DEPARTMENT OF THE ARMY
HUNTSVILLE CENTER, CORPS OF ENGINEERS
P.O. BOX 1600
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REPLY TO
ATTENTION OF:

CEHNC-OE-CX

JAN 27 2006

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Buildings and Installed Equipment Containing Explosives Residues that Present Explosion Hazards, Military Munitions (MM) Center of Expertise (CX) Interim Guidance Document 06-03.

1. PURPOSE: This memorandum provides guidance on the following:

a. Classification of buildings (and their installed equipment) as to likely extent of explosives residuals presence.

b. Inspection of buildings (and their installed equipment) for the presence of residual explosives presenting explosive hazards.

c. Removal of explosive hazards from buildings and installed equipment.

2. BACKGROUND: Both the DERP-FUDS program and the closing of military establishments have generated the need to eliminate potential explosive hazards from facilities formerly used to process ammunition and explosives. The enclosed interim guidance is a compendium of best practices that have proven successful in past operations to assess buildings and installed equipment for explosives hazards and to remove explosives hazards, if present. This interim guidance does not depend on the measurement of exact amounts of residual explosives (e.g. grams per square centimeter), since there are no DDESB-approved criteria by which to compare such measurements. Although some research has been done to establish quantitative criteria, it is not DDESB-approved. Therefore, the focus of this guidance is on the use of visual inspection and simple colorimetric tests.

3. APPLICABILITY: This guidance is applicable to all U.S. Army Corps of Engineers Major Commands, Subordinate Commands, and Districts having responsibility for projects to remove explosive hazards from buildings (and their installed equipment) formerly used for the manufacture, storage, handling, maintenance, destruction, treatment, or disposal of ammunition and explosives.

4. REFERENCES:

a. ER 1110-1-8153, OE Response.

b. EP 1110-1-18, OE Response.

c. EM 1110-1-4009, OE Response.

d. Report, "Sensitivity Testing Of Contaminated Surfaces To Establish Non-Reactivity Levels Of Ammonium Perchlorate, Cyclotrimethylenetritramine, And Trinitrotoluene On Wood, Concrete, And Metal" Naval Surface Warfare Center, 30 June 2000.

5. REQUIREMENTS AND PROCEDURES: Refer to the enclosed interim guidance.

6. EFFECTIVE DATES: The requirements and procedures set forth in this interim guidance are effective upon receipt. They will remain in effect indefinitely, unless superseded or cancelled by other policy or regulation.

7. POINT OF CONTACT: The point of contact for this guidance is Mr. John Sikes, CEHNC Military Munitions Center of Expertise, at 256-895-1334.

Encl
as

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Buildings and Installed Equipment Containing Explosives Residues that Present Explosion Hazards

BACKGROUND

Former ammunition and explosives operating and storage buildings (and their installed equipment) may contain residual explosives presenting explosion hazards. Both the DERP-FUDS program and BRAC have generated the need to assess former ammunition and explosives buildings for explosives hazards and remove such if they are present.

In the past, it was standard practice to only partially remove residual explosives from buildings and installed equipment to prepare them for shutdown. Prior to inactivating a facility, installation explosives workers would normally wash down the exterior of equipment, walls, and floors. The workers would also flush piping and vessels used to process explosives.

These procedures do not necessarily remove all residual explosives; and furthermore, some residual explosives may present explosive hazards. For this reason, the installations normally classified deactivated buildings and their installed equipment as "3X". "3X" means that residual explosives may remain that present explosive hazards. Such a building could sit for years in this condition. Later, if the building is part of a BRAC or FUDS action, additional removal of remaining explosives hazards is normally required. This interim guidance explains the general BRAC or FUDS assessment and removal process.

Only very limited test data exist pertaining to what concentration (i.e., grams per square centimeter) of explosives on a surface presents explosive hazards. There are no DOD nor Service-approved surface concentration thresholds for explosivity or reactivity. Therefore, for explosives safety purposes, it is not necessary to perform wipe tests with subsequent lab analysis to determine exact numerical explosives concentrations on surfaces, since there are no criteria to compare against.

Rather than measurement of exact surface concentrations, visual inspection and field colorimetric screening tests (i.e. positive or negative result) can conservatively determine whether a given surface presents potential explosive hazards.

This interim guidance provides a three step process to 1) classify buildings as to their extent of explosive residue presence; 2) inspect/test buildings for explosive residues; and 3) remove explosives residues such that no explosive hazards remain. ***It is strongly recommended that Corps of Engineers personnel using this guidance consult with individuals with knowledge of the specific explosives operations that took place in a particular building. COE personnel should also review paperwork that approves the building for demolition, i.e., Environmental Baseline Survey, previous work orders, and any historical files of the building..***

This interim guidance errs on the safe side. In other words, it may classify some residues as presenting explosives hazards, when in reality, if the residues were tested, they would not explode.

However, this guidance will also correctly classify many instances of where trace amounts of explosives may exist but do not present explosive hazards. This guidance does not address these trace amounts because this guidance focuses on explosives safety. Such trace residuals may qualify as a hazardous waste, but not based on the reactivity or flammability characteristic. Hazardous waste classification of such is beyond the scope of this guidance.

1. **STEP ONE: CLASSIFY THE LIKELY EXTENT OF EXPLOSIVES RESIDUES PRESENCE.** Depending on the type of former explosives operations, classify the explosives residue presence in a building or its installed equipment as **"significant"** or **"limited".**

a. Significant explosives residues presence.

(1) Significant presence is caused by operations that can result in extensive migration of significant amounts of explosives in the building and its installed equipment. Depending on the specific operation, such migration may be due to the release of explosives in solid, liquid, or vapor form. Explosives can migrate into inaccessible areas such as cracks, voids, behind wall and roof panels, drains, roof rafters, porous surfaces, etc.

(2) In general, any operation capable of generating the release of significant quantities of explosives solids, liquids, or vapors must be assumed to result in significant explosives residues presence.

(a) Solids. Operations capable of generating explosives dusts are those that result in significant migration and residuals presence. In general, any operation involving the high speed, mass handling of exposed solid explosives will produce explosives dusts. Dust can migrate and settle onto both accessible and hidden surfaces. To compound this migration, daily equipment washdowns can carry these explosives into the waste system. In contrast to explosives-dust producing operations, operations that generate explosives chunks, slabs, etc, generally do not result in significant migration (other than possibly into wastewater drains, and sumps).

(b) Liquids. In-process liquid explosives can leave significant residues inside all pipes and vessels that carry them. Daily wash-downs of equipment can carry dissolved or suspended explosives into cracks in the floor and into drains and sumps. Spills can also result in significant migration into floor cracks, drains, and sumps. For purposes of assessment, liquid explosives includes explosives that are:

1 In the liquid state at normal temperatures (e.g., nitroglycerin).

2 Heated and melted for further processing (e.g., for loading into projectiles or blending with other explosives)

3 Dissolved in a solvent.

4 Suspended in a liquid carrier.

5 Colloided. Limited to in-process propellants in liquid- or paste-colloid state that have not yet been dried to a solid colloid.

(c) Gases. Generally, whenever an explosive that is a solid at normal temperatures is heated into a liquid (melted), some of the melted explosive volatilizes into the air. This gaseous explosive can migrate about the building and condense on any surface it comes in contact with, includinig hidden surfaces. After condensation, the explosive is again a solid.

b. Limited explosives residues presence. In contrast to significant presence, limited presence involves minor release of explosives in the immediate operating area with very little migration. Many types of operations produce only limited explosives residues presence. For example, operations involving no exposed explosives produce little, if any, explosives residues. Operations involving exposed explosives wherein there is no mass high speed handling generally do not produce more than limited presence.

c. Table 1 on the following pages provides examples of explosives operations/buildings and classifies each example as to

(1) The phase (solid, liquid, gas) of the explosives residue(s) released when the process was in operation.

(2) The extent of explosives residues (significant or limited).

Table 1. Phase and Extent of Explosives Residues

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
		Significant	Limited
1. Amatol manufacture	Solid (spills of explosive in the cooling/pelletizing/flaking area)		X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see note 3)	X	
2. Ammonium nitrate manufacture	Solids (generated during handling and packing of dried crystals)		X
	Liquids (vessels/piping/evaporators/prilling towers used in actual manufacture, which involves ammonium nitrate in solution in water; washdown water; wastewater)	X	
3. Booster pellet pressing, high speed, high volume, automated	Solids (dusts)	X	
	Liquids (washdown water)	X	
4. Bullet impact testing	Solids (chunks)		X
5. Cast loading	Solid (dust particles generated during crushing of sprues for remelting, or tamping pelletized explosive onto top of casting)	X	X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted explosive)	X	
6. Change houses[1]	Solid		X
7. Chipping	See pelletizing		
8. Closing plug installation or removal	Solid		X

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
9. Composition B manufacture	Solid (spills of explosive in the cooling/pelletizing/flaking area)		X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see note 3)	X	
10. Contained detonation chamber	Solid (small amounts of undetonated explosive)		X
11. Contaminated waste processing (a type of thermal treatment)	Solid (unburned explosive; presence of more than trace amounts unlikely)		X
12. Cutting, high speed, high volume	Solid (small chunks not caught by coolant)		X
	Liquid (washwater, coolant recovery/reconditioning system)	X	
13. Cyclotol manufacture	Solid (spills of explosive in the cooling/pelletizing/flaking area)		X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see Note 3)	X	
14. Depriming cartridge cases, press fit primers, high speed, high volume, automated	Solid (dusts)	X	
15. Depriming cartridge cases, press fit primers, low speed, low volume, automated or manual	Solid (loose primers, small particles)		X
16. Depriming cartridge cases, threaded primers	Solid (small particles)		X
17. Detonator press loading, high speed, high volume, automated	Solid (dusts)	X	
	Liquid (washdown water)	X	
18. Drilling explosives, low speed, automated, not liquid cooled	Solid (small particles)		X
	Liquid (washdown water)		X

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
19. Drilling explosives, liquid cooled	Solid (small chunks not caught by coolant)		X
	Liquid (coolant recovery/reconditioning system, washdown water)	X	
20. Explosive D manufacture	Liquid (in picric acid/ammonia reaction vessels and piping; spills; wash-down water; wastewater)	X	
21. Explosive waste incineration (a type of thermal treatment)	Solid (residual unburned explosive)		X
22. Explosives or explosives dust vacuum collection	Solid (dusts)	X	
23. Extrusion, propellant grains and demolition charges, high speed, high volume	Solid (chunks and particles)		X
	Liquid (washdown water)	X	
24. Firing hardstands for missiles, guns, etc.	Solid (small particulates)		X
25. First fire composition manufacture	See pyrotechnic mixingpropellant blending		
26. Flaking	See pelletizing		
27. Flare mix manufacture	See pyrotechnic mixingpropellant blending		
28. Flashing (a type of thermal treatment)	Solid (unburned explosive)		X
29. Fuze installation or removal	Solid (release of explosives very unlikely)		X
30. Fuze liner removal	Solid (chunks of explosive adhere to fuze liner exterior and can fall off on floor)		X
31. Gaging ammunition	Solid (release of explosive very unlikely)		X

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
32. HBX manufacture	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see Note 3)	X	
33. HMX manufacture	Liquid (HMX is dissolved in solvents at certain stages of manufacture)	X	
34. Hot gas decontamination	Solid (small particles of explosive that fell off the items to be treated may remain in the hot gas chamber)		X
35. Ignition mix manufacture	See pyrotechnic mixingblending		
36. Incendiary mix manufacture	See pyrotechnic mixing blending		
37. Incineration	Solid (small amounts of unburned explosive may remain in the incinerator)		X
38. Inspection (e.g. surveillance workshops, "K" lines)	Solid (small amounts of explosive may have been spilled during inspection)		X
39. Lathe turning, low speed, not liquid cooled	Solid (dusts, small chunks)		X
	Liquid (wash-down water)	X	
40. Lathe turning, liquid cooled	Solid (small particles that are not captured by coolant)		X
	Liquid (wash-down water, coolant recovery/reconditioning system)	X	
41. Laundering facilities for explosives workers' coveralls[2]	Solid (small particles dropped from clothing prior to washing)		X
	Liquid (laundry washwater)		X
42. LCL (less than car-load) building	Solid (minor spills)		X

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
43. Lifting plug installation or removal	Solid (very small particulates at most)		X
44. Linking or de-linking ammunition	Solid (release of any explosive not likely)		X
45. Loading dock	Solid (small possibility of minor spills due to accidentally punctured containers of ammunition or bulk explosives)		X
46. LTL (less than truck load) Building	Solid (minor spills)		X
47. Melt out of explosives from projectiles or bombs	Solid (spills of explosive in the cooling/ pelletizing/flaking area)		X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted explosive)	X	
48. Melt-pour of explosives into projectiles, warheads, bombs, etc	See Cast loading		
Milling	See Drilling		
49. Missile final assembly/disassembly (does not include assembly/disassembly of explosives components)	Solid		X
50. Missile maintenance	Solid		X
51. Nitrocellulose manufacture	Liquid (in nitrating vessels, in wringers and dryers, equipment wash-down water, wastewater)	X	
52. Nitroglycerine manufacture	Liquid (in nitrating vessels, separators, washers, settling tanks, nitroglycerin storage tanks, equipment wash-down water, wastewater)	X	

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
53. Octol manufacture	Solid (spills of explosive in the cooling/ pelletizing/flaking area)		X
	Liquids (washdown Water)	X	
	Gas (from melted explosive)	X	
54. Pack/unpack bay in a maintenance or production building	Solids		X
55. Packaging and shipping	Solids		X
56. Painting or marking ammunition or packaging	Solids (no release likely)		X
57. Palletizing	Solids (no release likely)		X
58. Pelletizing	Solids		X
	Liquids (washdown water, spills from melted explosive)		X
	Gas (from melted explosive)	X	
59. Personnel shelters	Solids (no release likely)		X
60. Photoflash powder manufacture	See PyrotechnicsMixing		
62. Popping Plant (a type of thermal treatment)	Solid (unburned explosive)		X
63. Pressing , low speed, automated or manual (normally used in the press loading larger items, such as projectiles and warheads)	Solid		X
64. Pressing, high speed, high volume, automated (normally used in the pressing of smaller items, such as detonators and small shaped charges)	Solid (dusts)	X	
	Liquid (washdown water)	X	

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
65. Primer loading, high speed, high volume, automated	Solid (dusts)	X	
	Liquid (washdown water)	X	
66. Primer mix manufacture	See Pyrotechnics	X	
Priming cartridge cases	Solid		X
67. Projectile base plate assembly or removal	Solid		X
68. Projectile crimping	Solid		X
69. Projectile fin assembly or removal	Solid		X
70. Projectile main charge pressing	Solid		X
71. Projectile ogive assembly or removal	Solid		X
72. Projectile pull-apart (from cartridge case)	Solid		X
73. Projectile rotating band or obturator assembly or removal	Solid		X
74. Projectile seating	Solid		X
75. Projectile tracer assembly to bullet, tracer element has no metal body (typical for small caliber ammunition [.50 cal and smaller])	Solid (dusts)	X	
76. Projectile tracer assembly to or removal from projectiles, tracer elements have metal bodies (typical for medium and large caliber [20mm and larger])	Solid (small particles)		X
77. Propellant collection, in containers, high speed, high volume	Solid (dusts) (normally captured in a vacuum collection system)	X	
	Liquid (in washdown water)	X	

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
78. Propellant collection, in containers, low speed (usually manually dumped), low speed, low volume	Solid (individual grains of propellant)		X
79. Propellant collection, using vacuum collection system	Solid (dusts)	X	
80. Propellant loading or removal, bagged propellant	Solid (individual grains)		X
81. Propellant loading or removal, unbagged (loose) propellant, high speed, high volume	Solid (dusts) (normally captured in a vacuum collection system)	X	
	Liquid (washdown water)	X	
82. Propellant loading or removal, unbagged (loose) propellant, low speed, low volume	Solid (individual grains)		X
83. Propellant manufacture – single, double, or triple base	Solid (small chunks released at extrusion and cutting operations)		X
	Liquid (solvent/propellent mixing equipment, waste water, equipment wash-down water, nitroglycerin tankage and supply lines [double and triple base only]	X	
84. Propellant or propellant dust vacuum collection	Solid (dusts)	X	
85. Pyrotechnic ingredient mixing, dry	Solid (dusts)	X	
	Liquid (wash-downs)	X	
86. Pyrotechnic ingredient mixing, wet	Liquid (in mixing vessels and associated piping, from spills during wet mixing, from wash-downs)	X	

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
87. RDX manufacture	Solid (in drying rooms or equipment)	X	
	Liquid (in nitration vessels and piping, from spills, wash-down water, wastewater)	X	
88. Rotary kiln furnace (a type of thermal treatment)	Solid		X
89. Shaker testing	Solid		X
90. Signal mix manufacture	See Pyrotechnics		
91. Starter mix manufacture	See Pyrotechnics		
92. Static test stand for warheads, projectiles, etc	Solid		X
93. Steam out of explosives from projectiles or bombs	See Melt Out	X	
94. Storage (e.g., earth covered magazines, aboveground magazines, covered storage pads, service magazines)	Solid (low possibility of traces of spilled explosives)		X
95. Supplementary charge insertion or removal	Solid (small particles)		X
96. Temperature conditioning units or magazines	Solid		X
97. Temporary storage bay in a maintenance or production building	Solid		X

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
98. Tetryl manufacture	Solid (in drying rooms or equipment)		X
	Liquid (inside all reaction vessels and piping serving them; from washdown water and process waste water)	X	
99. Tetrytol manufacture	Solids (in drying rooms or equipment)		X
	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT and tetryl)	X	
100. TNT manufacture	Solid (flaking operation)		X
	Liquid (nitrating vessels and associated piping, molten TNT purification vessels, washdown water; waste water	X	
	Gas (explosive effluent tetranitromethane emitted at trinitration step; TNT vapors from molten TNT purification vapors	X	
102. Torpex manufacture	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see Note 3)	X	
103. Tracer mix manufacture	See Pyrotechnics		
104. Tritonal manufacture	Liquids (washdown water, spills of melted explosive)	X	
	Gas (from melted TNT) (see Note 3)	X	

Table 1. Phase and Extent of Explosives Residue (cont)

Type of Ammunition or Explosives Operation or Facility	Phase of Explosive Released (Solid, Liquid, Gas)	Extent of Explosives Residues Presence	
105. Vacuum collection system for propellant or explosives	See Propellant Vacuum Collection		
106. Vibration testing			X
107. Wash out of explosives from projectiles or bombs	See Melt-out		

Notes to Table 1

1. EXCEPTION: change houses used by workers exposed to high amounts of explosives dusts or gases may contain significant residual explosives in the shower drains.
2. EXCEPTION: laundering facilities that laundered coveralls used by explosives workers exposed to significant quantities of explosives dusts or gases may have significant residual explosives in the washing equipment, drains, sewers, and sumps.
3. Such TNT vapor occurs during the manufacture of "composite" explosives formed by melting TNT, then mixing in the other explosive(s), which remain in solid form. These additive explosives are normally ground to small particle sizes, then mixed with the molten TNT. They have higher melting temperatures than TNT. Some explosives, such as tritonal, are mixtures of TNT and a metal powder, such as aluminum. The aluminum, like explosives that are added to the molten TNT, does not melt either. Since the additive explosives or metals do not melt, they do not produce gaseous explosives vapors. Only TNT vapors are produced.

2. **STEP TWO: INSPECT AND TEST FOR EXPLOSIVES RESIDUES.** Visual inspection, supplemented by colorimetric tests, can conservatively determine the presence of explosives hazards. Visual inspection, in this interim guidance, means inspection with the naked eye.

a. <u>General rules.</u>

(1) All surfaces where explosives residues are suspected to have been deposited must be visually inspected. The scope of this inspection – that is, the number of surfaces – depends on whether there is a significant versus a limited presence of explosives (see paragraphs 2.b. and 2.c.). In any event, if a surface that is suspected to contain residues cannot be inspected, assume there are explosive hazards.

(2) If explosives can be seen on a surface, assume there are explosives hazards.

(3) If no explosive or suspect material can be seen on a surface, there are no explosives hazards.

(4) If unidentifiable foreign material can be seen on a surface, perform either a colorimetric field test or a flame test.

(a) Colorimetric field test. "EXPRAY" is a readily available commercial colorimetric test kit and is in wide use. EXPRAY can detect a very wide range of explosives compounds. If an EXPRAY test is positive, assume there are explosives hazards. Note: EXPRAY can detect extremely small amounts of explosive and will therefore give a very safety-conservative "positive" reading in many cases where the concentrations of explosives are very small. Therefore, positive results obtained from an "EXPRAY" test do not necessarily indicate an explosive hazard exists. One can conservatively assume that it does, or one can perform a flame test.

(b) Flame test. It is also permissible to test a small sample of unidentifiable material for its reaction to flame. Using non-sparking tools, collect a sample of the material no larger than a pinhead. Locate the sample in an area away from any areas known or suspected to contain explosives. Place the sample on a clean, dry, non-flammable surface, such as a steel plate. Although the test quantity is so small it will not expose test personnel to explosive hazards, leather gloves, full face protection, and ear protection are recommended. The operator will expose the sample to flame, such as a portable blowtorch. It is best to perform this test at least 10 times. An energetic reaction (rapid burning or a "pop") during any test indicates that explosive hazards exist.

b. <u>Specific rules for buildings, equipment and operations with **LIMITED** explosives residues presence.</u>

(1) Visually inspect/test accessible surfaces IAW the general rules in paragraph 2a.

(2) It is not necessary to visually inspect inaccessible surfaces. Explosives migration into these areas is very unlikely.

c. <u>Specific rules for buildings, equipment and operations with **SIGNIFICANT** explosives residues presence.</u>

(1) Visually inspect/test accessible surfaces IAW the general rules in paragraph 2a.

(2) Inaccessible surfaces can be accessed for inspection/test by disassembly. Care must be taken when disassembling equipment with known or suspected explosives residues. All threaded connections, flanges, mating surfaces, etc, should be soaked with penetrating oil and allowed to sit for 24 hours before disassembly. Pipes and tanks with known or suspected explosives residues can be filled with water before disassembly. Disassembly can be performed manually, or with remotely controlled power equipment. Manual disassembly poses greater hazards to operators: do not use chisels, saws, or drills; do not loosen threaded connections by using cheater bars on wrenches; do not pound equipment with hammers; and do not hammer wedges into mating surfaces to separate them. If manual disassembly is not selected, then powered disassembly (saws, shaped charges, shears, etc) can be done, but it must be must be done remotely if explosives are present or the absence of explosives cannot be verified. To determine the separation distance from remotely controlled disassembly operations, contact the Huntsville Center Military Munitions Center of Expertise.

(3) Inaccessible surfaces that cannot be disassembled can sometimes be inspected by specialized equipment (such as a borescope pipe inspection "snakes"). Examples are the interiors of piping, vessels, and other inaccessible surfaces. However, such equipment normally lacks the discrimination of the human eye and is often unable to render an image that allows personnel to determine whether the surface is merely discolored, or whether there is material (explosive or otherwise) on the surface. If any foreign material is seen, assume it presents explosive hazards unless a sample can be remotely collected for colorimetric or flame test (see paragraph 2.a. (3)(b)).

(4) Inaccessible surfaces that are not disassembled or remotely inspected/tested shall be considered to contain explosives residues presenting explosive hazards. In place of disassembly, it is often most effective to simply assume the inaccessible surfaces contain significant explosives residues, and burn the building as described in paragraph 3.a.

(5) Cracks. Cracks may hide contamination. Cracks often occur in welds or joints, but can occur in other areas as well. Experience has shown the amount of explosive contaminant in cracks is insufficient to create a hazard where the outside surfaces are confirmed clean, the material is nonporous, and the material is no more than 1/8-inch thick. Assume all nonporous materials over 1/8-inch thick have cracks, unless a detailed visual inspection proves otherwise.

(a) Visually inspect cracks for explosives or foreign material. Test foreign material with colorimetric test or flame test (see paragraph 2.a. (3)(b)).

(b) If visual inspection fails to find any explosive, use the following rules:

(1) Hairline cracks: No explosive hazard.

(2) All other cracks: Explosive hazard.

(6) Porous surfaces. Porous materials may absorb some explosives and render them undetectable to the naked eye. Porous generally refers to building materials, such as wood, gypsum board, etc., and paper products, like cardboard. Porous materials are not resistant to absorption of liquid or vapor explosives. Porous materials may absorb some explosives and render them undetectable to the naked eye. Nonporous refers to metal, glass or other materials with hard, smooth, and resistant surfaces. Porous material containing an absorbed explosive may leave no visible trace or signature that it is contaminated. If evidence of a liquid or vapor contaminant is present, you must assume the contaminant penetrates the porous material surface, and physical cleaning will not decontaminate the material. Ammunition and explosives buildings and installed equipment are primarily made of four materials: metal, wood, concrete, and transite. Under certain conditions, some of these materials may absorb explosives. See Table 2.

(7) Drains, waste disposal systems, and slabs. In addition to explosives residues in the building and its installed equipment, drains and waste disposal systems (e.g. industrial and sanitary sewers, acid reconstitution lines) must also be assumed to present explosion hazards. The concrete slabs and soil underneath the building may also contain significant amounts of explosives residues in cases where there are cracks in the slab or leaks in the floor drains and explosives residues have been deposited over the years from water wash-downs of explosives contaminated equipment.

Table 2. Absorption of Explosives as a Function of Type of Material and Phase of Explosive

Type of Material[1]	Phase of Explosive		
	Solid[2]	Liquid[3]	Vapor[4]
Wood	Non-absorptive	Absorptive	Non-aAbsorptive[6]
Metal (except cast iron)	Non-absorptive	Non-absorptive[8]	Non-absorptive
Cast iron	Non-absorptive	Non-absorptive[7]	Non-absorptive[7]
Concrete	Non-absorptive	Non-absorptive[7]	Non-absorptive[7]
Transite	NA[5]	NA[5]	Non-absorptive

Notes

1. Assumes material contains no cracks. Cracks are addressed in paragraph 2.c.(5) in this interim guidance.

2. Includes not only chunks, slabs, etc, but also explosives dusts. Explosives dusts are NOT vapors. Dusts are composed of individual particles of explosive in the air. Each particle consists of many

(millions) of molecules of the explosive. Vapors consist of individual molecules of the explosive in the gaseous state.

3. Includes explosives that are liquids at normal temperatures (e.g., nitroglycerine), explosives that are liquids at elevated temperatures (e.g., TNT, white phosphorous), and explosives that are dissolved in solvents (e.g., flare mix dissolved in hexane during a mixing operation).

4. Vapor phase explosives are found where explosives are melted to pour them into shell or bomb bodies. They are also found where explosives are washed, steamed, or melted out of shell or bomb bodies.

5. Transite, an extremely fire-resistant material, was used for roof shingles and sometimes for the exterior siding of ammunition and explosives buildings. Solid or liquid explosives contact with transite is therefore an unlikely scenario.

6. Of particular concern is wood in proximity to any explosives manufacturing operation involving nitration or nitric acid. This wood can itself become be partially nitrated so as to form low-grade cellulose nitrate, a flammable solid.

7. Small amounts of liquid or vapor explosive can migrate into concrete and cast iron, but not in sufficient quantities to present explosion hazards.

8. Explosives can reside below the rust and scale inside of pipes and tanks.

3. STEP 3 – REMOVE EXPLOSIVES RESIDUES.

a. <u>Buildings and installed equipment with **SIGNIFICANT** explosives residues presence</u> (see Table 1).

(1) In terms of effectiveness, cost, implementability, and explosives safety, burning a building in place is the preferred method to remove explosive hazards from explosively contaminated buildings and installed equipment. The normal procedure is to to heat the article or piece of equipment to a level above the decomposition temperature of the explosive and hold it there long enough to assure the largest mass is at that temperature, consuming the explosive. Dunnage and combustible material (wooden pallets are often used) will be added to the buildings to augment the temperatures within the building. stack enough wood (pallets are often used) inside the building to insure that the building interior is engulfed in flame for a minimum of 1/2 hour. This is sufficient to bring the building and equipment up to and over the temperature at which explosives will decompose, burn, or detonate (any or all reactions are possible, but the result is the same: the explosives are gone). The vast majority of explosives will decompose, detonate, or burn when exposed to temperatures of 900 degrees Fahrenheit for 5 seconds. There are a few exceptions; H6 and HEX-48 require 1100 degrees for five seconds. Regardless, experience has shown that a sustained, vigorous engulfing burn for at least 1/2 hour will ensure all building and equipment will reach these temperatures.

(2) Although many explosives will merely burn when the building is burned, some explosives residues, particularly those located in confined locations (process vessels, piping) can detonate during the burn. The inspections done in STEP TWO will ideally allow an estimate of the maximum credible event (MCE), in pounds of explosive. The MCE then

establishes the minimum separation distance (MSD) in feet for personnel during the burn (contact the Huntsville MMCX for minimum separation distances). If such an estimate cannot be made, then Eexperience has shown that a very safety conservative default maximum credible event for these accidental detonations is 100 lbs. Based on a possible detonation of a 100 lbthis MCE, a minimum separation distance of 1250 feet will be established during the burn to protect personnel.

(3) Detonations during the burn can expel process equipment from the building that will require inspection and likely require re-flashing. To reduce the number of detonations during the burn, vent explosives-laden vessels and piping and any equipment (e.g., motors, dust collectors) capable of pressure containment to minimize the probability of accidental detonation during burning.

(a) Remote cutting using linear shaped charges is generally the safest and most efficient venting method for disassembly, inspection, and venting. All personnel shall be 1250 feet away during shaped charge venting. In cases where pipes and vessels are suspected to contain large amounts of explosive, they should, if practicable, be manually disassembled to the point where they can be movedremoved from the buildings and taken to a remote location for venting. Perforators and detonating cord will be used to flash the accumulated explosives and also gain access to any areas of piping or equipment that are not readily available for visual inspection. After the venting, they should be returned to the building for the burn. This process is recommended to avoid a large accidental detonation inside the building during burn operationsventing. Such an accidental explosion could complicate subsequent demolitiondisassembly operations.

(b) If use of explosives is not permitted (e.g., sensitive Department of Energy plants with radiological hazards), approved alternate methods of In lieu of using linear shaped charges, careful manual disassembly areis acceptable. Prior to disassembly, flood vessels and pipes with water and apply large amounts of penetrating oil over a period of 24 hours. Do not manually (i.e., by hand) disassemble flanged, welded, or threaded connections. Remote saws can be used provided the exterior of the pipe/item is continually sprayed with water or other coolant during cutting. Water jet cutters can also be used to cut, disassemble, and wash pipes and equipment. All personnel shall withdraw to a distance of 1250 feet during disassembly operations. Disassemble flanged connections by first applying large amounts of penetrating oil, applied repeatedly over 24 hours. Do not unscrew threaded connections. For manual disassembly of piping with threaded or welded joints, the piping may be remotely sawed provided the exterior of the pipe is continually sprayed with water or other coolant during cutting. All personnel shall withdraw 1250 feet during sawing.

(4) Although the "1/2 hour" rule of thumb has proven effective, it is suggested the effectiveness of the burn should be verified. Measuring burn temperatures, and the period of

time this temperature was maintained, is an important aspect of the explosive decontamination process. In particular, extensive initial temperature monitoring of the first buildings burnted at a project site provides data to indicate what amount of wood is necessary for subsequent burns in other buildings. The primary method used to monitor and verify that the structures, equipment and process piping have been decontaminated is by verifying that these features achieved a temperature at which the explosives of concern decompose, burn, or detonate. Temperature verification can be conducted using several reputable methods. They can be used in combination.

(a) Temperature sensitive crayons (such as OMEGASTICK®), pellets (such as OMEGAPELLET®) or lacquers (such as OMEGALAQ®) are placed inside piping and in or on building and equipment, and at several locations throughout the buildings being thermally decontaminated. Select crayons, pellets, or paints that undergo their intended change at 900°F.
Note: all the remaining changes to this document were also suggested by the Rock Island BRAC office…CHDoyle

1 Crayons and pellets melt at the target temperature. Their melting and resolidification in a new shape, or their disappearance, is proof that the melting point has been reached.

2 Lacquers, when initially applied, dry to a dull opaque mark. When the target temperature is reached, the material melts and upon cooling solidifies to a glossy-transparent appearance. If a temperature significantly above the target is achieved or the target temperature is held for an extended period, the paint may char.

(b) Real-time temperature monitoring can also be conducted at select locations within the buildings and equipment during the burns. Thermocouples can be placed in areas of the buildings that are of greatest concern (and that are also most insulated by surrounding equipment or building structural features) to document that the required decontamination temperatures were achieved. Data loggers (such as multi-measurement System MMS-3000-T6V4) and thermocouples provide continuous real-time monitoring of the burns. The thermocouple wires are protected from the heat as they will degrade at the burn temperatures and the data logger must be placed outside of the building in a location protected from the heat.

(c) Certipacks can also verify that the requisite temperature is attained. Certipaks can be prepared by dissolving two grams of the type of explosive at the site (explosive can be recovered from the site if available) in 10 ml of acetone. Porcelain boiling chips are immersed in the solution and allowed to sit for ten minutes. The chips are then removed and allowed to air dry on a square of aluminum foil. Once dry, six of the beads/chips are randomly selected. Three are tested for the presence of detectable levels of explosives using Expray. Once it is confirmed that the contamination can be detected, three to five beads/chips are wrapped in aluminum foil packages (stainless steel or galvanized sheet steel can also be used) and placed in clean one-quart paint cans for placement in and around the building and equipment. Following flashing of the buildings, the cans are recovered, unless they melt (if they are melted, 900 degrees has been obtained and it is unnecessary to recover and test the beads) . The recoverable beads in the foil are then tested for the presence of explosives using Expray.

(d) Post-burn inspection and testing can be performed as a final check. UXO-qualified personnel can inspect and test selected surfaces using EXSPRAYEXPRAY. Selection is based on judgment of on-site personnel. See paragraph 3 for responsibilities in management of the disposition of building debris and scrap.

(5) If a building and its installed equipment cannot be burned in place, then a much more time-consuming, expensive, and most importantly - riskier process of manualengineered disassembly and explosives removal must be followed. From an explosives safety standpoint, this process is not recommended unless permits cannot be obtained to burn the buildings. Operators face greatly increased risk when disassembling equipment containing significant explosives residues. The disassembly operations required are far more extensive than the disassembly and venting operations required prior to simply prepare a building for burning.

(a) If installed equipment must be manually disassembled for inspection and decontamination, then the same procedures as described in paragraph 3.a (3) apply (e.g., remote cutting using linear shaped charges, saws, shears, etc.)

(b) It is recommended that components of the building and installed equipment be reduced sufficiently in size to allow their treatment in conventional hazardous waste incinerators, heating ovens, or in hot gas decontamination units. At some sites, regulators have permitted the open-air burning of disassociated equipment.

(c) In lieu of the thermal treatment just discussed, manual conventional cleaning (such as pressure washing, steam cleaning, brushing, scraping) or chemical neutralization may be employed.

(d) Once the contaminated equipment is addressed, the building itself must be addressed. Inspect all building surfaces for explosives, and remove as much explosives as possible from walls, ceilings, rafters, etc. via steam cleaning or other methods. The walls will be inspected for wall penetrations, hollow block construction, openings and cracks and crevices. Any noticeable cracks in the hollow walls will require that the crack be flooded with water within three feet on either side of the cracked area. Alternatively, explosives accumulated is hollow walls can be vented by using donor charges. Conventional demolition equipment can then be used to raze the building. If there is the possibility of explosives residuesremaining in inaccessible building structural components or cracks, then the equipment operator should be provided shielding.

(6) Building slabs. Large amounts of explosives can accumulate beneath building slabs under certain conditions. If equipment with significant contamination was subjected to periodic washdowns when the equipment was operational, explosive-laden wash water can migrate through cracks in the slab and accumulate beneath it.

(a) The burning procedures described in paragraph 3.a.(1) – 3.a.(4) will not necessarily remove these explosives accumulations. There are several alternatives, depending upon whether the explosives of the "primary" or "secondary" variety.

<u>1</u> Primary explosives. These are highly sensitive initiating explosives used in primers and detonators. They include lead azide, lead styphnate, mercury fulminate, and DDNP. Dry, undecomposed nitrocellulose, and nitroglycerin, although not technically primary explosives, should be considered as such for the purposes of this subparagraph. Do not lift slabs when the significant presence of these explosives beneath slabsthem is known or suspected. Attempt to confirm the absence of these explosives by remotely drilling through the slab into the soil beneath. The building usage and classification, slab configuration and the soil geology will determine the number and locations of drilling samples. Maintain a minimum separation distance of 1250 feet during drilling. Fill drill holes with water to desensitize sample material and take samples for field test and/orlaboratory analysis. If results are confirmed negative, lift slabs using conventional equipment (e.g., backhoes). If the results are positive or if primary explosives are suspected to be present, do not lift the slabs. The only safe treatment option is to lay large linear shaped charges over the cracks, and detonate them in order to detonate the primary explosives. Maintain a minimum withdrawal distance of 2500 feet during detonation. The slab can then be lifted using hardened equipment. The drilling and lab analysis step can be skipped, and the project can proceed directly to the use of linear shaped charges if this is more cost effective.

<u>2</u> Secondary explosives. These explosives are much less sensitive than primary explosives. Examples include TNT; Compositions A, B, and C; Explosive D; octol, etc. Nitroguanodine, although not technically a secondary explosive, should be considered such for the purpose of this subparagraph. Slabs may be lifted when secondary explosives are known or suspected to exist in slab cracks or underneath slabs. However, pinch points may be created at existing cracks when a slab is lifted. Before lifting, thoroughly soak all cracks with water (or better yet, oil).

b. <u>Buildings and installed equipment with **LIMITED** explosives residues presence</u> (see Table 1).

(1) Any explosives presence in these buildings will not be capable of migration into hidden surfaces and can be readily detected by visual examination of all readily accessible areas. Any explosives (or, in some cases, ammunition) found can be manually removed.

(2) After visual inspection and manual removal of any residual explosives, such buildings and their installed equipment can be considered to present no explosive hazards.

4. Management of scrap and building debris after the removal.

a. Buildings with only limited explosives residuals are still intact after any residual explosives are removed from them. Very little, if any, building or equipment debris is generated during removal. These buildings are often are not razed with Army funding unless they have structural weaknesses posing safety hazards.

b. However, buildings and equipment with significant explosives residues presence are normally destroyed by the process of removing the residuals, and significant amounts of building and equipment debris are generated. For these, building debris and process equipment must be disposed in a landfill or recycled.

(1) Prior to transfer from DoD control, this material must be inspected (and verified and certified) as presenting no explosive hazards. For building and equipment debris generated from "burn in place", the "two 100 percent inspection" rule used for UXO removals does not apply since a very rigorous removal process (high temperature) has already been applied.

(2) Rather than 100 percent inspections, the contractor will, after the burn, check temperature sensitive crayons, certipaks, etc. to insure target temperatures have been reached, and then, using expert judgment, inspect and EXPRAY-test selected items of building and equipment debris.

c. The contractor will:

(1) Ensure the specific procedures and responsibilities for processing building and equipment debris for certification as scrap metal are being followed, performed safely, consistent with applicable regulations, and in accordance with the USACE-approved project work plan and site safety and health plan.

(2) Be responsible for ensuring Work and Quality Control (QC) Plans specify the procedures and responsibilities for processing building and equipment debris for the final disposition as waste or scrap metal.

(3) Ensure a Requisition and Turn-in Document, DD Form 1348-1A (or equivalent) is completed for all building and equipment debris to be transferred for final disposition.

(4) Perform random checks to satisfy that the building and/or equipment debris is free from explosive hazards.

(5) Certify and verify building and equipment debris as free of explosive hazards.

(a) The contractor will ensure that building and equipment debris is properly inspected in accordance with the procedures above. Only personnel who are qualified per USACE policy will perform these inspections. Project personnel that are qualified per USACE policy will certify and verify the debris as presenting no explosive hazards.

(b) DD form 1348-1A (or equivalent) will be used as certification/verification documentation. All DD 1348-1A (or equivalent) must clearly show the typed or printed names of the certifier and verifier, organization, signature, and contractor's home office and field office phone number(s) of the persons certifying and verifying the scrap metal.

(c) Local directives and agreements may supplement these procedures. Coordination with the local concerns will identify any desired or requested supplementation to these procedures.

(d) In addition to the data elements required and any locally agreed to directives, the DD 1348-1A (or equivalent) must clearly indicate the following for building and equipment debris:

(1) Basic material content (Type of material; e.g., concrete, wood, mixed construction materials, metal).

(2) Estimated weight.

(3) Load number.

(4) Location where building/equipment debris was obtained.

d. Enter the following certification/verification statement on each DD 1348-1A (or equivalent) for turn over of building/equipment debris. Both the certifier and verifier will sign.

"This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, are free of explosive hazards."

e. Be responsible for ensuring that these inspected materials are secured in a closed, labeled and sealed container. In cases where the size of building debris or installed equipment may not permit its containerization, the contractor will ensure such materials are kept in a segregated area and take measures to prevent unauthorized entry.

f. The contractor can transfer to the general public articles, pieces of equipment, or building debris verified and certified as presenting no explosive hazards. These items are safe for welding, sawing, or other heat-generating processes.

g. For Articles, pieces of equipment, or building debris known or suspected to contain explosives hazards the contractor should only transfer such to knowledgeable Government installations or qualified buyers possessing a BATF explosive manufacturer's license. However, Ssuch material can be sold to organizations or individuals who are not Government entities and do not possess a BATF license (usually metal recycling facilities or smelters) if:

(1) They have the proper facilities and detailed knowledge to safely store, handle, and, if necessary, disassemble items known or suspected to present explosives hazards.

(2) They agree they will process the material to remove explosive hazards.

(3) They agree to provide an end-use certificate or recycling certificate.

(4) They successfully pass a Government safety audit or pre-award survey (or the equivalent by the responsible entity or agency) verifying satisfaction of paragraph 4.g.(1) above.

h. For containerized materials, insure inspected materials are documented as follows:

(1) The container will be closed and clearly labeled on the outside with the following information: The first container will be labeled with a unique identification that will start with **USACE/Installation Name/Contractor's Name/Container No. 0001/Seal's unique identification** and continue sequentially.

(2) The container will be closed in such a manner that a seal must be broken in order to open the container. A seal will bear the same unique identification as the container or the container will be clearly marked with the seal's identification if different than the container.

(3) A documented description of the container will be provided by the contractor with the following information for each container: contents, weight of container, location where

building or equipment debris was obtained, name of contractor, names of certifying and verifying individuals, unique container identification, and seal identification, if required [see paragraph 4.c.(7)(a)]. These documents will also be provided by the contractor in a separate section of the final report.

(i) For non-containerized materials (such are removed from the site by the truckload), insure inspected materials are documented as follows:

(1) A hard copy paper will be provided to the shipper containing the following information: The first load will be labeled with a unique identification that will start with **USACE/Installation Name/Contractor's Name/Load No. 0001** and continue sequentially.

(2) A documented description of the load will be provided by the shipper with the following information for each load: contents, weight of load, location where building or equipment debris was obtained, name of contractor, names of certifying and verifying individuals, and load number. These documents will also be provided by the contractor in a separate section of the final report.

j. Maintain The Chain Of Custody and Final Disposition. The contractor, in coordination with the Corps of Engineers, will arrange for maintaining the chain of custody and final disposition of the certified and verified material. The certified and verified material will only be released to a shipper that will:

(1) Upon receiving the material in the truckload, each with its own load number, after reviewing and concurring with all the provided supporting documentation, sign as having received and agreeing with the provided documentation that the truckload contained no explosive hazards when received. This will be signed on company letterhead and state that the contents of the truckload will either be delivered directly to a solid waste landfill (for building or equipment debris); or, to a smelter (for equipment/metal debris) and will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

(2) Send notification and supporting documentation to truckload-generating contractor that the truckload has been delivered to the landfill (for building or equipment debris) or (for equipment debris), the contents of the truckload have been smelted and are now only identifiable by their basic content. This notification and supporting documentation will be incorporated by the contractor into the final report as documentation supporting the final disposition of the building/equipment debris.