

Chemical Protection and Decontamination



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Headquarters, Department of the Army

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CBRN defense has four operational elements that serve as key capability categories—sense, shape, shield, and sustain. Figure 1 shows the interrelationship between the elements. The elements interrelate to varying extents, with shape having the most influence on the other operational elements.

- **Sense.** Sense is the capability to continually provide updated and accurate information about the CBRN situation at a specific time and place. Contamination avoidance implements this element by detecting, identifying, and quantifying those CBRN hazards in all physical states (solid, liquid, gas) with sensors, arrays, and detectors.
- **Shape.** Shape provides the ability to characterize the CBRN hazard. The force commander's staff collects and assimilates information from sensors, intelligence, and medical assets in near real time to provide actual and potential impacts of CBRN hazards. This information allows commanders to develop a clear understanding of current and predicted CBRN situations.
- **Shield.** Shield provides the capability to shield the force from harm caused by CBRN hazards by preventing or reducing individual and collective exposures, applying prophylaxis to prevent or mitigate negative physiological effects, and protecting critical equipment. Avoidance, mitigation, and active- and passive-defense measures assist commanders with shielding personnel and equipment.
- **Sustain.** Sustain is the ability to conduct decontamination and medical actions that enable the quick restoration of combat power, maintain or recover essential functions that are free of CBRN hazard effects, and facilitate the return to preincident operational capability as soon as possible.

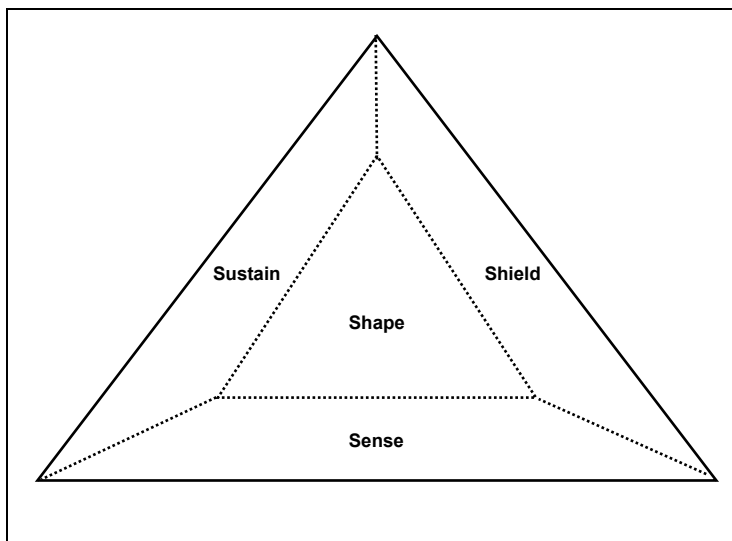


Figure 1. Interrelationship Between CBRN Operational Elements

MOPP analysis considers mission, enemy, terrain and weather, troops and support available, and time available and provides the recommended MOPP levels.

- Mission.
 - What is the mission?
 - What additional protection, such as collective protection, is available?
 - How physically and mentally demanding is the mission (for example, work intensity)?
 - How quickly must the mission be accomplished?
 - What is the expected duration of the mission and likely follow-on missions?
 - Are adequate food and water supplies available?
- Enemy (Threat).
 - Is an attack probable?
 - Is an attack imminent or in progress?
 - Is the immediate area of operations contaminated once the attack is over?
 - What are the likely targets, threat agents, and warning times?
- Terrain and Weather.
 - What is the ambient air temperature?
 - What is the humidity?
 - What is the wet-bulb globe temperature index reading for the unit's area of operations?
 - Is it cloudy, sunny, or windy?
 - Is the terrain sandy, mountainous, or marshy?
- Troops and Support Available.
 - How many personnel are available?
 - What individual protective equipment (IPE) is available?
 - What is the training status of available personnel?
- Time Available.
 - What is the date-time group for completion of the mission?
 - How much time is available for completion of the mission?
 - Can completion of the mission be delayed?

Mask Only. The mask is worn with the long-sleeve duty uniform (for limited skin protection). The Mask-Only command may be given—

- When riot control agents are being employed and no CBRN threat exists.
- During a downwind vapor hazard of a nonpersistent CBRN agent.

CAUTION

Mask Only is not normally an appropriate command when blister or nerve agents are involved. Leaders make risk-based decisions for Mask-Only posture.

Joint Service, Lightweight, Integrated Suit Technology (JSLIST). The JSLIST and protective mask are designed to protect personnel from traditional warfare agents in a combat environment, but they provide limited protection from some toxic industrial chemicals (TICs). Personnel equipped with standard MOPP gear must not remain in a TIC environment and should seek a clean area as soon as possible.

MOPP Ready. Units in MOPP Ready are highly vulnerable to persistent agent attacks and will automatically upgrade to MOPP 0 when they determine or are notified that CBRN weapons have been used or that the threat exists for CBRN weapons use. When a unit is at MOPP Ready, personnel will have field-expedient items (such as wet-weather gear) identified for use in the event of an unanticipated CBRN attack. Personnel carry their protective masks with their load-carrying equipment (LCE). Individual MOPP and IPE gear are labeled and stored no farther back than a logistics site (such as the brigade support area) and are ready to be brought forward to individuals when needed. The time required to push MOPP gear forward should not exceed 2 hours.

MOPP 0. Units in MOPP 0 are highly vulnerable to persistent agent attacks and will automatically upgrade to MOPP 1 when they determine or are notified that persistent CBRN weapons have been used or that the threat exists for CBRN weapons use. The primary use for MOPP 0 is during periods of increased alert when an enemy has a CBRN employment capability, but there is no indication of use in the immediate future. IPE is issued to individuals; they inspect it and prepare it for use. Personnel carry their protective masks and LCE. The standard issue overgarment and other IPE are carried or are readily available. To be considered readily available, equipment must be carried by each individual, stored within arm's reach, or be available within 5 minutes; for example, within the work area, vehicle, or fighting position.

MOPP 1. The primary use for MOPP 1 is when a CBRN attack in theater is possible. When directed to MOPP 1, personnel immediately don the overgarment. In hot weather, the overgarment jacket can be left open and the overgarment can be worn directly over underwear. Other IPE making up the individual MOPP gear (footwear covers, protective helmet cover, mask, gloves) are readily available or carried. Personnel attach M9 paper and carry M8 paper, nerve-agent antidotes, and decontamination kits or keep them at hand. MOPP 1 provides a great deal of protection against persistent agents. The leaders monitor hydration levels.

MOPP 2. The primary use for MOPP 2 is when a CBRN attack is likely. Personnel wear or don the overgarment, footwear covers, and protective helmet cover. As with MOPP 1, the overgarment jacket may be left open, but trousers remain closed. The mask with mask carrier and gloves are carried. Personnel attach M9 paper to their overgarment and carry M8 paper, nerve-agent antidotes, and decontamination kits or keep them at hand. Personnel maintain hydration levels.

MOPP 3: The primary use for MOPP 3 is when personnel are operating inside areas where chemical-agent contact hazards or operationally significant percutaneous (absorbed through the skin) vapor hazards do not exist. MOPP 3 is not appropriate if a contact hazard is present. Personnel wear the overgarment, footwear covers, protective mask, and protective helmet cover. Again, flexibility is built into the system to allow for personnel relief at MOPP 3, particularly in hot weather. Personnel can open the overgarment jacket, but the trousers remain closed. The protective gloves are carried.

MOPP 4. MOPP 4 is used when the highest degree of protection is required or when CBRN agents are present and the actual hazard has not been determined. Personnel completely encapsulate themselves by closing overgarments, adjusting drawstrings to minimize the likelihood of any openings, and donning protective gloves. As with other MOPP levels, flexibility is built into the system to provide relief to the individual. Once the hazard is identified and risk assessment measures are employed, the overgarment may be left open.

Table 1 shows the equipment requirements for each MOPP level.

Table 1. MOPP Level Equipment Requirements

Equipment	MOPP Level					
	Ready	0	1	2	3	4
Mask	Carried	Carried	Carried	Carried	Worn	Worn
Overgarment	Ready	Available	Worn	Worn	Worn	Worn
Footwear covers	Ready	Available	Carried	Worn	Worn	Worn
Helmet cover	Ready	Available	Carried	Worn	Worn	Worn
Gloves	Ready	Available	Carried	Carried	Carried	Worn

TOXIC INDUSTRIAL MATERIAL (TIM) HAZARDS

The exposure to some industrial material can have a lethal or debilitating effect on humans. There is a nearly universal availability of large quantities of stored, highly toxic, industrial materials throughout the world. The lethality and widespread availability of TIM (in conjunction with its general proximity to urban areas, low cost, and low-security storage facilities) make them an attractive option for terrorist use.

TIC is a subgroup of TIM and consists of commercial chemical substances with acute toxicity produced in large quantities for industrial purposes. The knowledge of where TICs are stored and how they are transported are two of many factors that must be considered when assessing possible terrorist use.

Units use the following publications to identify protection requirements for specific material:

- Department of Transportation, *Emergency Response Guidebook*.
- National Institute for Occupational Safety and Health, *Pocket Guide to Chemical Hazards*.

U.S. forces frequently operate in environments where TIMs—particularly TICs and toxic industrial biological and radiological material—are present. A number of these chemicals could interfere significantly across the range of military operations. Many TIMs are flammable, are explosive, or react violently with air or water. TIMs can have short- and long-term health effects, ranging from short-term transient effects to long-term disability to rapid death. TICs are often corrosive and can cause damage to the eyes, skin, respiratory tract, and military equipment. Military protection, detection, and medical countermeasures are not specifically designed for TIM hazards.

LEVELS OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

The JSLIST and protective mask give immediate protection against traditional warfare agents. They do not provide complete protection from certain TICs, but they provide the best-available protection to enable evacuation from the hazard area. You may be required to evacuate to a minimum safe distance of at least 300 meters upwind from the contamination if possible or as directed by the commander.

There are four levels of protection (Table 2) established by the U.S. Environmental Protection Agency according to Section 120, Part 1910, Title 29, Code of Federal Regulations (29 CFR 1910.120). The level of skin and respiratory protection provided by the selected chemical-protective ensemble determines the protection that is furnished to the responder. The levels of protection are divided into four categories (Levels A, B, C, and D) and are worn according to the guidelines published by the Occupational Safety and Health Administration and National Fire Protection Agency. PPE places an increased level of mental and physiological stress on individuals (for example, heat stress and respiratory resistance), which must be carefully monitored and evaluated through all phases of an operation.

Table 2. Levels of Protection

Level	Equipment	Use
A	Positive-pressure mask with self-contained breathing apparatus, fully encapsulating suit, chemical-resistant gloves and boots	Highest level of skin, respiratory, and eye protection is required.
B	Positive-pressure mask with self-contained breathing apparatus; chemical-resistant overgarment, hood, gloves, and boots	Highest level of respiratory protection is required.
C	Full facepiece mask; chemical-resistant overgarment, gloves, and boots	Criteria (29 CFR 1910.134[d]) is met for the use of an air-purifying respirator.
D	Work uniform with safety boots	Criteria is met for nuisance contamination only.

SERPACWA is intended for use before exposure to chemical warfare agents (CWAs) and only in conjunction with MOPP gear. When applied before exposure, SERPACWA reduces or delays the absorption of chemical agents through the most vulnerable areas of the skin. Individuals will apply SERPACWA when command-directed.

Before you don the chemical-protective overgarment/IPE (MOPP 1), use a dry towel to wipe off sweat, insect repellent, camouflage paint, sand, and dirt from your skin in the following areas. Then, apply SERPACWA to these same areas. (See the SERPACWA packet label.)

- Wrists.
- Neck.
- Lower legs.
- Armpits.
- Groin.
- Waistline.

Note. The barrier properties of SERPACWA may be reduced if any insect repellent or camouflage paint remain on skin surfaces where it is applied.

If exposure to CWA is confirmed or suspected after SERPACWA is applied, follow the appropriate protocol for decontamination (see FM 3-11.5).

PREATTACK ACTIONS

Take the following steps before an attack:

1. Assess the chemical threat, potential risk, and likelihood of an attack.
2. Implement a coordinated chemical defense plan.
3. Prepare to provide first aid for unit personnel.
4. Determine and implement the appropriate MOPP levels.
5. Determine whether to apply SERPACWA.
6. Minimize skin exposure.
7. Continue good hygiene and sanitation methods.
8. Deploy and activate detectors.
9. Designate and prepare shelters.
10. Watch for attack indicators (chemical cloud, distinctive odor, release of an agent).
11. Cover unprotected mission-essential equipment.

Take the following steps during an attack:

1. Give attack warnings. The detection and warning of an attack are critical to the implementation of protective measures. The warning signal for the attack directs personnel to take cover and use protective measures.
2. Take cover. Taking cover protects personnel against blast, shrapnel, heat, liquid, and particulate contamination. After taking cover, personnel don their masks and other protective gear as appropriate.
3. Use MOPP 4. All personnel should assume MOPP 4 (full IPE) in the absence of any other information and remain in MOPP 4 until directed to reduce their MOPP level. The MOPP ensemble can also be supplemented by using protective clothing such as wet-weather clothing; an air crewman's cape; or the suit, contamination avoidance, and liquid protective.

POSTATTACK ACTIONS

Take the following steps after an attack:

1. Begin postattack recovery. If an adversary uses air-bursting chemical munitions and the mission permits, avoid outside activities to the maximum extent possible during the chemical-droplet fall phase. Outside activities could result in erroneous initial reconnaissance results and unnecessarily contaminated personnel and equipment.
2. Avoid potentially contaminated surfaces and areas. Minimize contact with potentially contaminated surfaces and areas until there are indications that contamination is no longer a hazard.
3. Obtain and report observations or evidence of an attack. Provide reconnaissance and assessment information for all types of damage, hazards, and chemical agents.
4. Survey, control, and mitigate health hazards (evaluate and treat casualties). The health support service provides treatment for casualties according to established medical protocols.
5. Adjust MOPP. Commanders should adjust MOPP to the lowest possible level that is consistent with the identified hazards.
6. Document exposure. Medical staffs should clearly document exposure in the personal medical records of exposed personnel.
7. Sample, monitor, and analyze residual hazards. Once the situation permits, perform detection procedures to determine the extent and duration of residual hazards.
8. Plan and implement decontamination and contamination containment actions. These actions are planned and implemented to minimize the operational impacts of contamination.
9. Conduct unmasking procedures (all-clear). Commanders should revert to an appropriate MOPP level, based on the current threat and in conjunction with the all-clear signal. All personnel should return their IPE to a ready status in anticipation of the next attack warning.
10. Perform chemical filter exchange. Filter exchange is another action that is based on design, physical condition, climatic conditions, and the possible threat agent.

The signs and symptoms of poisoning are shown in Table 3.

Table 3. Signs and Symptoms of Poisoning

<i>Mild Nerve-Agent Poisoning</i>
Unexplained sudden headache
Difficulty seeing (blurred vision)
Unexplained runny nose
Excessive flow of saliva (drooling)
Tightness of the chest and breathing difficulties
Stomach cramps
Nausea
Muscular twitching around the area of exposed or contaminated skin
<i>Severe Nerve-Agent Poisoning</i>
Severely pinpointed pupils
Red eyes with tearing
Strange, confused behavior
Gurgling sounds when breathing
Vomiting
Loss of bladder or bowel control
Severe muscular twitching
Convulsions
Unconsciousness or stoppage of breathing
<i>Biological-Agent Poisoning</i>
Dizziness, mental confusion, or doubled or blurred vision
Skin tingling, numbness, paralysis, or convulsions
Rashes or blisters
Coughing
Fever, aching muscles, fatigue, or difficulty in swallowing
Nausea, vomiting, or diarrhea
Bleeding from body openings or blood in urine, stool, or sputum (spit)
Shock (symptoms appear in minutes or hours after the toxin attack)

UNMASKING PROCEDURES

Note. Always ensure that first aid treatment is immediately available in case personnel display symptoms of agent poisoning.

If an agent is still present after conducting unmasking procedures, the senior person selects one of the following options:

- If the mission allows, moves Soldiers to a new area and reconducts unmasking procedures.
- If the mission prohibits movement, reconducts unmasking procedures after 1 hour.

The following steps take about 15 minutes:

1. Soldiers conduct all M256 tests, including a check for liquid contamination, and ensure that results are negative.
2. The senior person selects one or two individuals to start the unmasking procedures.
3. Soldiers move to a shady place if possible. Bright, direct sunlight can cause pupils to constrict, giving false signs of nerve-agent exposure.
4. Soldiers unmask for 5 minutes and then reseal and clear their masks.
5. The senior person observes Soldiers for 10 minutes.
6. The commander/leader determines whether to issue the all-clear signal for unmasking if no symptoms appear.
7. Leaders continue to observe Soldiers for delayed symptoms.

Note. The M256 series chemical detector kit does not detect all agents. Therefore, unmasking procedures without the kit should be considered even if the detector is available.

Without the M256 Series Chemical Detector Kit

The following steps take at least 35 minutes:

1. Soldiers move to a shady area if possible and use M8/M9 paper to test for liquid contamination.
2. The senior person selects one or two individuals to start the unmasking procedures.
3. Soldiers—
 - Keep their eyes wide open.
 - Take a deep breath, hold it, and break the seal of their mask for 15 seconds.
 - Clear and reseal their masks.
4. The senior person observes Soldiers for 10 minutes.
5. Soldiers—
 - Break the seal of their mask if no symptoms appear.
 - Keep their eyes wide open.
 - Take two or three breaths.
 - Clear and reseal their masks.
6. The senior person observes Soldiers for 10 minutes.
7. Soldiers unmask for 5 minutes if no symptoms appear and then remask.
8. The senior person observes Soldiers for 10 minutes.
9. The commander/leader determines whether to issue the all-clear signal for unmasking if no symptoms appear.
10. Leaders continue to observe Soldiers for delayed symptoms.

Note. The onset of symptoms may take several hours if Soldiers are exposed to blister agents.

The decision to decontaminate is a risk assessment and is made within the context of mission, enemy, terrain and weather, troops and support available, time available, and civil considerations and the resources available. Decontamination levels and techniques are shown in Table 4.

Table 4. Decontamination Levels and Techniques

<i>Level</i>	<i>Technique¹</i>	<i>Purpose</i>	<i>Best Start Time</i>	<i>Performed By</i>
Immediate	Skin decontamination	Saves lives	Before 1 minute	Individual
	Personal wipe-down	Stops agents from penetrating	Within 15 minutes	Individual or buddy
	Operator wipe-down	Limits agent spread	Within 15 minutes	Individual or crew
	Spot decontamination	Limits agent spread	Within 15 minutes	Individual or crew
Operational	MOPP gear exchange ²	Provides temporary relief from MOPP 4	Within 6 hours	Unit
	Vehicle wash-down	Limits agent spread	Within 1 hour (CARC) ³ or within 6 hours (non-CARC)	Battalion crew or decontamination platoon
Thorough	Detailed equipment, aircraft, and troop decontamination	Provides probability of long-term MOPP reduction	When mission allows reconstitution	Decontamination platoon or contaminated unit
Clearance	Unrestricted use of resources	Considers METT-TC depending on the type of equipment contaminated	When mission permits	Supporting strategic resources

¹The technique become less effective the longer it is delayed.

²Performance degradation and risk assessment must be considered when exceeding 6 hours (see FM 3-11.4).

³CARC = chemical agent resistant coating.

The MOPP gear exchange (Table 5) with JSLIST is best conducted at the squad level. It can be done with a buddy team, a triple buddy team or, in an emergency, individually. For planning purposes, estimate 30 minutes for a squad- or platoon-size element to complete the exchange. Since individual performance is severely degraded after 6 hours in MOPP 4, the MOPP gear exchange should be scheduled before that time.

Table 5. MOPP Gear Exchange

Steps	Notes
1. Decontaminate gear.	This removes gross contamination from individual gear (weapon, helmet, LCE).
2. Prepare to decontaminate.	This facilitates later removal of overgarments and overboots. (Remove M9 paper, untie drawstrings, and unfasten hook-and-pile fasteners.)
3. Decontaminate mask and hood.	This removes gross contamination. (Use an M291 decontamination kit.)
4. Remove chemical-protective coat.	This limits the spread of agents and helps prevent agents from penetrating to undergarments or skin.
5. Remove chemical-protective trousers.	Care must be taken to avoid contaminating clothing or skin.
6. Remove chemical-protective overboots.	Soldiers step directly onto the coat that is spread on the ground as each boot is removed. This acts as a contamination-free zone.
7. Remove chemical-protective gloves and liners.	Soldiers must avoid letting their gloves come in contact with the coat that is spread on the ground.
8. Put on chemical-protective trousers.	Soldiers must ensure that their trousers touch the uncontaminated surface only.
9. Put on chemical-protective coat.	Soldiers must fasten and tie drawstrings and hook-and-pile fasteners.
10. Put on chemical-protective overboots.	Soldiers must remain standing on the coat while donning uncontaminated boots.
11. Put on chemical-protective hood.	Ensure that the barrel lock-release button faces forward when securing the hood of the JSLIST to prevent unfastening and contamination exposure.
12. Put on chemical-protective gloves and liners.	Soldiers must tuck their gloves and liners into the cuffs of their sleeves. Soldiers place M9 detector paper on as required by the unit standing operating procedure.
13. Reverse roles.	Buddy teams reverse roles and execute each step, ensuring that contamination is not spread to Soldiers who have already completed the exchange.
14. Secure gear.	Soldiers place a new chemical-protective helmet cover on their helmet if used. They secure assigned gear and continue the mission.

RSDL is a broad-spectrum, liquid CWA decontaminant that will remove, destroy, or neutralize chemical agents or the T-2 toxin (a biological agent) on contact.

Each RSDL kit consists of a green pouch containing three green individual decontamination packets. Each decontamination packet contains an applicator pad that is impregnated with enough lotion to complete personal decontamination for one individual. The lotion is the decontaminating material, and the applicator pad is used to apply the lotion and wipe the skin surface to enhance decontamination effectiveness. The RSDL allows you to quickly decontaminate your skin through the physical removal and chemical reduction of toxic agents.

For best results, start wiping your face and other areas of exposed skin within 1 minute. RSDL reacts rapidly and provides the full removal and destruction of CWAs within 2 minutes. When operational conditions permit, remove RSDL by washing with water or soap and water.

M100 SORBENT DECONTAMINATION SYSTEM (SDS)

The M100 SDS is a portable decontamination system used for operator wipe-down during immediate decontamination operations. It replaces the M11/M13 decontamination apparatus, portable, and associated Decontamination Solution 2 used for operator spray-down. The M100 SDS—

- Is nontoxic and noncorrosive.
- Is environmentally friendly and poses no storage or transportation risks.
- Requires no water to complete the mission.
- Has an operating temperature of -25°–120°F (-32°–49°C).

The M100 SDS consists of two decontamination kits. Each kit includes a package containing a wash mitt and a 0.7-pound pack of reactive sorbent powder, a case, detailed instructions, and straps. Decontamination is accomplished by using the mitt to rub and wipe contaminated surfaces with sorbent.

Pour the sorbent powder into the palm of the mitt, and then use the mitt to rub and wipe contaminated surfaces until target areas are visually dry. Add more sorbent to the mitt as required during decontamination operations.

ACAA emplacement procedures are as follows:

1. Determine the wind direction and speed from a current chemical downwind message or by a field-expedient method.
2. Determine how far upwind to place the detectors. This distance is based on the—
 - Wind speed. The faster the wind speed, the farther upwind the detector should be placed (not to exceed 150 meters from the unit position).
 - Weather. Rain or snow tends to wash the agent out of the air. Hot, sunny weather tends to create higher vapor concentrations.
 - Terrain. The more broken the terrain and the more obstacles (trees, buildings), the closer the detectors should be placed.
 - Threat situation.
3. Determine the detector array to be used by considering the above concerns, number of detectors available, and position of the unit (see Figure 2 and Figure 3).

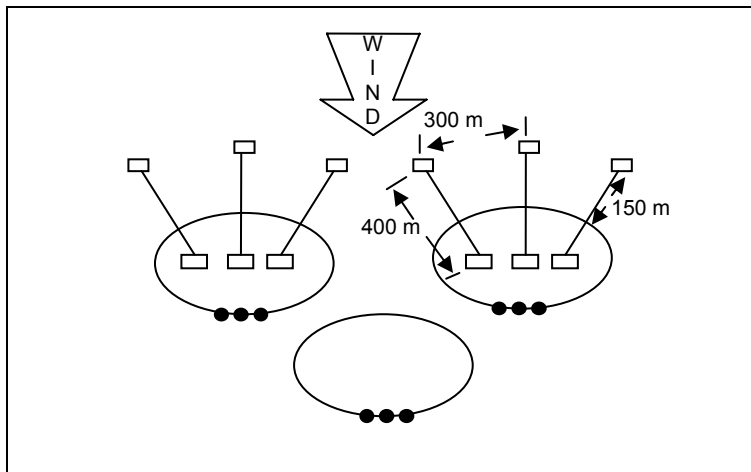


Figure 2. ACAA Setup, Example 1

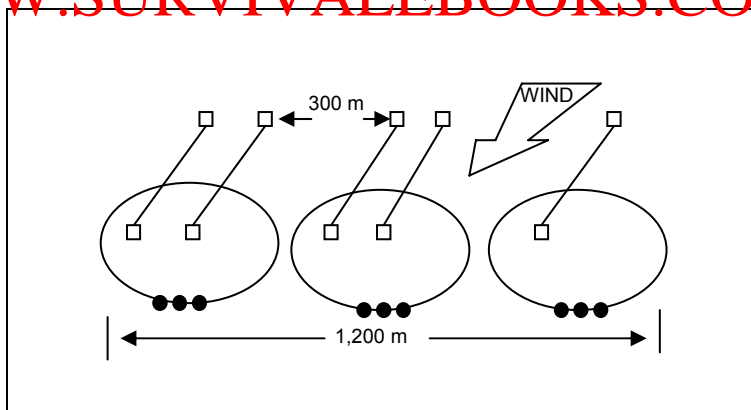


Figure 3. ACA Setup, Example 2

Adhere to the following guidelines:

- Emplace detectors the maximum distance from the unit, but not exceeding 150 meters.
- Space detectors no more than 300 meters apart.
- Do not place detectors where obstructions could alter wind currents.
- Connect detectors to alarms with telephone cable. The maximum wiring distance should not exceed 400 meters.
- Place alarms near monitoring positions.

Note. Do not connect more than five alarms to one detector.

Use the following formulas to determine warning times:

$$\frac{D \times 60}{WS \times 1,000} = WTM$$

where—

- D* = Distance, in meters
WS = Wind speed, in kilometers per hour
WTM = Warning time, in minutes

$$\frac{D \times 36}{WS \times 10} = WTS$$

where—

- D* = Distance, in meters
WS = Wind speed, in kilometers per hour
WTS = Warning time, in seconds

Example: The distance is 150 meters, and the wind speed is 5 kilometers per hour. The warning times are 1.8 minutes or 108 seconds.

$$\frac{150 \times 60}{5 \times 1,000} = \frac{9,000}{5,000} = 1.8 \text{ minutes}$$

$$\frac{150 \times 36}{5 \times 10} = \frac{5,400}{50} = 108 \text{ seconds}$$

Table 6 shows sample warning times for 150-meter distances.

Table 6. Sample Warning Times

<i>Distance Between Unit and Detectors, in meters</i>	<i>Wind Speed, in kilometers per hour</i>	<i>Time Before Agent Reaches Unit Location, in seconds</i>
150	5	108
150	10	54
150	15	36
150	20	27

NOTES:
