UNCLASSIFIED

NOT MEASUREMENT SENSITIVE

ATPD-2404
21 OCTOBER 2011

INTERFACE STANDARD

ENVIRONMENTAL CONDITIONS FOR THE HEAVY BRIGADE COMBAT TEAM TRACKED VEHICLE SYSTEMS

UNCLASSIFIED: Distribution Statement A. Approved for public release.

FOREWORD

1. This standard is approved for use by the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC), Research, Development and Engineering Command (RDECOM), Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Comments, suggestions, or questions on this document should be addressed to U.S. Army Tank-automotive and Armaments Command, ATTN: RDTA-EN/STND/TRANS, MS# 268, 6501 E. 11 Mile Road, Warren, MI 48397-5000 or emailed to DAMI_STANDARDIZATION@conus.army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

1 SCOPE

1.1 Scope.

This standard establishes nuclear survivability and environmental interface requirements for Heavy Brigade Combat Team (HBCT) tracked vehicle systems, subsystems and equipment.

1.2 Application.

This standard is applicable for complete tracked vehicle systems and the subsystems/equipment integrated into the tracked vehicle system, both new and modified.

2 APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are referenced in sections 4, and 5 of the main body of this standard. This section does not include documents referenced in other sections of this standard or recommended for additional information or examples. While every effort has been made to ensure completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 4, and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards and handbooks.

The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those sited in the solicitation or contract.

INTERNATIONAL STANDARDIZATION AGREEMENTS

QSTAG 1031 - Quadripartite Standardization Agreement (QSTAG) 1031, Addition 1, Annex D (SECRET).

(Copies of these documents are available from http://nsa.nato.int/nsa/ or NATO Standardization Agency, North Atlantic Treaty Organization HQ, 1110 Brussels, Belgium, or as directed by the contracting officer.)

COMMERCIAL ITEM DESCRIPTIONS

A-A-52557 - Fuel Oil, Diesel; for Posts, Camps, and Stations
A-A-59133 - Cleaning Compound, high Pressure (Steam) Cleaner

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5

MIL-PRF-6083	-	Hydraulic Fluid, Petroleum Base, for Preservation and Operation
MIL-DTL-16884	-	Fuel, Naval Distillate
MIL-PRF-46170	-	Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base, NATO Code No. H-544
MIL-DTL-83133	-	Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F 34), NATO F-35, and JP-8+100 (NATO F-37)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-810	-	Department of Defense Test Method Standard
MIL-STD-1472	-	Human Engineering

(Copies of these documents are available from https://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications.
The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ARMY REGULATIONS AND PAMPHLETS

AR 70-38	-	Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions
DA-PAM 70-3	-	Army Acquisition Procedures

(Copies of these documents are available from http://www.army.mil/usapa/index.html.)

U.S. ARMY NUCLEAR AND COMBATING WMD AGENCY (USANCA)

United States Army Nuclear and Combating WMD Agency (USANCA) Memorandum for Project Manager HBCT; Subject: Chemical, Biological, Radiological, Nuclear (CBRN) Survivability Criteria for the Abrams; 25 July 2011 (SECRET)

(Copies of these documents are available from usarmy.belvoir.hqda-dcs-g-3-5-7.mail.usanca-mailbox@mail.mil with ATTN: Capabilities Division in the subject line, or U.S. Army Nuclear and Combating WMD Agency, ATTN: Capabilities Division, 5915 16th Street, Building 238, Fort Belvoir, VA 22060-5514)

2.3 Non-Government publications.
The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D975	-	Standard Specification for Diesel Fuel Oils
ASTM D1655	-	Standard Specification for Aviation Turbine Fuels
ASTM D 4814	-	Standard Specification for Automotive Spark-Ignition Engine Fuel

(Copies of these documents are available from www.astm.org or ASTM International, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence.
In the event of a conflict between the text of this document and the references cited herein, the test of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been established.

3 DEFINITIONS

This terminology section is meant to define the general terminology as it is used in this standard. In certain cases the terminology use may be somewhat different from its use in the general engineering community. No attempt has been made to be complete, therefore limiting the glossary to such terms as are found in the standard and that are important to the application of the standard

3.1 Environmental test.
A structured procedure to help determine the effects of natural or induced environments on materiel.

3.2 Induced environment.
An environmental condition that is predominantly man-made or generated by the materiel platform. Also, refers to any condition internal to materiel that results from the combination of natural environmental forcing functions and the physical/chemical characteristics of the materiel itself.

3.3 In-service use.
The anticipated use of materiel during its intended service use life.

3.4 Life cycle profile.
A time history of events and conditions associated with materiel from its release from manufacturing to its removal from service, including demilitarization. The life cycle should include the various phases materiel will encounter in its life, such as: packaging, handling, shipping, and storage prior to use; mission profiles while in use; phases between missions such

as stand-by or storage, transfer to and from repair sites and alternate locations; and geographical locations of expected deployment.

3.5 Material.
The physical constituents comprising materiel, e.g., metals, plastics, cloth, paper, etc.

3.6 Materiel.
A commodity or set of commodities. A generic class of hardware designed to perform a specific function. All items (including ships, tanks, self-propelled weapons, aircraft, etc., and related spares, repair parts, and support equipment, but excluding real property, installations, and utilities) necessary to equip, operate, maintain, and support military activities without distinction as to its application for administrative or combat purposes.

3.7 Mission profile.
That portion of the life cycle profile associated with a specific operational mission.

3.8 Operational check.
This is a failure finding task to determine if an item is fulfilling its intended purpose. Means to operate the materiel or component as usual (all modes and functions) and determine whether or not it is useable for its intended purpose.

3.9 Operational worthiness.
The capability of materiel, a subsystem, or component to perform its full array of intended functions.

3.10 Platform.
Any vehicle, surface, or medium that carries the materiel. For example, an aircraft is the carrying platform for installed avionics items or transported or externally mounted stores. The land is the platform for a ground radar set, for example, and a person for a man-portable radio.

3.11 Platform environment.
The environmental conditions materiel experiences as a result of being attached to or loaded onto a platform. The platform environment is influenced by forcing functions induced or modified by the platform and any platform environmental control systems.

3.12 Relative humidity.
The ratio of the actual vapor pressure of the air to the saturation vapor pressure. Source: American Meteorological Society. (1959). *Glossary of Meteorology*. Boston: AMS Relative humidity (RH) indicates the degree of saturation of the air.

3.13 Subsystem.
A portion of a system containing two or more integrated components that, while not completely performing the specific function of a system, may be isolated for design, test, or maintenance. For the purpose of establishing environmental requirements, either of the following shall be

considered as subsystems. In either case, the devices or equipment may be physically separated when in operation and will be installed in fixed or mobile stations, vehicles, or systems.

a. A collection of devices or equipment designed and integrated to function as a single entity but wherein no device or equipment is required to function as an individual device or equipment.
b. A collection of equipment and subsystems as designed and integrated to function as a major subdivision of a system and to perform an operational function or functions. Some activities consider these collections as systems, however as noted above, they will be considered as subsystems.

3.14 System.
A composite of equipment, subsystems, skilled personnel, and techniques capable of performing or supporting a defined operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self-sufficient within its operational or support environment.

3.15 Temperature shock.
A change in temperature greater than or equal to 10 degrees C (18 degrees F) within one minute.

3.16 Test item.
Specific materiel, a subsystem, or component being tested, including its container and packaging materials, that is representative of the materiel being developed. A representative sample of materiel that is used for test purposes.

3.17 Test procedure.
A sequence of actions that prescribes the exposure of a test item to a particular environmental forcing function or combination of environmental forcing functions, as well as inspections, possible operational checks, etc.

4 GENERAL REQUIREMENTS

4.1 General.
Each system, subsystem and equipment shall maintain its operational worthiness within the environment specified herein. The environments defined include:

1) Natural Environment: Specifies the environmental condition that the system is required to operate within. Storage, transportation, maintenance and other life cycle configurations are included.
2) Induced Environment: An environmental condition that is predominantly man-made or generated by the materiel platform. Also, refers to any condition internal to materiel that results from the combination of natural environmental forcing functions and the physical/chemical characteristics of the materiel itself. Storage, transportation, maintenance and other life cycle configurations are included.

3) Nuclear: Specifies the environmental conditions after a nuclear event which subsystems and equipment integrated inside (internal) and outside (external) are required to reside and operate.
4) Chemical, Biological, Radiological, and Nuclear (CBRN): Specifies the CBRN contamination survivability criteria for Army materiel.
5) Other specific environments may be defined within the specific subparagraphs are necessary.

The absence of an external or internal description indicates that that requirement applies to both internal and external subsystems and equipment. Verification shall address all life cycle aspects of the system, including (as applicable) normal in-service operation, checkout, storage, transportation, handling, packaging, loading, unloading, launch and the normal operating procedures associated with each aspect.

5 DETAILED REQUIREMENTS

Paragraph 5 of this standard specifies the environmental requirements for tracked vehicle systems, subsystems and equipment managed by Project Manager (PM) HBCT. Each system requirement includes the analysis, test or combination thereof that determines the effectiveness of the design and supports the system tests that are typically performed by a DoD test facility.

5.1 Natural environment.

5.1.1 High temperature.

5.1.1.1 Storage and transportation.

The system shall meet its full performance requirements without performance or physical degradation after 12 months without preservation and 5 years with preservation, to a maximum air temperature of 160 degrees F (71 degrees C). Air temperature variation during any 24 hour period shall be sinusoidal with a maximum variation of 60 degrees F. The average temperature during this period shall be between negative 40 degrees F and positive 130 degrees F. Periodic maintenance may be performed during the 12 month period without preservation. Compliance shall be verified by combination of analysis and test.

5.1.1.2 Operational.

The system shall meet its full performance requirements without performance or physical degradation while operating at ambient air temperatures up to 125 degrees F (52 degrees C). Compliance shall be verified by combination of analysis and test.

5.1.2 Low temperature.

5.1.2.1 Storage and transportation.

The system shall meet its full performance requirements without performance or physical degradation after 12 months without preservation and 5 years with preservation, to a minimum air temperature of -60 degrees F (-51 degrees C). Air temperature variation during any 24 hour period shall be sinusoidal with a maximum variation of 60 degrees F. The average temperature during this period shall be between -40 degrees F and +130 degrees F. Periodic maintenance may be performed during the 12 month period without preservation. Compliance shall be verified by combination of analysis and test.

5.1.2.2 Operational.
The system shall meet its full performance requirements without performance or physical degradation while operating to a minimum ambient air temperature of -60 degrees F (-51 degrees C). Below -25 degrees F (-32 degrees C), winterization kits and one-hour vehicle warm-up are permitted. Compliance shall be verified by combination of analysis and test.

5.1.3 Humidity.

5.1.3.1 System.
The system shall meet its full performance requirements without performance or physical degradation while operating and after 12 months storage without preservation or 5 years storage with preservation in ambient relative humidity of up to 100 percent under climatic design types hot, basic and cold, including all daily cycles as defined in AR 70-38. Compliance shall be verified by combination of analysis and test.

5.1.3.2 Subsystem storage and transportation.
The subsystem or equipment shall meet its full performance requirements, without degradation, after aggravated temperature-humidity conditions up to and including:

a) Temperature range: 86 degrees F to 140 degrees F (30 degrees C to 60 degrees C)
b) Relative humidity range: 95 ± 5 percent.

Compliance shall be In Accordance with (IAW) the induced hot-humid conditions of MIL-STD-810G Method 507.5, Procedure I, for 15 cycles.

5.1.3.3 Subsystem operational.
The subsystem or equipment shall meet its full performance requirements, without degradation, during and after aggravated temperature-humidity conditions up to and including:

a) Temperature range: 86 degrees F to 140 degrees F (30 degrees C to 60 degrees C)
b) Relative humidity range: 95 ± 5 percent.

Compliance shall be IAW the induced hot-humid conditions of MIL-STD-810G Method 507.5, Procedure I, for 15 cycles.

5.1.4 Salt fog.
The system, subsystem or equipment shall meet its full performance requirements, without degradation, and show no evidence of damage after exposure to a 5% aqueous salt. Compliance

shall be IAW MIL-STD-810G Method 509.5 for 48 hours of exposure and 48 hours of drying time.

5.1.5 Fungus.
The system, subsystem or equipment shall not support fungal growth in all of its life cycle configurations. Compliance shall be IAW MIL-STD-810G Method 508.6.

5.1.6 Sand.

5.1.6.1 Blowing sand external.
The system, externally mounted subsystem or externally mounted equipment shall meet its full performance requirements without performance or physical degradation during and after exposure to 0.3 to 0.5 grams per cubic foot (g/ft^3) blowing silica sand from 0.01mm to 1mm in diameter, at a velocity of no less than 15 meters per second (m/s). Compliance shall be IAW MIL-STD-810G, Method 510.5 and Procedure II for 60 minutes on each face. Protective covering is allowed for optics.

5.1.6.2 Blowing sand internal.
The internal subsystems or equipment shall meet their full performance requirements without performance or physical degradation during and after exposure to 1.1 ±0.25 grams per cubic meter (g/m3) blowing silica sand at a velocity of no less than 1.5 ±0.2 meter per second (m/s). Compliance shall be IAW MIL-STD-810G, Method 510.5 and Procedure II for 90 minutes on each face (Protective covering for the glass is allowed for internal subsystems or equipment).

5.1.7 Dust.

5.1.7.1 Blowing dust external.
The system, external subsystems or external equipment shall meet their full performance requirements without performance or physical degradation during and after exposure to 6×10^{-9} gm/cm^3 silica flour dust from 0.0001mm to 0.01mm in diameter blowing at a velocity of no less than 18 m/s. Compliance shall be IAW MIL-STD-810G, Method 510.5 and Procedure I for 60 minutes on each face.

5.1.7.2 Blowing dust internal.
The internal subsystems or equipment shall meet their full performance requirements without performance or physical degradation during and after exposure to 11 ±7.0 g/m^3 silica flour dust blowing at a velocity of 1.5 ±0.2 m/s. Compliance shall be IAW MIL-STD-810G, Method 510.5 and Procedure I for 6 hours at 23 degrees C and 6 additional hours at the maximum high operating temperature as specified in this document for all life cycle configurations.

5.1.8 Altitude.

5.1.8.1 Operating.
The system, subsystem or equipment shall operate at altitudes from 1300 feet below to 15,000 feet above sea level and atmospheric pressures of 508 millibars to 1080 millibars. Compliance shall be IAW MIL-STD-810G Method 500.5, Procedure II.

5.1.8.2 Non-operating.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation damage after storage at elevations of 0 to 50,000 feet above sea level. Compliance shall be IAW MIL-STD-810G Method 500.5 Procedure I, for duration of 4 hours for all life cycle configurations.

5.1.9 Solar radiation.
The system and subsystems or equipment exposed to the sun by external mounting or open hatches shall meet their full performance requirements without performance or physical degradation during and after exposure to solar radiation for 16 hours a day at the maximum high temperature system environment specified herein. Compliance shall be IAW MIL-STD-810G Method 505.5, Procedure I.

5.1.10 Icing freezing rain.
The system and externally mounted subsystems or equipment shall meet their full performance requirements without performance or physical degradation during and after exposure to icing conditions of suspended ice crystals averaging 5 to 20mm in diameter of sufficient density to limit visibility to 5 feet. Icing conditions shall persist for extended durations allowing ice buildup of 6 inches. Compliance shall be IAW MIL-STD-810G Method 521.3.

5.1.11 Rain.
The system and externally mounted subsystems and equipment shall meet its full performance requirements without performance or physical degradation during and after exposure to a 12 hour rainfall with droplet size ranging from 0.5mm to 4.5mm with a median of 2.5mm at a wind velocity of 18 m/s. Compliance shall be IAW MIL-STD-810G Method 506.5, Procedure I.

5.1.12 Snow.
The system and externally mounted subsystems or equipment shall meet their full performance requirements without performance or physical degradation during and after exposure to falling snow crystals of 0.5 to 20mm diameter of sufficient density to accumulate 4 inches per hour. Snow conditions shall persist for extended durations allowing snow loads of 20 lbs/ft^2. Compliance shall be by a combination of test, analysis and/or inspection.

5.1.13 Wind.
The system shall meet its full performance requirements without performance or physical degradation for sustained wind velocities up to 55 knots with gusts up to 85 knots. Compliance shall be by a combination of test, analysis and/or inspection.

5.2 Induced environment.

5.2.1 Vibration.

The system, subsystems and equipment shall meet their full performance requirements without performance or physical degradation during and after vibrational stresses as outlined in the composite isolated random-on-random vibration Tables I through VI for turret and hull/sponson locations. Compliance shall be by test IAW MIL-STD-810G Method 514.6, Vibration, Procedure I, Category 20, Ground Vehicles.

Table I. Turret vertical vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	0.00011396
2	36	0.00771864
3	62	0.00017939
4	87	0.000473
5	113	0.0018724
6	139	0.00498461
7	165	0.00086041
8	191	0.00148355
9	216	0.00085938
10	242	0.00580799
11	268	0.0031428
12	294	0.00107434
13	319	0.00022362
14	345	0.00030966
15	371	0.00029694
16	397	0.00095027
17	423	0.00026361
18	448	0.00116864
19	474	0.00010423
20	500	5.3726E-05

Broadband G RMS =	0.81

Test Duration
150 min for simulated 6000 miles

Amplitude Exaggeration Factor = 2.69

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	20	0.0111159
Sweep Rate	2	26	0.1456742
25 min.	3	42	0.1996458
Linear	4	50	0.0143167
	5	55	0.0176909
Bandwidth	6	79	0.0076211
4.0	7	89	0.0132166
Hz	8	101	0.1258407

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	40	0.0086833
Sweep Rate	2	64	0.0071623
25 min.	3	83	0.0477998
Linear	4	100	0.0325563
	5	110	0.1403283
Bandwidth	6	144	0.0042402
8.0	7	179	0.0045302
Hz	8	202	0.0170295

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	59	4.5658E-05
Sweep Rate	2	77	0.0010259
25 min.	3	125	0.0618134
Linear	4	182	0.0050753
	5	268	0.0138949
Bandwidth	6	294	0.0009843
12.0	7	303	0.0009199
Hz	8		

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	79	0.0002384
Sweep Rate	2	129	0.0092573
25 min.	3	152	0.002058
Linear	4	243	0.0087094
	5	287	0.0003933
Bandwidth	6	316	6.6421E-05
16.0	7	357	0.0010099
Hz	8	404	0.0119685

Notes:
1) Control System Frequency Resolution = 1Hz
2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Table II. Turret longitudinal vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	3.3311E-05
2	36	0.00482701
3	62	0.00109504
4	87	7.5246E-05
5	113	0.00212645
6	139	0.00058694
7	165	8.7136E-05
8	191	5.5466E-05
9	216	9.1772E-06
10	242	2.6661E-05
11	268	9.266E-06
12	294	3.6813E-06
13	319	6.7726E-07
14	345	8.6117E-07
15	371	1.8513E-06
16	397	5.675E-06
17	423	1.0608E-05
18	448	0.00034245
19	474	0.00049351
20	500	6.8959E-05

Broadband G RMS =	0.43

Test Duration
150 min for simulated 6000 miles

Amplitude Exaggeration Factor = 2.69

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	19	0.002642
Sweep Rate	2	26	0.0186367
25 min.	3	26	5.9089E-05
Linear	4	50	0.0568218
	5	53	0.2356028
Bandwidth	6	70	0.0153865
4.0	7	89	0.0057652
Hz	8	101	0.0695885

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	38	0.0006815
Sweep Rate	2	51	0.0028896
25 min.	3	53	0.0003136
Linear	4	76	0.0051134
	5	88	0.0039073
Bandwidth	6	107	0.0921744
8.0	7	141	0.0012416
Hz	8	202	0.0004206

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	57	0.0033509
Sweep Rate	2	77	0.0011421
25 min.	3	79	1.6494E-05
Linear	4	114	0.0053923
	5	182	0.0002846
Bandwidth	6	237	3.4362E-05
12.0	7	268	5.9268E-05
Hz	8	303	1.4873E-08

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	76	0.0033509
Sweep Rate	2	105	0.0069295
25 min.	3	152	0.0003961
Linear	4	243	3.5623E-05
	5	281	1.8591E-06
Bandwidth	6	328	5.5411E-07
16.0	7	357	4.3153E-06
Hz	8	404	7.8992E-05

Notes:

1) Control System Frequency Resolution = 1Hz

2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Table III. Turret transverse vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	0.00034911
2	36	0.00223195
3	62	8.573E-05
4	87	7.1971E-05
5	113	0.00021845
6	139	9.5091E-05
7	165	9.1476E-05
8	191	0.0002029
9	216	0.00036095
10	242	0.00274829
11	268	0.00030644
12	294	8.4464E-05
13	319	2.3575E-05
14	345	6.6883E-05
15	371	0.00017246
16	397	0.00079405
17	423	5.7875E-05
18	448	4.7273E-05
19	474	5.3894E-05
20	500	2.8173E-05

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	15	0.0022393
Sweep Rate	2	26	0.0184658
25 min.	3	38	0.2231295
Linear	4	53	0.0108915
	5	63	0.0012418
Bandwidth	6	70	0.0003341
4.0	7	89	0.0045123
Hz	8	100	0.0013935

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	29	1.3199E-05
Sweep Rate	2	83	0.0024956
25 min.	3	100	0.0008614
Linear	4	107	0.0036374
	5	141	0.0003478
Bandwidth	6	158	0.0010078
8.0	7	189	0.0024279
Hz	8	201	0.0052833

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	44	0.0019815
Sweep Rate	2	77	0.0003317
25 min.	3	149	0.001464
Linear	4	160	0.0032034
	5	211	0.0012248
Bandwidth	6	248	0.0020454
12.0	7	268	0.0001995
Hz	8	301	0.000183

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	59	0.0001153
Sweep Rate	2	152	0.0002343
25 min.	3	243	0.0036255
Linear	4	252	0.0002448
	5	316	9.9412E-06
Bandwidth	6	331	1.9152E-05
16.0	7	357	0.0002139
Hz	8	401	0.0064459

Broadband G RMS = 0.40

Test Duration
150 min for simulated 6000 miles

Amplitude Exaggeration Factor = 2.69

Notes:
1) Control System Frequency Resolution = 1Hz
2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Table IV. Hull/sponson longitudinal vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	1.26E-04
2	62	4.93E-04
3	114	2.62E-03
4	166	1.73E-03
5	218	1.72E-03
6	271	7.10E-04
7	323	7.31E-04
8	375	7.75E-04
9	427	5.27E-04
10	479	1.53E-03
11	531	6.53E-04
12	583	1.14E-03
13	635	1.19E-03
14	687	3.85E-04
15	739	2.63E-03
16	792	1.58E-03
17	844	6.09E-04
18	896	2.50E-04
19	948	1.99E-04
20	1000	2.79E-04
21	2000	1.00E-01

Broadband G RMS =	4.69

Test Duration
150 min for simulated 6000 miles

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	30.76164	2.59E-04
Sweep Rate	2	34.42374	3.33E-03
25 min.	3	61.52328	1.38E-02
Linear	4	70.31233	3.65E-02
	5	82.76345	1.64E-02
Bandwidth	6	86.42556	2.56E-03
4.0	7	93.74976	4.12E-02
Hz	8	108.3982	6.52E-02

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	61.52328	6.79E-04
Sweep Rate	2	79.10136	9.39E-03
25 min.	3	106.9333	1.39E-02
Linear	4	140.6247	7.25E-03
	5	165.5269	2.71E-03
Bandwidth	6	172.8511	1.74E-02
8.0	7	187.4995	1.86E-02
Hz	8	216.7963	3.92E-03

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1		
Sweep Rate	2		
25 min.	3		
Linear	4		
	5		
Bandwidth	6		
12	7		
Hz	8		

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1		
Sweep Rate	2		
25 min.	3		
Linear	4		
	5		
Bandwidth	6		
16	7		
Hz	8		

Notes:
1) Control System Frequency Resolution = 1Hz
2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Table V. Hull/sponson transverse vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	1.11E-04
2	62	2.60E-03
3	114	6.03E-03
4	166	3.44E-03
5	218	2.23E-03
6	271	6.01E-03
7	323	6.98E-03
8	375	3.46E-03
9	427	5.69E-03
10	479	8.54E-03
11	531	9.10E-03
12	583	9.07E-03
13	635	3.11E-03
14	687	1.23E-03
15	739	1.36E-02
16	792	2.10E-02
17	844	4.15E-03
18	896	9.74E-04
19	948	4.69E-04
20	1000	3.48E-04
21	2000	3.00E-02

Broadband G RMS =	3.64

Test Duration
150 min for simulated 6000 miles

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	30.76164	6.87E-02
Sweep Rate	2	34.42374	6.59E-01
25 min.	3	39.55068	1.47E-01
Linear	4	49.07214	2.04E-01
	5	54.9315	1.62E-01
Bandwidth	6	65.9178	2.40E-02
4.0	7	99.60912	5.90E-01
Hz	8	107.6657	2.20E-01

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	61.52328	2.20E-03
Sweep Rate	2	98.14429	4.13E-02
25 min.	3	121.5817	2.53E-02
Linear	4	140.6247	9.74E-02
	5	165.5269	2.62E-02
Bandwidth	6	183.105	8.94E-02
8.0	7	199.2183	9.76E-03
Hz	8	215.3315	4.26E-03

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	92.28492	4.31E-03
Sweep Rate	2	103.2712	1.55E-02
25 min.	3	164.7945	1.34E-02
Linear	4	182.3726	1.47E-02
	5	197.7534	1.38E-03
Bandwidth	6	210.937	5.17E-04
12.0	7	248.2904	6.65E-03
Hz	8	322.9972	3.82E-03

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1		
Sweep Rate	2		
25 min.	3		
Linear	4		
	5		
Bandwidth	6		
16.0	7		
Hz	8		

Notes:
1) Control System Frequency Resolution = 1Hz
2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Table VI. Hull/sponson vertical vibration.

Broadband Random Vibration

Break Point #	Frequency (Hz)	PSD Amplitude (g2/Hz)
1	10	5.43E-04
2	62	6.65E-03
3	114	8.00E-03
4	166	1.09E-02
5	218	6.37E-03
6	271	3.99E-03
7	323	6.01E-03
8	375	1.66E-03
9	427	1.60E-03
10	479	2.66E-03
11	531	1.36E-03
12	583	7.44E-04
13	635	5.21E-04
14	687	4.23E-03
15	739	1.49E-03
16	792	1.80E-03
17	844	9.09E-04
18	896	4.71E-04
19	948	3.50E-04
20	1000	4.11E-04
21	2000	3.00E-01

Broadband G RMS =	7.73

Test Duration
150 min for simulated 6000 miles

Notes:
1) Control System Frequency Resolution = 1Hz
2) Narrowband sweep times are for one direction. (Example: 20 min. low to high. 40 min. low to high to low

Sweeping Narrowband Random Vibration

Band #1	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	30.76164	7.05E-02
Sweep Rate	2	34.42374	7.01E-01
25 min.	3	39.55068	1.34E-01
Linear	4	65.9178	2.88E-01
	5	70.31233	1.03E+00
Bandwidth	6	93.74976	2.15E-01
4	7	99.60912	2.95E-01
Hz	8	108.3982	3.11E-01

Band #2	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	61.52328	2.64E-03
Sweep Rate	2	68.84748	5.12E-03
25 min.	3	79.10136	4.32E-02
Linear	4	121.5817	1.10E-02
	5	181.6402	1.46E-01
Bandwidth	6	187.4995	1.29E-01
8	7	199.2183	3.30E-02
Hz	8	216.7963	1.14E-02

Band #3	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1		
Sweep Rate	2		
25 min.	3		
Linear	4		
	5		
Bandwidth	6		
12	7		
Hz	8		

Band #4	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1		
Sweep Rate	2		
25 min.	3		
Linear	4		
	5		
Bandwidth	6		
16	7		
Hz	8		

Band #5	Break Point #	Center Frequency	PSD Amplitude (g2/Hz)
	1	153.8082	5.24E-04
Sweep Rate	2	172.1187	2.18E-04
25 min.	3	267.3333	2.19E-03
Linear	4	270.9954	4.70E-03
	5	388.1826	1.75E-04
Bandwidth	6	406.4931	9.49E-04
20	7	498.0456	1.25E-03
Hz	8	541.9908	1.35E-02

5.2.2 High Temperature.

5.2.2.1 Storage and Transportation.

The subsystem or equipment shall meet its full performance requirements without performance or physical degradation after storage at up to 160 degrees F (71 degrees C). Compliance shall be by test IAW with MIL-STD-810G Method 501.5 High Temperature Procedure I, Storage for 48 hours at 71 degrees C.

5.2.2.2 Operational.
Subsystems or equipment exposed to air temperatures near or on the engine (in engine compartment, on transmission or final drive) shall meet their full performance requirements without performance or physical degradation during its worst case thermal operating cycle at ambient air temperatures of 340 degrees F (171 degrees C).

Subsystems or equipment exposed to air temperatures immediately above the engine (in and above engine compartment) shall meet their full performance requirements without performance or physical degradation during its worst case thermal operating cycle at ambient air temperatures of 340 degrees F (171 degrees C) and with the surface exposed to the engine at a skin temperatures of 360 degrees F (182 degrees C).

Subsystems or equipment that are mounted above the recoil portion of a weapon shall meet their full performance requirements without performance or physical degradation during its worst case thermal operating cycle at ambient air temperatures of 160 degrees F (71 degrees C) and with a mounting surface skin temperature of 180 degrees F (82 degrees C).

Subsystems or equipment that are not exposed to engine temperatures shall meet their full performance requirements without performance or physical degradation during its worst case thermal operating cycle at ambient air temperatures of 160 degrees F (71 degrees C).

Compliance shall be by test IAW MIL-STD-810G Method 501.5 High Temperature Procedure II at a constant temperature of 160 degrees F (71 degrees C) for 6 hours with the minimum airflow for all potential mounting locations. The subsystem or equipment shall be operating in its thermally worst case mode.

5.2.3 Low temperature.

5.2.3.1 Storage and transportation.
The subsystem or equipment shall meet its full performance requirements without performance or physical degradation after storage at -60 degree F (-51 degrees C). Compliance shall be by test IAW MIL-STD-810G Method 502.5, Low Temperature Storage Procedure I and storage for 20 hours at -60 degrees F (-51 degrees C).

5.2.3.2 Operational internal.
The subsystem or equipment mounted internal to the system shall meet its full performance requirements without performance or physical degradation during continuous operation, with manipulation, immediately after power up at an ambient temperature of -51 degree F (-46 degrees C).

Compliance shall be by test IAW MIL-STD-810G Method 502.5 Low Temperature Procedure II for 4 hours at -51 degree F (-46 degrees C). The temperature of the non-operating subsystem or equipment shall stabilize to -51 degree F (-46 degrees C) prior to the 4 hour operational test.

5.2.3.3 Operational external.
The subsystem or equipment mounted on the exterior of the system shall meet its full performance requirements without performance or physical degradation during continuous operation, with manipulation, immediately after power up at an ambient temperature of -60 degree F (-51 degrees C). Compliance shall be by test IAW MIL-STD-810G Method 502.5 Low Temperature Procedure II for 4 hours at -60 degree F (-51 degrees C). The temperature of the non-operating subsystem or equipment shall stabilize to -60 degree F (-51 degrees C) prior to the 4 hour operational test.

5.2.4 Temperature shock.
The subsystem or equipment shall meet its full performance requirements after withstanding sudden changes in the temperature range between the low storage temperature and high storage temperature extremes specified herein. Compliance shall be by test IAW MIL-STD-810G Method 503.5 Procedure I-C, with three (3) cold and three (3) hot temperature conditions. Transition time from high temperature to low temperature chamber or low temperature to high temperature chamber shall less than five (5) minutes.

5.2.5 Shock.

5.2.5.1 Basic shock.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation with continuous operation during and after exposure to peak, half-sine wave shock impulses applied in each direction of three mutually perpendicular axes. The shock pulse shall be as described in Table VII**.** Compliance shall be by test IAW MIL-STD-810G Method 516.6 Procedure I.

5.2.5.2 Functional shock.
The subsystem or equipment shall meet its full performance requirements without performance or physical degradation with continuous operation during and after exposure to 18 shock impulses of 15 ± 3 g, 75.0ms half sine wave applied in each direction of three mutually perpendicular axes. Compliance shall be by test IAW MIL-STD-810G Method 516.6 Procedure I.

Table VII. Tabulated acceleration curve.

Freq. (Hz)	Equivalent Static Acceleration (g)
1	0.5
25	50.0
85	50.0
200	34.0
500	32.0

5.2.5.3 Gunfire shock.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation with continuous operation during and after exposure to 18 half-sine wave shock impulses of 200 g ± 20%, 1.0 ± 0.1ms applied in each direction of the three mutually perpendicular axes.

The system, subsystem or equipment directly affected by the recoil of larger than 100 mm canons shall meet its full performance requirements without performance or physical degradation with continuous operation during and after exposure to 18 half-sine wave shock impulses of 500 g ± 20%, 1.0 ± 0.1 ms applied in each direction of the three mutually perpendicular axes.

Compliance shall be by analysis and test.

5.2.5.4 Ballistic shock.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation with continuous operation during and after exposure to shock impulses described in Table VIII applied in each direction of the three mutually perpendicular axes. Compliance shall be by test IAW MIL-STD-810G Method 516.6 Procedure I.

Table VIII. Ballistic shock equivalent static acceleration.

Frequency (Hz)	Shock level (g)
30	20
175	500
10000	30000
100000	300000

5.2.5.5 High intensity shock.
The subsystem or equipment mounted in crew compartments, directly affected by the recoil of larger than 100 mm canons shall remain intact and not become a secondary projectiles when

subjected to exposure of 6 half-sine wave shock impulses of 1200 g ± 20%, 1.0 ± 0.1ms applied in each direction of the three mutually perpendicular axes.

The subsystem or equipment mounted in turret bustle and turret basket crew compartments shall remain intact and not become a secondary projectiles when subjected to exposure of 6 half-sine wave shock impulses of 550 g ± 20%, 0.5 ± 0.05ms applied in each direction of the three mutually perpendicular axes.

The subsystem or equipment mounted in crew compartments, but not located in the turret bustle, turret basket or affected to canon recoil shall remain intact and not become a secondary projectiles when subjected to exposure of 6 half-sine wave shock impulses of 950 g ± 20%, 0.5 ± 0.05ms applied in each direction of the three mutually perpendicular axes.

Compliance shall be by test IAW MIL-STD-810G Method 516.6 Procedure I.

5.2.5.6 Transport shock.
The system shall meet its full performance requirements without performance or physical degradation after shock impulses at the vehicle tracks that interface with the transport bed with shock and vibration characteristics defined in Table IX. Compliance shall be verified by combination of analysis and test.

5.2.5.7 Handling shock.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation with continuous operation during the shock stresses resulting from a free fall from a height of 2 feet with the vehicle tracks impacting the ground surface. Compliance shall be verified by combination of analysis and test.

5.2.5.8 Bench handling.
The subsystem or equipment shall meet its full performance requirements without performance or physical degradation after undergoing a bench handling test IAW MIL-STD-810G Method 516.6 Procedure VI. Compliance shall be by test IAW MIL-STD-810G Method 516.6 Procedure VI.

Table IX. Transportation mode shock and vibration.

Transportation	Direction	Shock Level (g)	Vibration					
			Vertical		Longitudinal		Transverse	
			(g's)	(Hz)	(g's)	(Hz)	(g's)	(Hz)
Road Transporter (1)	Longitudinal	8	2	300	2	300	2	300
Rail	Longitudinal	10	2	70	2	70	2	70
Fixed Wing Aircraft (C5) (2)	Forward Side Vertical (up) Vertical (down) Aft	3 1.5 2.5 2.5 1.5						
Ship (3)	All Directions	2.0						

Notes: (1) AMCP 706-355 Engineering Design Handbook (The Automotive Assembly).
(2) AR 705-35 Criteria for Air Portability and Airdrop of Material.
(3) AMCP 706-357 Engineering Design Handbook (Automotive Bodies and Hulls).

5.2.6 Leakage (immersion).
The subsystem or equipment shall deny water entry and operate after immersion to a depth of 1 meter for 2 hours. The subsystem or equipment shall be conditioned to 27 degrees C above water temperature. Subsystems or equipment located on the hull exterior or engine compartment that may be submerged during fording shall deny water entry and operate after immersion to a depth of 2 meters for 2 hours. Compliance shall be IAW MIL-STD-810G Method 512.5 Immersion Procedure I. Connector covers equivalent to Item interconnect harness connectors are permitted. Pressurized air may be used to remove water from the connector pins after immersion.

5.2.7 Steam and water jet cleaning.
The system, subsystem or equipment shall meet its full performance requirements, without degradation, and show no evidence of damage or deformation following a steam and water (at 75 degrees C) jet cleaning process, which uses a cleaner conforming to A-A-59133. Nozzle pressure shall be 110 + 11 pounds per square inch gage (psig). A 0.25 to 0.30 inch orifice shall be used for the water jet.

Compliance shall be verified by test and inspection. The jet spray shall be applied perpendicular to the surface being cleaned at a distance of 1.0 + 0.5 foot from the surface for steam cleaning and 5.0 + 0.5 feet from the surface for water jet cleaning, and the surface cleaned at a rate of 1.0 square foot per minute.

5.2.8 Noise levels.
Maximum Noise Levels for subsystems and equipment shall be within the guidelines specified by MIL-STD-1474.

5.2.9 Explosive atmosphere.
The system, subsystem or equipment shall not cause ignition of an explosive atmosphere. Compliance shall be IAW MIL-STD-810G Method 511.5 Procedure I.

5.2.10 Rapid decompression.
The subsystem or equipment shall meet its full performance requirements without performance or physical degradation damage after rapid decompression from an altitude of 15,000 feet to an equivalent altitude of 40,000 feet in less than 15 seconds, with sustained exposure to the reduced pressure for at least 10 minutes for all life cycle configurations. Compliance shall be IAW MIL-STD-810G Method 500.5, Procedure III.

5.2.11 Contamination by fluids.
The system, subsystem or equipment shall meet its full performance requirements without performance or physical degradation after exposure to the following fluids for all life cycle configurations:

a. Fuel per A-A-52557 (DF-1, DF-2 or DF-A) or ASTM D975 (Commercial diesel No. 1-D or No. 2-D)
b. MIL-DTL-5624 (Grade JP-4 and JP-5), MIL-DTL-83133 (Grade JP-8) or ASTM D1655 (Commercial turbine jet -1 or A-1)
c. ASTM D 4814 (MoGas) or regular automotive leaded gasoline
d. Marine diesel fuel oil per MIL-DTL-16884
e. Hydraulic fluid per MIL-PRF-46170
f. Petroleum hydraulic fluid per MIL-PRF-6083
g. Cleaning agents per A-A-59133

Compliance shall be IAW MIL-STD-810G Method 504.1 Procedure II.

5.2.12 Combined environment.
The system, subsystem or equipment shall meet the operational environmental condition requirements specified herein over the temperature range as noted in Table X. Compliance shall be by a combination of test and/or analysis.

Table X. Combined environmental conditions for operation.

Environmental Condition Type	Temperature		
	-50 to -35 degrees F	-25 to +110 degrees F	+90 to +125 degrees F
Solar Radiation		X	X
Humidity	Nil	Nil to100%	3 to 88%
Sand and Dust	X	X	X
Atmospheric Pressure	X	X	X
Salt Fog	X	X	X
Altitude	X	X	X
Vibration	X	X	X
Snow	X	X	
Rain		X	X
Wind	X	X	X
Ice Freezing Rain	X	X	
Gun Firing Shock	X	X	X
Ballistic Shock	X	X	X
Functional Shock	X	X	X
Noise Levels	X	X	X
Nuclear Hardness	X	X	X

5.3 Nuclear hardness criteria.
Subsystems or equipment that support the Mission Essential Functions (MEF) defined in the system Scope of Work (SOW) shall meet their full performance requirements without performance or physical degradation after exposure to the radiation levels, blast levels and thermal levels specified in the following documentation as defined in Table XI:

1) United States Army Nuclear and Combating WMD Agency (USANCA) Memorandum for Project Manager HBCT; Subject: Chemical, Biological, Radiological, Nuclear (CBRN) Survivability Criteria for the Abrams; 25 July 2011 (SECRET)
2) Quadripartite Standardization Agreement (QSTAG) 1031, Addition 1, Annex D (SECRET).

Compliance shall be as defined in Table .

Table XI. Nuclear survivability criteria requirement.

Criteria Type	Equipment Location	Reference to Criteria Document	Compliance Method
Combined Neutron/ Gamma Ionizing Dose	External	USANCA Memorandum (Item 1)	Analysis and Test
	Internal	USANCA Memorandum (Item 1)	Analysis and Test
Gamma Dose Rate	External	USANCA Memorandum (Item 1)	Analysis and Test
	Internal	QSTAG 1031 (Item 2)	Analysis and Test
Neutron Fluence	External	USANCA Memorandum (Item 1)	Analysis and Test
	Internal	USANCA Memorandum (Item 1)	Analysis and Test
Blast	External	USANCA Memorandum (Item 1)TBD	Analysis or Test
Thermal	External	USANCA Memorandum (Item 1)	Analysis or Test

5.4 Chemical, biological, radiological and nuclear survivability (CBRN).
The system and subsystem CBRN requirements are defined in Appendix A (NBC Contamination Survivability Criteria for Army Material) of this document.

6 NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.
This standard contains the environmental conditions for the HBCT tracked vehicle systems.

6.2 Acquisition requirements.
Acquisition documents should specify the following:

a. Title, number, and date of the specification.
b. If required, the specific issue of individual documents referenced (see 2.2.1, 2.2.2 and 2.3).

6.3 Acronyms.

Table XII. Acronyms.

Acronym	Acronym Definition
CBRN	Chemical, Biological, Radiological, Nuclear
DA-PAM	Department of the Army Pamphlet
DOD	Department of Defense
HBCT	Heavy Brigade Combat Team
IAW	In Accordance With
MEF	Mission Essential Functions
PM	Program Manager
QSTAG	Quadripartite Standardization Agreement
SOW	Statement of Work
TBD	To Be Determined
USANCA	United States Army Nuclear and Combating WMD Agency

APPENDIX A

NBC CONTAMINATION SURVIVABILITY CRITERIA FOR ARMY MATERIAL

30 May 2005

Department of the Army
APPROVED

NBC CONTAMINATION SURVIVABILITY CRITERIA FOR ARMY MATERIEL

30 May 2005

This reissue supersedes 12 August 1991 version. This version updates the Background paragraph. The NBC contamination survivability remains unchanged.

NBC CONTAMINATION SURVIVABILITY CRITERIA FOR ARMY MATERIEL

1. **PURPOSE AND AUTHORITY**. To establish quantitative NBC contamination survivability criteria for Army materiel designed to perform mission-essential functions. Current established criteria were approved by memorandum dated October 24, 1991 (Attached).

2. **SCOPE AND USE**

a. Quantitative criteria, expressed in terms of decontaminability, hardness, and compatibility, are designed to ensure that all materiel systems developed to perform mission-essential functions can be used by personnel who are wearing protective clothing and equipment, and that such systems survive the effect of:

--- Contamination by chemical and biological agents,

--- Radioactive contaminants and neutron induced gamma activity, and

--- Decontamination processes.

b. Criteria for surviving *initial* effects of nuclear weapons are not included in the scope of this document.

c. These criteria are engineering design criteria, intended for use only in a developmental setting. They do not define doctrine or operational criteria for decontamination, establish protection criteria, provide guidelines on how to achieve the required survivability, establish test protocols, or specify survivability in training environments.

d. As directed in AR 70-75, NBC contamination survivability criteria will be stated as essential characteristics in appropriate requirements documents and used to design and test the survivability of materiel developed to perform mission-essential functions. Once applied to a piece of equipment/materiel, these criteria will be modified only by the Nuclear and Chemical Survivability Committee upon consideration of proven economic, technical, and/or operational reasons.

3. **SUGGESTED IMPROVEMENTS.** Recommendations for improvement to the criteria are encouraged. Recommended changes should be forwarded to the U.S. Army Nuclear and Combating Weapons of Mass Destruction Agency (USANCA), ATTN: MONA-CWI, 7150 Heller Loop, Bldg 5073, Springfield, VA 22150-3198.

4. **BACKGROUND**

a. The nuclear, biological, and chemical (NBC) threat is recognized. Military personnel must be trained, organized, and equipped to operate effectively on a battlefield that includes nuclear, biological, and chemical environments. Accordingly, materiel designed to perform mission-essential functions must be survivable/sustainable in these environments.

b. The Quadripartite Working Group on NBC Defense approved in May 81, a concept for survivability of materiel contaminated by chemical or biological agents or by residual nuclear radiation. The criteria contained herein are based on that concept and on the studies "NBC Contamination Survivability Standards" completed in Aug 82 and "Impact of Chemical Survivability Criteria on Unit Performance" completed in Nov 87.

c. In Apr 84, DA published AR 70-71, "NBC Contamination Survivability of Army Materiel", which formally established the NBC Contamination Survivability Program throughout the Army.

d. AR 70-1 "Army Acquisition Policy", re-published on 31 Dec 2003 (superseded AR 1000-1, "Basic Policies for Systems Acquisition", published in May 81), requires that NBC protection be considered for systems expected to be exposed to an NBC contaminated environment.

e. Quadripartite Standardization Agreement (QSTAG) 747, Edition 2, NBC Contamination Survivability Criteria for Military Equipment was ratified by the Quadripartite Countries (US, UK, CA, and AS) in Mar 98 for use in development and procurement of mission-essential equipment. Additionally, a related document Allied Engineering Publication (AEP) 7, Nuclear, Biological and Chemical (NBC) Defense Factors in the Design, Testing and Acceptance of Military Equipment was published in Oct 95.

f. In Jan 95, DA published a new Survivability Regulation, AR 70-75, Survivability of Army Personnel and Materiel. AR 75-75 consolidated AR 70-60, Nuclear Survivability of Army Materiel, 1 Oct 84 and AR 70-71, NBC Contamination Survivability of Army Materiel, 1 Apr 84. HQDA updated AR 70-75 on 2 May 05.

5. **PHILOSOPHY**. Criteria contained herein are based on the following philosophy:

> *A soldier or crew surviving an NBC attack should be able to continue using mission-essential systems and equipment, in a full protective ensemble if necessary. When the mission permits, the systems and equipment should be capable of rapid restoration to a condition such that all operations can be continued in the lowest protective posture consistent with the mission and threat, and without long-term degradation of the materiel.*

6. **CHARACTERISTICS OF NBC CONTAMINATION SURVIVABILITY.** NBC contamination survivability is the capability of a system and its crew to withstand an NBC contaminated environment, including decontamination, without losing the ability to accomplish the assigned mission. Characteristics of NBC contamination survivability are decontaminability, hardness, and compatibility. To survive NBC contamination, materiel must meet criteria for all three.

a. **Decontaminability**. The ability of a system to be decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying is termed "decontaminability." Key to this definition is the requirement to be able *to reduce the hazard to personnel.* Since the principal benefit of decontamination is to allow the crew to reduce its level of protection, decontaminability criteria must be related to the response of unprotected personnel. Even under a "fight dirty" concept of operations, decontaminability is required. NBC contaminants could eventually breach the shield of the protective ensemble. Therefore, when operations permit, they should be removed where they present a hazard. Further, decontamination reduces the soldier's vulnerability when the shield is dropped to satisfy basic physiological needs or to replace components of the NBC protective ensemble. Criteria for decontaminability were developed by analyzing toxicity data; determining agent concentration levels corresponding to negligible risk (5 percent mild incapacitation) to unprotected personnel; and relating agent concentration to time, temperature, wind speed and threat parameters. Decontaminability is enhanced by considering:

(1) Materials. Maximize use of materials that do not absorb NBC contaminants and that facilitate their rapid removal with decontaminants readily available on the battlefield.

(2) Design. Incorporate designs that reduce or prevent accumulation of NBC contamination and make those areas that are exposed readily accessible for decontamination.

(3) Contamination control. Employ devices and means that reduce the amount of contamination to be removed, such as positive overpressure systems for combat vehicles, packaging for supplies, and protective covers.

(4) NBC equipment. Provide for integration of NBC detection, measurement, decontamination, and contamination control devices. Considerations for integration of such devices at the earliest stage of the materiel acquisition process promote maximum achievement of effective contamination avoidance, control, removal, and decontamination verification.

b. **Hardness**. The ability of a system to withstand the damaging effects of NBC contamination and decontamination agents and procedures required to carry out the decontamination process is termed "hardness." Although strongly related to decontaminability, hardness is a distinct characteristic; decontaminability is concerned with reducing the hazard to personnel as a result of decontamination efforts, while hardness is concerned with *condition of the equipment* after it has been subjected to an agent and decontamination. Criteria for hardness were developed by analyzing vulnerabilities of construction materials to agents and decontaminants; considering mission profiles of classes of materiel designed to perform mission-essential functions; and determining allowable percentage degradations of quantifiable essential performance characteristics such as reliability, availability, and maintainability (RAM) standards.

c. **Compatibility**. The ability of a system to be operated, maintained, and resupplied by personnel wearing the full NBC protective ensemble is termed "compatibility." Even if a piece of equipment is completely hardened against NBC contamination and decontaminants and can also be easily decontaminated, it still must have the capability of being operated effectively while in an NBC contaminated environment. Thus, in the development of equipment designed to perform mission-essential functions one must consider the *combination of the equipment and personnel in anticipated NBC protection.*

(1) Collective protection enhances compatibility because it provides crew members a clean environment until they must exit to perform some essential task outside the enclosure. Unless individual protective gear is decontaminated or discarded, reentering crewmen will enter dirty. In some cases, agents may enter collective protection enclosures before the equipment is buttoned up. Thus, although collective protection may provide a "shirt sleeve" environment most of the time during a battle, it does not provide compatibility. However, for those systems for which collective protection does provide a continuous clean environment, the combat developer may elect to fulfill the compatibility requirement by utilizing collective protection. In doing so, he accepts the possibility of crew degradation should contamination enter and the crew be forced to don the individual protection ensemble.

(2) Criteria for compatibility were developed by considering mission profiles of classes of equipment designed to perform mission-essential functions, analyzing performance degradation of crew members operating the equipment while in protective ensemble, determining allowable percentage degradations of mission-essential functions, and relating those degradations to time and temperature parameters.

7. CRITERIA

a. **Decontaminability Criteria** (See explanatory notes).

(1) Contaminants. The exterior and interior surfaces of materiel developed to perform mission-essential functions shall be designed such that NBC contamination remaining on, or desorbed or reaerosolized from, the surface following decontamination shall not result in more than a negligible risk (as defined in table 1) to unprotected personnel working inside, on, or 1 meter from the item. The following (worst case) conditions apply:

o Exterior surfaces initially are uniformly and separately contaminated with:

oo 10 g/m^2 of thickened droplets of GD having a mass median diameter (MMD) of 2-5 mm

oo 10 g/m^2 of unthickened VX

oo 10 g/m^2 of unthickened HD

oo 10^5 $spores/m^2$ of biological agent 1-5 micrometers in size

oo 4 g/m^2 of insoluble radioactive contaminants 37-200 micrometers in size and 185 GBq/m^2 gamma activity.

o Initial contamination levels on interior surfaces subject to contamination are a factor of 10 lower than on exterior surfaces in the absence of evidence to the contrary.

o Decontamination begins 1 hour after contamination using standard field decontaminants or simulants, equipment and procedures; and the decontamination process, excluding monitoring, lasts no longer than 75 minutes.

o Suitable simulants may be used.

o Exposure of unprotected personnel to the decontaminated materiel is not to exceed 12 hours based on the mission profile determined by the combat developer.

o Surface temperature is 30°C and exterior wind speed no greater than 1 m/s (3.6 km/h).

(2) Induced activity. Materiel developed to perform mission-essential functions shall be designed such that, when exposed to a neutron fluence from a nuclear detonation that results in a total dose of 3,000 cGy (rad) to the crew of the equipment, the neutron induced activity in the item will result in no more than a negligible risk (as defined in Table 1) to unprotected personnel arriving at H+2 and remaining inside, on, or 1 meter from the item for a period of time based on the mission profile, not to exceed 12 hours.

b. **Hardness Criterion** (See explanatory notes). Materiel developed to perform mission-essential functions shall be hardened to ensure that degradation over a 30-day period of no more than 20 percent (or other value designated by the combat developer based on approved rationale) in selected quantifiable mission-essential performance characteristics is caused by 5 exposures to NBC contaminants, decontaminants, and decontaminating procedures encountered in the field.

c. **Compatibility Criterion** (See explanatory notes). The design of materiel developed to perform mission-essential functions shall take into consideration the combination of equipment and personnel in anticipated NBC protection. The combination of equipment and NBC protection shall permit performance of mission-essential operations, communications, maintenance, resupply, and decontamination tasks by trained and acclimatized troops over a typical mission profile in a contaminated environment not to exceed 12 hours:

o In meteorological conditions of areas of intended use.

o With no degradation, excluding heat stress, of crew performance of mission-essential tasks greater than 15 percent (or other value designated by the combat developer based on approved rationale) below levels specified for these tasks when accomplished in a non-NBC environment.

d. **Explanatory Notes**:

(1) Selected negligible risk values are in Table 1.

(2) A 1-hour delay prior to beginning decontamination allows time for agent sorption, yet it is generally not long enough to allow elimination of surface hazard by weathering.

(3) Initial contamination levels for interiors are a factor of 10 lower to account for the protection provided by the enclosure. Interior surface contamination will be limited to the exposed areas that could reasonably be expected to result from a successful surprise attack on the materiel item postured in its most vulnerable configuration, and to those exposed surfaces normally susceptible to agent transfer from a contaminated crew.

(4) Seventy-five minutes is a typical time for decontaminating items with present decontamination procedures.

(5) A 30°C temperature represents a *reasonable* worst case temperature in the *majority* of likely areas of conflict.

(6) Requiring low airspeeds (less than 3.6 km/h) results in greater chemical agent concentrations over time.

(7) A radioactive fallout contamination of 185 GBq/m^2 would result in a H+1 dose rate of approximately 5 cGy (rad)/h at 1 meter from a typical large armored vehicle. Using 50 cGy (rad) as a negligible risk dose which would come from exposure over a mission profile period (maximum of 12-hours), one half from operational exposure (i.e., direct radiation from initial effects or from fallout on the ground) and the other half from equipment contamination, a decontaminability standard of 25 cGy (rad) dose per mission period is reasonable.

(8) A neutron induced activity of 25 cGy (rad) per mission (maximum of a 12-hour exposure) should be attainable for all items if reasonable attention is given to problem materials.

(9) The "5 exposure" requirement in the hardness criterion refers to a *cumulative total* of contamination/decontamination cycles using one or more contaminants and associated decontamination processes.

(10) Mission Profile is a time-phased description of the operational events and environments an item experiences from beginning to end of a specific mission. It identifies the tasks, events, durations, operating conditions, and environment of the system for each phase of a mission. A mission profile should be based on a typical scenario for the item/system.

8. **METHODOLOGY FOR APPLICATION OF CRITERIA.** The criteria will be applied to individual items of equipment and materiel IAW current AR 70-75 as follows:

a. General --The combat developer will determine if one or more NBC contamination survivability characteristics (decontaminability, hardness, compatibility) are inappropriate for an item of equipment/materiel and so state in appropriate requirements documents with supporting rationale.

b. Decontaminability --The combat developer will determine if any part of the equipment/material should not be required to meet the criteria (e.g., tires, certain parts of the undercarriage, etc).

c. Hardness -- The combat developer will select the specific quantifiable performance characteristics for which the hardness criteria will apply. Rationale for deviation from the 20 percent default value must be approved by HQ TRADOC and USANCA.

d. Compatibility --The combat developer will select the specific quantifiable tasks for which the compatibility criteria will apply and will determine if collective protection can substitute for compatibility. Rationale for deviation from the 15 percent default value must be approved by HQ TRADOC and USANCA.

9. **TEST AND EVALUATION**. The combat developer will define mission times, mission essential performance characteristics, and mission essential tasks. These definitions will be included in all RAM Rationale Reports. The evaluators/assessors and testers will determine the methods, agents, and/or simulants which will be used during testing to address the established criteria.

10. **DEFINITIONS**

a. **Mission-essential functions** -- minimum operational tasks that a system is required to perform in order to accomplish its mission profile.

b. **Mild incapacitation** -- inability to perform the combat mission for a short period of time because of symptoms such as tightness in the chest and shortness of breath, but subsequent recovery without special medical attention.

TABLE 1
NEGLIGIBLE RISK VALUES FOR NBC CONTAMINANTS

CONTAMINANT	VAPOR/AEROSOL	LIQUID [b]
CHEMICAL	(mg · min/m^3)	(mg/70-kg man)
VX	0.25 (0.02 for visual acuity) [a]	1.4
GD	2.5 (0.5 for visual acuity) [a]	30
HD	50	180 (0.01 mg/cm^2) [d]
BIOLOGICAL[c] (maximum residue of 500 spores/m^2)		
RADIOLOGICAL (maximum 12-hour exposure) Contaminants: 25 cGy (rad) Induced Activity: 25 cGy (rad)		

[a] Applies to pilots.

[b] Applies to skin dose, not absorption through the eyes.

[c] Negligible risk values for biological agents are not determinable with the present data base. Since extremely minute quantities of some biological agents can cause incapacitation, equipment should be designed to allow a residue of no more than 500 spores/m^2 of the specified initial contamination levels.

[d] Since the effect of HD is localized, it is not appropriate to consider a threshold dose of liquid HD as applying to the entire 70-kg man. Use of mass/body surface area (mg/cm^2) units to describe the dose for which negligible effects are observed is preferable with the provision that the location and surface area must be specified, since mild incapacitation depends on where the contamination exists and the extent of body surface involved.

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, DC 20310 – 04

REPLY TO
ATTENTION OF

DAMO-SW

OCT 24 1991

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Department of the Army Approved Quantitative NBC Contamination Survivability Criteria

1. Reference:

a. AR 70-71, Nuclear, Biological, and Chemical Contamination Survivability of Army Materiel, 1 April 1984.

b. Memorandum, HQDA, DAMO-SW, 12 December 1990, Subject: Department of the Army Approved Quantitative NBC Contamination Survivability Criteria.

c. Quadripartite Standardization Agreement (QSTAG) 747, NBC Contamination Survivability Criteria for Military Equipment, 12 August 1991.

2. The revised NBC Contamination Survivability Criteria at enclosure 1 are hereby promulgated. These criteria will be applied to mission-essential Army equipment as determined by the combat developer in coordination with USANCA. This revision is based upon, and implements, QSTAG 747 (ref 1c) which was ratified by the Quadripartite countries (US, UK, CA, and AS) on 12 August 1991. The only changes are for neutron induced gamma activity (NIGA) challenge dose of 3000 cGy (rad) vis-a-vis previous standard of 2600 cGy (rad) and visual acuity negligible risk values for vapor/aerosol being only applied to pilots.

3. These revised criteria supersede those promulgated by reference 1b.

4. Request dissemination of the revised criteria to subordinate commands, agencies, activities, and government contractors, as appropriate.

DAMO-SW
SUBJECT: Department of the Army Approved Quantitative NBC Contamination Survivability Criteria

5. Recommendations for improvements to the criteria are always encouraged. Recommended changes should be forwarded to the U.S. Army Nuclear and Chemical Agency, ATTN: MONA-CM, 7500 Backlick Road, Building 5073, Springfield, VA 22150-3198.

FOR THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS:

Encl

LOUIS J. DEL ROSSO
Major General, GS
Director, Space and Special Weapons

DAMO-SW
SUBJECT: Department of the Army Approved Quantitative NBC Contamination Survivability Criteria

DISTRIBUTION:
HQDA (SARD-ZCS/MAJ T. Clark), (DAMO-SWC/LTC H. Willhoite), (DALO-SMG/LTC M. Ahern), (DAMI-FIT/Mr. Eric Nelson), (DASG-HCD-D/MAJ Deffer), Washington, D.C. 20310

COMMANDER:
AMC, ATTN: AMCAM-CN, Alexandria, VA 22333-0001
TRADOC, ATTN: ATCD-GB (LTC D. Kirby/MAJ D. Anderson), Fort Monroe, VA 23651-5000
OPTEC, ATTN: CSTE-CS, Park Center IV, 4501 Ford Avenue, Alexandria, VA 22303-1458
TECOM, ATTN: AMSTE-TE-T (Mr. F. Gasiorowski), Aberdeen Proving Ground, MD 21005-5055
CRDEC, ATTN: SMCCR-FP (Dr. W. Magee, Jr.), Aberdeen Proving Ground, MD 21010-5423

COMMANDANT:
USACMLSCH, ATTN: ATZN-CM-CS (Mr. B. Hooks), Fort McClellan, AL 36205-5020

DIRECTOR:
BRL, ATTN: AMXBR-VLD-R (Dr. J. T. Klopcic), Aberdeen Proving Ground, MD 21005-5066
AMSAA, ATTN: AMXSY-CR (Mr. M. Carothers), Aberdeen Proving Ground, MD 21005-5071

PEO:
Air Defense, ATTN: AMCPEO-AD, Redstone Arsenal, AL 35898-5000
Armaments, ATTN: AMCPEO-AR, Bldg 171, Picatinny Arsenal, NJ 07806-5000
Aviation, ATTN: AMCPEO-AV, 4300 Goodfellow Blvd, St. Louis, MO 63120-1798
Close Combat Vehicles, ATTN: AMCPEO-CCV, U.S. Army Tank Automotive Command, Warren, MI 48397-5000
Combat Support, ATTN: AMCPEO-CS, U.S. Army Tank Automotive Command, Warren, MI 48397-5000
Command and Control Systems, ATTN: SPIS-CC, Fort Monmouth, NJ 07703-5000
Communications Systems, ATTN: AMCPEO-COM, Fort Monmouth, NJ 07703-5000

DAMO-SW
SUBJECT: Department of the Army Approved Quantitative NBC Contamination Survivability Criteria

Fire Support, ATTN: AMCPEO-FS, Redstone Arsenal, AL 35898-5000
Intelligence and Electronic Warfare, ATTN: AMCPEO-IEW, Vint Hill Farms Station, Bldg S-209, Warrenton, VA 22186-5115
Mangement Information Systems, ATTN: AS-PEM, STOP C-21, Bldg 1465, Fort Belvoir, VA 22060-5895
Standard Army Information Systems, ATTN: AS-PES, STOP C-3, Fort Belvoir, VA 22060-5456
Strategic Defense, ATTN: DASD-ZA, U.S. Army Strategic Defense Command, P.O. Box 15280, Arlington, VA 22215-2080
Strategic Information Systems, ATTN: AS-PESS, Bldg 283, Squier Hall, Fort Monmouth, NJ 07703-5000
Troop Support, ATTN: AMCPEO-TRP, U.S. Army Troop Support Command, St. Louis, MO 63120-1798

PM:

Light Helicopter, 4300 Goodfellow Blvd, St. Louis, MO 63120-1798
Mobile Electric Power, 7500 Backlick Road, Springfield, VA 22150-3107
Petroleum and Water Logistics, U.S. Army Troop Support Command, St. Louis, MO 63120-1798
Physical Security Equipment, U.S. Army Belvoir Research, Development, and Engineering Center, Fort Belvoir, VA 22060-5606.
Light Armored Vehicles, U.S. Army Tank Automotive Command, Warren, MI 48397-5000

CF:
Commander, Dugway Proving Ground, Dugway, UT 84022-5000

Custodian:
Army - AT

Preparing Activity:
Army - AT

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.daps.dla.mil.