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Company BIO,

aeSolutions is a supplier of safety lifecycle services. Our engineering and automation division specializes in performance-based process safety engineering and automation solutions. aeSolutions primarily serves the Oil and Gas, Petrochemical, and Chemical industries.

Evolution of the traditional Fire panel

In 2005, aeSolutions recognized an industry need for Fire and Gas panels based on a SIL capable PLC safety control platform. Large industrial clients were looking for a system capable of monitoring and controlling Fire system 1/0, combustible gas, toxic gas, and oxygen depletion detectors, initiating suppression release, controlling HV AC, and performing process safety shutdowns.

To develop the Fire and Gas system requirements needed by industry, we first needed to understand the regulatory requirements, applicable industry standards, and the types of fire and gas systems currently in use ..

Here are some of the key regulatory requirements mandated by OSHA.

OSHA 1910.155 Fire Detection- 3rd party approval by Nationally recognized laboratory

OSHA 1910.164 Fire Detection Systems - Circuit Supervision

OSHA 1910.165 Employee Alarm Systems - Circuit supervision - Power Supply Monitoring

Other key drivers are determining which industry standards are applicable. Are the standards mandatory? Many local and state codes reference the International building code. This code requires the use of NFP A 72 for fire alarm signaling systems. The authority having jurisdiction (AHJ) in each jurisdiction has the final authority in determining the applicable standards that the fire alarm system must meet.

aeSolutions found that legacy fire and gas monitoring systems were typically comprised of multiple systems networked to each other. Many industrial clients were using three systems to perform fire and gas mitigation. The three systems were; Fire panels which monitored initiating device circuits, monitored and controlled suppression circuits, and notification appliance circuits (NFP A 72 compliant). The second system monitored Gas detection in the facilities. The third system was a building management system that controlled HV AC. Maintaining and troubleshooting system issues would require expertise in multiple systems, usually requiring multiple resources from different vendors. Multiple communication links were required to pass data to/from each system.

aeSolutions collaborated with a technical authority from a key industrial client to develop a systems requirements specification on which the FGS1400 MKII system is based.

Several of the key system requirements for the Fire panel were for it to be capable of monitoring and controlling Fire, Gas, Process ESD, and HV AC control all in one control system platform. It needed to be scalable, and able to monitor multiple protected premise, and report data back to a central location. It needed to be based on a SIL capable safety instrumented PLC platform.

SIL capable safety instrumented PLC based systems offer many benefits. Several key benefits are:

• Provide a more robust platform with published failure rates

• Capable of redundancy for logic solvers, communications, and 1/0 where needed

• Provide safety rated 1/0 with diagnostics and failure rates

• Provide safety-based programming functionality.

The safety instrumented PLC based systems offer other benefits. They are able to capture and display a wide range of detector diagnostics from Flame, Gas, and process transmitters.

After careful consideration of all of the requirements for the fire and gas panel requirements, aeSolutions developed the FGS1400 MKII product. In the following paragraphs the capabilities and functionality of the FGS1400 MKII system are described.

The FGS1400 MK II is a pre-engineered, FM approved (3010), fire alarm system. The FM approval also allows for combination system monitor and control. HVAC and safety related process interlocks fall into this category, as does toxic gas and oxygen depletion, and combustible gas monitoring. It is based on the Siemens S7-400 Safety PLC platform. Each system is furnished with a 24 Volt battery set and charger system that has been FM approved to be compliant with the NFP A 72 requirements for primary and secondary power supplies.

The system is comprised of three main components, the Fire Alarm Panel, the Battery Charger Panel, and the Battery Set. An engineering workstation running Siemens PCS 7 configuration software and Siemens Safety Matrix configuration and monitoring tool is also required and may be purchased with the system or separately.

The FGS1400 MK II Fire Alarm Panel is a scalable system. It supports both local and remote 1/0. Each FGS1400 MK II local panel houses the CPU, First Responder Interface (FRI), 1/0, and other peripheral equipment required for the proper operation of the FGS 1400 MK II system. Remote 1/0 cabinets are optional. Remote 1/0 cabinets are used for system expandability and to reduce geographic limitations and reduce installation cost of the system. Remote 1/0 cabinet communication is via fiber optic technology. Each FGS1400 MK II cabinet has a lockable door. Each system is custom engineered for the I/0 requirements of a specific application. Field device circuits are terminated in either the local or remote panels.

There are two options for First Responder Interfaces(FRI); a TP1200 Comfort Touch panel, and a PCBox computer with a remote monitor. The Comfort communicates with the S7-400 Safety PLC via a Profibus link. The PC Box computer communicates with the S7-400 Safety PLC via Ethernet. System status and diagnostic information for the fire alarm system and its main components is available through the FRI. Monitoring of the fire alarm zones is also available from the FRI. The FRI provides an Event Summary

page as well as a historical event page. In addition to the touch screen, there is one keyswitch and three momentary pushbuttons mounted on the front of the fire alarm panel to support system operation. Control of the system both via the FRI and the pushbuttons is disabled when the keyswitch is in the "LOCKED" position. The system can be monitored from the FRI regardless of the position of the keyswitch.

FRI's may be mounted in remote IO fire panel cabinets. This provides operations and maintenance personnel with the same level of detailed information in each remote location.

A Fire command center using aeSolutions FGS1400 Master OS product may be used to interface to multiple FGS1400 MK II fire and gas systems that are within a single protected premise. The Master OS product will allow an operator to view and control from one location the status of multiple FGS1400 MK II fire and gas systems. The FGS1400 Master OS product is FM approved as a fire command center and proprietary supervising station.

aeSolutions offers a product line of NFP A 72 compliant FM approved power supply systems. There are three standard power supply sizes. The three sizes are 50 Amp, 100 Amp, and 150 Amp power supplies. The 50 Amp power supply standard battery set is 600 Amp Hour. Smaller battery sets are allowed if system load requirements allow. Battery sets larger than 600 Amp hours are not allowed for 50 Amp power supplies. The 100 Amp power supply standard battery set is 1200 Amp Hour. Smaller battery sets are allowed if system load requirements allow. Battery sets larger than 1200 Amp hours are not allowed for 100 Amp power supplies. The 150 Amp power supply standard battery set is 1800 Amp Hour. Smaller battery sets are allowed if system load requirements allow. Battery sets larger than 1800 Amp hours are not allowed for 150 Amp power supplies.

Battery capacity for each system provided is calculated using a battery calculation tool. A battery calculation report is furnished with each battery and charger combination. This report is required for all systems that are to receive an FM Approval.

An engineering workstation is required for system configuration, troubleshooting and monitoring. The workstation requires Siemens PSC 7 configuration software, Siemens Safety Matrix configuration and monitoring software, Siemens TIA Portal touchpanel configuration software, and a Siemens CPl 623 card for communication between the S7-400 Safety PLC and the engineering workstation. PCS 7 configuration software is used to develop the system configuration as well as monitor the logic online as it executes, and to aid in troubleshooting. Safety Matrix is a Cause and Effect Matrix formatted configuration and monitoring tool. TIA Portal is used to build and edit the Siemens Comfort touchpanel screens and point database. PCS7 OS software is used to develop the software for the windows based FRI' s.

Four main types of fire related devices and circuits are supported: Initiating Device Circuits (JDC), Notification Appliance Circuits (NAC), Fire Safety Functions (FSF) and Suppression Device Circuits (SDC).

Per NFP A 72, an **Initiating Device** is a component that transmits "a change of state condition, such as a smoke detector, manual fire alarm box or supervisory switch." Analog initiating devices transmit "a signal indicating varying degrees of a condition as contrasted with a conventional initiating device, which can only indicate an on-off condition." Both on-off and analog initiating devices are supported. The system is capable of meeting the NFPA 72 integrity monitoring requirements for Class A and B initiating

device circuits that monitor dry contact initiating devices. Class B style circuits are approved for 4-20 maDC initiating devices.

A **Notification Appliance** is a "component such as a bell, horn, speaker, light or text display that provides audible, tactile, or visible outputs, or any combination thereof." The system is capable of meeting the NFP A 72 integrity monitoring requirements for Class B notification appliance circuits.

A **Fire Safety Function** is a building or fire control function "intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire." DIN rail mounted relays listed for fire related functions have been pre-approved for use with the system to support interfacing with common fire safety function components such as motor starters. The system supports energize to trip and de-energize to trip FSFs and meets NFP A 72 integrity monitoring requirements.

Suppression Devices are the solenoids and control heads for dumping fire suppressants either through automatic logic or by manual initiation. Integrity monitoring for suppression devices is supported. This system is not certified for water deluge system service at this time.

Signaling Line Circuits (SLC) - addressable field devices are not supported by the FGS1400 MKII at this time.

Combination System I/0 -, Gas Detection
The FGS1400 MK II conforms with FM Approvals Combustible Gas Standard 6320 and Toxic Gas and Oxygen depletion Detection Standard 6340. It also conforms with ANSI/ISA 12.13.01 Performance Requirements for Combustible Gas Detectors standard. The FGS1400 MKII is compatible with two, three and four wire gas detectors generating a 0.4-20mADC signal linearly proportional to 0 to Full Scale. The system can be configured to recognize and respond to manufacturer specific diagnostic information transmitted within the 0.4-20 mADC signal, typically transmitted below 4 mA by the detector. Note that if a detector is transmitting a signal below 4mA, the system can indicate values down to 0.4 mADC

Signals below 0.4 maDC will generate an open circuit indication at the HMI. This under-range condition will generate a system trouble signal as well. The under range trip point is software selectable and will depend on the transmitter selection.

The FGS1400 MK II has the capability to recognize and alert the user that a gas concentration in excess of the measuring range of the instrument has been detected. Note that if a detector is transmitting a signal above 20mA, the system will indicate values up to 22.8 mADC (117.5%) over-range. Signals above 117 .5% will generate a short circuit indication at the HMI. This over-range condition will generate a system Trouble signal as well. The over-range condition trip point is software selectable and will depend on the transmitter selected.

The system can also detect instrument power failure and loss of continuity in any one or more conductors to any detector. This condition is reported as an open circuit indication and also generates a system trouble signal.

Toxic gas detectors are typically calibrated Oto Upper Limit in parts per million (PPM) where the Upper Limit is defined at the time of system configuration.

Access to this configuration is limited to authorized personnel through password access. Combustible gas detectors are calibrated O - 100 %LEL (%Lower Explosive Limit). For compliance with the applicable

FM standards, high-high gas alert trip points cannot be configured higher than 60%LEL. In these cases, the system assumes a trip point of 60%LEL, the maximum allowed by FM standards. Access to this configuration is limited to authorized personnel through password access.

Gas detector actions and trouble signals can be bypassed for maintenance or calibration within the controller on a detector-by-detector basis. An audible and visible supervisory alert is provided when any detector is bypassed. Bypassing is accomplished through the Safety Matrix monitoring and engineering tool running on a PC. Security access to this tool is controlled through the Safety Matrix tool's security. When a detector is bypassed the high, high-high and out of range conditions no longer generate audible or visible notifications. However, they will be captured in the active and historical event lists for record purposes.

Trouble and supervisory (bypassed) signals are reported to the local HMI. Indications of these conditions appear on the overview screen and corresponding entries are captured in the active event list. When the initiating condition clears, the indications on the overview screen will self-clear. The entries in the event list, however, are latched and must be acknowledged by the user before they will clear. The local buzzer will sound on trouble and supervisory conditions and must be acknowledged by the user.

Gas alert signals are reported to the local HMI. Indications of these conditions are latched on the overview screen and corresponding entries are captured in the active event list. Once the initiating condition clears, the user is given an Ok to Reset message at which time the user can clear the gas alert condition.

Combination System 1/0 - HV AC Control

The FGS1400 MKII system has the capability to control all of the facilities HVAC.

The system can control air exchange rates in buildings. Normally the system increases ventilation on the detection of a combustible gas. If Hi gas levels are detected, the HV AC is turned off, and supply and exhaust dampers are closed to encapsulate the building. Then suppression is released to prevent an event.

The FGS1400 MKII system has the capability to interface to Siemens smart motor starters (Simocode). This reduces construction cost, and allows for more detailed diagnostics.

An integral part of the FGS1400 MKII system is its power supply. It is required to maintain the FM listing of the FGS1400 MKII Fire and Gas solution. The PS1400 is a pre-engineered, FM approved, Power Supply System that is designed to provide power for fire alarm systems, and toxic and combustible gas monitoring systems. Each system consists of a 24 Volt Battery Set and a charger system that has been FM approved to be compliant with the NFP A 72 requirements for primary and secondary power supplies.

The PS 1400 Primary/Secondary power supply system is comprised of two main components, the Battery Charger Panel and the Battery Set.

The Battery Charger Panel has a lockable door and houses the primary and auxiliary power supply components. The primary power supply is fed from a customer supplied single phase 120/208/240/400/480 VAC feed (Option specific) and consists of a Battery Charger that provides a 24 VDC nominal output. A second 120 VAC feed supplies power to the Battery Charger Panel's optional 24 VDC Auxiliary Power Supplies.

The Battery Charger performs several functions: 1) it charges the Battery Set, 2) it provides unregulated power for powering field circuits, and 3) it powers one or two DC-DC converters (if equipped) that provide system regulated power. The Battery Charger monitors its own health as well as that of the AC feed and the battery voltage, and provides individual status contacts that can be wired to a Programmable Logic Controller (PLC) for indication and alarming. The PLC is not provided with the Power Supply System. A fused disconnect between the battery charger and battery set is provided. A means for detecting a disconnected battery condition is provided by using a low range current transducer to measure the charge current being supplied to the Battery Set. If this current drops below a minimum threshold, the Battery Set is assumed to be disconnected or supplying power. If the charger output fails, current flow will reverse as the Battery Set begins to provide system power.

The Battery Set is provided as a secondary power supply as required by NFPA 72. The Battery Set is floor mounted and self-contained, i.e. it does not have to be mounted in an enclosure. Plastic guards are provided to protect the terminals from damage or shorting. Battery capacity for each system is calculated using a battery calculation tool.

The DC-DC Converter(s) provide a tightly regulated 24 VDC nominal output. Regulated power is used for those components and circuits that require tight voltage regulation and where ground fault detection is not required. A separate ground fault detection circuit is provided for unregulated power, for alarming and reporting to a PLC. Separate regulated and unregulated 24VDC circuits including a disconnect means and over-current protection are provided for powering the Fire Alarm Panel.

One or two auxiliary power supplies may also be provided for powering those components and circuits that do not require battery backup power. These power supplies are optional and are not furnished with all systems.

Another key feature of the FGS1400 MKII Fire and Gas system is its ability to display detailed graphics of the protected premise, detailed diagnostics of the health of the system, alarm management, and trending of data. aeSolutions has a product called the Master OS. It is a pre-engineered, FM approved, Proprietary Supervising Station that will allow the monitoring of multiple FGS1400 MKII Fire and Gas systems. The FGS-1400 Master OS is only designed to work with FGS1400 MKII Fire and Gas systems. It cannot be used to monitor third party Fire and Gas panels. It communicates to the FGS1400 MKII Fire and Gas systems via Ethernet. It is based on the Siemens PCS7 software platform.

The Master OS is a personal computer based system. Software required for the Master OS is PCS7, and Siemens Safety Matrix Viewer.

Three hardware/software architectures are available. The architectures are: Single Station, Server/Client, and redundant Server/Client. Single station is a standalone single Master OS unit that collects and displays FGS 1400 MKII status information at a single location. Server/Client architecture allows a single tag server to collect data from the FGS1400 KMII Fire and Gas systems and pass the data to multiple client Master OS Stations. Redundant Server/Client architecture allows a pair of tag servers to collect data concurrently from the FGS1400 MKII Fire and Gas systems and pass the data to multiple client Master OS Stations allowing increased availability.

Communications between the Master OS and each FGS1400 MKII Fire and Gas panel are continuously monitored. An alarm is generated anytime there is a loss of communications.

With increased cyber security threats, aeSolutions is incorporating advanced security features. These security features and functions allow only known devices communications access, and to track by logging data flow traffic for the devices, allowing technicians to analyze as needed. Security protection for the FGS1400 MK II are smart transparent devices that are built to secure this and many other platforms allowing logical isolation and adding provisioning at the systems level for DMZ's (demilitarized zones) for data collection, 3rd party vendor access, field technician access and in basic mode is a the systems protector of DoS (denial of Service) broadcast storms that can and have brought remote and online systems down. At aeSolutions we treat security in the highest regard and have designed these security modules at the highest level. High availability, Integrity and safe operations are built to design specifications.