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

This TOP provides procedures for evaluating the safety of electrical and electronic equipment in fire control systems for tank weapons and field and air defense artillery. Checklists are included as a guide for identifying electrical and electronic hazards, mechanical hazards and miscellaneous other hazards.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 3-2-503
AD No.

SAFETY EVALUATION OF FIRE CONTROL SYSTEMS - ELECTRICAL AND ELECTRONIC EQUIPMENT

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1. SCOPE. This TOP provides procedures for evaluating the safety of electrical and electronic equipment in fire control systems for tank weapons and field and air defense artillery. It applies whether the equipment is tested as systems, subsystems, assemblies, components, or single entities. A complete evaluation is based on physical tests, examinations of the test item with the use of safety test checklists, and observations made during other phases of development tests of the system. These tests are intended to identify potential electrical and electronic hazards, mechanical hazards, and miscellaneous other hazards such as those from electromagnetic radiation, thermal sources, and chemical contamination. (For RF radiation tests see TOP 3-2-616 1/; for ionizing radiation tests see TOP 3-2-711 2/.)

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities. No special facilities are required.

1/ TOP 3-2-616, Radio Frequency Radiation Hazards to Personnel, 12 June 1968.
2/ TOP 3-2-711, Safety Evaluation - Radioactive Components of Materiel, 9 June 1970.

*This TOP supersedes TOP 3-2-503, 20 October 1976. - AD35606

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2.2 Instrumentation.

ITEM	MAXIMUM ERROR OF MEASUREMENT*
Voltmeters	±5% of full scale
Ohmmeters	±5% of full scale
Ammeters	±5% of full scale
Field intensity meters	±5% of full scale
Thermometers	±1°F or ±0.5°C
Light meters	±10% absolute
Noise measuring sets	±1 dB
Air contamination test sets	±5% of full scale

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3. PREPARATION FOR TEST.

3.1 Preliminary Safety Review and Documantation Preparation. Ensure that a safety statement has been received from the developer as required by AR 70-10 3/. All safety and health hazards identified by the developer or contractor must be documented in the safety statement. All hazards identified must be taken into account in test planning.

Select a series of physical test phases to demonstrate positively that the test item can be operated under all conditions of expected field use without danger to personnel or other equipment. Speccific tests will be selected based on a study of the function and operation of the test system, and may include portions of any or all of the following:

Vibration testing (TOP's 1-1-050 4/ and 6-2-540 5/).

Immersion test (MIL-STD-810C, method 512.1 6/).

Rain test (MIL-STD-810C, method 506.1).

Salt fog test (MIL-STD-810C, method 509.1).

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

3/ AR 70-10, Test and Evaluation During Development and Acquisition of Materiel, 29 August 1975.
4/ TOP 1-1-050, Vibration Testing, 4 March 1972.
5/ TOP 6-2-540, Vibration Tests, 30 December 1969.
6/ MIL-STD-810C, Environmental Test Methods, 10 March 1975.

Metallurgical and mechanical tests of materials (TOP 3-2-806 7/).

Temperature testing (MIL-STD-810C, several methods).

Human engineering tests (TOP 1-2-610 8/ and 10-2-505 9/).

Ensure that specific tests are included in the test plan to verify compliance with the safety and health criteria established for the system. Ensure that the system has been evaluated for health hazards as required by AR 40-5 10/. The US Army Environmental Hygiene Agency must evaluate the safety of all sources of non-ionizing radiation before test personnel may be exposed to the source of that radiation.

Prepare a schedule for initial examination and continuous observations of all performance tests and other field operations to identify and evaluate any hazards that are inherent in the test system, but which may not be revealed in specific physical tests. Use the checklists appended to this TOP to direct observers to specific areas of potential safety interest throughout all operations of the test system during the development test cycle.

Review the system support package, all instructional material, literature, and draft technical manuals.

Ensure required Standing Operating Procedures (SOPs) and Test Operations Procedures are available. The procedures for all hazardous operations will be documented in SOPs.

3.2 Operator Training and Familiarization. Ensure that the required new equipment operator training is conducted by the developer.

Conduct a preoperational briefing for all personnel prior to the start of the test. All personnel will review the hazards and precautions outlined in the safety statement and SOP.

3.3 Receipt Inspection. An initial safety inspection of the test item shall be performed by qualified test personnel with the assistance of a safety engineer, as required, prior to conducting all other tests of the item. The checklists in Appendix C provide a guide to the types of hazards which may be encountered. Satisfactory resolution concerning all potential hazards shall be obtained prior to conducting tests.

4. TEST CONTROLS.

4.1 Test Item Configuration. Test items are tested in the configuration and condition in which they are expected to be deployed and operated by the field army when performing the final safety evaluation, and issuing the safety confirmation. Preliminary safety releases issued with constraints may be issued for test hardware not in field release condition.

7/ TOP 3-2-806, Metallurgical and Mechanical Tests of Materiels, 10 January 1973; Change 1, 30 January 1974, Change 2, 13 November 1975.
8/ TOP 1-2-610, Human Factors Engineering, 20 December 1977.
9/ TOP 10-2-505, Human Factors Engineering, 1 September 1971.
10/ AR 40-5, Health and Environment, 25 September 1974.

4.2 Procedures for Accumulating Data. The results of initial safety inspection, hazard analysis of all test results, interviews, and operator reports of unsafe conditions will be used as methods of accumulating data.

4.3 Personnel. The test director, assisted by an occupationally qualified safety engineer, as required, will participate in the accumulation of data and analysis of the data using hazard analysis and risk assessment procedures.

4.4 Risk Assessment. Hazard analysis and risk assessment procedures will be used to establish the degree of hazard. The probability that the mishap will occur and the severity of potential consequences will be considered in this evaluation. Risk assessment procedures are described in Appendix A.

4.5 Data Required. Record the following:

4.5.1 Test Item. Nomenclature, serial number, and manufacturer; and identification of, and any modification to, the equipment or shelter in which the test item is mounted.

4.5.2 Instrumentation. Type, nomenclature, accuracy, date of last calibration, and location of each piece of instrumentation.

5. PERFORMANCE TESTS.

5.1 Method.

a. Perform an initial evaluation of the potential electrical, mechanical, and miscellaneous hazards in the system under test as described below, using the checklists of Appendix C prior to operating the test item.

b. Repeat the safety examination and record each appropriate element in the checklists at selected points in the test to determine whether the inherent safety of the system is affected by wear and operation incident to the accomplishment of other test phases (reliability, endurance, etc.).

c. Throughout all test operations that are conducted to evaluate other performance and reliability factors, make continuous observations to identify any potential hazards to personnel and equipment that may not have been anticipated by the test checklists. Investigate further any identified potential hazards by the conduct of special tests of the equipment under "worst case" conditions as selected by the test engineer. Determine the adequacy of all design features intended to eliminate or minimize potential hazards, and investigate any potential hazards which may occur or become more serious with additional operating hours.

d. Hazard analysis and risk assessment are conducted in conjunction with the acquisition of results from safety tests, safety inspections, operator comments, a review of the draft technical manual, safety-related observations, and results from other subtests. The hazards that are identified are evaluated using the techniques described in Appendix A.

5.1.1 Electrical and Electronic Hazards. Examine all instructional material; determine the location of all potential electrical hazards, and ensure that these hazards are clearly indicated and that appropriate precautionary notices and instructions are provided.

The test item shall be thoroughly inspected for safety during the initial safety inspection and during all phases of testing and evaluation. Comments and observations from equipment operators should be obtained.

The following electrical and electronic hazard sources should be considered when performing this evaluation:

a. Shock.

b. Short circuit.

c. Stored electrical charge (batteries, capacitors, and stray voltage).

d. Improper and/or inadequate ground.

e. Fire.

f. Overheating.

g. Ventilation.

h. Insulation failure.

i. Ionizing and non-ionizing radiation.

j. Sparks.

k. Arcing.

ℓ. Explosion or implosion.

m. Lightning protection.

A sample checklist upon which a safety evaluation of electrical and electronic hazards can be performed is included in Appendix C.

5.1.2 Mechanical Hazards. Carefully examine all instructional material to determine potential mechanical hazards.

Perform a thorough test item safety inspection and observe the item throughout all testing and evaluation phases. Solicit the comments and observations of equipment operators and maintainers.

The following potential mechanical hazard sources should be considered when performing this evaluation:

a. Rotating, reciprocating, and transverse motions.

b. Cam action.

c. Cutting actions - motion.

d. Cutting exposure - sharpness.

e. Punching, shearing, and bending actions.

f. Rate of speed.

g. Instability (center of gravity).

h. Entrapment.

i. Lack of clearance.

j. Stored energy - physical.

k. Improper rigidity.

ℓ. Impact.

A sample checklist upon which a safety evaluation of mechanical hazards can be performed is included in Appendix C.

5.1.3 Miscellaneous Hazards. Examine all instructional material to determine whether all potential hazards, not classified as electrical or mechanical, and all human factors and other considerations, not previously examined, are adequately treated.

Examine the system and all components in all operating modes and configurations for potential hazards not covered in previous tests. Consideration should be given to the following hazardous conditions:

a. Fire and explosion.

b. Hot substances and hot exposed surfaces.

c. Dangerous fuels, cleaning fluids, acids, caustics, solvents, and other harmful chemicals.

d. Toxic dusts, gases, fumes, and mists.

e. Visible and invisible high-intensity light sources.

f. Improper lighting of work areas.

g. Inefficient and poorly designed heating, cooling, and ventilating equipment.

h. Excessive noise.

i. Lasers.

j. High pressure gas on hydraulic lines.

k. Electromagnetic radiated power density.

When applicable, measure and record:

a. Temperature of exposed, hot surfaces.

b. Air contamination and oxygen depletion in shelters and other confined work spaces.

c. Internal temperatures generated within the equipment.

d. Ambient temperature in work areas.

e. Ambient sound level in work areas.

f. Intensity and distribution of illumination in work areas.

A sample checklist upon which an evaluation of miscellaneous hazards can be based is included in Appendix C.

5.2 Data Required. Tabulate the results of each examination and each physical test related to safety of the test system. Record the conditions of use from the log book, such as temperature, humidity, and other environmental data. Record and describe any features that require further investigation, including any hazards that could occur or increase as a result of increased operating hours.

6. DATA REDUCTION AND PRESENTATION.

6.1 Data Presentation. The format shown in Figure 1, Appendix A, will be used to present all conditions which are hazardous to personnel, equipment, and property.

6.2 Narrative Description of Test Results. Sufficient narrative comments will be included on each condition to provide background information to be used in the analysis of test results.

6.3 Analysis. Each hazardous condition will be analyzed as outlined in Appendix A to determine the category (severity) and probability of the hazard. For electrical and electronic hazards, additional guidance is contained in Appendix B for assigning hazard severity and probability levels. The classification guide in TOP 1-1-012 11/ will be used to classify deficiencies, shortcomings, and suggested improvements 12/.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander: US Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, MD 21005. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

11/ TOP 1-1-012, Classification of Deficiencies and Shortcomings, 1 April 1979.

12/ DARCOM Regulation 385-12, Life Cycle Verification of Materiel Safety, 29 June 1972.

APPENDIX A
EQUIPMENT OPERATION HAZARD ANALYSIS

Operating hazard analysis may be performed during development testing to identify hazards associated with equipment, procedures, and personnel. Data from all development subtests can be used to prepare the Equipment Operation Hazard Analysis.

Figure 1 is a typical Equipment Operation Hazard Analysis Worksheet. This worksheet is designed to assure a complete analysis and classification of hazards that have been identified. The following instructions apply to the worksheet:

a. Hazard Description - Describe the personnel error, environmental condition, design inadequacy, procedural deficiency, system or component malfunction that presents a hazard to personnel, equipment, or property.

b. Hazard Effect - Describe the worst potential consequences to operation or maintenance personnel, equipment or property should the hazard continue to exist.

c. Hazard Category - Categorize the hazard in accordance with the provisions of MIL-STD-882A 13/. This is accomplished in two parts. First, consider the hazard effect described in the second column of the worksheet. Based on this description, assign one of four possible hazard categories shown below:

(1) CATEGORY I - CATASTROPHIC: May cause death or system loss.

(2) CATEGORY II - CRITICAL: May cause severe injury, severe occupational illness, or major system damage.

(3) CATEGORY III - MARGINAL: May cause minor injury, minor occupational illness, or minor system damage.

(4) CATEGORY IV - NEGLIGIBLE: Will not result in injury, occupational illness, or system damage.

13/ MIL-STD-882A, System Safety Program Requirements, 28 June 1977.

HAZARD DESCRIPTION	HAZARD EFFECT	HAZARD CATEGORY	HAZARD CONTROLS AND REMARKS

Figure A-1. Typical Equipment Operation Hazard Analysis Worksheet.

After assigning the hazard category, then the qualitative probability that the hazard effect will occur in a specific individual item or in the Army inventory must be assigned. One of six possible hazard probability levels must be assigned from those listed below:

Hazard Probability

Descriptive Word	Level	Specific Individual Item	Inventory
Frequent	A	Likely to occur frequently	Continuously experienced
Reasonably Probable	B	Will occur several times in life cycle of an item	Will occur frequently
Occasional	C	Likely to occur sometime in life cycle of an item	Will occur several times
Remote	D	So unlikely it can be assumed that this hazard will not be experienced	Unlikely to occur but possible
Extremely Improbable	E	Probability of occurrence cannot be distinguished from zero	So unlikely it can be assumed it will not be experienced
Impossible	F	Physically impossible to occur	Physically impossible to occur

Together, the hazard category (severity) and the hazard probability completely classify the hazard in accordance with MIL-STD-882A. For example, a hazard that could occasionally result in a critical mishap is a Category II-C hazard. This designation is entered in the third column of the worksheet.

To classify the hazard as a deficiency, shortcoming, or suggested improvement, the Hazard Classification Guidelines provided as Figure 2 should be used. This classification is also entered in the third column of the worksheet.

d. Hazard Controls and Remarks - Comments relative to what should be done to prevent the hazard or protect against the consequences are included in the fourth column of the worksheet.

		HAZARD PROBABILITY					
		FREQUENT	REASONABLY PROBABLE	OCCASIONAL	REMOTE	EXTREMELY IMPROBABLE	IMPOSSIBLE
SPECIFIC INDIVIDUAL ITEM		Likely to occur frequently	Will occur several times in life of item	Likely to occur sometime in the life of item	So unlikely, can be assumed that this hazard will not be experienced	Probability of occurrence cannot be distinguished for zero	Physically impossible to occur
FLEET OR INVENTORY		Continuously experienced	Will occur frequently	Will occur several times	Unlikely to occur, but possible	So unlikely, can be assumed that this hazard will not be experienced	Physically impossible to occur
		A	B	C	D	E	F
HAZARD SEVERITY							
CATASTROPHIC - May cause death or system loss	I	DEFICIENCY	DEFICIENCY	DEFICIENCY	DEFICIENCY	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
CRITICAL - May cause severe injury or illness, or major system damage	II	DEFICIENCY	DEFICIENCY	DEFICIENCY	SHORTCOMING	SUGGEST IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
MARGINAL - May cause minor injury or illness, or minor system damage	III	DEFICIENCY	SHORTCOMING	SHORTCOMING	SUGGESTED IMPROVEMENT	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
NEGLIGIBLE - Will not result in injury or illness, or system damage	IV	SHORTCOMING	SUGGESTED IMPROVEMENT	SUGGESTED IMPROVEMENT	SUGGESTED IMPROVEMENT OR ACCEPTABLE	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE

Figure A-2. Hazard Classification Guidelines.

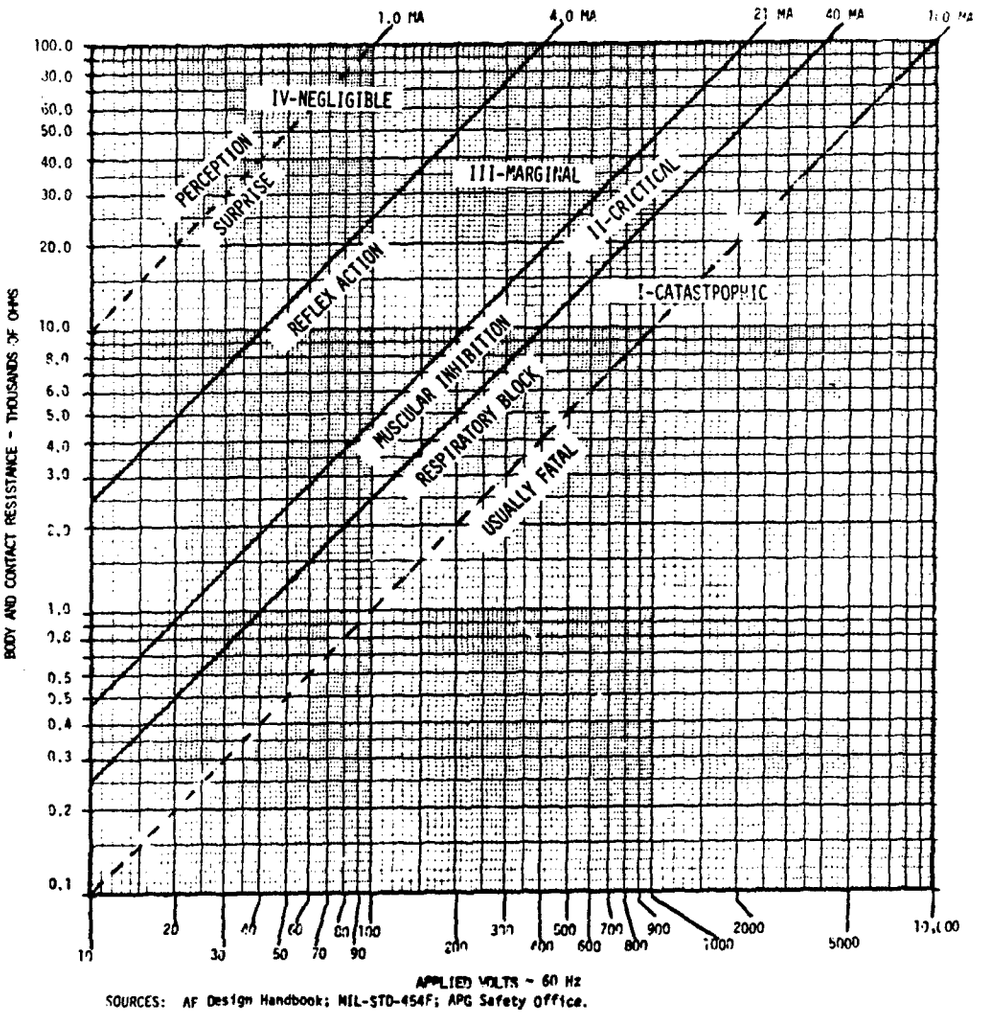
APPENDIX B
CLASSIFICATION OF ELECTRONIC AND ELECTRICAL SHOCK HAZARDS

These guidelines apply to the analysis of electronic and electrical hazards in electronic equipment and components to which MIL-STD-454F 14/ applies.

Accidental contact by operating and maintenance personnel with electrically energized terminals, contacts, and like devices in electronic equipment may result in sufficient current flow through the body to cause serious injury or death. Requirement No. 1 of MIL-STD-454F presents those design features required of electrically energized equipment to minimize the danger they represent to personnel. These requirements are largely assessed when the checklist for electrical and electronic hazards found in Appendix C is used to evaluate electronic equipment.

Each hazard that is identified when using the checklist or any other test must be categorized in accordance with MIL-STD-882A, and subsequently classified as a potential deficiency, shortcoming, or suggested improvement. In addition to voltage considerations, estimates should also be made of the amount of current that could flow through the body, and of the corresponding probable effects of shock. It should be noted that many high-voltage, low-energy devices such as small cathode-ray tubes, are supplied by power supplies that limit total current available to a specific maximum value. This "short circuit" maximum current should be considered when assessing the hazard of such voltages. Figures B-1 and B-2 present the electrical shock hazard to adult males using the values of Table 1-I of Requirement 1 of MIL-STD-454F as a guide. Figures B-1 and B-2 present usual physiological effects on adult males, as listed in Table 1-I of MIL-STD-454F, and MIL-STD-882A hazard-severity levels consistent with these physiological effects. After examining Figures B-1 and B-2, it is evident that the physiological effect and associated hazard severity levels depend upon the body and contact resistance, the applied potential, and whether the power source is 60 Hz AC or DC. The body and contact resistance depends upon several exposure factors: the probable current path through the body, the duration of exposure, body weight, potential contact surface area, and whether the contact area is wet or dry. These exposure factors are probabilistic, and their combination, resulting in a particular exposure, can be assigned a qualitative hazard-probability level consistent with the requirements of MIL-STD-882A. Using Note 2 of either Figure B-1 or B-2 it is possible to estimate the body and contact resistance for most common exposures. Thus having estimated the body and contact resistance for a potential exposure, and knowing the power source and applied voltage, the appropriate figure may be used to determine the probable physiological effect and resultant hazard-severity level. This hazard-severity level and the qualitative hazard-probability level already established are used to complete the hazard-analysis procedure described in Appendix A of this document.

14/ MIL-STD-454F, Standard General Requirments for Electronic Equipment, 15 March 1978, with Notice 1, 1 September 1978, Notice 2, 30 June 1979, and Notice 3, 10 September 1979.



SOURCES: AF Design Handbook; MIL-STD-454F; APG Safety Office.

See Notes on following page.

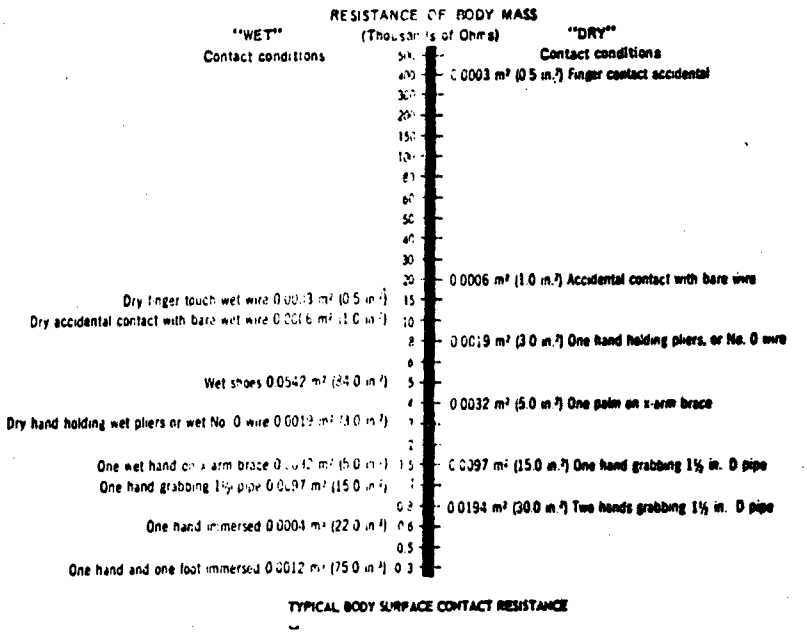
Figure B-1. Guide to Classification of Electrical Shock Hazards (Adult Males - 60 Hz).

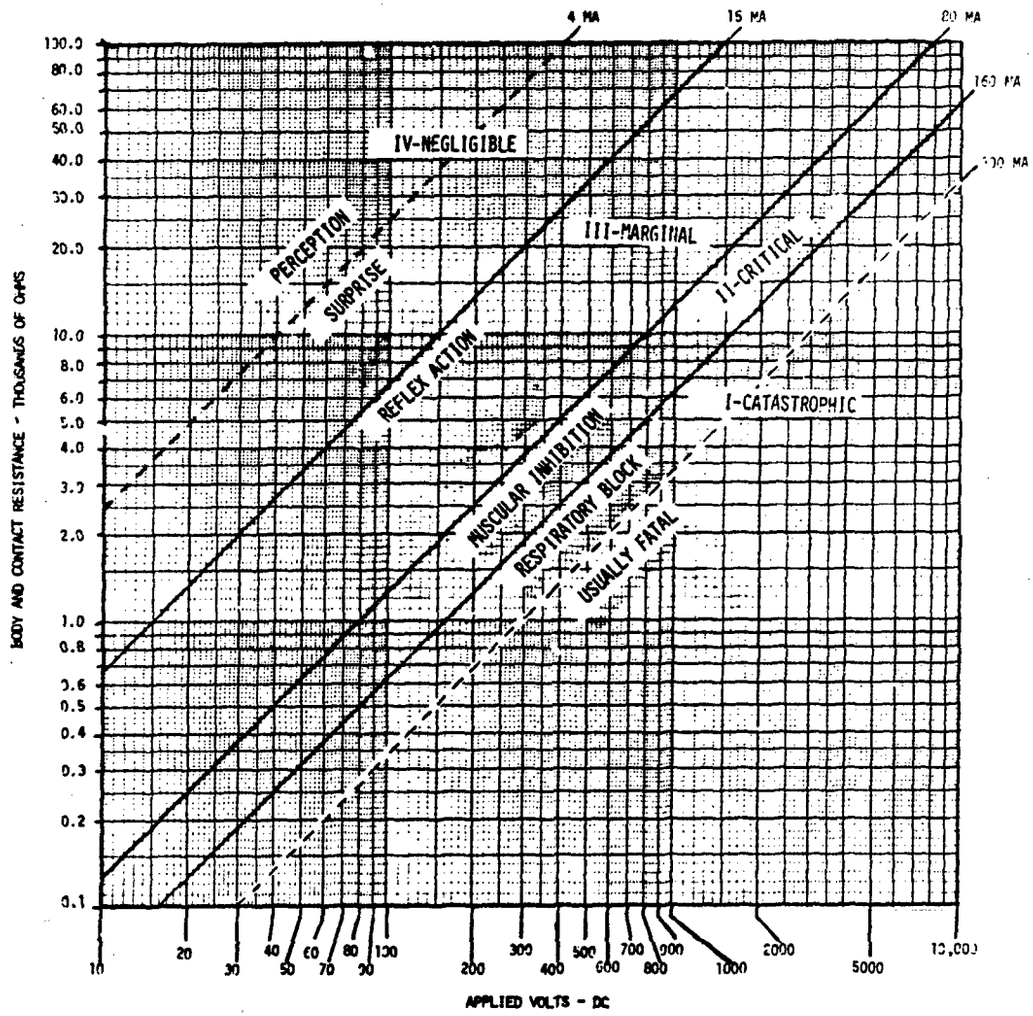
NOTE 1

THIS FIGURE SHOWS THE ELECTRICAL CURRENT HAZARD TO ADULT MALES AS A FUNCTION OF THE APPLIED 60-Hz VOLTAGE AND THE BODY AND CONTACT RESISTANCE. SUSCEPTIBILITY TO SHOCK IS GENERALLY GREATER FOR FEMALES AND PERSONS OF BELOW AVERAGE WEIGHT.

AN ELECTRIC CURRENT OF A GIVEN AMOUNT AFFECTS THE BODY IN MANY DIFFERENT WAYS DEPENDING ON THE PATH OF THE CURRENT. CURRENT PATHS INCLUDING THE HEAD OR TRUNK RESULT IN MORE SERIOUS INJURY THAN THOSE CONFINED TO ONE EXTREMITY. CURRENT PATHS THROUGH OR NEAR THE HEART OR RESPIRATORY SYSTEM MUSCLES OR THROUGH THE BRAIN ARE THE MOST CRITICAL.

NOTE 2





SOURCES: AF Design Handbook; MIL-STD-454F; APG Safety Office.

See Notes on following page.

Figure B-2. Guide to Classification of Electrical Shock Hazards (Adult Males - DC).

NOTE 1

THIS FIGURE SHOWS THE ELECTRICAL CURRENT HAZARD TO ADULT MALES AS A FUNCTION OF THE APPLIED DC VOLTAGE AND THE BODY AND CONTACT RESISTANCE. SUSCEPTIBILITY TO SHOCK IS GENERALLY GREATER FOR FEMALES AND PERSONS OF BELOW AVERAGE WEIGHT.

AN ELECTRIC CURRENT OF A GIVEN AMOUNT AFFECTS THE BODY IN MANY DIFFERENT WAYS DEPENDING ON THE PATH OF THE CURRENT. CURRENT PATHS INCLUDING THE HEAD OR TRUNK RESULT IN MORE SERIOUS INJURY THAN THOSE CONFINED TO ONE EXTREMITY. CURRENT PATHS THROUGH OR NEAR THE HEART OR RESPIRATORY SYSTEM MUSCLES OR THROUGH THE BRAIN ARE THE MOST CRITICAL.

NOTE 2

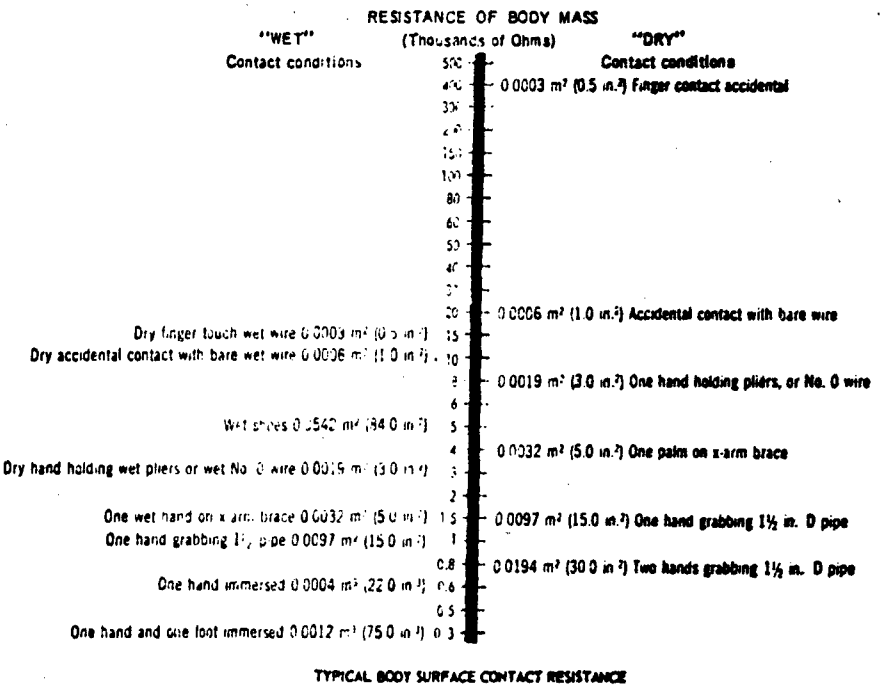


Figure B-2 (Cont'd)

APPENDIX C
CHECKLISTS FOR IDENTIFYING HAZARDS

CHECKLIST FOR ELECTRICAL AND ELECTRONIC HAZARDS

YES	NO	NA

1. Is the path to ground from the equipment continuous and permanent?

2. Does the grounding system have sufficient mechanical strength to minimize the possibility of accidental ground disconnection?

3. Is the ground connection to the chassis or frame mechanically secured by one of the following methods?

   a. Secured to a spot-welded terminal lug.

   b. Secured to a portion of the chassis or frame that has been formed into a soldering lug.

   c. Secured to a terminal on the ground wire by a screw or nut and a lockwasher.

4. Is a grounding stud (hand-operated quick-disconnect nut) provided for all transmitting equipment to permit attachment of a portable ground rod?

5. Is the ground stud identified by a label or other marking?

6. Is the grounding system of sufficient gage size to conduct safely any currents that may be imposed upon it, including lightning protection?

7. Is the impedance of the ground system sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuits?

8. Are ground connections to shields and other mechanical parts, except the chassis and frame, made independently of the electrical circuits?

9. Is the ground wire color-coded green or green with yellow stripes?

YES	NO	NA

10. Are all external metal parts, control shafts, bushings, and shields, exclusive of antenna and transmission line terminals, at ground potential at all times?

11. Is shielding sufficiently separated from exposed conductors to prevent shorting or arcing?

12. Do plugs and convenience outlets for use with portable tools and equipment have provisions for automatic grounding of the frame or case of the tools and equipment when the plug is mated with the receptacle?

13. Are operating personnel protected from accidental contact with voltages in excess of 30 volts?

14. Are shorting rods provided in all transmitting equipment having voltages in excess of 70 volts rms?

15. Are all contacts, terminals, and like devices having potentials in excess of 500 volts rms or dc clearly marked: DANGER HIGH VOLTAGE _____ (maximum voltage applicable) VOLTS, in white on red background?

16. Are assemblies operating at potentials in excess of 500 volts rms or dc completely enclosed from the remainder of the assembly, and is the enclosure provided with non-bypassable interlocks?

17. Are guards, safety covers, and warning plates provided for potentials between 70 and 500 volts rms or dc on contacts, terminals, and like devices?

18. Are barriers or guards protecting voltages, 70-500 volts, clearly marked to indicate approximate normal highest voltage encountered upon its removal?

19. Are built-in test points provided where measurements are required on equipment employing 300 volts or more?

20. Are test points and paralleled voltage dividers provided to allow measurements of all test voltages at a potential of 300 volts or less?

21. Does the design of test points require plug-in (not clamp-on) of test instruments?

YES	NO	NA

22. Are all high-voltage circuits and capacitors (500 volts and over) discharged to 30 volts within 2 seconds or less of the time the case is opened (valid for 0.25 joules or more)?

23. When equipment is designed to operate on more than one type of input power, are adequate precuations taken to prevent connection of improper power?

24. Where design considerations require plugs and receptables of similar configurations, are mating plugs and receptacles suitably coded and marked?

25. Are dc input power connections clearly marked for polarity?

26. Do meters have protection against high voltage or current at the terminals?

27. Are current and voltage overload protective devices provided?

28. Are physically similar but electrically noninterchangeable components so keyed that it is impossible to insert a wrong unit?

29. Are green indicator lamps provided to indicate "power on" situation to the equipment?

30. Are single-phase power cables properly color-coded (black (hot), white (neutral), green (ground))?

31. Are three-phase cables coded as indicated in 30 above with Phase 2 red and Phase 3 blue?

32. Are wires and cables adequately supported and terminated to present shock and fire hazard?

33. Are wires and cables properly protected at points where they pass through metal partitions?

34. Are both sides of the supply voltage not directly connected to the chassis?

35. Are controls located away from high voltage points and hot tubes?

YES	NO	NA

36. Are internal controls such as switches located away from dangerous voltages?

37. Is the equipment designed so that receptacles are "hot" and the plugs are "cold" when disconnected?

38. Does the design of plugs and receptacles preclude exposure to electrical shock or burns when normal disconnect methods are used?

39. Does the main power breaker cut off all power to the complete equipment or system?

40. Is the main power breaker clearly identified?

41. Is the main power breaker in an easily accessible location?

42. Are safety switches provided which will deactivate associated mechanical drive units without disconnecting other parts of the equipment?

43. Are power input side of the main power switch and the incoming power line connectors protected from accidental contact by operators or maintenance personnel?

44. Are equipment power switches located in a manner to preclude activation of equipment by accidental contact?

45. Are emergency controls placed in readily accessible positions?

46. Are potential electrical hazards adequately treated in the instructional manual?

47. Can the power be cut off while installing, replacing, or interchanging a complete equipment assembly or part thereof?

48. Are all cathode-ray tubes adequately shielded to protect personnel from injury due to imploding?

49. Are high voltage signs conspicuously displayed near cathode-ray tubes?

50. Are instructions provided for disposal of transmitting and receiver-protector tubes, spark gaps, self-luminescent sources, and other items containing radioactive material?

YES	NO	NA

51. Are there provisions for preventing hazardous overcharging and overheating conditions that could damage batteries or cause an explosion with resultant personnel injury or equipment damage?

52. Is adequate ventilation provided for batteries that generate hydrogen gas during charge or use?

53. Are there provisions for preventing excessive system voltages during battery charging operations?

ANTENNAS

54. Are antenna and transmission line terminals at ground potential except for radiated RF energy on their external surfaces?

55. Is insulation provided to protect personnel from RF burns?

56. Are antenna tips designed to prevent puncture wounds?

57. If vehicle-mounted antennas could contact overhead electrical lines, are warning labels provided?

58. Are lock-out devices provided for antennas operated from remote locations?

59. Are rotating antennas provided with a local, power-cutoff switch at the antenna?

SHELTERS, VANS, TRAILERS

60. Are shelter ground rods and straps provided?

61. Is a ground stud provided at the power entry box?

62. Is the ground stud identified by a label or other marking?

63. Are all convenience outlet ground pins hard-wired to the ground stud?

64. Are all ground wires color coded green?

65. Is the ground wire separate from the neutral circuit?

YES	NO	NA

66. Does the power cable have a green ground wire which is not used as a current-carrying conductor or power return?

67. Does all GFE have the ground isolated from neutral? (except generators)

68. Is the power cable ground wire connected to the ground stud?

69. Is a power-on indicator light provided that is extinguished only when the power source to the shelter is terminated?

70. Are indicator lights properly color coded? (Information, white; Caution, amber; Danger, red; and Power On, green)

71. Are maintenance personnel protected from accidental contact with all potentials over 70 volts? (excluding convenience outlets)

72. Are remotely located assemblies provided with safety switches to allow independent disconnection of the equipment?

73. Do floor surfaces provide adequate insulating characteristics?

CHECKLIST FOR LASER HAZARDS

1. Has the US Army Environmental Hygiene Agency performed a hazard-evaluation survey of the laser system?

2. Does the laser design comply with the requirements of Title 21, Code of Federal Regulations, Part 1040? Is there a label affixed to the laser indicating compliance with this standard?

3. Is the laser exempt from the requirements of Title 21, CFR, Part 1040? If so, is there a label affixed to the laser indicating that its an exempt laser?

4. Exempt lasers:

   a. Is there an interlock system incorporated into the access panels or doors of such laser equipment if hazardous optical radiation levels are present upon opening the housing or if accidental laser activation could result from working in the inclosure?

YES	NO	NA

b. Is there a readily visible indication or audible warning that is activated if the interlock is cheated?

c. Is there a laser-emission indicator provided which alerts the operator at all times when the laser is prepared to fire (armed) and during laser emission?

d. Are these indicators visible under daylight as well as nighttime illumination conditions?

e. Is there a beam attenuater provided which reduces the laser output to a Class I level when the laser is in a stowed position or "training mode?"

f. Is there a protective filter in laser equipment at optical sight or any sights which might expose the operator to hazardous reflections in normal use of the laser?

g. Does laser activation require at least two separate actions by the operator?

h. Is the laser fire button clearly labeled and physically protected to prevent accidental activation?

i. Is the laser activation circuitry for pulsed lasers of a fail-safe design such that continual depression or short circuit of the fire control button will not cause repeated laser emissions unless such repetition is required?

j. Are appropriate warning labels prominently affixed to the laser system housing near the beam exit port and/or the laser fire button for all Class III and Class IV lasers?

k. Are Eye-Safe, Group B, laser-training or combat-simulation devices appropriately labeled?

5. Are instructions provided for disposal of transmitting and receiver-protector tubes, spark gaps, self-luminescent sources, and other items containing radioactive material?

6. Do operating manuals contain all necessary precautions for operating laser equipment?

YES	NO	NA

7. Are precautions taken against scattering of the laser beam during sand storms, rain, snow, fog, or when other foreign material is present in the air?

8. Are warnings posted to warn personnel from viewing a laser spot using ordinary optical equipment?

9. Are warnings posted to warn personnel from intercepting the laser beam by eye?

CHECKLIST FOR MECHANICAL HAZARDS

1. Is the equipment designed so that the center of gravity, configuration, and location of legs and supports make the equipment unlikely to tip over from unbalance or strong wind?

2. Are expandable and collapsible structures such as shelters, jacks, supports, masts, tripods, etc., free of projections, sharp edges, or design features which might be hazardous to personnel?

3. Are lifting rings provided for equipment which is normally moved or lifted by machine, and are they designed to safely support the total weight of the shelter and installed equipment?

4. Do doors and hinged covers have positive-acting hold-open devices?

5. Are locking mechanisms for doors and drawers designed to prevent injury to the operator when the lock is released?

6. Is it evident when a cover is in place but not secured? If equipment can be damaged through operation with vent covers in place, are interlocks provided to prevent this?

7. Is the equipment provided with suitable carrying handles?

8. Are handles recessed rather than extended where they might be hazardous?

9. Are handles positioned so they cannot catch on other units, wiring or protrusions?

	YES	NO	NA
10. Are handles located over center of gravity whenever possible?			
11. Is equipment weighing over 35 pounds (16 kg) labelled to indicate lifting requirements?			
12. Are doors and other openings free of hazards from improperly designed catches, hinges, supports, fasteners, and stops?			
13. Are heavy parts located as close as possible to load-bearing structures, and as low as possible?			
14. Is the weight distributed so that the equipment is easy to handle, move, or position?			
15. When the equipment is to be manpacked, is the weight and configuration designed so that the combat effectiveness of the foot soldier is not jeopardized?			
16. Is the equipment free of sharp or overhanging edges and corners that might cause injury to personnel?			
17. Are limit stops provided on roll-out racks and drawers?			
18. Are there provisions for easily overriding limit stops on roll-out racks and drawers?			
19. Is the method of opening a cover evident from the construction of the cover? If not, is an instruction plate permanently attached to the outside of the cover?			
20. Are components placed to allow sufficient space for use of test equipment and tools?			
21. Where item design includes the use of pressurized systems and components, are safety and/or relief valves, controls and other safety features provided?			
22. Do exposed gears, cams, levers, fans, belts, or other reciprocating, rotating, or moving parts have adequate safety covers?			
23. When required, are provisions made for protection against eye hazards from flying particles?			

YES	NO	NA

24. Are guards or other safety devices provided for easily damaged conductors such as wave guides or high-frequency cables and for high-pressure gas or hydraulic lines?

25. Are potential mechanical hazards adequately treated in the instruction manual?

26. When glass is used, is it glareproof, and shatterproof where the use of glass is essential to equipment operations or where breakage would endanger personnel?

27. Are access doors shaped as necessary to permit passage of components and required implements?

28. Are critical warning lights isolated from other less important lights for best effectiveness?

SHELTERS, VANS, TRAILERS

1. Does vehicle weight distribution comply with technical requirements? Ref (SCL-1280)

2. Does lateral stability comply with technical requirements? (SCL-1280)

3. Does the mounting of shelters on vehicles provide sufficient mechanical strength to minimize potential equipment damage?

4. Do instruction manuals or instruction plates provide adequate instructions for placement of semitrailers when detached from towing vehicle?

5. Are steps and ladders and methods of supporting them safely made?

6. Are entrances to equipment shelters free of hazardous obstructions?

7. Do walking and climbing surfaces provide adequate nonslip characteristics?

8. Are fasteners and methods of securing equipment to walls and racks sufficiently strong to prevent breakaway and falling?

YES	NO	NA

9. Can equipment shelters mounted on vehicles be entered without encountering a hazard?

10. If personnel are required to work on the shelter roof, are ladders, non-slip roof surfaces and guardrails or chains provided?

11. Are provisions made in vehicular and shelter installations for securing equipment tools and accessories during movement?

12. Are struts and latches provided to secure hinged and sliding components against accidental movement.

13. Are safety measures provided in the event the trailer becomes detached from the towing vehicle?

14. When semitrailers are detached from towing vehicles do dolly wheels or landing gear provide adequate support?

15. If a standard military vehicle has been modified to accommodate the equipment, is the vehicle still capable of satisfactory and safe operation?

CHECKLIST FOR MISCELLANEOUS HAZARDS

1. Have fire and explosion hazards been kept to a minimum by use of proper components and ventilation?

2. Are fire extinguishers provided and mounted in easily accessible locations?

3. Are fire extinguishers the proper type for the equipment and for the overall installation?

4. Are properly marked fire exits provided in shelters when required?

5. Have precautions been taken to assure that the storage and distribution of flammable material is done safely?

6. Is a self-closing metal can provided for oily rags and waste where required?

	YES	NO	NA
7. If multi-fuel heaters are provided:			
a. Is the fuel line as short as possible inside the shelter?			
b. Is there a shut-off valve inside the shelter?			
c. Is a fuel line and jerry-can adapter provided for connection to the external fuel source?			
d. Is the heater exhaust pipe located as far as possible from the fuel intake valve?			
e. Does the routing of the heater exhaust pipe preclude a concentration of carbon monoxide in the shelter?			
f. Are fuel supply cans located outside the shelter and away from the heater?			
8. If battery compartments are located in the shelter:			
a. Are they enclosed and provided with forced-air ventilation to the outside of the shelter?			
b. Is a device provided to warn personnel that the battery vent lid or door is closed or that the forced-air-ventilation fan is not working?			
c. Is the compartment labelled to warn personnel of the potential presence of explosive gas accumulations?			
d. On vehicle-mounted shelters, is the vehicle exhaust located in a manner to preclude entry of carbon monoxide into the shelter?			
e. Does the equipment installation provide adequate overhead clearance for personnel?			
9. Are protective devices and warning signs provided against all sources of potentially dangerous radiant energy; e.g., ultraviolet, microwave, laser, and X-ray?			
10. Is the hazardous range of microwave-radiating equipment clearly presented?			

YES	NO	NA

11. Has the Army Environmental Hygiene Agency evaluated the hazards associated with laser, microwave, and radiation sources?

12. Does the illumination enhance safety by providing:

    a. Suitable brightness for the task?

    b. Uniform lighting on the task?

    c. Suitable contrast between task and background?

    d. Freedom from glare from illuminant or surfaces?

    e. Suitable quality and color?

13. Do warning lights provide sufficient contrast with ambient illumination levels?

14. Does the ventilating system provide for operator safety by ducting excess heat librated by equipment to the outside of the shelter?

15. Is cooling air for shelter-mounted equipment completely separated from the personnel space to prevent contamination of the surrounding air?

16. Are adequate precautions made to prevent exposure of personnel to respiratory hazards from toxic gases, dusts, fumes, and mists?

17. Have tests been made to insure no radium has been used in the equipment?

18. Is the equipment free of radioactive material? (Tubes, knobs, meters, dials, scales, markings, etc. - if no, indicate isotope and quantity in remarks column of supplemental sheet.)

19. Are radiation markings and labels affixed to all parts or components containing radioactive material?

20. Are adequate safety devices and safety instructions provided for handling and use of gases stored under high pressure extreme temperatures; e.g., hydrogen, helium, oxygen, nitrogen?

YES	NO	NA	
			21. Is protection provided against hot surfaces that might be dangerous to personnel?
			22. When necessary, are ear and eye protection devices provided?
			23. Is the ambient noise level acceptable for personnel safety and efficiency?
			24. Is the equipment provided with sufficient cautions plates to warn maintenance personnel of potential safety hazards?
			25. Are warning signs coded and colored in accordances with ANSI Z35-1-1972 15/?
			26. Does instructional material stress "good housekeeping" as an important means for accident prevention?
			27. Are all safety requirements of the applicable specification or technical requirement complied with?
			28. Are all potential hazards adequately identified and described in instruction manuals and by clear warning signs?

15/ ANSI Z35-1-1972, Accident Prevention Signs, Specifications for.

AD-A092174

US ARMY TEST AND EVALUATION COMMAND
Aberdeen Proving Ground, Maryland 21005

TOP 3-2-503
AD No. A092174
Change 1

14 September 1982

SAFETY EVALUATION OF FIRE CONTROL SYSTEMS -
ELECTRICAL AND ELECTRONIC EQUIPMENT

TOP 3-2-503, 15 August 1980, is changed as follows:

1. Remove pages and insert new pages as indicated below:

Remove pages--	Insert pages--
A-4 and A-5	A-4 and A-5

2. Attach this sheet to the front of the reference copy for information.

Tab 1

After assigning the hazard category, then the qualitative probability that the hazard effect will occur in a specific individual item or in the Army inventory must be assigned. One of six possible hazard probability levels must be assigned from those listed below:

Hazard Probability

Descriptive Word	Level	Specific Individual Item	Inventory
Frequent	A	Likely to occur frequently	Continuously experienced
Reasonably Probable	B	Will occur several times in life cycle of an item	Will occur frequently
Occasional	C	Likely to occur sometime in life cycle of an item	Will occur several times
Remote	D	So unlikely it can be assumed that this hazard will not be experienced	Unlikely to occur but possible
Extremely Improbable	E	Probability of occurrence cannot be distinguished from zero	So unlikely it can be assumed it will not be experienced
Impossible	F	Physically impossible to occur	Physically impossible to occur

Together, the hazard category (severity) and the hazard probability completely classify the hazard in accordance with MIL-STD-882A. For example, a hazard that could occasionally result in a critical mishap is a Category II-C hazard. This designation is entered in the third column of the worksheet.

To classify the hazard as a deficiency, shortcoming, or suggested improvement, the Hazard Classification Guidelines provided as Figure 2 should be used. This classification is also entered in the third column of the worksheet.

d. Hazard Controls and Remarks - Comments relative to what should be done to prevent the hazard or protect against the consequences are included in the fourth column of the worksheet.

		HAZARD PROBABILITY					
		FREQUENT	REASONABLY PROBABLE	OCCASIONAL	REMOTE	EXTREMELY IMPROBABLE	IMPOSSIBLE
SPECIFIC INDIVIDUAL ITEM		Likely to occur frequently	Will occur several times in life of item	Likely to occur sometime in the life of item	So unlikely, can be assumed that this hazard will not be experienced	Probability of occurrence cannot be distinguished from zero	Physically impossible to occur
FLEET OR INVENTORY		Continuously experienced	Will occur frequently	Will occur several times	Unlikely to occur, but possible	So unlikely, can be assumed that this hazard will not be experienced	Physically impossible to occur
		A	B	C	D	E	F
HAZARD SEVERITY							
CATASTROPHIC - May cause death or system loss	I	DEFICIENCY	DEFICIENCY	DEFICIENCY	DEFICIENCY	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
CRITICAL - May cause severe injury or illness, or major system damage	II	DEFICIENCY	DEFICIENCY	DEFICIENCY	SHORTCOMING	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
MARGINAL - May cause minor injury or illness, or minor system damage	III	DEFICIENCY	SHORTCOMING	SHORTCOMING	SUGGESTED IMPROVEMENT	SUGGESTED IMPROVEMENT OR ACCEPTABLE	ACCEPTABLE
NEGLIGIBLE - Will not result in injury or illness, or system damage	IV	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE

Figure A-2. Hazard Probability vs. Hazard Severity