Guide to Alarm Equipment

A Joint Document of

FALSE ALARM REDUCTION ASSOCIATION

www.faraonline.org

and

NATIONAL ELECTRONIC SECURITY ALLIANCE

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Guide to Alarm Equipment Table of Contents

Introduction

The purpose of this reference guide is to provide public safety and the alarm industry with recommendations regarding alarm system equipment and installation practices that have proven to be highly effective in reducing false alarms and which will make a significant impact on the false alarm problem when fully implemented. The reference guide contains major alarm system components, describes their function, provides recommended applications and lists either the false alarm potential or the false alarm prevention aspects of each component.

General Recommendations

- **Customer Service-** FARA & NESA encourage every alarm company to strive for excellence in customer service and equipment installation and design.
- **Training-** Installation personnel should be supervised by persons who are qualified and experienced in the installation, inspection, and testing of premises security systems. Sales, design and monitoring personnel should also be appropriately trained. Examples of qualified personnel shall include, but not be limited to, the following:
  - Personnel trained and certified by equipment manufacturers.
  - Personnel licensed or certified by federal, state or local authority.
  - Personnel certified or accredited by the Canadian Security Association (CANASA), Central Station Alarm Association (CSAA), Electronic Security Association (ESA), National Electronic Security Alliance (NESA), Security Industry Association (SIA) or the alarm association in their state or any equivalent training facility or program.
- **Follow-up**- One proven method of false alarm reduction is for alarm companies to call their customers the day after an alarm activation. This allows the customers some interaction with their company and gives a chance for additional customer training and/or service calls to deal with faulty equipment.
- **User Training-** Alarm company representatives could drastically reduce the number of false alarms by taking the time to teach the customer and all potential users at the alarm location how to properly use the alarm when it is installed. It is just as important to continue the training process at other valuable times also, such as when the alarm is inspected, after a false dispatch occurs, or if there have been changes to the customer's system or environment.
- **Verification**- Enhanced Call Verification (ECV) has proven to drastically reduce the number of requests for dispatch that are made to public safety. When ECV is utilized, the monitoring operator will first attempt to reach a responsible party at the alarm site. If that contact fails, the monitoring operator will call a different phone number, usually the cell phone of a responsible party, in an attempt to verify the validity of the alarm signal prior to requesting public safety dispatch. Contacting responsible parties may jog their memory about the balloons left over from the office party or a check of the time may show it is the typical time for one of the employees of the business to leave, and who needs more training on arming the system. Additionally, if the monitoring operator telephones the site and receives a busy signal, it may be because the system has seized the phone line or the alarm itself is attempting to call the monitoring center. Therefore, more than one attempt should be made to contact a responsible party prior to requesting public safety dispatch. Two-way voice communication and/or video verification may also be used as ECV methods.
- **Cross Zoning-** Two devices are installed. The alarm will not signal without both devices tripping. FARA & NESA also recommend that monitoring companies consider not dispatching public safety on single motion detector signals. The alarm owner or the responsible party should be notified.
- **Cancellation of Alarm Signals**- All jurisdictions should accept alarm dispatch cancellations from the monitoring company after verification, if the jurisdiction is notified prior to the arrival of the public safety responders at the alarm site.

Type of Signals and Response

Signal Name	Description	Proper Response
Burglar Alarm	Usually audible signal indicating a burglary or break in.	Attempt to reach a responsible party at the alarm site. If that contact fails, call a different phone number, usually the cell phone of a responsible party, in an attempt to verify the validity of the alarm signal prior to requesting public safety dispatch.
Fire Alarm	A signal that reports a fire, water flowing in a sprinkler system, or dangerous conditions such as smoke or overheated materials that may combust spontaneously.	Call requesting public safety dispatch unless local AHJ allows you to make a call to verify first.
Holdup/Robbery Alarm	A silent alarm signal generated by the manual activation of a device intended to signal a robbery in progress.	Call requesting public safety dispatch, then attempt to verify the validity of the signal.
Emergency or Panic Alarm	An audible alarm system signal generated by the manual activation of a device intended to signal a life threatening or emergency situation requiring law enforcement response.	Attempt to reach a responsible party at the alarm site. If that contact fails, call requesting public safety dispatch.
Ambush/Duress Alarm	A silent signal generated by the entry of a designated code into an arming station in order to signal that the alarm user is being forced to turn off the system and requires law enforcement response.	Call requesting public safety dispatch, then attempt to verify the validity of the signal.
Trouble	A signal indicative of a fault in a monitored circuit or component.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Supervisory	A signal indicating the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Late to Close	The alarm system has not been armed by the agreed upon time deadline.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Late to Open	The alarm system has not been disarmed, and there is a time deadline beyond which the user wants to be sure that the premises are occupied.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Unexpected Openings	The alarm system has been disarmed at a time outside the normal schedule.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Low Battery	Indicates when battery is almost dead.	Responsible party should be contacted. Public Safety **should not** be dispatched.
AC Power Fail	Indicates that primary AC power has failed.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Reset or Restoral	Indicates that a device is restored to its original or normal condition.	Signal should be logged for future reference. Public Safety **should not** be dispatched.
Cancel	A signal indicating that the previous alarm signal, or alarm in process, is to be disregarded.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Industrial Process Alarm	A signal that reports off-normal condition for a wide variety of commercial and industrial processes, including sump-pump operations, water levels, pressures and temperatures, chemical processes, and special furnace operations.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Late to Test Signal	Failure to receive an anticipated test signal (sent in an effort to confirm proper operation of the equipment) at the scheduled time.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Exit Error	A signal produced when an entry/exit zone is still violated at the expiration of the Exit Time.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Closing or Recent Closing	A signal indicating that the security system has recently been armed.	Responsible party should be contacted. Public Safety **should not** be dispatched.
Test Initiation Report	At the initiation of a test, the control panel sends a message to the central station that a test is in progress.	Signal should be logged for future reference. Signals should be ignored until the termination of test signal is received. Public Safety **should not** be dispatched.
Test Termination Report	When a test is terminated, the control panel sends a message to the central station that the test is over.	Signal should be logged for future reference. Signals should be ignored until the termination of test signal is received. Public Safety **should not** be dispatched.

Do-It-Yourself Systems

Description:	**Do-It-Yourself Systems are alarm systems and components purchased at a retail center by the alarm user and installed by the alarm user.**	
Types:	All in one system in one box or control and wired components, control and wireless components.	
Major Causes for False Alarms:	Improper installation, poor quality, lack of operation knowledge by the alarm user. In many cases the quality of the electronics is very poor to attract an end user to purchase a do-it-yourself-system.	

Self Contained Systems

Description:	**Self contained systems are designed for users to take home and plug in.** Usually involves a motion detector.	
Types:	All in one system in one box, control and wired components, control and wireless components.	
Major Causes for False Alarms:	Should be used as a notification device for the alarm user. User lacks expertise to properly aim the motion sensor or install the system, which will lead to false alarms. Police would be contacted only in the event of a verified point of entry.	

Control Panels

Description:	**The control panel is the "brain" of the alarm system.** When a detection device of any kind is activated, the signal is transmitted to the control panel, which in turn activates the audible sounding device, and the communicator, (if the system has one) to report the alarm. The control panel turns the system on and off via remote arming stations. It also includes the alarm system's power supply and standby battery. Digital Communicators are the most common method used in homes to transmit an alarm signal from the home over regular telephone wires to an alarm monitoring station. When the alarm is activated, the digital communicator seizes the telephone line and dials the central station computer, confirms contact and delivers a coded signal giving the location and type of alarm that has been activated. The central station operator then attempts verification when appropriate and notifies the proper authorities.	
Types:	Number of zones, capability to power devices, wired, wireless or hybrid inputs. Combination System - System where fire alarm system components may be used in whole or in part in common with a non-fire signaling system such as a paging system, burglar alarm system or a process monitoring supervisory system without degradation of or hazard to the fire alarm system.	
Applicable Standard:	UL 864: Standard for Control Units for Fire Protective Signaling Systems. (Fire Systems ONLY) SIA-ANSI CP-01 – Control Panel Standard. See SIAC's list of Cities and States that require CP-01 (http://www.siacinc.org)	
Major Causes for False Alarms:	Setting entry and exit times at a time that is too fast for the alarm user. Changing programming away from SIA control panel standard defaults. Failure of battery backup power caused by prolonged electrical power failure and/or any other failure of the battery of the alarm control panel.	

Arming Stations

Keypads

Description:	**The digital keypad is similar to the keypad on a touch-tone telephone**. A preset combination number is entered into the keypad to arm (turn on) and disarm (turn off) the system. The combination code can be changed.	
Types:	LCD display, LED display, wired or wireless, built in zones.	
Major Causes for False Alarms:	If the station has single action buttons to set off a fire or panic alarm, it can be accidentally triggered. Single action programming should be changed immediately. One plus duress feature (using one digit higher than the regular code for the duress code) should be prohibited on keypad due to high occurrence of false alarms.	

Keyswitch

Description:	Key operated arming stations use a high security key to arm (turn on) and disarm (turn off) the system. A red light is normally used to indicate if the system is armed.	
Types:	Ace (round) Lock or High Security. Inside or outside.	
Major Causes for False Alarms:	Tamper switch that is designed to activate if the switch is removed from the wall can cause alarms if loose or removed by contractors or others in error.	

Keyfobs

Description:	**Small radio transmitter, commonly located on a key chain that is used to arm and disarm the alarm system**. May have a panic feature.	
Types:	Key chain, watch, car visor mounted or wall mounted.	
Major Causes for False Alarms:	If the keyfob has single action buttons to set off a panic alarm it can be accidentally triggered. Deactivate or replace single action buttons immediately. Location of panic feature on remote not recommended	

Integration with Other Systems

Description:	Access control systems can be interconnected or integrated so that when credentials are presented, the alarm system is disarmed or a certain door is bypassed to prevent an alarm. Closed circuit television can be interconnected or integrated so that cameras are repositioned or certain cameras are recorded when the alarm system or a particular sensor is activated.	 
Types:	Integrated systems. Interconnection between separate systems.	
Major Causes for False Alarms:	Lack of synchronization between the access control system or features and the alarm system or features can lead to false alarms when the alarm is bypassed too late or the bypass is removed too early.	

Programming & Features

Feature	Additional Description	False Alarm Potential	FARA – NESA Recommendation Regarding Application
Wired System	Alarm system that uses wires between sensors and the control panel.	Wires separating can cause false alarms. Rodent damage to wires in attic spaces or corrosion to wires exposed to uncontrolled environments such as wires run in basements and under pier and beam houses.	Wire splices should be twisted, hot soldered and covered with electrical tape or secured with solderless crimp connectors crimped with the appropriate tool.
Wireless System	System that uses Radio Frequencies for communicating status conditions between the alarm sensors and alarm control panel.	May abruptly stop working from battery failure and require higher maintenance for operability.	Batteries must be checked and replaced according to manufacturer's recommendations. A supervised system that monitors the condition of the transmitter as well as its battery should be used.
Abort Window	A period of time that allows the user additional time to disarm the system before an alarm is transmitted.	Too little time prevents the user from disarming the system after false alarms.	All panels should be set to at least the default of 30 seconds established by the SIA CP-01 Standard. Time should be extended depending on environment or user.

Feature	Additional Description	False Alarm Potential	FARA – NESA Recommendation Regarding Application
Swinger Shutdown	One trip will shut down a zone until it is restored by a manual reset or may be automatically reset after forty-eight hours with no additional trips on any zones.	If swinger shutdown is set above 1, faulty equipment or environment will continue to cause a false alarm from the same source.	All panels should be set to the default of 1 established by the SIA CP-01 Standard.
Exit delay	Time allowed for user to arm (activate) the system and exit.	Sufficient delay time will help reduce false alarms from the source.	All panels should be set to the default of 60 seconds established by the SIA CP-01 Standard. A test should be performed to ensure all users can easily walk the distance in the time allowed.
Exit Time Restart	If the alarm user reenters premise prior to the end of the exit delay time, the exit time shall restart.	Panels without this feature enabled will go into alarm if a person reenters at the end of the exit period.	All panels should use this feature to allow the user time to reenter and reduce exit alarms.
Device Identification	Various methods can be used to pinpoint the source of an alarm.	If too many devices activate the same signal, it can be difficult to locate the source on an alarm.	The number of devices wired to each zone should be limited to more accurately identify the source of a false alarm.
Entry Delay	Period of time allowed, after entry to the premises, to disarm (deactivate) the security system before it notifies the monitoring company.	If the user does not have enough time to disarm (deactivate) the security system, false alarms are likely.	All panels should be set for at least 60 seconds (SIA default is 30 seconds). A test should be performed to ensure all users can easily walk the distance in the time allowed.
Call Waiting	Call waiting feature allows customer to receive multiple calls on a single line.	When the central station operator calls to verify the alarm when the alarm panel is still communicating, the operator will hear ringing and assume the site is not occupied.	Codes to disable the call waiting feature should be added to the panel programming so that the operator hears a busy signal when the panel is using the line.
Communications Paths	Phone systems, radio frequency (RF) including cellular and dedicated radio frequencies, and Internet.	Power outages or delay in signal path.	All devices in the communications path, including modems, routers and switching equipment should have at least 4 hours of backup power or comply with applicable standards.
Broadband (VoIP & DSL)	Voice over Internet Protocol and digital subscriber line systems are replacing standard phone lines.	Some Broadband signals can distort or prevent communication signals sent by the alarm panel.	Alarm users should contact their alarm company to verify that the system will continue to operate correctly with these technologies.
Grounding	Providing a proper ground can reduce static interference and dissipate surges.	Lack of a proper ground can lead to a false alarm when power surges or lightning strikes.	All systems should be grounded according to NEC (National Electrical Code) and manufacturer's specifications.
Tamper Switches	Reports attempts to gain access to device or panel.	Remodeling, construction or wear and tear can cause tamper signals. Many tamper switches are not hermetically sealed and are subject to corrosion.	Tampering should be sent to monitoring company as a trouble signal. Responsible party should be contacted. Public Safety **should not** be dispatched.
Backup Battery	Power source when standard power is interrupted.	Systems without enough power to operate are prone to false alarms.	System should include standby power for a minimum of four hours. Replacement should be every three years or more frequently if a site experiences a high occurrence of power outages or other environmental conditions that drain the life of the battery. Battery should be inspected and tested every year. Battery calculations must be performed on each system to ensure adequate capacity.

AC Power Source	Primary power for alarm system.	Eliminates accidentally turning off a power source, which places a drain on the battery. Example: If a business turns off breakers to turn off lights each night the panel will not get a proper charge.	Use a dedicated circuit when possible. Avoid ground fault interrupted circuits. Avoid switched circuits.
Transformer	Source of electricity.	If not permanently screwed into the wall, consumer could inadvertently unplug. This would cause a drain on the battery that could lead to false alarms.	Should be appropriately fastened (according to code) so that it cannot be accidentally unplugged.
Hybrid System	Alarm system that uses both wired and wireless methods for alarm sensors	See wired systems and wireless systems	Utilize both wired and wireless recommendations

Audio Verification

Description:	**Microphones at the alarm site are activated after an alarm to allow monitoring of the alarm site.**
Types:	One Way Audio- allows the operator to hear what is happening at the alarm site. Two Way Audio- allows the user to speak through an intercom directly to the monitoring station and vice versa.
Standard Uses:	To record and verify activity.
Uses To Avoid:	Where privacy is a concern.
Range:	Depends on sensitivity and number of microphones.
Activated By:	System activation.
Advantages:	Permits the monitoring company to listen in.
Disadvantages:	Added expense, privacy issue, requires microphones to cover full alarm site. Audible notification appliances may prevent operator analysis. Audio verification is not as reliable as video verification. Operator listening may not know the difference between customer, burglar, alarm user, or source of noise.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Alarm site can be monitored by the operator to provide audio verification and better intelligence about the premise activity before dispatch. Can assist in canceling false alarms.

Video Verification

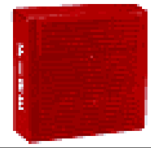
Description:	**When the alarm is activated, a camera is used to allow the monitoring center to see what is happening at the alarm site.** Some systems record for a period of time immediately before the alarm is activated and allow the operator to view that as well.
Types:	Integrated camera and motion detector or interconnection between separate camera and alarm system.
Standard Uses:	To record and verify activity.
Uses To Avoid:	Where privacy is a concern.
Range:	Depends on camera and lens.
Activated By:	Motion sensed by camera or when alarm system activates.
Advantages:	Video may be used to assist in identification and details of a crime.
Disadvantages:	Added expense, privacy issue, requires cameras to cover full alarm site. Operator analyzing the video may not know difference between customer and burglar. Many systems provide a relatively small amount of storage for archiving video, which may be problematic when needed as supporting evidence. Ability to verify subject to quality of camera and lighting.
Applicable Standard:	SIA/IACP CCTV for Public Safety and Community Policing Operational Guidelines.
False Alarm Reduction Recommendations:	Alarm site can be observed by the operator to provide visual verification and better intelligence about the premise activity before dispatch. Can assist in canceling false alarms.

Notification Appliances

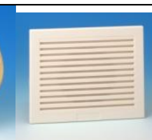
General Considerations

- Sound for each type of alarm (burglar, fire, etc) should be clear and distinctive to the user.

Horns

Description:	**Noise-making device used to indicate an alarm or other event.**  
Types:	Flush or surface mounting.

Siren

Description:	**An electronic device that produces a very loud, hard to ignore sound when activated.**  
Types:	Flush or surface mount. Self contained or a continuous tone or multi-tone.

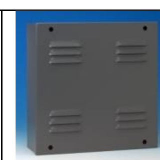
Speaker or Voice Evacuation System

Description:	**An electronic device that produces a very loud, hard to ignore sound when activated.** In some systems known as voice evacuation systems the alert or alarm tone may be followed by a taped or live announcement. 
Types:	Combination of speaker and siren driver or speaker and amplifier for live or taped voice announcements. Flush or surface mount. Continuous tone or multi-tone.

Chime

Description:	**An electronic device that produces a loud sound when activated.**  
Types:	Flush or surface mount.

Bell

Description:	**Electromechanical noise-making device.** A clapper is moved electromechanically to strike the bell and produce a loud ringing sound. 
Types:	Indoor or outdoor use.

Strobes

Description:	**A visual indicator light with very rapid, bright flashes**. Used to indicate an alarm or other event.  
Types:	Rated for Fire use, general notification. Lens colors may vary.

Active Graphic Annunciator

Description:	**Board or CRT screen with graphics to delineate alarm or sensor locations.** A visual indicator showing the location of an alarm. Annunciators pinpoint the exact location of an alarm or problem. With their help, the alarm user can locate a faulted door or sensor at closing time. In addition, service personnel can quickly locate a system defect. 

Static Graphic Annunciator

Description:	**LEDs illuminate areas of a map of the facility to show the location of an alarm or event.** Annunciators pinpoint the exact location of an alarm or problem. With their help, the alarm subscriber can locate a faulted door or sensor at closing time. In addition, service personnel can quickly locate a system defect.	

Tabular Annunciator

Description:	**LEDs illuminate a labeled area of a grid to show the location of an alarm.** Annunciators pinpoint the exact location of an alarm or problem. With their help, the alarm subscriber can locate a faulted door or sensor at closing time. In addition, service personnel can quickly locate a system defect.	

Smoke Emitting Devices

Description:	**When activated, a smoke emitting device rapidly produces a dense smoke, fog or vapor that reduces the visibility in a room to a minimum.** Smoke Emitting Devices are intended to be integrated into the premises alarm system, but may be a self-contained stand-alone unit. The purpose of this device is to reduce property losses in unattended premises. They should be manufactured specifically for this use and not adapted from other uses, such as entertainment. Some models allow user programming, such as delays, resets and control of volume of emission.	
Comments:	Reputable and responsible manufacturers and installers have developed and initiated adequate safeguards and procedures to safely install and operate these devices. FARA & NESA are concerned that all manufacturers may not follow these procedures and therefore recommend that localities consider adopting a local version of the FARA Model Smoke Emitting Devices Ordinance.	

Communications

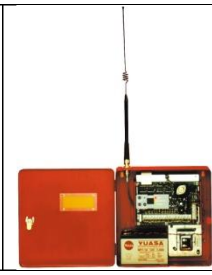
Digital Communicators

Description:	Also known as a digital dialer. **Means of transmitting alarm signals and other information to a central station, using the customer's existing phone line**. To transmit an alarm, the communicator seizes the customer's phone line and electronically dials the central station receiver. When the receiver answers, the communicator sends a message in the form of a sequence of tones. A mini-computer in the receiver accepts and acknowledges the message. It then prints out the information for display to the operator.	
Types:	Integrated with control or stand-alone.	
Comments:	Digital communicators need a loop start (POTS) telephone line to work reliably. VoIP lines, even when they appear to be compatible, lack the dependable power source to ensure that the signal can be consistently transmitted.	

Cellular (GSM)

Description:	The use of stationary cellular telephone equipment to provide means of alarm signal communication between the alarm system and the monitoring facility.	
Types:	Digital	
Comments:	None	

Long Range Radio

Description:	**A network of radio transmitters or transceivers** capable of sending alarm status messages to one or more radio receivers or transceivers which are at, or in communication with, an alarm monitoring facility or other alarm signal receiving station. 
Comments:	None

Internet

Description:	**Uses the Internet to deliver alarm messages**. Incorporates a very high level of encryption and two-way authentication. Internet transmitters at the alarm site send data to a compatible internet receiver at a central station over the internet. 
Comments:	The Internet may be primary with the standard phone lines or a wireless network as backup if the Internet is unavailable. Requires Customer Premise Equipment (may also be referred to as the alarm user's internet network) and is dependent on the security of that network. Relies on the premise and local network power.

Voice AutoDialer

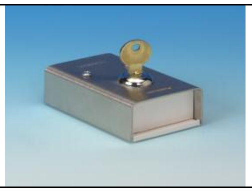
Description:	An electrical, electronic, mechanical, or other **device capable of being programmed to send a prerecorded voice message, when activated**, over a telephone line, radio or other communication system. 
Comments:	FARA and NESA do not recommend use of voice dialers for alarm systems. Ties up the PSAP phone lines by repeating information several times. Most local ordinances prohibit using these dialers to call police and fire departments. Much slower than digital communicators.

Receiving Equipment

Description:	**Alarm signals are received at a monitoring station** and processed by operators who make calls to verify the validity of a signal, make requests for dispatch of public safety as required and notify responsible parties. 
Comments:	Signals can be received at a self contained device or may be received at one device and fed into a computer to be processed. Alarm signals received by an alarm receiver indicate the type of alarm and a unique identifier that is used to reference details of the location of the alarm and emergency contact phone numbers.

Holdup or Panic Sensors

Holdup or Panic Switches

Description:	**A holdup or panic button is designed to generate an alarm signal by the manual activation of a device intended to signal a robbery, holdup or emergency in progress.** Depressing the button closes or opens the circuit to indicate an alarm. 
Types:	**Single action buttons** only require pressing the button to activate. **Dual action buttons** require pressing and holding the button for a specified length of time or pressing two buttons to activate. **Locking buttons** remain in position after they are pressed until they are reset. **Magnetic lever switches** use a magnet and reed switch encased in a hinged case. When the case is pulled or opened, the magnet is separated from the switch to change the status of the switch.

	Piezo pressure strips are concealed in an area that would not normally be subject to enough pressure to operate the switch. When sufficient pressure is applied, a processor activates to generate an alarm. Buttons can be installed in a fixed location or utilize a wireless frequency to allow them to be carried by a person or moved from place to place within a site. Devices can be surface or recessed.
Standard Uses:	To allow an authorized user to activate an alarm to indicate duress or emergency. Cashier, bank teller, senior citizens, homeowners.
Uses To Avoid:	Where activation would put the operator at personal risk that the operator is unprepared to accept. Hold-up alarms should not be installed in residential environments unless real, substantial need can be demonstrated.
Range:	Requires direct contact to activate.
Activated By:	Depressing one or more buttons.
Associated Work:	Connection of wiring. Locating to properly conceal and avoid unintended operation. Wiring to control panel zone that is active 24 hours a day.
Advantages:	Small, easy to operate
Disadvantages:	Risk when used if detected by robber or assailant. Because signals are generally silent, users are unaware that they have activated the alarm. Law enforcement is not aware of the type of emergency that exists when responding to this type of an alarm and therefore does not know what type of response is required.
Conditions for Unreliable Detection:	If switch is located in an area where the user cannot activate it without detection.
Major Causes for False Alarms:	Single action switches can be activated accidentally by the user as objects are moved. If user is unaware of proper operation.
Typical Defeat Measures:	Detection of location.
Applicable Standard:	UL 636.
False Alarm Reduction Recommendations:	Use simultaneous two-button activation or a keyed manual reset after activation. Train all personnel on when the button should and should not be used. Do not use in residential applications.

Foot Rail- Kick Bar

Description:	**Foot rails are floor mounted arched enclosures containing a switching device that operates when a person's foot is slid along the floor under the arch to make contact with a pivoting bar.**	
Types:	May vary in size but all operate the same.	
Standard Uses:	To allow an authorized user to activate an alarm to indicate duress or emergency. Cashier, bank teller, receptionist, guard desk.	
Uses To Avoid:	Where activation would put the operator at personal risk that the operator is unprepared to accept.	
Range:	Requires direct contact to activate.	
Activated By:	Person's foot is slid along the floor under the arch to make contact with a pivoting bar.	
Associated Work:	Connection of wiring. Locating to properly conceal and avoid unintended operation. Wiring to control panel zone that is active 24 hours a day.	
Advantages:	Hands free and covert operation.	
Disadvantages:	Fixed position. Risk when used if detected by robber or assailant.	
Conditions for Unreliable Detection:	If switch is located in an area where the user cannot activate it without detection.	
Major Causes for False Alarms:	If user is unaware of proper operation. If located in an area where accidental activation is likely.	
Typical Defeat Measures:	Detection of location.	
Applicable Standard:	UL 636.	
False Alarm Reduction Recommendations:	Train all personnel on when the button should and should not be used. Do not use in areas where items will be stored around or on top of the device.	

Money Clips

Description:	**Special type of switch placed in a cash drawer, with the bottom bill of a stack inserted in the switch.** The alarm is activated by removing that bill.	
Types:	Wired or wireless. Stand-alone or with integrated coiled cord.	

Standard Uses:	To allow an authorized user to activate an alarm to indicate duress or emergency. Cashier or bank teller.
Uses To Avoid:	Where activation would put the operator at personal risk that the operator is unprepared to accept.
Range:	Requires direct contact to activate.
Activated By:	Removal of last group of currency.
Associated Work:	Connection of wiring. Locating to properly conceal and avoid unintended operation. Wiring to control panel zone that is active 24 hours a day. Allowance for frequent movement of cash drawer.
Advantages:	Hands free and covert operation.
Disadvantages:	Fixed position. Risk when used if detected by robber or assailant. Some law enforcement agencies do not recommend using this type of alarm device.
Conditions for Unreliable Detection:	If switch is located in an area where the user cannot activate it without detection.
Major Causes for False Alarms:	If user is unaware of proper operation. If wiring between money clip and counter or wall is not flexible enough to withstand frequent opening and closing of cash drawer.
Typical Defeat Measures:	Detection of location.
Applicable Standard:	UL 636.
False Alarm Reduction Recommendations:	Train all personnel on when the money clip should and should not be used. Periodically check and replace wiring between money clip and counter or wall. Wire clips so that bills need to be removed from more than one clip to generate an alarm.

Indoor Sensors

Magnetic Switch

Description:	**Magnetic switches are contact switches used to detect the opening of a door or window** and depend on the direct physical operation/disturbance of the sensor to generate an alarm. Magnetic switches are composed of two parts - a two-position magnetic switch mounted on the interior of a door, window or container frame, and a magnet. In most cases, when the door or window is closed, the magnet pulls the switch to its "normal" non-alarmed position. When the door or window is opened, the magnet releases the switch, breaking the contact and activating the alarm. 
Types:	Surface or flush; single, double or triple reed; balanced or coded (see separate description), normally open or normally closed; standard or wide gap.
Standard Uses:	Magnetic switches are mounted on doors, windows, cabinets and containers to detect opening.
Uses To Avoid:	On loose fitting doors or where connecting wiring is exposed to tampering.
Range:	¾" to 2-3/4" depending on rating.
Activated By:	Separation between switch and magnet.
Associated Work:	Concealment of connecting wiring. To be effective, doors and windows should be properly and securely seated or mounted in their supporting frame.
Advantages:	Widely used, easily understood, reliable. Not affected by heat or moving objects.
Disadvantages:	Simplistic in design, the magnetic switch is limited to detecting normal opening of a barrier such as a door or window. Can be bridged. A magnetic contact on the average will only carry one amp at DC100 volts. On a rare occasion a surge or lightning strike will shoot current through the contacts many times the rated capacity. This will create an arcing and welding of the contact.
Conditions for Unreliable Detection:	Excessive movement of the door, window or access panel in its frame/setting can generate conditions for unreliable detection and should be corrected prior to installation of the security switches.
Major Causes for False Alarms:	Poor fitting doors or windows (caused by age and/or improper installation) and compounded by extreme weather conditions, which cause excessive movement of the door or window, are the major causes of false alarms. The constant vibration can contribute to a false alarm by causing the reed to flex and add fatigue even if the vibration is not sufficient to cause the reed switch to fully open or close. Mounting of magnet directly to metal that can drain the strength of the magnet. Cracks in case surrounding reed switch to expose the reed to the environment.
Typical Defeat Measures:	Penetration of the door or window without moving the magnet switch mechanism will bypass the alarm device. A second, free-moving and stronger magnet can be used to imitate the mounted magnet, allowing the door to be opened without generating an alarm. Switch location should not be observable to a potential intruder to reduce an intruder's ability to bypass or "jump" the terminals.
Applicable Standard:	UL 634.
False Alarm Reduction Recommendations:	Preferred mounting location is 12" or more from the frame toward the center of the door. Surface reed switches should be installed parallel to the magnet. "Wide gap" designation usually means a higher quality reed switch and a more powerful magnet. Installation of the reed in parallel to the magnet is preferred. Proper alignment and spacing from metallic materials is required. Requires specific training for alarm user to maintain doors and windows properly.

Balanced Magnetic Switch

Description:	**Balanced Magnetic Switches consist of a switch assembly with an internal magnet that is usually mounted on the door/window frame and a balancing (or external) magnet mounted on the moveable door/window.** Typically, the switch is balanced in the open position by the magnetic field produced by the two magnets. If the magnetic field is disturbed by the movement of the external magnet, the switch moves to a “closed" position. When the door is in the normal closed position, the magnetic field generated by the biasing magnet interacts with the field created by the switch magnet, so that the total net effect on the switch is stable. When the door is opened, the switch falls to one of the contacts, becoming unstable and generating an alarm. 
Types:	Surface or flush; single, double or triple reed. Balanced magnetic switches are available in casings designed to prevent the switch from electrically causing an explosion in a hazardous area. These switches are recommended for flammable or hazardous environments.
Standard Uses:	Balanced Magnetic Switches provide a higher level of security for windows and doors than magnetic or mechanical switches. The balanced magnetic switch should be mounted on the door frame, and the balancing magnet on the door. The switch should be adjusted to initiate an alarm when the door is opened between a half and one inch.
Uses To Avoid:	On loose fitting doors or where connecting wiring is exposed to tampering.
Range:	¾” to 2-3/4" depending on rating.
Activated By:	Separation between switch and magnet.
Associated Work:	Concealment of connecting wiring. To be effective, doors and windows should be properly and securely seated or mounted in their supporting frame.
Advantages:	Easily understood, reliable.
Disadvantages:	Simplistic in design, the magnetic switch is limited to detecting normal opening of a barrier such as a door or window.
Conditions for Unreliable Detection:	Excessive movement in the door or window will create conditions for unreliable detection and should be eliminated before security switches are installed.
Major Causes for False Alarms:	Poorly fitting doors or windows and improper installation are the primary causes of false alarms. Extreme weather conditions which cause excessive movement of the door, window or access portal can cause a false alarm.
Typical Defeat Measures:	A distinct advantage to using the balanced magnetic switch is its inherent ability to counter a common defeat measure used on straight magnetic sensors. This defeat measure involves placing an external magnet on the switch housing to hold the internal switch in place while the door or window is opened. The design of the Balance Magnetic Switch precludes this defeat mechanism from being effective. Switch location should not be observable to a potential intruder to reduce an intruder's ability to bypass or "jump" the terminals.
Applicable Standard:	UL 634.
False Alarm Reduction Recommendations:	Preferred mounting location is 12” or more from the frame toward the center of the door. Surface reed switches should be installed parallel to the magnet. “Wide gap” designation usually means a higher quality reed switch and a more powerful magnet. Installation of the reed in parallel to the magnet is preferred. Proper alignment and spacing from metallic materials is required. Requires specific training for alarm user to maintain doors and windows properly.

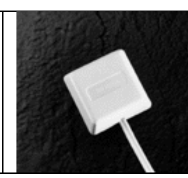
Mechanical Switch

Description:	**Mechanical switches are used to detect the opening of a door or window.** These sensors depend on direct physical operation or disturbance of the sensor to generate an alarm. Mechanical switches are spring-loaded or plunger devices that trigger when a door or window is opened. 
Types:	Lever or push rod or ball action. Normally closed or open.
Standard Uses:	Mechanical switches can be mounted on doors, windows, drawers, cabinets to detect opening.
Uses To Avoid:	Where the switch will be exposed to dirt, moisture that could jam the switch.
Range:	Point of contact.
Activated By:	Removal of pressure from the plunger.
Associated Work:	Recessing the switch and connecting wiring. To be effective, doors and windows should be properly and securely seated or mounted in their supporting frame prior to the installation of any security (or locking) devices, including mechanical switches.
Advantages:	Simple, cheap, easy to install, can be hidden.
Disadvantages:	Simplistic in design, is limited to detecting normal opening of a barrier such as a door or window. Can be troublesome due to dirt or moisture jamming the switch. Cannot be used on new wood doors that might distort or warp.
Conditions for Unreliable Detection:	Poor or lose fitting doors or windows will allow random movement of a door or window to trigger an alarm and could assist a knowledgeable intruder in gaining surreptitious entry.
Major Causes for False Alarms:	Poor fitting doors or windows and improper installation of doors, windows, locks or alarm switches. Lose fitting or improperly mounted doors or windows can be aggravated by extreme weather conditions (wind and storms) as well as seasonal fluctuations in the external and/or internal environment (heating versus air conditioning). Dirt, moisture, expansion or contraction of frame.
Typical Defeat Measures:	Holding the switch in the "normal closed" position while opening the door or window will preclude the initiation of an alarm. Typically this is accomplished with a small piece of metal designed to prevent the switch from triggering. Also, taping the switch in the "closed” position during daytime operations allows an intruder to return after the alarm has been activated and open the door or window without generating an alarm.
Applicable Standard:	UL 634.
False Alarm Reduction Recommendations:	Only hermetically sealed, watertight and airtight switches should be used. Should not be used on poorly fitting doors and windows. Requires specific training for alarm user to maintain doors and windows properly.

Acoustic Glassbreak Sensor

Description:	**Acoustic Glassbreak sensors, usually mounted on ceilings or walls, work by "listening" for an acoustic sound wave that matches the frequency of broken glass.** Once impact is made, high frequencies caused by the glass breaking travel away from the point of impact toward the outer edges of the glass surface. These vibrations excite the acoustic sensor processor which passes the frequency through a filter, compares the frequency for a match and signals an alarm if appropriate. 
Types:	Surface or flush mounted. Wired or wireless.
Standard Uses:	Depending on the manufacturer's specifications, acoustic sensors should be mounted on the window, window frame, wall or ceiling. If mounted on the glass, the sensor should be placed in the corner approximately two inches from the edge of the frame. If mounted on the wall or ceiling, the sensor should be installed opposite the window. NOTE: Although not recommended, the sensor may be mounted on the window. If so, the mounting adhesive should be specified to withstand long exposure to summer heat, winter cold and condensation that might collect on the window. It should be noted that a window glass can get as hot as150 degrees F in the summer and as cold as -30 degrees F in the winter, therefore, it is essential that the application adhesive meets these specifications.
Uses To Avoid:	Areas with excessive background noise.
Range:	Regardless of which sensor is used, coverage typically does not exceed 100 square feet of glass surface.
Activated By:	Sound.
Associated Work:	As a precaution all windows should be checked for cracks and replaced prior to installation of a Glassbreak sensor to ensure that a good frequency signature will be produced if the window is broken.
Advantages:	Can cover multiple panes of glass.
Disadvantages:	May not detect glass pane removal or some forms of cutting (thermal knife). Line of sight to window may be required.
Conditions for Unreliable Detection:	Inappropriate matching of sensor range capacity to the window size and poor location may cause the sensor to be out of effective detection range. The acoustical characteristics of the room in conflict with the sensor's performance specifications. "Soft" acoustic rooms (e.g. carpeted with window drapery) that absorb vibration or by altering the acoustic characteristics of the "hard" room (e.g., adding window shutters, blinds, draperies, rugs) after the sensor has been tuned can cause detection inadequacy of the sensor.
Major Causes for False Alarms:	Improper calibration or installation. Sharp impact noises. Improper application or placement. The simpler designs of acoustic detectors sense the high frequency tinkle of shattered glass. These simple designs tend to cause false alarms by confusing the breaking of glass such as tableware, or the sound of bells, with the sound of breaking windows. Thunderstorms or background noise, such as office, industrial and cleaning machinery, can create noise in the frequency detection range of the sensor. Many sounds are similar to the sound of breaking glass, such as jingling keys, a telephone ringing, clinking ice cubes, dishes or glasses being washed, dogs barking, air compressors and fans.
Typical Defeat Measures:	Detaching or cutting of an opening in the window or the removal of a window pane (with or without a sensor mounted on it) can bypass the sensor. The break frequency can be distorted by muffling the sound of the breaking glass reducing the potential for the "correct" frequency registered by the sensor.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper placement calibration and testing are required to avoid false alarms. Recalibration will be required if carpeting in the room is changed to hardwood or tile flooring or visa versa. Dual technology sensors are preferable to reduce false alarms.

Shock Glassbreak Sensor

Description:	**Glassbreak sensors monitor glass that is likely to be broken during intrusion**. The sensors are housed in a single unit and mounted on a stable interior element (wall or ceiling) facing the main glass surface. Shock sensors feel/sense the typical 5 KHz frequency shock wave that is created when glass is broken. When the processor detects this shock it signals an alarm. 
Types:	Two types of "shock" sensors (transducers) are used: electric piezo and non-electric piezo. Most use piezo transducers to "feel/sense" the 5 KHz frequency. However, some use a non-electric piezo transducer, which does not have any electricity present until the piezo "bends" when it is "hit" by a 5 KHz signal. The non-electric piezo type reduces false alarms dramatically.
Standard Uses:	The sensor is mounted on the window plate or sheet glass.
Uses To Avoid:	Toughened, wired or laminated glass.
Range:	Regardless of which sensor is used, coverage typically does not exceed 100 square feet of glass surface.
Activated By:	Vibration- Frequency of glass break.
Associated Work:	As a precaution, all windows should be checked for cracks and replaced prior to installation of a Glassbreak sensor to ensure that a good frequency signature will be produced if the window is broken. The mounting adhesive should be specified to withstand long exposure to summer heat, winter cold and condensation that might collect on the window. It should be noted that a window glass can get as hot as150 degrees F in the summer and as cold as -30 degrees F in the winter, therefore, it is essential that the application adhesive meets these specifications. Wiring, adjusting and testing.
Advantages:	Small, unobtrusive, do not require line of sight. Piezo-electric type has no moving parts.
Disadvantages:	A sensor is required for each pane of glass. Cannot be used on all types of glass.
Conditions for Unreliable Detection:	Where windows have cracks or glass is not firmly sealed in place.

Major Causes for False Alarms:	Improper application or placement of the sensor. Improper seating of the window pane to allow excessive movement which may duplicate the activation frequency. Storms! Easily activated externally without actually breaking the glass.
Typical Defeat Measures:	The removal of a window pane (with or without a sensor mounted on it) can bypass the sensor. The break frequency can be distorted by muffling the sound of the breaking glass reducing the potential for the "correct" frequency registered by the sensor.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Use manufacturer approved adhesive. Do not use on loose fitting glass or glass with any cracks. Dual technology sensors are preferable to reduce false alarms.

Dual Technology Acoustic/Shock Glassbreak Sensor

Description:	**Glassbreak sensors monitor glass that is likely to be broken during intrusion**. The sensors are housed in a single unit and mounted on a stable interior element (wall or ceiling) facing the main glass surface. In dual-tech sensors, an acoustic device is linked with a shock device. This combination utilizes the complementary capabilities of both devices and provides for a low false alarm rate sensor. The acoustic portion of the sensor uses a microphone to detect frequencies associated with breaking glass. A processor filters out all unwanted frequencies and only allows frequencies at certain ranges to be analyzed. Once the processor receives the frequency, it is compared to those associated with glass breakage. If the signal matches frequencies characteristic of breaking glass, then a signal is sent to the AND gate. The shock portion of the sensor "feels" for the 5 KHz frequency in the form of a shock wave created when glass is broken. When the processor detects this shock, it sends a signal to the AND gate. Once the AND gate has received both signals, an alarm is generated. 
Types:	Wired or wireless.
Standard Uses:	Depending on the manufacturer's specifications, acoustic sensors should be mounted on the window, window frame, wall or ceiling. If mounted on the glass, the sensor should be placed in the corner approximately two inches from the edge of the frame. If mounted on the wall or ceiling, the sensor should be installed opposite the window. NOTE: Although not recommended, the sensor may be mounted on the window. If so, the mounting adhesive should be specified to withstand long exposure to summer heat, winter cold and condensation that might collect on the window. It should be noted that a window glass can get as hot as150 degrees F in the summer and as cold as -30 degrees F in the winter, therefore, it is essential that the application adhesive meets these specifications.
Uses To Avoid:	Areas with excessive background noise.
Range:	Regardless of which sensor is used, coverage typically does not exceed 100 square feet of glass surface.
Activated By:	Sound and vibration.
Associated Work:	As a precaution all windows should be checked for cracks and replaced prior to installation of a Glassbreak sensor to ensure that a good frequency signature will be produced if the window is broken.
Advantages:	The incorporation of two Glassbreak technologies into one sensor significantly reduces false alarms from background noise such as RFI and frequency noise created by office machines.
Disadvantages:	Requirement that two technologies activate can reduce sensitivity. May not detect glass pane removal or some forms of cutting (thermal knife). Line of sight to window may be required.
Conditions for Unreliable Detection:	Inappropriate matching of sensor range capacity to the window size and poor location may cause the sensor to be out of effective detection range. Acoustical characteristics of the room that conflict with the sensor's performance specifications. "Soft" acoustic rooms (e.g. carpeted with window drapery) that absorb vibration or by altering the acoustic characteristics of the "hard" room (e.g., adding window shutters, blinds, draperies, rugs) after the sensor has been tuned can cause detection inadequacy of the sensor.
Major Causes for False Alarms:	Improper calibration or installation may cause false alarms.
Typical Defeat Measures:	Detaching or cutting of an opening in the window or the removal of a window pane (with or without a sensor mounted on it) can bypass the sensor. The break frequency can be distorted by muffling the sound of the breaking glass reducing the potential for the "correct" frequency registered by the sensor.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Premises with loud music, clanging pots and pans, gym weights, and ceiling fans or sites with high levels of radio interference are not recommended for this device.

Foil

Description:	**Foil, or tape, is a ribbon of metallic material that is attached to various surfaces such as glass, door panels, walls, etc.** The foil is designed to break when an attempt is made to gain entry through the surface to which it is attached, thus causing the alarm to sound. 
Types:	Regular or self adhesive.
Standard Uses:	Applied to glass with protective coating of varnish or walls or doors between protective panels.

Uses To Avoid:	Laminated glass.
Range:	Requires direct contact to break foil.
Activated By:	Break in foil.
Associated Work:	Glass cleaning, varnishing connection of wiring between panes of glass and to panel.
Advantages:	Simple, inexpensive, reliable, visible deterrent.
Disadvantages:	No protection against glass cutting if foil is not cut. Labor intensive and requires high degree of maintenance.
Conditions for Unreliable Detection:	Where sections of foil can be bypassed.
Major Causes for False Alarms:	Condensation, temperature changes can cause breaks as foil flexes. Breaks easily. Hairline cracks are difficult to see, but have the potential to cause false alarms.
Typical Defeat Measures:	Bypass of sections.
Applicable Standard:	UL 681.
False Alarm Reduction Recommendations:	Older technology, should not be used unless installed and frequently inspected and repaired by qualified personnel.

Pressure Mat or Pad

Description:	**A pressure mat or pad is a simple switch that is activated by pressure.** The pressure mat or pad is a simple switch that consists of two metal plates or strips that are separated by a compressible insulating medium, such as foam rubber or nylon springs. When pressure is applied to the top layer it compresses the insulating material to make contact with the lower layer. The plates or strips and the insulating material are enclosed in sealed, insulated, watertight and airtight plastic. The Piezo Mat contains a very thin layer of piezo crystal film placed inside a semi-rigid mat. Any person standing on the mat compresses the crystal to produce a small voltage. This voltage is read by an amplifier and fed to a processor. The amount of voltage and number of pulses is considered by a processor to decide whether to generate an alarm.	
Types:	**Pressure mat** (open loop), **Pressure pad** (open or closed loop), **Piezo Mat** (open or closed loop). Versions are available with sensitivity adjusted to accommodate small pets.	
Standard Uses:	Generally used under rugs or carpets in an area where intruder is likely to pass. Placed in doorways, hallways, windowed areas and staircases, they can be used to isolate desired areas in lieu of protecting one or more perimeter opening. Should be placed under the carpet and the padding on top of a smooth flat floor.	
Uses To Avoid:	Can wear out if used in high traffic areas or where heavy objects may be temporarily placed or carts or vehicles will drive over them. Where pets and small children might wander through the home while the interior system is armed. It should be possible to turn off the interior system to permit free movement through the home while the perimeter system is armed.	
Range:	Requires direct contact. Varied lengths and sizes available.	
Activated By:	Direct Pressure.	
Associated Work:	Concealment, reconstruction of carpet.	
Advantages:	Inexpensive, simple, reliable.	
Disadvantages:	Easy to circumvent. Will only activate after intrusion is made. Labor intensive.	
Conditions for Unreliable Detection:	Because most mats are open circuit they can be bypassed. Can be avoided if not concealed.	
Major Causes for False Alarms:	Pets, movement of furniture, wear and tear on moving parts.	
Typical Defeat Measures:	Bypass of open circuit types. Avoidance.	
Applicable Standard:	UL 634.	
False Alarm Reduction Recommendations:	Use only in low traffic areas where the alarm user has no plans for pets or to change layout of furniture around where the mat will be located.	

Wire Sensors or Screens

Description:	**Wire can be laced across a wall or area to provide detection when the wire is broken.** Specially designed window screens are also available to cover windows and other openings.	
Types:	**Trip wire** – A wire is strung across the opening. **Wire in tube**- Wire is enclosed in dowels or tubes. **Wired Glass**- Wire is embedded inside the glass.	

	Screen- These screens contain inconspicuous, built-in alarm wire which protects against cutting or tearing the screen, and also contain a magnetic contact to guard against removal of the screen. **Lace Wiring**- wire is stapled to the surface of a wall or door and covered with a protective panel.
Standard Uses:	Detection of entry through door, window, vent or wall.
Uses To Avoid:	Where excessive moisture is present.
Range:	Requires direct contact to break wiring.
Activated By:	The alarm is indicated when the wire breaks.
Associated Work:	Wiring, installation of protective panel. Measurement of screens to ensure proper size.
Advantages:	Stable and reliable.
Disadvantages:	Labor intensive. Cuts or nicks in wire can be difficult to find and repair. Trip wire must be reset after the door is opened.
Conditions for Unreliable Detection:	If wiring can be moved to allow entry between wires.
Major Causes for False Alarms:	Nicks or cuts in wiring. Alarm screens are often removed and reseated by the alarm user, window cleaners, and non-alarm repair/maintenance people. Improperly re-seating and reconnecting the window screen to the alarm system will result in false alarms.
Typical Defeat Measures:	Bypass of circuit.
Applicable Standard:	UL 681.
False Alarm Reduction Recommendations:	Window screens can offer a reliable means of detection where other types of wire sensors are too prone to false alarms to be effectively used.

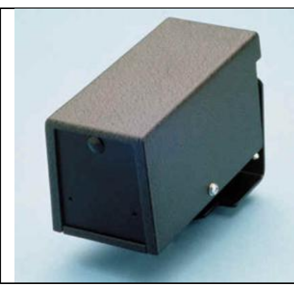
Wall Vibration

Description:	**Vibration sensors are designed to be mounted on walls, ceilings and floors and intended to detect mechanical vibrations caused by chopping, sawing, drilling, ramming or any type of physical intrusion attempt that would penetrate the structure on which it is mounted.** Two basic types of transducers are used to detect changes: piezo-electric transducers and mechanical transducers. Both types convert the seismic vibrations detected to electrical signals proportional to the vibrations. The signals are then sent through a screening filter which determines if the signal corresponds to the signal spectrum typical of an intrusion attempt. If the frequency is characteristic of an intrusion attempt, an alarm signal is generated. 
Types:	**Piezo-electric-** vibrations hitting a crystal produce small amounts of electricity that can be analyzed by a processor to generate an alarm. **Inertia**- vibrations cause a ball or cylinder to move to a piece of metal to break contact with another piece of metal. This simple break in circuit may generate an alarm or be fed to a processor that decides when to generate an alarm.
Standard Uses:	Wall, doors, ceilings, floors, safes, ATMS, vaults.
Uses To Avoid:	Walls of limited structural integrity such as sheet rock, plywood or thin metal, unless they are positioned on a main support. These types of walls are very prone to vibrations caused by sources other than intrusion actions.
Range:	Depends on structure to be monitored and upon sensor and processor. For example, a sensor will be more sensitive on a wall made of drywall than a wall made of cinderblocks or brick.
Activated By:	Vibration.
Associated Work:	Wiring, sensitivity adjustment and testing.
Advantages:	Small, reliable, sensitivity adjustments allow variety of surfaces to be sensed.
Disadvantages:	Piezo-electric type requires amplification to ensure reliable detection. Reliability is dependent on matching the sensor and processor to the structure to be monitored.
Conditions for Unreliable Detection:	Unstable or improper installation or spacing of units, and mounting of the sensors to materials (rugs, fabric, heavy wall coverings) that are not conducive to detecting vibrations will create unreliable detection conditions.
Major Causes for False Alarms:	Poor placement. Mounting on walls that are exposed to external vibrations (e.g., trains, planes), or if the walls are subject to vibrating machinery.
Typical Defeat Measures:	By avoiding entry through the protected area, or by selecting a point and method of entry in a segment of a wall, roof or floor that will permit the suppression/diffusion of the intrusion vibrations. Generation of a persistent but random number of false alarms over a long period of time, causing the alarm to be ignored or the response time greatly diminished.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Use only on a solid wall or solid structure that is not subject to vibration. Ask questions to verify that sources of vibration will not occur during hours that the sensor will be active.

Fiber Optic Wall

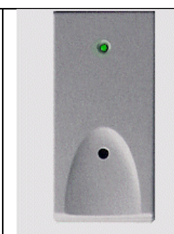
Description:	**A fiber optic wire sensor is in an open mesh network, that can be applied directly to an existing wall or roof, or installed in a wall (or roof) as it is being constructed**. The fiber optic network is designed to detect the low frequency energy (vibrations) caused by chopping, sawing, drilling, ramming or physical attempt to penetrate the structure on which it was mounted. Light travels through the fiber optic cable and is picked up by a detector, which is very sensitive to slight alterations in the transmission. When an adequate alteration in the light pattern takes place, the signal processor generates an alarm.	
Types:	n/a	
Standard Uses:	To cover a wall or roof.	
Uses To Avoid:	These sensors are very sensitive, and special consideration must be given to determine if this type of sensor is suitable for a particular wall/roof. A vibration sensor may generate false alarms if mounted on walls that are exposed to external vibrations (vehicle, train or heavy foot movement) or if the walls are subject to vibrating machinery.	
Range:	Dependent on the processor.	
Activated By:	Vibrations cause changes in the light pattern sent through the fiber optics to generate an alarm.	
Associated Work:	Application to wall, floor or ceiling.	
Advantages:	Can be calibrated easily and gauged to detect various forms of intrusion.	
Disadvantages:	Relatively expensive.	
Conditions for Unreliable Detection:	Improper installation or calibration. Caution should be exercised before using vibration sensors to protect walls of lesser structural integrity, such as sheet rock, plywood or thin metal. These walls are prone to vibrations from sources other than intrusion attempts.	
Major Causes for False Alarms:	Machinery that causes vibrations can generate false alarms and should be located away from the wall on which the fiber optic cable is mounted. Also, vibrations caused by exterior aircraft and train traffic can cause the wall/roof/building fabric to vibrate, thereby causing the vibration sensor to generate an alarm signal.	
Typical Defeat Measures:	Avoiding entry through a protected area or targeting an insensitive location as the point of entry.	
Applicable Standard:	n/a	
False Alarm Reduction Recommendations:	Use only on a solid wall or solid structure that is not subject to vibration. Ask questions to verify that sources of vibration will not occur during hours that the sensor will be active.	

Microwave Sensors

Description:	**Microwave sensors are motion detection devices that flood a designated exterior or interior area with an electronic field**. A movement in the area disturbs the field and sets off an alarm. Signals generated are within pre-set limits that do not affect humans or the operation of pacemakers. Although very little power is used, the system provides enough energy for a detector to project a signal up to 400 feet in an uninterrupted line of sight. Most sensors are tuned to measure the Doppler shift between 20 Hz and 120 Hz. Objects that fail to produce a signal or produce a signal outside the tuned frequencies are ignored. Objects that fall within the range cause the sensor to generate an alarm signal.	
Types:	There are two basic types of microwave sensors: monostatic sensors and bistatic sensors. A bistatic system can cover a larger area and would typically be used if more than one sensor is required. **Monostatic Units:** The transmitter and receiver are contained in a single dual function unit. The antenna is mounted within the sensor and can be shaped to cover a specific area (a long, slender beam or a short oval one). Monostatic microwave sensors transmit signals at two different transmitting frequencies. The frequencies are rapidly turned on and off, first at one frequency and then at the other. The receiver is then shut off for a short period of time after transmission. Because microwaves travel at a constant speed and the receiver is looking for reflected energy, the receiver can be programmed to receive only signals that are able to go out and return within a specific time period. This enables the user to protect a well defined detection zone. The receiver is programmed to ignore signals from stationary objects and only receive signals from disturbances/movement in the designated field of coverage. **Bistatic Units**: The transmitter and receiver for bistatic microwave sensors are separate units. The detection zone is created between the two units. The antenna can be configured to alter the signal field (width, height), creating different detection zones. The receiver is programmed to receive signals from the transmitter and detect a change in the frequencies caused by a movement in the field of coverage. Bistatic microwave transceivers are somewhat limited by poorly defined detection patterns, and nuisance alarms may be a problem if large metal objects are nearby or if windy conditions exist.	
Standard Uses:	Microwave sensors can be used to monitor both exterior areas and interior confined spaces, such as vaults, special storage areas, hallways and service passageways. In the exterior setting they can be used to monitor an area or a definitive perimeter line, as well as to serve as an early warning alert of intruders approaching a door or wall. In situations where a well-defined area of coverage is needed, monostatic microwave sensors should be used.	
Uses To Avoid:	When it might be aimed at windows, light partition walls or metal objects that might vibrate.	

Range:	Monostatic microwave sensors are limited to 400 feet coverage. Bistatic sensors can extend up to 1,500 feet.
Activated By:	Movement toward and away from the sensor.
Associated Work:	Stable mount is critical. Walk testing to ensure coverage does not extend outside intended area of detection.
Advantages:	Very sensitive, very controllable.
Disadvantages:	Can penetrate most walls to cause false alarms.
Conditions for Unreliable Detection:	Since microwave sensors operate in the high frequency spectrum (Xband), close association or proximity to other high frequency signals can adversely affect the detection reliability of these sensors. Areas that contain strong emitters of electric fields (radio transmitters) or magnetic fields (large electric motors or generators) can affect the ability of microwave sensors to function properly, and should be avoided or compensated for by distinct signal separation. Zones that contain fluorescent lights can also pose a problem. The ionization cycle created by fluorescent bulbs can be interpreted by the detector as motion and thus provide false alarms. Self generated signal reflection is a common problem caused by improper placement/mounting. Positioning the sensor externally and parallel to the wall rather than imbedding it in the wall will avoid this problem. Also, large metal objects which can reflect the signal and/or provide "dead pockets" should be kept out of the detection zone, as should equipment whose operation involves external movement or rotating functions.
Major Causes for False Alarms:	Because of the high frequencies at which microwaves travel, the signal/sensor is not affected by moving air, changes in temperature or humidity. However, the high frequency allows the signal to easily pass through standard walls, glass, sheet rock, and wood. This can cause false alarms to be generated by movement adjacent to, but outside the protected area. Conversely, it is essential to test for, note, and compensate for any dead spots (areas of no detection) created by metal objects such as dumpsters, shipping crates, trash cans, and electrical boxes. These dead spots create ideal areas for intrusion attempts. In addition, signals reflected off these type objects/materials can "extend" sensor coverage to areas not intended to be covered, thus creating the potential for false alarms.
Typical Defeat Measures:	An intruder with some degree of periodic access to the denied area may be in a position to conduct "walk tests" or otherwise cause/observe the alarm activation pattern, and determine nominal detection coverage patterns, thereby identifying a possible low detection approach path. In addition, an intruder advancing at a deliberately slow rate of movement, who takes maximum advantage of any obscuring, blocking or signal absorbing characteristics associated with the surveillance environment, can reduce the probability of detection. However, regular calibration of the sensor(s), sanitation of the area, and the use of another type of sensor can substantially increase the probability of detection.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Because the microwave signal can easily pass through standard walls, glass, sheet rock, and wood, extensive walk testing is required to verify that movement in spaces above, below or adjacent to the covered area will not generate an alarm. Because signals can be reflected by metal to extend coverage to unwanted areas, microwaves should not be used in spaces where furniture or accessories may be moved. Avoid unless extensive testing is done to verify that the room conditions will not lead to false alarms.

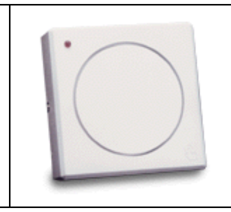
Audio Sensors

Description:	**Audio detectors listen for noises generated by an intruder's entry into a protected area.** The sensor is made up of two devices: Pick-up units mounted on the walls or ceilings of the monitored area, and an Amplifier unit which includes processing circuitry. The Pick-up units are basically microphones that listen for noise. These microphones collect sound for analysis by the processor circuit, which can be calibrated to a noise threshold that is characteristic for an intrusion attempt. If a certain amount of noise is detected from a monitored area within a selected time period, an alarm signal is generated.	
Types:	Wired or wireless.	
Standard Uses:	Audio sensors should be mounted in areas where the predicted intrusion noise is expected to exceed that of the normal environmental noise.	
Uses To Avoid:	Any surface that excessively vibrates. If background noise does exist, and if calibration is not accomplished to compensate for it, the microphone may be unable to detect/differentiate an intrusion noise. If excessive background noise is present, the audio sensor should not be considered.	
Range:	Depends on device and type of glass.	
Activated By:	Sound and/or vibration.	
Associated Work:	Wiring, sensitivity adjustment, testing.	
Advantages:	Reliable. Can monitor several panes of glass. Unaffected by changes in the thermal environment and fluorescent lights.	
Disadvantages:	Only detects breaking glass.	
Conditions for Unreliable Detection:	Ineffective sensitivity settings caused by extraneous background noise, such as clocks, office equipment, boilers and heating or air conditioning units.	
Major Causes for False Alarms:	Excessive background noise, such as airplanes, trains or loud weather (thunderstorms) may cause significant noise levels thereby generating an alarm.	
Typical Defeat Measures:	An intruder who makes a slow, deliberate entry, and takes measures to muffle the normal sounds of movement and intentionally allows sufficient lag time to occur between any noise generated by his movement may avoid detection.	
Applicable Standard:	n/a	
False Alarm Reduction Recommendations:	Areas with excessive background noise, such as airplanes, trains or loud weather (thunderstorms) should be avoided.	

Passive Ultrasonic or Infrasonic

Description:	**The passive Ultrasonic or Infrasonic sensor is a motion detection device that "listens" for ultrasonic sound energy in an area, and reacts to high frequencies associated with intrusion attempts**. The passive ultrasonic sensor "listens" for frequencies that have a range between 20 - 30 KHz. Frequencies in this range are associated with metal striking metal, hissing of an acetylene torch, and shattering of concrete or brick. The sound generated is transmitted through the surrounding air and travels in a wave type motion. When the sound wave reaches the detection sensor, it determines if the frequency is characteristic of an intrusion. If the criteria are met, an alarm signal is generated. 
Types:	Also known as Infrasonic.
Standard Uses:	Not widely used for security. More common for controlling lights or HVAC systems.
Uses To Avoid:	Areas with air turbulence.
Range:	Varies.
Activated By:	Sounds, changes in air pressure.
Associated Work:	Extensive testing.
Advantages:	Unaffected by heat, thus thermal changes in the environment does not hinder its detection ability. It is also easy to contain its energy within a selected area, since ultrasonic energy does not normally pass through walls, roofs or partitions.
Disadvantages:	Does not pass through furniture or other obstructions either (boxes, crates), thus creating “dead zones" of non-surveillance.
Conditions for Unreliable Detection:	Extreme changes in temperature or humidity from those prevalent during the initial installation and calibration may cause a change in detection reliability. As with most sensors, infrasonic sensors should be recalibrated periodically, at least on a seasonal basis.
Major Causes for False Alarms:	Some of the most common stimuli that cause infrasonic sensors to alarm are air movement from heating and air conditioning systems, drafts from doors and windows, hissing from pipes, and the ringing of a telephone. All these stimuli can create noise near or in the ultrasonic range, thereby triggering an alarm.
Typical Defeat Measures:	Passive ultrasonic sensors have a limited frequency spectrum, and intrusion sounds other than those that fall into the unit's spectrum (such as drilling), will not generate an alarm signal.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Avoid unless extensive testing is done to verify that the room conditions will not lead to false alarms.

Active Ultrasonic

Description:	**The Active Ultrasonic sensor is a motion detecting device that emits ultrasonic sound energy into a monitored area and reacts to a change in the reflected energy pattern.** Ultrasonic sound is transmitted from the device in the form of energy. The sound uses air as its medium and travels in a wave type motion. The wave is reflected back from the surroundings in the room/hallway and the device "hears" a pitch characteristic of the protected environment. When an intruder enters the room, the wave pattern is disturbed and reflected back more quickly, thus increasing the pitch and signaling an alarm. 
Types:	Wall and ceiling mounted. Transceivers or separate transmitters and receivers.
Standard Uses:	Typically, ultrasonic sensors are mounted on the wall or ceiling.
Uses To Avoid:	In areas with moving or swinging objects. Areas where automated HVAC equipment will change air flow.
Range:	Ceiling Mounted- 16 to 32 feet. Wall mount 33 to 50 ft. Longer range with separate units.
Activated By:	Doppler shift. Movement toward or away from the device.
Associated Work:	Walk testing. Stable mounting critical.
Advantages:	Ultrasonic sensors are not affected by heat, thus changes in the thermal environment do not hinder its detection ability. Ultrasonic energy is easily contained within a selected area avoiding the problem of the energy passing through walls and detecting activity outside the protected zone. Less prone to false alarms than microwave.
Disadvantages:	Alignment and testing required. Large sensor size.
Conditions for Unreliable Detection:	Ultrasonic energy will not pass through most substantive objects and material, (e.g. storage, shelving), thus creating dead zones within the coverage area where the sensor is ineffective. The sensor must be positioned so dead zones are minimal. Also, extreme changes in temperature or humidity from the initial calibration may cause a hindrance in detection reliability.
Major Causes for False Alarms:	Air movement from heating, air conditioning systems, drafts from doors and windows, hissing from pipes, and telephone rings. All of these stimuli can create noise near or in the ultrasonic range, thus triggering an alarm. Anything that causes movement, such as animals, has the potential to cause an alarm.
Typical Defeat Measures:	Slow horizontal movement by an intruder across the area of coverage is often difficult for ultrasonic sensors to detect. Proper calibration is needed to ensure that slow moving intruders will be detected. In addition, a knowledgeable and properly equipped intruder can use special "test lights” to detect coverage patterns and circumvent these areas.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Avoid unless extensive testing is done to verify that the room conditions will not lead to false alarms.

Passive Infrared

Description:	**Passive infrared sensors do not transmit a signal, they detect changes in radiated thermal energy.** PIRs "see/detect" infrared "hot" images by sensing the contrast between the "hot" image and the "cooler" background. The sensor head is typically divided into several sectors/zones, each defined with specific boundaries. Detection occurs when an emitting heat (thermal energy) source crosses a sector boundary. The PIR wavelength is subdivided into two major range detection categories: one covers Near Infrared Energy (e.g. thermal energy emitted by TV remote control devices), and the other covers the Far Infrared Energy (e.g. thermal energy emitted by people). It is this latter category which is employed in security applications. Infrared energy is measured in microns, with the human body producing energy in the region of 7-14 microns. Most PIR sensors are focused on this narrow band width. When the radiation change captured by the PIR exceeds a certain pre-set value (commonly a 3 degree change), the thermal sensor produces an electrical signal which is sent to a built-in processor for evaluation and possible alarm. 
Types:	**Reflective Focusing-** the energy waves are reflected off a concave mirror and directed into the sensing element. **Fresnel Lens method-** the lens allows the radiated energy to travel directly to the sensor. **Signal Processing-** examples of signal processing include pet alleys and pet immune detectors. In order to avoid capturing environmental thermal deviations, Rate of Change measurement circuitry or bi-directional pulse counting circuitry is employed. In Rate of Change measurement, the processor evaluates the speed at which the energy in the field of view changes. Movement by an intruder in the field of view produces a very fast rate of change, while gradual temperature fluctuations produce a slow rate of change. In the bi-directional pulse counting technique, signals from separate thermal sensors produce opposite polarity. An unprotected/unshielded human entering a field of view moving at a typical speed (walk or above) will normally emit/produce several signals which allow detection to occur. **Detection patterns**- the interchanging of different lens and reflectors/mirrors permits the field(s) of view and zones of surveillance to be changed and/or segmented. This can vary the range, density and size of the sensor's coverage. Each detection or surveillance zone can be pictured as a "searchlight" beam that gradually widens as the zone extends farther from the sensor with different segments being illuminated while others are "dark". This design characteristic allows the user to focus the "beam" on areas where protection is needed while ignoring other areas, such as known sources of false alarms. Tower/ceiling mounted PIRs theoretically provide a 360 degree detection pattern.
Standard Uses:	Installed on walls or ceilings, with the detection pattern covering the possible areas of intrusion.
Uses To Avoid:	Areas with heating devices that will cause rapid temperature increase. Areas with storage heaters. Applications where the sensor pattern cannot terminate on a flat surface.
Range:	Varies according to lens.
Activated By:	Detection occurs when an emitting heat (thermal energy) source crosses one or more sector boundaries.
Associated Work:	Walk testing.
Advantages:	Stable and reliable in right locations.
Disadvantages:	Less sensitive than ultrasonic or microwave.
Conditions for Unreliable Detection:	Because the PIR looks for thermal radiation projected against a cooler background, detection is based on temperature. As the environment approaches the same temperature as the intruder, the detectors become less sensitive. This is especially true for environments ranging between 80 - 100 degrees. Theoretically, if a person was radiating the same temperature as the environment, he would be invisible to the sensor. Where the detector patterns terminate in mid air.
Major Causes for False Alarms:	Heat radiating from small animals and /or rodents. Time activated space heaters, ovens and hot water pipes if they are in the field of view. PIR sensors that are not designed with the capacity to filter (ignore) visible light can be affected by car headlights or other sources of focused light. Although infrared energy from sunlight is filtered by ordinary window glass, objects in a room can become heated over time and subsequently begin emitting/reflecting infrared energy. If this energy is "turned off/on", (such as by the movement of clouds), it can create a random "on/off" situation, thereby generating false alarms.
Typical Defeat Measures:	Shadowing, cloaking or masking the intruding heat source (person/machine) from the field of view decreases the probability of detection as it reduces the possibility of sufficient radiated/emitted heat being focused on the thermal sensor. In addition, knowing the dead spots of the detection pattern can permit an intruder to bypass active regions. Walking into the sensor rather than across the sensor's field of view can also reduce the detection capability by not allowing the boundaries of the detection beams to be broken.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Avoid areas that will frequently be occupied by people or animals while system is armed. Avoid directing at a window, heat source or reflected heat source. Mount on a stable wall or ceiling to avoid alarms caused by vibration. Incorrect installation of pet immune detectors will still detect animals. Animals jumping on furniture will create problems. Thorough testing of each sensor is required to verify that the environment of the sensed area will not cause a false alarm. Use of a masking kit provided by the manufacturer (other tapes may not stick properly) to mask off a problem area such as a large plant with blowing leaves during heating and cooling could prevent false alarms.

Interior Active Infrared

Description:	**Interior active infrared sensors generate a curtain pattern of modulated infrared energy and react to a change in the modulation of the frequency or an interruption in the received energy.** Both of these occurrences happen when an intruder passes through the protection zone. Interior active infrared sensors are made up of a transmitter and receiver encased within a single housing unit. The transmitter uses a laser to project onto a special retro-reflective tape. Energy is reflected off the tape back to the receiver, which is located in the same housing unit as the transmitter. Upon reaching the receiver, the energy passes through a collecting lens that focuses the energy onto a collecting cell, which converts the infrared energy to an electrical signal. The receiver monitors the electrical signal and generates an alarm when the signal drops below a preset level for a specific period of time. An intruder passing through the field of detection will interrupt the signal and temporarily cause the signal to fall below the threshold value. 
Types:	Surface mount sensor with reflectors.
Standard Uses:	Depending upon which type of tape is used as the reflective medium, coverage patterns can be between 15-25 feet wide by 17-30 feet long. In addition, the laser plane angle can be adjusted from 37 to 180 degrees. This system has a high probability of detecting intruders. Speed or direction of the intruder, and the temperature of the environment, have no effect on detection characteristics.
Uses To Avoid:	Areas where equipment or items are frequently moved and may block the beam.
Range:	Varies.
Activated By:	Interruption of the beam.
Associated Work:	Alignment.
Advantages:	No power required at reflector location.
Disadvantages:	Difficult to keep in alignment.
Conditions for Unreliable Detection:	Dust or other particles collecting on the surface of the reflective tape will hinder the detection capabilities. The reflective tape must have no gaps and be continuous to ensure reliable detection, and the angle from the sensor to the ends or corners of the tape must not exceed 45 degrees.
Major Causes for False Alarms:	Activation of an incandescent light which shines directly into the sensor itself. Incandescent lights greater than 100 Watts (or sunlight) falling directly in line with the tape will be reflected back to the receiver with a magnitude significant for alarm signaling.
Typical Defeat Measures:	Avoidance of the projected laser plane. A knowledgeable intruder can deduce the field of the potential detection pattern from the location of reflective tape, and plan his movements to avoid detection.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid using in areas where merchandise is frequently moved around the sensor, where a stable mounting surface cannot be guaranteed or where grease, dust or dirt may accumulate on the sensor.

Dual-Technology Passive Infrared / Microwave or Ultrasonic

Description:	**Dual-Technology Passive Infrared/Microwave sensors use a combination of both microwave and passive infrared technology in combination with AND logic to provide a lower false alarm rate than either of the sensors independently.** This category of sensors is typically referred to as Dual-Tech. In this type Dual-Technology sensor, a passive sensor (PIR) and an active sensor (Microwave or Ultrasonic) are combined into one unit. Both sensing elements are located in a single casing, and are connected electronically by using the AND Logic function. The areas of coverage for each sensor are similar in shape so the detection zone is uniform. Since the two sensors will not "sense" an intrusion precisely at the same instant, the system is designed to generate an alarm when both sensors produce an output in a pre-selected time interval. 
Types:	Passive Infrared/Microwave and Passive Infrared/Ultrasonic.
Standard Uses:	The sensors can be installed along a perimeter line, a fence or a delineated buffer zone, or as a defense against intruders approaching a door or wall.
Uses To Avoid:	Areas where either technology will be constantly or frequently activated by causes not associated with an intruder.
Range:	Varies according to unit.
Activated By:	Movement.
Associated Work:	Wiring, adjustment and testing.
Advantages:	Reduction of false alarms.
Disadvantages:	Although a dual-technology sensor does reduce the false alarm rate (FAR), it also reduces the probability of detection, since both sensors must have a positive detection before initiating an alarm. The mathematical probability of detection for the dual-tech unit is the product of the probability of detection for both individual units. For example, given a theoretical individual detection of rate 99 percent and 98 percent, the detection percentage for the Dual-Technology (AND logic configuration) drops to 97.02 percent.
Conditions for Unreliable Detection:	Since passive sensors have the greatest probability of detection when the intruder is moving transversely, and active sensors have the greatest probability of detection when the intruder is moving radially, the position of the sensor will dictate a positional trade-off that diminishes the sensor's detecting ability. Any condition that causes unreliable detection for the microwave sensor or the PIR sensor can cause problems for the dual-tech sensor because the AND Gate Logic function needs signals from both sensors to generate an alarm. Likewise, any environmental conditions that affect the performance of either sensor will reduce the effectiveness of the dual-tech. However, dual-technology sensors can be both cost effective (cheaper than purchasing two individual sensors) and help reduce false alarms if employed in a predictable and/or controlled environment.

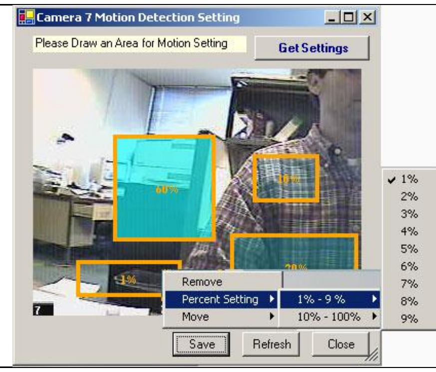
Major Causes for False Alarms:	False alarm rate for the dual technology sensor is very low; however, a combination of environmental conditions (e.g. fluorescent lights, heater exhaust) may cause false detection. Environmental conditions that affect each sensor individually should be considered (compensated for) to keep from reducing effectiveness of the dual technology unit.
Typical Defeat Measures:	Knowledge of the dead spots in the detection pattern will permit an intruder to bypass all active regions. Short of this knowledge, extreme slow motion movement is difficult for microwave sensors to detect, and blocking or masking the infrared sensor's field of view can further decrease its sensitivity and reduce the probability of sufficient "heat" being detected by/focused on the PIR portion of the sensor. In addition, walking into the PIR sensor, rather than across its field of view, can reduce the detection capability of the sensor by not "breaking" the boundaries of the PIR detection beams.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid areas where environment will keep one of the technologies activated a significant amount of the time. The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Avoid areas that will frequently be occupied by people or animals while system is armed. Avoid directing at a window, heat source or reflected heat source. Mount on a stable wall or ceiling to avoid alarms caused by vibration.

Indoor or Outdoor Sensors

Photo Electric Beam

Description:	**Photo electric beam sensors transmit a beam of infrared light to a remote receiver creating an "electronic fence".** These sensors are often used to "cover" openings such as doorways or hallways, acting essentially as a trip wire. Once the beam is broken/ interrupted, an alarm signal is generated. Photoelectric beam sensors consist of two components: a transmitter and a receiver. The transmitter uses a Light Emitting Diode (LED) as a light source and transmits a consistent infrared beam of light to a receiver. The receiver consists of a photoelectric cell that detects when the beam is present. If the photoelectric cell fails to receive at least 90% of the transmitted signal for as brief as 75 milliseconds (time of an intruder crossing the beam), an alarm signal is generated. The beam is modulated at a very high frequency which changes up to 1,000 times per second in a pattern that correlates with the receiver's expectation to guard against a bypass attempt by using a substitute light source. In order to bypass the sensor, the angle of the beam and modulation frequency would have to be matched perfectly. 
Types:	Indoor and Outdoor. Surface and flush mount. Varied ranges.
Standard Uses:	To protect a hallway, doorway or long wall surface.
Uses To Avoid:	Areas with heavy dust, grime or dirt accumulation that could block lenses.
Range:	The transmitter and receiver can be distanced up to 1,000 feet and still provide adequate coverage.
Activated By:	Interruption of beam.
Associated Work:	Secure mounting surface is critical. Alignment of receiver and transmitter.
Advantages:	A photo electric beam sensor is unaffected by changes in thermal radiation, fluorescent lights or Electronic Frequency Interference/Radio Frequency Interference (EFI/RFI). The photo electric sensor also has a high probability of detection and low false alarm rate.
Disadvantages:	Requires line of sight between the receiver and the transmitter.
Conditions for Unreliable Detection:	Anything that disturbs the transmission of light can affect the detection reliability of the sensor. Factors such as fog, smoke, mist or dust and reflective particles cause the light particles to be refracted or scattered. If these conditions create a 10% or more reduction in the signal received, an alarm signal is generated. Extreme variations in background lighting or sunlight may also reduce sensitivity.
Major Causes for False Alarms:	Any objects that may break the beam such as birds, animals, blowing leaves, snow or paper will interrupt the signal, therefore generating an alarm. In addition, improper alignment of the transmitter, receiver or mirrors may generate an alarm. Mirrors can also collect dust, causing refraction/diffusion of the reflected beam. Susceptibility to being knocked out of alignment when surface-mounted on wall brackets. In a warehouse application, fork lifts or other equipment may shift them. In warehouse applications, machinery or other objects may partially obstruct the beam greatly increasing the sensitivity and foreign susceptibility to false alarms.
Typical Defeat Measures:	Stepping over or passing under the signal path will defeat the intent of the sensor. However, mirrors can be used to counter this vulnerability by creating a "Zig-Zag" multiple beam barrier pattern. The path of the beam can be altered using mirrors to create a less predictable detection barrier; however, the use of mirrors reduces the signal strength of the beam and diminishes the effective distance of the beam. A common problem with mirrors is that they are often accidentally knocked out of alignment, generating a need to calibrate and realign the mirrors periodically.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Sensor alignment will need to be checked and lenses will need to be cleaned frequently. Responsible parties should be dispatched before public safety for all outdoor sensors.

Video Motion Detection

Description:	**Video Motion Detection sensors detect changes in the monitored area by comparing the "current" scene with a pre-recorded "stable" scene of the area.** Video Motion Detectors monitor the video signal being transmitted from the camera. When a change in the signal is received, indicating a change in the image composition caused by some sort of movement in the field of surveillance, an alarm signal is generated, and the intrusion scene is displayed at the monitoring station. 
Types:	Once activated, most systems allow the security monitor to manipulate the camera's field of view, (e.g. enlarge, scan, tilt and pan). Some systems also have a "listening", as well as a voice communication capability. Can be used with visible or concealed cameras.
Standard Uses:	Examples of monitoring capabilities include: dead zones between two fences, outside storage lots, interiors of warehouses (particularly at night), approaches to "rear doors", and vehicle/pedestrian entry points, loading docks and at guard posts where the CCTV system can be tied to a Duress Alarm.
Uses To Avoid:	Care must be given to securely mount the cameras, deny easy access to them, and keep the field of view as open and uncluttered as possible. In all applications, vegetation and obstacles to visual observation must be eliminated or reduced to a point where they do not detract from the utility of the system.
Range:	Varies depending on the camera and lens.
Activated By:	Change in signal from camera.
Associated Work:	Correct positioning, lighting conditions, and stability of cameras are all factors to be considered.
Advantages:	CCTV systems provide the added benefit of documenting the events of an intrusion and the characteristics of the intruder. Visible cameras have deterrent value. Concealed cameras have greater security/monitoring value.
Disadvantages:	Requires camera, expense.
Conditions for Unreliable Detection:	Areas that have poor lighting or extended periods of darkness may provide conditions for unreliable detection. Under these conditions either Infrared or Low Level Light camera configurations are recommended. Low light levels, even if the only source is ambient light, can be compensated for by the use of LLLTV cameras, whereas an infrared system is useful for detecting the "heat differential" generated by an intruder.
Major Causes for False Alarms:	(1) natural light sources such as changes in the sun angle (sun rise/sun set) or scene brightness alterations from cloud motion, wind blown objects passing through the scene or camera vibrations, or (2) man-made light sources such as vehicle headlights, traffic lights, changes in parking lot or security lights patterns. Any of the above can generate an alarm signal, as each reflects a change in the image view. Insects flying close to the lens of the camera can also initiate an alarm signal and have been interpreted as larger objects moving in the field of coverage; however, a trained operator can detect this on the monitor.
Typical Defeat Measures:	Moving around the field of view. For this reason it is recommended that some of the cameras be placed as covertly as possible, and networked to one or more other sensors which can also act as a triggering or focusing mechanism.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid in areas with frequent traffic or changes in the monitored area. Best used to alert a person to view a video monitor to verify if additional action is needed. Responsible parties should be dispatched before public safety for all outdoor sensors.

Outdoor Sensors

Exterior Active Infrared

Description:	**Active infrared sensors generate a multiple beam pattern of modulated infrared energy and react to a change in the modulation of the frequency, or an interruption in the received energy.** Both of these occurrences happen when an intruder passes through the area covered by the beams. An active infrared sensor system is made up of two basic units, a transmitter and a receiver. One of the units is located at one end of the protection zone and the other at the opposite end of the zone. The transmitter generates a multiple frequency straight line beam to the remote receiving unit, creating an infrared "fence" between the transmitter and the receiver. Energy reaching the receiver passes through a collecting lens that focuses the energy into a collecting cell, which converts the infrared energy to an electrical signal. The receiving unit monitors the electrical signal and generates an alarm when the signal drops below a preset threshold for a specific period of time. An intruder passing through the field of detection will interrupt the signal and temporarily cause the signal to fall below the threshold value. 
Types:	Exterior and Interior.
Standard Uses:	Typically, exterior active infrared sensors are used in conjunction with a single or double fence barrier which defines the perimeter to be covered.
Uses To Avoid:	Areas with animals or vegetation that cannot be controlled.

Range:	A sensor zone length can extend up to 1,000 feet.
Activated By:	Interruption of beam.
Associated Work:	Precise alignment of the transmitter to the receiver is critical for reliable detection. The detection beam is relatively narrow and requires regular calibration/realignment. In areas where freezing ground or extreme winds are expected, the transmitter and receiver foundations should be installed deep enough to restrict movement or misalignment of the two units. In areas where the units are susceptible to being hit or jarred, protective barriers should be installed around them. Snow and grass around the transmitter and receiver should be removed by hand or blower to prevent damage or misalignment of the units.
Advantages:	Reliable with proper alignment and control of animals.
Disadvantages:	Active infrared sensors are line of sight devices that require the area between the two units to be uniformly level and clear of all obstacles/obstructions that could interfere with the IR signal. Low spots in the terrain will create "holes" in the surveillance pattern while obstacles/obstructions will disrupt the "coverage" pattern. Detector misalignment can be caused by movements in the ground (e.g., earth tremors), objects hitting the unit (e.g., falling rocks, vehicles, falling trees) or even freezing and thawing of the ground.
Conditions for Unreliable Detection:	Weather conditions such as fog, heavy rain or severe sand/dust will attenuate the infrared energy and can affect the reliable detecting range. In areas where conditions like these are routine, another type of device should be considered, or the detection zone should be decreased to compensate for energy reduction.
Major Causes for False Alarms:	Major causes of nuisance alarms are those that involve animal interaction with the protected area. Vegetation also can pose a problem if allowed to grow to a size where its movement (caused by windy conditions) will generate an alarm.
Typical Defeat Measures:	Since active infrared detectors are line of sight devices, the most common method of defeat is bridging or tunneling under the detection beams. For this reason it is recommended that any dips or gullies between the transmitter and receiver units/columns be filled in to make the area uniformly level. Another typical defeat measure is to use the transmitter and receiver columns for support to vault over the detection beams. This can be prevented by overlapping the beam detection zones.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Sensor alignment will need to be checked and lenses will need to be cleaned frequently. Responsible parties should be dispatched before public safety for all outdoor sensors.

External Microwave

Description:	**A microwave beam is generated by a transmitter and sent to a receiver. Blocking the beam generates an alarm.**	
Types:	Wide depth pattern or high pattern.	
Standard Uses:	Perimeter detection by beam fence.	
Uses To Avoid:	Areas with moving objects, trees, etc.	
Range:	Varies.	
Activated By:	Blocking beam.	
Associated Work:	Clearing path of all moving objects.	
Advantages:	Less susceptible to environment than many external sensors, long range.	
Disadvantages:	Very sensitive, requires alignment, expense.	
Conditions for Unreliable Detection:	Moving objects.	
Major Causes for False Alarms:	Moving objects.	
Typical Defeat Measures:	n/a	
Applicable Standard:	n/a	
False Alarm Reduction Recommendations:	Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Sensor alignment will need to be checked frequently. Responsible parties should be dispatched before public safety for all outdoor sensors.	

Fence Vibration

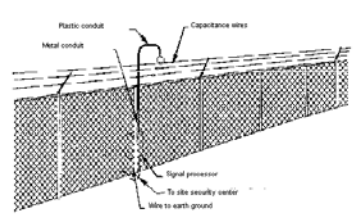
Description:	**Fence vibration sensors mounted on fence fabric detect frequency disturbances associated with sawing, cutting, climbing or lifting of the fence fabric**. All of these type actions generate mechanical vibrations and/or stress in the fence fabric that are different from the vibrations associated with normal or natural occurring environmental activity, and typically have higher frequencies and larger amplitudes. Fence vibration sensors detect these vibrations by using either electro-mechanical or piezo-electric transducers. Signals from the transducers are sent to the signal processor to be analyzed. Upon arriving at the processor, frequencies uncharacteristic of intrusion are filtered out. Frequencies characteristic of intrusion are passed through the screening filter, thus triggering an alarm. 
Types:	**Electro-Mechanical Sensors-** use either mechanical inertia switches or mercury switches to detect fence vibration or stress. The signal processor for the electro-mechanical sensors has a pulse accumulation circuit that recognizes a momentary contact opening of the electro-mechanical switch. **Mechanical-inertia switches-** consist of a vibration sensitive mass that rests on two or three electric contacts thus creating a closed circuit. The mass is movable and reacts to minute changes in the vibrations (frequencies) generated in the fence during a penetration attempt. The vibration disturbs the mass and is moved or separated from one or more of the contact points momentarily opening the circuit and creating an alarm. In some sensors the mass is intentionally constrained or restricted by some internal guides to ensure that only a significant vibration will cause movement, break the circuit and activate the alarm. **Mercury switches-** consist of a glass vial containing a small amount of mercury with a set of normally "open" electrical contacts located in close proximity, but not touching or immersed in the mercury. An impact-disturbance of the fence fabric causes the mercury to be displaced from its normal resting position, making momentary contact with one of the electrical contacts and creating an alarm. **Piezo-electric Sensors-** convert the mechanical impact forces generated during an intrusion attempt into electrical signals. Unlike the open/close signal generated by electro-mechanical sensors, piezo-electric sensors generate an analog signal that varies proportionally in amplitude and frequency to the vibration activity on the fence fabric. These signals are sent to the signal processor for evaluation, where they first pass through a filter that screens out signals uncharacteristic of intrusions. The signal processor then interprets the remaining signals to determine if sufficient activity has occurred to warrant an alarm.
Standard Uses:	Fence vibration sensors perform best when mounted directly to the fence fabric. Each sensor is connected in series along the fence with a common cable to form a single zone of protection.
Uses To Avoid:	On loose fences, in areas with excessive vibration.
Range:	The sensor zone lengths have a recommended range of 300 feet.
Activated By:	Vibration.
Associated Work:	Securing fence and fence fabric.
Advantages:	Vibration sensors are the most economical fence sensor and the easiest to install. The sensors have a high probability of detecting intrusion and work well protecting properly installed and maintained fence lines.
Disadvantages:	Because vibration sensors are prone to activation from all types of vibrations, additional sensing equipment is frequently added to the processor capability to reduce false activations. One type of enhancement is the pulse count accumulator circuit. With this device, sensitivity is determined by a number of "pulses" required to create an alarm. A pulse is a specific amplitude of activity occurring due to fence stress or vibration associated with cutting chain links or climbing the fence fabric. A minimum number of pulses is required during a preset period of time before an alarm is generated.
Conditions for Unreliable Detection:	Proper installation and spacing of sensors is critical to reliable detection. Poor quality fences with loose fabric can create too much background activity (flexing, sagging, swaying), initially generating false alarms and eventually transmitting little reliable intrusion activity. Likewise, adverse weather conditions can cause sensitivity settings above/below what is required for reliable detection to occur. Fence corners pose particular challenges for readily detecting intrusion vibrations, because of the increased bracing of the fence posts and more solid foundations typically used at a corner or turn-point.
Major Causes for False Alarms:	Shrubbery and tree branches as well as animals and severe weather that come in contact with the fence can cause the fence to vibrate triggering the sensors to react. In areas with high wind or numerous animal interactions with the fence line, vibration sensors should not be used. Vibration sensors should only be used in areas or circumstances where natural or man-made environmental vibrations are minimal or non-existent. Vibration sensors are not satisfactory nor are they reliable in areas or situations where high vibrations are likely to be encountered, such as in close proximity to construction sites, railroad tracks/yards or highway and roadway activity.
Typical Defeat Measures:	The most common defeat method is to avoid contact with the fence by bridging it. Overhanging trees and structures can assist the intruder in this regard. Similarly, cars, buses, trucks, equipment or storage containers positioned/parked next to the fence can serve as platforms for jumping/bridging the fence. Although less common, deep tunneling, if accomplished without contacting the fence supports, will allow an intruder to bypass a fence mounted vibration sensor system.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the fence and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Adding information about the prevailing weather conditions to increase or decrease the sensitivity of the processor. A weather sensor station can be mounted on the fence line to feed information to a field processor. The field processor then adjusts vibration alarm sensitivity based on inputs from the weather station to ensure an effective sensitivity range is maintained. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to

	protect the internal fence that would be sensed to avoid false alarms.

Electric Field

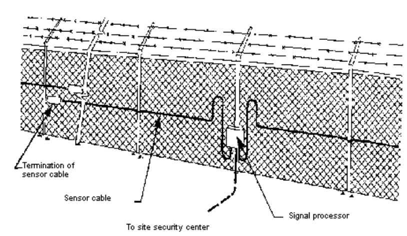
Description:	**Electric field sensors generate an electrostatic field between/around an array of wire conductors and an electrical ground. Sensors in the system detect changes or distortion in the field.** This can be caused by anyone approaching or touching the fence. The E-field sensor consists of an alternating current field generator which excites a field wire (two or more sensing wires), around which an electrostatic field is created and an amplifier signal processor, which detects changes in the signal amplitude of the sensing wires. The alternating current on the field wire creates an electrostatic field in the air between the field wire to ground. When an intruder enters the "field", large amounts of the electric charge flow through the intruder due to the human body disrupting the field. The processor detects this change and generates an alarm. To reduce false alarms, the signal goes through a filter which rejects high frequencies caused by wind vibration and low frequencies caused by objects striking the fence wires. However, the filter allows frequencies associated with intrusion characteristics to continue to the processor. At the processor, three conditions must be met to signal an alarm: the signal amplitude must exceed a preset value that discriminates small animals, the frequency must be in a range that is associated with humans, and the signal must persist for a set period of time. Once these conditions are met, the processor signals an alarm.	
Types:	Single or multiple zone units.	
Standard Uses:	E-field wire configurations are mounted on free-standing posts or chain link fences. All the wires are mounted parallel to each other and to the ground, thereby achieving uniform sensitivity along the fence length. Springs are used at the connectors to reduce vibrations caused by wind.	
Uses To Avoid:	Areas with adverse weather conditions such as rain, snow or lightning storms. Vegetation and animal movement along the fence line can cause the sensors to react.	
Range:	Varies by unit.	
Activated By:	Changes or distortion in the field.	
Associated Work:	Clearing vegetation. Wiring, adjustment and testing.	
Advantages:	An advantage that an E-field sensor has over other fence sensors is the self adjusting circuit, located in the processor, which rejects wind and ambient noise. This circuit not only requires the amplitude of an intrusion attempt to exceed a preset level, but also for a preset period of time. The E-field sensor has an extremely low nuisance alarm rate. In some cases bridging and tunneling can be detected, depending on how close the disturbance activity is to the sensor. Sensor zone length can extend up to 1500 feet. The E-field sensor should be considered if bridging or tunneling are expected intrusion tactics.	
Disadvantages:	Expense.	
Conditions for Unreliable Detection:	Adverse weather conditions such as rain and snow can create problems, as can lightning storms. In addition, vegetation and animal movement along the fence line can cause the sensors to react. Large spacing between wires should be avoided, as it is possible to move between the wires without causing an alarm if sufficient space exists. NOTE: Although Electronic Magnetic Interference (EMI) is not normally a major factor, interference difficulties can arise in situations where multiple systems are deployed in a congested area, unless different frequencies are used by each sensor.	
Major Causes for False Alarms:	Anything causing excessive fence vibration such as weather, birds, and animals will contribute to nuisance alarms. Overgrown vegetation coming in contact with the fence line can also be a problem and should be avoided by keeping grass and shrubbery clear of the fence.	
Typical Defeat Measures:	Although electric field sensors provide some means of detecting underground intrusion activity because of disturbances in the electric field, the sensor field can be bypassed by deep tunneling (6 feet or more) or bridging over the fence.	
Applicable Standard:	n/a	
False Alarm Reduction Recommendations:	Proper maintenance of the fence and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Other fence sensors (vibration, taut wire) can be added to provide a higher level of detection probability and reduce false alarms. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to protect the internal fence that would be sensed to avoid false alarms.	

Capacitance

Description:	**Capacitance sensors detect changes in an electrostatic field created by an array of wires. A signal is generated when an intruder changes the capacitance of the field by approaching or contacting the wires**. Capacitance sensors consisting of three closely spaced 16 gauge wires are arrayed and installed on the top of a fence. A low voltage signal is induced in the wire array creating an electrical field with the fence serving as the electrical ground. A sensor processor continually measures the differential capacitance between the sensing wires and ground. Once a change in the signal is detected at the processor, a filter screens the signal and allows signals which meet the parameters deemed characteristic of an intruder to be forwarded. When this occurs, an alarm signal is generated. Normally physical contact is required to activate the alarm. However, by increasing the sensitivity level, a presence in close proximity can be detected without direct physical contact with the array.	

Types:	n/a
Standard Uses:	Wires are secured to a fence top or wall by using high dielectric brackets. The brackets can be adapted to any barrier but are most commonly used on outriggers atop chain link fences.
Uses To Avoid:	Where vibrations will be caused by weather, vegetation or animals.
Range:	The sensor segment can extend 1,000 ft.
Activated By:	Changes in an electrostatic field.
Associated Work:	Proper landscaping maintenance of the fence line. Wiring, adjustment and testing.
Advantages:	Due to the system's operating principle, weather and EMI/RFI have no affect on the sensor's detection ability.
Disadvantages:	High level of maintenance required to assure the capacitance characteristics of the fence are always adjusted.
Conditions for Unreliable Detection:	Unreliable detection may occur from vibrations caused by weather and animals, interpreted as intrusion attempts. Vegetation coming in contact with the fence will change the capacitance, thereby affecting the detection characteristics. To avoid this, proper landscaping maintenance of the fence line must be done (grass cut, trees removed, shrubs removed).
Major Causes for False Alarms:	Animals, such as birds and squirrels, contacting the fence will generate an alarm. This can be reduced by removing possible food sources (shrubs, grass). In addition, blowing debris, or anything making physical contact that changes the characteristics of the fence, may generate an alarm condition. Inducing tension with springs at the termination points can reduce this possibility.
Typical Defeat Measures:	Bypassing the sensors by tunneling or bridging is a method of defeat. Because of the high mounting location, it is recommended that other sensors be used in conjunction with this configuration to detect lower level intrusion actions (e.g. cutting of the vertical fence fabric).
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the fence and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to protect the internal fence that would be sensed to avoid false alarms.

Strain Sensitive Cable

Description:	Strain sensitive cables are line sensors that use electric energy as a transmission and detection medium. The line sensors maintain uniform sensitivity over the entire length of the protection zone. The cable runs from the signal processor to an end-of-line resistor, which guards against cutting, shorting or removal of the cable from the processor. **When mounted on the fence, the cable is subjected to mechanical vibrations caused by attempts to cut, climb or raise the fence fabric. These stresses induce electrical signals in the cable proportional to the force exerted. The signals are then sent to a processor for filtration of signals characteristic of intrusion.** "Listening" features can be incorporated into the sensor capabilities, enabling the user to "hear" what caused the alarm.	
Types:	**Coaxial Cable:** The strain sensitive "coaxial" cable conducts a permanent electric charge along the center of the cable. The center is covered with a non-conductive material which is encased in braided wire. The cable is then coated with an ultraviolet resistant coating, allowing it to be mounted directly on the fence fabric. An electrical signal is constantly maintained on the coaxial cable while attached to the fence. When intrusion is attempted by cutting, climbing or raising of the fence fabric, stress and vibrations occur. These stresses produce an electrical signal proportional to the force of the stress on the fence itself. The signals are then passed through a filter, allowing only signals characteristic of an intrusion to pass. When a signal received at the processor is significant enough to register detection, an alarm signal is generated. At that time, if incorporated, the user can use the listening feature to "hear" the vibration noise to which the sensor is reacting. The sound is similar to what a person would hear if they could press their ear to the fence post. **Magnetic Polymer:** Strain sensitive "magnetic polymer" cable sensors function as poles of a linear magnet. This is done by pairing two semicircular, magnetic, polymer conductors and separating them by an air gap. Two insulated wires run between the polymers. Parallel to these wires are two uninsulated wires free to move in the air gap between the magnetic field created by the polymer conductors. Vibration and stress on the fence fabric cause the active conductors (uninsulated wire) to move within the air gap. When this movement takes place, slight electric signals are generated and sent to the signal processor. The processor compares the signal and generates an alarm if it's outside the pre-calibrated parameters. Processors are available that "learn" from normal fence fluctuations and revise the data, thus enhancing the performance of the system. The "magnetic polymers" multiple conductors form a symmetrical and balanced pair configuration which makes the cable essentially unsusceptible to both Electro-Magnetic Interference and Radio Frequency Interference. Its low impedance creates higher signal-to-noise ratios, which provide more finite signal processing. The magnetic polymer cable also functions as a transducer microphone, and can have a “listening" operation implemented in the system, allowing the user to audibly interpret the activity taking place at the fence line.	
Standard Uses:	The cable is mounted directly to the fence fabric.	
Uses To Avoid:	Areas subject to bridging over or tunneling or severe weather.	
Range:	Sensor zone lengths can extend up to 1,000 feet.	
Activated By:	Mechanical vibrations caused by attempts to cut, climb or raise the fence fabric.	
Associated Work:	Quality fence and stable installation are necessary for reliable detection. Strain-sensitive cables should be installed using ties halfway between the bottom and the top of the fence. Also, stainless steel wire ties (vs. plastic ties) should be used to prevent silent removal by burning (e.g. Cigarette butane lighter).	
Advantages:	Adjustments can be made to avoid many sources of false alarms.	
Disadvantages:	Strain sensitive coaxial sensors are very sensitive to high Electro-Magnetic Interference (e.g., power substations) and Radio Frequency Interference (RFI).	

Conditions for Unreliable Detection:	Poor fence construction and/or unstable installation and lack of proper maintenance will decrease detection potential.
Major Causes for False Alarms:	Severe weather can present nuisance alarms; however, with proper calibration and installation most normal weather problems can be avoided.
Typical Defeat Measures:	As with other fence-based sensors, bridging over or tunneling under the fence will bypass the detection system. Also, an intruder conscious of the system installation and configuration may be able to climb the fence without detection.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the fence and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Routine animal-caused alarms can be filtered out by employing the listening device to determine legitimate intrusion signals from false ones. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to protect the internal fence that would be sensed to avoid false alarms.

Fiber Optic Fence

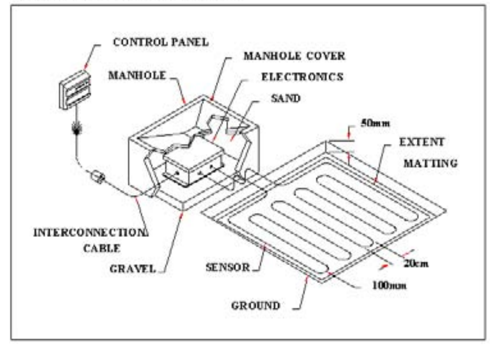
Description:	**Fiber optic sensors use light rather than electricity for transmission and detection.** Fiber optic cable is ideal for incorporation into existing fences, or it can be used as stand alone fencing. Optical fiber is a fine, strong strand of glass or other optical medium. In operation, light is pulsed through the fiber in a manner similar to an electric signal through a wire. Fiber optics, however, offer several distinct advantages over other conductive materials. The power of light passing though a fiber optic is measured in decibels (dB) of light energy, with the fiber optic absorbing approximately 3 dB of light per kilometer, allowing use of the system over great distances. 
Types:	**Fiber Optic Continuity:** The fiber optic continuity sensor is similar to any closed loop device. As long as the sensor cable remains intact, with light passing from the transmitter to the receiver, no alarm is transmitted. If the cable is broken, the signal transmission ceases and an alarm is generated. In one form a composite strand sensor is combined with a fiber optic continuity sensor within a barbed steel tape. An installed system appears similar to a taut wire installation; however, it does not require the mechanical activation of switches, making preventive maintenance and repair of the system more affordable. The fiber optic barbed tape can be used as a free standing fence or it can be applied to an existing fence. It can also be attached to walls and buildings. **Fiber Optic Microbending / Disturbance:** As the name implies, the fiber optic cable must be bent or disturbed in some way, to affect the wave guide of the light being transmitted and thereby signaling a disturbance. Detection is a function of stress on the fence fabric. The fiber optic cable acts as a line sensor when installed on the fence fabric itself. The system contains an electro-optics unit, which transmits light using an LED for the light source. The light travels through the fiber optic and is picked up by the detector, which is very sensitive to slight alterations in the transmission caused by vibration or strain on the fence. When an adequate alteration in the light pattern takes place, an alarm signal is generated.
Standard Uses:	Fiber optic fence sensors should be mounted directly on, or woven into, the fence fabric. A quality and stable installation of the fence is necessary for reliable detection.
Uses To Avoid:	Freedom from rattles, clanks, knocking sounds, and vibration/stress activity maximizes line sensor quality. Areas of high activity can make reliable detection difficult.
Range:	Varies.
Activated By:	Disturbance of light.
Associated Work:	Strengthening fence installation.
Advantages:	Optical fiber is more immune to electrical interference and electrical magnetic interference disruption than other sensors. It is intrinsically safe and uses very stable equipment, making it highly reliable overall.
Disadvantages:	Cost.
Conditions for Unreliable Detection:	Poor fence quality (stability) is the most common condition for unreliable detection. Loose fence fabric and poor stability cause the sensitivity setting for the fence to be calibrated lower than preferred. This makes the system less likely to detect an intruder. When properly installed on a good quality, stable fence or installed in a taut wire-like configuration, the system is very stable.
Major Causes for False Alarms:	Although the system is impervious to transient voltage/lightning strikes, system problems can still be created by Radio Frequency Interference (RFI), Electro-Magnetic Interference (EMI), extreme changes in temperatures and blowing debris. Although most normal weather conditions can be screened out by the alarm processor, extreme weather turbulence that disturbs or damages the optical fiber cable can create nuisance alarms. In addition, animal activity coming in contact with the fence can be interpreted as human activity, falsely signaling an intrusion attack.
Typical Defeat Measures:	Bridging or tunneling will bypass the fence and, therefore, bypass the sensor. Careful or assisted climbing, particularly at the more rigid turn points, may not produce the activity level required for alarm activation.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	To enhance the potential for intrusion detection, in-ground sensors can be installed within the protected fence area providing another level of detection. Video motion detection cameras mounted outside or inside the protected fence area can increase the intrusion detection potential, and allow security personnel to assess the intrusion zone visually. An additional way to enhance the security of a fiber optic fence is to mount a volumetric motion detection device (e.g. microwave, active infrared) along the perimeter of the fence. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to protect the internal fence that would be sensed to avoid false alarms.

Taut Wire

Description:	**Taut wire sensors combine barbed wire fencing with micro-switches to detect changes in tension on the fence fabric, rather than the vibration or stress associated with fence disturbance sensors.** The taut wire sensor is actually a series of microswitches connected to tensioned barbed wire installed on the top of a chain link fence or installed as the fence itself. The switch consists of a movable center rod "suspended" inside a cylindrical conductor. In the normal "open" position, the center rod is in the middle of the cylinder, and does not touch the outer cylinder. Switches are installed approximately 6 inches apart in a vertical line on the inside of a tamper-proof case/enclosure that is mounted on a fence post near the middle of the sensor zone. The enclosure stands the full height of the fence and can be designed to project outward to include outriggers, if desired. Individual strands of barbed wire are tensioned and attached to the switch so that the switch remains in the normal "open" position. Increasing or relaxing the tension of the wire, which would happen if an intruder attempted to climb, spread or cut the wire, causes the inner center rod to come in contact with the outer cylinder, "closing" the contact and initiating the alarm sequence. A unique, critical feature of the switch is a pliable, plastic support for the switch housing. This material exhibits cold-flow properties that allow the switch to always assume a neutral position when acted upon by gradual external forces such as fence settling or freezing/thawing temperatures. This feature prevents the switch from becoming pre-stressed thereby altering the intended sensitivity of the sensor. 
Types:	Taut wire sensors can be mounted in two different configurations: (a) on top of an existing fence in conjunction with barbed wire outriggers to provide protection from climbing, or (b) as the fence fabric itself. **Outriggers:** In situations where the taut wire sensors are mounted on the top of an existing fence using barbed wire outriggers, they are targeted to deter/detect intrusion attempts by climbing. In this configuration, the sensors will have little affect on the cutting of the lower fence fabric, potentially allowing undetected access. Because of this vulnerability, it is recommended that another type of sensor (e.g. vibration), which can be mounted on the fence fabric, be used in conjunction with the taut wire system to detect cutting or raising of the fence fabric in the lower section of the fence. **Fence Fabric:** If mounted as the fence fabric, strands of barbed wire in a single zone are supported at each fence post, except the switch assembly post, by a supporting bar. The supporting bars loosely support the strands of barbed wire, allowing them to move freely to activate the taut wire switches. NOTE: The combination of these two techniques provides an integrated barrier that detects cutting, climbing, and raising the fence fabric. An advantage to this method is its high reliability, low false alarm rate and low nuisance alarm rate.
Standard Uses:	Taut wire sensors are used to protect perimeter fence lines.
Uses To Avoid:	Where tunneling or bridging is probable.
Range:	Varies.
Activated By:	The Taut Wire design is intended to activate an alarm on the first switch contact, as this may be all that is indicative of an intrusion attempt or penetration action.
Associated Work:	Tedious, regular tensioning of the system is required to ensure the system performs as intended. To enhance the system, in-ground sensors can be installed inside the protected fence area, providing protection in the event the taut wire sensors are bypassed by tunneling or bridging.
Advantages:	Taut wire sensors are very reliable, and provide a high probability of detection and an extremely low false alarm rate. Exertion needed on the wire for activation is substantial; therefore, weather is not a factor in consideration for this sensor. Typically, small animals do not pose a threat for false alarms either, because of the magnitude of a 35 pound force needed for activation of the sensor.
Disadvantages:	Regular tensioning (maintenance) of the system is critical to ensure the system performs as intended. They are one of the most expensive fence sensor systems, because of the laborious installation and maintenance time required.
Conditions for Unreliable Detection:	The system is one of the more reliable fence-based detectors, as it is less susceptible to environmental conditions and small animals. However, improper maintenance (tensioning) of the sensors can cause conditions for unreliable detection.
Major Causes for False Alarms:	Medium to large animals that "push" the fence while grazing or nesting can generate an alarm.
Typical Defeat Measures:	Tunneling or bridging the fence itself. Tunneling is most likely to occur at a mid-point between fence posts in relatively soft ground. Bridging can occur anywhere along the fence line, with the most likely locations being those that are not under regular observation or provide the greater degree of concealment during the approach.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the fence and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors. Consider an external fence without sensors to protect the internal fence that would be sensed to avoid false alarms.

In-Ground Fiber Optic

IN-GROUND FIBER OPTIC SENSOR



Description:	**Fiber optic sensors are also used as an in-ground, pressure-sensitive, detection system. In operation, light is pulsed through the fiber optic in a manner similar to an electric signal through a wire.** Light, when introduced into the core of the fiber optic, is retained by a process of total internal reflection until it exits onto a receiving device, however, external pressures on the cable create changes in the signal flow. The fiber optic cable acts as a line sensor installed in the burial medium itself. The system contains an electro optics unit which transmits light using an LED for the light source. The light travels through the fiber optic and is picked up by the detector, which is very sensitive to slight alterations in the transmission caused by vibration or strain in the burial medium caused by walking, running, jumping or crawling. When an adequate alteration in the light pattern takes place, an alarm signal is generated.
Types:	n/a
Standard Uses:	Prevention of tunneling.
Uses To Avoid:	The sensors should not be installed in or under concrete or asphalt. The installation area should have proper drainage to prevent water from collecting over the detection zone.
Range:	Varies.
Activated By:	Disruption of light.
Associated Work:	In-ground fiber optic fence sensors should be installed away from poles or trees. If installed near poles, the detection zone should be at a distance equal to the height of the pole.
Advantages:	Sensitivity.
Disadvantages:	Cost.
Conditions for Unreliable Detection:	Areas with erosion problems, because of extensive rains and/or a lack of vegetation can cause the fiber optic cable to become either exposed or buried deeper in the soil. This will cause the sensitivity settings for the fiber optic cable to be ineffective.
Major Causes for False Alarms:	Tree roots can be a cause for nuisance alarms. This is because windy conditions above ground which can cause movement in the roots and in turn bend the fiber optic and trigger an alarm. Large animals passing over the detection zone can also generate alarms.
Typical Defeat Measures:	Bridging over the sensors will bypass the system.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the area around the cable and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors.

Electromagnetic Cable or Ported Coax Buried Line

Description:	Ported Coax Buried Line Sensors are coaxial cables that have small, closely spaced holes in the outer shield. These openings allow electromagnetic energy to escape and radiate a short distance. Emissions from these cables create an electric field that is disturbed when an intruder enters the field. **Ported coaxial cables are installed in pairs, approximately 5 feet apart.** Processors emit a pulse of RF energy through one of the cables and receive it through the other. The speed at which the pulse travels is constant, creating a standard amplitude signature that is picked up by the signal processor. This signature is stored and continually updated to account for minor/gradual changes in the burial medium and environment**. When an intrusion is attempted, the pulse signature changes radically, and is picked up by the signal processor. If the variation falls outside of allowable parameters, an alarm signal is generated.**
Types:	**Continuous Wave:** With Continuous Wave sensors the RF energy is transmitted simultaneously by both cables and received by the opposite number. The energy emission is constant, thus creating a detection zone above ground with a continuous surface. When an intruder enters the detection zone, the electric field is disturbed, signaling the processor to generate an alarm. **Pulse:** Pulse sensors emit a pulse of RF energy through one cable and receive it through the other. The speed at which the pulse travels is constant, creating a standard amplitude signature that is picked up by the signal processor. This signature is stored and continually updated to account for slow/small changes in the burial medium and environment. When an intrusion is attempted, the pulse signature changes and is picked up by the signal processor. If the variation falls outside of allowable parameters, an alarm signal is generated.
Standard Uses:	Perimeter coverage.
Uses To Avoid:	Routing the cables underneath chain link fences should be avoided.
Range:	The cables are buried approximately 9 inches below the surface of the ground, depending on the soil density, creating an electric field approximately 3-4 feet above the ground that extends 9-12 feet wide. The variation in zone size depends on cable separation and the characteristics of the burial medium. With this sensor cable, zone length can extend up to 500 feet.
Activated By:	Disruption of signal.
Associated Work:	If metallic pipes or cables must be routed through the sensor cable field, they should be buried at least 3 feet below the ported coaxial cable. When installing the cables along or near fence lines, the cables must be installed between 6 and 10 feet from the fence to avoid distortions and to reduce potential false alarms caused by the motion of the fence fabric disrupting the detection field.
Advantages:	Sensitivity.

Disadvantages:	Cost, adjustment and testing time.
Conditions for Unreliable Detection:	Because of the limited height of the detection zone, sites that experience heavy snowfall are prone to unreliable detection. Also, burial mediums that have drain ducts located beneath the buried cables will pose a problem if ducts are not constructed of metal. Wind disturbance of standing water over the cables also causes erroneous signals; therefore, the burial zone should be graded to provide immediate runoff and good drainage. NOTE: Ported Coax sensors are affected by high EMI from sources such as large electrical equipment or electrical sub stations and should not be used in close proximity to these type installations.
Major Causes for False Alarms:	Movement of nearby metallic fence fabric, vehicles and signs, as well as organic objects (e.g., people, medium to large animals, medium to large vegetation), can cause alarms. Individual small animals typically do not have the magnitude to affect the system; however, a congregation of small animals can generate an alarm.
Typical Defeat Measures:	Bypassing the area by bridging over the detection zone is the principle method employed.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Proper maintenance of the area around the buried line and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors.

Balanced Buried Pressure or Fluid Pressure Sensor

Description:	**A Balanced Buried Pressure line sensor is an in-ground system that detects vibrations and seismic energy**. These energy waves are typically caused by personnel, animal or vehicular movement across the surface of the ground in which the sensors are installed. Pressure line sensors consist of pressurized, closed end, pliable tubes or hose segments filled with water or an antifreeze-like solution. Usually two sensors tubes are used per zone. The zone size will vary depending on soil density and composition, and the nature of any surface material. The tubes are very sensitive to changes in pressure and react to pressure exerted on the medium in which they are implanted/buried. A processor monitors/regulates the pressure inside the tubes and generates a signal if the pressure deviates from a determined norm. When an intruder/vehicle approaches the detection zone, the ground starts to compress in direct relation to the extent of the pressure waves exerted by the weight and movement impact. The impact caused by a runner will create a greater pressure than a walker; a heavy person walking upright will create a greater pressure than a smaller person moving on hands and knees. The buried tube sensor nearest the point of pressure reacts to the energy (pressure) carried through the soil (buried medium) and in turn changes the pressure in the farthest tube proportionally. The pressure sensing unit detects the change in pressure in both tubes and generates an electrical signal proportional to the pressure exerted. The signals from both tubes are compared and transmitted to the analyzer. When the pressure between the two tubes exceeds a pre-set value, the analyzer generates an alarm signal. NOTE: A self-compensating valve is used to maintain pressure within the tubes, adjusting to gradual/moderate changes associated with the burial medium such as those caused by moisture content (rain) or temperature changes (frost/drought). However, this valve does not adjust to rapid changes in pressure typical of personnel and vehicle movement, and other man-made or sudden natural movements such as earthquakes or explosions.
Types:	n/a
Standard Uses:	Perimeter coverage.
Uses To Avoid:	Concrete is not a good conductor for the relative "light" pressure waves created by personnel, and in fact it serves as a good "insulator", thereby reducing the probability of human movement being detected. Therefore, it is essential to employ additional surveillance/detection means when dealing with expanses of concrete and possible human movement.
Range:	The detection zone is created by burying the tubes approximately 4 feet apart, with the pressure-sensing unit linked and placed between the sensor tubes. Depending on the nature of the soil, this type of system can create a detection zone with up to a 350 foot radius.
Activated By:	Changes in pressure.
Associated Work:	The depth at which the tubes are placed depends on the composition of the medium in which the tubes are placed. Normally, 10 inches is sufficient for earth and sand. Soil with an asphalt covering requires tubes to be placed at a more shallow depth of 4 - 8 inches. When working with a concrete surface/area, the sensor tubes should be buried just beneath the under surface of the concrete.
Advantages:	Wide coverage.
Disadvantages:	Cost, impact of weather, test and implementation time.
Conditions for Unreliable Detection:	Because of the differential pressure principle employed and the nature of the self-compensating valve, the system has a high degree of immunity to typical environmental noise and weather conditions. However, tree roots closer than 10 feet to the sensor set can pose a problem due to the potential for windy conditions above ground that can transfer pressure waves into the ground via the root system generating an alarm. Also, areas with heavy snowfall (and/or shifting sand) may have trouble with the system properly sensing seismic vibrations, depending on the depth and composition of the snow/sand.
Major Causes for False Alarms:	Improper installation or calibration can cause normal activity to be interpreted as intrusion. Also, proximity to heavy road/rail traffic or seismic activity from pulsating or shock machinery can cause false alarms.
Typical Defeat Measures:	Avoiding the potential zone(s) of detection; cushioning movement vibrations, dispersing/lowering impact energy, and/or bridging/planking over or through the detection zone are all, in varying degrees, viable defeat measures.
Applicable Standard:	n/a

False Alarm Reduction Recommendations:	Proper maintenance of the area around the sensor and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors.

Buried Geophone

Description:	**Buried geophone transducers detect the low frequency seismic energy created in the ground by someone or something crossing through the detection screen above the sensors.** The system consists of two elements, a processor and a series of geophone sensors. The geophone sensors detect seismic energy vibrations created by running, crawling or walking on the ground above its location. The seismic energy is converted by the sensors to electrical signals which are sent to the processor for evaluation. Upon reaching the processor, the signal is sent through an electronic filter. The filter screens out (ignores) all signals that are not characteristic of an intrusion attempt. When the characteristics of the signal satisfy the processor's alarm criteria, an intrusion alarm is generated. 
Types:	An audio "listen-in" feature can be incorporated into the sensor field to aid in differentiating between nuisance alarms and valid intrusion attempts. The listen-in feature allows the operator at a monitoring station to listen to the audible seismic signals from the geophones. A trained operator can usually differentiate between normal stimuli and stimuli associated with intrusion attempts.
Standard Uses:	Geophone sensors are typically fielded with 20 to 50 geophones per line.
Uses To Avoid:	Areas where time to monitor and filter signals is not available.
Range:	Geophone sensor zone lengths can extend up to 300 feet.
Activated By:	Disruption of seismic energy.
Associated Work:	The geophones should be buried, depending on manufacture's directions 6 - 12 feet apart, with a recommended burial depth between 6 to 14 inches in soft to compact soil and 6 inches in asphalt. It is recommended that burial field soil be stable and relatively compact, and the geophones should be installed between layers of sand, as compact sand is very conductive of seismic vibrations.
Advantages:	Wide coverage.
Disadvantages:	Cost, time to adjust.
Conditions for Unreliable Detection:	The main cause for unreliable detection is the burial medium in which the sensors are located. Loose or inconsistent soil causes the seismic energy waves to have little affect on the geophones.
Major Causes for False Alarms:	Geophones can detect very low levels of seismic activity, and because of this sensitivity, trees, fences, light poles, and telephone poles can pose major nuisance problems. All of these items are anchored in the ground and transfer seismic energy to the ground when subjected to high wind. Also, large animals passing over/through the detection zone can generate an alarm signal.
Typical Defeat Measures:	Bridging over the sensors will bypass the system.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Geophones should be installed at least 30 feet from trees, 10 feet from fences, and at a distance equal to the height of any nearby poles. Proper maintenance of the area around the sensor and clearing of vegetation and trees is critical. Avoid areas with vegetation, large animals or frequent vibration from wind, trains or trucks. Responsible parties should be dispatched before public safety for all outdoor sensors.

Radar

Description:	**Radar is an active sensor that uses ultrahigh frequency radio waves to detect intrusion of a monitored area**. Radar sensors transmit a signal from an energy source in the ultrahigh frequency range of 100 MHz to 1 GHz. The Radar signal "bounces" off objects in the detection zone, and the reflected signal is then analyzed by a processor to determine the relative size, azimuth and distance of the object. The information is then converted to symbology and displayed on a local monitor screen. 
Types:	**Monostatic Units**: In monostatic devices the transmitter and receiver are contained within one unit, referred to as a transceiver. Typically, detection for intrusion is achieved by the radar transceiver rotating in a pre-set "sweep" pattern. During rotation the transceiver transmits high frequency energy pulses, forming/scanning a detection zone. A signal processor, located within the transceiver, is programmed to recognize reflected energy from the normal environmental surroundings, thus not signaling an alarm. However, when a moving or foreign / new object is detected within the zone, a Doppler shift in the reflected energy is created. When the magnitude of the reflected energy surpasses the processor's criteria, an alarm signal is generated. **Bistatic Units:** The transmitter and receiver(s) for bistatic models are separate units. The detection zone is created between the units. The transmitter is typically transmitting in a designated "sweep" pattern, with receivers at several locations designed to maximize the potential for detection. The transmitter generates a field of high frequency energy, which "bounces/reflects" off "foreign" objects and is detected by one or more receivers. When the resulting signals satisfy the detection criteria, an alarm signal is generated.
Standard Uses:	Radar sensors are used primarily to monitor exterior areas, although in some situations Radar sensors can be used to monitor large interior open areas. In both situations, the ground should be reasonably level and the perimeter boundaries straight. If portions of the perimeter are hilly or have crooked boundaries, the radar unit may be elevated to provide a better line of sight/view, or radar sensors can be used to monitor the straight and level sections of the perimeter, while other types of detectors (e.g. in-ground sensors, video motion detection) can be used to monitor the remaining sections.

Uses To Avoid:	Areas with foreign objects in path.
Range:	Varies.
Activated By:	Disruption of energy pattern.
Associated Work:	Clearing area.
Advantages:	Wide coverage.
Disadvantages:	Cost, adjustment time.
Conditions for Unreliable Detection:	"Dead zones" created by large objects, buildings or hill masses/depressions can provide safe havens for intruders, allowing them to avoid the radar field. In addition, extreme weather conditions, such as rain/snow storms can decrease detection potential.
Major Causes for False Alarms:	Nuisance alarms can be generated by detection of foreign objects outside the protected area or by the random reflection of radar energy.
Typical Defeat Measures:	Uneven terrain may create enough "hidden pockets", allowing the intruder to be undetected by using a slow/low approach pattern through the protected volume.
Applicable Standard:	n/a
False Alarm Reduction Recommendations:	Avoid without extensive testing of the environment to be monitored. Responsible parties should be dispatched before public safety for all outdoor sensors.

Acoustic Detection (Air Turbulence)

Description:	**Acoustic air turbulence sensors "listen" for basic sound pressure waves generated by helicopter rotor blades**. The approaching helicopter will produce frequencies within a range of 20 - 40 Hz, depending on the model. Once frequencies are detected, the acoustic air turbulence sensor sends the signal to a processor that filters out frequencies not associated with helicopter flight. If the signal passes through the narrow acoustic band filter of 20 - 40 Hz, an alarm signal is generated.	
Types:	n/a	
Standard Uses:	This sensor can be very useful in detecting helicopter-borne intrusion attempts, which would otherwise bypass normal perimeter sensors (fence and in-ground).	
Uses To Avoid:	The sensors should be located away from any vehicular/road traffic and/or railroad right of ways to minimize potential interference from any pressure/wind turbulence generated by high speed truck or train movement.	
Range:	Under test conditions some helicopters, including some of the quietest, have been detected at distances up to 500 feet. However, for increased probability and reliability of detection, detector sensitivity is typically set for a range of 300 feet. Detection zones should overlap to insure all approach/segments of the protected area are covered by at least one sensor. There is no restriction on the distance of sensors from the main control unit, as long as system communication is properly designed. Therefore, the protected area can literally extend for miles.	
Activated By:	Air turbulence.	
Associated Work:	Adjustment and testing.	
Advantages:	Sensitivity.	
Disadvantages:	Cost, adjustment time.	
Conditions for Unreliable Detection:	Sensitivity settings set too low to compensate for vehicular traffic. Also, improper spacing of the sensors, allowing some areas not to be covered by the detection pattern.	
Major Causes for False Alarms:	Wind generating a broad band noise causes the most difficulty for the acoustic air turbulence sensor. Also turbulence generated at a distance and conveyed via pressure wave propagation can be interpreted as broad band rumbling if they impact the pressure sensitive transducer of the sensor. Turbulence created by wind viscosity and the roughness of the terrain can also generate conditions for nuisance alarms.	
Typical Defeat Measures:	The system will not detect airborne assault or other methods, such as glider, parachute, or ultralight.	
Applicable Standard:	n/a	
False Alarm Reduction Recommendations:	Avoid without extensive testing of the environment to be monitored. Responsible parties should be dispatched before public safety for all outdoor sensors.	

Fire Initiating Devices

Manual Pull Stations

Description:	**Manually activated device generally used to activate the fire alarm.**	
Types:	Single or dual action. Conventional, analog or addressable, break-glass or non break-glass. Non coded or coded.	

Standard Uses:	Manual pull stations are located according to specific standards in each of the paths that people normally use to exit a building.
Uses To Avoid:	Where likely to be activated by vandals.
Range:	n/a- See NFPA 72 and Building code for spacing requirements.
Activated By:	People.
Associated Work:	Mounting.
Advantages:	Relatively immune from false alarms from external sources.
Disadvantages:	Subject to nuisance alarms from people pulling the pull station.
Major Causes for False Alarms:	People.
Applicable Standard:	NFPA 70, NFPA 72, NFPA 101.
False Alarm Reduction Recommendations:	Locate in areas that are visible to others to avoid prank alarms. Install guards that generate a preliminary siren in areas prone to prank alarms. Install in classrooms instead of at exit doors in schools.

Fixed Heat Detector

Description:	**Detector that will trigger an alarm when the temperature at the device reaches a preset limit.**	
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered, system powered. Self restoring or single use. Fixed or analog, available in variety of temperature settings.	
Standard Uses:	Valuable additional protection in areas such as kitchens and attics, where smoke detectors are not recommended.	
Uses To Avoid:	They are not recommended for the use in bedrooms or sleeping areas.	
Range:	Typical center distance spacing guideline is 30 to 50 feet. See NFPA 72 and Building code for spacing requirements.	
Activated By:	Heat above a preset limit.	
Associated Work:	Mounting.	
Advantages:	Can be used in areas not compatible with smoke detectors. Relatively false alarm free.	
Disadvantages:	Heat detectors may not provide early enough warning to aid escape from a life-threatening fire.	
Major Causes for False Alarms:	Relatively false alarm free. Wiring problems or remodeling.	
Applicable Standard:	NFPA 70, NFPA 72, NFPA 101.	
False Alarm Reduction Recommendations:	Verify highest possible temperature in area where sensor is mounted to select the detector with the proper temperature rating.	

Rate of Rise Heat Detector

Description:	**Detector that will trigger an alarm if the temperature at the detector increases at a preset rate.**	
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered, system powered. Self restoring or single use. Analog available in variety of temperature settings.	
Standard Uses:	Valuable additional protection in areas such as kitchens and attics, where smoke detectors are not recommended.	
Uses To Avoid:	They are not recommended for the use in bedrooms or sleeping areas.	
Range:	Typical center distance spacing guideline is 30 feet. See NFPA 72 and Building code for spacing requirements.	
Activated By:	Heat increase exceeding preset level.	
Associated Work:	Mounting.	
Advantages:	Can be used in areas not compatible with smoke detectors. Relatively false alarm free.	
Disadvantages:	Heat detectors may not provide early enough warning to aid escape from a life-threatening fire.	
Major Causes for False Alarms:	Relatively false alarm free. Wiring problems or remodeling.	
Applicable Standard:	NFPA 70, NFPA 72, NFPA 101.	
False Alarm Reduction Recommendations:	Verify highest possible temperature in area where sensor is mounted to select the detector with the proper temperature rating. Do not use in areas where rapid rise of temperature may occur normally. Seal all holes in mounting box.	

Combined Rate-Of-Rise/Fixed-Temperature Heat Detectors

Description:	**Detector that will trigger an alarm if the temperature at the detector increases at a preset rate or exceed a preset level.**	
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered, system powered. Self restoring or single use.	

	Analog available in variety of temperature settings.
Standard Uses:	Valuable additional protection in areas such as kitchens and attics, where smoke detectors are not recommended.
Uses To Avoid:	They are not recommended for the use in bedrooms or sleeping areas.
Range:	Typical center distance spacing guideline is 30 feet. See NFPA 72 and Building code for spacing requirements.
Activated By:	Heat increase exceeding preset level **or** heat above preset level.
Associated Work:	Mounting.
Advantages:	Can be used in areas not compatible with smoke detectors. Relatively false alarm free.
Disadvantages:	Heat detectors may not provide early enough warning to aid escape from a life-threatening fire.
Major Causes for False Alarms:	Relatively false alarm free. Wiring problems or remodeling.
Applicable Standard:	NFPA 70, NFPA 72, NFPA 101.
False Alarm Reduction Recommendations:	Verify highest possible temperature in area where sensor is mounted to select the detector with the proper temperature rating. Do not use in areas where rapid rise of temperature may occur normally. Seal all holes in mounting box.

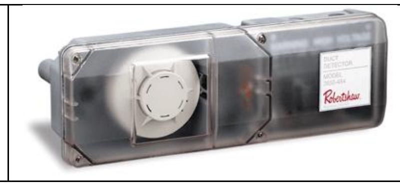
Photoelectric Smoke Detector

Description:	**Detector in which a beam of light is projected across a sensing area onto a photocell. Smoke particles reduce the amount of light reaching the photocell, triggering an alarm.**  
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered or system powered. Combination with heat detector. **Photoelectric Light Scattering Smoke Detector -** Most photoelectric smoke detectors are of the spot type and operate on the light scattering principle. A light-emitting diode (LED) is beamed into an area not normally "seen" by a photosensitive element, generally a photodiode. When smoke particles enter the light path, light strikes the particles and is reflected onto the photosensitive device causing the detector to respond. **Photoelectric Light Obscuration Smoke Detector-** The light obscuration detector employs a light source and a photosensitive receiving device, such as a photodiode. When smoke particles partially block the light beam, the reduction in light reaching the photosensitive device alters its output. The change in output is sensed by the detector's circuitry, and when the threshold is crossed, an alarm is initiated. Obscuration type detectors are usually of the projected beam type where the light source spans the area to be protected.
Standard Uses:	Photoelectric detectors are better at sensing slow smoldering or smoky fires, such as a smoldering mattress.
Uses To Avoid:	Excessively dusty or dirty areas, outdoors, wet or excessively humid areas, over ashtrays or where people will smoke, extreme cold or hot environments, manufacturing areas, near fluorescent light fixtures, areas where particles of combustion are normally present, such as in kitchens or other areas with ovens and burners; in garages, where particles of combustion are present in vehicle exhausts.
Range:	Typical center distance spacing guideline is 30 feet. See NFPA 72 and Building code for spacing requirements.
Activated By:	Smoke particles.
Associated Work:	Mounting.
Advantages:	Sensitivity to slow smoldering or smoky fires.
Disadvantages:	Slightly higher cost compared to Ionization detectors.
Major Causes for False Alarms:	Insects, dirt, drywall dust, light and other forms of contamination into the sensing chamber can also reflect light from the light source onto the photosensitive device. Electrical transients and some kinds of radiated energy can affect the circuitry. Burnt food, steam, people that forget to open their flue, smoke machines, smokers, and gas are other sources of false alarms.
Applicable Standard:	NFPA 70, NFPA 72, NFPA 90A, NFPA 92A, NFPA 101, UL 217, UL 268.
False Alarm Reduction Recommendations:	The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Areas with: high humidity, temperatures higher or lower that the range specified by the detector, frequent smoke, excessive amounts of insects or dust should be avoided.

Ionization Smoke Detector

Description:	**Smoke alarm in which the air in a sensing chamber is ionized, permitting an electric current to flow across the sensing chamber.** Smoke particles reduce the level of ionization, disrupting the electric current flow and producing an alarm. 
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered or system powered.
Standard Uses:	The characteristics of an ionization detector make it more suitable for detection of fast flaming fires that are characterized by combustion particles in the 0.01 to 0.4 micron size range.
Uses To Avoid:	Excessively dusty or dirty areas, outdoors, wet or excessively humid areas, over ashtrays or where people will smoke, extreme cold or hot environments, manufacturing areas, near fluorescent light fixtures, areas where particles of combustion are normally present, such as in kitchens or other areas with ovens and burners; in garages, where particles of combustion are present in vehicle exhausts.
Range:	Typical center distance spacing guideline is 30 feet. See NFPA 72 and Building code for spacing requirements.
Activated By:	Smoke particles.
Associated Work:	Mounting.
Advantages:	Detection of fast flaming fires.
Disadvantages:	Sensitivity to chemicals.
Major Causes for False Alarms:	Dust and dirt can accumulate on the radioactive source and cause it to become more sensitive. Electrical transients and some kinds of radiated energy can affect the circuitry. Use of Some chemicals can activate the detector.
Applicable Standard:	NFPA 70, NFPA 72, NFPA 90A, NFPA 92A, NFPA 101, UL 217, UL 268
False Alarm Reduction Recommendations:	The wiring or mounting holes should be sealed to prevent bugs, air, or dirt from entering. Areas with: chemicals, high humidity, temperatures higher or lower than the range specified by the detector, frequent smoke, excessive amounts of insects or dust should be avoided.

Duct Detectors

Description:	An HVAC system supplies conditioned air to virtually every area of a building. Smoke introduced into this air duct system will be distributed to the entire building. **Smoke detectors designed for use in air duct systems are used to sense the presence of smoke in the duct.** 
Types:	In duct or sampling tube. Ionization or photoelectric. Standard duty or explosion proof.
Standard Uses:	Control of air handler units.
Uses To Avoid:	Duct smoke detection is not a substitute for an area smoke detector, is **not** a substitute for early warning detection and is **not** a replacement for a building's regular fire detection system.
Range:	Consult NFPA 90A.
Activated By:	Smoke.
Associated Work:	Cutting appropriate holes in the duct.
Advantages:	Best way to automatically initiate action to minimize the spread of smoke through the air handling system.
Disadvantages:	Access to detector can be difficult at times, frequent cleaning required.
Conditions for Unreliable Detection:	Dirt contaminated air filters can restrict air flow causing a reduction in the operating effectiveness of the duct smoke detectors.
Major Causes for False Alarms:	Lack of cleaning and maintenance. Sometimes duct detectors are powered outside of the fire alarm system. Simple power failures can cause excessive trouble signals.
Applicable Standard:	UL 268A, NFPA 72, NFPA 90A, NFPA 92A, NFPA 101, ASHRAE Handbook and Product Directory, "Fire and Smoke Control"
False Alarm Reduction Recommendations:	Maintenance and cleaning at the interval specified by the manufacturer is critical to avoiding false alarms.

Flame Detectors

Description:	**Sensor that detects the infrared, ultraviolet, or visible radiation or light output from a flame.** 
Types:	**IR-** The Infrared Flame Detector detects hydrocarbon flames from burning wood, paper, gas, natural gas, etc. These kinds of fires burn with a typical yellow/red color due to the radiated hot Carbon Dioxide (CO_2). The hot CO_2 gasses emit energy in the infrared at 4.4μ resonance frequency. The cold CO_2 gasses in the air filter the sunlight in that same frequency and therefore makes the detector solar blind (at sea level). Blue flames as from burning Hydrogen or other non-Hydrocarbon fires do not emit CO_2 and are almost invisible to the IR detector. Some IR detectors also analyze the flicker frequency of a fire. An uncontrolled flame flickers at 0 to 20 Hz due to the

	cycle of burning fuel and Oxygen and sucking new fuel and Oxygen to the fire. **UV-** UV detectors utilize a high speed, maximum sensitivity tube to sense the radiation emitted by the fire in the Ultraviolet band. Quality detectors will be blind to ultraviolet radiation emitted from the sun. **UV-IR**- the technologies may be combined to detect a wider range of fires.
Standard Uses:	**IR detectors** are used in aircraft hangars, automotive, compressors, offshore platforms, solvent/chemical storage and at tank farms or in areas with electrostatic painting, gas cabinets, hydrogen, metal fabrication, semiconductor production or solvent/chemical storage. **UV detectors** are suited for applications with high background radiation levels, such as turbine packages or off-shore facilities or aircraft hangars that could have UV radiation sources present. **UV-IR detectors** are particularly suited for applications where hydrocarbon fires are likely and UV radiation sources may be present (Aircraft hangars, Loading Racks, Powder coating). The detectors maintain constant fire protection while arc welding takes place.
Uses To Avoid:	Areas with bright sunlight or sunlight reflections, close proximity to artificial lights such as tube fluorescence or (glass protected) halogen lamps, near arcs from electrical discharges (static or electric motors), near radiation caused by arc welding, where oil or grease will accumulate on the detector lens.
Range:	100 feet or more depending on the detector and fire source.
Activated By:	Flame.
Associated Work:	Mounting and testing.
Advantages:	Early detection of specific fire types.
Disadvantages:	Cost.
Major Causes for False Alarms:	Bright sunlight or sunlight reflections, artificial lights such as tube fluorescence or (glass protected) halogen lamps, arcs from electrical discharges (static or electric motors), radiation caused by arc welding.
Applicable Standard:	NFPA 70, NFPA 72, NFPA 90A, NFPA 92A, NFPA 101, UL 217, UL 268.
False Alarm Reduction Recommendations:	Maintenance and calibration at the interval specified by the manufacturer is critical to avoiding false alarms.

Carbon Monoxide Detectors

Description:	**Detects a toxic colorless and odorless gas and common combustion by-product.** Combustion appliances including: furnaces, fireplaces, grills, generators, gas water heaters, etc., require proper installation and service in order to prevent CO exposure. 
Types:	Wired or Wireless. Conventional, analog or addressable. AC powered, battery powered or system powered.
Standard Uses:	Households containing a fuel-burning appliance, fireplace, or in those having an attached garage.
Uses To Avoid:	Do not place the detector right next to or over a fireplace or flame-producing appliance. Keep the detector out of the way of pets and children. CO alarms are not substitutes for smoke alarms.
Range:	Check with Manufacturer.
Activated By:	A toxic colorless and odorless gas and common combustion by-product.
Associated Work:	Mounting.
Advantages:	Provide early warning of accumulating CO.
Disadvantages:	Average life span of many carbon monoxide detectors is about 2 years.
Major Causes for False Alarms:	Barbecue grills or kerosene or gas heater, using fireplace without adequate ventilation, running vehicle or generator inside an attached garage.
Applicable Standard:	NFPA 720.
False Alarm Reduction Recommendations:	Mount the detector between the sleeping and living areas and possible sources of carbon monoxide, yet as far as possible away from frequent sources of lower levels of carbon monoxide. Avoid the following locations: • Within 5 feet (1.5 meters) of any cooking appliance • Near an open window or door, because the fresh air entering the opening may delay CO from reaching the alarm • In damp or very humid areas or next to bathrooms with showers. Install detectors at least 5 feet (1.5 meters) away from bathrooms • Locations where normal ambient temperatures are not met. Normal ambient temperature limits are 40°F to 100°F (4.4°C to 37.8°C) Accommodation spaces should be well ventilated when household cleaning supplies or similar contaminants are stored or used.

For More Information Contact:

For more information on this topic or other matters related to alarm systems, please contact:

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