during propagation. These properties are dependent upon weather, biological activity in the water column, surface sea state and other environmental factors.

3.2.2.1 Noise

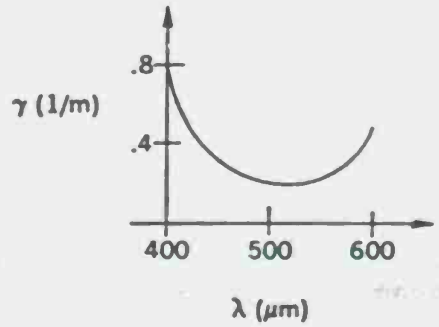
DEFN – Optical seawater noise is an all-encompassing term for any unwanted energy in seawater at optical wave-lengths.

INPUT/DEPENDENCE – Such noise is due, in general, to light scattering off particles and molecules in seawater.

3.2.2.2 Optical Water Parameters

DEFN – Optical water parameters are those that provide definitive numbers to describe the "goodness" of optical propagation at a given spot in the ocean.

INPUT/DEPENDENCE – Water clarity is the major input to signal degradation at optical wavelengths. Related to water clarity is the ocean's favorable transmission at one wavelength over another. The curve below shows a typical attenuation vs. wavelength curve for seawater.



Attenuation α is due to absorption a and scattering s ($\alpha = a + s$), whose curves tend to be similar in shape to the above, but whose relative contribution varies radically with water type. Generally, the minimum of the above curve occurs in the blue-green region of the visible spectrum.

3.2.3 Site Properties

DEFN – Site properties are the environmental properties of a given search site that influence the overall operation of a search mission.

3.2.3.1 Submarine Topography

Submarine topography refers to the nature of the bottom, e.g., its flatness, "hilliness," etc., at a given search site.

INPUT/DEPENDENCE – Submarine topography affects a search mission by defining, for example, the amount of resolution needed to find a given object in either very flat or very mountainous terrain. Topography is dependent, to some extent, on bottom currents and type of soil, but mostly on millions of years of geologic activity.

3.2.3.2 Depth

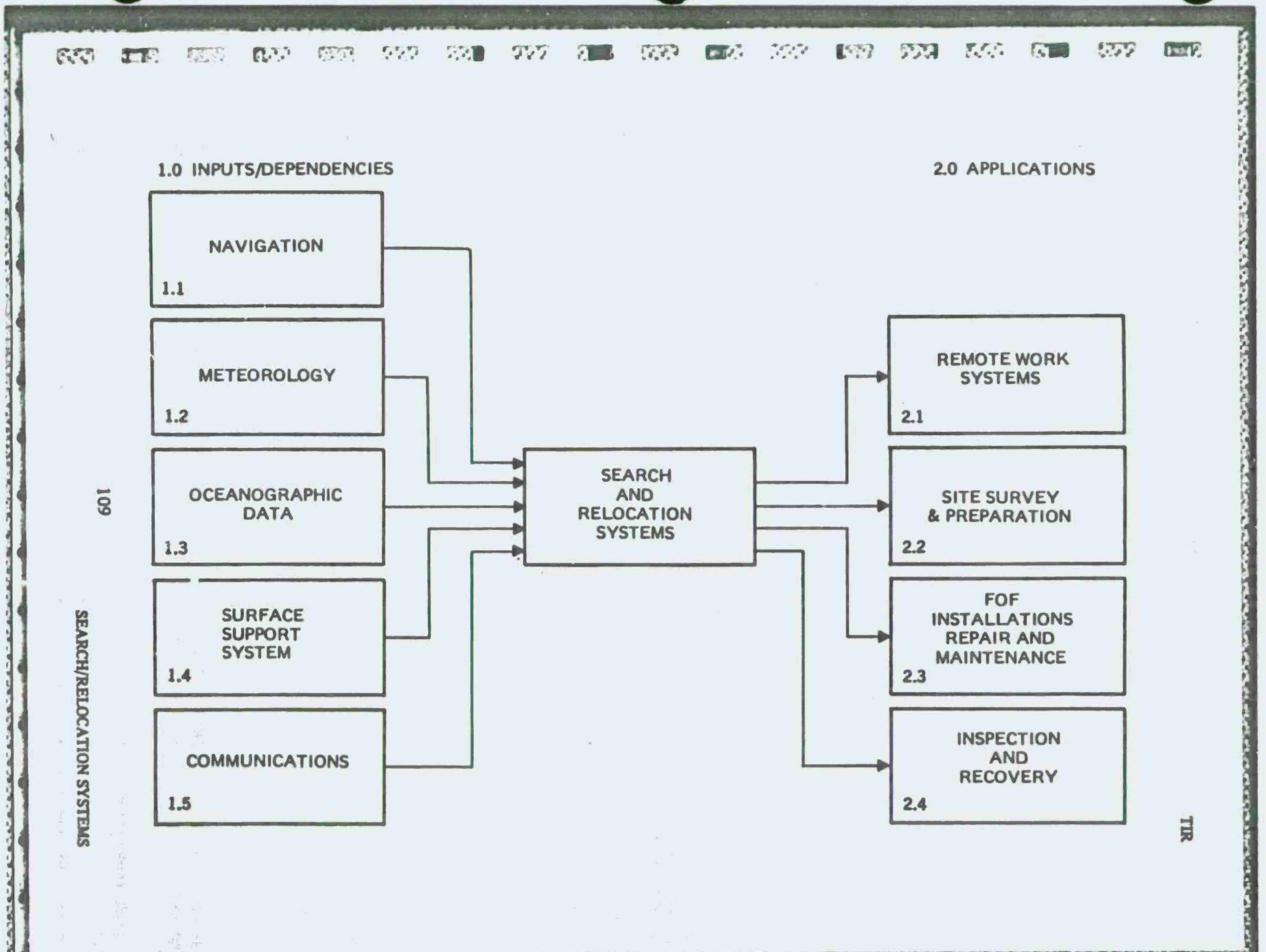
DEFN – Depth in this case is simply the depth of the ocean floor at a specific search site.

INPUT/DEPENDENCE – The depth of a search site influences the type of search system required for a given mission, e.g., its power output.

3.2.3.3 Search Area

DEFN – Search area is the amount of surface or bottom area that must be searched during a search mission.

INPUT/DEPENDENCE – Search area is a factor in determining the type of search system to be used for a specific mission and the length of time required.


1.0 INPUTS/DEPENDENCIES
2.0 APPLICATIONS
NAVIGATION
1.1
METEOROLOGY
1.2
OCEANOGRAPHIC DATA
1.3
SURFACE SUPPORT SYSTEM
1.4
COMMUNICATIONS
1.5
SEARCH AND RELOCATION SYSTEMS
REMOTE WORK SYSTEMS
2.1
SITE SURVEY & PREPARATION
2.2
FOF INSTALLATIONS REPAIR AND MAINTENANCE
2.3
INSPECTION AND RECOVERY
2.4
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TIR

1.0 Inputs/Dependencies

1.1 Navigation

DEFN – Navigation is the process of guiding a ship toward a specific location or direction and finding an FOF site on the sea floor; thus, surface navigation systems allow a surface ship to know its exact coordinates at any surface location, and bottom navigation systems are used to locate the FOF site and, where appropriate, determine the orientation of a Remote Work System prior to beginning operations.

IMPACT – Search depends on surface navigation for initial positioning of a surface platform to start a search mission, and on bottom navigation to find the FOF site on the sea floor.

1.2 Meteorology

DEFN – Meteorology (weather) defines the environmental conditions of a given surface site.

IMPACT – A search mission is heavily dependent on good weather. Wind, precipitation, stormy conditions, etc., can be serious detriments to mission success. Meteorology data for a search site are required to monitor present environmental conditions, some of which could point to impending bad weather.

1.3 Oceanographic Data

DEFN – Oceanographic data are those that describe ocean water properties at a certain ocean site. Of special importance to a search mission are acoustic and optical seawater properties as well as surface conditions such as sea state.

IMPACT – Poor seawater conditions can greatly impair the performance of a search mission. Thus, oceanographic data must be monitored.

1.4 Surface Support System

DEFN – The surface support system refers to all equipment and hardware necessary on the surface to accomplish a search mission.

IMPACT – In most cases, all search equipment is on the surface platforms. In the instance of a vehicle used for search, the surface platform provides all vehicle support.

1.5 Communication

DEFN – Communication is the process of information exchange from point to point.

IMPACT – Search depends on communication in an instance in which more than one surface ship is involved in a certain mission. Communication between ships is required to properly locate the desired site and to perform the desired mission.

2.0 Applications

2.1 Remote Work Systems

DEFN – Remote Work Systems are undersea platforms or equipments that can perform a work task and are controlled from the surface.

DEPENDENCIES – Remote Work Systems depend on search in that the subsurface installation (e.g., an FOF) on which work is to be performed must be located prior to the start of the work mission.

2.2 Site Survey and Preparation

DEFN – Site survey is the process of investigating an ocean location with the intent of using that location as a site for FOF installation (as an example). Site preparation refers to readying a site for such an installation.

DEPENDENCIES – Site survey is essentially a search function. Search equipment, both optical and acoustic, can be used directly to characterize a given site.

2.3 FOF Installation, Repair, and Maintenance

DEFN – FOF installation, repair, and maintenance are three typical work functions to be performed on FOF's.

DEPENDENCIES – FOF installation, repair, and maintenance depend on search equipment to aid in the task performance. Search systems can provide the necessary "eye in the sea" to facilitate mission accomplishment.

2.4 Inspection and Recovery

DEFN – Inspection is the process of viewing a subsurface object to ascertain its overall condition. Recovery refers to bringing such an object to the surface.

DEPENDENCIES – Inspection and recovery depend on search systems to provide an "eye in the sea" to facilitate accomplishment of an inspection or recovery mission.

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