APPENDIX F

WEAPONS OF MASS DESTRUCTION, TOXIC INDUSTRIAL MATERIALS, AND THE USE OF OBSCURATION

International and domestic law place severe limitations on the use of chemical and bacteriological weapons in armed conflict. The US condemns the use of all biological and bacteriological agents under any circumstances. Potential enemies may not operate under the same restrictions and may employ weapons of mass destruction (WMD) or release toxic industrial materials (TIM). Commanders and leaders must be prepared to assume an adequate NBC defensive posture when conducting urban operations. Leaders must be aware of how the urban environment affects the protection, detection, and decontamination process. Additionally, urban areas can contain many TIM. Release of these materials can pose a significant threat to friendly forces and noncombatants. This chapter will provide commanders and leaders with information and guidance concerning defense against WMD and TIM. (For additional information, see FM 3-9.)

Section I. NUCLEAR, BIOLOGICAL, AND CHEMICAL CONSIDERATIONS

Personnel who must move through a contaminated urban area should employ the procedures outlined in the appropriate NBC field manual.

F-1. PROTECTION FROM NBC WEAPONS EFFECTS

Buildings are usually not strong enough to provide shelter from a nuclear explosion but do provide some protection against fallout. They also have unique characteristics concerning the use of biological and chemical agents.

a. **Nuclear.** The lowest floor or basement of a reinforced concrete or steel-formed building offers good protection from nuclear hazards and liquid chemical contamination. Tunnels, storm drains, subway tubes, and sewers provide better protection than buildings. Tanks and BFVs provide limited protection.

b. **Biological.** Biological attacks are difficult to detect or recognize. Biological agents can be disseminated or dispersed using aerosols, vectors, and covert methods. (See FM 3-3 for more detailed information). Since biological agents can be sprayed or dropped in bomblets; personnel who observe such indicators should promptly report them. Prompt reporting and treatment of the sick speeds the employment of medical countermeasures. Although buildings and shelters provide some protection against spraying, they provide little protection against biological agents.

c. **Chemical.** Chemical agents cause casualties by being inhaled or by being absorbed through the skin. They may afford soldiers a few seconds to mask. Buildings have a channeling effect and tend to contain the effects of an agent, causing great variation in chemical concentration from room to room or from building to building. Chemical agents usually settle in low places, making basements, sewers and subways hazardous hiding places. A prepared defender should include some collective protective measures in the defensive network. Personnel using fans may be able to put enough overpressure into tunnels to keep some chemical agents from entering. The individual protective mask and battle dress overgarment provides the best protection against chemical agents.

d. **Personal Hygiene and Field Sanitation.** Personal hygiene is a critical defensive measure against infection and disease. Soldiers fighting in urban areas are exposed to many infectious diseases such as diarrhea, hepatitis, and even cholera. Lessons learned from recent Russian operations in Chechnya reinforce this point. An extremely high proportion of Russian troops suffered from diseases they had contracted from eating or drinking from unsafe sources. Modern urban areas are characterized by sophisticated sanitation systems. The populace relies on this human service. If those systems are destroyed or degraded, either by friendly or threat actions, the resulting sanitary conditions can become much worse than those in areas where sanitary facilities are more primitive. Commanders and leaders must ensure that personnel employ appropriate field sanitation measures and that their immunizations are current. Food and water sources must be kept sanitary and human waste disposed of correctly.

e. **Mission-Oriented Protective Posture.** Commanders should plan their mission-oriented protective posture (MOPP) realizing that urban area logistics also apply to NBC equipment. Protective clothing, detection and decontamination equipment, and sealed containers of food and water must be stockpiled the same as other supplies. When operating in protective clothing, commanders must make allowances for the strenuous activities normally associated with combat in urban areas.

(1) ***Detection.*** After an NBC attack, companies should dispatch their detection and survey teams. Detection in urban areas is complicated by the containing nature of buildings. Teams should conduct tests and surveys of major streets, intersections, and buildings in their area for inclusion in initial NBC reports. A systematic survey of all buildings, rooms, and underground facilities must be accomplished before occupation by unmasked personnel. All data should be forwarded using the appropriate NBC report.

(2) ***Decontamination.*** Personnel must begin decontamination operations as soon after an NBC attack as the mission allows. Personnel should conduct individual decontamination of themselves and their personal equipment. Unit commanders must determine the need for MOPP gear exchange and the requirements for a hasty or deliberate decontamination operation.

(a) *Radiological.* Personnel should wear wet-weather gear for certain decontamination operations (hosing down buildings) to prevent radioactive material from touching the skin.

(b) *Chemical and Biological.* Roads, sidewalks, and other hard surfaces are best decontaminated by weathering, if time permits. Agents can also be covered with several inches of dirt or sand to provide protection. Fragment testing should be conducted periodically to ensure that the agent has not seeped through the covering. For critical sections of terrain or roads, a mobile decontaminating system such as the M12A1 power driven decontaminating system can be used to spray a slurry of foam; this aids rapid decontamination. Buildings are difficult to decontaminate especially wooden ones. Some techniques for their decontamination are scrubbing with slurry; washing with hot, soapy water; washing or spraying with a soda solution; and airing.

F-2. SMOKE OPERATIONS

The use of smoke as an integral part of either offensive or defensive operations can complement missions in urban areas. Chemical support from smoke generator units, if available, can be employed for both offensive and defensive operations. Whenever smoke is employed, regardless of the source, combat patience must be practiced to insure that the effects of the smoke are maximized prior to moving, conducting assaults or counterattacks, or breaching operations.

a. In the offense, smoke can support the maneuver of combat elements and deception operations. Smoke employed in the defense obscures enemy air and ground observation, limiting the accuracy of enemy fires and target intelligence.

b. Smoke should not be used when it degrades the effectiveness of friendly forces. An extremely dense concentration of smoke in a closed room can displace the oxygen in the room, smothering soldiers even when they are wearing protective masks.

c. Smoke pots, generators, or artillery smoke munitions should be used to cover the withdrawal of defending forces or the movement of attacking forces. Artillery-delivered white phosphorus can also be effective on enemy forces by causing casualties and fires. The incendiary effects of both white phosphorus and base ejection munitions on the litter and debris of urban areas must be considered.

d. Smoke grenades can be used to provide a hasty screen for concealing personnel movement across streets and alleys. Smoke grenades can also be used for signaling; those launched by an M203 can be used to mark targets for attack helicopters or tactical air.

e. The use of smoke in urban areas is affected by complex wind patterns caused from buildings. Obscuration planning must include covering as much of the objective area as possible. Failure to obscure key structures provides enemy observers reference points for fire placement within the objective area.

F-3. RIOT CONTROL AGENTS

National Command Authority (NCA) approval is required prior to using riot control agents (RCAs).

a. **Executive Order 11850.** Executive Order (EO) 11850 prohibits the use of RCAs during offensive operations regardless of whether the enemy is using noncombatants as human shields. EO 11850 also renounces first use in armed conflict except in defensive military modes to save lives such as—

- Controlling riots.
- Dispersing civilians where the enemy uses them to mask or screen an attack.
- Rescue missions.

b. **Effects and Employment.** Riot control agents, such as CS, generally have no lasting effects. RCAs can be disseminated in hand grenades, ring airfoil projectiles, 40-mm and 66-mm cartridge grenades, or bulk agent aerial and ground dispersers. Units will normally employ RCAs, once permission is secured from the NCA through command channels, by using hand grenades or 40-mm rounds fired from the M203 grenade launcher. The protective mask and BDUs will protect soldiers from the effects of the RCAs. RCAs are not effective against a well trained threat that is equipped for chemical defense.

Section II. RELEASE OF TOXIC INDUSTRIAL MATERIALS (TIM) DURING URBAN OPERATIONS

In urban areas all over the world today, large amounts of very dangerous chemicals are routinely stored, handled and transported. There is a very real possibility that an accidental or deliberate release of toxic materials can occur during urban operations. Commanders must include an analysis of the threat of hazardous material release in the planning process and risk analysis prior to commencing operations. The inadvertent or planned release of a deadly chemical can present a threat to US soldiers and the local population and also create a negative effect on world opinion that may directly affect the urban operation.

F-4. TOXIC INDUSTRIAL MATERIALS IN URBAN AREAS

Toxic materials may be located throughout any large urban area (Figure F-1). The most common chemicals that pose a risk to friendly forces and noncombatants are irritant gases, especially chlorine, sulfur dioxide, ammonia and hydrogen chloride. These substances have relatively high toxicity when inhaled and they are produced, stored and transported in large volumes. Production sources and stockpiles are frequently located near inhabited areas. Most toxic industrial chemicals are released as vapors. These vapors tend to remain concentrated downwind from the release point and in natural low-lying areas such as valleys, ravines, and man-made underground structures. Irritants are not the only toxic materials likely to be in urban areas. The list in paragraph 9-5 shows common sources of large amounts of chemicals in urban areas. In addition to any irritants that may be released, many substances generated during fires in chemical stockpiles create a special problem not only to troops and non-combatants on the ground, but also to the pilots and crew of low flying aircraft.

Figure F-1. Large urban chemical manufacturing plant.

F-5. MOST COMMON TYPES AND LOCATIONS OF TOXIC INDUSTRIAL MATERIALS

The most common types of TIM are listed below. The most common locations of TIM are shown in Table F-1. Barges, pipelines, rail cars, and tank trucks deliver large quantities of chemicals directly to cities located great distances from stationary sources of chemicals. Transportation assets frequently traverse routes near highly populated areas (Figures F-2 and F-3, page F-6). Pipelines remain the most vulnerable chemical transportation assets, because they pass through areas beyond the influence of security assets located at fixed facilities and in populated areas.

- Irritants (acids, ammonia, acrylates, aldehydes, and isocyanates)
- Choking agents (chlorine, hydrogen sulfide, and phosgene)
- Flammable industrial gases (acetone, alkenes, alkyl halides, amines)
- Water supplies contaminants (aromatic hydrocarbons, benzene, etc.)
- Oxidizers that increase explosion dangers (oxygen, butadiene, and peroxides)
- Chemical asphyxiants (Aniline, nitrile, and cyanide compounds)
- Incendiary gases (compressed isobutane, liquefied natural gas, propane,)
- Incendiary liquids (liquid hydrocarbons, gasoline, diesel, jet fuel)
- Industrial compounds that act much like blister agents (dimethyl sulfate)
- Organophosphate pesticides that act as low-grade nerve agents.

LOCATION	TYPE OF TIM
Airports	Aviation gasoline, jet fuel.
Farm and garden supply warehouses	Pesticides
Shipping terminals	Bulk petroleum and chemicals
College laboratories	Organic chemicals, radioactive materials
Electronics manufacturers	Arsine, arsenic trichloride
Food processing and storage areas	Ammonia
Glass and mirror plants	Fluorine, hydrofluoric acid
Pipelines and propane storage tanks	Ammonia, methane, and propane
Plastic manufacturers	Isocyanates, cyanide compunds
Landscaping businesses	Ricin (a food and water poison)
Medical facilities	Radioactive isotopes, mercury
Inorganic chemical plants	Chlorine
Hard rock ore mines	Potassium and sodium cyanide
Pesticide plants	Organophosphate pesticides
Petroleum storage tanks	Gasoline, diesel fuel
Photographic supply distributors	Cyanides, heavy metals
Rail and trucking lines	Anhydrous ammonia; sulfuric phosphoric ans hydrochloric acids, and flammable liquids
Chemical manufacturing plants	Chlorine. Peroxides, and other industrial gases
Power stations and transformers	Polychlorinated biphenyls (PCBs)
Large refrigeration units (grocery stores, dairy processing plants)	Anhydrous ammonia

Table F-1. Location and types of TIM.

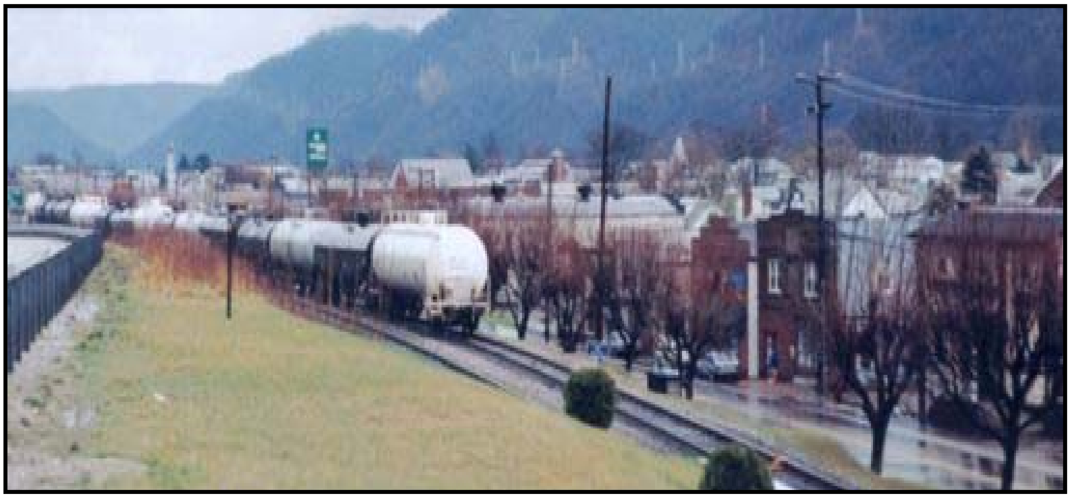

Figure F-2. TIM transported on a rail line.

Figure F-3. Barge carrying fuel oil.

F-6. CHEMICALS MOST OFTEN CAUSING DEATH OR SERIOUS INJURY

A study by the US Environmental Protection Agency, analyzing over 7,000 large scale releases of industrial chemicals, indicated four chemicals accounted for almost 30 percent of all the deaths and serious injuries. These were:

- Chlorine.
- Hydrochloric acid.
- Sulfuric acid.
- Anhydrous ammonia.

F-7. CHLORINE GAS

Chlorine hazards should not be underestimated. Large chlorine releases from rail cars, large storage tanks, or tank trucks in enclosed areas such as narrow streets pose substantial hazards (Figure F-4). In these situations, chlorine can be a very dangerous choking agent.

a. Such a situation was illustrated at the Pliva Pharmaceutical Factory in the capital of Croatia, during the war between Croats and Serbs. This factory used acids, ammonia, bases, chlorine, and other toxic substances to produce pharmaceutical products. Croatian modeling indicated that, in the event of a major attack, concentrations of chlorine and stannic acid lethal for 50 percent of the population would extend up to 4 km away from the facility.

b. Croatian industrial engineers also studied the potential effects of an instantaneous release of chlorine from a single rail tank car damaged by conventional weapons such as bombs or artillery fire. The models indicated that with a normal load of 16 cubic meters per railcar, a lethal concentration of chlorine could extend up to 5 kilometers downwind and that serious adverse health effects could occur as far as 12 kilometers downwind.

c. These distances provide a good idea of the ranges that TIM can travel and affect friendly personnel or noncombatants. Commanders should request this type of specific information, whenever conducting UO near facilities that may contain TIM.

Figure F-4. Standard rail car filled with chlorine gas.

F-8. THE EFFECTS OF A LARGE RELEASE OF TOXIC INDUSTRIAL MATERIALS

The damage caused by the release of TIM during urban operations will depend on the type and size of the discharge, the period during which personnel are exposed, and the length of time between exposure and treatment. The most effective action is immediate evacuation outside the hazard's path. Most military protective masks, respirators, and protective clothing provide only limited protection against industrial chemicals, although they are much better than no protection at all.

a. A massive discharge of a hazardous chemical in an urban area took place at Union Carbide's factory at Bhopal, India, in 1984. A tank containing methylisocyanate, an extremely reactive chemical used in the production of insecticide, leaked for about one hour. This developed into one of the largest industrial disaster ever to occur.

b. Methylisocyanate (CH3NCO) is used in several chemical manufacturing processes. It has an extremely irritating effect on mucous membrane and is highly toxic when inhaled. Symptoms accompanying exposure are coughing, increased saliva production, tear flow and difficulty in keeping the eyes open, much like the effects of riot control agents.

c. About one-third of the town's total population of 800,000 were affected. About 100,000 of these required some kind of medical treatment, about 50,000 were hospitalized, and about 2,500 immediately inhaled lethal doses. Approximately 16,000 people eventually died.

F-9. INTERNATIONAL HAZARDOUS MATERIAL SYMBOLS

There is a standard, internationally recognized, marking scheme for TIM in use worldwide. It uses a combination of colors, shapes, and symbols. These symbols may not be found on all TIM or cargo, but most modern manufacturing and transportation facilities will have at least some markings similar to these. Figure F-5 contains examples.

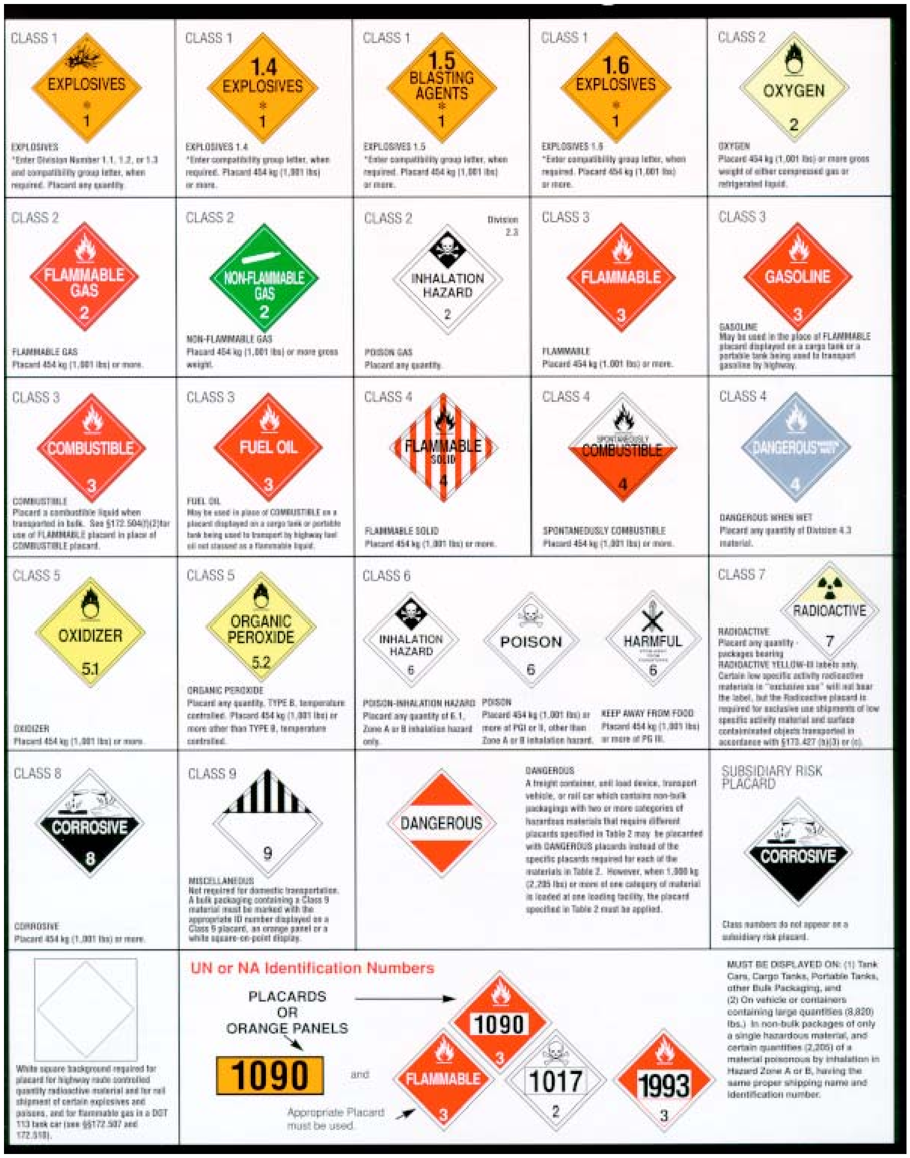

Figure F-5. Example of standard hazardous material markings.

F-10. THE RELEASE OF HAZARDOUS CHEMICALS DURING URBAN COMBAT

The fighting in Croatia during the breakup of the former Yugoslavian Republic has provided some indication of the degree of threat faced by a force fighting in a modern urban area. This is best typified by the situation surrounding attacks on the Petrochemia chemical plant located less than 1 kilometer away from the town of Kutina (Figure F-6).

Figure F-6. Petrochemia chemical plant, Kutina, Croatia.

a. Petrochemia produced fertilizer, carbon black, and light fraction petroleum products. Hazardous substances at the plant included ammonia; sulfur, which poses a hydrogen sulfide inhalation hazard in the event of a fire; nitric, sulfuric, and phosphoric acids; heavy oil; and formaldehyde. Studies conducted by the Croatian government indicated that a massive fire at Petrochemia would pose a danger to public health across a 100-kilometer radius, extending into Bosnia, Hungary, Slovenia, and Italy. The plant was attacked by Serbian forces using rockets, bombs, artillery, machine gun tracers, and mortars on six occasions during 1993 to 1995. During a missile attack in 1995, Petrochemia was hit 32 times with rockets in the area where anhydrous ammonia, sulfur, heavy oil, and other chemicals were stored (Figure F-7).

b. The Croatian Ministry of Defense took extensive actions to mitigate and prevent public health hazards from attacks on the plant. These included:

- Installing area alarm signals.
- Organizing special fire brigades and hazardous materials response units.
- Conducting mass casualty training exercises.
- Stationing a Croatian army field decontamination unit near the plant.
- Creating special helicopter fire suppression and casualty evacuation units.
- Preparing local emergency rooms to treat contaminated patients.
- Conducting special training for police to control rail and road traffic.

In spite of these preparations, the manager of the Petrochemia plant admitted that, in the event of repeated attacks, "...uncontrolled negative consequences may develop."

c. Other chemical plants were also attacked during the war in Croatia.

(1) Serbs using rockets containing cluster bombs attacked a natural gas refinery in eastern Slavonia, located only 1 kilometer from the center of a city, and which produced ethane, propane, and butane. Fortunately, the government had reduced the amounts of dangerous chemicals on hand and had curtailed plant operations as the Serb forces advanced.

Figure F-7. Petrochemia chemical plant under attack by Serbian forces.

(2) An attack on a chemical plant near the town of Jovan resulted in an instantaneous release of 72 tons of anhydrous ammonia. Fortunately, that plant was located 30 kilometers from the town and local public safety officials had time to evacuate its 32,000 residents.

(3) Mortar attacks were launched on the Herbos pesticide plant, located in Croatia's industrial center at Sisak. Fortunately, these attacks did not hit vital process control and chemical storage areas.

(4) During the war, Serbian forces attacked large fuel storage tanks along the highway from Belgrade to the outskirts of Zagreb and started large fires at Osijek, Sisak, and Karlovak. The refinery, at Sisak, which produced liquefied petroleum gases (LPG), fuels, petroleum coke, and solvents, was hit hard by 400 to 500 Serbian artillery rounds; 38 storage tanks were destroyed. Refineries are usually designed so that two fires can be controlled and suppressed at one time, but at this refinery firefighters had to fight as many as five major fires simultaneously (Figure F-8, page F-12).

d. Croatian defense and public safety officials modeled potential releases that might result from military attacks to determine the potential health effects. They determined that if isopropylamine were released from a standard 150-cubic-meter tank, it would result in concentrations immediately dangerous to life and health up to 145 meters downwind. Similar analyses for ethylamine reflected dangerous concentrations 1,760 meters downwind.

Figure F-8. Specialized equipment used in an oil well fire in Croatia.

e. These historical examples provide some lessons for leaders and commanders.

(1) Infantry units conducting UO near potentially hazardous sites must be aware of the potential TIM and be prepared to initiate appropriate MOPP levels or evacuate the area based on the tactical situation.

(2) TIM sites are vulnerable targets and may be used as an asymmetric threat against friendly forces.

(3) Medical personnel need to be briefed on the potential hazards and carry medical supplies appropriate to the situation.

(4) If stability and support operations will be conducted near a possible TIM site, contingency plans need to be made for the evacuation of noncombatants in the event of a TIM release.

(5) Units should avoid putting logistical and medical assets near a TIM site, if possible.

(6) UO can be seriously affected by the release of TIM and may result in mass CASEVAC.

(7) Unit chemical officers can provide assistance in analyzing the possible effects of TIM and provide advice on hazards and methods to mitigate effects.

F-11. MINIMUM DOWNWIND HAZARD DISTANCES

For planning, Table F-2 shows minimum downwind hazard distances (day and night) from chemical production or storage sites for selected toxic industrial chemicals. These are the distances a lethal exposure level could reach if a massive release occurred. Note that toxic industrial chemicals normally have a greater downwind hazard distance at night.

CHEMICAL	QUANTITY	DISTANCE	
		DAY	NIGHT
Chlorine	Up to 100 Tons	2 km	5 km
Phosgene	Up to 50 Tons	2 km	5 km
Ammonia	Up to 500 Tons	2 km	5 km
Hydrogen Cyanide (Hot Weather) (Cold Weather)	Up to 50 Tons	 2 km 1 km	 5 km 2.5 km
Hydrogen Sulfide	Up to 50 Tons	2 km	5 km
Methyl Isocyanate	Up to 50 Tons	2 km	5 km
Hydrogen Flouride	Up to 100 Tons	1 km	2.5 km
Sulfur Trioxide	Up to 50 Tons	1 km	2.5 km
Nitrogen Tetroxide	Up to 50 Tons	1 km	2.5 km
Hydrogen Chloride	Up to 100 Tons	1 km	2.5 km
Ammonia	Up to 50 Tons	1 km	2.5 km
Bromide	Up to 50 Tons	1 km	2.5 km
Sulfur Dioxide	Up to 50 Tons	1 km	2.5 km

Table F-2. Minimum downwind distances.

9-12. OTHER THREATS FROM TOXIC INDUSTRIAL MATERIALS

TIM present many other threats to include the following.

a. Water contamination hazards were present in Croatia during the war. Transformers were destroyed at power stations located along the Dalmatian coast. Ground water is highly susceptible to contamination. In certain areas, contaminants can move several hundred feet or even miles per day, posing public health hazards at great distances from the source of contamination. Croatian hydrogeologists found concentrations of polychlorinated biphenyls (PCBs), flame-retardants, and explosives in several areas.

b. Lightning rods in Croatia contain sources of radioactive cobalt that are much stronger than those used by other countries. Attacks on industries at Osijek in Eastern Slavonia released radiation from these rods. Many of the lightning rods were found because snow had melted around them.

c. Radioactive materials used in medical treatment or research present a significant threat of accidental release during urban combat operations. Cleanup after release is an extensive task. For example, releases of radioactive cesium from an abandoned piece of medical equipment caused an environmental disaster in the Brazilian town of Goiania.

d. Liquid propane (LP) and other fuel storage tanks present a serious threat to forces engaged in UO. Some urban industrial areas have large concentrations of LP gas and other fuel storage tanks. Fires in these tanks are almost impossible to extinguish without special equipment and must be allowed to burn out. If the fire superheats the tanks, boiling liquid expanding vapor explosions (BLEVE) can occur. BLEVE can throw huge pieces of the tank well over 100 meters (Figure F-9, page F-14).

Figure F-9. 18,000-gallon liquid propane tank in industrial area.