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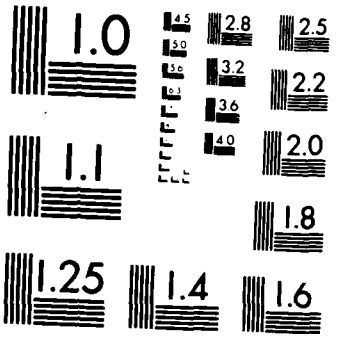

NOSC TR 993

Technical Report 993

DEEP SUBMERGENCE RESCUE VEHICLE (DSRV) OPTICS ELECTROSTATIC DISCHARGE (ESD)/RELIABILITY REPORT

S. J. Hoard and H. C. Wheeler

September 1984
Final Report

Prepared for
Deep Submarine Systems Project Office
Naval Sea Systems Command

Approved for public release; distribution unlimited

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152

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AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
(ESC) electrostatic control
Body capacitance
Bandwidth
Surface resistivity measurement
(MOS) metal oxide semiconductor
(CMOS) complementary metal oxide semiconductor

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Controls and installation procedures incorporated at NOSC are discussed for implementing an electrostatic work area conforming to guidelines and specifications of DOD-STD-1086, DOD-HDBK-262, MIL-STD-454, NAVSEA S600-AB-GTP-101 manual and associated industry standards. The ESD work area includes designed types of materials and test equipment needed for a Category 1 through Category 4 control environment when performing, handling, repairing and storing ~~MOS, CMOS~~, and JFETs (Junction Field Effect Transistors) associated with DSRV optics equipment.

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1.0 INTRODUCTION

1.1 BACKGROUND

In the past, various segments of industry have become aware of the damage static electricity can impose on metal oxide semiconductors (MOS) as evidenced by low production yields. Sensitivity of other parts to electrostatic discharge (ESD) more recently has become evident through use, test, and failure analysis. Technology trends are towards greater complexity, increased packaging density, and thinner dielectrics between active elements. All of these result in parts becoming even more sensitive to ESD. Parts can be destroyed or damaged by ESD voltages as low as 20 volts as a result of the construction and design features of current microtechnology.

The Code 944 DSRV Optics Laboratory at Naval Ocean Systems Center (NOSC) handles, assesses reliability, coordinates repairs, and tests the DSRV optics. Electronic components currently are extremely sensitive to ESD because of recent improvements in the DSRV optics technology. Code 944 has instituted controls at the component laboratory level to prevent ESD damage while handling the sensitive components and assemblies. This report documents ESD control measures in place at the DSRV optics facility and evaluates them as required by the ESD specifications.

1.2 TECHNICAL APPROACH

The ESD control program accomplishes the following tasks:

a. Reviews Navy ESD control program directives and defines general criteria/requirements

b. Identifies, analyzes, and classifies DSRV optics system components handled by the lab to determine their sensitivity to ESD

c. Defines specific ESD control requirements based upon ESD sensitive items being handled

d. Identifies ESD controls currently in place

e. Compares requirements from item c with current control measures in item d to define additional measures required

f. Identifies potential sources for procurement of additional control devices

g. Procures and installs necessary control devices

h. Provides recommendations on ESD control improvements in related areas such as personnel training, quality assurance, and safety

2.0 NAVY ESD CONTROL PROGRAM REQUIREMENTS

Many established military specifications and standards commonly imposed on equipment manufacturers require controls to protect electrostatic discharge sensitive (ESDS) items. DOD-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosives) (Reference 1), covers the establishment and implementation of an ESD Control Program. DOD-HDBK-263, Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices) (Reference 2), provides information to implement the requirements of DOD-STD-1686.

DOD-STD-1686 limits the control program to only the more sensitive ESDS parts which are susceptible to damage from personnel discharges of up to 4000 volts. These ESDS parts are classified as follows:

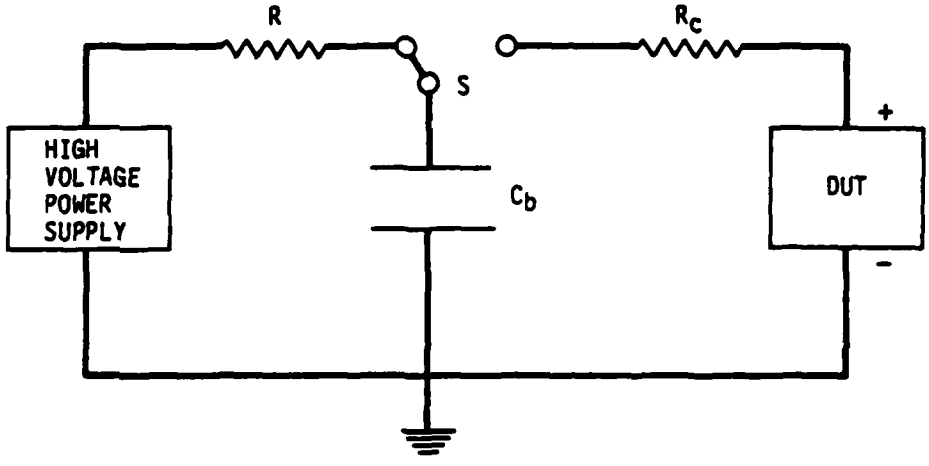
Class 1: Sensitivity range 0 $\leq$ 1000 volts
Class 2: Sensitivity range > 1000 $\leq$ 4000 volts

DOD-HDBK-263, Table IV, provides an additional ESDS classification based on voltage sensitivity. It defines Class 3 sensitivity range as > 4000 to $\leq$ 15000 volts.

ESD Susceptibility of Electronic Devices (VZAP-1) (Reference 3), contains a list of individual electronic components classified according to ESD failure voltage levels. ESDS classes for VZAP-1 listings are based on the class levels established in DOD-STD-1686 and DOD-HDBK-263. The human body model was used to duplicate the type of discharge that can occur during actual handling and operational conditions. A schematic of the test fixture of this model is shown in Figure 1 and its equivalent circuit is shown in Figure 2. The human body model has been the most widely used and standardized ESD susceptibility testing model to date; it is explained in detail in DOD-HDK-263, Section 6.0.

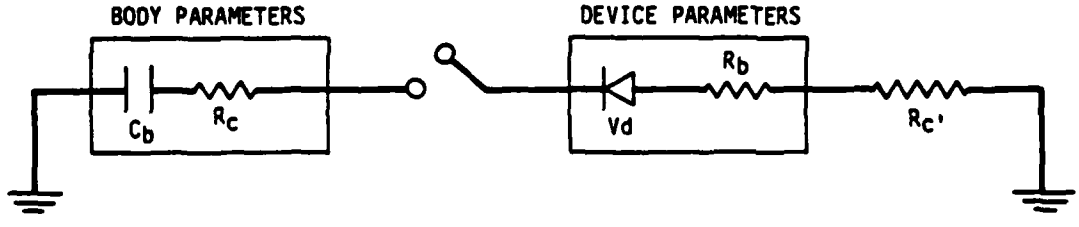
VZAP-1 was used to classify the DSRV optics components where test data were available. Components not listed in VZAP-1 were classified in accordance with the requirements of NAVSEA OD 46363, Requirements for the Electrostatic Discharge Protection of Electronic Components and Assemblies (Reference 4). This document outlines the requirements for the ESD protection of electronic components and assemblies. Category 1 electronics components are very sensitive to ESD damage and include metal oxide semiconductors (MOS or CMOS) devices with no input protection circuitry on all input circuits. Category 2 electronic components include MOS and CMOS devices with input protection on all input terminals, Junction Field Effect Transistors (JFETs), all small signal transistors with f_T > 500 MHz, and all dielectrically isolated microcircuits not listed as Category 1.

Category 3 electronic components include all microcircuits and small signal discrete semiconductors not listed in Categories 1 and 2. Components classified as Category 4 are considered insensitive to ESD and require no protection. A complete list of documents and their requirements pertaining to



R = Charging Resistor
S = High Voltage Switching Element
C_b = Source Body Capacitance
R_c = Source Contact Resistance
DUT = Device Under Test

Figure 1. Human body model test circuit.



C_b = Body Capacitance
R_c = Contact Resistance
V_d = Voltage Drop Across Stressed Junction
R_b = Device Internal Resistance
R_c' = Device Contact Resistance to Ground

Figure 2. Human body model equivalent circuit.

an ESD control program is summarized in NAVSEA S6000-AB-GTP-101, Military Specifications, Standards and Contract Clauses Specifying Controls for Protection Against Electrostatic Discharge (Reference 5). General information is in MIL-STD-454H, Standard General Requirements for Electronic Equipment (Reference 6).

Selected references are listed for information in Appendix A. Reference 7, Electronic Packaging and Production, February 1984, provides an excellent review of ESD materials, testing, and sources.

3.0 IDENTIFICATION, ANALYSIS, AND CLASSIFICATION OF ESD SENSITIVE COMPONENTS IN DSRV OPTICS SYSTEM

Through direct interface with DSRV Optics Lab personnel and review of equipment repair logs, the following devices were identified as being maintained and repaired by lab personnel:

PART NUMBER	DEVICE
410-2908022	Hydroproducts Bow Camera
410-2908023	Hydroproducts Skirt Camera
410-2908024	Hydroproducts Zoom Camera
410-2908025	Hydroproducts Right-Angle Camera
410-2887782	EDO Western Bow Camera
410-2887784	EDO Western Skirt Camera
410-2887783	EDO Western Mother-Sub Camera
410-2908009	35mm Still-Picture Camera
410-2908019	Mercury Vapor Lamp
410-2908020	Mercury Vapor Lamp Ballast
410-2908007	Quartz-Iodide Skirt Lamp
410-2908008	Quartz-Iodide Trapeze Lamp
410-2908018	Strobe Flash Tube
410-2908010	Strobe Electronics
410-2908025	Sub-Sea Systems Camera

Appendix B contains a detailed breakdown of the devices listed above into subassemblies (where applicable) and further into components. Assemblies and equipment containing Class 1 and Class 2 parts were categorized as Class 1 or Class 2 based upon the most sensitive class of parts used therein. The individual components were then analyzed using VZAP-1 or OD 46363 to establish their degree of sensitivity to ESD. There is commonality of ESD sensitive components among the devices being processed. In addition, there are instances where components are classified between two classes, i.e., 1-2. This is because the device's sensitivity is not well-defined nor is the borderline between two classes.

Based on the ESD sensitivity of their components, the inventory of DSRV optics devices was classified as follows:

Category 1: EDO Western Bow Camera
EDO Western Mother-Sub Camera
EDO Western Skirt Camera

Category 2: Hydroproducts Bow Camera
Hydroproducts Skirt Camera
Hydroproducts Zoom Camera
Hydroproducts Right-Angle Camera
Strobe Electronics
Sub-Sea Systems Camera

Not ESD Sensitive:

35mm Still-Picture Camera
Mercury Vapor Lamp
Mercury Vapor Lamp Ballast
Quartz-Iodide Skirt Lamp
Quartz-Iodide Trapeze Lamp
Strobe Flash Tube

4.0 ESD CONTROL REQUIREMENTS

Since Category 1 ESD sensitive devices are handled by the lab facility, Category 1 ESD control measures have been implemented. There are five alternative control measures defined in NAVSEA OD 46363 for the protection of Category 1 electronic components and assemblies. Table 1 summarizes the applicable alternatives and the control measures currently in place in the NOSC DSRV Optics Lab. The current lab work station is shown in Figure 3. The work station is equipped with the required Category 1 ESD station controls, i.e., signs and posters, wrist strap, table mat, floor mat, static shielding bags, and conductive containers. A portable ionizer is also employed at the station, although it is not shown in Figure 3.

Table 1. NAVSEA OD 46363 ESD control requirements for Category 1 devices.

		Alt.4	Alt.5	In Place at NOSC
1.	Controlled Relative Humidity	X	X	*
2.	No Carpeting	X	X	X
3.	Common Ground	X	X	X
4.	Grounded Chairs/Stools		X	X
5.	Grounded Work Station	X		X
6.	Anti-Static Trays/Carriers	X	X	X
7.	Grounded Equipment/Tools	X	X	X
8.	Protection for Spraying, Cleaning, Sandblasting	X	X	X
9.	No Plastic Gloves, Finger Cots	X	X	X
10.	Wrist Bracelets	X	X	X
11.	Outer Garment	X		X
12.	Component Body Handling Procedures	X	X	X
13.	Protective Covering Procedures	X	X	X
14.	Packaging/Storage Materials	X	X	X
15.	Container Marking Material	X	X	X

*Requirement satisfied by use of ionized air blower. In addition, work on sensitive devices will be suspended when relative humidity is less than 25%.

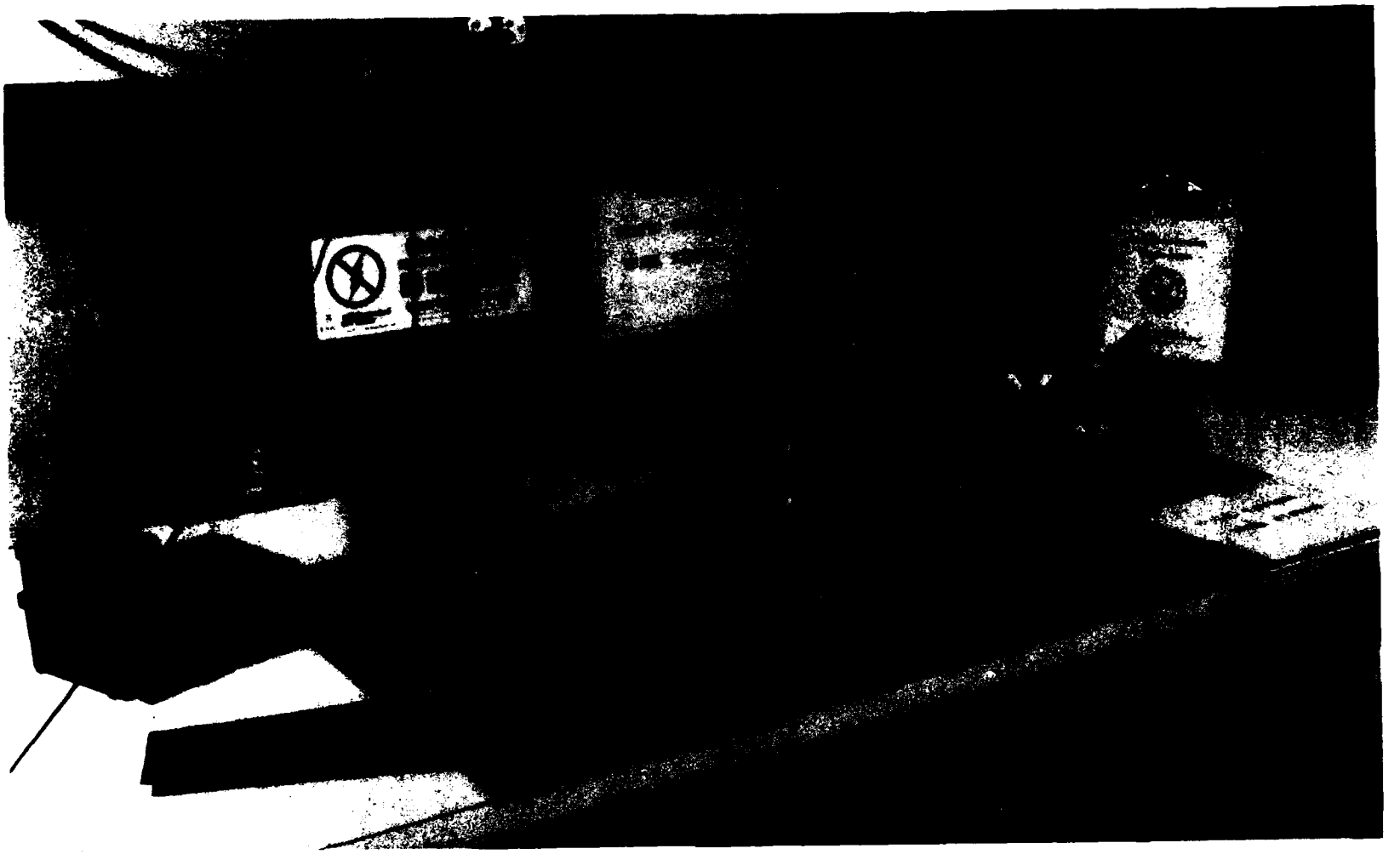


Figure 3. NOSC DSRV Optics Laboratory, ESD work station, June 1984.

Alternative 4, Category 1 Control Measures are identical to Alternative 5, Category 1 Control Measures with the exception of the requirement for grounded chairs or stools. Grounded chairs or stools are not required for Alternative 4, provided the operator or technician wears an outer garment (smock, etc.) with a surface resistivity of less that 10^{12} ohms/square when measured per ASTM test method D257 or equivalent. The DSRV Optics Lab has a supply of smocks which meet these requirements. A smock may be used at any time for added protection.

A major facility requirement to meet Alternative 4 or 5, Category 1 requirements is controlled relative humidity. This requirement applies to all Category 1 alternatives. Where it can be shown that it is not economically feasible to maintain high levels of relative humidity (i.e., it causes rusting and corrosion problems), ionized air blowers may be used. The relative humidity can also be monitored and operations suspended during periods when the relative humidity is less than the required limit.

The Lab uses the portable ionizer to control static at the work station. The relative humidity will be monitored to ensure that work is not performed on ESDS items when the relative humidity is less than 25 percent. The electrostatic voltage in the work area will also be monitored to maintain the sensitivity level below that of the most sensitive item being handled.

4.1 SOURCES FOR STATIC CONTROL PRODUCTS

Appendix D to this report provides a list of sources from which to procure ESDS materials and supplies.

Sources 1 and 2 of Appendix D supply the complete line of ESDS supplies and sources 3 and 4 specialize in electrostatic detection equipment only.

5.0 ADDITIONAL RECOMMENDATIONS

In carrying out this study, other related aspects of ESD control were considered and findings are summarized in the following sections.

5.1 PERSONNEL TRAINING

Training in ESD awareness should be provided to all people who handle, procure, specify, or design ESDS items. Such training should include identification of ESDS items in the equipment, some basic ESD theory, ESD handling precautions, the need for, use and types of ESD protective packaging, and the safety aspects involved where grounding is a part of the ESD handling procedures. An ESD training outline is available in DOD HDBK 263, Section 10.2.

For the NOSC DSRV Optics Laboratory, the technician currently in charge possesses the knowledge necessary to meet the tailored ESD training requirements of DOD HDBK 263.

5.2 QUALITY ASSURANCE PROGRAM

A quality assurance program should be established to assure conformance to specification requirements.

5.2.1 Certification of ESD Protected Areas and Grounded Work Benches

Prior to use, the protected area should be certified by Quality Assurance to verify that it conforms to the following requirements:

a. Electrostatic voltages in areas where Category 1 and Category 2 items are handled without ESD protective covering shall be limited to the lowest voltage sensitivity level of these items as a minimum. The lowest verifiable voltage sensitivity of devices maintained or repaired by the Lab is the LM108 Op Amp, 200v.

b. Protected areas shall extend, as a minimum, 1 meter from the periphery of a Category 1 or Category 2 item work area.

c. Personnel grounding systems shall be incorporated.

d. Grounding or ionizing systems for processing machinery such as hot air blowers shall be incorporated.

e. Prime static sources shall not be permitted in or near the ESD protected area.

f. Power tools (e.g., soldering irons, solder pots, etc.) and test equipment used in protected areas shall be grounded.

5.2.2 ESD Program Monitoring

ESD program monitoring is a necessary continuing effort of the in-house ESD quality control function. It should cover all aspects of the ESD control program.

Quality Assurance personnel should audit the ESD program periodically (at least, monthly). Operating personnel should monitor personal equipment, i.e., wrist straps, outer garments, etc., on a daily basis and maintain records of such actions. Prior to working on ESDS items in the protected area, the following monitors should be performed:

a. Resistance measurements of all grounding to assure that resistances are low enough (0.5 megohm minimum) to limit residual ESD voltages and high enough (1.5 megohm maximum) to protect personnel from nearby voltage sources.

b. Test for the effectiveness of the ESD protected area and grounded work benches to limit electrostatic voltages to safe levels (less than 200v) using electrostatic meters or detectors.

c. Test for the effectiveness of ESD protective equipment such as ionizers, build-in detectors/alarms, and humidity control where used.

A number of ESD material manufacturers provide a complete line of real time monitors which provide alarm when elements of the protected area exceed specification requirements. The DSRV Optics Lab chose the Trek Model 1800 Field Detector and Alarm System to monitor electostatic discharge. The Trek Model 1800 is designed to be worn in a shirt pocket for personal use or mounted to monitor a bench or work area. An audible alarm sounds when an ESD event occurs.

For surface resistivity measurements, the Lab chose the Plastistat SR-7700 surface resistivity meter. The hand held, battery operated, power megohm meter was specifically designed to characterize materials per DOD HDBK 263.

5.3 PERSONNEL SAFETY

The safety requirements of MIL-STD-454, Requirement No. 1, should be considered in the construction of ESD protected areas. Suggested practices include:

a. Wrist bracelet ground leads should be insulated and ground-isolation resistors should be positioned close to their respective wrist bracelet, conductive bench top, etc., to lessen the possibility of accidental grounding or contact with dangerous potentials.

b. Fail-safe isolation circuits should be provided to preclude personnel being short-circuited to building or power ground. Series resistance must be sufficient to limit current to 5.0 ma maximum.

6.0 SUMMARY

A review of the devices handled by the facility revealed some Category 1 ESDS components which require the highest level of protection. Appendix B to this report provides an ESD sensitivity analysis of the devices handled or repaired. Appendix C provides details of Alternatives 4 and 5, Category 1 ESD controls.

The DSRV Optics Laboratory instituted Alternatives 4 and 5 Category 1 ESD controls. The protective outer garment, an Alternative 4 requirement, may also be used with the grounded chairs or stools, an Alternative 5 requirement. The work station is grounded with a conductive table top and floor mat.

A portable ionizer is used to provide static control at the work station. Static shielding bags are used to transport Categories 1 and 2 ESDS items and conductive containers are used for Category 3 items. The Lab maintains a supply of anti-static bags which are used for storing Category 3 items.

The Lab uses the Plastistat SR-7700 Surface Resistivity Meter for monitoring the surface resistivity of static control materials. The Trek Model 1800 Field Detector and Alarm System is used for electrostatic detection and monitoring in the work area.

The technician in charge is knowledgeable in ESD theory and maintains excellent safety practices. Adhering to the ESD control procedures and utilizing the static control materials in the Lab will substantially reduce problems associated with ESD in the future.

APPENDIX A

ESD REFERENCES

1. DOD STD 1686, Electrostatic Discharge Control Programs for Protecton of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosives).

2. DOD HDBK 263, Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices).

3. ESD Susceptibility of Electronic Devices, VZAP-1, Rome. Air Development Center, Spring 1983.

4. NAVSEA OD 46363, Requirements for Electrostatic Discharge Protection of Electronic Components and Assemblies.

5. NAVSEA S6000-AB-GTP-101, Military Specification, Standards and Contract Clauses Specifying Controls for Protection Against Electrostatic Discharge.

6. MIL-STD-454H, Standard General Requirements for Electronic Equipment.

7. Electronic Packaging and Production, EOS/ESD Issue, February 1984.

APPENDIX B

ESD CLASSIFICATION OF ITEMS

HYDROPRODUCTS CAMERAS

ESDS components listed below are contained in the following cameras:

Hydroproducts Bow Camera	410-2908022
Hydroproducts Skirt Camera	410-2908023
Hydroproducts Zoom Camera	410-2908024
Hydroproducts Right-Angle Camera	410-2908025

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4116	DIODE	3
IN4126	DIODE	3
IN825	DIODE	3
IN4007	DIODE	3
MC1510G	IC	3
MC1900F	IC	3
MC1910F	IC	2
MC936F	IC	3
MC938F	IC	3
MC951F	IC	3
MC956F	IC	3
MCA1932P	IC	3
CA3018	TRANSISTOR	3
SE501K	TRANSISTOR	3
2N2219	TRANSISTOR	3
2N2222	TRANSISTOR	3
2N2644	TRANSISTOR	3
2N2804	TRANSISTOR	3
2N2905	TRANSISTOR	3
2N3439	TRANSISTOR	3
2N3499	TRANSISTOR	3

ID NUMBER	NOMENCLATURE	ESDS CAT
2N3644	TRANSISTOR	3
2N4236	TRANSISTOR	3
2N4914	TRANSISTOR	3
2N5195	TRANSISTOR	3
2N5551	TRANSISTOR	3
2N930	TRANSISTOR	3
809BE	TRANSISTOR	3
MD6002	TRANSISTOR	3
CA3018	TRANSISTOR	3
SE501K	TRANSISTOR	3

EDO WESTERN CAMERAS

ESDS components listed below are contained in the following cameras:

EDO Western Bow Camera	410-2887782
EDO Western Skirt Camera	410-2887784
EDO Western Mother-Sub Camera	410-2887783

ID NUMBER	NOMENCLATURE	ESDS CAT
JAIN414B	DIODE	1-2
IN751	DIODE	3
IN277JAN	DIODE	2
IN4729	DIODE	3
MMDB914	DIODE	3
IN4001	DIODE	3
IN3614	DIODE	3
LF156H	IC	2
LM124D	IC	2
DS1633J	IC	3
LM108H	IC	1
LM193H	IC	3
LM3054N	IC	3

ID NUMBER	NOMENCLATURE	ESDS CAT
LM320T-12	IC	3
MC14011BAL	IC	2
MC14046BAL	IC	1-2
MC14053BAL	IC	1-2
MC14538BAL	IC	2
MC1569R	IC	2
MC7812CT	IC	3
MHQ6002	IC	2
MHQ6100	IC	2
SD4330F	IC	2
SG1524J	IC	2
TA6993W	IC	2
UA723HM	IC	1-2
2N6037	TRANSISTOR	3
34838	TRANSISTOR	3
MMBF310	TRANSISTOR	3
MMBTH24	TRANSISTOR	3
MMBTH81	TRANSISTOR	3
U310	TRANSISTOR	3
2N2907	TRANSISTOR	3
2N222A	TRANSISTOR	3
2N5114	TRANSISTOR	3
2N3568	TRANSISTOR	3
2N3635	TRANSISTOR	3
2N4150	TRANSISTOR	2

STROBE ELECTRONICS

The following ESDS Components are contained in Strobe Electronics, P/N 410-2908010:

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4004	DIODE	2
JANIN3003B	DIODE	3
DTG-2400	TRANSISTOR	3
DTS-423	TRANSISTOR	3
SK3104A	TRANSISTOR	3

EDO WESTERN CAMERAS

Individual assemblies for EDO Western Cameras are listed below with their ESDS components categorized. Assemblies and equipment containing Class 1 and Class 2 parts should be categorized as Class 1 or Class 2 based upon the most sensitive class of parts used therein.

LENS ASSEMBLY P/N 35329-1

ID NUMBER	NOMENCLATURE	ESDS CAT
JAIN4148	DIODE	1-2
IN751	DIODE	3
2N2907A	TRANSISTOR	3
2N222A	TRANSISTOR	3
LM124D	IC	2
LM156H	IC	2

SYNC GENERATOR P/N 34692-1G

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4148JAN	DIODE	1-2
IN751	DIODE	3
2N2907A	TRANSISTOR	3
2N2222A	TRANSISTOR	3

ID NUMBER	NOMENCLATURE	ESDS CAT
LM124D	IC	2
LM156H	IC	2
TA6993	IC	2
UA723HM	IC	1-2
DS1633J	IC	3
LM193H	IC	3
MHQ6100	IC	2
MC14046	IC	1
MC14011	IC	2

VIDEO PROCESSOR P/N 34636-IG

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4148JAN	DIODE	1-2
U310	TRANSISTOR	3
2N2907A	TRANSISTOR	3
2N5114	TRANSISTOR	3
RCRO5G105JS	RESISTOR	3
RN55D	RESISTOR	3

DEFLECTION YOKE ASSEMBLY P/N 34912-2

ID NUMBER	NOMENCLATURE	ESDS CAT
IN277JAN	DIODE	2
IN4729	DIODE	3
2N2907A	TRANSISTOR	3
2N2222A	TRANSISTOR	3
2N3568	TRANSISTOR	3
2N3635	TRANSISTOR	3
MC14538BAL	IC	2

POWER SUPPLY P/N 34653-2E

ID NUMBER	NOMENCLATURE	ESDS CAT
IN3614	DIODE	3
SDA330F	DIODE	3
2N4150	TRANSISTOR	2
2N2907A	TRANSISTOR	2
RCR07G132JS	RESISTOR,FILM	3
RN55C3651F	RESISTOR,FILM	3
MC1569R	IC	3
SG1524J	IC	2

END CAP ASSEMBLY P/N 35591-2

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4001	DIODE	3
IN751	DIODE	3
2N6037	TRANSISTOR	3
UA723HM	IC	1-2
LM320T-12	IC	3
MC7812CT	IC	3
RCR05G622JS	RESISTOR,FILM	3

PREAMP ASSEMBLY P/N 34581-1A

ID NUMBER	NOMENCLATURE	ESDS CAT
MMBD914	DIODE	3
MMBFU310	TRANSISTOR	3
MMBTH81	TRANSISTOR	3
MMBTH24	TRANSISTOR	3
34830	TRANSISTOR	3

SUB-SEA SYSTEMS CAMERAS

Individual assemblies for Sub-Sea Systems Cameras are listed below with their ESDS components categorized. Assemblies and equipment containing Class 1 and Class 2 parts should be categorized as Class 1 or Class 2 based upon the most sensitive class or parts used therein.

SYNC GENERATOR

ID NUMBER	NOMENCLATURE	ESDS CAT
IN5336	DIODE	3
IN4153	DIODE	2
CA3140	IC	2
TA6993	IC	2

VERTICAL DEFLECTION BOARD

ID NUMBER	NOMENCLATURE	ESDS CAT
2N5088	TRANSISTOR	3
2N5086	TRANSISTOR	3
U401	IC	2

VIDEO AMPLIFIER AND CLAMPING CIRCUIT

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4153	DIODE	3
IN705A	DIODE	3
2N4250	TRANSISTOR	3
2N4126	TRANSISTOR	3
2N706	TRANSISTOR	3
2N706A	TRANSISTOR	3
2N741	TRANSISTOR	3
2N711	TRANSISTOR	3

VIDEO PRE-AMPLIFIER AND AUTO TARGET

ID NUMBER	NOMENCLATURE	ESDS CAT
2N4250	TRANSISTOR	3
2N4124	TRANSISTOR	3
2N5265	TRANSISTOR	3
40841	TRANSISTOR	3
2N5088	TRANSISTOR	3

HIGH VOLTAGE POWER SUPPLY

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4153	DIODE	2
MR852	DIODE	3
IN985	DIODE	3
IN4005	DIODE	2
IN992	DIODE	3
2N4250	TRANSISTOR	3
2N4124	TRANSISTOR	3
MJE340	TRANSISTOR	3
2N1040	TRANSISTOR	3

LOW VOLTAGE REGULATOR

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4005	DIODE	2
UZ5708	DIODE	3

HORIZONTAL DEFLECTION AND CATHODE BLANKING

ID NUMBER	NOMENCLATURE	ESDS CAT
IN4153	DIODE	2
MR852	DIODE	3
2N4275	TRANSISTOR	3
2N706	TRANSISTOR	3
2N4124	TRANSISTOR	3
2N4250	TRANSISTOR	3
MJE340	TRANSISTOR	3

PRE EQUALIZER AMPLIFIER

ID NUMBER	NOMENCLATURE	ESDS CAT
2N5910	TRANSISTOR	3
2N4275	TRANSISTOR	3
LH0002CH	IC	2

APPENDIX C

ALTERNATIVE CONTROL MEASURES

FOR

CATEGORY 1 ELECTRONIC COMPONENTS AND ASSEMBLIES

1.0 FACILITY

1.1 RELATIVE HUMIDITY

The protected areas RH shall be at 25 percent or greater when measured with equipment accurate to ± 2 percent or better.

1.2 CARPETING

Carpeting is prohibited in the protected area.

1.3 COMMON GROUND

All grounds shall be connected to a common point, that point to earth ground.

1.4 CHAIRS OR STOOLS

Chairs or stools that could contact persons handling electronic components or assemblies should have a surface resistivity of 10 ohms/square or less and shall be grounded through a 0.50 megohms minimum to 1.50 megohms maximum resistance.

1.5 GROUNDED WORK STATION

Handling and testing of electronic components and assemblies shall be performed at a grounded work station.

2.0 PROCESSING EQUIPMENT

2.1 TRAYS, CARRIERS, TOTE BOXES, CUSHIONING MATERIAL, AND BAGS

Storage or handling containers for electronic components and assemblies shall have a surface resistivity of 10 ohms/square or less.

2.2 ELECTRICAL EQUIPMENT, TOOLS, SOLDERING IRONS, SOLDER POTS, FLOW SOLDERING EQUIPMENT

Soldering irons, solder pots, or flow soldering equipment should be hard grounded and transformer or direct current isolated from the power line. Resistance readings from the tip of a hot soldering iron to ground should be less than 0.2 ohm for soldering Category 1 components and less than 10 ohms for soldering Category 2 components.

2.3 TEST EQUIPMENT

Test equipment shall have all exposed metallic surfaces electrically connected to the test equipment power system ground (200 ohms or less).

2.4 SPRAYING, CLEANING, PAINTING, AND SANBLASTING EQUIPMENT

Ionized air blowers, conductive solvents, or ionized nozzles should be used as applicable to prevent electrostatic charge buildup in the work area when spraying, cleaning, painting, or sandblasting ESDS items.

3.0 PERSONAL APPAREL

3.1 SMOCKS, GLOVES, FINGER COTS

Personnel handling components or assemblies shall wear an outer garment with a surface resistivity of less than 10 ohms/square when measured per ASTM Test Method D257 or equivalent.

3.2 WRIST BRACELETS

Personnel handling electronic components and assemblies shall wear a skin-contact wrist bracelet which is connected to the common ground through a 0.50 megohm minimum to 1.5 megohm maximum resistance.

4.0 HANDLING

4.1 COMPONENT BODY HANDLING

Where possible, components should be handled by their body/case rather than by their leads.

4.2 PROTECTIVE COVERING

Each electronic component and assembly shall be covered, wrapped, or bagged whenever they are not being handled or bagged.

4.3 POWER APPLIED TO LEADS

No power shall be applied to electronic test sockets while components are being inserted or otherwise connected.

5.0 PACKAGING AND STORAGE

5.1 PACKAGED COMPONENTS AND ASSEMBLIES

Components and assemblies received shipped or stored shall be individually wrapped in a material with a surface resistivity of 10 ohms/square or less. In lieu of individual wrapping, components may have their leads shorted together through a material whose surface resistivity is 10 ohms/square or less.

6.0 MARKING OF CONTAINERS

Electronic components and assemblies received or to be shipped or stored shall have their associated containers marked or tagged with a legend of an attention attracting color easily readable to normal or corrected vision at a visual inspection distance of three feet, stating the appropriate Category of ESD sensitivity.

The following legend test shall be used:

"CAUTION - ELECTROSTATIC SENSITIVE DEVICE: Category _____ _____. Do not remove anti-static protection except in protected areas. See OD 46363 for protective measures required for testing or handling this item."

6.2 PACKING MATERIAL

Unwrapped or unprotected electronic components or assemblies shall be packed in material of surface resistivity less that 10 ohms/square.

APPENDIX D

SOURCES FOR STATIC CONTROL PRODUCTS

1. The SIMCO CO., INC.
   2257 North Penn Road
   Hatfield, PA 19440

2. 3M
   Static Control Systems Division
   Box EPP-1, 225-4S
   St. Paul, MN 55144
   1(800) 328-1684

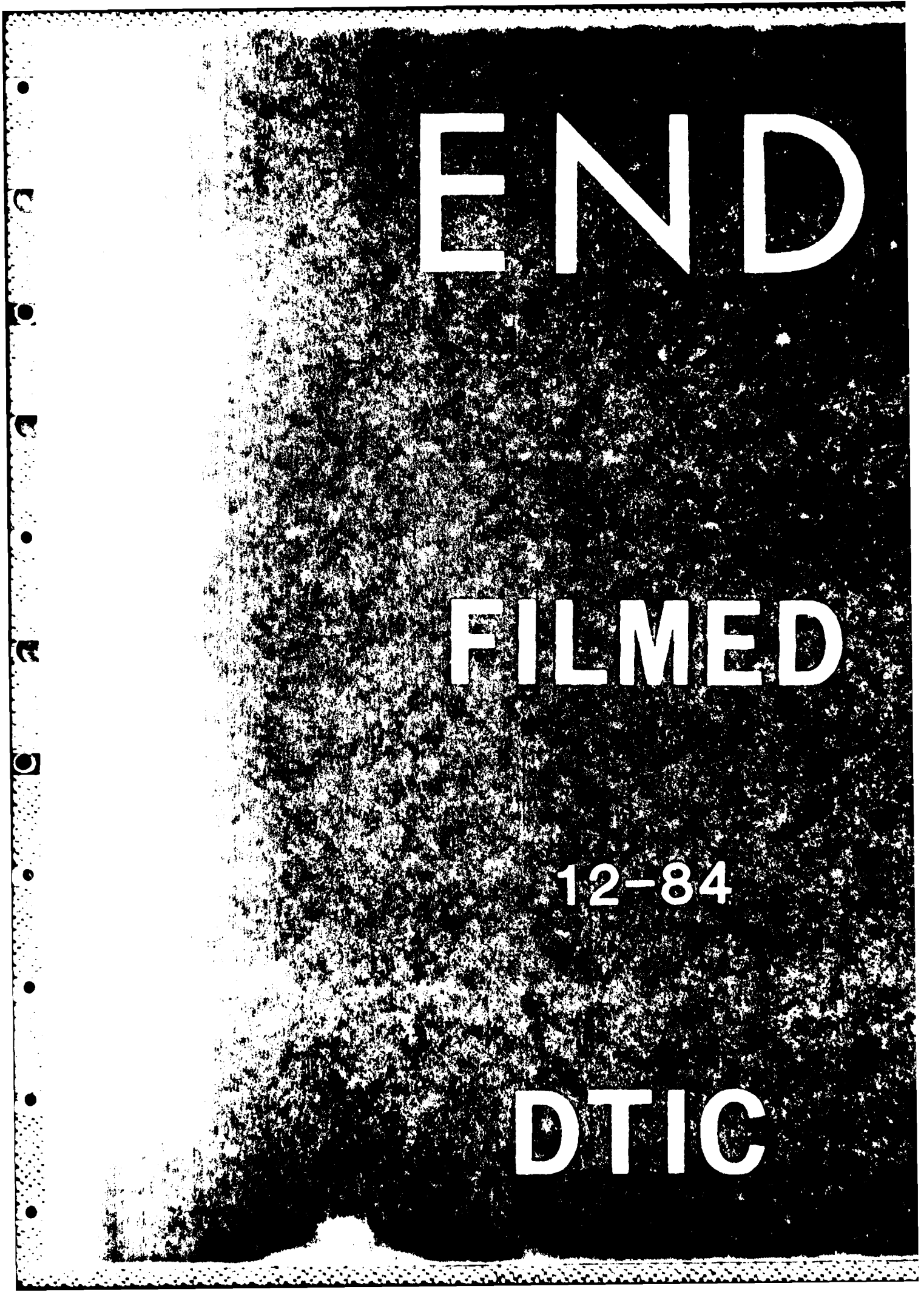
3. BK Sweeney Mfg. Co.
   Denver, CO 80216

4. Monroe Electronics, Inc.
   Lyndonville, NY 14098

APPENDIX E

ABBREVIATIONS AND ACRONYMS

ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
Cb	BODY CAPACITANCE
CMOS	COMPLEMENTARY METAL OXIDE SEMICONDUCTOR
DOD	DEPARTMENT OF DEFENSE
DSRV	DEEP SUBMERGENCE RESCUE VEHICLE
DUT	DEVICE UNDER TEST
ESD	ELECTROSTATIC DISCHARGE
ESDS	ELECTROSTATIC DISCHARGE SENSITIVE
f_T	COMMON-EMITTER SHORT-CIRCUIT CURRENT GAIN-BANDWIDTH PRODUCT
HDBK	HANDBOOK
JFET	JUNCTION FIELD EFFECT TRANSISTORS
MHz	MEGAHERTZ
MOS	METAL OXIDE SEMICONDUCTOR
NAVSEA	NAVAL SEA SYSTEMS COMMAND
NOSC	NAVAL OCEAN SYSTEMS COMMAND
OP AMP	OPERATIONAL AMPLIFIER
Rb	DEVICE INTERNAL RESISTANCE
Rc	CONTACT RESISTANCE
Rc	DEVICE CONTACT RESISTANCE TO GROUND
STD	STANDARD
Vd	VOLTAGE DROP
VZAP-1	RELIABILITY ANALYSIS CENTER'S FIRST REPORT OF ELECTROSTATIC DISCHARGE (ESD) SUSCEPTIBILITY OF ELECTRONIC DEVICES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