Fire Detection and Alarm System Basics

Hochiki America Corporation
7051 Village Drive, Suite 100
Buena Park, California 90621
www.hochiki.com

Fire Alarm Circuit Classes

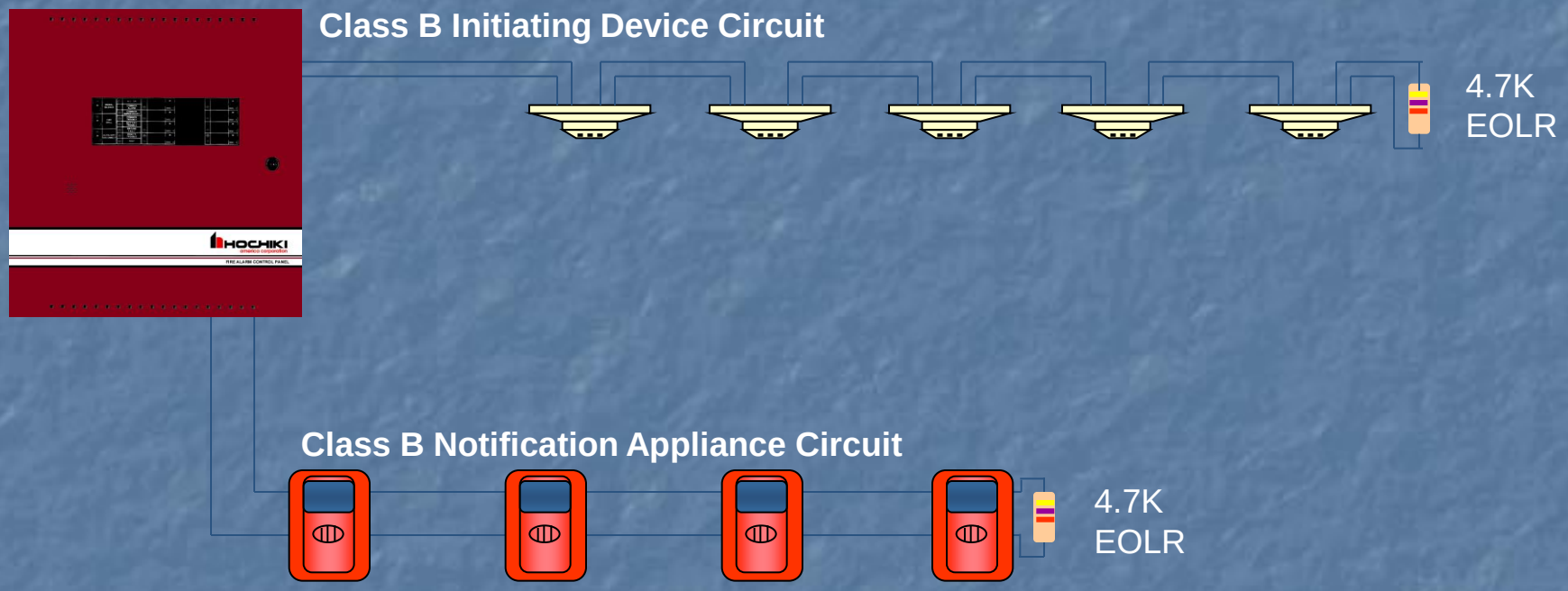
2007 NFPA 72, 6.4.2.1 ***Class***. Initiating device circuits, notification appliance circuits, and signaling line circuits shall be permitted to be designated as either Class A or Class B, depending on their performance during nonsimultaneous single circuit fault conditions as specified by the following:

(1) Initiating device circuits and signaling line circuits that transmit an alarm or supervisory signal, or notification appliance circuits that allow all connected devices to operate during a single open or a nonsimultaneous single ground fault on any circuit conductor, shall be designated as Class A

(2) Initiating device circuits and signaling line circuits that do not transmit an alarm or supervisory signal, or notification appliance circuits that do not allow all connected devices to operate beyond the location of a single open on any circuit conductor, shall be designated as Class B

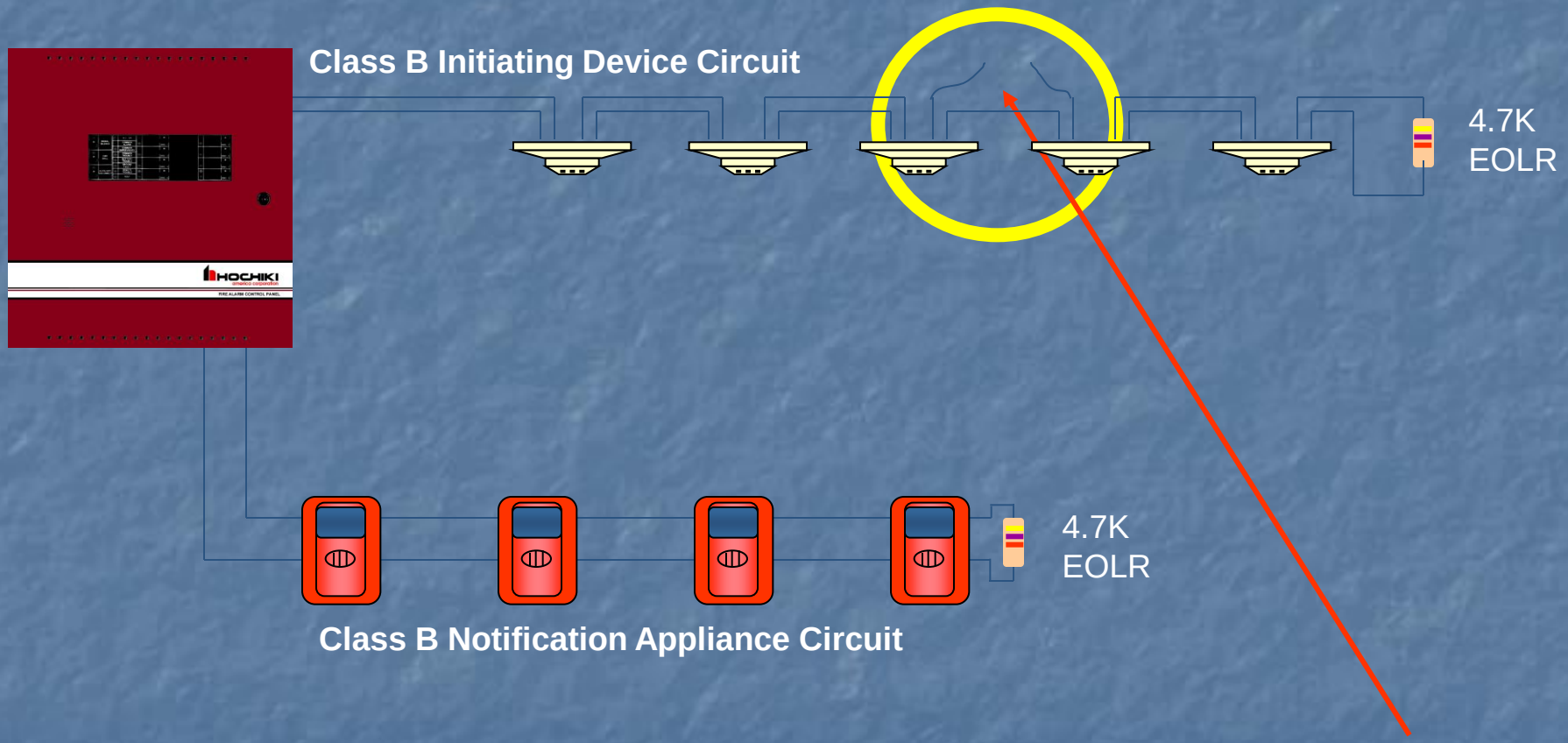
2007 NFPA 72, 6.4.2.2. An open or ground fault condition shall result in the annunciation of a trouble signal at the protected premise within 200 seconds as required in 4.4.7

Class B Circuits



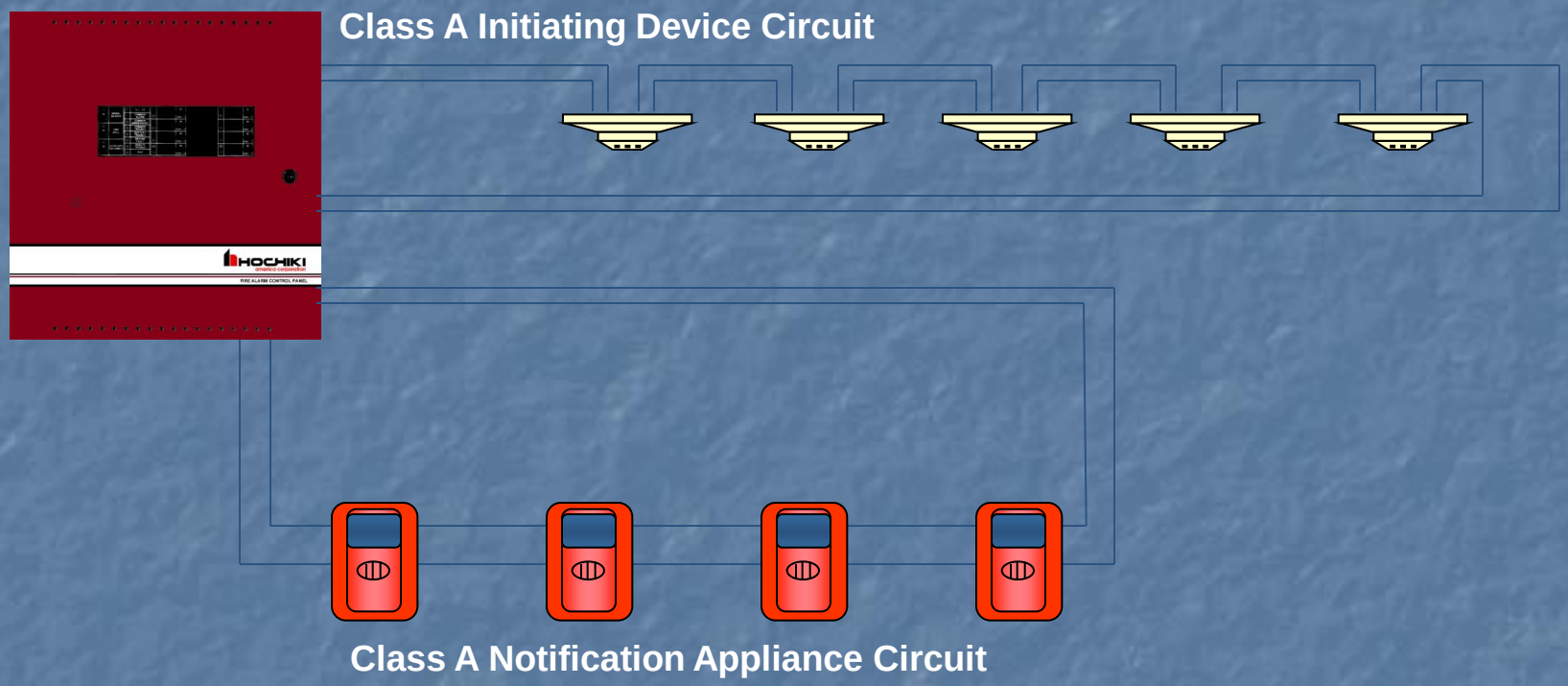
End of line supervision resistors are required to supervise the integrity of the loop.

Class B Circuits



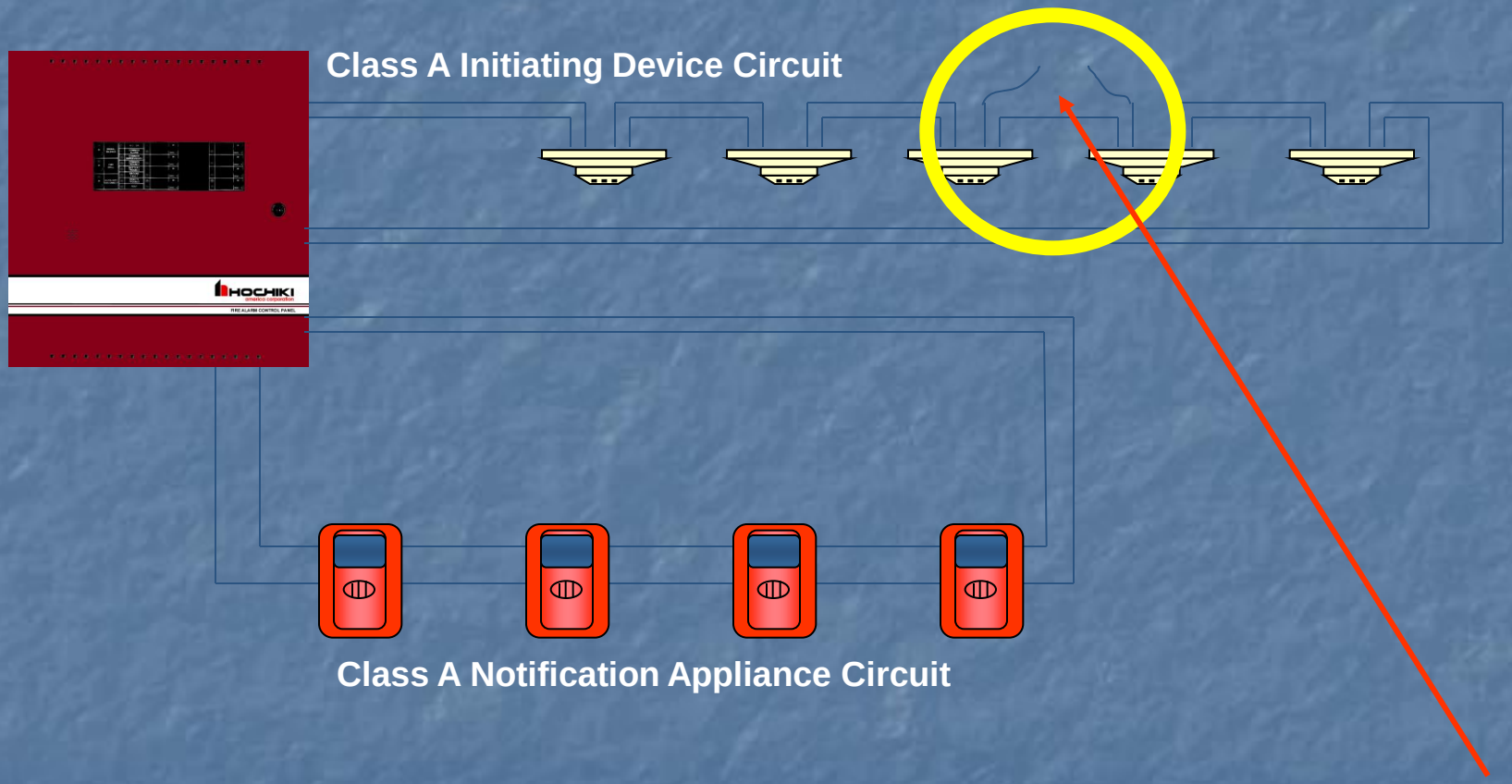
Single open circuit condition causes a trouble on the panel and renders all devices beyond the fault inoperative.

Class A Circuits



End of line supervision resistors are not necessary as the loop returns to the panel and is driven from both ends.

Class A Circuits



Single open circuit condition causes a trouble on the panel. All devices on the loop remain operative.

Additional Fire Alarm Terminology

Addressable Device - A fire alarm system component with discreet identification that can have its status individually identified or that is used to individually control other functions.

Analog Addressable Sensor - An initiating device that transmits a signal indicating varying degrees of condition as contrasted with a conventional or addressable initiating device, which can only indicate an off/on condition.

Signaling Line Circuit (SLC) - A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or out put signals or both are carried.

SLC Interface - A system component that connects a signaling line circuit to any combination of initiating devices, initiating device circuits, notification appliances, notification appliance circuits, system control outputs and other signaling line circuits.

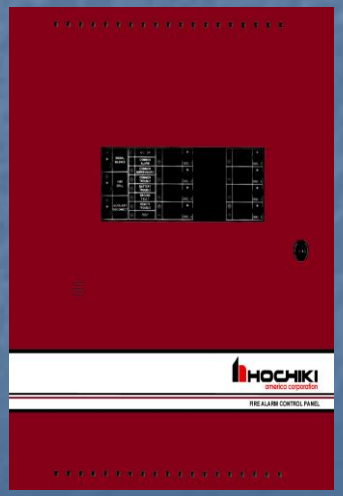
Protocol - A language for communicating between control panels and their proprietary devices.

Comparing System Types

To better understand today's newer technology, a firm understanding of the types of systems available is necessary. The three most popular types of systems installed today are:

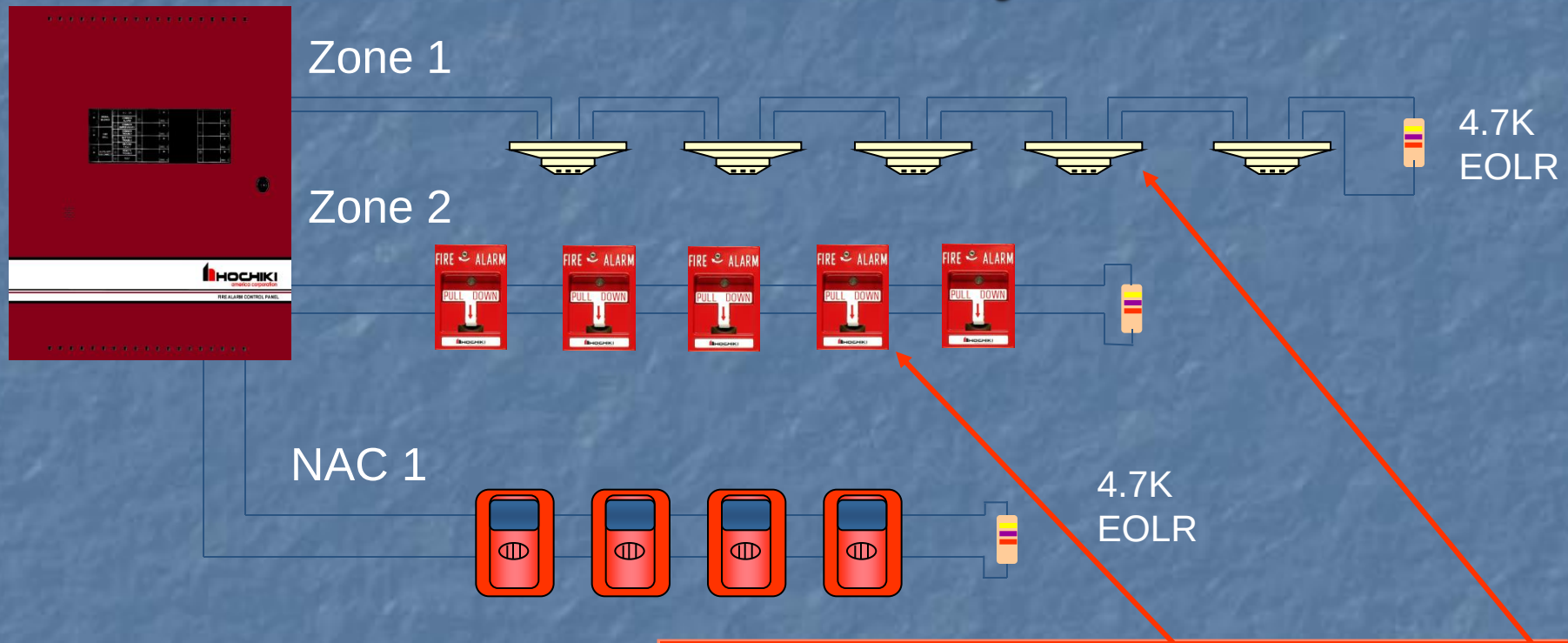
- Conventional
- Addressable
- Analog Addressable

Conventional Systems



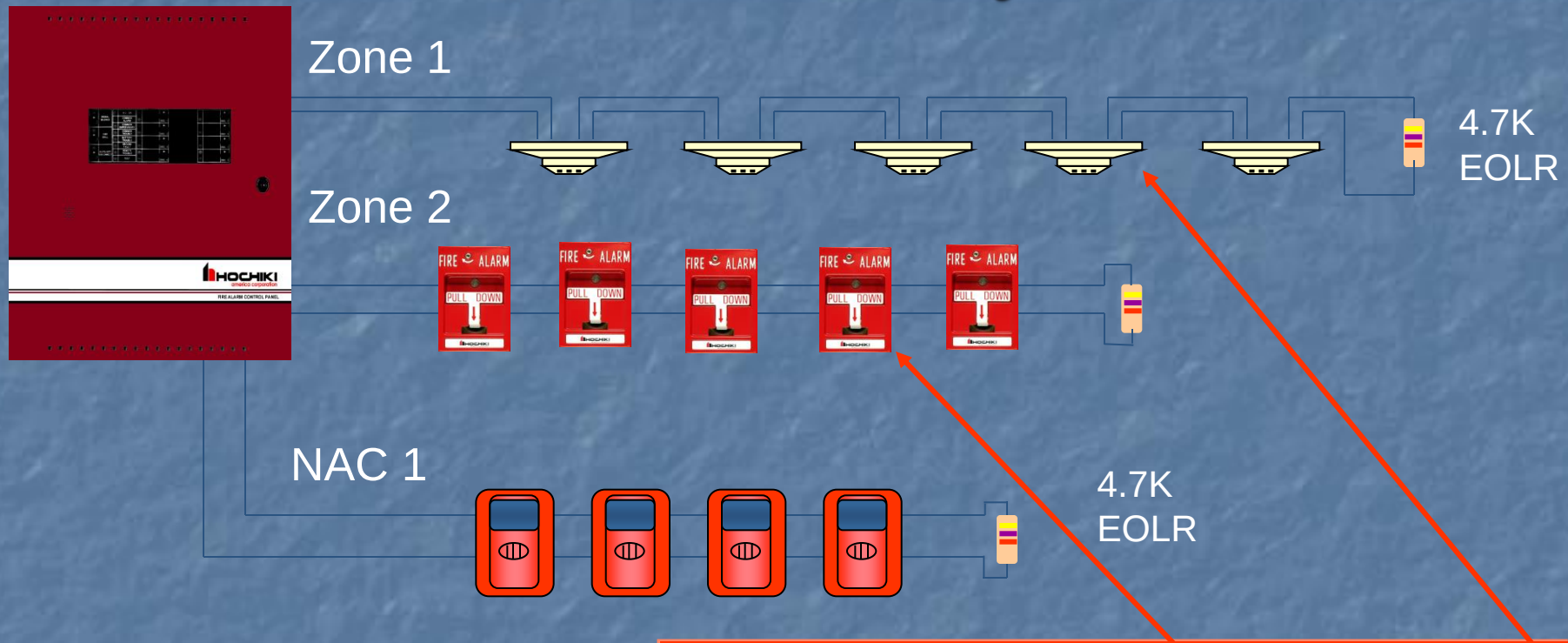
- Conventional control panels range in size from 1 zone to over 100 zones.
- Zones typically consist of some or all of the initiating devices in an area or floor of a building.
- Some control panels zone capacity is expandable while others are not, limiting its usefulness if a facility adds additional buildings or rooms.

Conventional Systems



Multiple devices are combined into a single zone. Zones can contain 30 or more devices.

Conventional Systems

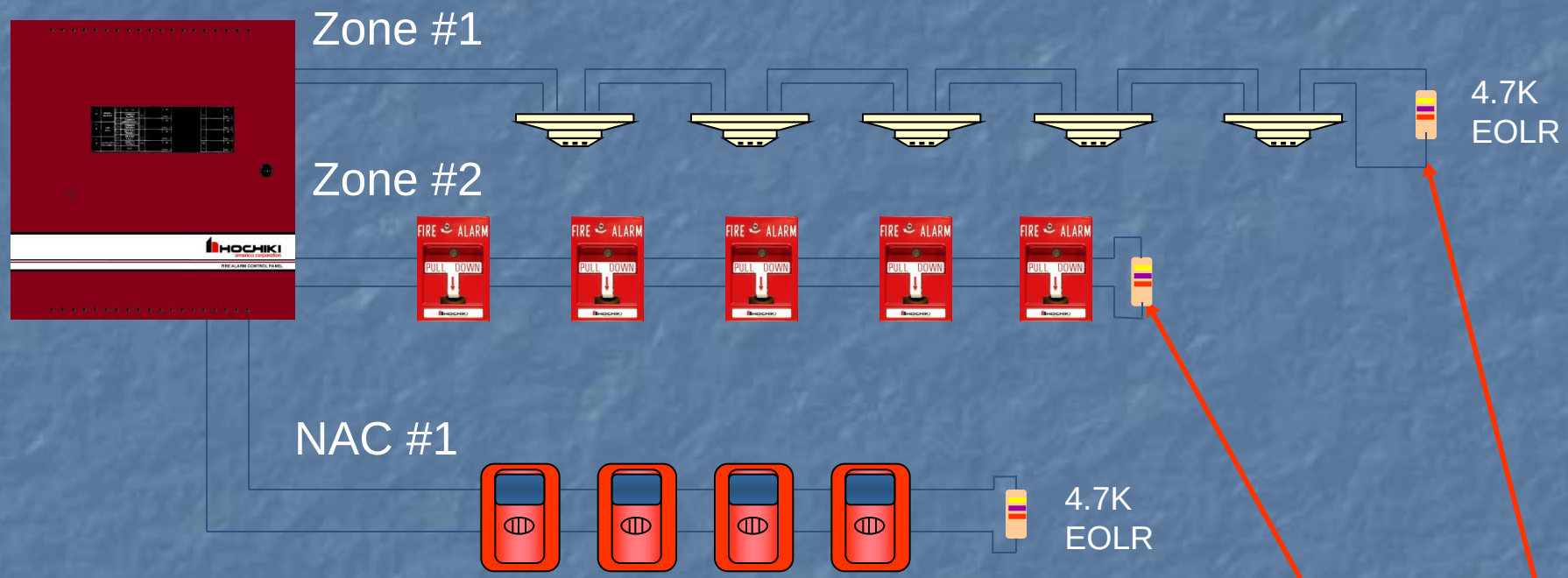


Care must be taken when laying out zones to comply with code requirements.

Zone Considerations

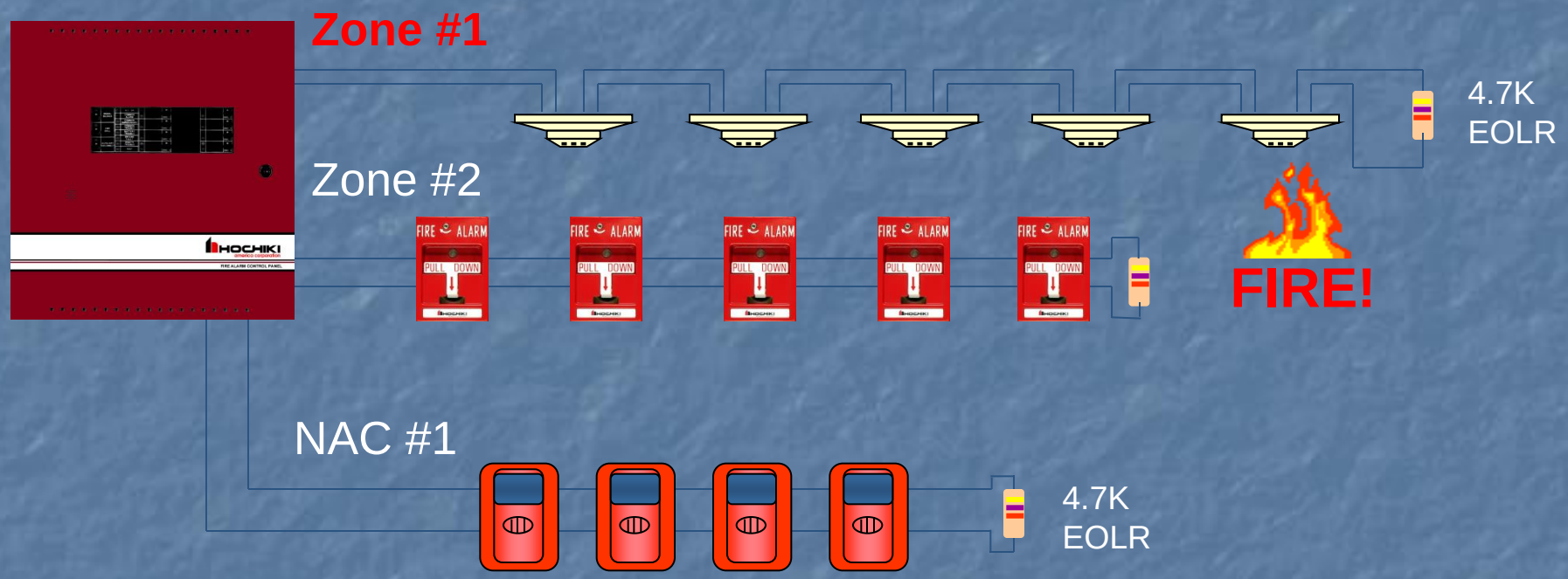
- 2007 NFPA 72 **6.8.5.5.2** Limits the number of waterflow switches in a single zone to 5.
- 2007 NFPA 72 **6.8.5.6.2** Limits the number of supervisory devices in a single zone to 20.
- 2007 NFPA 72 **Annex A.4.4.6.6** Suggests that the maximum number of square feet in a single zone be limited to no more than 22,500.

Conventional Systems



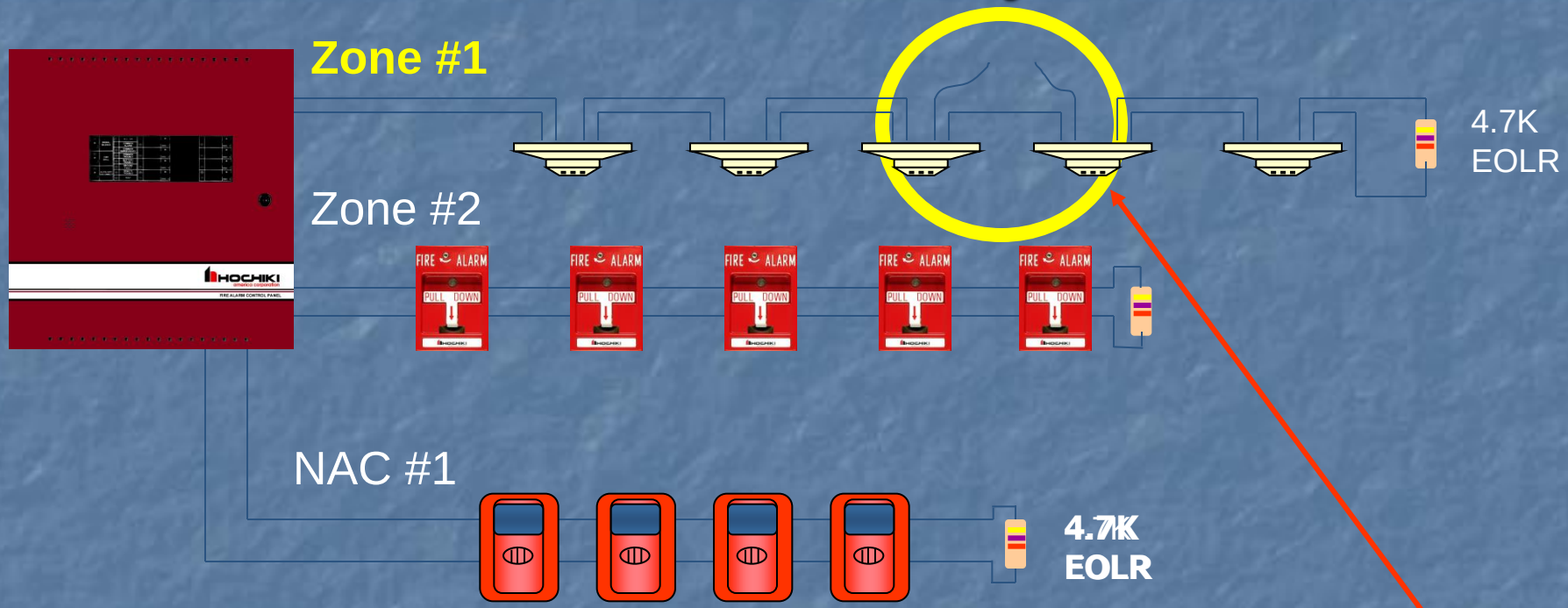
Wiring must be installed in a supervised manner either Class A, or Class B with an EOLR.

Conventional Systems



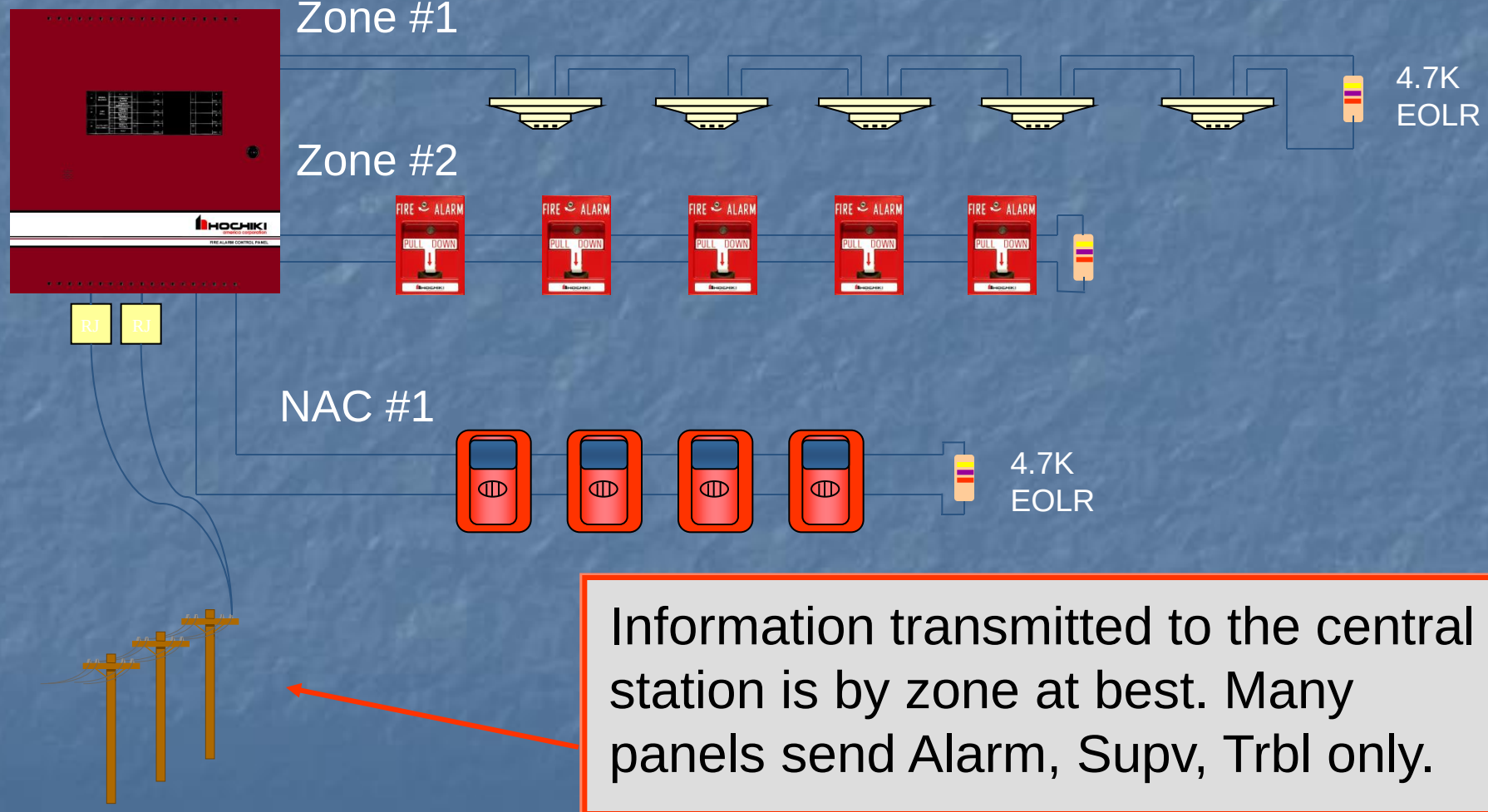
Alarm conditions are annunciated by zone only. Inspection is required to determine the device.

Conventional Systems



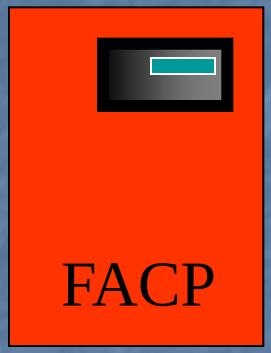
Trouble conditions are annunciated by zone only. Inspection is required to determine the cause.

Conventional Systems



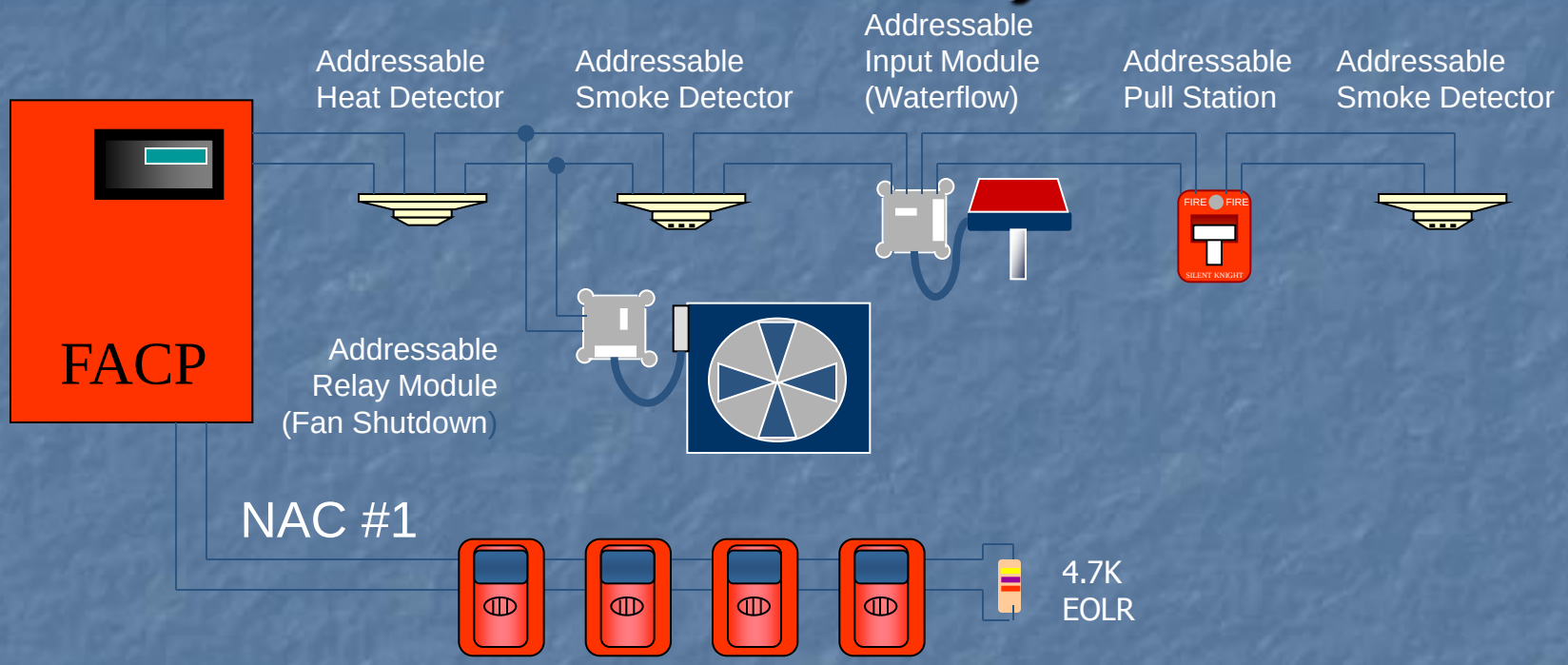
Information transmitted to the central station is by zone at best. Many panels send Alarm, Supv, Trbl only.

Addressable Systems



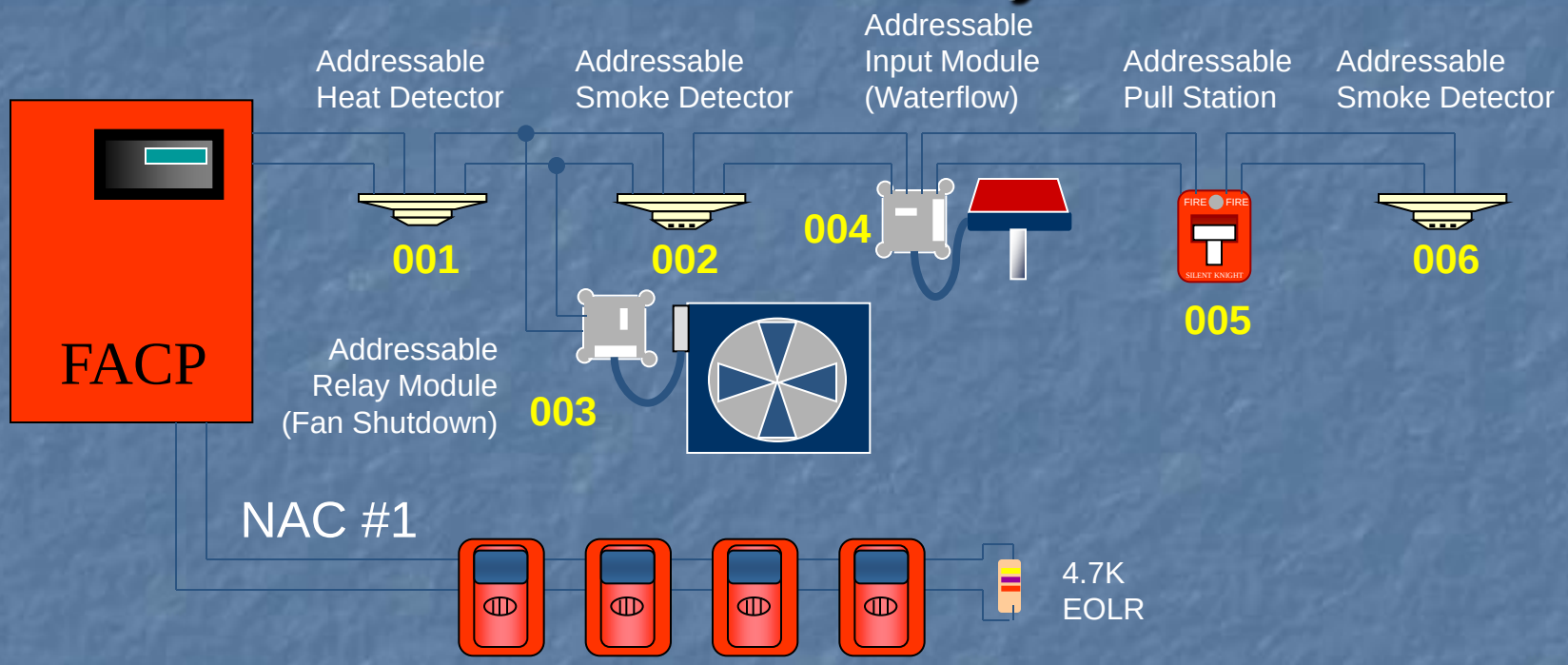
- An addressable systems point capacity is determined by the amount of SLC “Signaling Line Circuits” it contains.
- Each SLC circuit provides power, communication, & supervision for all of the devices connected to it.
- Each SLC can accommodate over 100 addressable devices, depending upon the manufacturer.

Addressable Systems



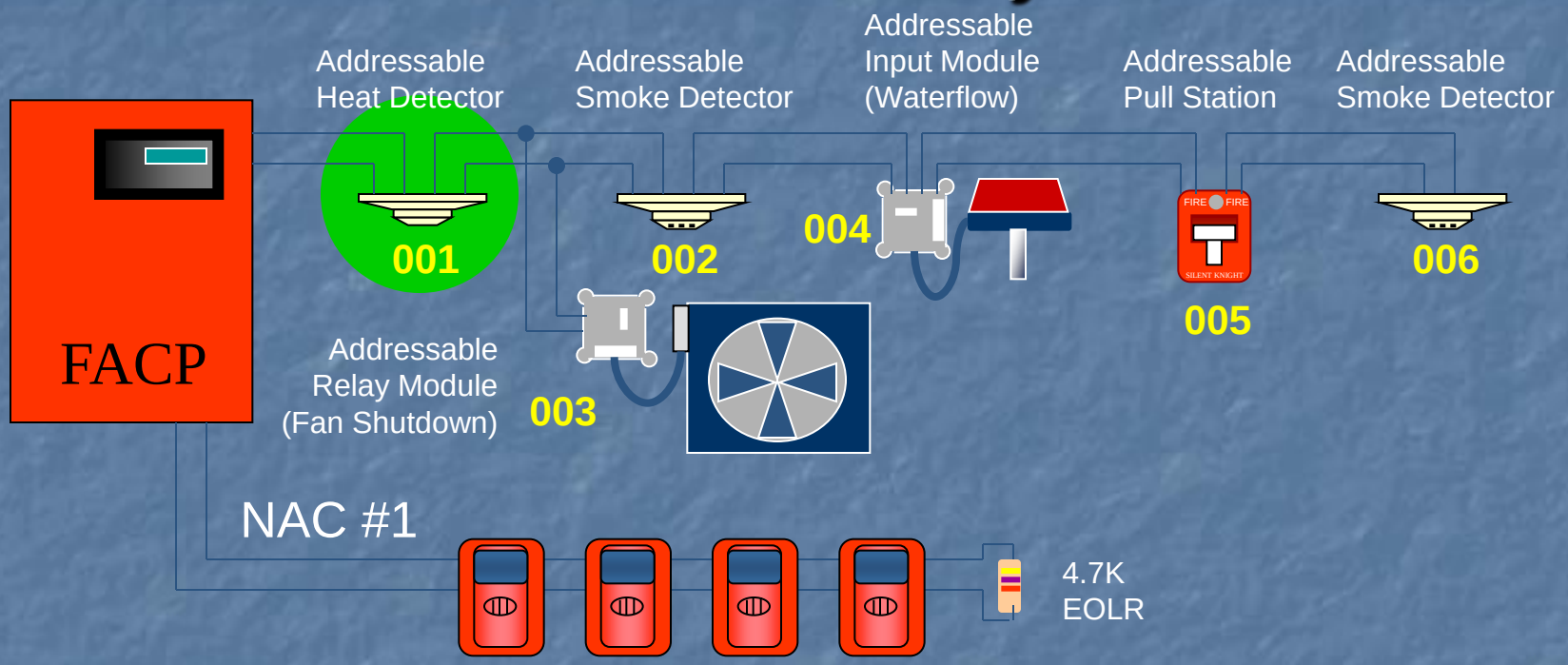
Each SLC loop can contain a variety of addressable devices. Non-addressable devices are connected via addressable module.

Addressable Systems



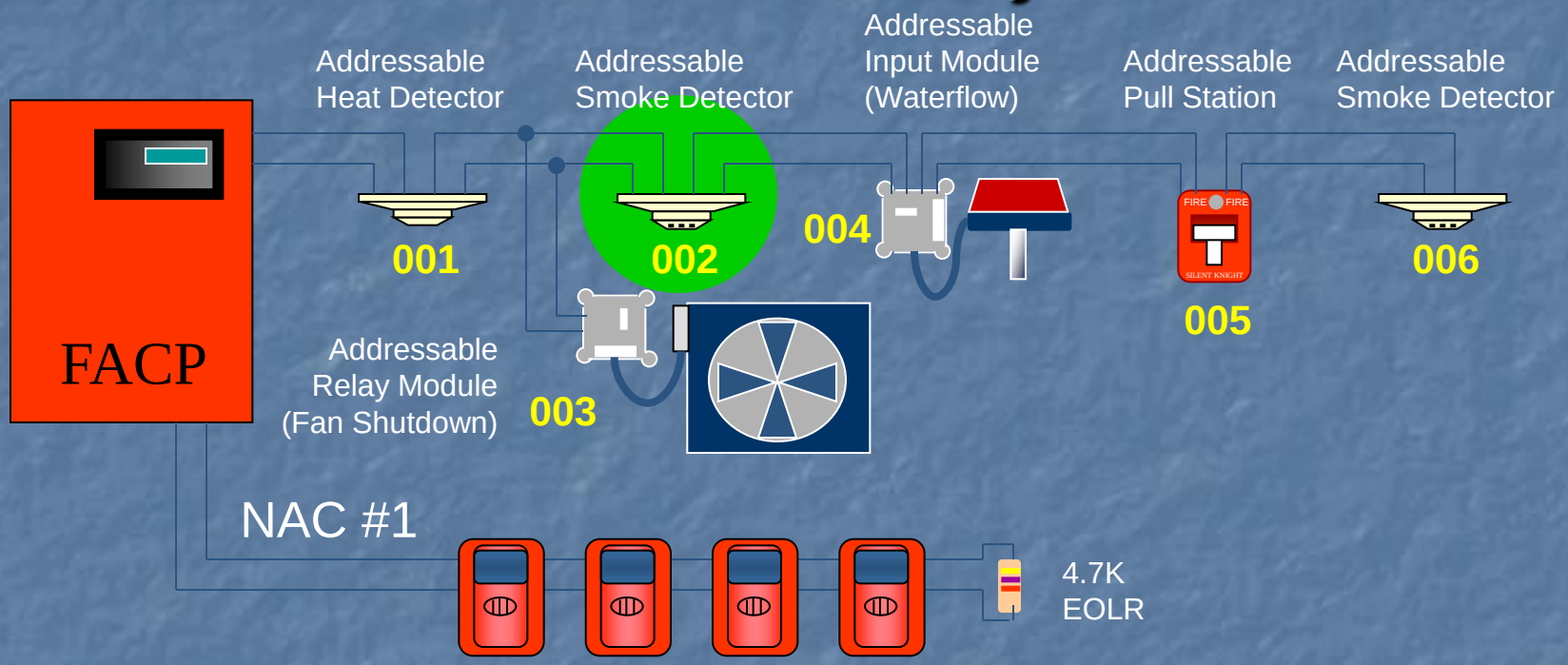
Each point on the SLC loop is given a unique address when installed.

Addressable Systems



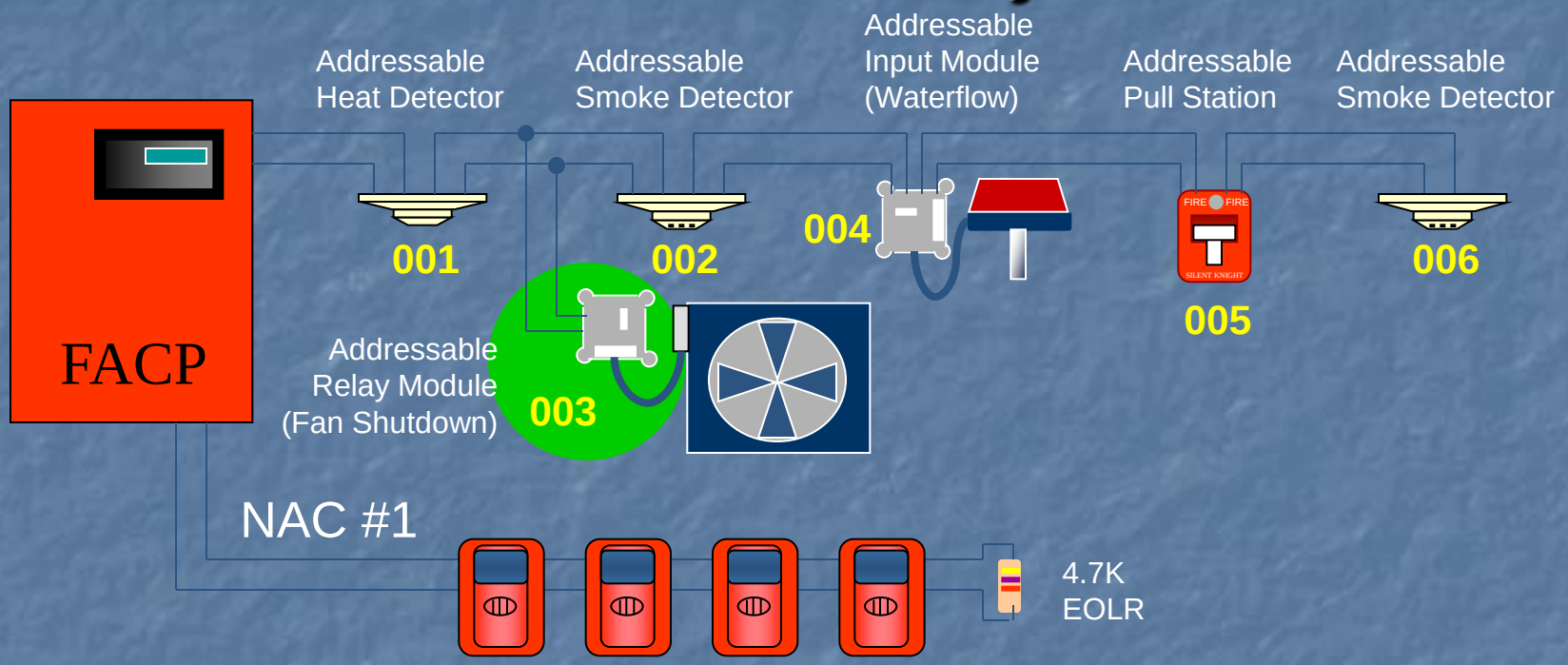
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



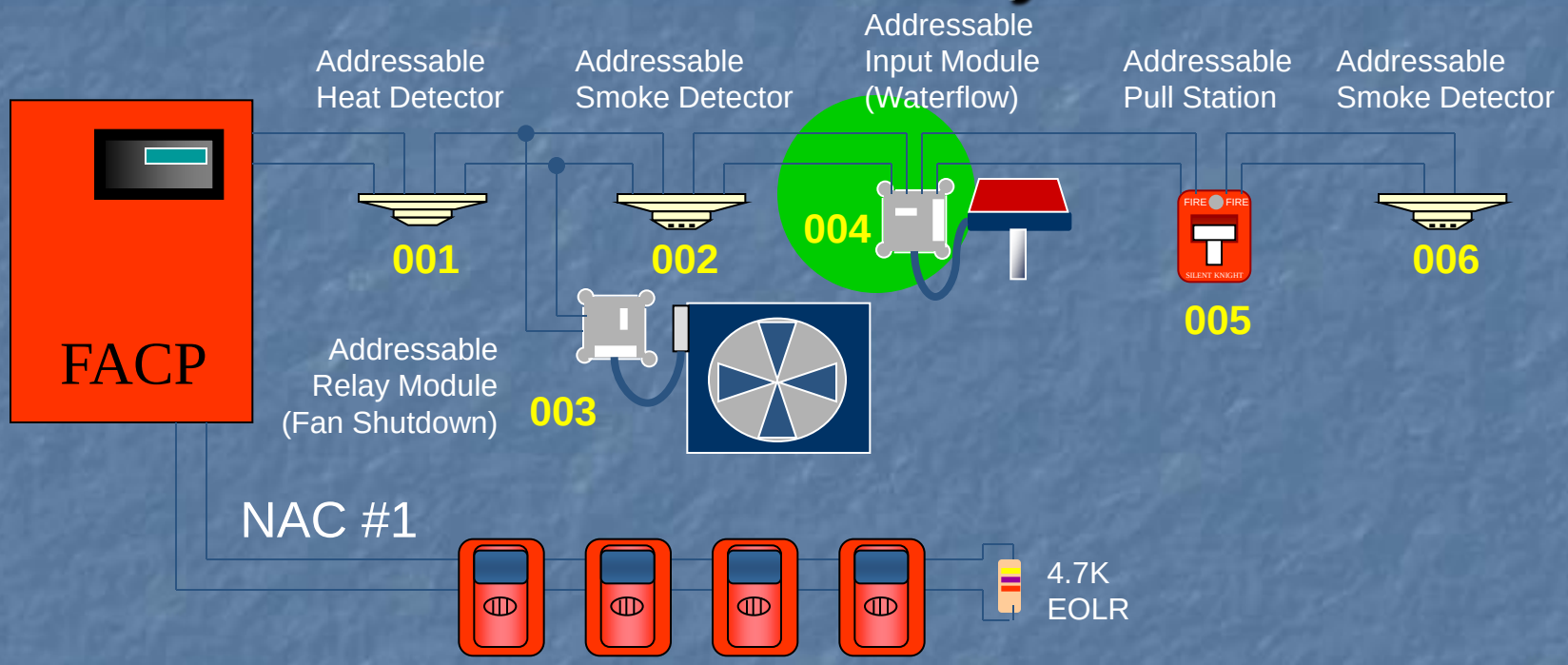
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



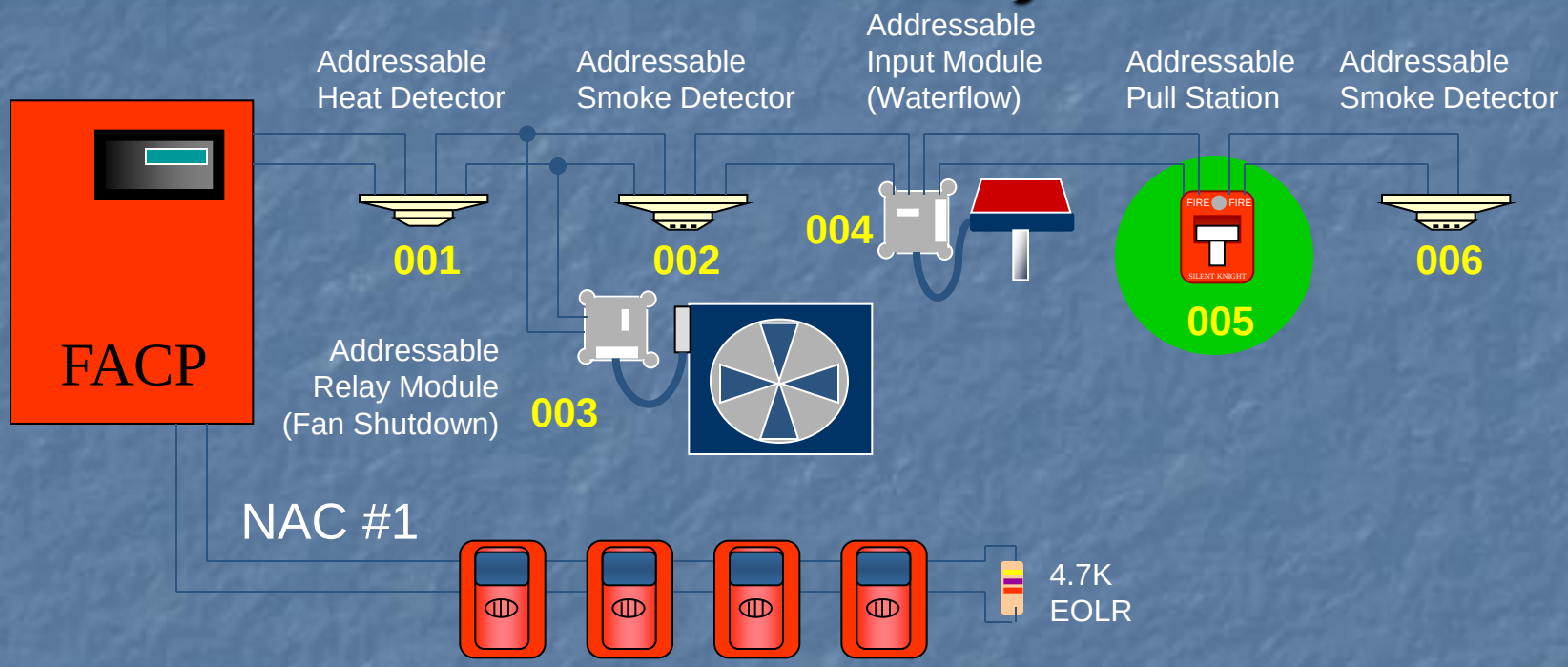
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



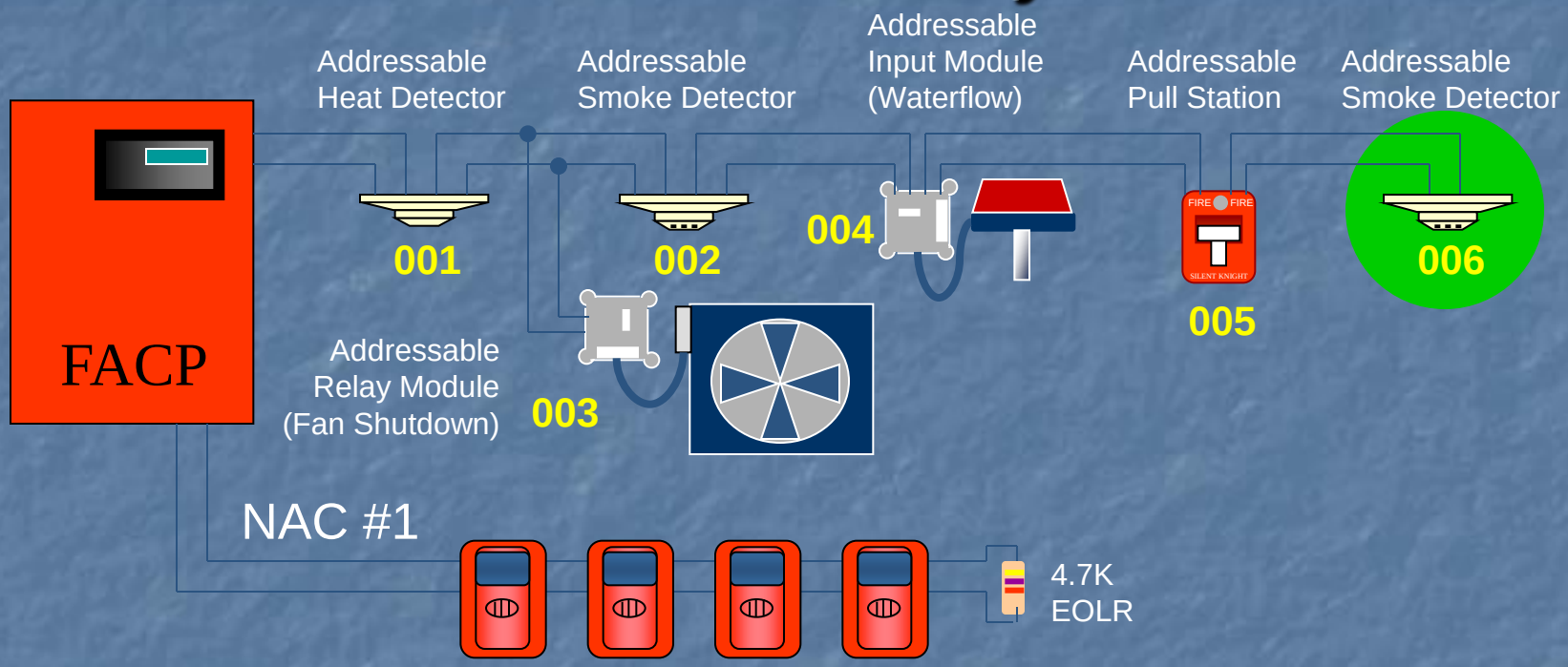
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



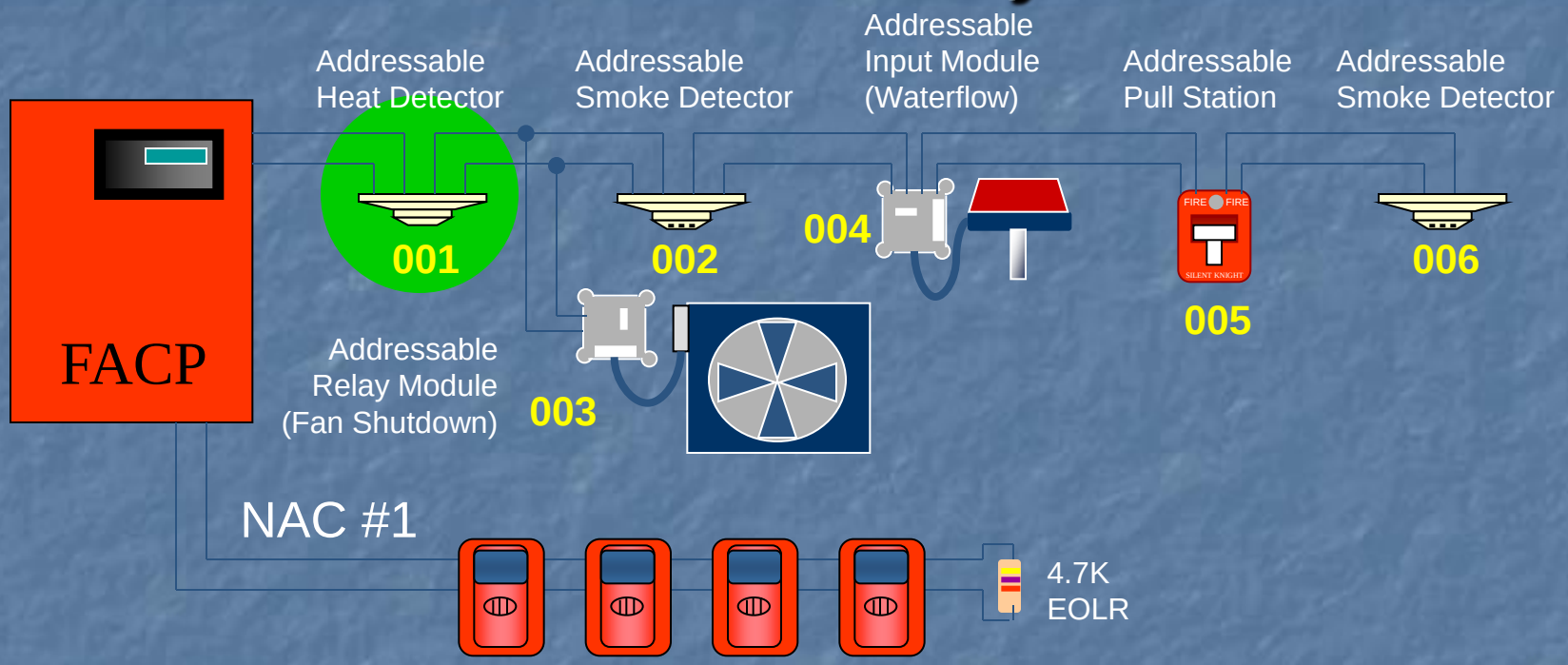
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



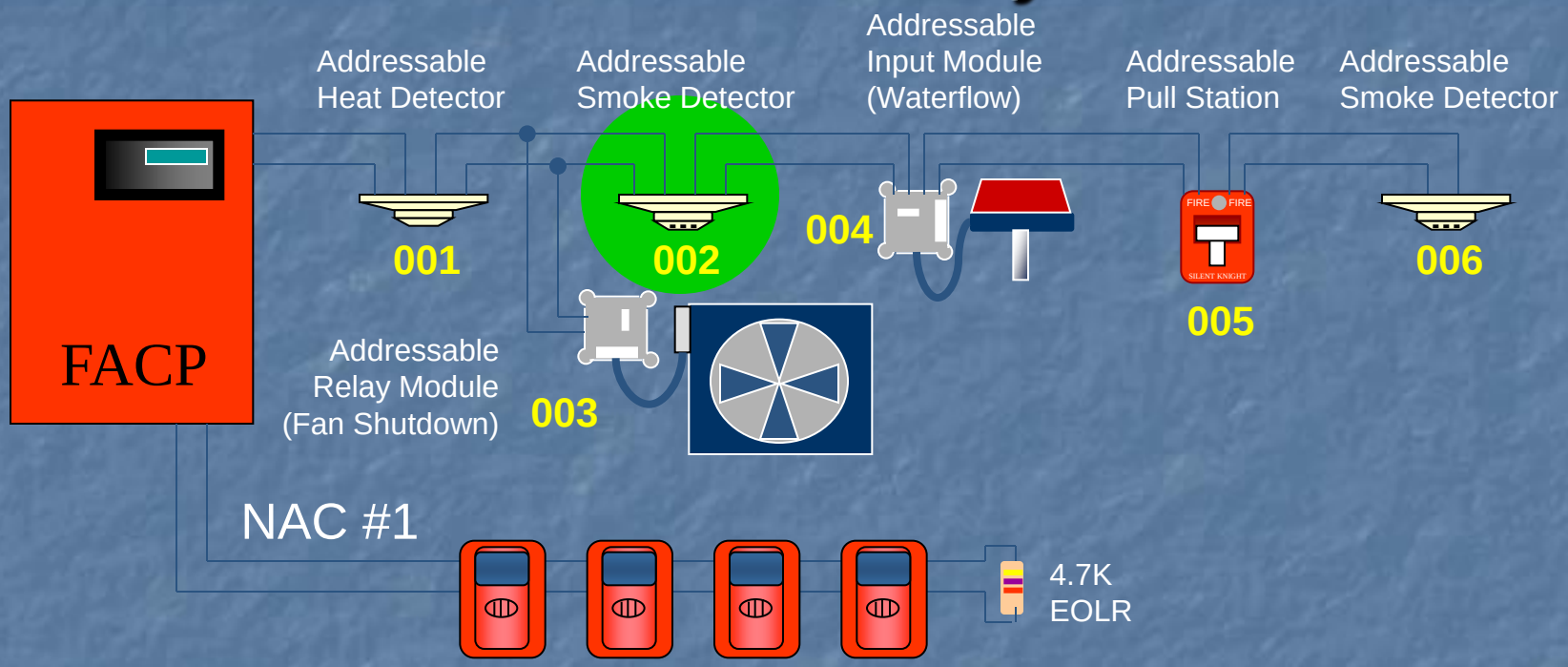
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



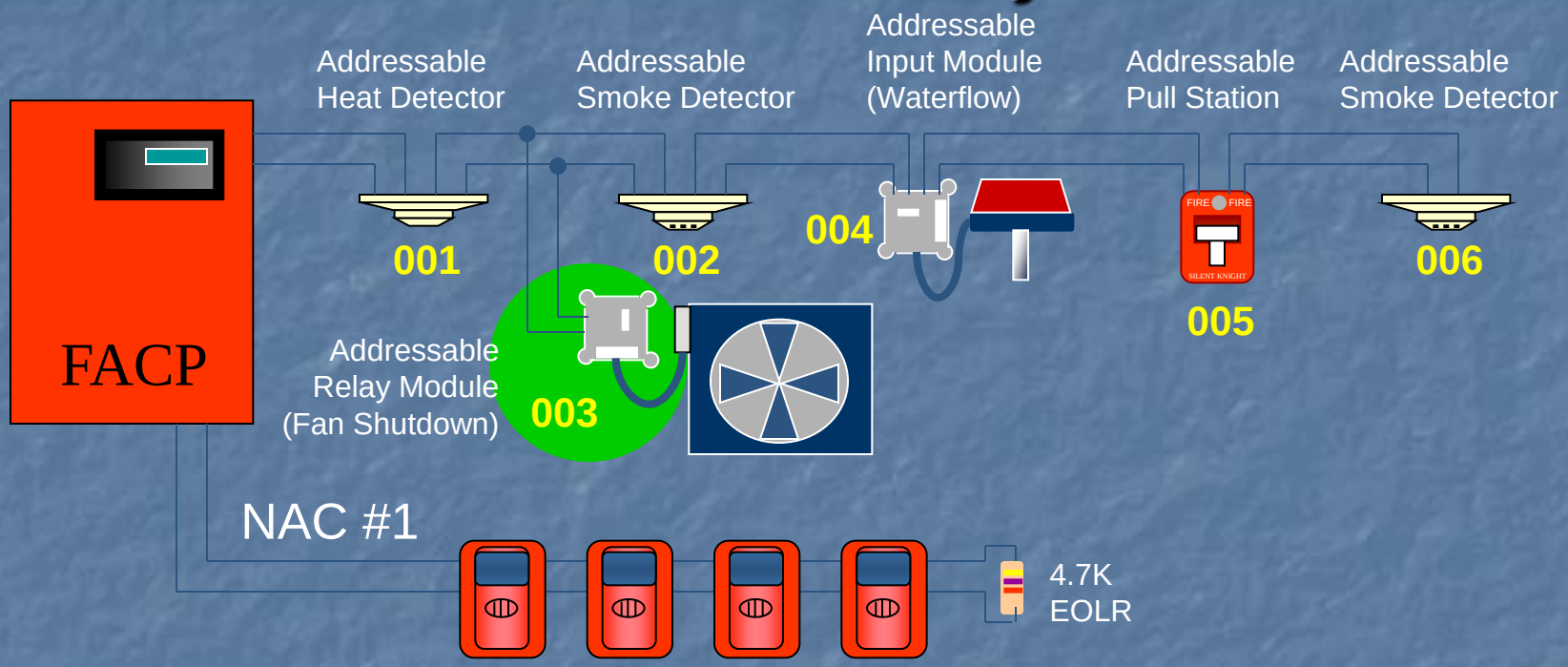
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



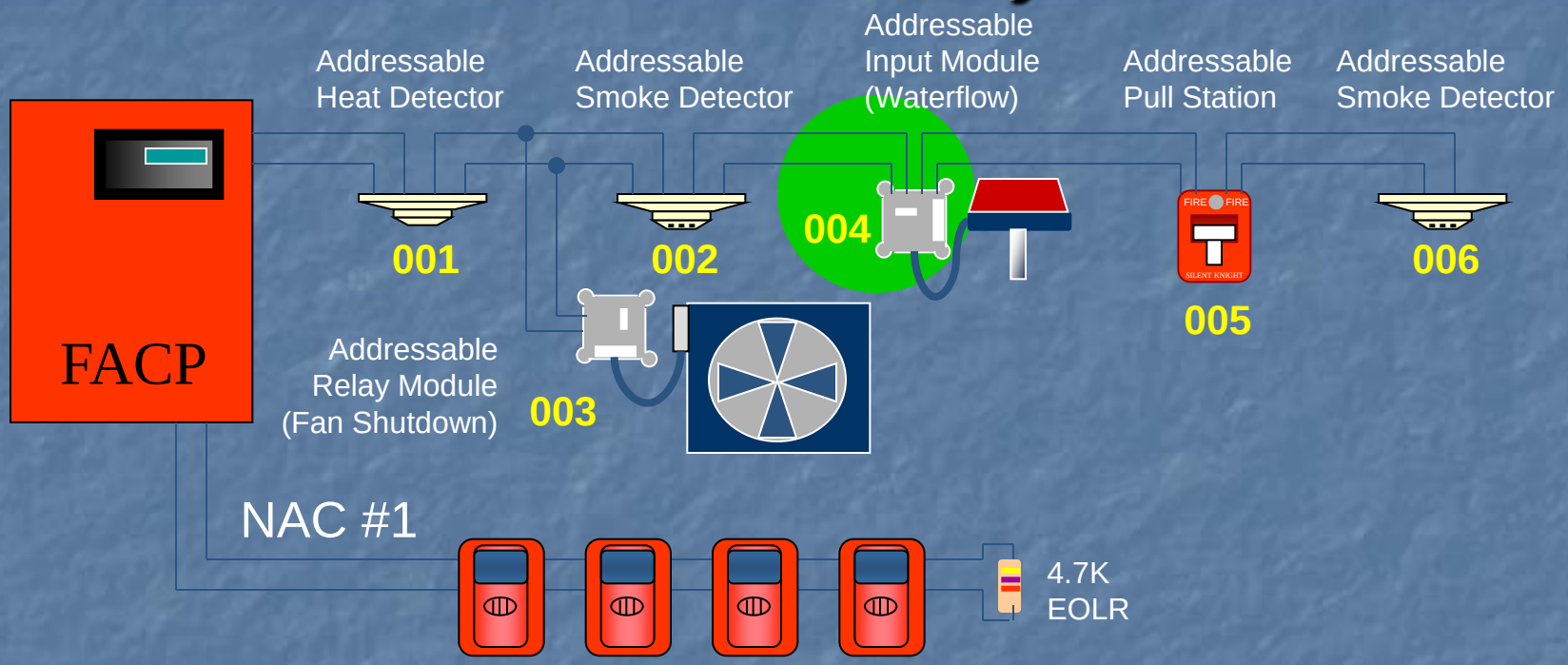
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



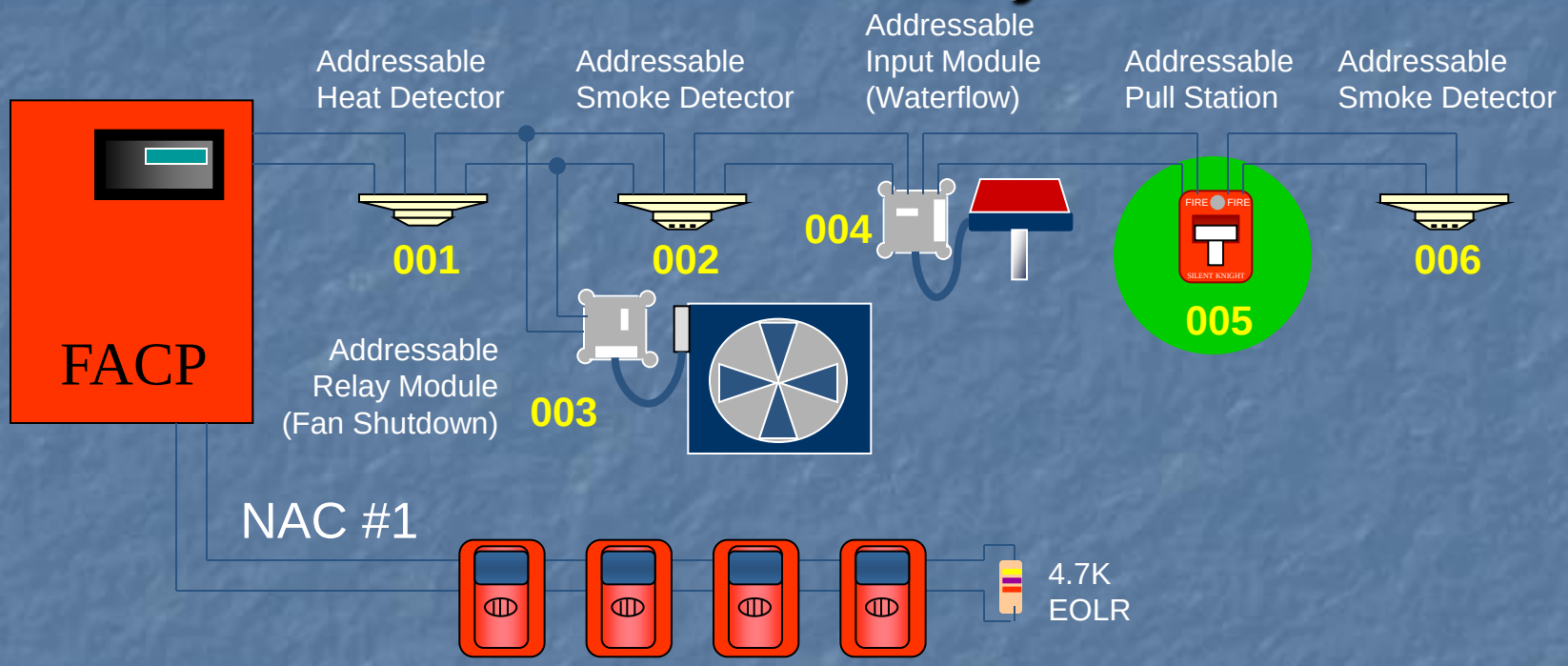
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



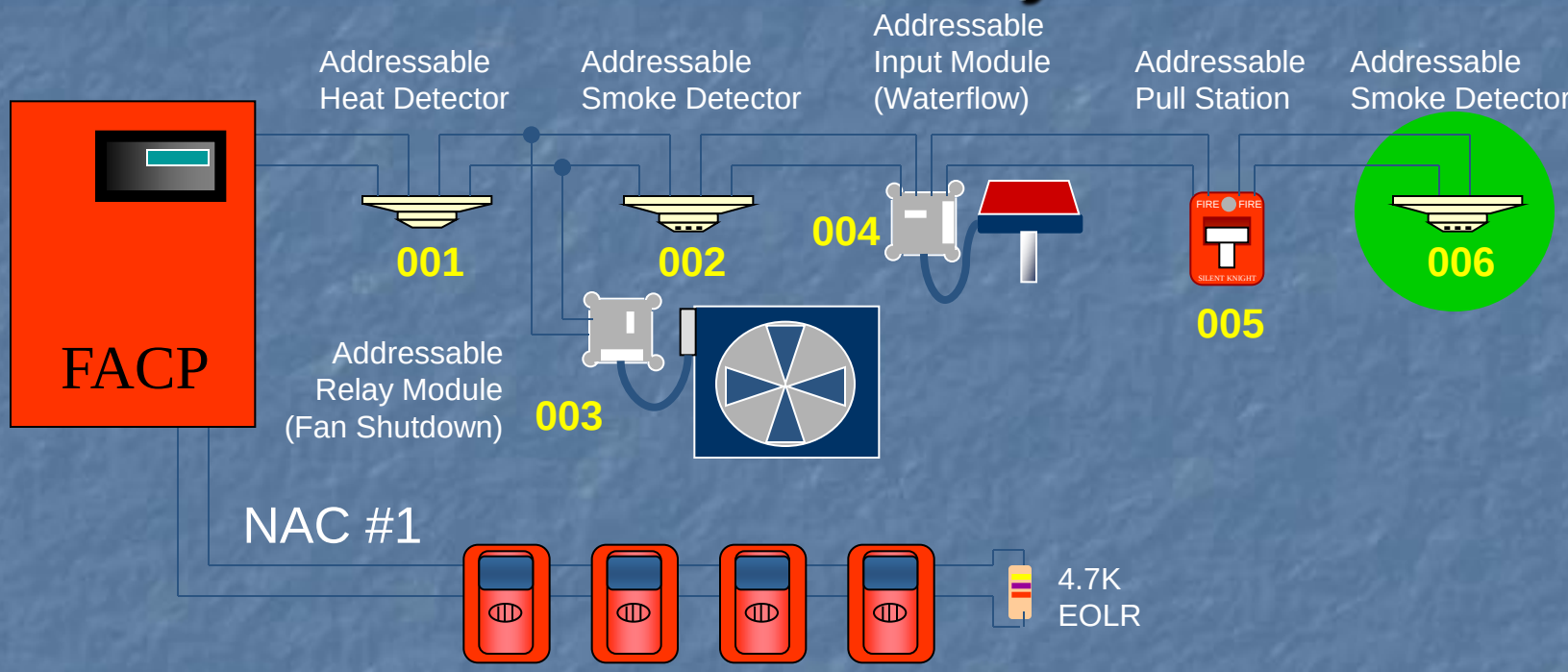
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



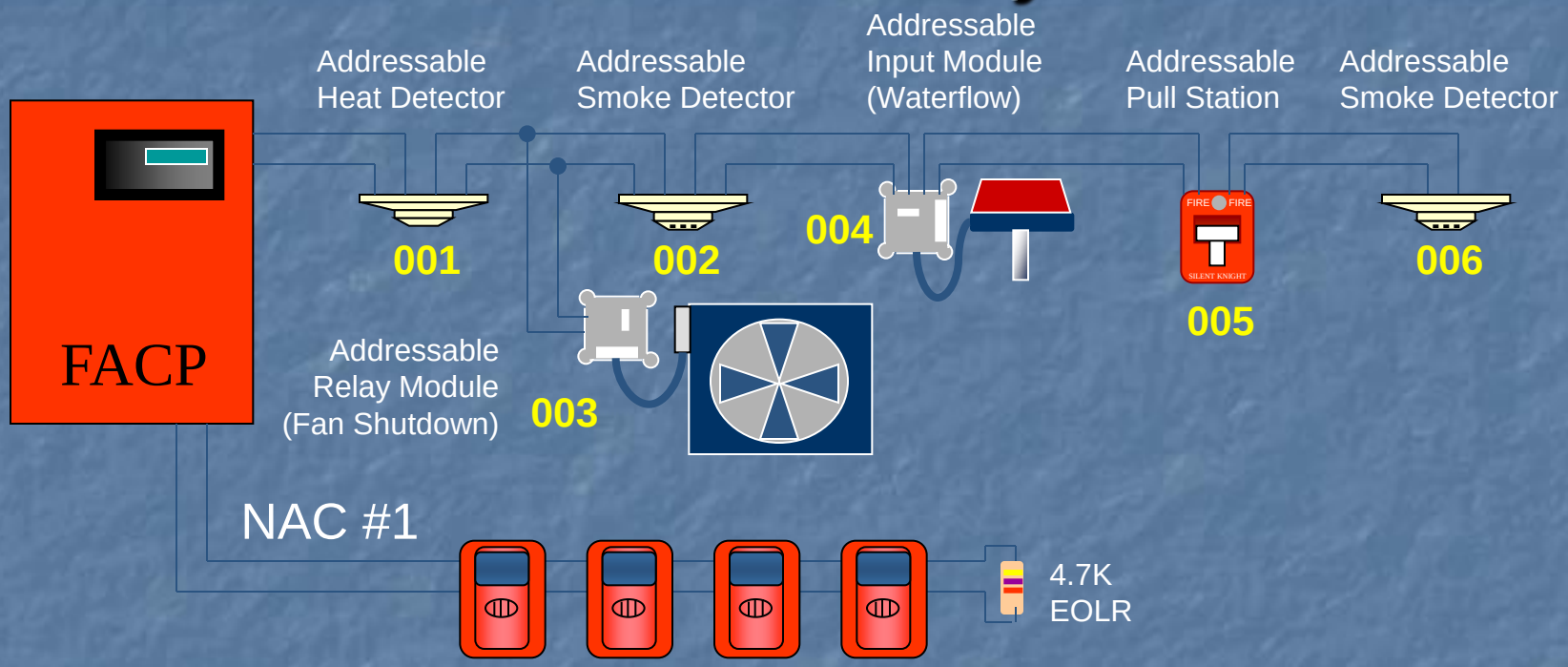
Supervision is accomplished from the panel by polling the devices on the SLC loop.

Addressable Systems



Supervision is accomplished from the panel by polling the devices on the SLC loop.

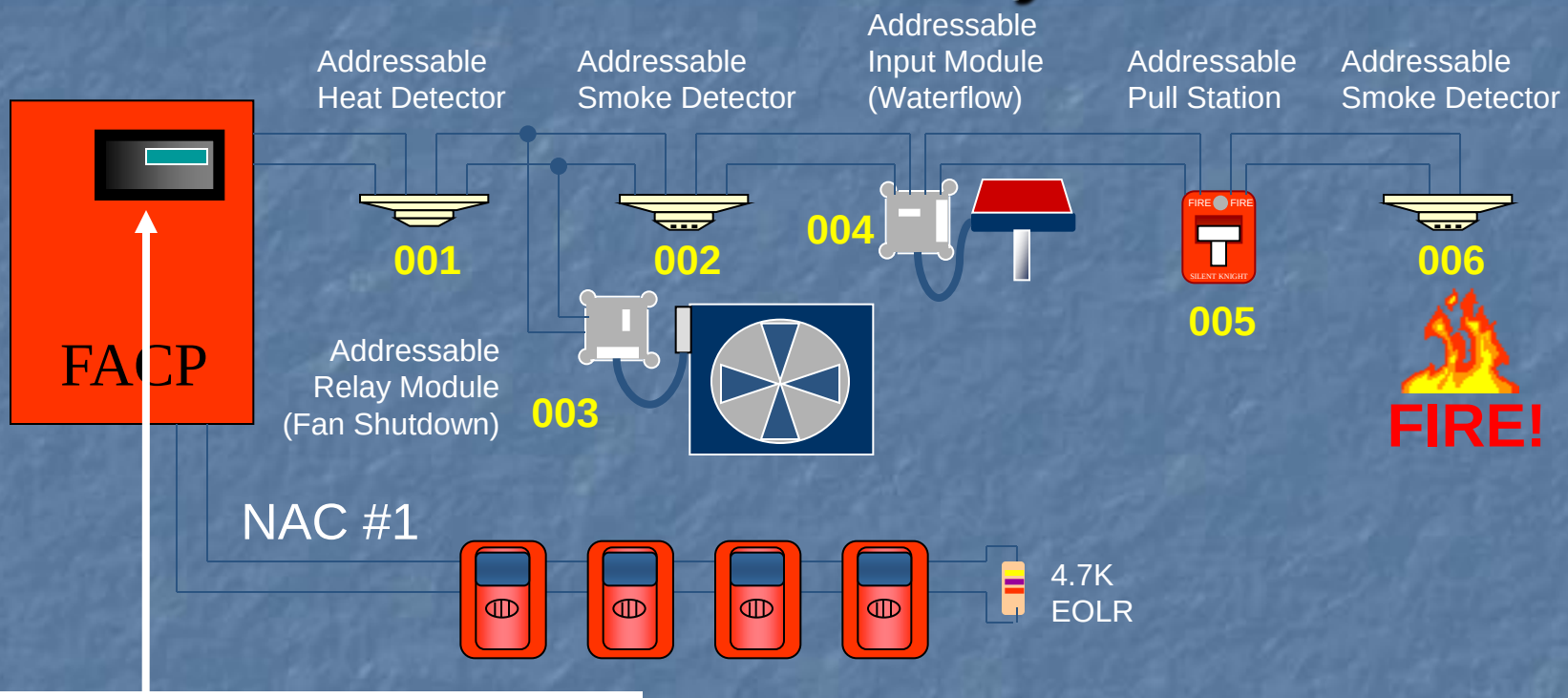
Addressable Systems

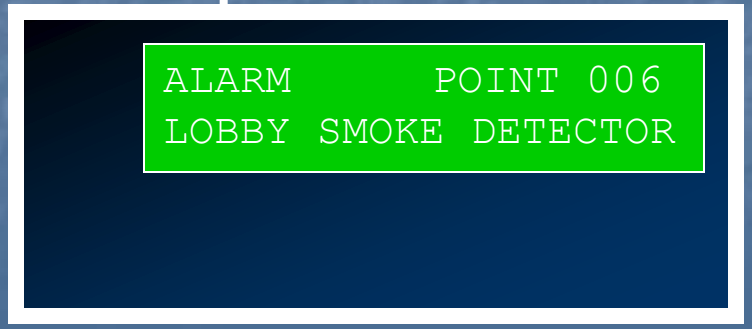


Supervision is accomplished from the panel by polling the devices on the SLC loop.

< Replay

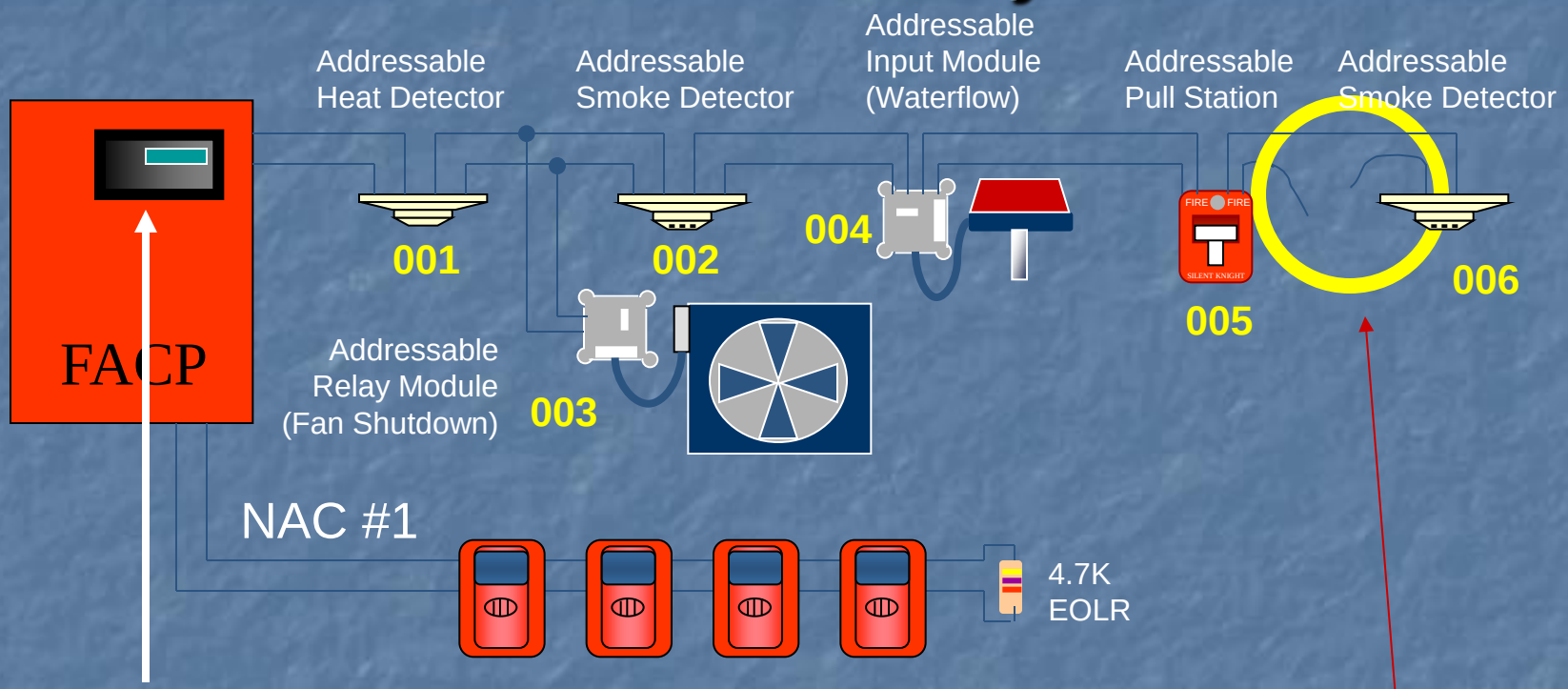
Addressable Systems





Alarm conditions are annunciated by point allowing responding personnel to quickly find the fire.

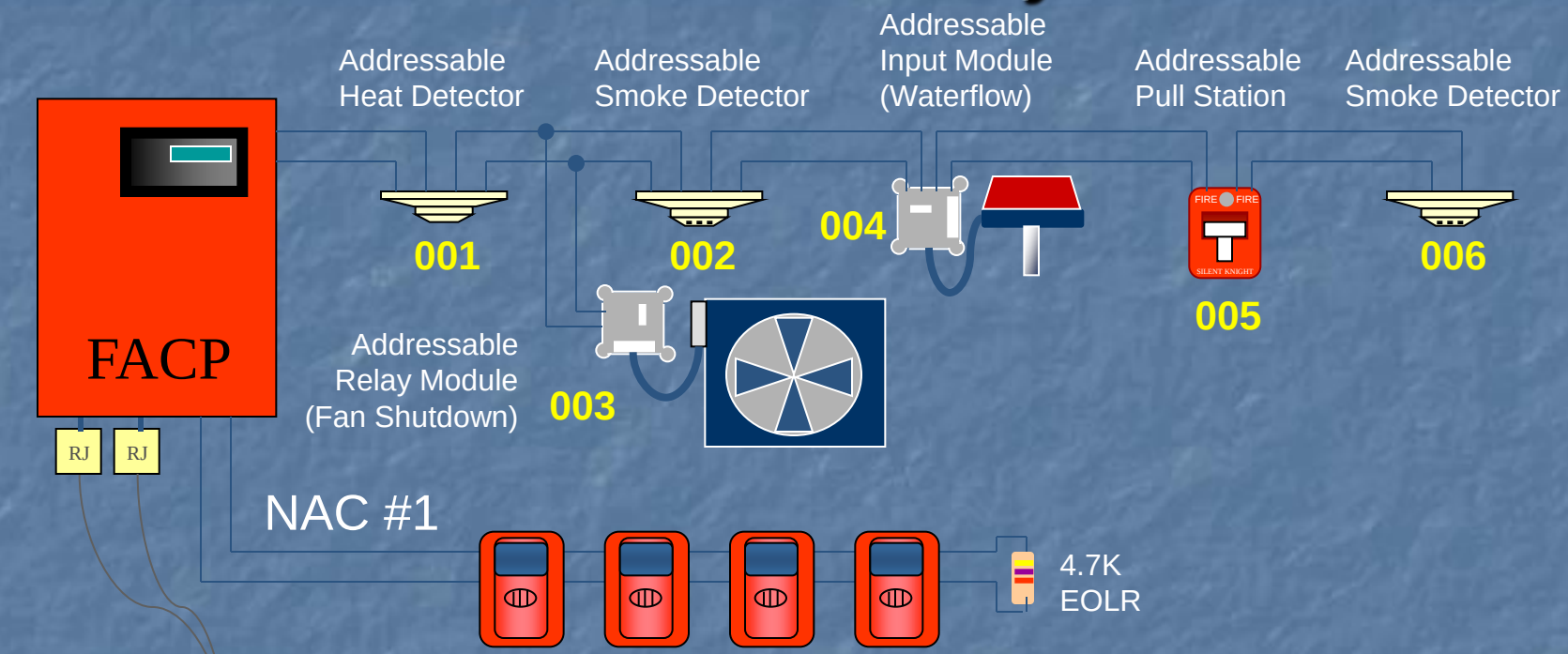
Addressable Systems




```
TRBL  POINT 006
DISCONNECTED
LOBBY SMOKE DETECTOR
```

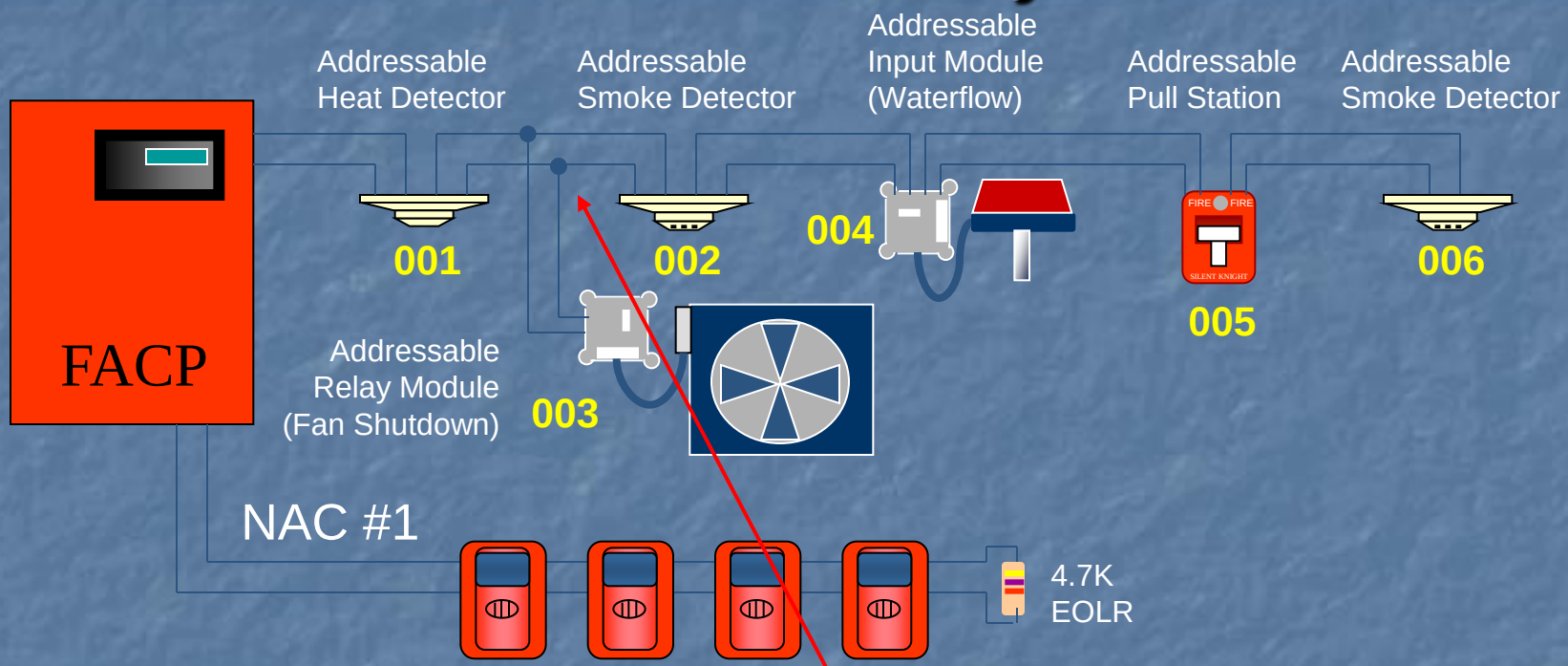
Trouble conditions can be located more quickly by analyzing the affected points.

Addressable Systems



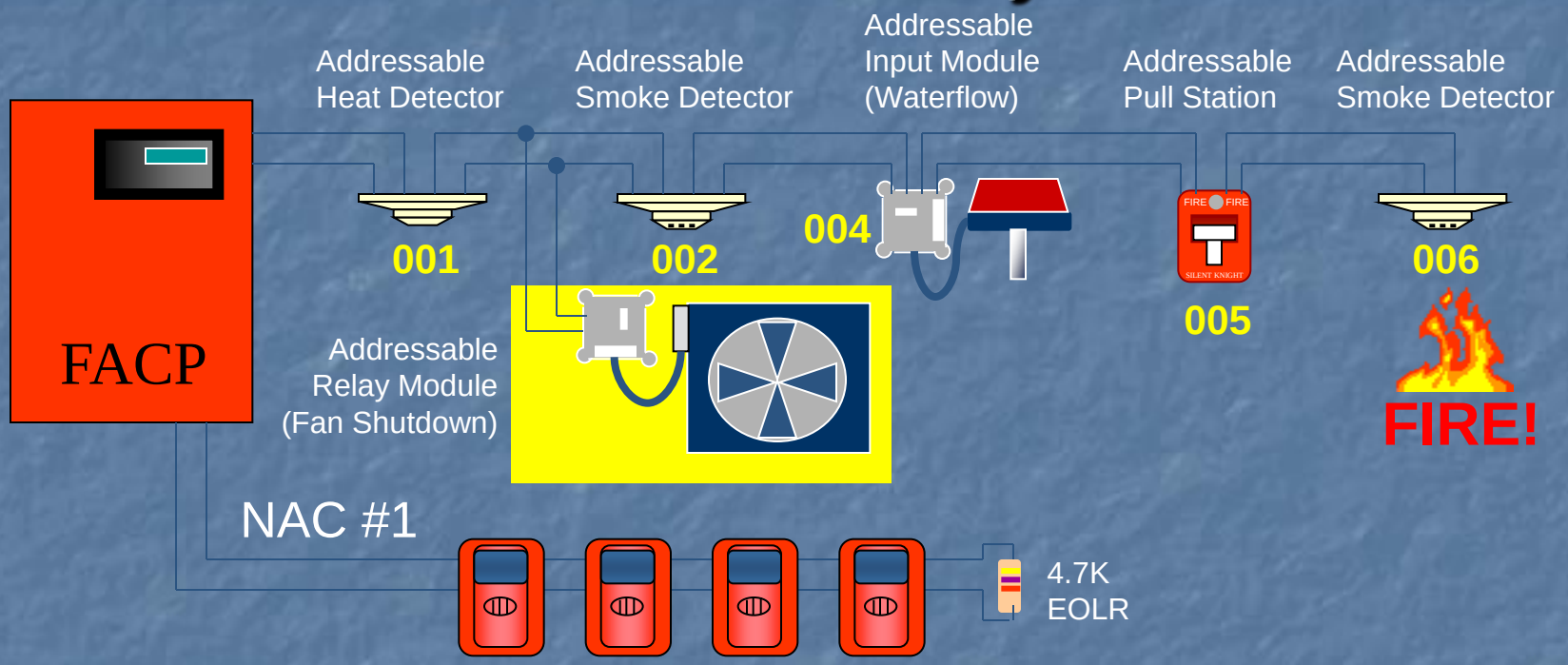
More detailed information can be sent to the central station aiding in a quick resolution to the problem.

Addressable Systems



Since supervision is accomplished through polling, t-tapped wiring is permitted. (Class B wiring)

Addressable Systems



Many systems support flexible input/output programming to link initiating devices to outputs.

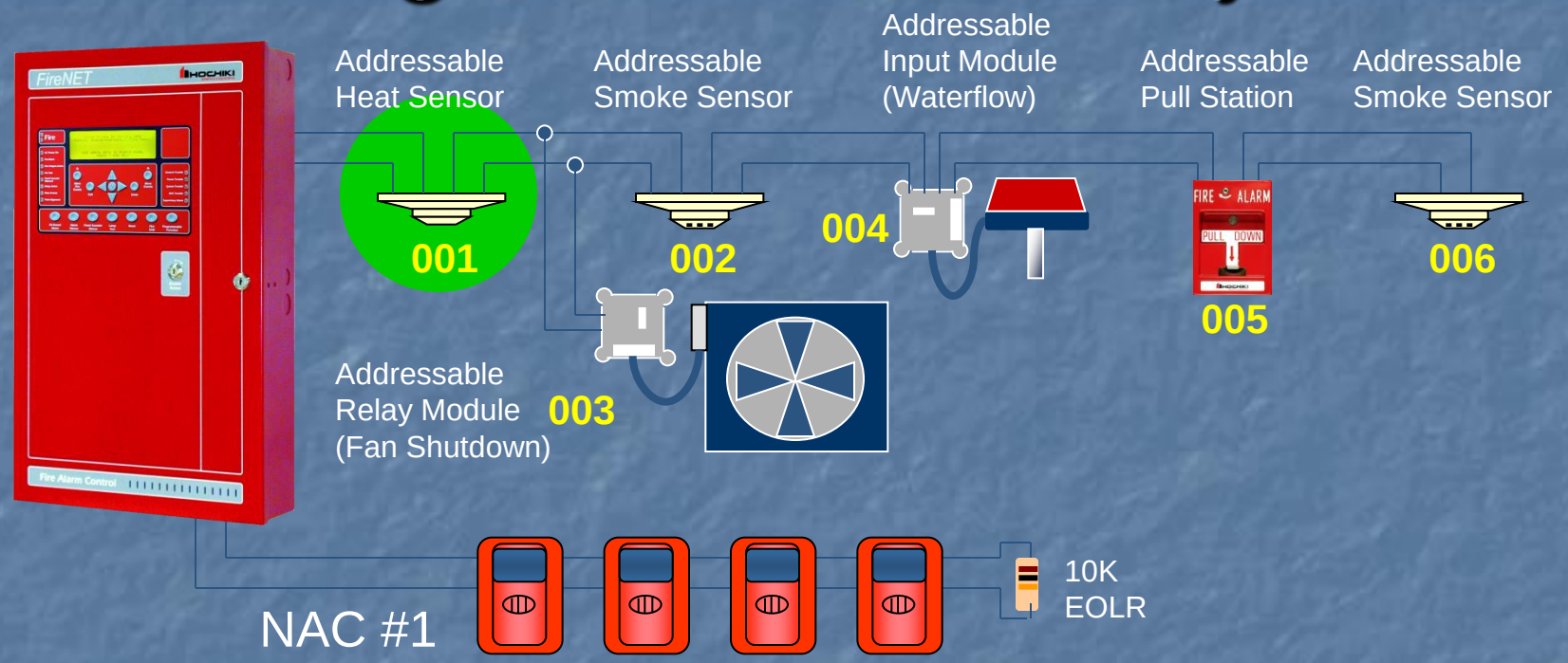
Comparison

- Conventional
  - Lower initial equipment costs.
  - Wide range of compatible devices.
  - Can be easier to program.
  - Limited expansion capability.
- Addressable
  - Easier to install.
  - More system status information at the panel and central station.
  - Input/Output programming much more flexible.
  - Usually much more room available to expand.

Analog Addressable Systems

- Detectors in an analog addressable systems become “sensors” relaying information to the control panel corresponding to how much smoke or heat that detector is sensing.
- The control panel makes the decisions based on this information when to alarm etc.

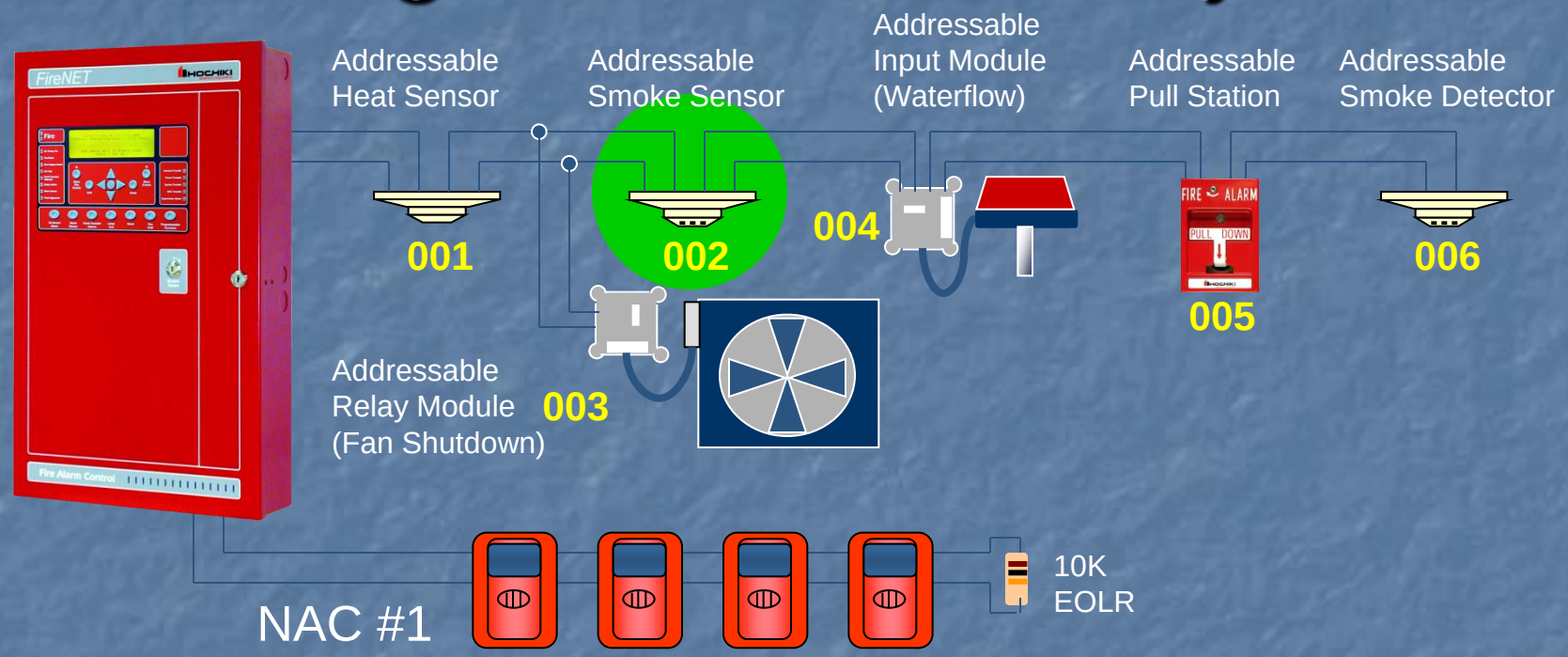
Analog Addressable Systems




```
HEAT DETECTOR
MECHANICAL ROOM
POINT 001     A=062
NORMAL        F=190
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

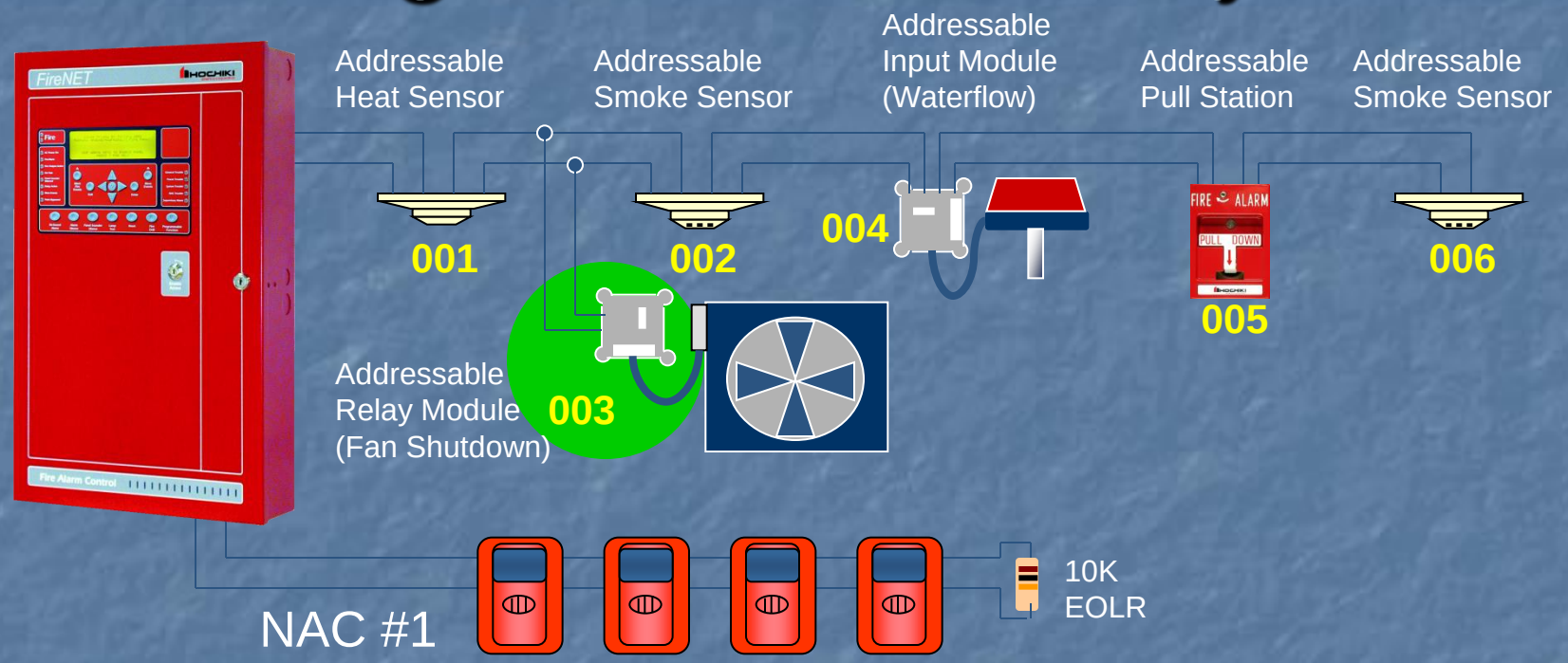
Analog Addressable Systems




```
SMOKE DETECTOR
LOBBY NORTH
POINT 002      A=060
NORMAL         F=188
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

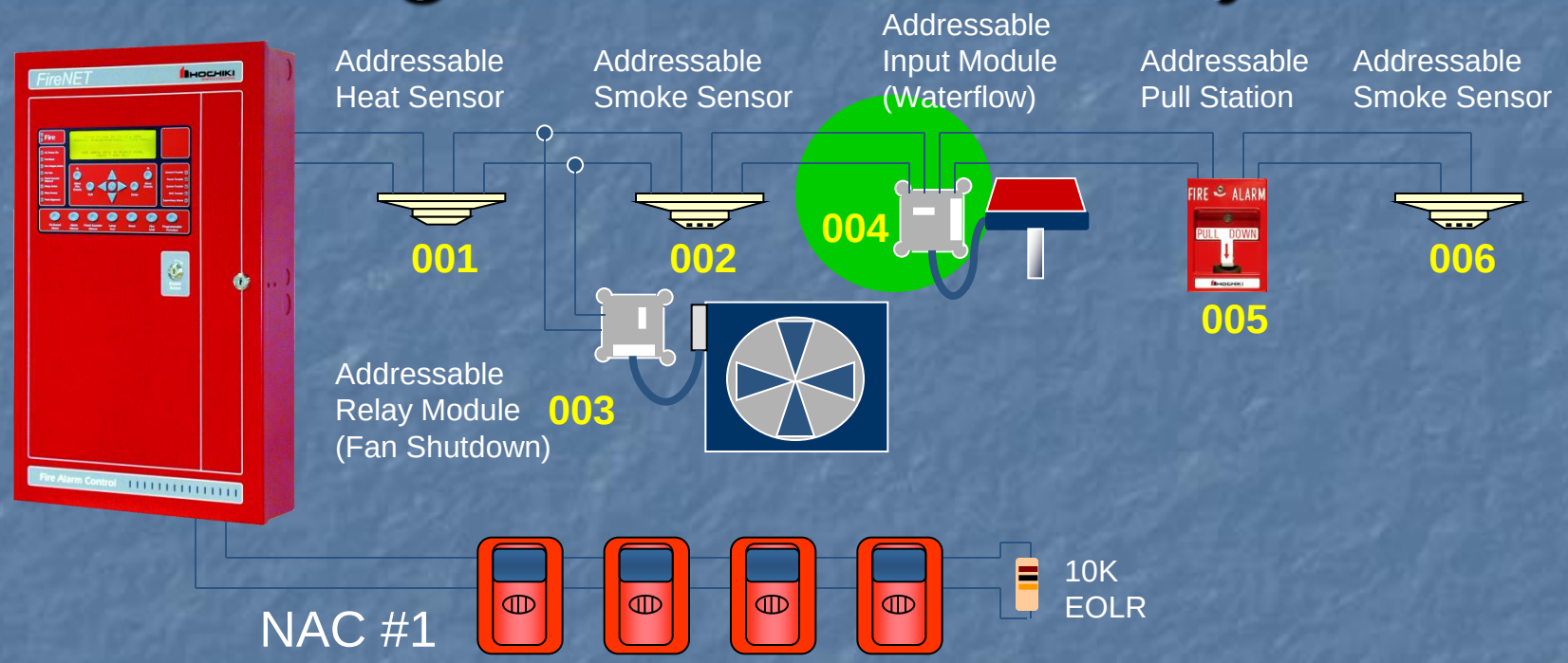
Analog Addressable Systems




```
RELAY MODULE
FAN SHUTDOWN
POINT 003      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

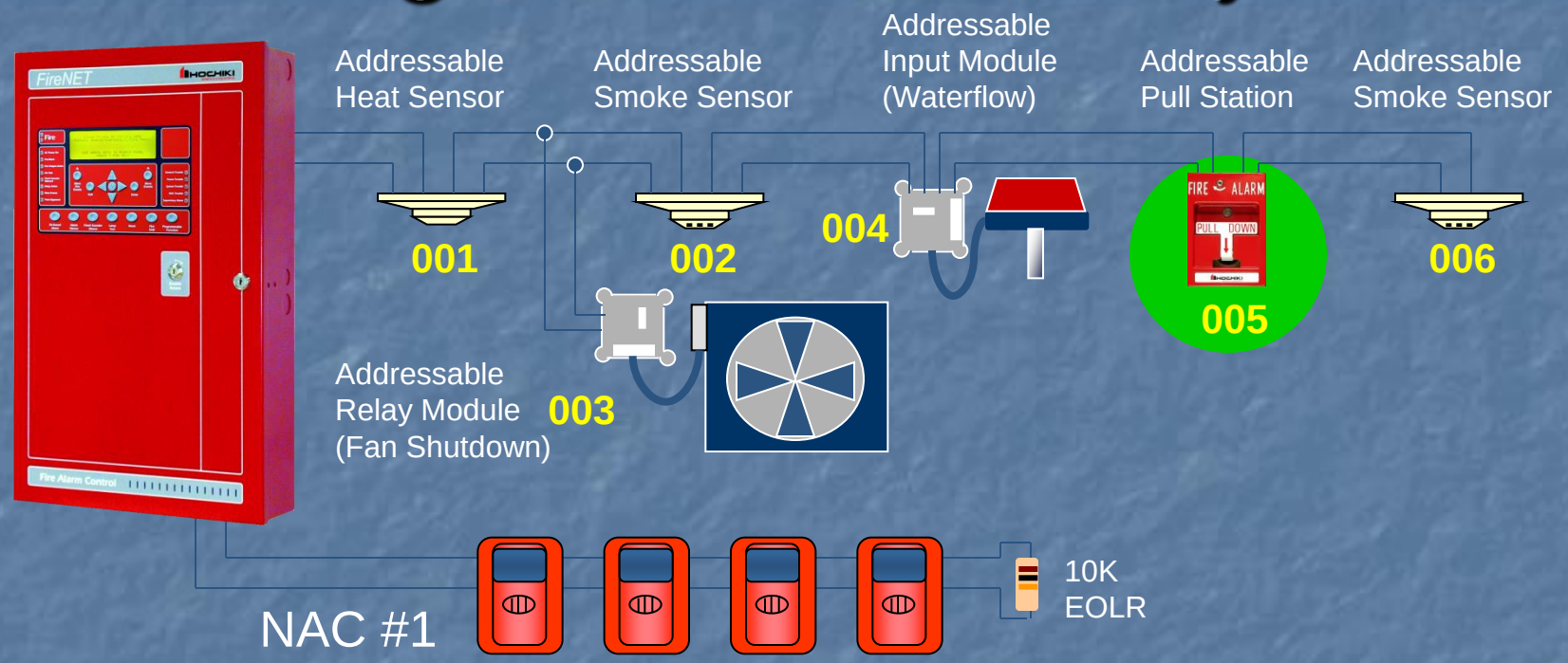
Analog Addressable Systems




```
INPUT MODULE
WATERFLOW
POINT 004      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

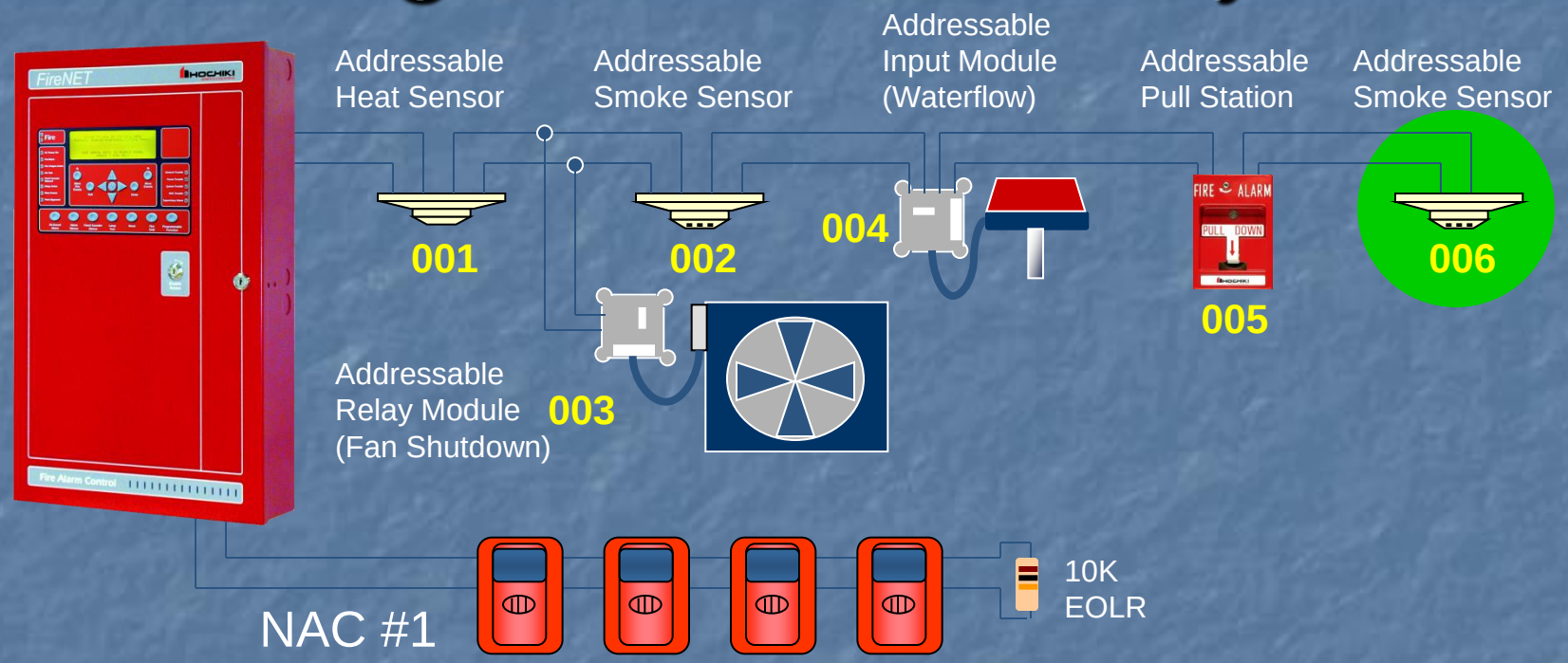
Analog Addressable Systems




```
INPUT MODULE
MANUAL PULL
POINT 005      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

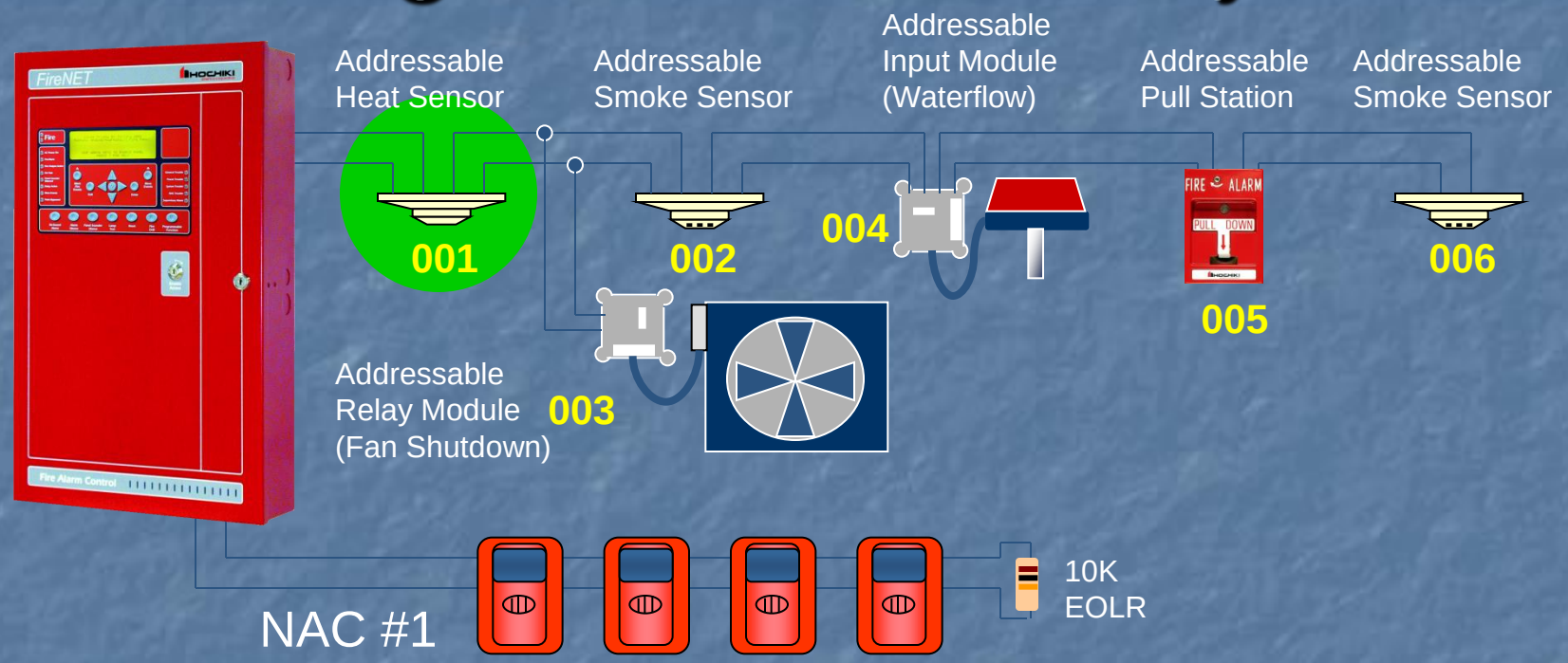
Analog Addressable Systems




```
SMOKE DETECTOR
FRONT DESK
POINT 006      A=061
NORMAL         F=189
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

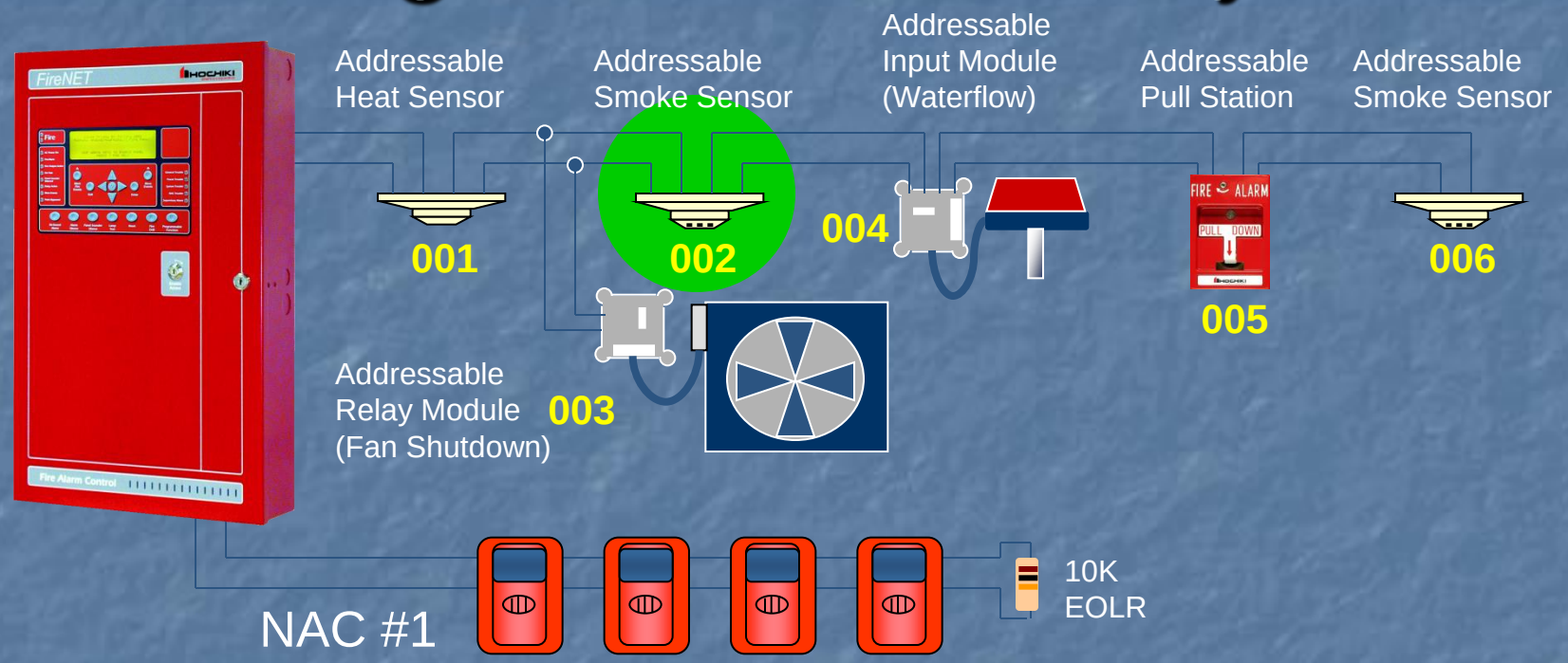
Analog Addressable Systems




```
HEAT DETECTOR
MECHANICAL ROOM
POINT 001     A=062
NORMAL        F=190
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

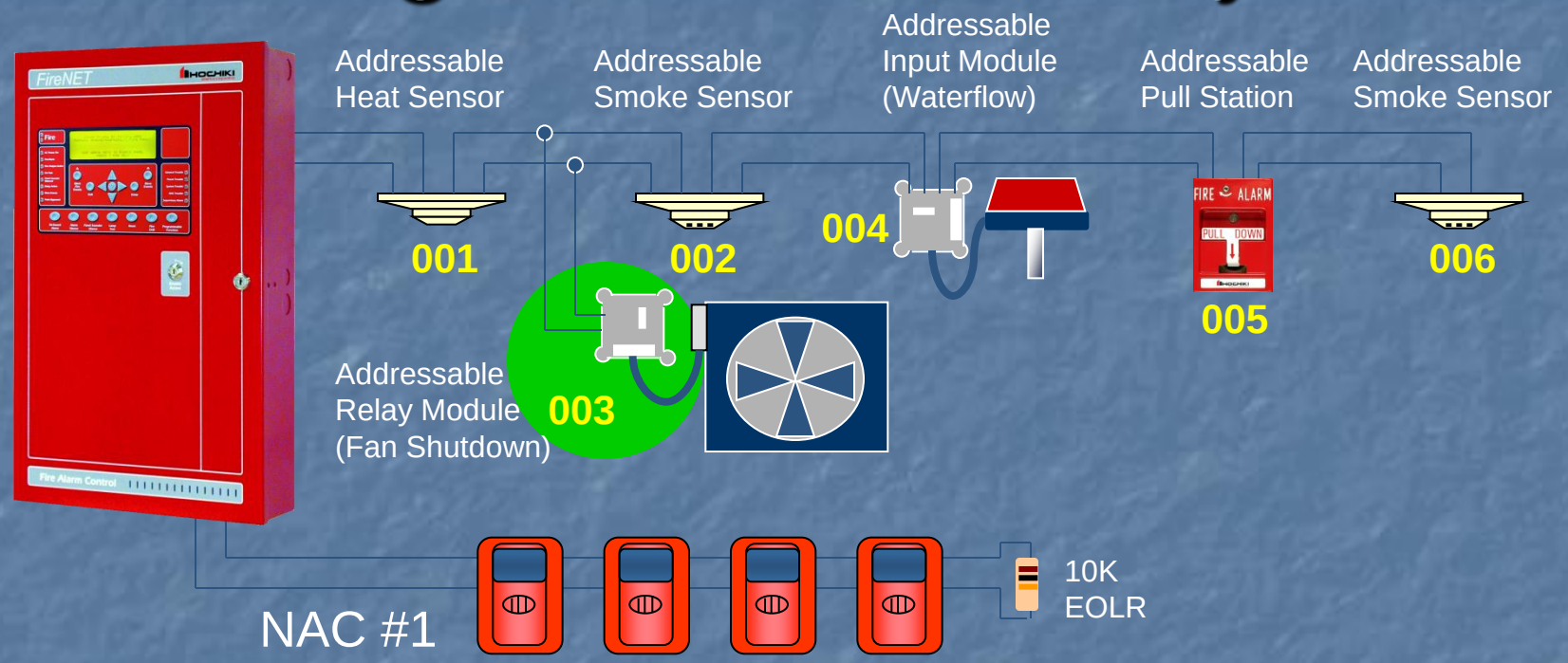
Analog Addressable Systems




```
SMOKE DETECTOR
LOBBY NORTH
POINT 002      A=060
NORMAL         F=188
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

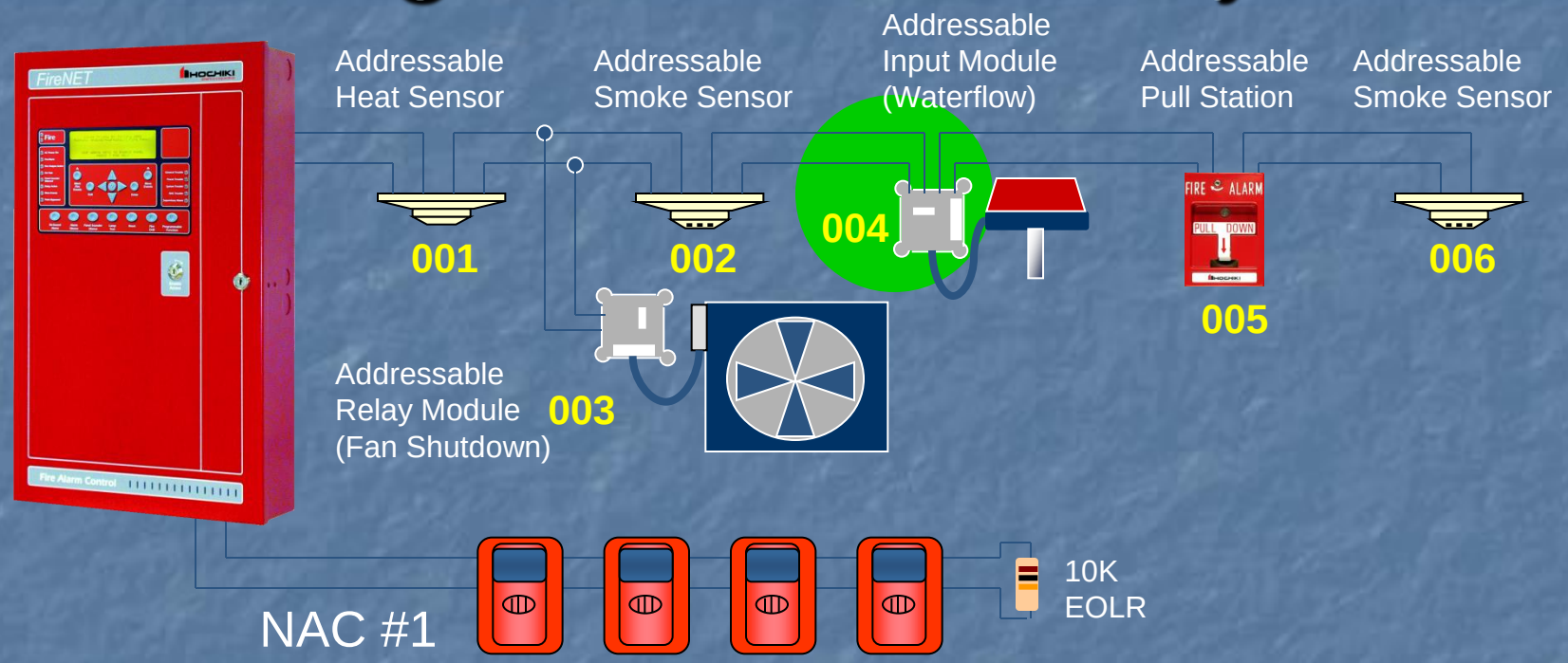
Analog Addressable Systems




```
RELAY MODULE
FAN SHUTDOWN
POINT 003      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

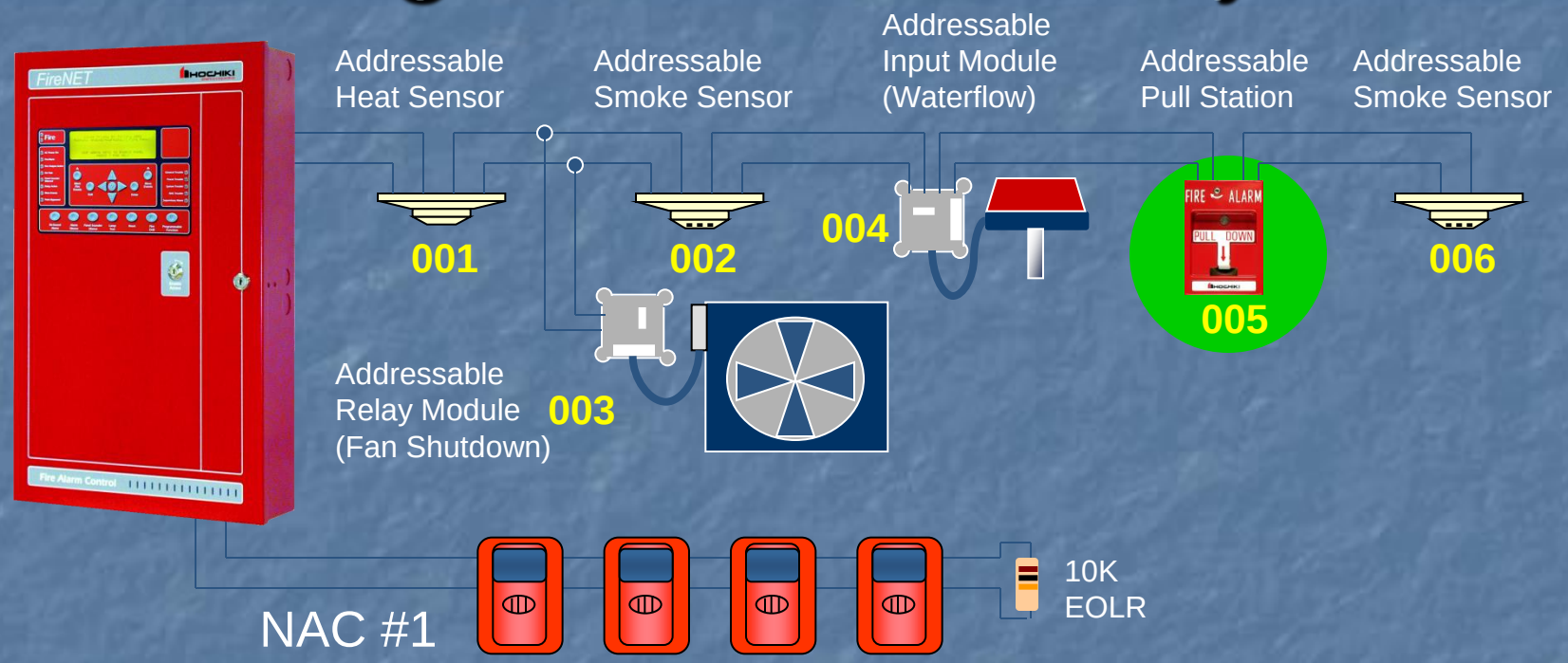
Analog Addressable Systems




```
INPUT MODULE
WATERFLOW
POINT 004      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

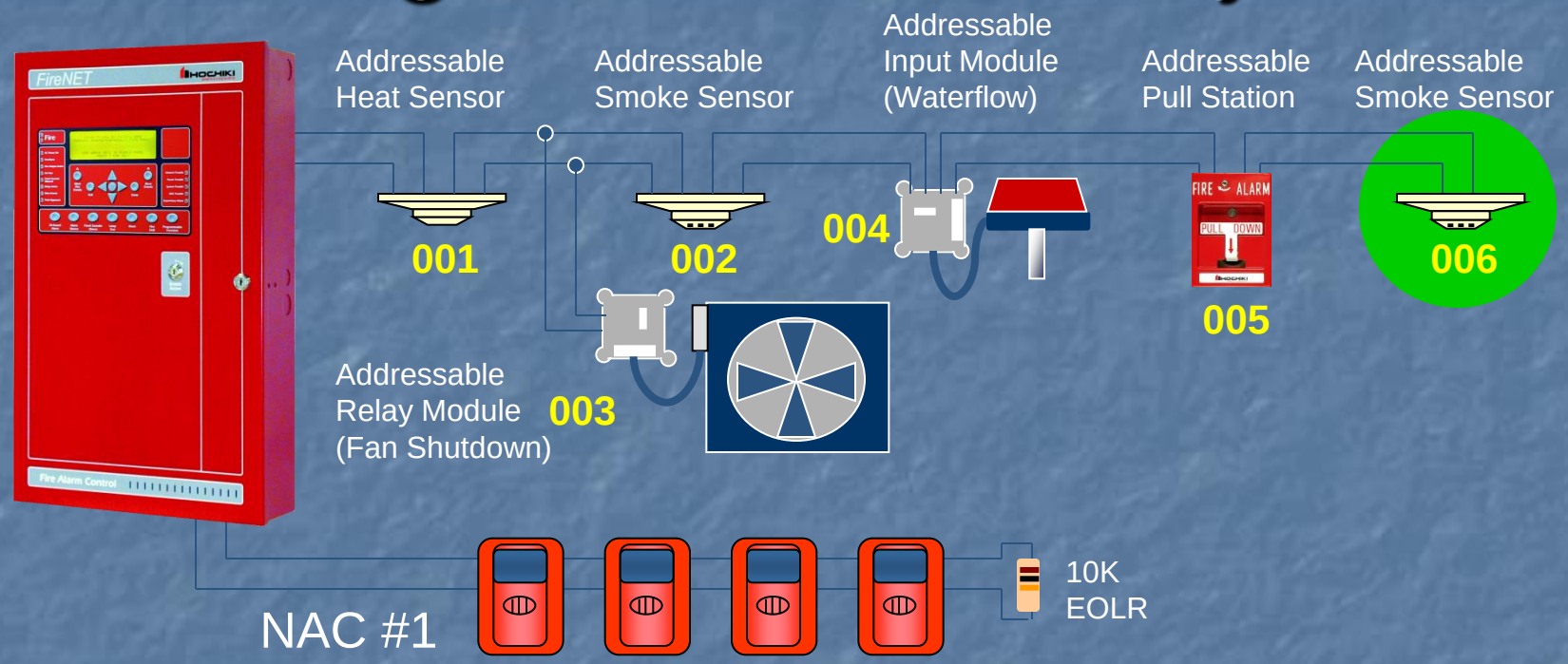
Analog Addressable Systems




```
INPUT MODULE
MANUAL PULL
POINT 005      A=N/A
NORMAL         F=N/A
```

Supervision is still checked by polling. In addition an analog value is transmitted to the panel for processing.

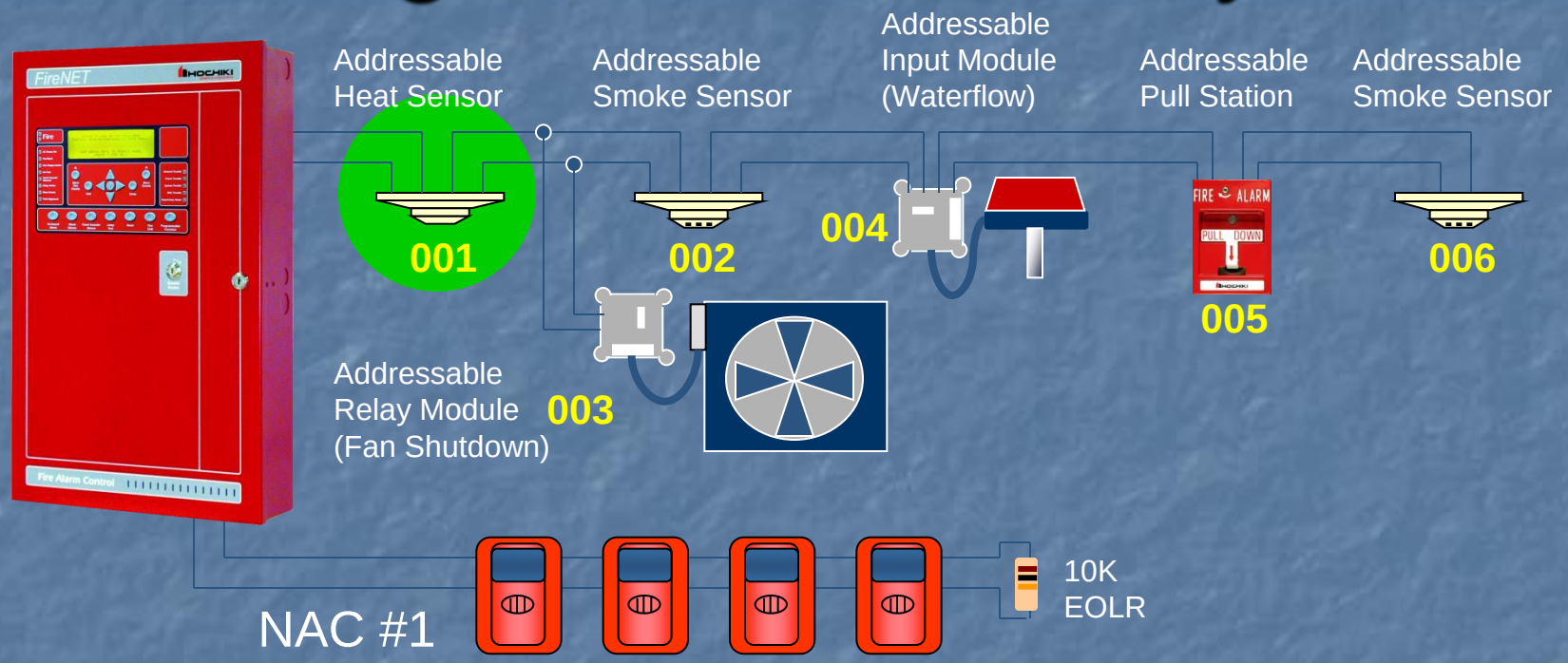
Analog Addressable Systems




```
SMOKE DETECTOR
FRONT DESK
POINT 006     A=061
NORMAL        F=189
```

< Replay

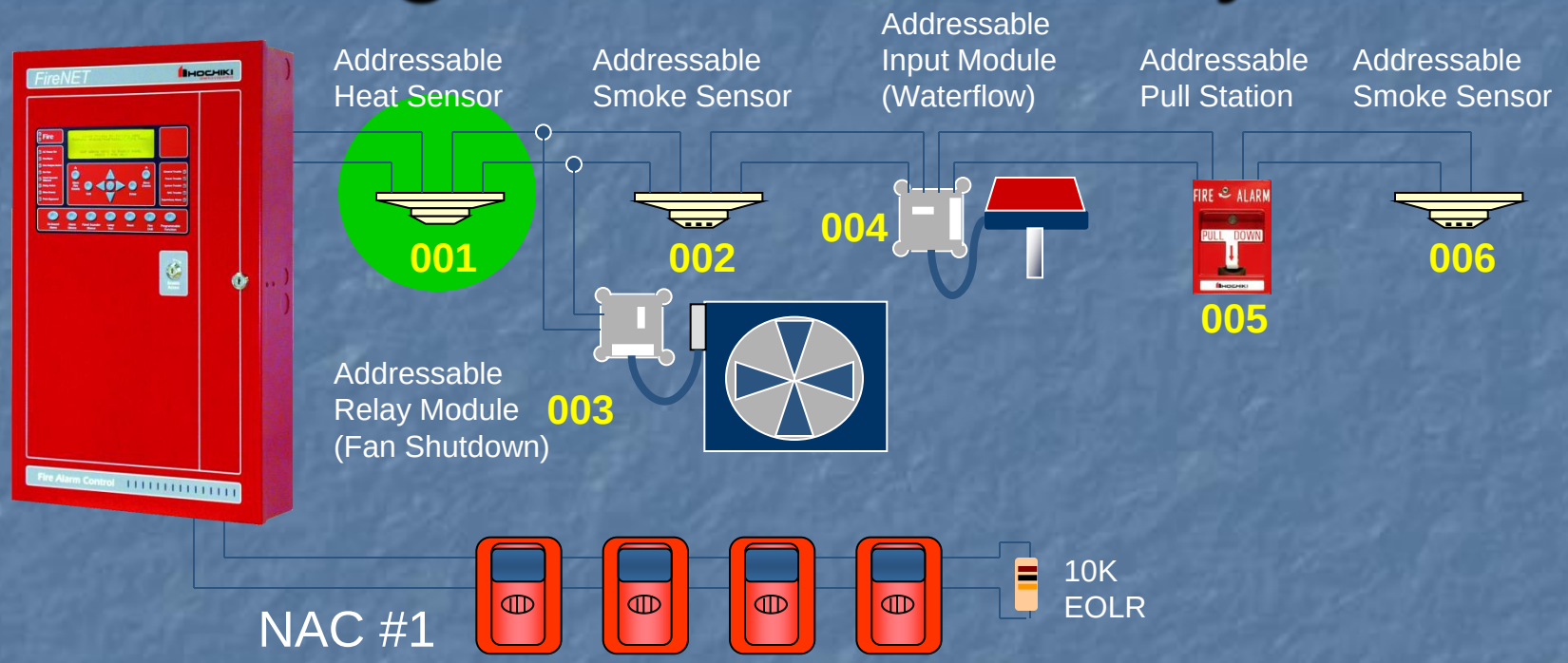
Analog Addressable Systems




```
HEAT DETECTOR
MECHANICAL ROOM
POINT 001     A=062
NORMAL        F=190
```

This analog value corresponds to the amount of heat or smoke in that detectors area of coverage. Higher = more.

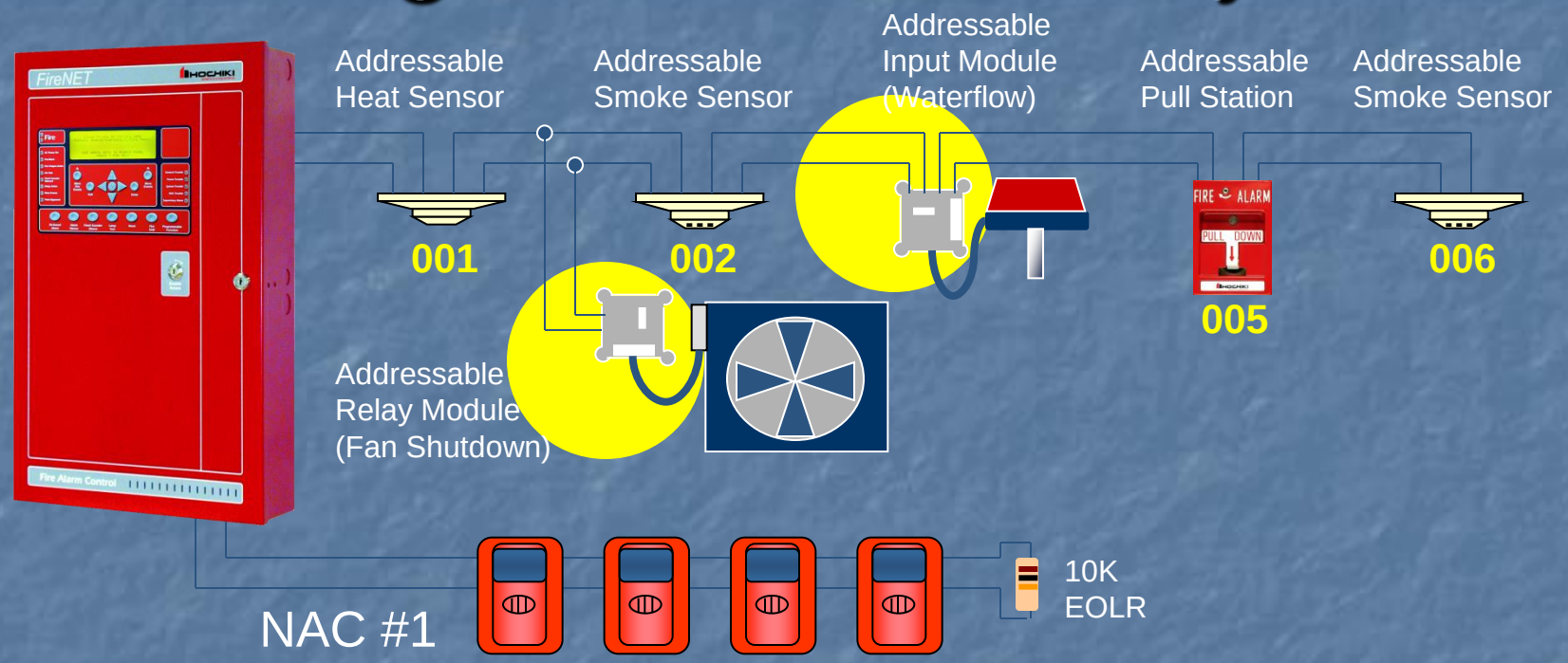
Analog Addressable Systems




```
HEAT DETECTOR
MECHANICAL ROOM
POINT 001     A=062
NORMAL        F=190
```

If the analog value exceeds the alarm threshold, an alarm occurs. This alarm threshold is calculated by the panel.

Analog Addressable Systems




```
INPUT MODULE
WATERFLOW
POINT 004      A=N/A
NORMAL         F=N/A
```

Input/output modules do not relay analog values to the panel as they are monitoring or controlling on/off devices.

Analog Addressable Features

- An analog addressable control panel is capable of several enhanced features not available on conventional, and some addressable systems.
  - Drift Compensation / Maintenance Alert
  - Adjustable Detector Sensitivity
  - Day/Night Detector Sensitivity Adjustment
  - U.L. Calibrated Sensitivity Test Instrument

Drift Compensation

- Drift compensation is the process by which an analog addressable control panel automatically adjusts an analog detectors alarm threshold to compensate for contaminants such as dust.
- This ensures the detector maintains a consistent sensitivity level, helping to avoid false alarms due to dirty detectors.

Maintenance Alert

- Drift compensation occurs until it is nearing a point where it can no longer compensate and remain within U.L. requirements. This point is called “Maintenance Alert”
- Some systems handle a maintenance alert condition as a trouble while others flag the condition only, and continue to operate normally.

Calibration Trouble

- A detector in a maintenance alert condition will eventually go into calibration trouble if not serviced.
- A detector in calibration trouble is not functioning correctly and requires service immediately.

Adjustable (Day/Night) Sensitivity

- In order to allow for varying environmental conditions or to provide quicker detection, analog systems typically allow you to change the sensitivity of a detector within a range of U.L. tolerances.

- This is typically made user friendly by giving the installer choices such as high-medium-low.

Adjustable (Day/Night) Sensitivity

- By changing a detectors sensitivity you are instructing the panel to adjust its alarm threshold (analog) value up or down accordingly.
- Some systems allow this sensitivity adjustment to happen automatically on a day/night schedule.

U.L. Calibrated Sensitivity Test

- 1996 NFPA 72 **7-3.2.1**
  Detector sensitivity shall be tested within 1 year after installation and every alternate year thereafter. After the second required calibration test, where sensitivity tests indicate that the detector has remained within its listed and marked sensitivity range, the length of time shall be permitted to be extended to a maximum of 5 years. …
- **Testing Methods**
  - A calibrated test method; or
  - Manufacturers calibrated sensitivity test instrument; or
  - Listed control equipment arranged for the purpose; or
  - Smoke detector/control unit arrangement whereby the detector causes a signal at the control unit where its sensitivity is outside the acceptable range; or
  - Other approved calibrated method acceptable to AHJ

U.L. Calibrated Sensitivity Test

- Analog addressable control panels are UL listed for the purpose of performing the calibrated sensitivity testing internally.
- A printout from the panel is usually available to provide evidence to the AHJ that the test was performed.

Communication Protocols

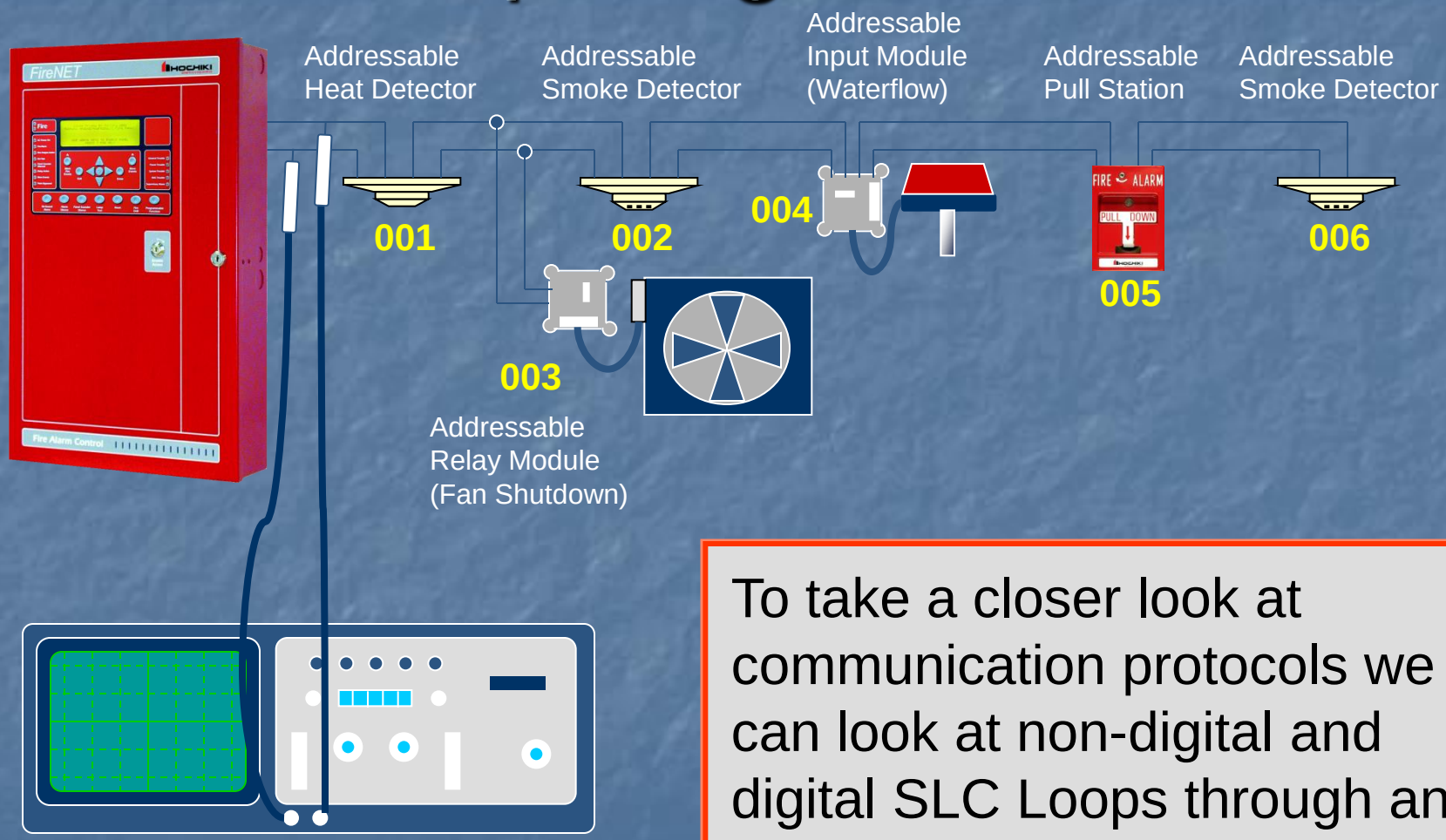
- Each manufacturer of (analog) addressable fire alarm systems utilize a unique communications protocol on the SLC loop to communicate between the control panel and the addressable devices.
- Most protocols are developed by detector manufacturers.
- Many manufacturers subtly modify standard protocols, developed by detector manufacturers, to provide a proprietary environment for their equipment & distributors.

Communication Protocols

- Many of the panels installation requirements and operational parameters are based on the communication protocol used.
  - SLC Loop Length
  - SLC Loop Wire Type
  - SLC Loop Communications Speed
  - SLC Loop Alarm Response Time

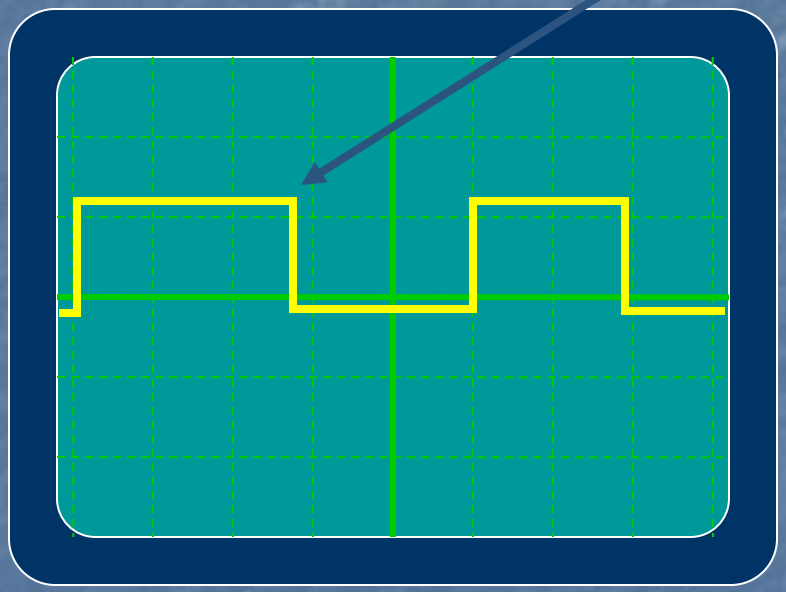
- Communication protocols can be broken down into two categories.
  - Non-Digital
  - Digital

Comparing Protocols



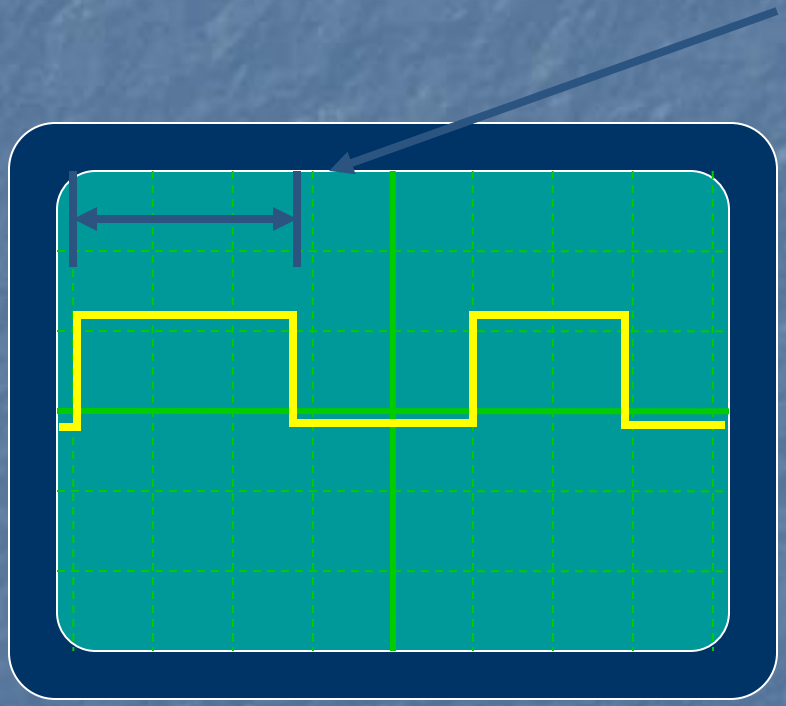
To take a closer look at communication protocols we can look at non-digital and digital SLC Loops through an oscilloscope.

Non-Digital Protocol



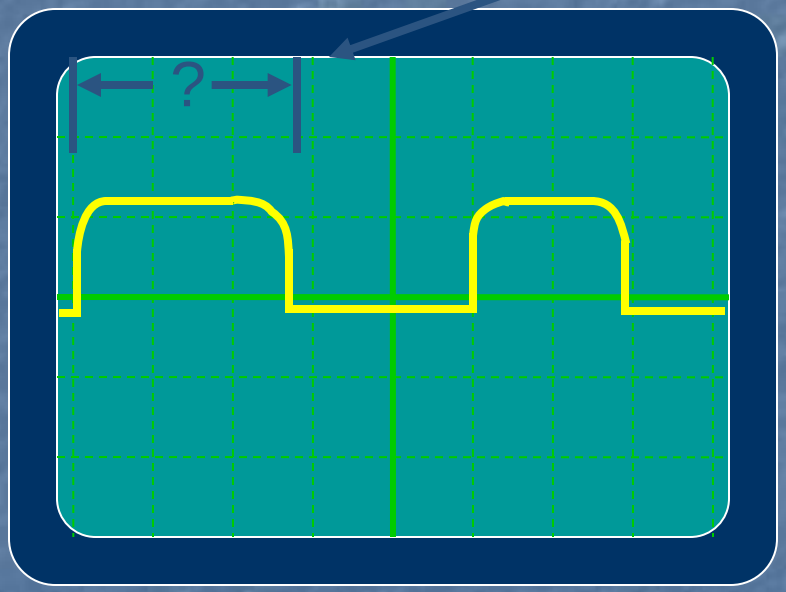
Each detector when polled responds to the panel with square wave pulses.

Non-Digital Protocol



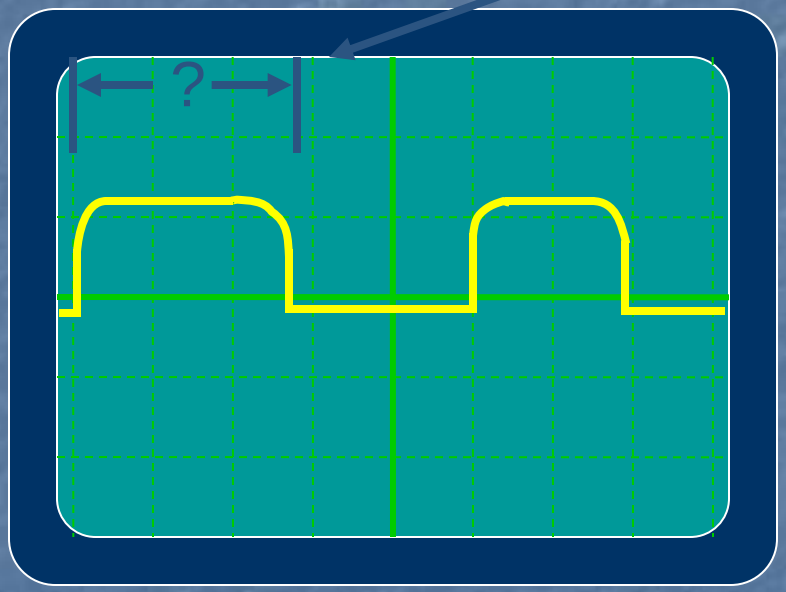
The panel reads these square wave pulses and determines the values by measuring the length (time) of each.

Non-Digital Protocol

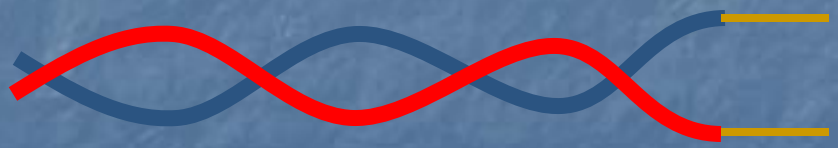


Various sources of interference can cause these square wave pulses to round off. This makes an accurate reading very difficult.

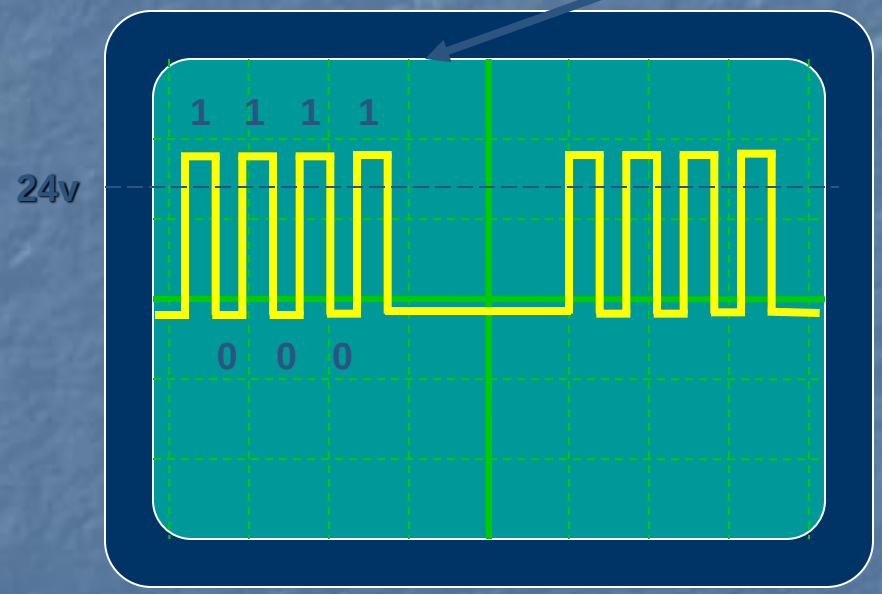
Non-Digital Protocol



Most manufacturers that utilize a non-digital protocol will specify special requirements such as twisted or shielded wire to counteract this problem.

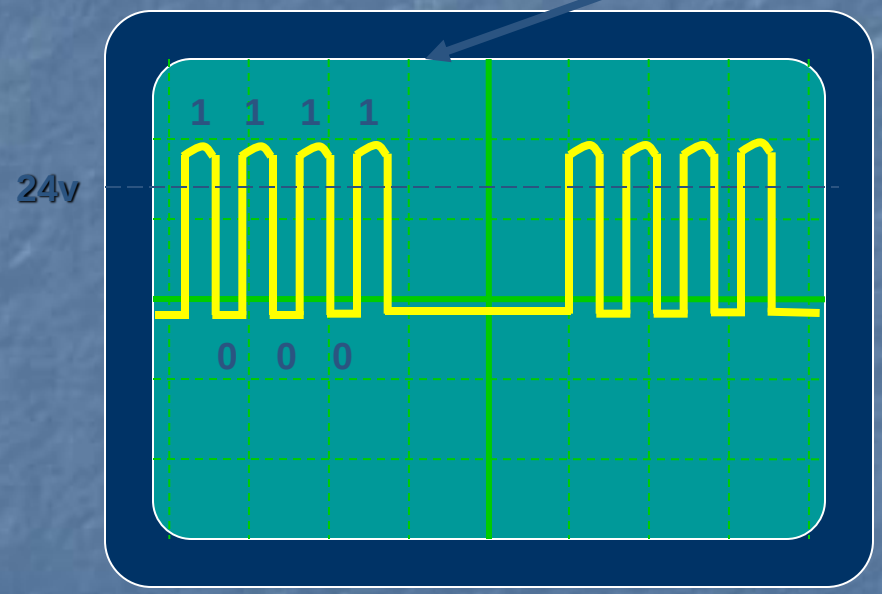


Digital Protocol



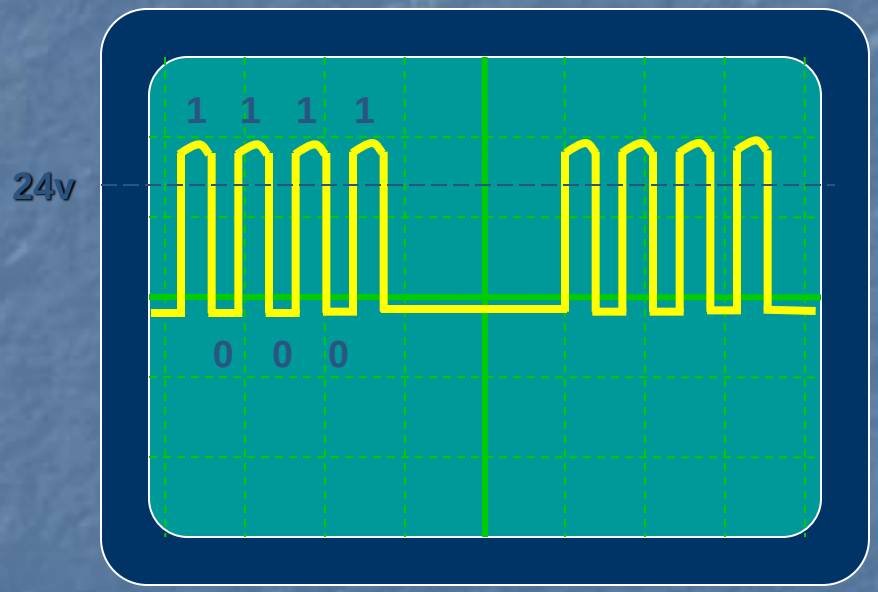
Using a digital protocol the panel looks for for a series of “1” or “on” bits that are detected by looking for voltage rather than the length of a pulse.

Digital Protocol



Even if a source of interference causes rounding off of the digital pulses the voltage is still present for the panel to determine the digital value.

Digital Protocol



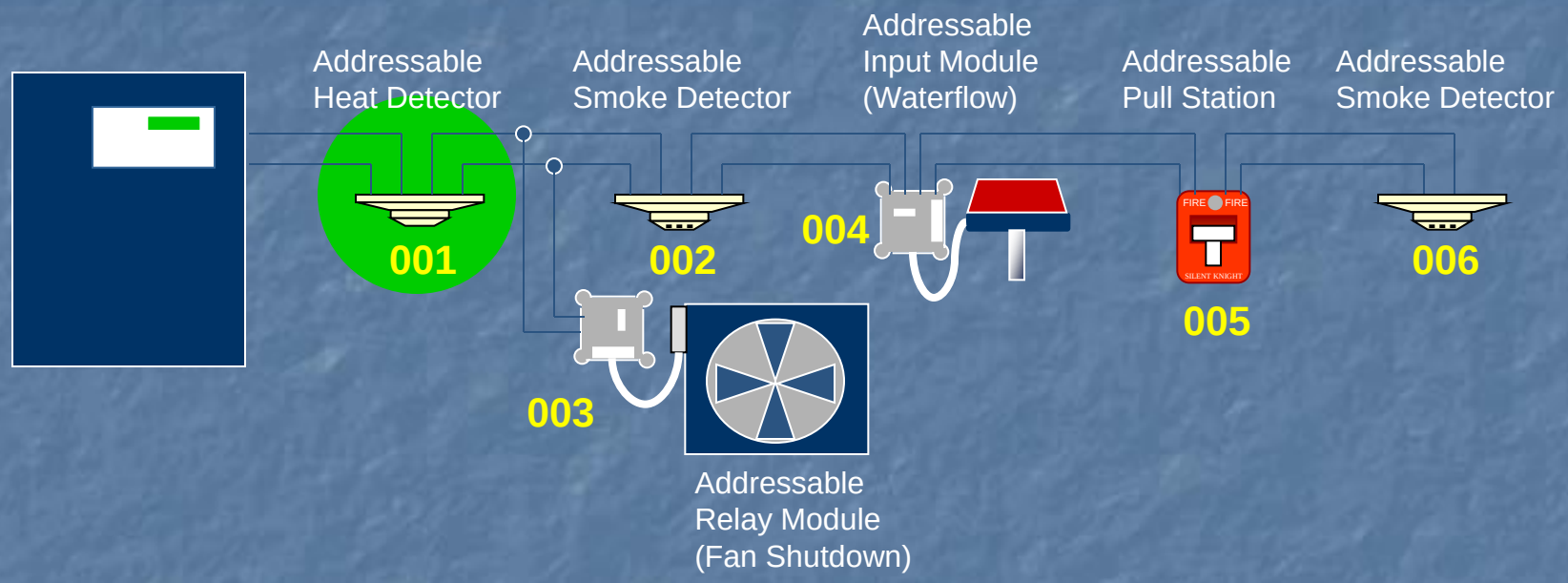
Digital protocol panels do not typically require special cabling since interference does not pose any substantial signal problems.

Retrofits can be done using existing cable.

Non-digital Loop Response

- When an alarm occurs on many non-digital protocol systems, some panels must continue polling until it reaches the alarming device, before an alarm is initiated.
  - Larger systems with hundreds of points can cause delays initiating an alarm.

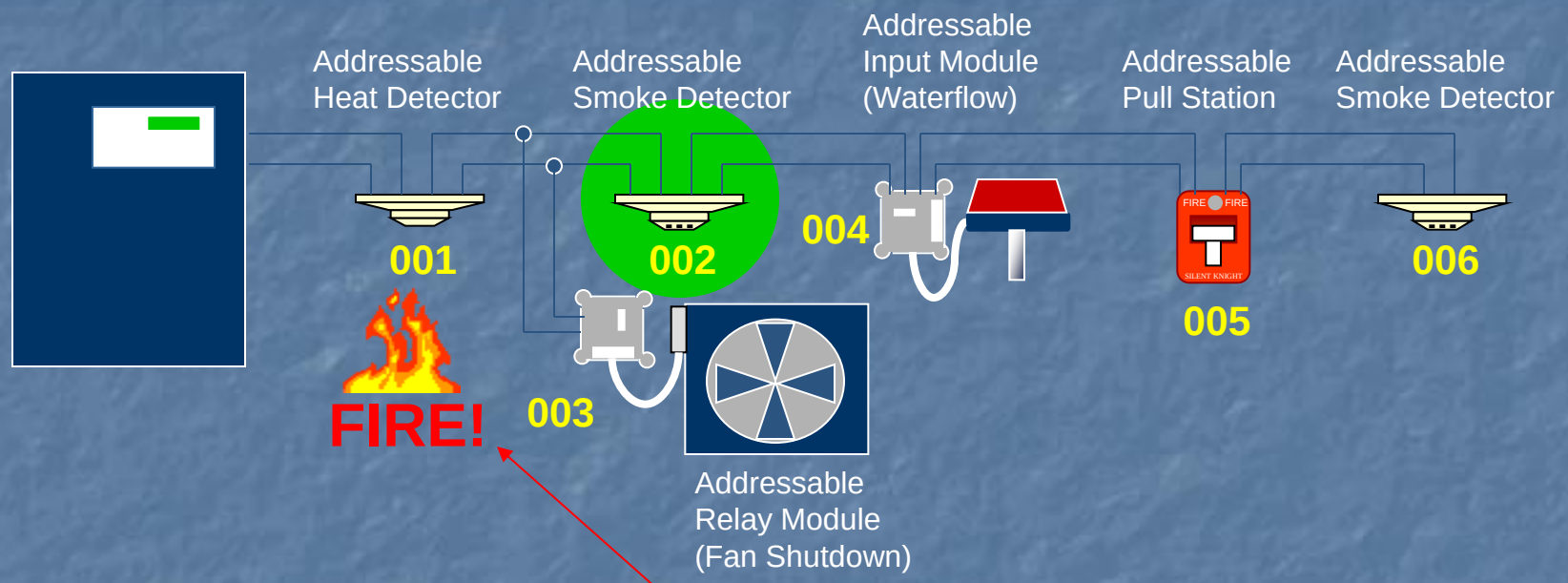
Non-Digital Loop Response




```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

Non-Digital Loop Response

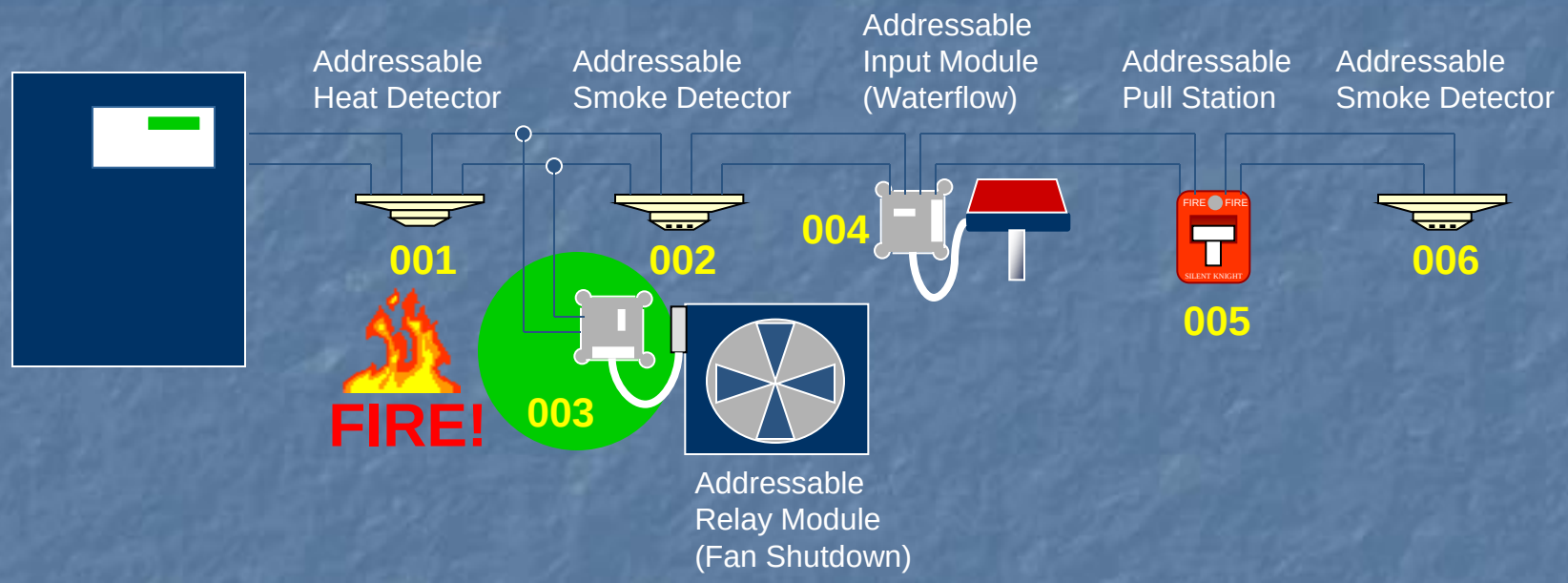



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

A fire erupts at the Heat Detector (Point 001) while the system is polling the Smoke Detector (Point 002).

Non-Digital Loop Response

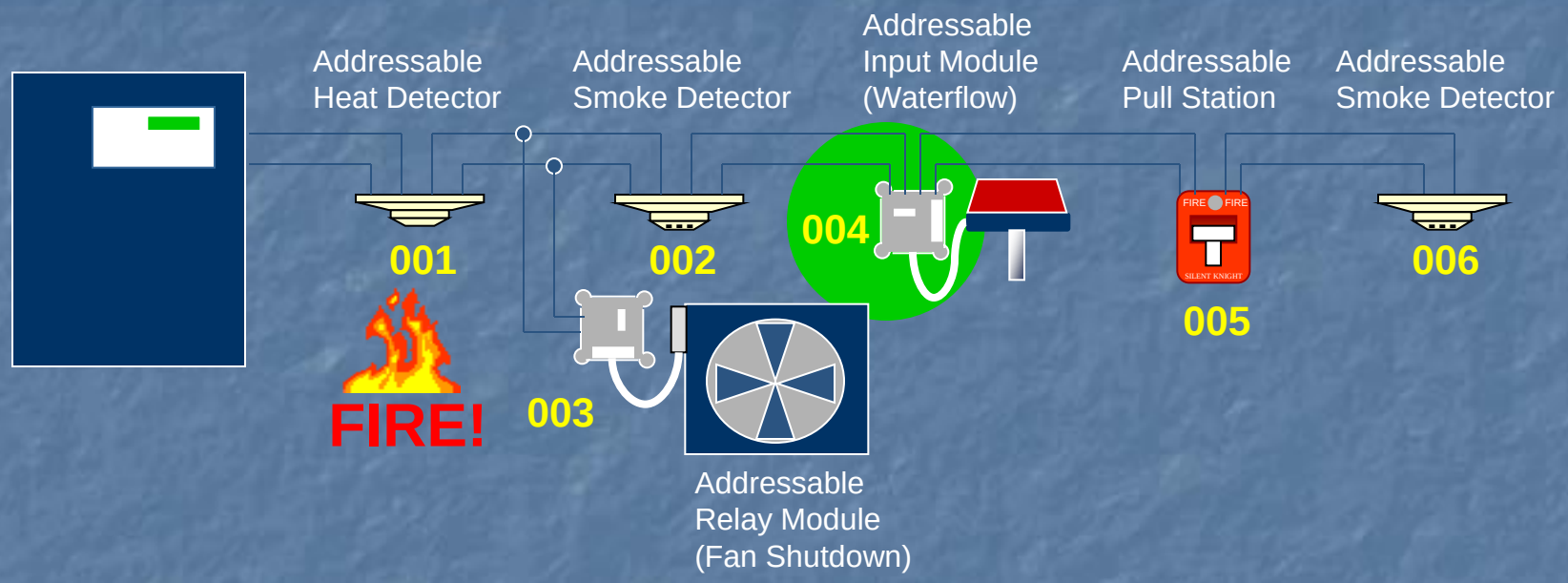



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

An alarm is not initiated. The system continues polling until it reaches the point in alarm.

Non-Digital Loop Response

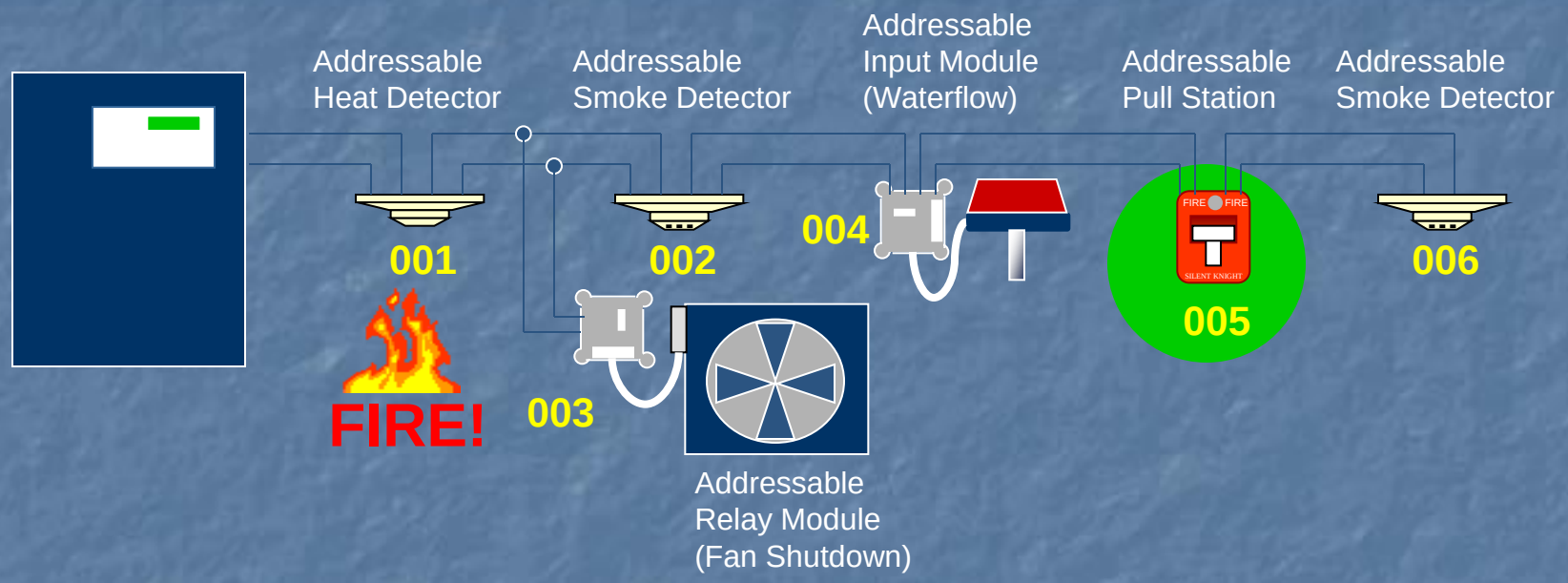



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

An alarm is not initiated. The system continues polling until it reaches the point in alarm.

Non-Digital Loop Response

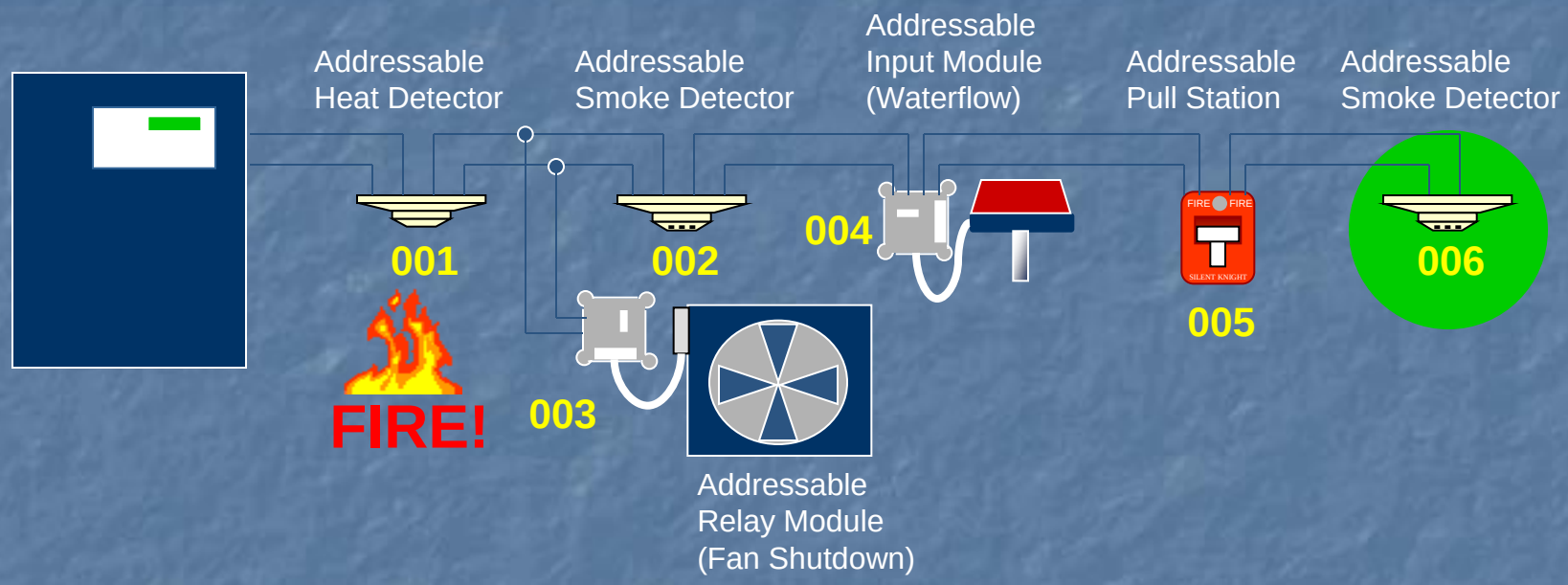



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

An alarm is not initiated. The system continues polling until it reaches the point in alarm.

Non-Digital Loop Response

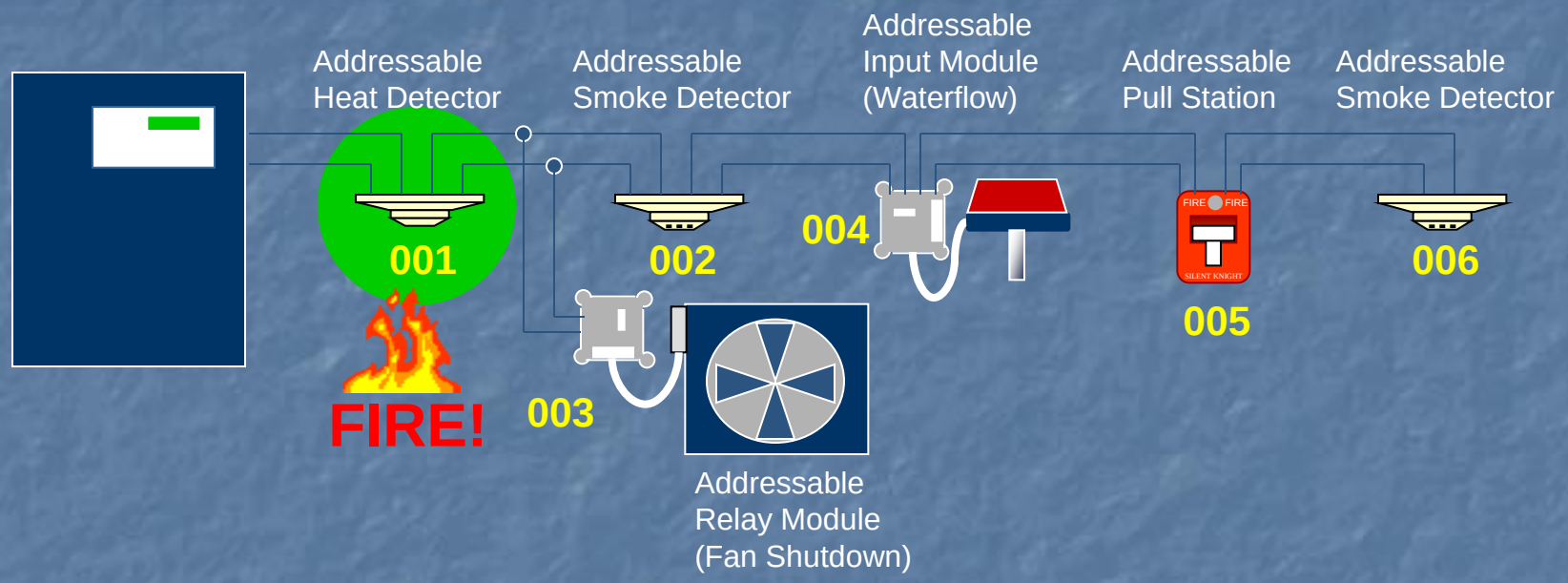



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

An alarm is not initiated. The system continues polling until it reaches the point in alarm.

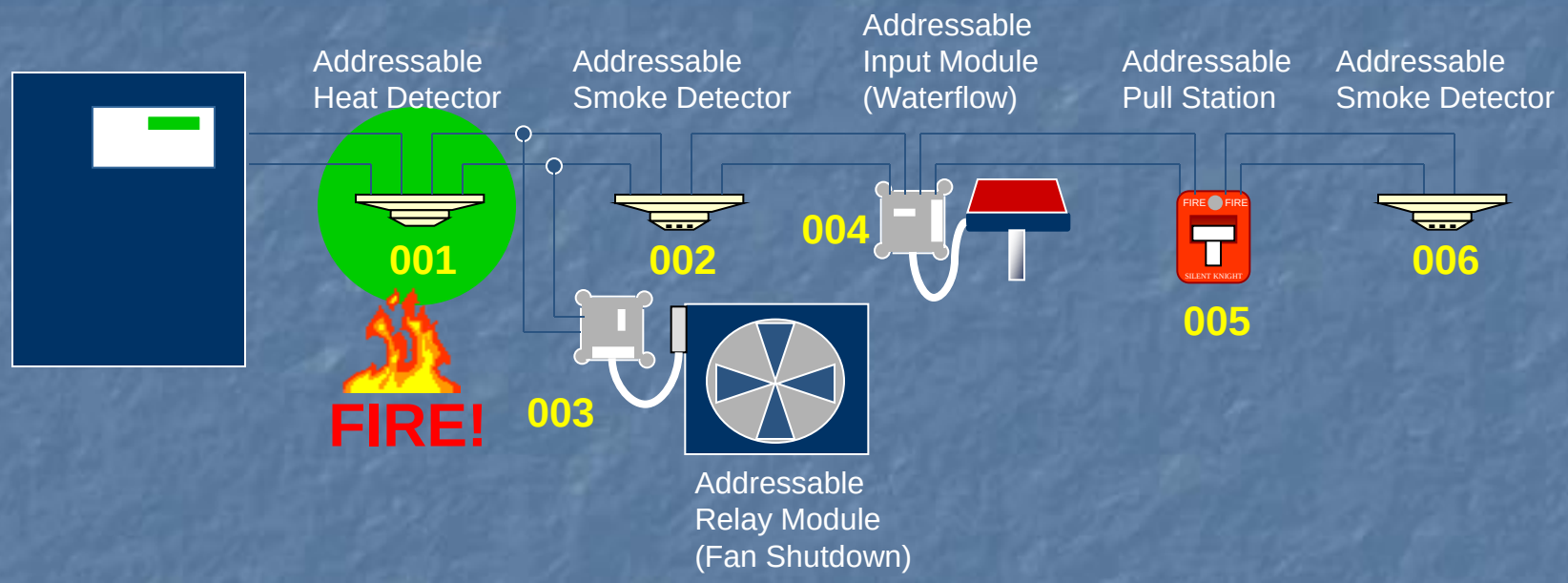
Non-Digital Loop Response




```
ALARM
POINT 001
HEAT DETECTOR
15-Jan-00  3:10 PM
```

ALARM!

Non-Digital Loop Response



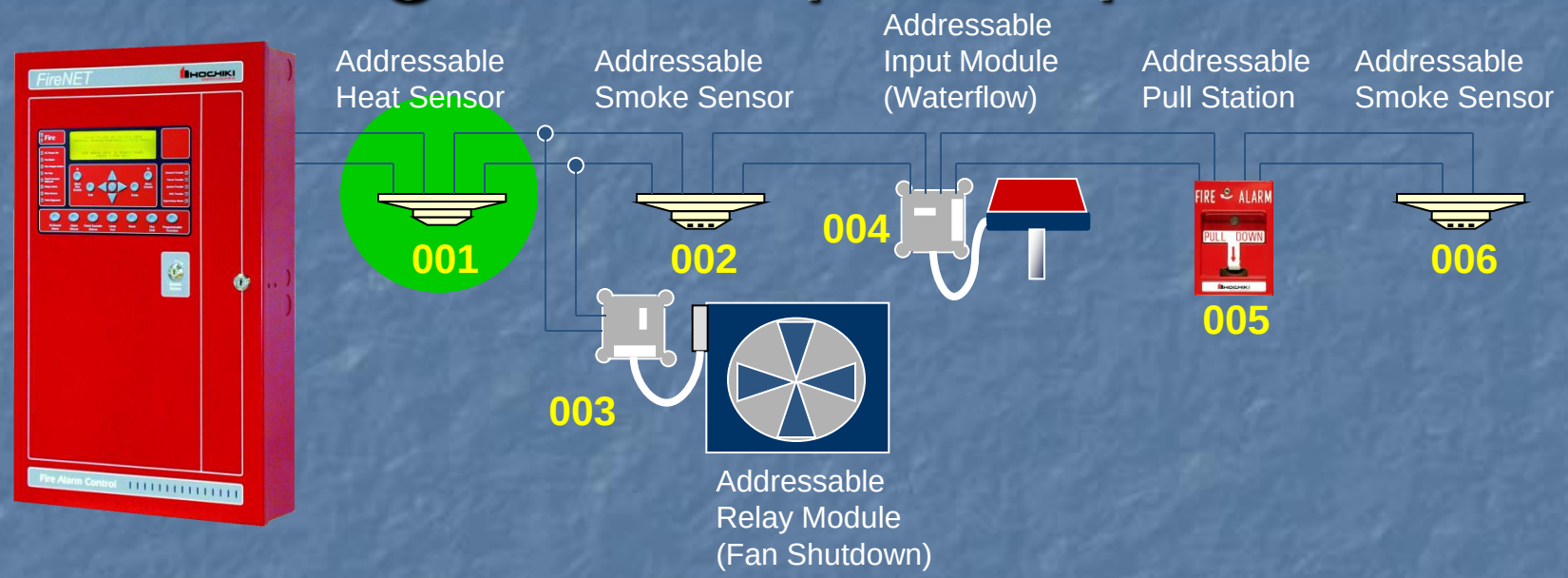

```
ALARM
POINT 001
HEAT DETECTOR
15-Jan-00  3:10 PM
```

Systems with hundreds of points can take 15 -20 seconds or longer to respond to alarm conditions.

Digital Loop Response

- When an alarm occurs on most digital protocol systems, an interrupt request from the device sensing the alarm interrupts the polling sequence to immediately handle the alarm.
  - Systems with hundreds of points will respond to alarms in the same amount of time that they would to smaller systems with very few points.

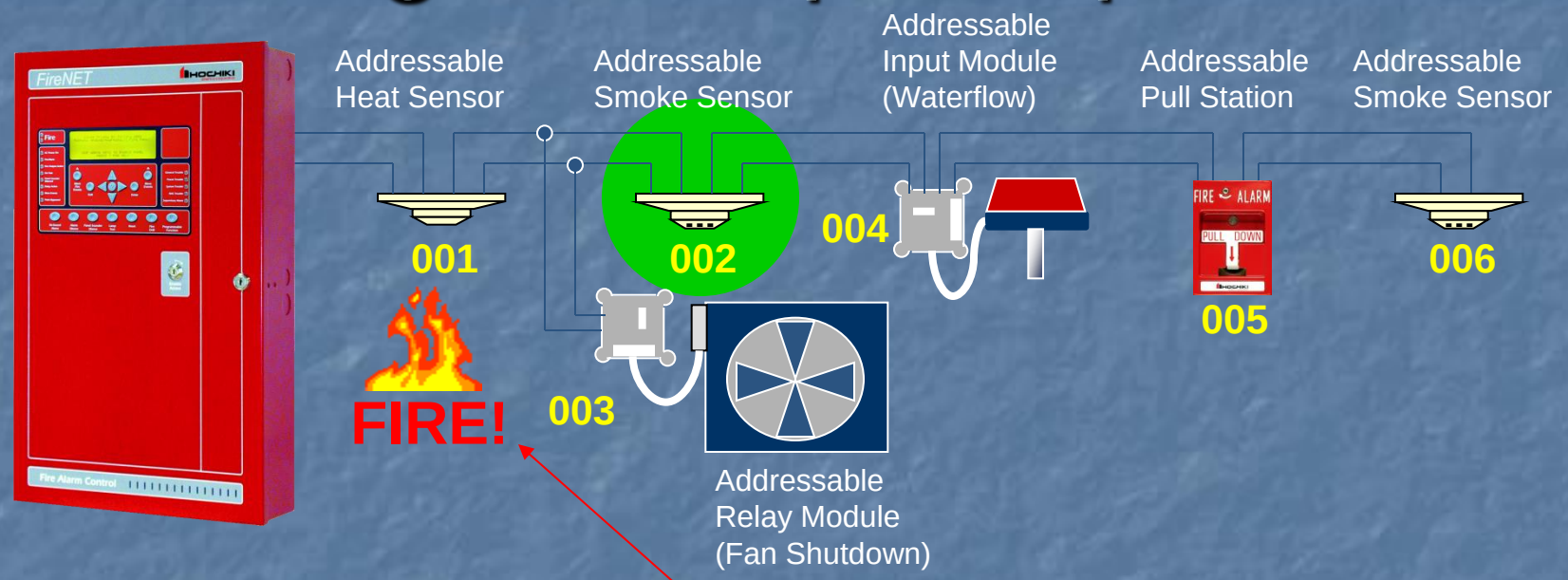
Digital Loop Response




```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

Digital Loop Response

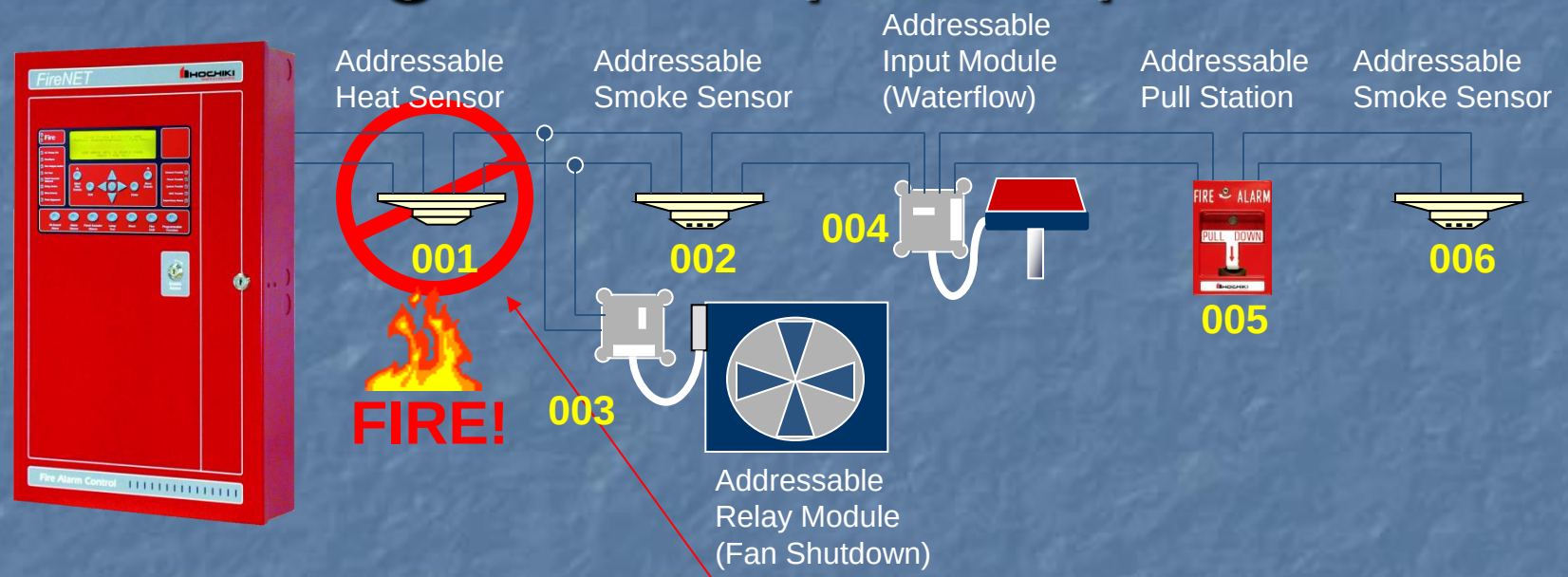



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

A fire erupts at the Heat sensor (Point 001) while the system is polling the Smoke Detector (Point 002).

Digital Loop Response

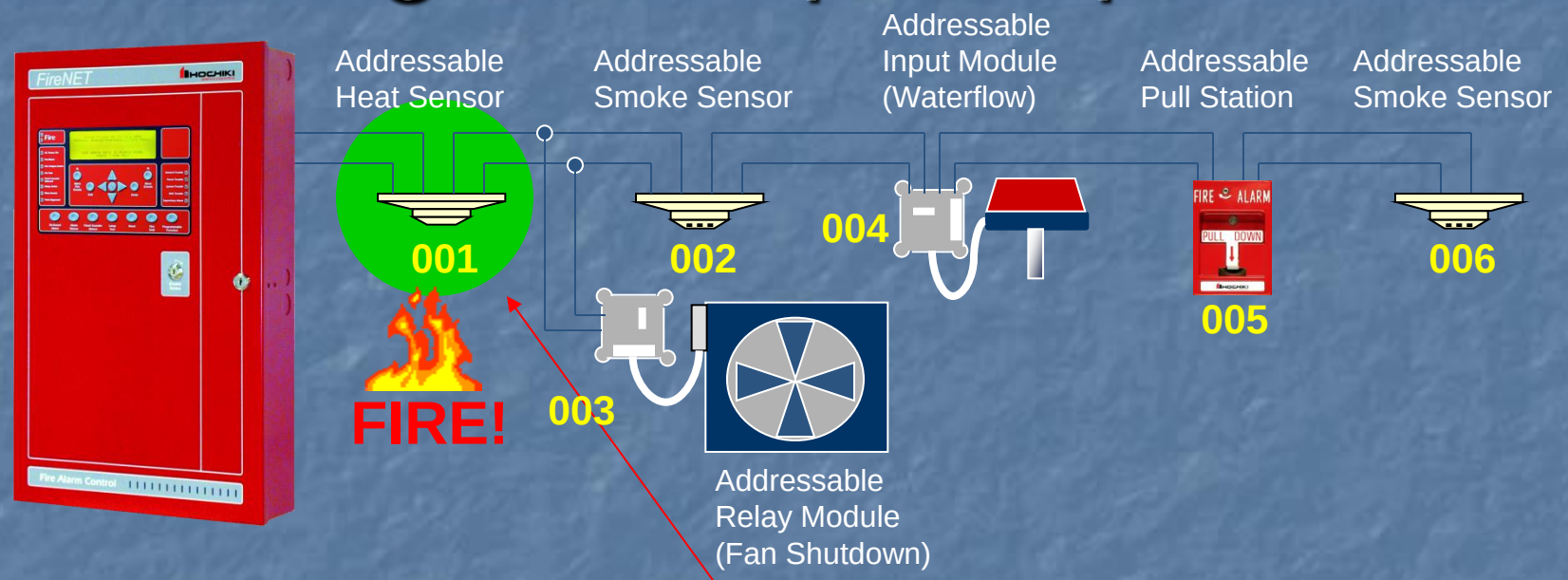



```
ABC FIRE SYSTEMS

ALL SYSTEMS NORMAL
15-Jan-00  3:10 PM
```

The Heat Sensor (Point 001) interrupts the polling process to handle the alarm immediately.

Digital Loop Response




```
ALARM
POINT 001
HEAT SENSOR
15-Jan-00  3:10 PM
```

ALARM!

THE END

Hochiki America Corporation
7051 Village Drive, Suite 100
Buena Park, California 90621
www.hochiki.com