

Accessories

All detector mounting bases have wiring terminals that are accessible from the "room-side" after mounting the base to the electrical box. The bases mount to North American 1-gang boxes and to 3-1/2" or 4" octagon boxes, 1-1/2" (38 mm) deep. They also mount to European BESA and 1-gang boxes with 60.3 mm fixing centers. The SIGA-SB4, SIGA-RB4, and SIGA-IB4 mount to North American 4" sq. electrical boxes in addition to the above boxes. They include the SIGA-TS Trim Skirt which is used to cover the "mounting ears" on the base.

Removing a detector from its base (except isolator base) does not affect other devices operating on the same circuit.

Standard Base SIGA-SB, SIGA-SB4 - This is the basic mounting base for EST Signature Series detectors. The SIGA-LED Remote LED is supported by the Standard Base.

Relay Base SIGA-RB, SIGA-RB4 - This base includes a relay. Normally open or closed operation is selected during installation. The dry contact is rated for 1 amp @ 30 Vdc (pilot duty). The relay's position is supervised to avoid accidentally jarring it out of position. The relay base does not support the SIGA-LED Remote LED.

The relay is controlled by the detector and operates as follows:

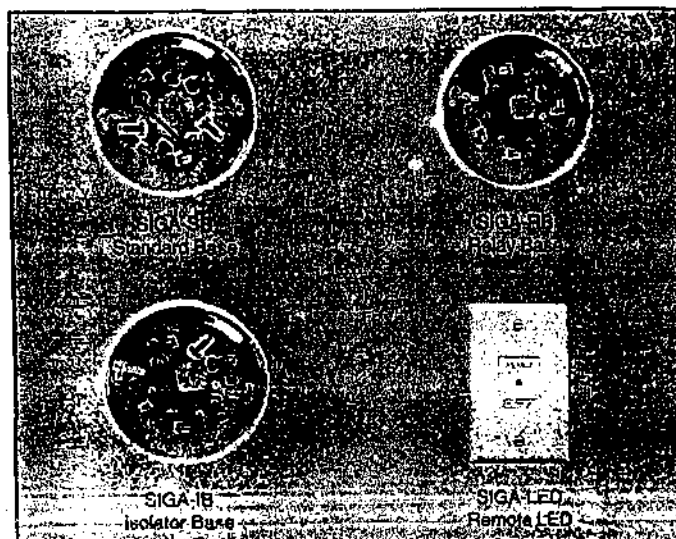
- at system power-up or reset, the relay is de-energized.
- when a detector is installed in the base with the power on, the relay energizes for 4 seconds, then de-energizes.
- when a detector is removed from a base with the power on, the relay is de-energized.
- when the detector enters the alarm state, the relay is energized.

Isolator Base SIGA-IB, SIGA-IB4 - This base includes a built-in line fault isolator. A detector must be installed for it to operate. The integral isolator relay is controlled by the detector or the loop controller. A maximum of 96 isolator bases can be installed on one circuit. The isolator base does not support the SIGA-LED Remote LED.

The isolator operates as follows:

- a short on the line causes all isolators to open within 23 msec.
- at 10 msec intervals, beginning nearest the loop controller, the isolators close to provide the next isolator down the line with power.
- when the isolator next to the short closes, it reopens within 10 msec.

In Class A operation, the process repeats beginning on the other side of the loop controller.



Remote LED SIGA-LED - The remote LED connects to the SIGA-SB or SIGA-SB4 Standard Base only. It features a North American size 1-gang plastic faceplate with a white finish and red alarm LED.

Trim Skirt SIGA-TS - Supplied with 4" bases, it can also be ordered separately to use with the other bases to help hide surface imperfections not covered by the smaller bases.

Warnings & Cautions

This detector will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your fire protection specialist.

This detector will NOT sense fires that start in areas where heat cannot reach the detector. Heat from fires in walls, roofs, or on the opposite side of closed doors may not reach the detector to alarm it.

The heat sensor in this device only provides a source of information to supplement the information provided by photoelectric or ionization smoke detectors which may be located nearby. **The heat detector by itself does NOT provide life safety protection.** Under no circumstances should heat detectors be relied on as the sole means of fire protection.

Ordering Information Table

Catalog Number	Description	Carton Dims. Inches (mm)	Ship Wt. lbs (kg)
SIGA-HPS	Intelligent Fixed Temperature Heat Detector - UL/ULC Listed	5 (127)w x 3.6 (91)h x 5 (127)d	.5 (.23)
SIGA-HRS	Intelligent Fixed Temperature/Rate-of-Rise Heat Detector - UL/ULC Listed		
Accessories			
SIGA-SB	Detector Mounting Base	6 (152)w x 1 (25)h x 6 (152)d	.2 (.09)
SIGA-SB4	4" Detector Mounting Base c/w SIGA-TS Trim Skirt		
SIGA-RB	Detector Mounting Base w/Relay		
SIGA-RB4	4" Detector Mounting Base w/Relay c/w SIGA-TS Trim Skirt		
SIGA-IB	Detector Mounting Base w/Fault Isolator		
SIGA-IB4	4" Detector Mounting Base w/ Fault Isolator c/w SIGA-TS Trim Skirt	3.8 (97)w x 2.8 (71)h x 6 (152)d	.2 (.09)
SIGA-LED	Remote Alarm LED	6 (152)w x 1 (25)h x 6 (152)d	1 (.04)
SIGA-TS	Trim Skirt (supplied with 4" bases)		



EDWARDS SYSTEMS TECHNOLOGY
 SARASOTA, FLA 813-756-3278 Fax: 813-739-4295
 FARMINGTON, CT 203-678-0410 Fax: 203-677-1621
 OWEN SOUND, CANADA 519-376-2430 Fax: 519-376-7258
 INTERNATIONAL: CANADA 905-678-6767 Fax: 905-678-9791

85001-0243
 4 of 4 Iss. 1

It is our intention to keep the product information current and accurate. We can not cover specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information or questions relative to this Specification Sheet, contact EST.
 © 1994 EST Printed in Canada

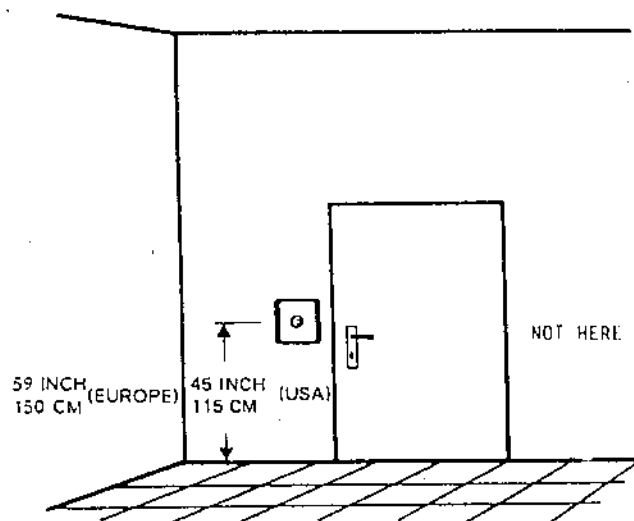


Fig XII-2 Installation of manual alarm station beside regular door

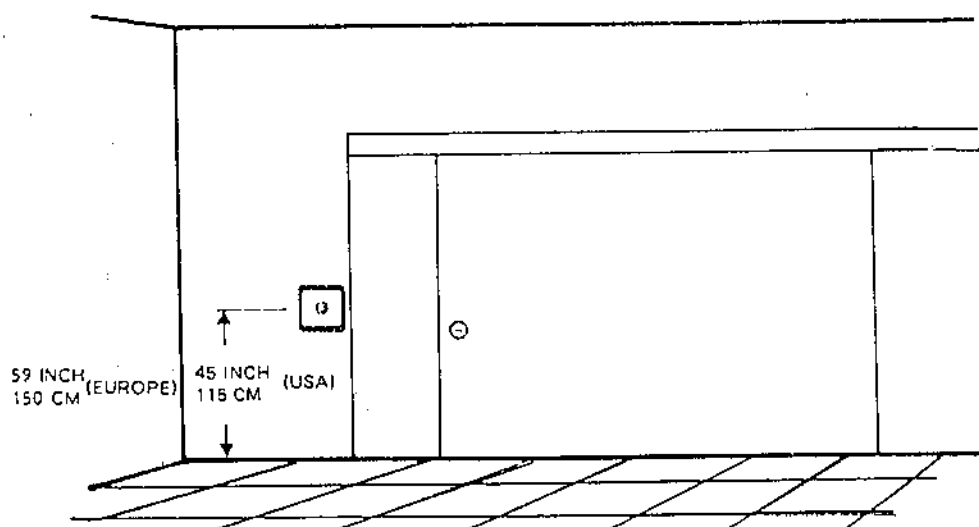


Fig XII-3 Installation of manual alarm station beside sliding doors

4.2 CONNECTIONS

If cable is not fed to the equipment by means of conduit, it must be firmly secured by cable clamps. As a minimum, 10 inches (25cm) of free cable or wire ends should be provided. Leads must be fed to the equipment in such a way as to exclude any dust and moisture. Where necessary, leads must be sealed or fitted with water drips.

4.2.1 Identification of wires

All cable sheathing must be continued through the entry sockets into the equipment. The same color wire must be used throughout a zone circuit.

Example:

DEVICE	CABLE	CONDUCTOR
Call point	'a' wire w/o stripe	white or yellow
	'b' wire with stripe	any color except white or yellow
Response indicator	'a' wire w/o stripe	white or black
	'b' wire with stripe	any color except white or black

Maintaining color code is essential. However, in cases where it is not possible to maintain the color code, the ends of cables must be marked by colored insulation tubing.

4.2.2 Check of Installation wiring

Prior to connecting the installation wiring to the terminals provided on the control panel, check the wiring for extraneous voltages, short, open, and ground circuits. Because of predominant use of solid state components in today's fire alarm systems, a large number of system devices may have to be disconnected in order to use insulation testers. Consider using a volt/ohm-meter as a primary circuit tester.



RISK AREA	SYSTEM CONNECTED DETECTION DEVICE(S)	ALTERNATIVE TYPE(S) AND LIMITATIONS
GUEST ROOMS	smoke detector(s) with buzzer, minimum 85 dB sound power at 10 ft (3m)	smoke/heat detector combinations (smoke alarm remains local) are sometimes used, but not recommended. Heat detectors cannot protect persons (response time)
BATH ROOMS (guest room)	none, protection achieved by guest room unit	none
ESCAPE ROUTES	smoke detector(s)	none, all other detector types too slow
ESCAPE STAIRS PUBLIC STAIRS	smoke detector(s)	none, all other detector types too slow
PUBLIC AREAS	smoke detector(s), beam type may be considered for certain areas, e.g. ball rooms	none, all other detector types too slow for areas where people need protection
DINING AREAS COFFEE SHOPS BARS	smoke detectors are recommended, table side cooking may lead to false alarms — apply verification strategy	heat detectors may be used near cooking counters
KITCHENS	heat detector(s), fixed temperature type in cooker hoods	none
AIR CONDIT. VENTILATION DUCTS	smoke detector mounted in duct sampling unit	none
TECHNICAL PLANT ROOMS BOILER ROOMS	smoke detectors are recommended, welding may provide deceptive phenomena	heat detector/smoke detector combinations
WORKSHOPS	smoke detectors are recommended, welding may provide deceptive phenomena	heat detector/smoke detector combinations
COMPUTER AREAS	smoke detectors — matrixed ionization and photo-electric types	none
UNDERGROUND CAR PARKS	heat detector/ rate-of-rise detector	

Table X-2 Choice of Detectors for various hotel areas



The sensitivity of an ionization-type smoke detector may also be affected by high altitudes as encountered in mountain areas. For hotels located at altitudes of more than 4500ft (1300m) above sea level, the detector manufacturer should be consulted for advice.

4.2 HEAT DETECTORS

Heat detectors come in rate-of-rise and in fixed-temperature models. They are suitable for most areas where the application of smoke detectors is restricted. One should bear in mind, however, that heat detectors respond at a much later time during fire development than smoke detectors.

Heat detectors are recommended for the following areas:

- Areas with extremely high humidity (above 95 %RH)
(also requires water-resistant base and enclosure)
- Areas where smokeless fires are expected
- Very dusty or dirty areas
- Areas where smoke and vapour is generated
- Kitchens
- Heating plants using solid fuel
- Heating plants using heavy oil with room height below 22.5ft (6.8m)
- Heating plants using light oil with room height below 9ft (2.7m)
- Small garages and parking areas for vehicles with combustion engines

Heat detectors are not recommended for rooms with a ceiling height in excess of 22.5ft (6.8m), or where smouldering rather than open-flame fires can be expected. They are also not suitable for areas where early warning is important.

Rate-of-rise heat detectors may also produce false alarms as a result of deceptive influences, for instance in areas above heaters, ovens, fryers, steam pipes and the like.

5. SITING OF DETECTORS

The area to be monitored by each detector and its siting, are crucial for fast fire detection. Considering the multitude and variety of hotels, it would be unrealistic to try to include all instances and buildings in this set of guidelines. Therefore, only the most common applications are covered.

In cases where difficulties in application arise and where doubts as to the correct siting and size of a monitoring area exist, the problems may be solved by conducting fire tests. In these special cases, consultation with a recognized detector manufacturer is also recommended.



AREA OF COVERAGE	ADDITIONAL ALARM INDICATOR	REMARKS
minimum one per room (bed area)	yes, one in front of each door leading to a guest room, unless addressable detectors are used	fire detection system must have built-in alarm verification strategy
		—
typ 900 sqft (80m ²) per detector	not required, built-in detector indicator should face towards lobby	PRIORITY 1 area for monitoring
typ 900 sqft (80m ²) per detector	not required, built-in detector indicator should face towards lobby	PRIORITY 1 area for monitoring
typ 900 sqft (80m ²) per detector	not required, built-in detector indicator should face towards lobby	—
see mfgs. specs. and local codes	not required, built-in detector indicator should face towards lobby	—
see mfgs. specs. and local codes	not required	consider dry extinguishing system or non-toxic foam
typically one probe per exhaust duct	vital for identification since detector usually not visible	only if required by local authorities
see mfgs. specs. and local codes	always required, best location outside entrance	careful siting of detectors is very important
see mfgs. specs. and local codes	recommended if area is not permanently manned	careful siting of detectors is very important
typ 900 sqft (80m ²) per detector	for detectors in floor and ceiling voids	consider automatic dry extinguishing system Halon 1301
see mfgs. specs. and local codes	not required, built-in detector indicator should face towards firemen's entrance	—



5.1 MONITORED AREA

Fire phenomena (smoke, heat, and radiation) spread in many different ways. Detection principles take account of the manner of this spread. The area to be monitored by a particular detector, therefore, is significantly determined by the manner of fire phenomena spread.

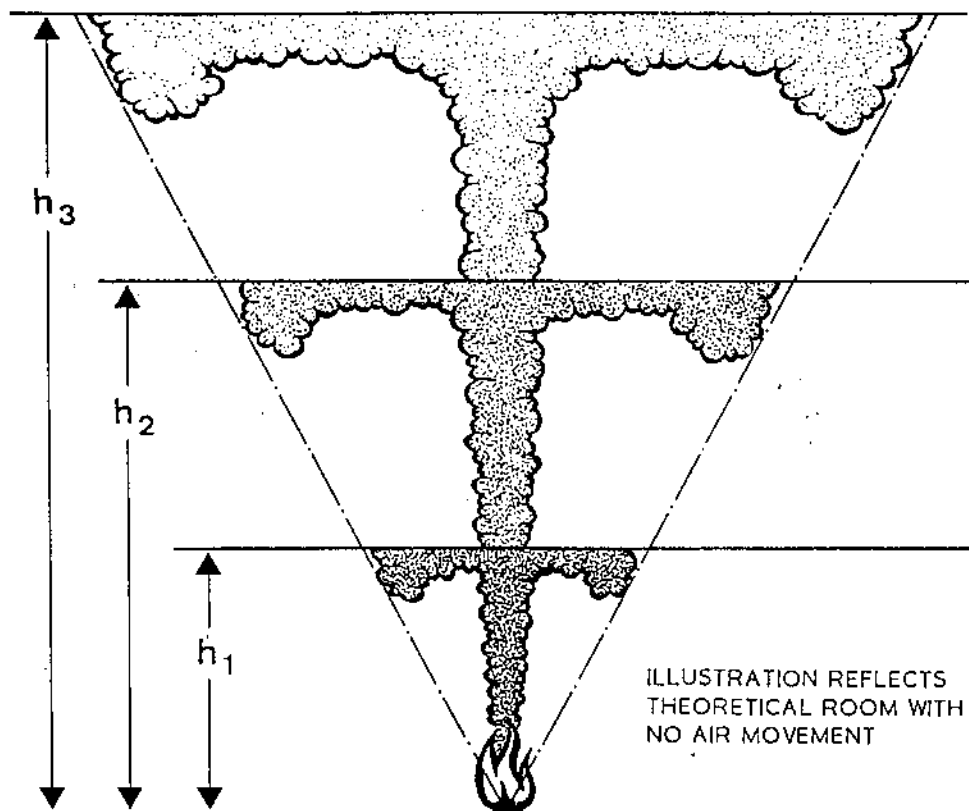


Fig X-6 Typical smoke distribution in rooms with various ceiling heights

Fig X-6 tries to illustrate the manner in which smoke spreads through an unventilated room. The upward lift of the smoke in the middle is caused by the thermal effect of the fire itself. When the smoke reaches the ceiling, it is forced to spread in a horizontal circular manner, cooling down to a certain extent.

3.1 PRE-ACTION SPRINKLER SYSTEMS

Pre-action systems are used in premises exposed to either frost or very high temperatures.

Here, provision is made for the electronic fire-detection system to pre-condition the sprinkler pipework. When an automatic fire detector responds, the dry valve opens automatically, and, as a result of the higher pressure, water is released into the pipework. The sprinkler system is now comparable to a wet system, with each head responding immediately when the trigger temperature is reached.

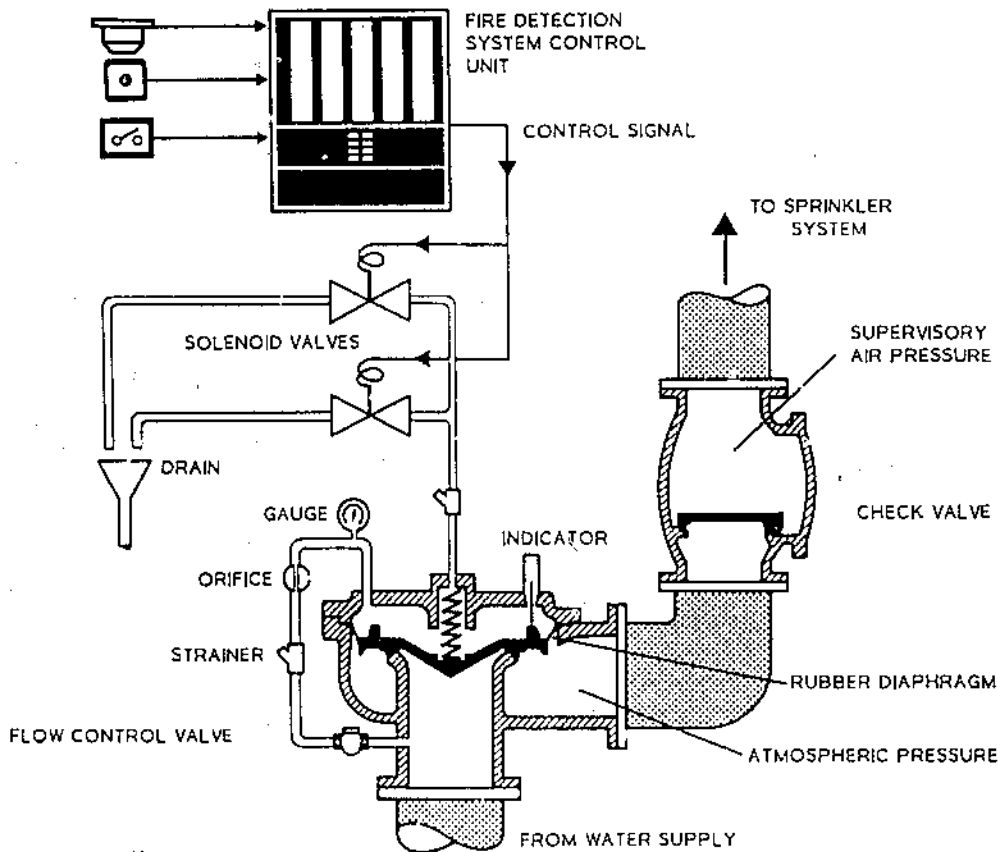


Fig VII-2 Principle of a pre-action sprinkler system

2. SIGNAL INPUTS TO FIRE-DETECTION/ALARM SYSTEMS

Besides the input signals of the automatic detectors and manual stations, the following signals should be fed into the fire-detection control panel:

- Sprinkler flow switches (A)
- Sprinkler tamper switches (S)
- Fire extinguishing and hose reel monitoring (S)
(if indicated)
- Smoke damper actuation (S)

It is important that the alarm signals (A) and the supervisory signals (S) are treated differently, e.g. indicated and transmitted accordingly.

3. SIGNAL OUTPUTS TO FIRE SUPPRESSION SYSTEMS

In special cases the fire-detection system is used to control the actuation of a fire-suppression system, e.g. deluge system, pre-action sprinkler system, dry-extinguishing system.



Introduction

It would be unrealistic to assume that fires can be totally prevented. However, early detection of fires and subsequent quick response by in-house staff or fire departments can result in extinguishing most fires in their incipient stages, thereby preventing damage of any consequence to life and/or property.

This is, therefore, why the Sheraton Corporation highly recommends the installation of early warning and effective communication systems. Sometimes those systems, supplemented by well trained employees or municipal fire fighters, are the only means of preventing fires from spreading. In Sheraton hotel buildings, however, alarm, detection and communication systems are installed as a fire-safety enhancement to permanently installed fire-extinguishing systems.

In order to be able to effectively coordinate the detection, alarm, communication, and extinguishing systems, the Design Manual and the Specifications cover a variety of design concepts. Also local codes or authorities may prefer what components, system sections, or installation procedures are to be emphasized.

To avoid protection redundancy, unnecessary cost and false alarms, etc., the Design Manual and the Specifications should be studied thoroughly by those involved in the design of the hotel's fire alarm, detection and communication systems, and in the coordination with extinguishing systems, so that there is reasonable assurance that specifications reflect those components needed to supplement existing extinguishing systems and meet local requirements.

As documented in section XIV of this book, it is of greatest importance that an installed system is maintained and always kept operational. This not only secures its intended functions but also protects the once made investment.

Prior to the development of the final specifications, the local authorities should always be consulted.

John Veelenturf

Vice President
Director of Safety & Security
The Sheraton Corporation



SYMBOLS OFTEN USED IN ILLUSTRATIONS



System connected fire detector



Single station smoke detector with built-in buzzer



Manual alarm station



Alarm horn



Loudspeaker



Alarm bell



Response indicator



Emergency "EXIT" sign



Fire door



Sprinkler head



Sprinkler flow switch, Monitoring switch



Automatic alarm to fire brigade



Emergency telephone



Firewarden's microphone



Tape recorder / player



Ventilation / Air conditioning



Intelligent Ionization Smoke Detector

Model SIGA-IS

Features

- INTEGRAL MICROPROCESSOR
- NON-VOLATILE MEMORY
- AUTOMATIC DEVICE MAPPING
- ELECTRONIC ADDRESSING
- ENVIRONMENTAL COMPENSATION
- INTELLIGENT DETECTOR
- WIDE 0.61% TO 1.91%/FT. SENSITIVITY RANGE
- PRE-ALARM SENSITIVITY SETTING
- IDENTIFICATION OF DIRTY OR DEFECTIVE DETECTORS
- AUTOMATIC DAY/NIGHT SENSITIVITY ADJUSTMENT
- TWIN RED/GREEN STATUS LEDS
- STANDARD, RELAY and FAULT ISOLATOR MOUNTING BASES
- DESIGNED AND MANUFACTURED TO ISO 9001 STANDARDS

Description

EST's Signature Series Model SIGA-IS Intelligent Ionization Smoke Detector gathers analog information from its smoke sensing element and converts it into digital signals. The detector's on-board microprocessor measures and analyzes these signals. It compares the information to historical readings and time patterns to make an alarm decision. Digital filters remove signal patterns that are not typical of fires. Unwanted alarms are nearly eliminated.

The microprocessor in each detector provides four additional benefits - **Self-diagnostics and History Log, Automatic Device Mapping, Stand-alone Operation and Fast, Stable Communication.**

Self-diagnostics and History Log - Each Signature Series detector constantly runs self-checks to provide important maintenance information. The results of the self-check are automatically updated and permanently stored in the detector's non-volatile memory. This information is accessible for review any time at the control panel, PC, or by using the SIGA-PRO Signature Program/Service Tool.

The information stored in the detector's memory includes:

- detector type, serial number, and address.

Intelligent Ionization Smoke Detector, SIGA-IS



- date of manufacture, hours of operation, and last maintenance date.
- current detector sensitivity values and the extent of environmental compensation.
- original detector sensitivity values upon manufacturing.
- number of recorded alarms and troubles.
- time and date of last alarm.
- analog signal patterns just before the last alarm.
- up to 32 possible trouble codes which may be used to specifically diagnose faults.

In the unlikely event that an unwanted alarm does take place, the history file can be called up to help isolate the problem and prevent it from happening again.

Automatic Device Mapping - The loop controller learns where each device's serial number address is installed relative to other devices on the circuit. This "mapping" feature provides supervision of each device's installed location to prevent a detector from being reinstalled (after cleaning etc.) in a different location from where it was originally. The history log for the detector at its original location remains relevant and intact.

The Signature Series Data Entry Program also uses the mapping feature. With interactive menus and graphic support, the wired circuits between each device can be examined. Layout or "as-built" drawing information showing wire branches (T-taps), device types and their address are stored on disk for printing hard copy. This takes the "mystery" out of the installation. The preparation of "as-built" drawings is fast and efficient.

Device mapping allows the Signature loop controller to discover:

- unexpected additional device addresses.
- missing device addresses.
- changes to the wiring in the circuit.

Stand-alone Operation - A decentralized alarm decision by the detector is guaranteed. On-board intelligence permits the detector to operate in stand-alone mode. If loop controller CPU communications fail for more than 4 seconds, all devices in that circuit go into stand-alone mode. The circuit acts like a conventional alarm receiving circuit. Each detector on the circuit continues to collect and analyze information from its surroundings. The detector alarms if the preset smoke obscuration level is reached. If the detector is mounted to a relay base, the relay operates.

Fast Stable Communication - On-board intelligence means less information needs to be sent between the detector and the loop controller. Other than regular supervisory polling response, the detector only needs to communicate with the loop controller when it has something new to report. This provides very fast control panel response time and allows a lower baud rate (speed) to be used for communication on the circuit. The lower baud rate offers several advantages including:

- less sensitivity to circuit wire characteristics.
- less sensitivity to noise glitches on the cable.
- less emitted noise from the analog wiring.
- twisted or shielded wiring is not required.

Electronic Addressing - The loop controller electronically addresses each detector, saving valuable time during system commissioning. Setting complicated switches or dials is not required. Each detector has its own unique serial number stored in its "on-board memory". The loop controller identifies each device on the circuit and assigns a "soft" address to that device's serial number. If desired, detectors can be addressed using the SIGA-PRO Signature Program/Service Tool.

Environmental Compensation - Detection sensitivity is almost independent of its installed environment and its physical condition. Environmental compensation means the sensing element adapts to long-term changes caused by dirt, humidity, aging etc. It even compensates for small amounts of normal ambient smoke. Approximately six times an hour, the detector adjusts and updates the sensitivity (% obscuration) baseline for its ionization sensing element. Approximately once every hour this information is written to its permanent memory. The detector's 'learned' baseline is not lost, even when the detector is removed for cleaning.

The detector's sensitivity setting selected by the installer floats up or down to remain constant relative to the changing baseline. This is called differential sensing.

Sensitivity Range - The SIGA-IS Ionization Detector has a sensitivity range or window of 0.61% to 1.91% obscuration per foot. The installer selects the detector's ALARM sensitivity level from five available settings within the range.

Pre-Alarm - Pre-alarm warnings may alert local staff to a possible fire condition allowing them to investigate before entering into a full alarm condition which requires building evacuation. The wide sensitivity range permits the use of early warning pre-alarm values. The pre-alarm value is 75% of the alarm setting.

Automatic Day/Night Sensitivity Selection - Signature Series detectors may be programmed for different sensitivities during day and night periods. This allows the detector to be more sensitive during unoccupied periods when lower ambient background conditions are expected.

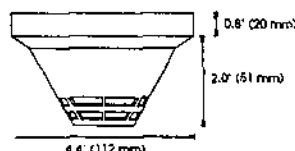
Stability - The SIGA-IS detector's sensitivity remains stable in wind velocities up to 75 ft/min (0.38 m/sec). Ambient temperature has very little effect on the detector. The detector may be installed in rooms with ambient temperatures up to 120°F (49°C).

Status LEDs - Twin LEDs are visible from any direction. A flashing GREEN led shows normal system polling from the loop controller. A flashing RED led means the detector is in alarm state. Both leds on steady shows alarm state - stand-alone mode. Normal green led activity is not distracting to building occupants, but can be quickly spotted by a maintenance technician.

Quality and Reliability - EST detectors are manufactured in North America to strict international ISO 9001 standards. All electronics utilize surface mount technology (SMT) for smaller size and greater immunity to RF noise. A conformal coating is used for humidity and corrosion resistance. All critical contacts are gold plated.

Installation

Signature Series detectors mount to North American 1-gang boxes, 3-1/2" or 4" octagon boxes and to 4" square electrical boxes, 1-1/2" (38 mm) deep. They mount to European BESA and 1-gang boxes with 60.3 mm fixing centers.



Testing & Maintenance

Each detector automatically identifies when it is dirty or defective and causes a "dirty detector" message. The detector's sensitivity measurement can also be transmitted to the loop controller. A sensitivity report can be printed to satisfy NFPA sensitivity measurements which must be conducted at the end of the first year and every two years thereafter.

The user-friendly maintenance program shows the current state of each detector and other pertinent messages. Single detectors may be turned off temporarily, from the control panel. Availability of maintenance features is dependent on the Fire alarm system used. Scheduled maintenance (Regular or Selected) for proper detector operation should be planned to meet the requirements of the Authority Having Jurisdiction (AHJ). Refer to current NFPA 72 and ULC CAN/ULC 536 standards.

Compatibility

The SIGA-IS detectors are compatible only with EST's ZAS-2 Signature Loop Controller.

Application

Although ionization detectors have a wide range of fire sensing capabilities they are best suited for detecting fast, flaming fires. The table below shows six standard test fires used to rate the sensitivity of smoke and heat detectors. The table indicates that no single sensing element is suited for all test fires.

EST recommends that this detector be installed according to latest recognized edition of national and local fire alarm codes.

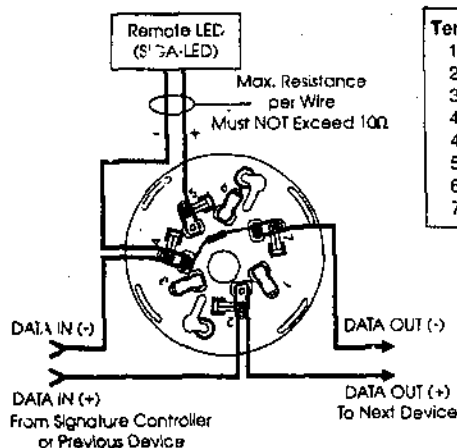
Test Fire	Type of Detector				
	SIGA-IS Ion	SIGA-PS Photo	SIGA-HRS & SIGA-HFS Rate-of-Rise/ Fixed Temp.	SIGA-PHS Photo/Heat 3D	SIGA-IPHS Ion/Photo/Heat 4D
Open Wood	optimum	unsuitable	optimum	very suitable	optimum
Wood Pyrolysis	suitable	optimum	unsuitable	optimum	optimum
Smouldering Cotton	very suitable	optimum	unsuitable	optimum	optimum
Poly Urethane Foam	very suitable	very suitable	suitable	very suitable	optimum
n Heptane	optimum	very suitable	very suitable	optimum	optimum
Liquid Fire without Smoke	unsuitable	unsuitable	optimum	very suitable	very suitable

Typical Wiring

The detector mounting bases will accept #18 AWG (0.75mm²), #16 (1.0mm²), and #14 AWG (1.5mm²) wire sizes.

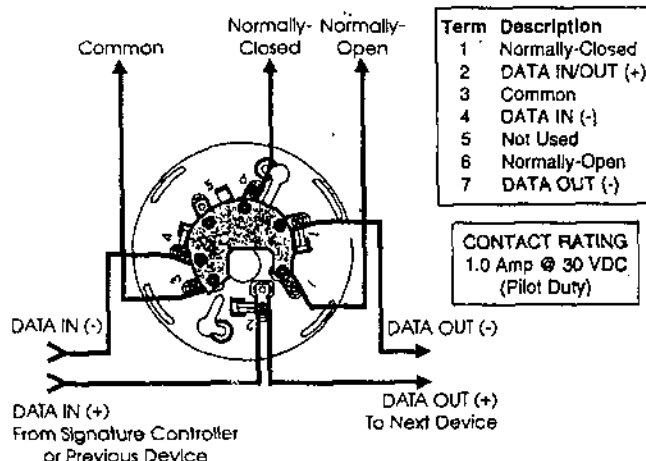
Note: Sizes #16 AWG (1.0mm²) and #18 AWG (0.75mm²) are preferred for ease of installation. See ZAS-2 Loop Controller catalog sheet for detailed wiring requirement specifications.

Standard Detector Base, SIGA-SB, SIGA-SB4



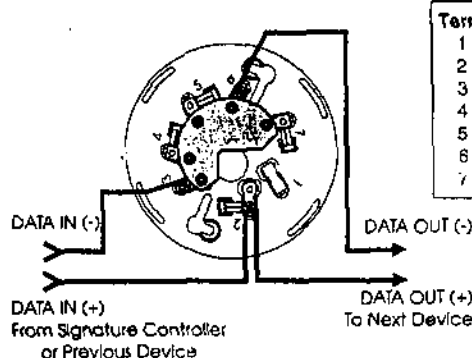
Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	Not Used
4	DATA IN (-)
4	Remote LED (-)
5	Remote LED (+)
6	Not Used
7	DATA OUT (-)

Relay Detector Base, SIGA-RB, SIGA-RB4



Term	Description
1	Normally-Closed
2	DATA IN/OUT (+)
3	Common
4	DATA IN (-)
5	Not Used
6	Normally-Open
7	DATA OUT (-)

Isolator Detector Base, SIGA-IB, SIGA-IB4



Term	Description
1	Not Used
2	DATA IN/OUT (+)
3	DATA IN (-)
4	Not Used
5	Not Used
6	DATA OUT (-)
7	Not Used

Tamper-Resist Lever Arm
- Break off to disable -
(Located on Base)

Access Slot for
Tamper-Resist Mechanism

Warnings & Cautions

This detector will not operate without electrical power. As fires frequently cause power interruption, we suggest you discuss further safeguards with your fire protection specialist.

This detector will NOT sense fires that start in areas where smoke cannot reach the detector. Smoke from fires in walls, roofs, or on the opposite side of closed doors may not reach the detector to alarm it.

EDWARDS SYSTEMS TECHNOLOGY

SARASOTA, FLA. 813-756-3278 Fax: 813-739-4295
FARMINGTON, CT. 203-676-0410 Fax: 203-677-1621
OWEN SOUND, CANADA 519-376-2430 Fax: 519-376-7258
INTERNATIONAL: CANADA 905-678-6767 Fax: 905-678-9791

Accessories

All detector mounting bases have wiring terminals that are accessible from the "room-side" after mounting the base to the electrical box. The bases mount to North American 1-gang boxes and to 3-1/2" or 4" octagon boxes, 1-1/2" (38 mm) deep. They also mount to European BESA and 1-gang boxes with 60.3 mm fixing centers. The SIGA-SB4, SIGA-RB4, and SIGA-IB4 mount to North American 4" square electrical boxes in addition to the above boxes. They include the SIGA-TS Trim Skirt which is used to cover the "mounting ears" on the base.

Removing a detector from its base (except isolator base) does not affect other devices operating on the same circuit.

Standard Base SIGA-SB, SIGA-SB4 - This is the basic mounting base for EST Signature Series detectors. The SIGA-LED Remote LED is supported by the Standard Base.

Relay Base SIGA-RB, SIGA-RB4 - This base includes a relay. Normally open or closed operation is selected during installation. The dry contact is rated for 1 amp @ 30 Vdc (pilot duty). The relay's position is supervised to avoid accidentally jarring it out of position. The relay base does not support the SIGA-LED Remote LED.

The relay is controlled by the detector and operates as follows:

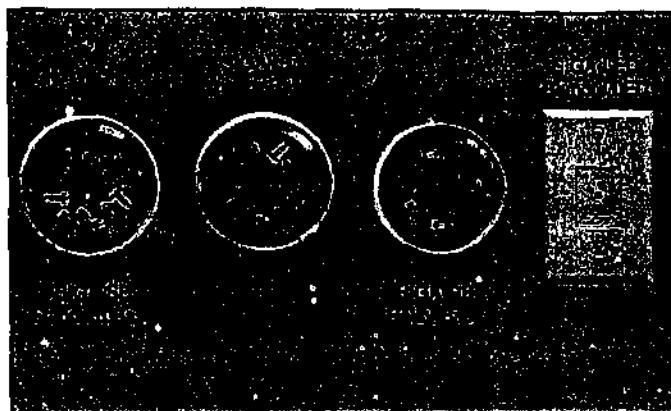
- at system power-up or reset, the relay is de-energized.
- when a detector is installed in the base with the power on, the relay energizes for 4 seconds, then de-energizes.
- when a detector is removed from a base with the power on, the relay is de-energized.
- when the detector enters the alarm state, the relay is energized.

Isolator Base SIGA-IB, SIGA-IB4 - This base includes a built-in line fault isolator. A detector must be installed for it to operate. The integral isolator relay is controlled by the detector or the loop controller. A maximum of 96 isolator bases can be installed on one circuit. The isolator base does not support the SIGA-LED Remote LED.

The isolator operates as follows:

- a short on the line causes all isolators to open within 25 msec.
- at 10 msec intervals, beginning nearest the loop controller, the isolators close to provide the next isolator down the line with power.
- when the isolator next to the short closes, it reopens within 10 msec.

In Class A operation, the process repeats beginning on the other side of the loop controller.



Remote LED SIGA-LED - The remote LED connects to the SIGA-SB or SIGA-SB4 Standard Base only. It features a North American size 1-gang plastic faceplate with a white finish and red alarm LED.

Trim Skirt SIGA-TS - Supplied with 4" bases, it can also be ordered separately to use with other bases to help hide surface imperfections not covered by the smaller bases.

Specifications Table

Catalog Number	SIGA-IS
Sensing Element	Ionization - 1.0 uCi Americium 241
Storage and Operating Environment	Air Velocity Range: 0 to 75 ft/min (0 to 0.38 m/s) with up to 1 hour long gusts of 300 ft/min (1.52 m/s) Temperature: 32°F to 120°F (0°C to 49°C) Humidity: 0 to 93% RH, Non-Condensing Altitude: 5,000 ft (1,524 m) maximum
Sensitivity Range	ULI / ULC - 0.61% to 1.81% obscuration/foot
User Selected Alarm Sensitivity Settings	Most Sensitive: 0.7% ft. More Sensitive: 1.0% ft. Normal: 1.2% ft. Less Sensitive: 1.4% ft. Least Sensitive: 1.8% ft.
Pre-alarm Sensitivity	75% of Alarm Sensitivity Setting
Operating Voltage	15.2 to 19.95 Vdc (19 Vdc nominal)
Operating Current	Quiescent: 45µA @ 19 V Alarm: 45µA @ 19 V Emergency Stand-alone Alarm Mode: 18mA Pulse Current: 100 µA (100 msec) During Communication: 9 mA maximum
Construction & Finish	High Impact Engineering Polymer - White
Compatible Mounting Bases	SIGA-SB, SIGA-SB4 Standard Base, SIGA-RB, SIGA-RB4 Relay Base, SIGA-IB, SIGA-IB4 Isolator Base
LED Operation	On-board Green LED - Flashes when polled On-board Red LED - Flashes when in alarm Both LEDs - Glow steady when in alarm (stand-alone) Compatible Remote Red led SIGA-LED Flashes when in alarm
Compatibility	Use With: SIGNATURE Loop Controller
Address Requirements	Uses 1 Device Address
Agency Listings	UL, ULC

Ordering Information Table

Catalog Number	Description	Carton Dims. inches (mm)	Ship Wt. lbs (kg)
SIGA-IS	Intelligent Ionization Detector - ULC/ULC Listed	5 (127)w x 3.6 (91)h x 5 (127)d	.5 (.23)
Accessories			
SIGA-SB	Detector Mounting Base - Standard	6 (152)w x 1 (25)h x 6 (152)d	.2 (.09)
SIGA-SB4	4" Detector Mounting Base c/w SIGA-TS Trim Skirt		
SIGA-RB	Detector Mounting Base w/Relay		
SIGA-RB4	4" Detector Mounting Base w/Relay c/w SIGA-TS Trim Skirt		
SIGA-IB	Detector Mounting Base w/Fault Isolator		
SIGA-IB4	4" Detector Mounting Base w/Fault Isolator c/w SIGA-TS Trim Skirt	3.8 (97)w x 2.8 (71)h x 6 (152)d	.2 (.09)
SIGA-LED	Remote Alarm LED		
SIGA-TS	Trim Skirt (supplied with 4" bases)	6 (152)w x 1 (25)h x 6 (152)d	.1 (.04)



EDWARDS SYSTEMS TECHNOLOGY

SARASOTA, FLA. 813-756-3278 Fax: 813-739-4295

FARMINGTON, CT. 203-678-0410 Fax: 203-677-1621

OWEN SOUND, CANADA 519-376-2430 Fax: 519-376-7258

INTERNATIONAL: CANADA 905-678-6767 Fax: 905-678-9791

85001-0291

4 of 4 Iss.1

It is our intention to keep the product information current and accurate. We can not cover specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information or questions relative to this Specification Sheet, contact EST.

© 1994 EST

Printed in Canada

Smoke Detector

Cat. No. 6250B Ionization — Type
24 Volts dc

Features

- **UNIPOLAR TYPE DUAL IONIZATION CHAMBER**
Provides exceptional stability. Gives faster response to smoldering fires at lower sensitivity settings.
- **PLUGS INTO SEPARATE MOUNTING BASE**
- **TAMPER RESISTANT**
- **NON POLARIZED**
Simplifies installation of field wiring
- **TWO WIRE CIRCUIT**
Minimizes installation wiring cost. Can be used on same circuit with all existing EST two wire smoke detectors.
- **50 DETECTORS ON TWO-WIRE CIRCUIT**
- **FOUR WIRE CIRCUIT OPTIONAL WITH 6251B-003 BASE.**
- **SENSITIVITY**
Field adjustable where conditions require.
- **LOCAL FUNCTIONAL TEST SWITCH**
Provides calibrated functional test of complete detector eliminating the need to generate smoke.
- **LOW CURRENT DRAIN**
Standby current is 30 μ A, alarm current is 55 mA at nominal voltage.
- **MAY BE USED FOR RELEASING DEVICE SERVICE**
- **VISUAL INDICATION OF ALARM**
Lamp (LED) on unit lights on alarm.
- **REMOTE VISUAL ANNUNCIATOR CAPABILITY**

Description

EST Cat. No. 6250B smoke detector utilizes the most advanced design in detector technology. By sensing the changes in conductivity of ionized air caused by products of combustion, it responds quickly to both fast burning "clean" fires and slow smoldering fires.

The detector initiates an alarm signal and lights an indicator on the unit to give visual on-the-spot indication of alarm.

The 6250B is designed with an inherent stability that inhibits false alarms caused by transient electrical disturbances. It has a unipolar type single source dual ionization chamber that automatically compensates for temperature, humidity and barometric changes. Sensitivity is preset for quick field installation. It can be field adjusted to compensate for special environments.

Reliable, solid-state circuitry minimizes current drain and allows up to 50 detectors to be installed per zone.

The detector can be powered and supervised from the same two-wire power limited low voltage circuit.



Incorporated within the detector is a sensitivity test switch which makes sensitivity checking and trouble shooting easy without sophisticated test equipment or the need to generate smoke. The switch is concealed to prevent unauthorized testing of the detector.

Field wiring connections are made to screw terminals on the mounting base. The detector plugs into base and automatically locks by a simple twist and push motion. This tamper proof feature is standard on all bases and prevents unauthorized removal of the detector from its base. The detector is easy to install, clean and maintain.

Specifications 6250B Series

Sensitivity	Field adjustable. The 6250B meets U.L. 268 at 0.6% to 1.8% obscuration per foot. Factory set at 1.2% nominal.
Detection	Unipolar type single source dual ionization chamber
Operating Voltage Range	16V dc to 29V dc Nominal — 22V dc
Current Consumption	Standby - 30 μ A at nominal voltage. Alarm - 55mA (maximum) at nominal voltage, or as limited by associated control equipment Supervisory - Limited by associated control equipment.
Temperature	32° to 100°F (0° to 38°C)
Humidity Range	0% to 93% Relative Humidity
Ionization Source	0.5 μ C (maximum) Americium 241
Visual Alarm Indicator	Light emitting diode (L.E.D.)
Color	White
Weight	1 lb. (.45 kg)

WARNING : These devices will not operate without electrical power. As fires frequently cause power interruptions, we suggest you discuss further safeguards with your local fire protection specialist.

Smoke detectors are not designed to detect toxic gases which can build up to hazardous levels in some fires.

Application Data

smooth ceilings up to 15 feet (4.6m) high, maximum foot (9.2m) spacing of smoke detectors is recommended. Closer detector spacing normally results in faster response. Avoid corners that create dead spaces and locations near ventilating outlets that create drafts or high air velocities.

On a sloped ceiling, locate the highest detectors within horizontal feet (0.9m) of the peak. Ceilings with beams, joists or soffits, that exceed 8 inches (200mm) depth, require individual planning and usually, closer spacing on a smooth ceiling.

Do not use smoke detectors in locations where combustion products will normally be present in the air. Typical of these locations are kitchens, furnace rooms, loading areas and garages.

Detectors connected to two wire initiating circuits may be considered inoperative when manual stations or heat detectors on the same zone operate. If contacts on relay bases are to be used for essential services, a maximum of only two 6250B or 6270B smoke detectors should be connected on any alarm initiating circuit.

For additional application information, see Technical Bulletin P-847550-0222, or contact an EST representative.

Installation

Detectors using the 6249B-001 or 6251B-001A series bases may be mounted on a standard 3-1/2" or 4" octagon box, 1-1/2" (38mm) deep (minimum). Detectors using the 6251B-003 Relay Base may be mounted on standard 4 inch octagon box, 2-1/8" (54mm) deep (minimum). A 6252 face trim ring is available to adapt all bases to fit a standard 4 inch square box.

Mounting

For flush mounting the box is recessed into the ceiling. The 6255 bracket may be used for mounting the detector bases on drop or suspended ceilings.

For surface mounting the box is mounted directly on the ceiling. The 6253 skirt is a decorative enclosure that will cover any 3-1/2" or 4" octagon box, 1-1/2" (38mm) deep (minimum).

Guide Specifications

AREA SMOKE DETECTORS

Furnish and install, where indicated on the plans, EST Cat. No. 6250 smoke detectors. Detectors shall be of solid state unipolar type, single source, dual chamber construction and shall operate on the ionization principle and be capable of detecting both visible and invisible products of combustion. Each detector shall contain a maximum of 0.5µC Americium 241.

The detectors sensitivity range shall be factory set and shall also be capable of field adjustments to compensate for special environments.

All smoke detectors shall be equipped with self-compensating circuitry to provide maximum stability against effects of aging, dust and film accumulation.

The detector shall be designed to latch into alarm. An alarm condition shall be indicated by a steady red glow from the lamp (LED) mounted on the detector.

Remote smoke alarm indicators shall be connected to detectors where shown on the plans.

A calibrated concealed test switch within the detector shall be capable of simulating a maximum acceptable amount of less than 8% smoke for alarm. The test feature shall provide individual calibrated local testing of the detector and shall not require generation of smoke within the building, or the use of aerosol sprays.

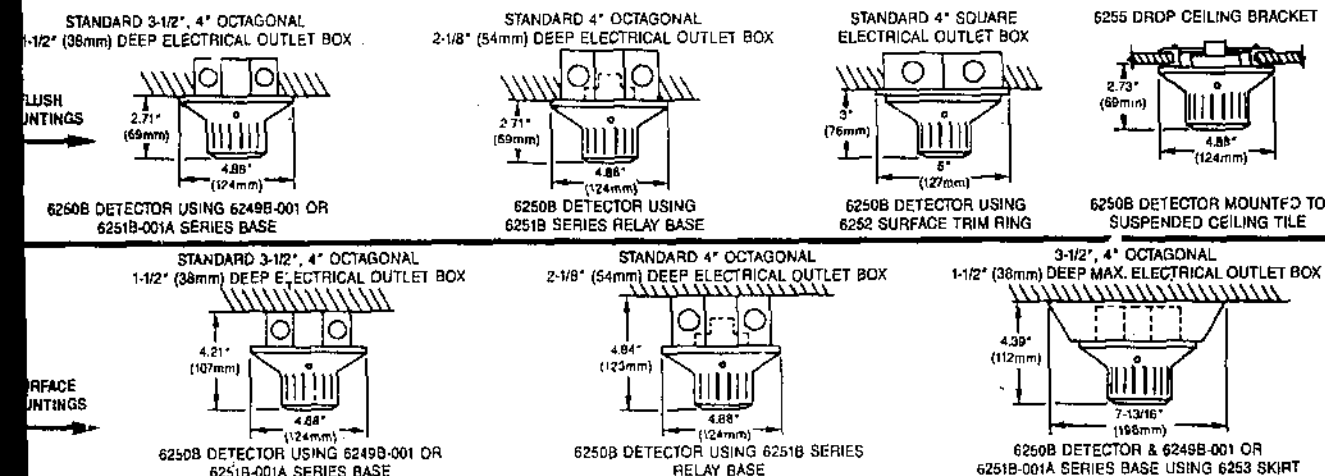
The detector shall be plug-in mounted to a separate base. The base shall be provided with screw terminals for field wiring connections. A built-in shorting device shall be provided on each base to permit checking of the installation wiring before detectors are installed. The detector shall plug into the base by a simple twist and push motion. The detector shall automatically lock onto its base to resist unauthorized removal. The detector shall be removable by using a special removal tool.

Detectors shall be wired to the control panel with a two wire circuit using 2 conductor copper cable. Maximum number of detectors per circuit shall be in accordance with system zoning requirements and/or the fire alarm control panel limitations.

Auxiliary alarm operated relay contacts shall be provided where called for in the plans to provide supplementary alarm functions such as fan shutdown or door closure.

The detector shall be listed by Underwriters' Laboratories (UL) under their current standard for smoke detectors, U.L. 268 with a minimum sensitivity setting of 1.8% obscuration per foot.

Mounting



EDWARDS SYSTEMS TECHNOLOGY

SARASOTA, FLA. 813-756-3278 Fax: 813-751-6384
 FARMINGTON, CT. 203-878-0410 Fax: 203-677-1621
 OWEN SOUND, CANADA 519-376-2430 Fax: 519-376-7258
 INTERNATIONAL: CANADA 416-678-6767 Fax: 416-676-2872

85001-0267

2 of 4 Iss. 1

Accessories

For Cat. No. 290, 6249, 6250, 6269 and 6270 Series Detectors

Every Cat. No. 290, 6250 or 6270 detector installation must include the detector assembly and a 6249B-001 or 6251 series mounting base.



Cat. No. 6249B-001

Cat. No. 6251B-001A



Cat. No. 6251B-003

Cat. No. 6249B-001 Base with Wire Leads

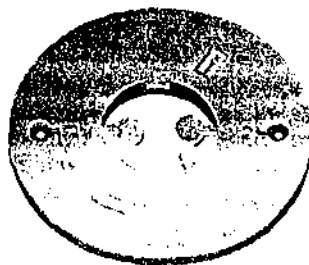
Base for 290, 6250 and 6270 series detectors. Provides plug-in tamper resistant mounting for detectors and includes 8" wire leads for connection to installation wires. Mounts on 3-1/2" or 4" octagon box, 1-1/2" (38mm) deep (minimum).

Cat. No. 6251B-001A Base with Screw Terminals

Base for 290, 6250 and 6270 series detectors. Provides plug-in tamper resistant mounting for detectors and includes screw terminals for connection of installation wires. Mounts on 3-1/2" or 4" octagon box, 1-1/2" (38mm) deep (minimum).

Cat. No. 6251B-003 Relay Base with Screw Terminals

Relay base for 290, 6250 and 6270 series detectors. Provides plug-in tamper resistant mounting for detectors and includes screw terminals for connection of installation wires and auxiliary alarm relay with 2 form C (DPDT) contacts. Relay operates on alarm to actuate connected devices or circuits. Contacts rating using a resistive load is 3.0 A, 120V ac and 5.0 A, 28V dc. Mounts on 4" octagon box, 2-1/8" (54mm) deep (minimum).



Cat. No. 6252 Surface Trim Ring
Surface trim ring — to adapt 6249B-001 and 6251 series bases, and 6249 or 6269 detectors to fit 4" square box.



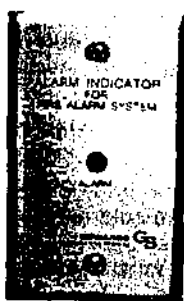
Cat. No. 6253 Skirt

Skirt for 290, 6249, 6250, 6269, 6270 detectors — decorative enclosure for mounting detectors on a surface mounted 1-1/2" (38mm) deep maximum 3-1/2" or 4" octagon box.



Cat. No. 6255 Bracket

For mounting 290, 6250 and 6270 series detectors on 6249B-001 or 6251 series bases on drop or suspended ceilings up to 1/2" (12mm) thick.



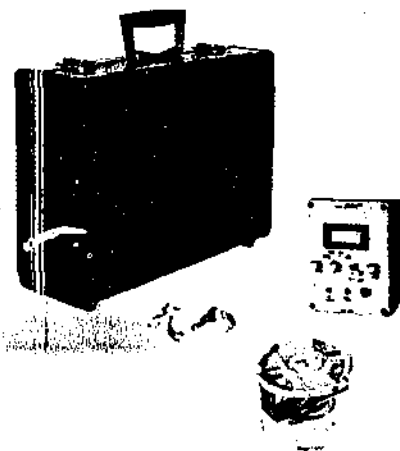
Cat. No. 5956B Smoke Alarm Indicator

Remote smoke alarm indicator — single gang, rectangular stainless steel face plate. LED lamp lights on a 290, 6249, 6250, 6269 or 6270 alarm.



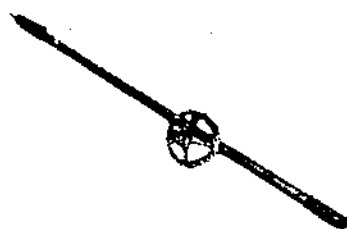
Cat. No. 6259 Removal Tool

For unlatching grille from detector housing or removing detector from base.



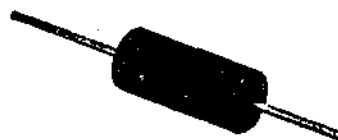
Cat. No. 6277 Detector Test Set

For checking voltage and checking and adjusting sensitivity of installed 6249, 6250, 6269 and 6270 area, and 6264 and 6266 duct detectors. Includes carrying case and connecting cables for each type of detector.



Cat. No. 6258 Installation Test Tool

For testing operation of installed 6249, 6250, 6269 and 6270 detectors and for installing and removing 290, 6250 and 6270 detectors from their base without use of a ladder. Includes tool and adjustable length (5 to 14 ft. — 1.5 - 4.3m) extension rod.



Cat. No. 6278-001A Calibrated Test Probe

For checking sensitivity of installed 6269 and 6270 detectors.

Installation Wiring

For Cat. No. 6250 and 6270 Series Detectors

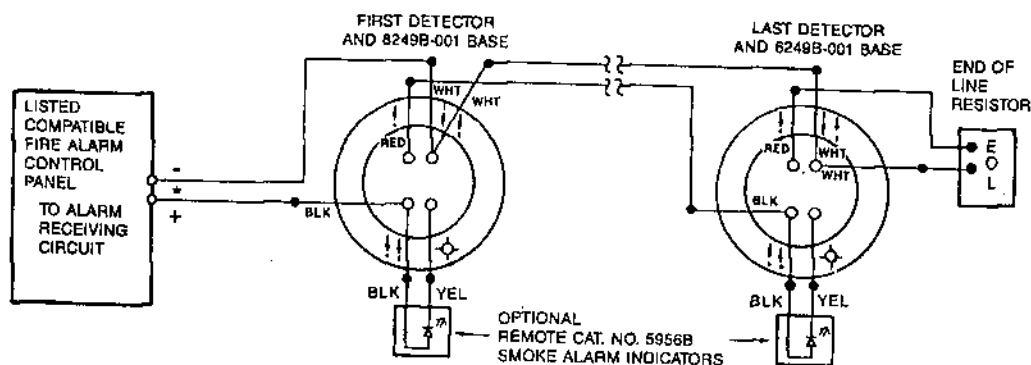


DIAGRAM 1 — Two-Wire Application of 6250 and 6270 Series Detectors Using 6249B-001 Base.

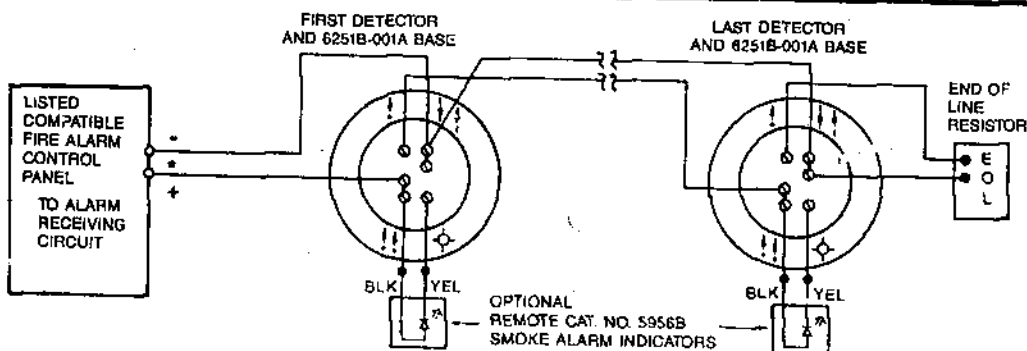


DIAGRAM 2 — Two-Wire Application of 6250 and 6270 Series Detectors Using 6251B-001A Base.

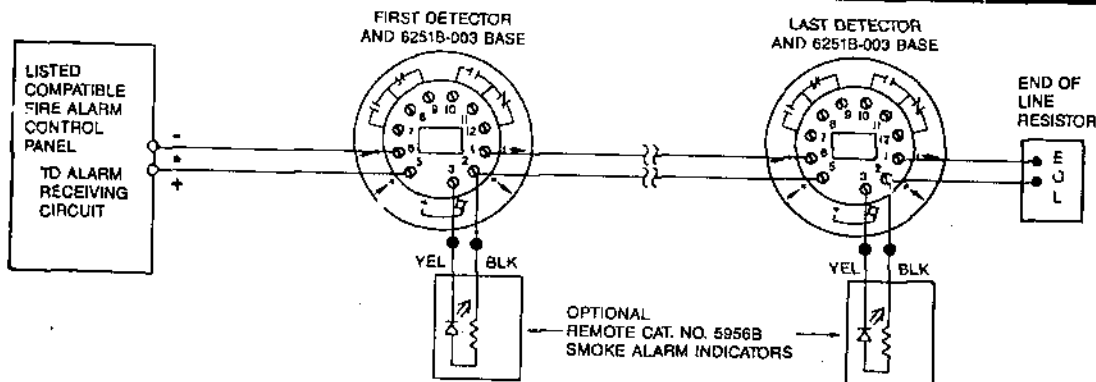


DIAGRAM 3 — Two-Wire Application of 6250 and 6270 Series Detectors With Relay Base

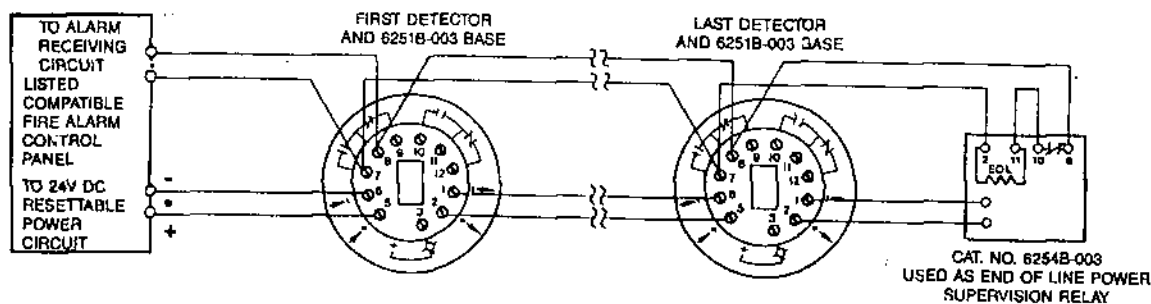


DIAGRAM 4 — Four-Wire Application of 6250 and 6270 Series Detectors Using Relay Base
for Installation of Remote Cat. No. 5956B Smoke Alarm Indicators, See Diagram 3.)

OBSERVATION OF POLARITY REQUIRED WHEN REMOTE SMOKE ALARM INDICATORS OR CAT. NO. 6251-003 RELAY BASE IS USED.

Manual Break Glass Call Point

271 Series

Features

- TRUE BREAK GLASS TYPE
- INSTALLER WIRING TERMINALS
- SEMI-FLUSH OR SURFACE MOUNTING
- COLOUR IMPREGNATED PLASTIC FINISH
- OPTIONAL MARKINGS AVAILABLE
- ATTRACTIVE STYLING
- IP RATING: IP44
- MULTI-LANGUAGE INSERTS AVAILABLE

Description

The EST 271-KR1 series Manual Break Glass Call Points are for indoor use and are part of a full range of plastic call points and accessories.

In all 271 series Call Points, the switch is held off by the 'edge' of the glass. When the glass is broken, the switch is released. This eliminates the risk of false alarms caused by glasses breaking on their own and glass fragments preventing the switch from moving to the operated position. A protective plastic coating on the glass prevents operator injury and inhibits the release of glass fragments. A hammer is not required.

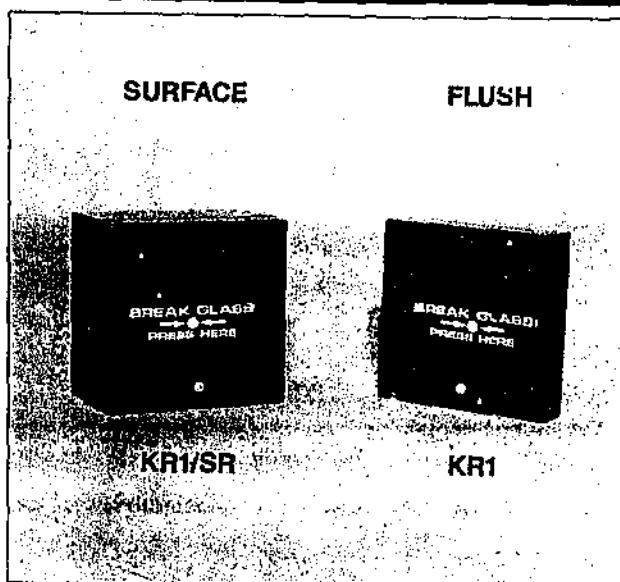
The 271-KR1 Call Point mounts quickly and easily to a standard U.K. B.E.S.A. switch/socket box. The 271-KR1/SR comes complete with its own red plastic surface mount backbox.

Testing is easy! When the special test key provided with every station is inserted, the glass drops and tests the switch.

Waterproof, special environment models, and various colours are also available. Consult International Sales for specific details.

Ordering Information

Catalogue Number	Description	Ship Wt.
271-KR1	Break Glass Call Point - N.O. Contacts	125g
271-KR1/SR	Break Glass Call Point - N.O. Contacts c/w Surface Box	175g
271-SR-P	Call Point Plastic Surface Mounting Box	50g
271-KG1	Call Point Replacement Glass Pack - 5 per Pack	70g



Note: This product is not U.L. or U.L.C. listed.

Specifications

Component Description	Material and Rating
Switch & Contacts	Silver Contacts rated at: 250 VAC 8.0 amp 50 VDC Resistive 3.0 amp 30 VDC Resistive 8.0 amp 30 VDC Inductive 3.0 amp
Maximum Contact Resistance	100 milliohms
Wire Terminals	Single conductor per Terminal - Maximum 2.5mm ² each
Surface Mounting Box	Modified Polyphenylene Oxide (Noryl SE 100) - Red
Call Point Base	Modified Polyphenylene Oxide (Noryl SE 100) - Red
Call Point Lid	Modified Polyphenylene Oxide (Noryl SE 100) - Red
Call Point Interior	Modified Polyphenylene Oxide (Noryl SE 100) - Black
Cover Fixing Screw	Zinc Plated Steel locating in Brass M3 Full Hexagonal nut
Functional Marking Label	Clear PVC, rear printed, coated in pressure sensitive adhesive. ENGLISH markings are standard. Consult International Sales for other languages available.

Installation

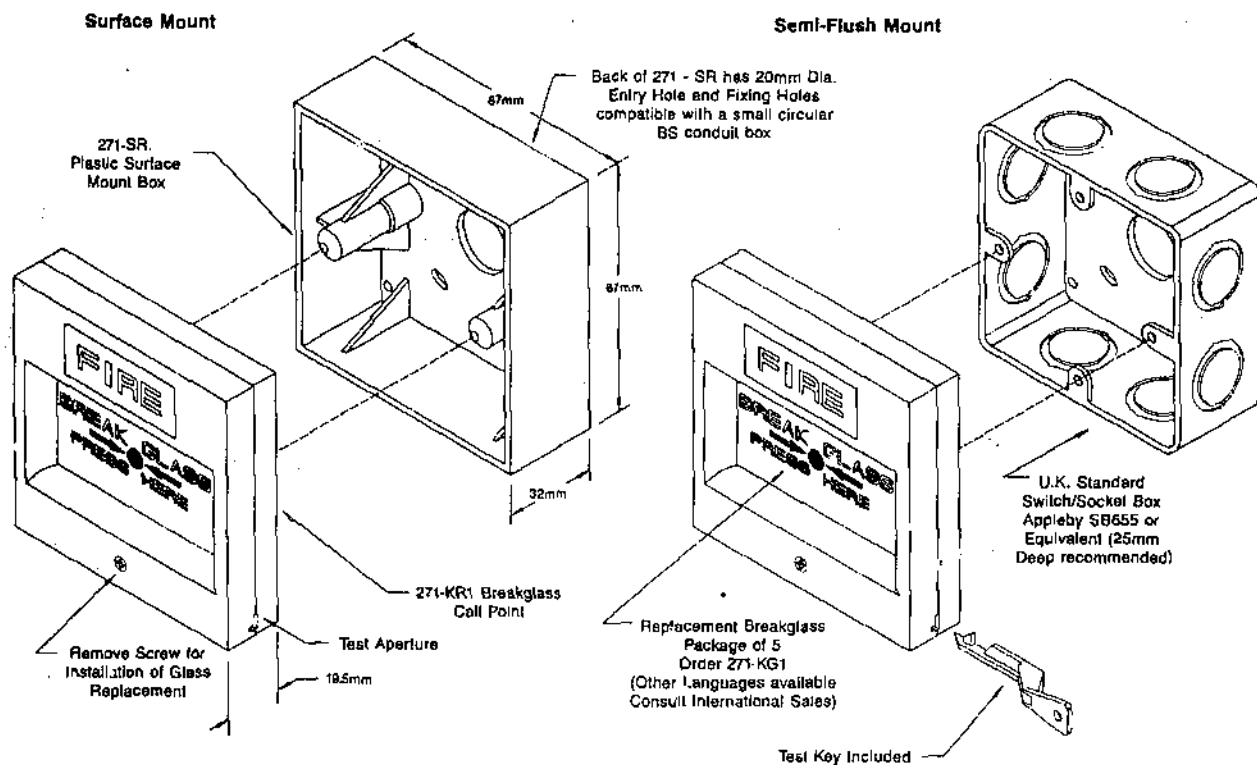
ST 271 series Manual Break Glass Call Points are high-quality Fire Alarm initiating devices. With an IP Rating of IP44, they are intended for indoor use only.

Approvals and Compliances

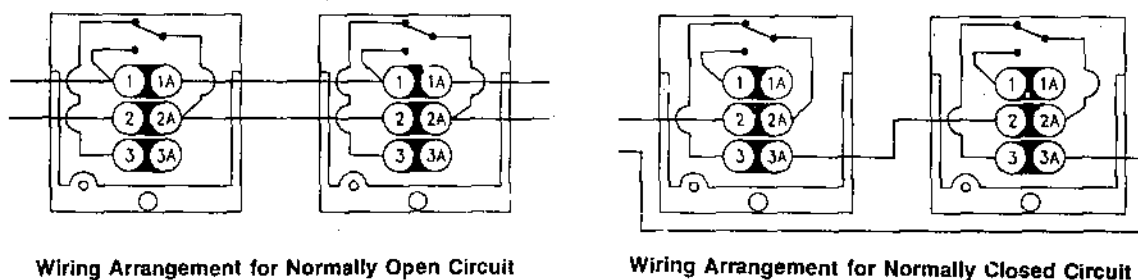
BS5839:Pt 2:1983 - Fire Alarm Models

Tested by the Fire Insurers' Research and Testing Organisation (FIRTO): Technical Evaluation Report TE1360

Type Approved by Lloyd's Register of Shipping - Certificate 86/0002 - Environmental Category ENV2: Enclosed spaces subject to temperature, humidity and vibration.



Typical Wiring



EDWARDS SYSTEMS TECHNOLOGY

SARASOTA, FLA. 813-756-3278 Fax: 813-751-6384
 FARMINGTON, CT. 203-678-0410 Fax: 203-677-1621
 OWEN SOUND, CANADA 519-376-2430 Fax: 519-376-7258
 INTERNATIONAL: CANADA 416-678-6767 Fax: 416-678-2872

85001-0083
 2 of 2 Iss. 1

It is our intention to keep the product information current and accurate. We cannot cover specific applications or anticipate all requirements. All specifications are subject to change without notice. For more information or questions relative to this Specification Sheet, contact EST.

Printed in Canada



A COMPARISON OF HALON REPLACEMENTS: FM200 vs. INERGEN

by A. Chattaway and D. J. Spring, Kidde International

Since the beginning of 1993, replacements have been readily available for Halon 1301 that do not deplete the ozone layer and that can be used for fire suppression in occupied spaces. The two leading replacements agents — FM200 and Inergen — both approved by the United States Environmental Protection Agency (EPA) for normally occupied areas⁽¹⁾, have very different characteristics, and this has led to confusion about their relative merits, particularly with regard to their toxicology and physiological effects.

This article presents this toxicological and physiological data in a comparative setting, dealing with the toxicology of the chemicals themselves at their fire-suppressing concentrations in air (with and without fire present). We hope this comparison will lead to a better understanding of the issues involved.

The Nature of the Agents

FM200 is the Great Lakes Chemical Corporation trade name for C_3HF_7 . This is a chemical developed specifically for fire-fighting applications and the chemical itself is Underwriters Laboratories listed⁽²⁾. It is a member of the hydrofluorocarbon (HFC) family of chemicals and is sometimes referred to as HFC-227ea. The most notable properties of FM200 include an ozone-depleting potential of zero and one of the shortest atmospheric lifetimes of any Halon replacement (31-42 years). (Relevant physical properties of FM200 and Inergen are shown in Table 1.)

Inergen is the registered trade name for a mixture of three atmospheric gases: nitrogen (52%), argon (40%) and carbon dioxide (8%). Basically, Inergen acts by depleting oxygen concentration to a

point below the level necessary to support combustion. Carbon dioxide is incorporated to increase the breathing rate of individuals exposed to the discharge, with a view to enhancing their survivability at the depleted oxygen concentrations. (The full implications of the added carbon dioxide are discussed in later sections.)

Applications/Systems Considerations

Although **FM200** is sold as an in-kind Halon replacement, its mode of action is quite different from that of Halon 1301, being almost exclusively physical (*i.e.*, extracting heat from a flame) rather than 80% chemical/20% physical⁽³⁾. Consequently, the cup-burner extinguishing concentration of FM200, at 5.8 % by volume, is higher than that of Halon 1301 which, following NFPA guidelines⁽⁴⁾, implies a design concentration of 7.0 % by volume. Again following NFPA guidelines, FM200 employs a very rapid discharge time of ~10 seconds, to minimize decomposition of the agent, as explained in detail later in this article.

Inergen operates principally through oxygen depletion. Most commonly-encountered combustible materials require a minimum oxygen concentration of 13-15 % by volume⁽⁵⁾ for combustion. In practice, the concentration is lowered to about 11-12 % by volume to ensure extinguishment. This implies an agent concentration of up to 50 % by volume, which in turn requires a longer discharge time (typically, one minute or longer) to keep pressure increases to tolerable levels, both from engineering and human exposure viewpoints. Long discharge times in turn allow more time for greater fire damage to occur, and as a result, for a greater release of toxic combustion products.

TABLE 1: PROPERTIES OF FM-200 AND INERGEN

Product	FM200	Inergen
Formula/composition	C_3HF_7	$N_2/Ar/CO_2$ 52:40:8
Molecular mass	170	34.1*
Extinguishing concentration (cup burner)	5.8	31.5
Design concentration (% by volume)	7.0-10.0	38-80*
% by volume O_2 at agent design concentration	19.4-18.8	13.8-4.2
Discharge time	≤ 10 seconds	≥ 1 minute
US EPA approval	Granted for normally occupied spaces	Granted for normally occupied spaces

* Weighted mean of three constituents.

* Minimum design concentration is taken as 1.2 times cup burner concentration.

Note: There is considerable confusion in the Ansul literature as to the exact design concentration range as opposed to the injected concentration of agent needed to achieve design concentration. Considerable extra quantities of Inergen are needed to be injected, since much is lost from the room during the discharge process.

Toxicity Tests

The LC50 Acute Toxicity Test is used to assess acute toxicity of gases — specifically fire extinguishing agents. Test animals are subjected to nose-inhalation of a given concentration of the chemical being tested for four hours, and the number of deaths recorded. The test is repeated at different concentrations, and when testing is complete, the resulting data is analyzed and the concentration that would have killed half the test subjects interpolated⁽⁶⁾.

Because of differences among species in response to chemicals, considerable caution is required in directly applying LC_{50} values derived from test animals to humans, but these results do allow comparative evaluations to be made among different agents⁽⁷⁾.

Since design concentrations of extinguishing agents are usually of lower magnitude than those used for by the LC_{50} tests, additional toxicological parameters are needed. One of the most useful is to determine the concentration that signals the onset of toxicity. NOAEL/LOAEL Cardiotoxicity Tests

measure the effect when an individual is breathing an atmosphere containing a halocarbon or hydrocarbon while experiencing increased adrenalin levels in the bloodstream caused by stress — a situation which can cause irregularities in the heartbeat (arrhythmias) to occur⁽⁸⁾.

Initial irregularities are classed merely as "observed," whereas at higher concentrations they become more severe and are classed as "adverse effects." There are four levels of concentration:

No Observed Effect Level (NOEL)

No Observed Adverse Effect Level (NOAEL)

Lowest Observed Effect Level (LOEL)

Lowest Observed Adverse Effect Level (LOAEL)

The figure that is used as a basis for protection of personnel is the NOAEL⁽⁹⁾.

The testing procedure used is similar to that for the LC_{50} test, in that nose-only exposure is used. Test animals breathe the given concentration for 30 minutes, then an adrenalin injection is administered. The animal's heartbeat is monitored, and any

observed effects are recorded and classified. The test is then repeated at different concentrations.

The cardiotoxicity test is intended to provide very conservative data. HFCs (and perfluorocarbons) are by their nature not especially cardiotoxic. To obtain measurable effects in test animals, extremely large adrenalin injections are administered, approximately ten times the maximum amount of adrenalin that a human would generate in escaping from a life-threatening fire situation⁽¹⁰⁾. This is an important point to bear in mind when reviewing toxicology assessments obtained from the cardiotoxicity tests.

Toxicity of the Individual Chemicals

FM200 is not toxic. When the acute toxicity tests were carried out, no deaths were recorded at any concentration up to and including 80% by volume during the four-hour inhalation study⁽¹¹⁾. (Note: at high agent concentrations, oxygen concentration is maintained at 20% by volume.) Furthermore, no evidence of skin, eye or respiratory irritation was observed, though there was evidence of anesthesia.

Other testing over longer time periods (30 and 90 days) have yielded similar results, confirming that FM200 poses very little risk in terms of toxicity.

The same chemical — HFC-227ea — has also been proposed for use in medical inhalers and is currently being tested by the IPAC consortium. To date, more than 70 studies have been carried out, including 3 using human volunteers⁽¹²⁾. The reason for this very low toxicity is probably due to the fact that FM200 is not appreciably metabolized, and is exhaled largely unchanged⁽¹³⁾. A comprehensive toxicological evaluation of FM200 concluded, "Brief episodic exposure to concentrations of less than 14 % by volume appears to present little or no risk to human health⁽¹⁴⁾."

In view of this very low toxicity, the U.S. EPA has determined that the first and most relevant toxicological effect for FM200 is cardiac sensitization. Data for FM200 is as follows⁽¹⁵⁾:

NOAEL 9.0 % by volume

LOAEL Greater than 10.5 but less than 14.0 % by volume

TABLE 2. EFFECT OF OXYGEN DILUTION (1 Atmosphere Total Pressure)

Added Inert Gas Concentration (% by volume)	Oxygen Concentration (% by volume)	Physiological Effect
0 - 28	20.9 - 15	No effect
28 - 43	15 - 12	Loss of efficiency, increasing confusion and faulty judgment, fatigue
43 - 52	12 - 10	Rapid fatigue, impaired neuromuscular coordination, impaired mental processes and disturbed respiration
52 - 71	10 - 6	Rapid collapse leading to unconsciousness
71 - 90	< 6	Unconsciousness in less than 60 seconds, leading to death unless removed from atmosphere

TABLE 3. PHYSIOLOGICAL EFFECTS OF CARBON DIOXIDE

CO ₂ concentration (% by volume)	Physiological Effect
3	OSHA short term exposure limit NIOSH exposure limit (10 minutes)
3	Breathing rate doubled
4	Breathing rate tripled; increased rate and force of heart contractions
5	Breathing quadrupled
7-10	Dyspnea, headache, faintness, confusion and deteriorating mental confusion
10	Lowest recorded concentration causing fatality in man (after 1 minute)
15	Unconsciousness, muscular rigidity and tremors
20+	Convulsions, cessation of breathing

At partial pressures above about 10 bar, both oxygen and nitrogen become sufficiently soluble in body fluids that narcotic effects (*i.e.*, effects on the central nervous system) become increasingly manifest as gas pressures increase⁽¹⁶⁾. However, at normal atmospheric pressure these effects are not observed in either of these gases, and neither is considered toxic. Instead, the physiological effects caused by added nitrogen and argon are purely those of oxygen dilution^(17,18). (See Table 2.)

Carbon Dioxide Effects

The physiological and pharmacological effects of carbon dioxide on the human body are very complex, partly because it is a natural metabolic waste product of the body. Exhaled air contains typically 4 % by volume of CO₂⁽¹⁹⁻²¹⁾. When low concentrations of CO₂ are added to inhaled air, the breathing rate (*i.e.*, the volume of air inhaled per minute) is stimulated^(22,23) (See Table 3).

The effects of inhaling CO₂ are not limited to breathing rate increases; the rate and force of heart contractions are also increased, and the pH of the blood falls (*i.e.*, it becomes more acidic) and this increases the concentration of catecholamine

hormones (such as adrenalin) circulating in the blood, with effects such as dilation of the blood vessels^(23,24).

At higher concentrations (above 5 - 6 %, by volume) the effects of CO₂ become more unpleasant, with respiratory distress and narcotic-like effects apparent. In fact, the EPA has set a limit of 5 % CO₂ which may not be exceeded. Thus, CO₂ can not truly be described as non-toxic.

Even low concentrations (3 %, by volume) can cause not insignificant effects on the body, including a doubling of the breathing rate and associated effects on the heart rate. It should be noted that the response of humans to chemicals is extremely variable among individuals; some humans can be very sensitive. For example, the lowest recorded concentration causing fatality in man, an exposure of 10 % by volume for 1 minute⁽²⁵⁾, is below the average dose/effect data shown in Table 3.

Toxicity in Relation to Use Concentration (No Fire)

If a fire extinguishing agent is to be used in an occupied space, the design concentration needs to be less than the LOAEL⁽⁴⁾. The EPA, working within OSHA guidelines, has applied a series of agent

concentration limits based on egress times⁽²⁶⁾. The relevant numbers for FM200 are as follows:

Design concentration > 10.5% (LOAEL), egress must be within 30 seconds

Design concentration 9.0 - 10.5% (between NOAEL and LOAEL), egress must be within 30-60 seconds

Design concentration < 9.0 (below NOAEL), egress time can exceed 60 seconds

In view of the conservative nature of these cardiotoxicity tests, however, Australian authorities have approved FM200 for use at concentrations up to 14.0 % by volume⁽²⁷⁾. Japanese authorities are expected to follow suit shortly⁽²⁸⁾.

In considering the safety of Inergen, two concentrations have to be noted, CO₂ and O₂. For a standard mixture of 52% N₂ + 40% Ar + 8% CO₂, and a nominal design concentration of 50 % by volume, the final fire-suppressing atmosphere will contain 4 % by volume CO₂ and 10.5 % by volume O₂, assuming the discharge is done at the same temperature as that for which the design has been done. Breathing this atmosphere will cause a threefold increase in breathing rate, together with an increase in the rate and force of heart contractions. Individuals in normal health may tolerate this but, because of the increase in circulating catecholamine hormones in the blood, there could be complications for persons on certain heart medications⁽²⁵⁾, and those persons should evacuate immediately if there should be an accidental discharge⁽²⁹⁾.

As with all gaseous fire suppressants, the concentrations of agent actually achieved in a protected space will depend on the ambient temperature and the volume of free space. If the design was done for 20°C and the actual temperature of the is 30°C, the actual CO₂ concentration would be 4.14% and not 4.0% by volume. Similarly, if the design was done for a storage space with a free volume of 200m³ but 70m³ of that space was occupied at the time of discharge, the actual CO₂ concentration would be 6.2% and not 4% by volume — and would thus exceed the EPA limit of 5.0%⁽⁹⁾.

Where the margin of safety is narrow, these effects are more critical for Inergen than for FM200 for equivalent increases in concentration over the

design, because of the toxic effects of CO₂ (See Table 3). These considerations depend on the precision with which the Inergen gas mixture is made up, particularly the width of the tolerance band for the amount of CO₂ in the mixture. If there is more than 8% by volume CO₂ present, then the risk will be greater for the reasons already discussed.

Toxicity of Fire Gases

In addition to any toxicological threat posed by the use of an agent to extinguish fire, the toxicity of the gases generated by the combusive process itself needs to be addressed. All fires consume oxygen and generate carbon monoxide and carbon dioxide, and may generate toxic/irritant gases such as HCL from burning PVC and HCN from polyurethane foams. Rapid extinguishment of any fire is very desirable to minimize the toxic effects of these gases^(30,31).

When halocarbons are used to suppress fires, a proportion of the agent decomposes. In the case of Halon 1301, the decomposition products were HF, HBr and Br₂ (and very limited quantities of COF₂)⁽³²⁾. The main decomposition product of FM200 is HF (and possibly a small amount of COF₂)⁽³³⁾. HF is a toxic gas, but under normal suppression conditions the quantities produced are not considered to be life-threatening. The "30 minute exposure likely to be lethal" concentration for HF has been estimated to be 2,900 ppm⁽³⁴⁾. Alternatively, the lowest recorded fatal dose (dose = concentration x exposure time) for a human was 1,500 ppm.min (50 ppm for 30 minutes)⁽³⁵⁾. The difference between these two sets of data illustrates once again the variability in biological response to chemicals.

The concentration of HF following an FM200 suppression of a small fire (0.06 ft.³/1000 ft.³) has been measured to be 25 ppm, whereas the suppression of a large fire (0.6 ft.³/1000 ft.³) generates ~ 500 ppm⁽³³⁾. These values indicate that, if the fire is small, an exposure of many minutes is not expected to be hazardous, but if a fire is large, the maximum exposure time should not exceed a few minutes. HF is a severe irritant with choking, acrid fumes, causing personnel to evacuate a fire site quickly, and exposures for able-bodied persons are more likely to

measured in seconds than in minutes. Furthermore, unpleasant HF fumes are likely to cause personnel to hold their breath, minimizing uptake of tant toxic gases.

The rapid discharge and suppression that occurs when FM200 is used does, however, minimize depletion and the generation of CO and CO₂, and overall toxicity of site atmosphere is maintained at acceptable level.

When Inergen is used as a suppressant, the potentially hazardous effects of the products of combustion of a fire — carbon monoxide, in particular — are especially serious, in comparison with the same fire suppressed by FM200. The reasons are:

Potentially Hazardous Effects of Inergen

1.

Increased breathing and heart rate mean that toxic gases are drawn into the body more rapidly and, once dissolved in the blood, reach body tissues rapidly. Toxic effects of CO depend on the degree of saturation of blood hemoglobin, and this depends in turn on the relative partial pressures of O₂ and CO in the lungs^(24,36-41). The enhanced breathing rate stimulated by Inergen will help maintain concentrations of O₂ at near normal levels, but the same effect will clearly raise lung concentrations of CO above what they would otherwise be.

2.

The longer discharge times of Inergen mean that as the fire grows larger at the point of suppression, more combustion products are generated and their concentrations are higher.

3.

Worldwide, studies show that the majority of fire fatalities are caused by CO inhalation. Experts agree that fires generate relatively higher proportions of CO when combustion occurs under oxygen deficient (fuel rich) conditions^(42,43). Thus, fires suppressed by oxygen starvation, as with Inergen, produce more CO than fires suppressed with chemical/physical suppressants^(44,45).

4.

The amount of CO₂ generated by a fire can be as much as 14% by volume⁽⁴⁵⁾, depending on fire size and ventilation. Further CO₂ added by using Inergen as a suppressant can produce very dangerous levels.

Safety Margins

It is possible to calculate several safety margins simply as a ratio of the relevant toxicological parameter to the extinguishing or design concentration. See Table 4 for a side-by-side comparison of the relative safety of FM200 and Inergen.

For FM200, the ratio of the LOAEL to the design concentration is 1.5 - 2.0, depending on whether 10.5% or 14.0% by volume is taken as the LOAEL. (NOTE: it should be remembered that the cardiotoxicity test for halocarbons is an extremely conservative test, owing to the large adrenalin injection used.)

It is not possible to calculate an exact safety margin for acute toxicity, as no "end point" could be found for the LC₅₀ of FM200. However, the safety margin is in excess of 11.

For Inergen, the ratio of the LOAEL to the design concentration varies from 1.6 to 0.78 (design concentrations of 38% to 80%). However, the adverse effects that constitute the LOAEL in the case of Inergen (increased breathing and heart rates) are very real indeed, and there is no tenfold margin of safety as there is with the FM200 cardiotoxicity tests already described.

Furthermore, as shown in Table 3, the CO₂ concentration following an Inergen discharge exceeds OSHA/NIOSH guidelines for even short term exposures.

TABLE 4. SAFETY COMPARISON OF FM200 AND INERGEN

Suppressant	<u>FM200</u>	<u>Inergen</u>
Design concentration (% by volume)	7.0-10.0	38 - 80
Discharge time	≤ 10 seconds	≥ 1 minute
NOAEL (% by volume)	9.0	50
LOAEL (% by volume)	10.5 - 14.0	62
Ratio of LOAEL to design concentration ^a	1.5 - 2.0	0.8 - 1.6
Ratio of acute toxicity to design concentration ^a	> 11	2.5 [*]
Physiological effects of agent at lower concentra- tions (above NOAL)	None	Increased breathing rate; increased rate and force of heart contractions.
Physiological effects at higher concentra- tions (above NOAEL)	Possible cardiac irregu- larities in individuals at or above LOAEL	Effect on breathing more severe; at higher concentrations, irregular breathing, faintness.
Fire toxicity	HF - acrid smell gives strong warning, limits exposure.	Increased uptake of CO and other toxic combustion products. Odorless CO special problem.
^a Larger values of this ratio mean a greater safety margin. [*] Using reported fatality with 10% by volume CO ₂ . ¹ C.P. Chengelis, "Toxicological Evaluation of HFC-227ea (FM200) - Background Document," submitted to the Halon Alternative Group of the United Kingdom by WIL Research Laboratories, June 20, 1994.		

Conclusions

This comparison, particularly taking into account safety margins and the toxic nature of increasing CO₂ concentrations, highlights difficult problems in the whole concept of fire suppression by oxygen starvation combined with alterations of body physiology to cope with the lower oxygen concentrations at fire sites. Lethal concentrations of CO can go completely unperceived until it is too late. In light of the facts we have reviewed, it would seem that an

enhanced respiration rate, with the resulting increase in the uptake of toxic gases, is the last thing to be desired at a fire site.

We must conclude that the rapid suppression of fires by chemical/physical means, with no requirement to alter physiological responses in the body, must be the safer course of action than suppression through oxygen starvation.

References

- U.S. Environmental Protection Agency, Final SNAP Rulemaking, Federal Register 59 FR 13043, March 18, 1994.
- M. L. Robin, "Properties of FM200: A Zero ODP replacement for Halon 1301", International CFC and Halon Alternatives Conference, October 20-22, 1993 Washington, DC.
- R. S. Sheinson, J. E. Penner-Hahn and D. Indritz, "The Physical and Chemical Action of Fire Suppressants", Fire Safety Journal (1989), 15, 437-450.
- NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, National Fire Protection Association, May 1994.
- "Summary: UL Fire Test Results on Inergen Fire Extinguishing Agent", Ansul White Paper 1006, Ansul Fire Protection.
- E. M. Boyd, "Predictive Toxicometrics", Scientifica, 72 pages 254-255.
- ibid, page 253.
- J.H. Wills et al., "Sensitization of the Heart to Catecholamine-induced Arrhythmia by Haloalkanes", Toxicol. Appl. Pharmacol. (1972), 22, 305-306.
- U.S. Environmental Protection Agency, Final SNAP Rulemaking February 15, 1994.
- ibid, 9 page 243
- C.P. Chengelis "Toxicological Evaluation of HFC-227ea (FM200) - Background Document" Submitted to The Halon Alternative Group of the United Kingdom by WIL Research Laboratories Inc. on behalf of Great Lakes Chemical Corporation, June 20, 1994.
- IPAC II "Reports on HFA-227". Studies undertaken by the IPAC consortium of chemical and pharmaceutical companies, May 1994.
- Reference 11, page 8.
- Reference 11, pages 9-10.
- Reference 9, page 282.
- C. J. Lambertsen, "Respiration", in "Medical Physiology", 14th edition, published by Mosby, St. Louis, 1980, pages 1924-38.
- ibid, chapter 73.
- Safety Bulletin, Compressed Gas Association, Arlington, Virginia, USA, 3rd edition, February 1992.
- A. C. Luft, "Aviation Physiology", in Handbook of Physiology, American Physiology Society, Washington, 1965.
- W. C. Bowman, M.J. Rand, and G.B. West, "Textbook of Pharmacology", Blackwell Scientific, London 1971, chapter 1.
- Reference 16, page 1693.
- J. M. Clark, R. D. Sinclair and J. B. Lennox, J. Appl. Physiol.: Respirat. Environ. Exer. Physiol. (1980), 48, 1065.
- Reference 16, pages 1915-24.
- J. A. S. Ross, "A Review of Atmospheric Breathability after Use of Oxygen Depleting Fire Extinguishers, University of Aberdeen Medical School, report commissioned by Great Lakes Chemical Corporation.
- N. I. Sax, "Dangerous Properties of Industrial Materials", Van Nostrand Reinhold, 6th edition, 1984, page 640.
- Reference 9, page 397.
- "Summary Report on HFC-227ea", by National Industrial Chemicals Notification and Assessment Scheme, Australia, Report No. NA/164, June 1994.
- M. Stamp, Great Lakes Chemical Corporation, private communication, June 22, 1994.
- "The Physiology of Inergen Fire Extinguishing Agent", Ansul White Paper 1005, Ansul Fire Protection.
- R. F. Dyer and V. H. Esch, "Polyvinyl Chloride Toxicity in Fires", J. Amer. Med. Assoc. (1976), 235, 393-7
- B. M. Halpin and W. G. Berl, "Human Fatalities from Unwanted Fires", Report NBS-GCR-79-168, National Bureau of Standards, Washington DC, 1978.
- C. L. Ford, "Halon 1301 Computer Fire Test Programme", Interim Report, E. I. DuPont de Nemours & Co. Inc., Wilmington, Delaware, January 10, 1972.
- M. L. Robin, "Large Scale Testing of Halon Alternatives", International CFC & Halon Conference, Baltimore, December 3-5, 1991.
- D. A. Purser, "Interactions Between Behavior Patterns and Physiological Impairment in Escape from Fires", presented at Interflam '93, 6th International Fire Conference.
- Reference 25, page 1548.
- Reference 16, pages 1920-4.
- Reference 20, page 299.
- C. J. Hillado, "Flammability Handbook for Plastics", Technomic Press 1974.
- D. A. Purser, Fire Prevention, May 1985, 28-32.
- H. L. Kaplan and G. E. Hartzell, J. Fire Sci. (1984), 2, 286-305.
- H. L. Kaplan, A. F. Grand and G. E. Hartzell, J. Combust. Toxicol. (1982), 2, 121-38.
- G. Mulholland, M. Janssens, S. Yusa, W. Twilley and V. Babrauskas, Proc. 3rd International Symposium on Fire Safety Science, Edinburgh, 1991, pages 585-94.
- Y. Tsuchiya and F. Mathieu, ibid, pages 605-14.
- W. T. Lowry, L. Juarez, C. S. Petty and W. Roberts, J. Forensic Sci. (1985), 30, 59-72.
- W. D. Woollely and P. J. Fardell, Fire Safety J. (1982), 5, 29-48.
- D. Drysdale, "An Introduction to Fire Dynamics", Wiley Interscience, 1985, page 351.