BURGLARY AND THEFT

Table of Contents

Page

List of Figures

List of Tables

1.0 SCOPE

This data sheet addresses the subject of burglary and theft losses in manufacturing and warehouse facilities, and, to a limited extent, mercantile locations. Currency, works of art, precious stones and metals, etc. require sophisticated alarm systems, very secure storage (e.g., safes or vaults), or combinations of alarms, safes, watch service, etc.

Robbery and employee theft are not addressed in this data sheet.

1.1 Changes

January 2010. Minor editorial changes were made for this revision. Section 4.0, *References*, was updated.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Buildings

2.1.1 Protection

2.1.1.1 Based on the probability of loss and the loss expectancy, burglary protection should be provided as shown in Table 1. The protection level of an alarm system is determined by adding the classification numbers for the components of the system. (A system consisting of Perimeter-2 and Area-1 alarm protection would offer Level 3 protection.)

Table 1. Protection For Buildings or Stock Rooms

*Probability of Loss**	*Loss Expectancy*	*Protection Level Needed*	*Response Needed*	*Line Supervision*
High	High	5	FM-15-S	Yes**
	Moderate	4	FM-20	Yes
	Low	2	FM-20	No
Moderate	High	4	FM-20	Yes***
	Moderate	3	FM-20	Yes***
	Low	2	FM-20	No
Low	Passive protection only if no contributing factors.			

* When the probability of loss is very high, susceptible commodities should be stored in a safe or vault and protected in accordance with Table 3.
** Line security is needed.
*** When the probability of loss is moderate, the presence of a loud local alarm can replace line supervision if reliable response is assured.

2.1.1.2 Use the following types of passive protection when “passive protection only” is recommended in this data sheet.

1. Adequate exterior lighting. This includes lighting an area of ten ft (three m) on either side of fences, and areas within 40 ft (12 m) of building entrances. Lights should be roof-mounted or pole-mounted so they are not easily attacked. Yard storage subject to theft should be in a well-lighted area.

2. Windows. Those easily reached from the ground and not fronting main roads should be blocked or protected. Windows on upper stories made accessible by nearby structures should also be protected. Protection, as permitted by the applicable governing building and fire codes, should be in the form of bars or screens as follows:

   a. Where the fire department must have quick access to the protected area, bars can be ¼ in. (6 mm) rods spaced one in. (2.5 cm) apart. In other areas, flat iron bars at least 1½ in. (four cm) by ⅜ in. (1 cm) should be used, spaced no more than five in. (13 cm) apart vertically and no more than 24 in. (61 cm) apart horizontally. ⅜ in. (1 cm) rivets or carriage bolts should be provided at the points where bars cross.

   b. The ends of bars should be securely fastened to the window frame using ⅜ in. (1 cm) carriage bolts or rivets, or they should be embedded in masonry walls. If this is not practical, the bars should be attached with ⅜ in. (1 cm) lag bolts.

c. If screens are used, wire should be a minimum of eight gauge in size, with mesh openings of no more than 2 in. (5 cm). The mesh should be securely attached to a heavy metal frame bolted to the window frame with ⅜ in. (1 cm) carriage bolts.

d. Bars or screens should be located on the inside of windows so that glass must be broken before the bars can be attacked. Heads of bolts used to secure bars or screens should be case hardened to resist drilling.

e. Glass store display windows are subject to ‘‘hit and run’’ attacks and should therefore be made of force resistant glazing when contents of the display area are of significant value, such as jewelry, television sets, etc.

3. Fences or Barriers. Fences should be flush with the ground and a minimum of 7 ft (2 m) in height, with barbed wire at the top tilted toward the outside of the protected area. Barrier systems (walls, barbed tape or concertina, etc.) should provide the same degree of protection.

4. Exterior doors. These should be of substantial construction with adequate locking devices. They should be a minimum of 1½ in. (4 cm) thick, and should be solid wood, wood core with 16 ga. metal facing on the interior, or solid metal. Windows in doors should be force resistant glazing or should be protected by metal grill work. The door frame should also be of substantial construction, well secured to the structure. A heavy dead-bolt lock should be provided, with a bolt that extends at least 1 in. (25 cm) into the bolt receptacle.

5. Protection against other tenants. Adequate cutoffs between tenants should be of solid masonry construction, complete from the floor to the underside of the roof. Any openings should be locked with suitable hardware. Other tenants should not have free access.

6. Visitors should be supervised for the duration of their visit.

Note: The above are adequate as the sole means of burglary protection only in cases of low probability or low loss expectancy.

2.1.1.3 Alarms should be connected to an FM Approved burglar alarm central station or police station wherever possible. Where this is not possible, watch service should be provided. (For Level 2 protection, a loud local alarm can be substituted for central station connection, if reliable local response can be assured.)

2.1.1.4 Alarm equipment should be FM Approved or an adequate equivalent.

2.1.1.5 Line supervision should be provided for Level 3 alarm systems and above. Where the loss probability is moderate, an FM Approved local alarm can substitute for line supervision. FM Approved digital dialing equipment is an adequate means of monitoring alarm signals where line security is not needed.

2.1.1.6 All locations should have suitable passive protection as judged adequate for the location.

2.1.1.7 During construction, renovation or equipment installation contractors should be supervised closely. Provide watch service and alarms and address related items (such as the means of alarm transmission notification and location accessibility) as outlined in Data Sheet 1-0, *Safeguards During Construction, Alteration and Demolition*. Provide fencing and lighting for the site.

2.1.2 Operation and Maintenance

2.1.2.1 Basic safeguards should be taken whenever the possibility of burglary or theft exists. They include:

1. A careful round at closing by a responsible employee to make sure that all windows, doors, skylights, etc. are closed and securely locked. If the property is fenced, gates should be locked.

2. Properly maintained interior and exterior lighting.

3. Properly maintained fences, doors, windows, etc.

2.1.2.2 All personnel responsible for operation of alarm system equipment should be thoroughly trained in the arrangement and operation of the system.

2.1.2.3 All components of alarm systems should be tested monthly.

2.1.2.4 All false alarms should be investigated and records should be maintained. Periodic review should be conducted to detect trends.

2.1.2.5 If alarms cannot be placed in service due to equipment failure, watch service should be provided until alarms are returned to service.

2.2 Yards

2.2.1 Protection

2.2.1.1 Yard storage should be protected with fencing, adequate exterior lighting, and secure locking devices on fence gates.

2.2.1.2 Where warranted according to Table 2, protection of yard storage beyond simple passive protection should be provided.

2.2.2 Operation and Maintenance

2.2.2.1 All personnel responsible for operation of alarm system equipment should be thoroughly trained in the arrangement and operation of the system.

2.2.2.2 All components of alarm systems should be tested monthly.

2.2.2.3 All false alarms should be investigated and records should be maintained. Periodic review should be conducted to detect trends.

2.2.2.4 If alarms cannot be placed in service due to equipment failure, watch service should be provided until alarms are returned to service.

2.3 Vehicles

2.3.1 Protection

2.3.1.1 Exterior perimeter alarms and/or vehicle alarms should be provided based on the probability of yard storage loss and loss expectancy as shown in Table 2.

2.3.1.2 Alarms should be connected to an FM Approved burglar alarm central station or police station.

2.3.1.3 Alarm equipment should be FM Approved, or an adequate equivalent should be provided.

2.3.1.4 Loaded trailers should not be parked in the yard. Where they must be left unattended, kingpin locks should be provided. Alarms should be provided in accordance with Table 2. Unless the commodities in the trailers are of low demand, this arrangement has a high probability of loss.

Table 2. Protection of Vehicles And Yard Storage

Probability of Loss	*Loss Expectancy*	*Exterior Alarms Needed*	*Response Needed*	*Line Supervision*
High	High	Yes	FM-15 *	Yes
	Moderate	Yes	FM-20 **	Yes
	Low	Yes	FM-20 **	No
Moderate	High	Yes	FM-20 **	No
	Moderate	Yes	FM-20 **	No
	Low	Passive protection only if no contributing factors.		
Low	Passive protection only if no contributing factors.			

* If the loss expectancy is very high, FM-15-S response should be provided.
** If a large value of the susceptible commodities are very easily transportable, such as loaded trailers, FM-15 response should be provided.

2.3.1.5 Watch service may be used as a substitute for exterior perimeter alarms. Key stations should be located in the yard to assure proper coverage.

2.3.1.6 Vehicles or loaded trailers should be protected with fencing, adequate exterior lighting, and secure locking devices on fence gates and loaded trailers.

2.3.2 Operation and Maintenance

2.3.2.1 All personnel responsible for operation of alarm system equipment should be thoroughly trained in the arrangement and operation of the system.

2.3.2.2 All components of alarm systems should be tested monthly.

2.3.2.3 All false alarms should be investigated and records should be maintained. Periodic review should be conducted to detect trends.

2.3.2.4 If alarms cannot be placed in service due to equipment failure, watch service should be provided until alarms are returned to service.

2.4 Vaults and Safes

2.4.1 Protection

2.4.1.1 When all susceptible commodities are stored in suitable safes or vaults, alarms should be provided based on the probability of loss and the loss expectancy as shown in Table 3. Otherwise, protect the safe or vault according to Table 3 and protect the building using Table 1 or 3, whichever requires the higher level of protection.

2.4.1.2 The safe or vault door should have a combination lock and be equipped with a relocking device. The door combination should be given to the minimum number of employees. The combination should be changed every six months or whenever someone who knows the combination leaves the company.

2.4.1.3 Alarms should be connected to an FM Approved burglar alarm central station or police station. Where the probability of loss is moderate and the loss expectancy is moderate or low, a loud local alarm can substitute for remote monitoring if reliable local response can be assured.

2.4.1.4 Alarm equipment should be FM Approved or meet adequate equivalent requirements.

2.4.1.5 Line supervision should be provided in all cases except where the loss expectancy is low. Where the probability of loss is moderate, a loud local alarm can substitute for line supervision if reliable local response can be assured.

2.4.1.6 Watch service may be used as a substitute for vault or safe alarms where needed if the watchman checks the vault or safe at least once every 30-60 min

2.4.1.7 All locations should have suitable passive protection as judged adequate for the location.

Table 3. Protection For Burglary Resistant Safes and Vaults

Probability of Loss	*Loss Expectancy*	*Minimum Safe or Vault(1)*	*Safe/Vault Protection Needed*	*Building Protection Needed (3)*	*Response Needed*	*Line Security or Supervision*
Very High	Very High	TRTL-60 TXTL-60 Class 2	Complete	Level 4	FM-15-S	Line Security
	High	TRTL-30x6 Class 1	Complete	Level 3	FM-15-S	Line Security
	Moderate	TRTL-30 TRTL-15x6 Class M	Complete	Level 3	FM-15-S	Line Security
	Low	TL-30 TL-15 (2)	Partial	None	FM-15	Line Supervision
High	Very High	TRTL-30x6 Class 1	Complete	Level 2	FM-15-S	Line Security
	High	TRTL-30 TRTL-15x6 Class M	Complete	Level 3	FM-15-S	Line Security
	Moderate	TL-30 TL-15 (2)	Complete	None	FM-15-S	Line Security
	Low	TL-15	Partial	None	FM-15	No
Moderate	High	TRTL-30 TRTL-15x6 Class M	Complete	Level 3	FM-15	Line Supervision (4)
	Moderate	TL-30 TL-15	Complete	None	FM-15 (5)	Yes (4)
	Low	(2)	None	Level 2	FM-15 (5)	No
Low	—	None (3)	Passive protection only if no contributing factors.			

Notes: (1) If the probability of loss is very high or if the probability is high with a high LE, additional protection may be required. This would generally be a combination of greater burglar resistant safes or vaults, higher levels of alarm systems, watch service, or passive protection.
(2) If the minimum safe or vault recommended in Table 3 is not provided, protect susceptible commodities in an area enclosed by walls, floor and roof of substantial construction. Cages are not adequate.
(3) Fire-resistant safes or unlabeled safes.
(4) Where probability of loss is moderate and the loss expectancy is moderate or low, a loud local alarm can substitute for line supervision.
(5) See Recommendation 2.4.1.3.

2.4.2 Operation and Maintenance

2.4.2.1 All personnel responsible for operation of alarm system equipment should be thoroughly trained in the arrangement and operation of the system.

2.4.2.2 All components of alarm systems should be tested monthly.

2.4.2.3 All false alarms should be investigated and records should be maintained. Periodic review should be conducted to detect trends.

2.4.2.4 If alarms cannot be placed in service due to equipment failure, watch service should be provided until alarms are returned to service.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss Expectancy Determination

The first step in developing a comprehensive program to prevent burglary and theft loss is to evaluate the exposure to such a loss. The need for protection, and the extent of protection, is a direct function of the probability of loss, and the expected magnitude of a loss.

There are many factors that affect the probability of a burglary or theft They are most easily evaluated when broken down into three categories: Demand, concentration of value, and transportability.

3.1.1 Demand

The demand is a direct indication of the desirability of goods from the point of view of burglary or theft This takes into consideration the cost of the goods in question, the ease with which they can be resold, and the number of potential buyers.

Very high-demand items have high unit values, are easily transportable, and can be readily resold to a large number of people or industries. This category includes gold, platinum, diamonds, and jewelry made of precious metals and stones. Because of the large loss expectancies generated by small volumes of these items, combinations of alarms, safes and vaults, watch service, etc. are recommended. These items are generally not within the scope of this document.

High-demand items are those with high unit value, marketable on a ‘‘no questions asked’’ basis. This category includes luxuries or non-essentials as well as high-value, commonly used industrial items.

Moderate-demand items are those which are less easily resold. This category includes items of lower unit value; it also includes those of high unit value which would only be of use to a limited number of people or industries.

Low-demand items are those that have limited appeal to the general public or are widely used but priced low. Also included are high- or moderate-value items of use to a limited number of people or industries.

Table 4 illustrates examples of various demand items. Caution must be exercised when classifying commodities. The demand for a particular item may vary due to such factors as scarcity, geography, unusual market prices, popularity, etc.

Demand refers to the marketability of a stolen item. While dollar values play a part in determining demand, they do so in an indirect way. Color televisions are expensive and are high-demand items. Oscilloscopes are also expensive, but are moderate-demand items due to the limited market. Designer clothes are expensive and are high-demand items. Children’s clothes would be much less expensive, but would still be high-demand items.

Examples:

1. Drill Bits used on oil rigs. These have a high unit value and would have a high demand in areas where oil drilling is common. The demand would be lower elsewhere.

2. Copper is listed as a high-demand item due to its cost. A few years ago, it was a moderate-demand item due to its lower value.

3. Children’s toys can change their demand every few years. Popularity and availability are major factors used to determine demand. Electronic toys and games are popular and expensive and are thus a high-demand item. (These may become less expensive in the future in the same way pocket calculators have increased in sophistication while decreasing in cost.)

Table 4. Demand

Very High Demand	*High Demand*	*Moderate Demand*	*Low Demand*
Diamonds	Antiques	Brass	Blowers/Fans
Drugs-narcotics	Audio/Visual Equipment	Cathode Ray Tubes (CRTs)	Chemicals
Fine Art	Bicycles *	Compressors	Containers/Drums
Gold	Cobalt Alloys	Computers	Cotton Bales
Precious Stones	Calculators *	Duplicating Machines	Dry Cleaning Equipment
Palladium	Cameras (includes lenses & accessories) *	Electric Motors	Glue
Platinum	Cigarettes	Household Appliances (Dishwashers, Refrig.,etc.)	Hand Tools (hammers, shovels, etc.)
Silver	Clothing *	Industrial Pumps	Heavy Industrial Machinery
	Copper	Lumber	Office Supplies (Pens, Pencils, Paper, etc.)
	Furniture *	Metal Working Machines	Perishable foods (fresh fruit, ice cream, etc.)
	Guns	Sophisticated Electronic Equipment (used in industry or research)	Pet Food
	Jewelry	Titanium	Rolled Paper
	Liquor *	Zinc Ingots	Salt
	Meat		Sandpaper
	Microwave Ovens		Scrap Metals (Steel, Aluminum, Iron, etc.)
	Motorcycles		Textbooks
	Personal Computers		Tool Boxes
	Printed circuit boards		Transformers
	Power Tools		
	Records/Tapes		
	Stereo Equipment		
	Televisions		
	Toys/Games (Electronic) *		

* These items are the luxury models that have a high unit value. Similar items with a lower unit value have a moderate demand.

3.1.2 Concentration

Loss history indicates that it is unlikely that more than two trailer loads of goods will be stolen. Therefore, the loss expectancy can be considered to be the value of 7000 ft^3 (200 m^3) of the goods subject to theft, which represents roughly the volume of two trailers. Common sense must also be used. For instance, commodities having a high weight per volume would overload a trailer before it is completely filled, so the loss experience would be based on the maximum weight two trailers could carry. (50,000 lbs [22 tons] is a rough estimate of the capacity of one trailer.)

3.1.2.1 Concentration of Value

When values are concentrated in one area, the likelihood of a major loss increases. For example, in a grocery warehouse, the canned goods (e.g., fruits, vegetables, juices) are stacked in cartons on pallets or in racks, and the value is concentrated into a small area, which could be stolen in a short period of time. On the other hand, if the canned goods were in a grocery store, on shelves, the value would be the same, but they would be loosely spread over a much larger area. These would not be considered to have ‘‘Concentration of Value.’’

3.1.3 Transportability

Transportability is simply a reflection of whether an item is movable. Goods arranged for bulk handling, such as palletized storage, where lift trucks are available, are generally considered transportable. On the other hand, the lack of a lift truck does not automatically mean that palletized goods are not to be considered transportable. Microwave ovens, stored in boxes on pallets, would be considered transportable if no lift trucks were available, as they can be moved one at a time.

3.1.4 Loss Probability

After determining the above three classifications, it is then possible to determine the probability of a major burglary or theft loss. Table 5 relates the various classifications to probability.

Table 5. Determining Probability

Demand	*Concentration*	*Transportability*	*Probability*
Very High	Yes *	Yes	Very High
Very High	No **	Yes *	High
High	Yes	Yes	High
High	No	Yes	Low
High	Yes	No	Moderate
High	No	No	Low
Moderate	Yes	Yes	Moderate
Moderate	No	Yes	Low
Moderate	Yes	No	Low
Moderate	No	No	Low
Low	All Combinations		Low

* By definition, very high-demand items must be easily transportable.
** Because of the small size of many very high-demand items, Concentration of Value should be adjusted accordingly and not be rigidly related to concentration of 7,000 ft^3 (200 m^3) of goods.

Of course, not all cases are precisely defined, so a certain amount of judgment is necessary.

3.1.5 Contributing Factors

It is necessary to allow room for judgment in devising a burglary protection scheme. Following are items that should be considered when applying this judgment.

1. Is the property to be protected in an area known to have a high crime rate? This can be established from police records or previous loss experience. (Evidence of vandalism can also be a clue to high crime rate areas.)

2. Is the property to be protected located such that a burglar could work for a considerable time without detection?

3. Can the property be easily entered through unprotected openings or deteriorated construction? (Metal walls can be easily penetrated, for example.)

4. Are there tenants in adjoining areas that have, or could allow access to the protected property? If the tenant's area is open to free access, burglars could work undetected in that area and gain access through doors or walls.

5. Are personnel not employed at the protected property properly controlled while working there? Are visitors supervised for the duration of their visit?

3.1.6 Examples

1. Storage of electric hand saws and drills in boxes on pallets in a warehouse.

   Demand: High (from Table 1-power tools)
   Concentration: Yes
   Transportability: Yes
   Probability: High

Note: Tools are considered transportable whether or not a fork lift is available. The tools can be easily moved by hand.

2. Storage of integrated circuits in tubes on shelves.

   Demand: High for common, multi-use types, or Low for specialized types
   Concentration: Yes
   Transportability: Yes
   Probability: High or Low depending on type

The common, multi-use type have a high demand because of high unit value and ease of resale to the electronics industry. Specialized types are low demand due to the very limited market. Only another manufacturer of the same item is likely to use the specialized integrated circuits.

3. 25 in. color television sets in hotel rooms.

   Demand: High
   Concentration: No
   Transportability: Yes
   Probability: Low

The television sets are not considered to have concentration of value. Theft of 7,000 ft^3 of television sets is not likely since the thief would have to obtain entry to each room to have access to the television set.

3.2 Yard Storage

Goods stored ‘‘out in the open’’ in the plant yard make a desirable target for theft because of visibility and ease of access. The probability of loss due to theft of yard storage can be determined using the system in this document. Generally, the probability should be increased one level to reflect the increased vulnerability. (Yard storage should be discouraged except in cases where it is impractical to locate storage in a more secure area.)

In some cases, filled or partly filled trailers are stored in the plant yard. These trailers are vulnerable to theft and present a desirable target. Unless the commodities in the trailers are of low demand, this arrangement has a high probability of theft loss.

Where warranted by the probability of loss and loss expectancy, protection of yard storage beyond simple passive protection should be provided. There are a number of methods of providing exterior perimeter alarm protection:

- *Taut wire systems* utilize a strong but nearly invisible wire strung along the top of a fence. The wire is held at a calibrated tension. Any increase or decrease in this tension caused by pressure on the fence results in an alarm.
- *Point-to-point microwave systems* have been found to decrease false alarms. This device uses microwave energy between a sending and a receiving point similar to beams. The microwave energy field fills an approximate area 6 feet high, 6 feet (2 m) deep and up to 500 ft (150 m) long. The field must be broken over a substantial portion of its cross-sectional area to start an alarm. While a small child can set off the alarm, wind, rain, birds or small windblown objects will not.
- *Electronic field* fence systems use a current-carrying field wire and separate sensing wires along a fence. An intruder coming close to the wires will disrupt the electromagnetic field and produce an alarm.
- *Metal detection* systems use buried wire loops and produce an alarm when ferrous metal objects pass over them.
- *Infrared systems* use an invisible infrared light beam to surround the protected area. An intruder breaking the beam will trigger an alarm.

- *Linear microphone systems* are small coaxial cables that pick up the "sound" of tiny vibrations through changes in a static charge in the insulation between its two conductors. They are programmed to distinguish sounds characteristic of intrusion.
- *Seismic alarm systems* use buried detectors. The pressure generated by a person walking over these detectors will actuate an alarm. Other seismic detectors will actuate an alarm due to pressure caused by a vehicle crossing the detector.
- *Vibration detectors* can be mounted on fencing and will respond to movement of the fence.
- *Mercury flow* switches can be mounted on fencing and will respond to movement of the fence or fence posts indicative of an intruder climbing the fence.

Vibration detectors or mercury flow switches are not normally applicable unless on-premise guards are able to monitor the areas.

3.3 Vehicle Protection

Loaded vehicles are particularly vulnerable to theft, and the storage of valuable commodities in vehicles should be avoided. Where this is not possible, suitable protection should be provided.

Vehicles may be protected with immobilizers, alarms, or combinations of each. An immobilization device is either an electrical or mechanical system. Electrical immobilizers are interrupted ignition circuits, grounded ignition circuits, general isolation of electrical circuits, starter motor circuit cut-outs, and fuel pump circuit cut-outs. All such electrical circuit systems are effective only if the wiring is concealed or protected at vulnerable points. Mechanical immobilizers act as locking devices upon the clutch, the gear lever, the hydraulic brakes, the hand-brake, the steering column, or as a fuel line interception.

Vehicle alarm systems activate an alarm in the event of an attack. These devices may be switches, electrical detectors, vehicle movement detectors or manual systems. Switches are used to detect interference with portions of the vehicle such as doors or the hood. Electrical devices can detect the presence or absence of electricity in a circuit, such as vehicle lights. Vehicle movement detectors are usually pendulums, horizontal spring balances or mercury switches. Movement of the vehicle will cause an alarm. All such systems can produce false alarms by accidental activation. Manually activated systems take the form of hijack buttons.

Where storage is in trailers, substantial kingpin locks should be used. Kingpin locks fit over the kingpin of a trailer hitch, making hookup impossible. Tractors parked on-site should not be connected to trailers and should have ignition keys removed and doors locked.

3.4 Protection Methods

There are basically three methods of protecting against burglary and theft losses. They are passive protection (doors, locks, bars, etc.), alarms, and watch service. The level of protection needed for a given situation is a function of the probability of loss and the potential dollar loss (loss expectancy).

3.4.1 Passive Protection

Passive protection consists of means of burglary deterrence other than alarm systems, watch service, or other detection methods. Examples include exterior fencing, lighting, window bars or screens, locks on doors and windows, etc.

Where the probability of loss is low, or where the loss expectancy is low, it may be acceptable to take no major steps to prevent burglary beyond normal locking of doors and windows. Passive protection is very important for protection of yard storage and/or storage of loaded trailers.

3.4.2 Alarms

In many cases, a properly designed burglar alarm system can provide adequate protection. Burglar alarm equipment ranges in sophistication from simple magnetic contacts for doors to television systems using digital image processing techniques. Installations can range in complexity from simply protecting doors to protecting all openings, walls, floors, roofs, and providing motion detection within the premises. Although they can be complex, the basic purpose of an alarm system is easily defined. It should detect a burglary attempt and provide a suitable response to prevent the successful completion of the burglary.

To ensure alarms are reliable and to minimize false alarms, experience has shown that burglar alarms must be properly maintained, inspected frequently, and carefully activated.

Burglar alarm systems can be classified according to the extent of protection provided.

Complete Protection. Complete protection means attempted entry is detected if a movable opening is opened or if entry is attempted by breaking through the protected area. For the parts of a structure, complete protection is as indicated below:

- *Doors*. Contacts plus one or more of the following: wiring, foil, beams, vibration detectors or floor traps. (Beams, and/or floor traps must pass directly in front of the doors.)
- *Windows*. Contacts (on movable windows) plus one or more of the following: foil, wiring, vibration detectors or beams. For nonmovable windows, contacts are not needed. (Beams and/or wiring must protect the area in front of the windows.)
- *Walls and Ceilings*. Beams, vibration detectors, wiring, or foil.
- *Floors*. Beams, vibration detectors, floor traps, wiring, or foil.
- *Other Openings*. Contacts (for movable openings) plus one or more of the following: foil, wiring, traps, vibration detectors or beams. (Protection must be located on or in front of these openings.)
- *Partial Protection*. Partial protection applies only to movable openings. It means attempted entry is detected if one of these openings is moved. Partial protection of openings consists of contacts or switches only.
- *Double Circuit*. Where foil, wiring, etc. is provided to protect a surface, a double circuit arrangement is one in which two separate foil strip circuits are provided, interwoven so that the foil cannot be simply ‘‘jumped’’ to defeat the alarm system.
- *Burglar Alarm Protection*. Categorized into two types: perimeter protection and area protection. There are different levels of protection within each category, and a burglar alarm system can consist of varying combinations of the different types. The type of alarm system suitable for a given situation is a function of the probability of burglary, the loss expectancy, and the configuration and construction of the building.

3.4.2.1 Alarm System Maintenance

Statistics show that the major weakness of alarm systems is false alarms. In fact, more than 90% of all alarm transmissions are false. This naturally results in a marked decrease in confidence in an alarm system by police. The majority of false alarms can be traced to a failure on the part of alarm system users to properly understand and maintain their alarms.

3.4.3 Perimeter Protection

The purpose of perimeter protection is to detect an attempt to enter the building through doors, windows, walls, roofs, etc. Several types of equipment are used to provide perimeter protection.

Contacts are used on movable openings, such as doors and windows. Separation of the two parts will open or close a circuit when actuated.

Mercury-flow switches are used on doors and windows that tilt open. Mercury resting between two electrical contacts is disturbed by movement, breaking the circuit.

Foil is used on glass doors, windows, etc. It is conductive and provides a closed circuit. Breaking the glass causes a break in the foil, opening the circuit and causing an alarm. Foil can also be provided on walls, ceilings, floors, etc.

For ordinary glass, foil should run down the sides and across the bottom of the window, spaced from two to four in. (five to ten cm) from the edge. If the glass panel is less than 16 in. (41 cm) wide, then a single, vertical strip of foil located in the center of the panel is sufficient.

For wired or laminated glass, foil should run down the sides and across the bottom of the window, spaced from two to 4 inches (5 to 10 cm) from the edges. Additionally, vertical strips of foil should be spaced on 8 inch (20 cm) centers over the remainder of the glass.

Where there are vertical joints between unframed glass panels (panels butted or cemented together), foil should extend across these joints to prevent separation of the glass panels.

For surfaces other than glass, foil should be provided. The foil should cover the entire surface, and the strips should be spaced no more than 6 in. (15 cm) on centers. The foil should be installed in such a manner as to resist the effects of moisture with an insulating, moisture-resistant adhesive. The foil should be in a double circuit arrangement (See Glossary, Appendix A). Plaster, concrete, or other masonry surfaces should be

covered with moisture-retardant paper before foil is applied. The foil should be covered so as to not be visible without close inspection, and should be protected from mechanical damage. (Where mechanical protection is not required, a coat of nonconducting paint is sufficient.)

Open wiring is similar to foil stripping, except that wire is used. This method is only suitable for protecting skylights or ceilings where the wiring is at least 8 ft (2.4 m) above the floor. The wiring should be provided in two layers, perpendicular to one another and spaced from 2 to 6 in. (50 to 150 mm) apart. The wiring should be arranged to transmit an alarm when an attempt is made to lower it.

Screens and grooved stripping are also similar to foil. Fine wire is woven into window screens or placed in grooves cut in wood doweling or wood strips, which are attached to the opening or surface to be protected. Wires should be spaced no more than 4 in. (10 cm) on center, and should be arranged as a double circuit. Cutting the screen or wire will interrupt the circuit and actuate an alarm. Also, screens and stripping should be arranged so that any movement of more than 2 in. (5 cm) will actuate an alarm.

Beams can be used as perimeter protection for walls and doors. They consist of a light source and a receiver arranged so that a person passing between the two will obstruct the beam and actuate an alarm. For a door, a single beam is sufficient. For walls, a ‘‘stacked’’ or crossed arrangement should be used. (As infrared beams are primarily used for area protection, a more detailed description can be found under Section 3.4.4 of this data sheet.)

Sonic and vibration detectors are devices that can be attached to walls, ceilings, windows, etc. and will actuate an alarm if attempts are made to penetrate the protected surface. They are generally designed to respond to the specific type of sound or vibration that is produced when the surface they protect is attacked. (A detector designed for glass would not be suitable for a metal wall, for example.)

Table 6 contains additional information on the above equipment.

3.4.3.1 Perimeter Protection Levels

The following levels of perimeter protection can be provided:

- *Perimeter 5* protection consists of complete protection of all openings, and all walls, floors, and ceilings enclosing the protected premises. Walls at least two stories (18 ft or 5.5 m) above ground or adjoining roofs need not be protected.
- *Perimeter 4* protection consists of complete protection of all accessible openings, walls, floors, and ceilings enclosing the premises, and partial protection of all inaccessible movable openings. Ceilings, walls and floors of reinforced or precast concrete need not be protected.
- *Perimeter 2* protection consists of complete protection of all accessible openings and concrete block or metal walls enclosing the premises. Reinforced concrete, brick, brick veneer, or precast concrete walls need not be protected.
- *Perimeter 1* protection consists of partial protection of movable accessible openings.

Note: There is presently no Perimeter 3 protection level.

3.4.4 Area Protection

Area protection is intended to provide detection of the presence of unauthorized persons within the premises. There are two ways of accomplishing area protection.

1. *Motion detection*. Motion detectors respond to motion within the protected area. There are three general types of motion detectors currently in widespread use: ultrasonic, microwave, and passive infrared.

a. The ultrasonic motion detector floods the protected area with a high frequency tone normally above the range of the human ear, and monitors the reflected sound. Motion in the protected area results in a change in the frequency and phase relationships of the reflected sound, which triggers the alarm. Ultrasonic frequencies typically range from 19 to 40 kHz. Frequency differences of 5 to 30 Hz are detectable. Ultrasonic sensors are monostatic (both transmitting and receiving elements are in one housing) and typically project a teardrop shaped pattern approximately 25 ft (7.6 m) wide and 35 ft (7 m) long. False alarms can be caused by drafts moving curtains, ultrasonic noises from equipment, etc.

b. Microwave motion detectors are typically monostatic and generate frequencies in the 10.5 gHz region of the electromagnetic spectrum. Microwave sensors can protect interior spaces up to 100 ft (30 m) long and 70 ft (21 m) wide, depending on the antenna used. A cross section of the energy pattern would be circular. There is a possibility of false alarms because the microwave signals can penetrate walls, windows, etc.

c. Passive infrared motion detectors scan the protected area with receptors sensitive to infrared (heat) energy. Warm-blooded creatures radiate infrared energy. These detectors will respond to the motion of a person within the protected area. The advantage of passive infrared motion detectors is that they are not as subject to false alarms from motion of nonliving things. False alarms can be caused if the detector is directed towards windows (sunlight), cycling heat sources, etc.

An infrared beam system consists of a light source and a light sensitive detector. The light source emits an infrared light beam up to 1,000 ft (303 m) long; an alarm occurs if the beam is broken. To prevent defeating beams with a portable light source, the beams are pulsed. Mirrors can be used to allow a change in direction of the beam without an additional light source and detector. Photoelectric units, which use a 60 to 500 ft (18 to 152 m) incandescent light beam, may still be found; however, they are generally not used in new installations.

When a single beam is used for protection of a door, it should be located approximately 36 in. (0.9 m) above the floor.

When multiple levels are used to protect walls, one level should be at 18 in. (0.45 m) and the other should be at 36 in. (0.9 m).

2. Sound detection. The sound detection method of protection responds to noise produced by intruders. There are two basic types; both use microphones to sense sound in the protected area. The simpler type provides an alarm if sounds above a preset level occur in the protected premises; the more complex system allows an operator to monitor the sounds to determine what produced the alarm. Sound systems are not suitable for locations where there are high ambient sound levels or frequent loud noises, and they must be sufficiently sensitive to respond to the level of noise produced by intruders.

Table 6. Alarm Equipment

Type of Alarm	*Major Use*	*Advantages*	*Disadvantages*
Mercury-flow switch, contacts, foil, open wiring, screens, grooved stripping	Protection at accessible openings	1. Simple.	1. Easily compromised.
		2. Trouble free.	2. Will not detect "stay behinds".
		3. Low cost.	
Infrared or photo-electric beams	Perimeter or area protection. Can be a single beam or a stacked arrangement providing vertical barrier.	1. Covers open areas but physical obstructions cannot be tolerated.	1. Beams can be located and defeated.
		2. Detects "stay behinds".	2. Susceptible to misalignment.
		3. Can activate other security devices such as cameras.	3. Dusty or smoky atmospheres may cause false alarms.
Sonic and vibration detectors	As a sensing device on any surface to which it is attached.	1. Can be extremely sensitive for specialized applications (vaults, etc.).	1. Cannot be used in areas of high vibration.
		2. Difficult to defeat unless exact location is known.	2. Detectors are type specific.
Ultrasonic motion detectors	Area protection. Saturates area with a pattern of high frequency sound waves. Movement interrupts waves and triggers alarm.	1. Detects "stay behinds".	1. Does not penetrate solids.
		2. Flexible interior coverage.	2. May not detect slow movements.
		3. Difficult to detect.	3. Can be subject to false alarms.
			4. Cannot be used in high sound absorbing areas.
			5. Cannot be used in areas subject to excessive vibration or air turbulence.
Microwave motion detectors	Area protection. Saturates area with microwaves. Range and sensitivity is considerably greater than ultra-sonic.	1. Equipment compact and easily installed.	1. Can penetrate solids.
		2. Not affected by air currents.	2. False alarms can be caused by other radio transmitters operating at similar frequency.
		3. Difficult to detect.	3. Not suitable for use in metal buildings as building movement is sensed as an alarm.
Passive infrared motion detectors	Area protection. Detects motion of infrared energy sources (warm-blooded creatures).	1. Not subject to false alarms from movement of nonliving things.	1. Subject to false alarms from hot metallic surfaces or from sun.
		2. Not affected by air in motion, sounds, vibration, electrical or radio disturbances, or changes in light level.	2. Subject to false alarms from rodents. Viewing pattern can be adjusted a few feet above floor to avoid.
		3. Will not penetrate glass or solids.	
		4. Covers fairly large area.	
Sound detection	Area protection. Audible sound picked up by microphones in the protected area.	1. Covers large volume.	1. Susceptible to outside noises.
		2. Can use existing intercom or speaker system as microphones.	2. Can be defeated by a "lock in" familiar with location and operation of microphones.
		3. Inexpensive installation.	3. Local alarms cannot be easily provided.
			4. Failure of one microphone may not be detected.
			5. Insensitive at locations with high ambient noise level.
			6. Proper interpretation of sounds detected depends on experience of operator.

3.4.4.1 Area Protection Levels

Area protection can be provided on the following three levels:

- *Area 3* protection consists of: motion detection in all parts of the premises so that a person moving no more than four steps at the rate of one step per second will actuate an alarm; or:
- Sound detection in all parts of the premises arranged to respond to sounds within the area that would be representative of an intrusion. Actual conditions at the location protected will determine the setting required.
- *Area 2* protection consists of beams or other motion detectors arranged to subdivide the protected premises into areas not to exceed 1,000 ft 2 (93 m 2) of floor area.
- *Area 1* protection consists of beams or other motion detectors arranged so that the length of the beam(s) is at least equal to the maximum dimension of the premises, and affording the most effective coverage (i.e., in a rectangular building, beam(s) must at least equal the building length, not the diagonal dimension).

Repeated false alarms may be directly related to environmental conditions. Combining two different detection principles in a single device not troubled by the same environmental conditions can reduce or eliminate false alarms. Verified technology sensors usually combine active and passive sensors to get confirmation of an alarm. In some applications, this can also mean improved range and detection performance over single-technology sensors. Examples of these combination devices are microwave and passive infrared or ultrasonic and passive infrared. If an event triggers both elements within a predetermined time frame, the alarm is considered valid.

3.4.5 Spot Protection

In some cases, commodities subject to theft may be located in a limited area within the plant, so it may not be necessary to provide burglar alarm protection for the whole plant. For example, if the commodities are kept in a cut-off area, then perimeter and area protection (if needed) can be provided only for that area. If the commodities are not kept in a cut-off area, then perimeter protection should be provided for the whole building, and area protection (if needed) provided only in the area where the susceptible commodities are located.

3.4.6 Object Protection

In some cases, the commodity subject to theft may be a single item or items. In this case special protection may be provided for the object.

- *Capacitance detectors* are often used to protect safes, file cabinets, metal storage cabinets or similar self-contained metal objects. This detector creates a protective electrostatic field around an insulated metal object. Touching the object causes an alarm.
- *Vibration detectors* are contact transducers which make a sensing device of any surface to which it is attached. Extreme sensitivity is possible.
- *Pressure detectors* can be used in mats, under rugs or objects, etc. Actuation of the alarm occurs when weight is removed from the device. It can also be set to actuate when weight is placed on the detector as commonly occurs in devices located in mats or beneath rugs, etc. located in front of openings.
- *Contact devices* can also be used to signal the removal of an object. In this application, they operate similarly to pressure detectors. Contact devices can be used to protect valuable pictures.

3.4.7 Determining Alarm System Classification

A point system is built into the classifications of perimeter and area alarms. The point value of a given combination of alarms is obtained by adding the individual classification numbers. For example, a system consisting of Perimeter-2 and Area-1 protection has a point value of 3. This is Level 3 protection.

Examples: A plant has precast concrete walls, personnel and truck doors, and neither roof openings nor windows.

1. All exterior doors have contacts, and ultrasonic motion detectors protect only the area directly inside the doors. This is a Level 2 (Perimeter 2) Alarm System.

2. All exterior doors have contacts. Ultrasonic motion detectors protect all interior areas including the area inside the doors. This plant has a Level 4 (Perimeter 1 and Area 3) alarm system.

3. All susceptible commodities are in a separate, cut-off area. Protection consists of a Perimeter 2 system (Example 1), a contact on the one storage room door and complete motion detection inside the storage room. This is a Level 5 (Perimeter 2 and Area 3-Spot Protection [See Page 11]) alarm system.

3.4.8 Alarm Supervision

In order for alarms to be effective, an appropriate response must be provided when an alarm is actuated. It is, therefore, necessary that an alarm system be monitored at all times.

The most desirable method of supervision is to connect alarms to an approved burglar alarm central station or proprietary station. In some cases, alarms may be connected to a constantly attended police station, if allowed by local authorities. There are several means of connecting alarms to a central station or police station.

The simplest method is to provide the connection through a direct wiring arrangement. Wire pairs can be leased from the telephone company for this purpose; this can, however, be expensive. This is ‘‘one-way’’ communication from protected premise to monitoring station. There is an effort to replace all copper circuits with optical lines and, as a result, this type of alarm monitoring is decreasing.

A common method of monitoring alarms is through a ‘‘McCulloh loop’’. In this arrangement, several different premises can be monitored through one pair of lines. Each location has an alarm transmitter that produces a specific code when actuated, which allows the monitoring station to determine which protected site on the loop is transmitting an alarm. Signal information flows only one-way, from the protected premise to the monitoring station.

Multiplex systems are another monitoring method. While a McCulloh loop system is technically a multiplex system, the term ‘‘multiplex’’ is normally used to refer to an electronic system that uses a sophisticated electronic coding system, usually computerized, to monitor a number of alarm systems on one high quality voice-grade telephone line.

Two-way transmission of information is possible. Each alarm system is polled on a regular basis to determine its status.

Digital alarm communicators use two ordinary telephone line connections to transmit alarms. When a burglary is detected, the alarm system automatically takes control of the telephone lines and dials the telephone number of the monitoring station. Upon acknowledgment from the monitoring station, data on the type of alarm, location, etc., is transmitted electronically; the system then awaits acknowledgment that the alarm was received. The dialing mechanism will continue to dial if it is unable to complete the connection on the first try. Some designs use multiple telephone numbers for the central station, which increases the probability of getting the alarm signal through. Digital communicators incorporate an internal timer that triggers an automatic status communication between the protected premise and the monitoring station every 24 hours. Failure of the automatic status communication results in a fault or trouble signal at the monitoring station. (These digital dialers are not to be confused with ordinary telephone dialers, which are not suitable as they only transmit a prerecorded voice message and have limited redialing capabilities).

Derived channel systems transmit alarm information through normal telephone lines. A scanner at the normal telephone exchange communicates with individual protected premises; it reports failure of communication to a polling computer located at a major telephone exchange. The polling computer then transmits the alarm or supervisory signal information to the appropriate monitoring station. Alarm and supervisory signals are transmitted independently of the normal service of the telephone. Communication between the protected premise and the monitoring station is multiplexed on the same telephone line and is bridged to the telephone exchange, bypassing the actual telephone switched system. This permits concurrent use of the service telephone and the alarm system without interference. Supervision is provided by either interrogation of the individual protected premises or continuous transmissions from protected premise to the scanners.

Use of the telephone network allows monitoring stations to be significantly distant from the protected premise such that response from the central station to the protected property is not possible due to the distance involved. Response must be by local police or contract guards located near the property.

Radio signaling known as ‘‘Point-to-Point’’ eliminates use of the telephone network. Signaling systems can be either one-way or two-way or combined with Digital Alarm Communicators to form hybrid systems.

In one-way systems, the protected premise continually transmits status signals to the monitoring station. However, an acknowledgment of successful communication is not received at the protected premise. Signaling from a central station to guards or police would be through conventional means.

In two-way systems, normal communication between the protected premise and the monitoring station is based on an interrogate-response cycle. An additional feature of this system is remote control capability.

Radio signaling of alarm systems can necessitate multiple retransmission of the signal to remote monitoring stations. This permits one station to monitor alarms at a significant distance from the protected premise when response from the central station to the protected property is not possible.

3.4.8.1 Proprietary Systems

In some cases, it is desirable to have alarm systems monitored in a central location at the protected property. This arrangement can be considered equivalent to central station or police station alarm monitoring. Alarm system requirements are generally the same as for remotely monitored alarm systems, with these additional requirements:

1. There should be a minimum of two watchmen on duty at all times, one of whom remains constantly at the alarm system monitoring the location. A reliable means of communication should be provided between the watchmen and the proprietary station.

2. A quick means of notifying the police or other authorities should be provided. Two separate means should be provided. Telephone lines should be supervised to prevent sabotage.

3.4.8.2 Closed-Circuit Television

Closed-circuit television is becoming increasingly popular as a component in security systems. As television systems require monitoring, they are most often found as a component of proprietary systems.

There are two types of television systems. The older involves a camera (or cameras) connected to a television monitor. The area covered by the cameras can be supervised at the monitor location. Devices are available to allow control of camera movements and zooming-in on areas of interest by the person watching the monitor.

An improvement to this system ties closed-circuit television and motion detectors together. When motion is detected, a signal at the monitoring location alerts the observer to the camera viewing that area.

A newer, more sophisticated method of television surveillance is increasing in use. In this system, the television image is processed electronically using digital techniques, so that any motion in the field of the camera can be detected and pinpointed.

Video systems alone do not provide adequate burglary protection. In some cases, they may be considered as suitable alternatives to watch rounds or other forms of motion detection, in conjunction with other alarms.

Each closed-circuit television system must be individually evaluated to determine its suitability for security.

3.4.8.3 Local Alarms

A local alarm can provide a psychological deterrence to burglars. Where allowed by local authorities, it should be added to an alarm system. It cannot, however, substitute for alarm monitoring at a remote location.

When the probability of loss is moderate, on alarm systems offering Level 4 protection or less, a loud local alarm can be considered equivalent to line supervision. It is necessary that local response be reliable; it is not sufficient to assume that passersby will respond to an audible alarm. Formal arrangements with occupants of neighboring buildings that are continually occupied during periods that the protected premises are unattended and who can be depended upon to call police can be considered reliable response.

3.4.8.4 Line Supervision

If an unsupervised connection between an alarm system and the monitoring station is broken, by normal breakdown or burglars, the alarm system is useless. It is therefore desirable to provide some means of supervising the connection.

A direct wire is the easiest type of connection to supervise. Supervision can consist of simply monitoring the line resistance to see whether it is open or short circuited. A more sophisticated line supervision method is to superimpose a tone or A.C. voltage on the line, and monitor for any changes.

In a McCulloh loop system, a break in a line on the loop causes a trouble signal at the monitoring station. This does not, however, indicate exactly where the trouble is, so it cannot be determined which alarm systems, if any, are out of service. Devices have recently become available that allow a form of line supervision on the McCulloh loop system. These devices can inform the monitoring station of the status of individual alarm systems on the loop. They are not installed on all systems, however, as they are costly.

As indicated previously, supervision of a digital communicator system is achieved on a 24-hour basis when it transmits a status communication. If the derived channel system is through constantly powered telephone lines, end-to-end line supervision exists.

Supervision of the alarm system using radio signaling is possible on the two-way systems via the interrogate-response cycle. Supervision of one-way radio signaling is possible if the system transmits a status signal every 24 hours (or less) which the monitoring station compares to a stored data base. Failure to transmit a status signal is treated as a trouble signal.

3.4.8.5 Line Security

In some cases, extremely high values may attract sophisticated burglary attempts. To resist these attempts, the line connecting the alarm system with the central station must have a form of supervision above and beyond line supervision. This form of supervision, called line security, must be capable of detecting sophisticated compromise attempts using portable equipment that substitutes voltage, impedance, or signal patterns on the monitored line.

Multiplex systems (other than McCulloh loop systems) can provide line security by automatically exchanging coded signals between the monitoring station and the protected premises on a regular basis.

3.4.8.6 Response

Response can be provided by police and/or guards employed by the central station. The key to effective response is that it be timely and performed by capable persons.

Response time is an important factor, but statistics for burglaries in the types of occupancies addressed by this data sheet indicate that, in most cases, burglars remain at the scene for periods ranging from 15 minutes to one hour or more.

Response times are greatly affected by traffic conditions, so it is unrealistic in many cases to guarantee extremely fast response. Also, reductions in police manpower in many large cities reduce the speed of response.

Factory Mutual classifies response time on two levels: 15 minutes or less, and 20 minutes or less. (Concentrations of extremely high values, such as are found in jewelry stores, etc. may call for faster response time.)

- ***FM-15*** Response is defined as the capability of response to the protected premises by police or suitably trained and equipped guards within 15 minutes of receipt of an alarm at the monitoring station.
- ***FM-20*** Response is the same as above, except that response is within 20 minutes.

Systems that meet the requirements of line security are classified as FM-15-S (15-minute response time) and FM-20-S (20-minute response time).

3.5 Watch Service

On-premises watch service can provide a suitable means of burglary protection. It is not always economically practical to provide watch service solely for this purpose. Other needs, such as fire protection, may be considered in determining the level of alarm protection. In order to be considered adequate, watch service should meet the following minimum requirements:

1. Watch service should cover all important areas, including yard storage, detached buildings, loaded trailers, etc. Key stations should be provided to assure proper coverage.

2. Frequency of rounds should be no less than once per hour. Rounds should be random, so that they are unpredictable. (In some cases, closed circuit television may be an adequate substitute for regular rounds or for decreased frequency of rounds.)

3. Watchmen should be responsible only for plant security and fire prevention functions. They should not perform maintenance or other functions along with their security function.

4. Watchmen should be well trained and equipped for proper response.

5. Means should be provided for quick notification of police or other authorities by all watchmen.

If all of the above requirements are met, watch service can be considered the equivalent of Level 3 alarms. Where a higher level of protection is needed, watch service can be combined with perimeter alarms to achieve the needed protection level. Watch service is generally incompatible with area protection.

A loud local alarm should be provided in combined watch service/alarm systems, in addition to central station or police station alarm monitoring.

Dogs cannot be used as a replacement for watch service, as they can be easily circumvented by shooting, poisoning, etc.

3.6 Vaults and Safes

Very high-value, easily transportable commodities, such as precious metals, present an attractive target for burglars, and therefore need a high level of burglary protection. One means of providing this protection is to store high-value items in burglary resistant vaults or safes.

Vaults are complete enclosures designed for the safe storage of valuable commodities. Vaults are normally constructed at the site, are permanently affixed, and are an integral part of the building in which they are located.

Burglary resistant vaults are rated by their ability to resist penetration or attack. The protection they afford is influenced by several factors. In the vault walls, ceiling and floors, thickness, material used and type of reinforcement are important factors. In the door, the thickness of solid steel, the types of material used and the design of the locking and relocking mechanisms should be evaluated.

The entire vault structure is rated as a single unit. If any component carries a lower classification, then the entire unit will be rated at the lower classification.

Recent testing using modern tools (electric hammers, matrix bit acetylene torches and hand tools or a diamond embedded matrix bit core drill) has determined the penetration resistance of vault walls and modular vault panels.

Generic construction uses commonly available construction materials unprotected by trademark registration for the walls, floor and ceiling of the vault. Concrete reinforced with deformed steel bars, No. 5 Imperial Type or Number 15 Metric type $\frac{5}{8}$ in. (16 mm) diameter Grade 40 placed in horizontal and vertical rows 4 in. (10 cm) on center and 4 in. (10 cm) apart, or concrete reinforced with expanded steel bank vault mesh that has a diamond pattern not exceeding 3×8 in. (8×20 cm), weighing a minimum of 6 lb per sq ft (30 kg/m^2) placed parallel to the face of the concrete slab is rated as follows:

Table 7. Vault Classification

Vault Classification	*Thickness of Concrete*	*Minimum Number of #5 Rebar Grids*	*Minimum Number of Expanded Steel Grids*
M	at least 9 in. (23 cm)	2	2
1	at least 12 in. (31 cm)	3	2
2	at least 18 in. (46 cm)	4	3
3	at least 27 in. (69 cm)	5	4

Modular panels can be used to form the walls, ceiling and floor of a vault. They are manufactured of intrusion-resistant material and are intended for assembly at the site. Some modular panels can also be disassembled, relocated and/or modified. Tested panels will bear an Underwriters Laboratories Inc. Burglary Resistant Vault Panel Label. These modular vaults can weigh considerably less than a corresponding generic vault.

Vault doors are constructed of intrusion-resistant materials with a burglary resistant lock equipped with a relocking device. (A relocking device locks the bolt mechanism if the lock is attacked to gain entry.) Tested doors will bear a UL Inc. Burglary-Resistant Vault Door label.

The ratings for burglary-resistant vault doors and modular panels are:

Table 8. Vault Door Classes

Class M:	15 min
Class 1:	30 min
Class 2:	60 min
Class 3:	120 min

Safes are steel containers with a combination lock designed for protection of valuable records or commodities. They are generally smaller than vaults and are often movable. Safes are either fire resistant or burglary resistant.

Fire-resistant safes are constructed to resist and retard the penetration of heat, to protect paper records from destruction by fire. These units have steel retaining walls which sandwich an inner insulating material. This construction provides minimal burglar protection.

Burglar-resistant safes are specifically designed to protect valuable commodities from theft This protection is provided by using open-hearth steel in the walls, roof, floor and door of the safe, and intricately designed locking and relocking devices. This construction will not protect paper from fire damage although it will provide protection against burglary.

There are a number of units available that combine both fire and burglar resistance.

A safe which has been tested will bear a label on the inside of the door indicating the degree or level of protection it affords. A burglary-resistant safe label indicates the type of protection it provides: tool resistant, torch resistant and explosive resistant. The resistance is designated by letter followed by a number.

TL = tool resistant
TR = torch resistant
TX = torch and explosive resistant.
Number = net working time for which safes must resist attack

Examples: TRTL-30 defines a safe that will resist tool and torch attack on the door for 30 min TRTL-15x6 and TRTL-30x6 defines safes that will resist tool and torch attack on all six sides for 15 or 30 min

TXTL-60 defines the highest safe rated by UL. It will resist tool, torch, and explosive attack on all six sides for 60 min

Safe walls, ceilings, and floors should be constructed of intrusion-resistant materials such as steel or alloys. In addition, safes should ideally be securely attached to the structure in which they are located to prevent them from being stolen and taken to a remote location for attack. This attachment should consist of bolting or welding to structural members, embedding in concrete, etc.

3.6.1 Vault and Safe Alarms

Where the probability of loss and the loss experience warrant, alarms should be provided on safes and vaults. If the only significant target for burglars is contained in a safe or vault, it may be adequate to provide alarms on the safe or vault only. In other cases, safe or vault alarms should be provided in addition to other alarms.

Two levels of vault and safe protection can be provided as follows:

- *Partial* protection consists of simply providing contacts on all vault or safe doors.
- *Complete* protection consists of protecting the entire surface of the vault or safe with foil, wiring, grooved stripping, etc. Vibration detectors, heat detectors, or microphones can be used to provide interior protection.

For safes weighing less than 1,000 lb (450 kg) that are not securely fastened to the structure, alarms should be provided to detect movement of the safe.

Heat detectors can be used to detect an attempt to cut through the body of the safe or vault using a torch. The detector is tripped when the temperature reaches a preset degree.

Capacitance detectors can be used to protect ungrounded safes.

Vibration detectors or pressure detectors can also be used to protect safes or vaults.

4.0 REFERENCES

For more information, please refer to the following data sheets as cited in the text.

Data Sheet 1-0, *Safeguards During Construction, Alteration and Demolition*

Data Sheet 5-40, *Fire Alarm Systems*

Data Sheet 9-1, *Supervision of Property*

Data Sheet 10-6, *Protection Against Arson and Other Incendiary Fires*

There are no conflicts with NFPA standards

APPENDIX A GLOSSARY OF TERMS

accessible opening: Any opening meeting these requirements: (a) within 18 ft (5.5 m), vertically, of the ground or adjacent roof areas; or (b) within 14 ft (4.3 m) of windows, roofs, fire escapes, etc. of adjacent buildings with uncontrolled access, subject to the following:

1. Openings in adjacent walls where a line between them forms an angle of 45° with each wall. (See Fig. 1a.)

2. Openings in opposite walls on the same floor level where a line between the openings forms an angle ranging from 45° to the left to 45° to the right. (See Fig. 1b.)

3. Openings in opposite walls directly above or below where a line drawn between them ranges from 75° above to 75° below. (See Fig. 1c.)

4. Any opening that is within 3 ft (1 m) horizontally of another opening on the same level in the same (or an attached) wall that leads to areas other than the protected premises can also be considered an accessible opening.

5. Openings in roofs that can be reached from the ground by use of fire escapes, permanently fixed ladders, etc., should be considered accessible.

burglary: Theft accomplished by breaking and entering a building or some portion of a building. Theft accomplished by breaking and entering through a perimeter fence or gate should not be classified as burglary unless breaking and entering a building is also involved.

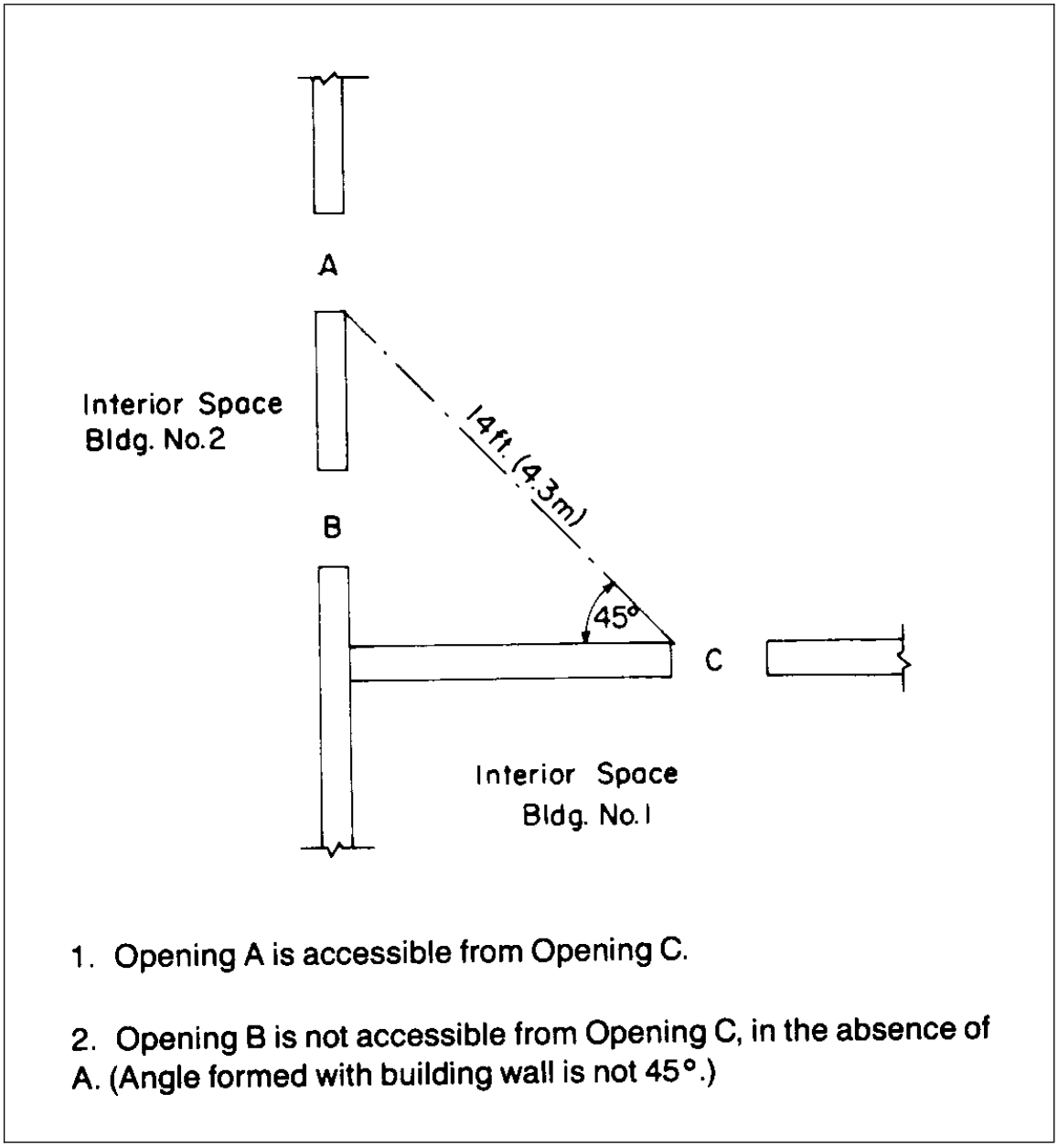


Fig. 1a. Plan view.

complete protection: Complete protection means attempted entry is detected if a movable opening is opened or if entry is attempted by breaking through the protected area.

double circuit: Where foil, wiring, etc. is provided to protect a surface, a double circuit arrangement is one in which two separate foil strip circuits are provided, interwoven so that the foil cannot be simply ‘‘jumped’’ to defeat the alarm system.

movable opening: Doors, operable windows, roof hatches, etc. are movable openings.

multiplex: An electronic system that uses a sophisticated electronic coding system, usually computerized, to monitor a number of alarm systems on one high quality voice-grade telephone line.

opening: Any opening having an area of 96 in.^{2} (620 cm^2) and one dimension of at least 6 in. (15 cm). Ducts having a minimum cross-sectional area of 144 in.^{2} (930 cm^2) are considered openings. An opening may be covered by a door or window, or blocked, inadequately barred, etc., and still be considered an opening.

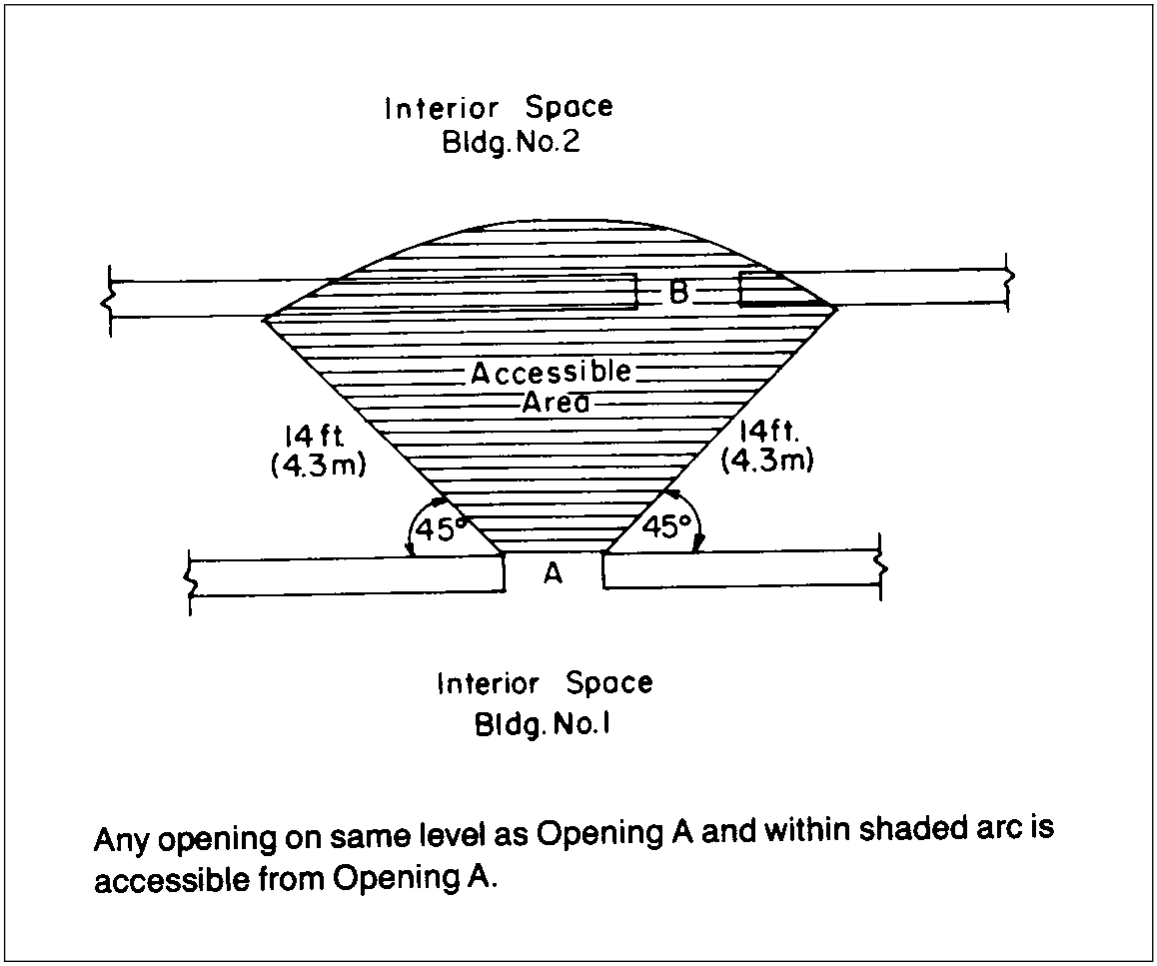


Fig. 1b. Plan view.

partial protection: Attempted entry is detected if a movable opening is moved. Partial protection of openings consists of contacts or switches only.

robbery: When violence or threat of violence is used to execute a theft

theft: The taking of property belonging to another, without the owner's consent, with intent to deprive the owner of its value and to appropriate it to the use or benefit of the thief.

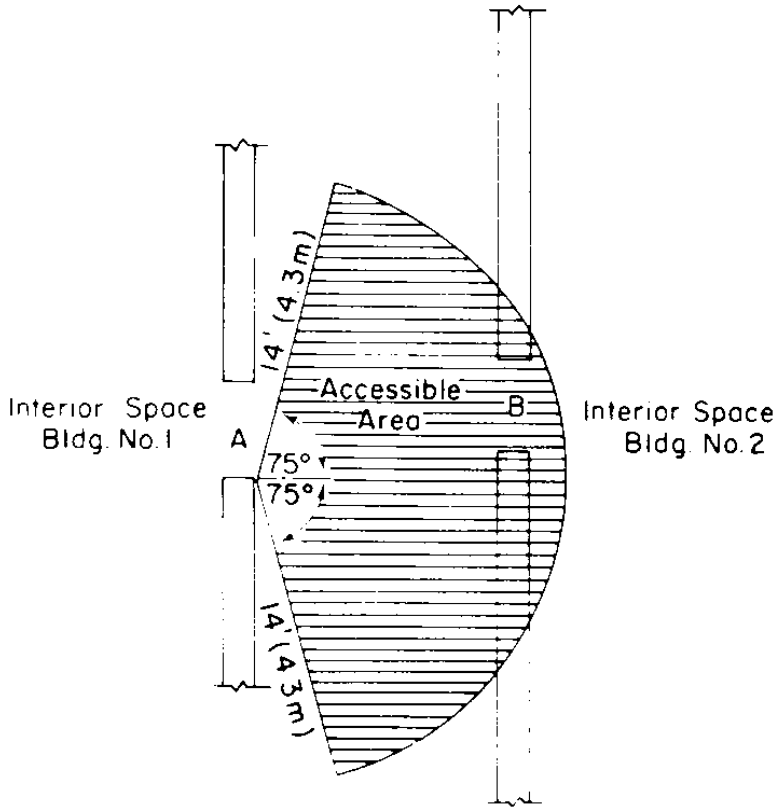
APPENDIX B DOCUMENT REVISION HISTORY

January 2000. This revision of the document has been reorganized to provide a consistent format.

June 1999, Reformatted

May 1998, Reformatted

June 1988, Last major technical revision



Any opening directly above or below Opening A and within the shaded arc is accessible from Opening A.

Fig. 1c. Elevation view.