

SECTION 283600 – HAZARDOUS MATERIAL GAS DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes hazardous material monitors and notification appliances.

1.3 SYSTEM DESCRIPTION

- A. Provide a complete design and installation of hazardous material gas detection and alarm systems where indicated or shown on drawings. System shall include, but not be limited to, building areas as indicated herein and on plans, and as required by code. Applicable system types to be applied are as follows:
 - 1. Flammable Gas Monitoring System
 - 2. Highly Toxic and Toxic Gas Monitoring System
 - 3. Hazardous Material Emergency Alarm System
- B. Drawings indicate material and equipment locations, and general design of gas detection systems.
- C. Provide all system control components required for gas detection, alarms, alarm annunciation, emergency shutdown, area exhaust continuous airflow monitoring, manual alarm notification, ventilation direct interlocks, and security panel interface as required per Code and the specifications. Gas detection system shall monitor areas where hazardous vapors from a leak are likely to concentrate or leak. Alarms and equipment interlocks shall be actuated at building code specified percent lower explosion limit values and TLV/PEL ppm levels. System shall be capable of indicating, alarming, emergency shutdown of equipment, ventilation control and interfacing to the security system to notify the MSU Police and Public Safety as specified below, on drawings, and in governing Building Code regulations.
- D. System design and content shall meet or exceed current state and federal codes and standards; including but not limited to Michigan Building Code, Michigan Mechanical Code, International Fire Code, National Electrical Code 70, Life Safety Code 101, and as applicable: NFPA 45, NFPA 55, OSHA CFR 29 Part 1910. System intrinsic safety design shall conform to CSA C22.2, No. 157, NEC / ISA, ANSI/ISA-RP 12.6, and NFPA-70 Article 504 requirements where required.
- E. All devices shall be UL listed.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's product technical data information for all system components.
- B. Shop Drawings:
 - 1. General system layout including all devices locations, device identification numbers along with sequence of operation, system interlock details for interface to building exhaust and ventilation system, building automation system, security system, etc.
 - 2. Wiring Diagrams:
 - a. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - b. Include all interconnections between components, control panels, and other system interfaces and devices. Include control panel wiring details.
 - 3. Piping Diagrams: Include diagrams for equipment and for system with all interconnections identified.
- C. Construction Documents: Include information specified in accordance with applicable codes and standards.
- D. Code Compliance Documentation: Include code references and code trail, and hazard evaluation for each zone or area.
- E. Product Certificates: UL listed.
- F. Operation and Maintenance Data:
 - 1. System operation description covering this specific Project.
 - 2. Operating instructions for mounting at each control panel.
 - 3. Operation and maintenance data for inclusion in Operating and Maintenance Manual.

1.5 WARRANTY

- A. Hazardous Material Gas Detection and Alarm System shall be provided with a two (2) year warranty and all applicable recommended spare and consumable parts for two years of operation.

PART 2 - PRODUCTS

2.1 SAFETY SYSTEM SUPPLIER

- A. Subject to compliance with requirements, provide turnkey hazardous material gas detection and alarm system including design responsibility, fabrication and installation.
- B. Supplier shall be factory trained and authorized service center for gas detection products specified and factory authorized to provide code compliant turnkey system design, fabrication, installation, service and training of specified products.

2.2 MAIN CONTROL PANEL

- A. Main control panel shall be wall mounted or free standing at location shown on plans, NEMA 12 enclosure painted safety blue, sized as required. Panel shall include gas system controller configured as required and interfaced to make a complete operating system. System controller shall have the ability to provide TCP/IP communication to transmit data to Remote Controllers and also the ability to communicate with a future computer system.
1. Provide HMI touch screen (see screen details below) with capability to display pertinent system information through (8) line digital display capable of full description for each input/output/alarm, emergency power terminal connections, shut down logic, alarm indication, emergency stop pushbutton, horn, beacons, contacts for retransmission of alarms to remote equipment and systems, circuit breakers, fuse protection, surge protection, all logic and interface relays, timers, power supply, terminal strips, wire ways, malfunction indication, power on indication, etc. as necessary to make complete operating system. Provide push button silence switch on front of control panel to acknowledge and silence or reset self-latching alarm circuit. Alarms shall stay latched to prevent them from automatically resetting when alarm condition goes away. Controller shall provide display of all channels, contacts necessary to provide code required interlocks and fault indication. Minimum viewing screen size 6”.
 2. The HMI interface shall include the following screens:
 - a. System Overview
 - b. Zone Alarm
 - c. History Trending
 - d. System Status / Alarm History
 - e. Sensor Status and Readings
 - f. Connectivity
 - g. Malfunction Alarm
 - h. Calibration Mode
 3. Gas Detection Controller: Provide controller with ability to provide a 15-minute TLV-TWA average value for each toxic gas sensor. System shall be capable of storing no less than one-week sensor readings. During calibration, controller shall detect calibration signal at sensor and inhibit all alarms and denote sensor is in calibration. Provide "one-man" non-intrusive calibration. Size controller for minimum 20% spare capacity for future use.
 4. Controller shall be one of the following as long as it complies with specification requirements: Drager Regard, SafeAir SafeGARD, MSA Suprema with accessory components as required to provide system operational logic.
 5. Provide battery backup as specified.
 6. Provide communication to site security system as noted in this document.
 7. System shall be standalone and not dependent upon the proper operation of other systems.
- B. Upon system reset, the alarm beacons shall be deactivated only if area monitored has returned to a safe condition. Purge ventilation systems shall remain activated for 30 minutes after alarm condition has cleared. A panel-mounted indicator shall denote that purge ventilation system is still activated and air flow proving device is sensing air flow. Provide a manual switch capability for "Auto - Manual On" purge fan control at the MCP and each remote panel where required.

- C. Alarm Test. Provide capability inside each local panel to test alarm circuitry and panel indicators. During test function, interlock signals to FACP and other notification systems shall be disabled. Switch shall automatically reset.

2.3 EMERGENCY ALARM SYSTEM REMOTE I/O DISPLAY PANEL

- A. Remote I/O Panel: Locate remote I/O panels as required to handle field mounted sensors and devices. Panel shall communicate to main system control panel and provide readout display of all system alarms. Panel shall serve as remote I/O for area gas detection sensors, emergency alarm annunciation devices, emergency alarm notification devices, safety shutoff valves, airflow input devices, etc. Panel shall be wall mount or freestanding, NEMA 12 enclosure painted safety blue, sized as required. Panel shall include gas detection system controller configured as required and interfaced to system network. System controller shall have the ability to provide TCP/IP communication to transmit data to Remote Controllers and also the ability to communicate with a future computer system.
- B. Provide local HMI touch screen with full capability of main panel controller noted above in locations where remote display is specified.
- C. Remote I/O panel shall be able to provide standalone operation in the event of a power failure or main system controller malfunction. Provide battery backup as specified.

2.4 EMERGENCY POWER BATTERY BACKUP SYSTEM

- A. Provide battery backup system to meet MBC / NFPA requirements for emergency alarm systems back up power supply system as required for full load duration mode; include sizing for load with duration of backup per code. Provide load calculation information in submittal data and for permanent site records. Interface power loss status contacts to security system as TROUBLE per building code requirements. Backup entire emergency alarm system hardware including all alarm and warning devices. Locate backup power system(s) adjacent to each control and remote I/O panel(s) as required. Panel shall be wall mount; NEMA 12 enclosure painted safety blue and identified with proper tagging for function and use.

2.5 INTERFACE TO OTHER SYSTEMS

- A. The emergency alarm system shall provide the central interface to other facility systems as noted in the Emergency Shutdown Interlocks Matrix. These systems include but are not limited to the following:
 - 1. Security System
 - 2. Facility Monitoring System
 - 3. Building Sprinkler System

2.6 FLAMMABLE GAS MONITORING SYSTEM

- A. Gas monitoring system design and provision related to storage, use, dispensing, mixing and handling of flammable gases / liquids / materials shall be in accordance with applicable code

sections referring to fueled equipment, emergency and standby power systems, emergency alarm systems, flammable and combustible liquids, flammable gases, and research and development areas, motor fuel-dispensing facilities and repair garages, hazardous materials – general provisions, aerosols, compressed gases, liquefied petroleum gases. Gaseous hydrogen systems shall also comply with NFPA 50A. Exceptions include gases used as refrigerants, in refrigeration systems, liquefied petroleum gases and natural gases regulated elsewhere, and fuel gas systems and appliances regulated under the International Fuel Gas Code. System shall also incorporate related system design criteria established by DOL 29 CFR; 1910.1000 – 74 and 1910.1200 – 74.

1. Identify flammable hazardous materials and scheduled use quantities according to code per zone. Define each zone design parameter required.
2. Design flammable gas / liquid vapor monitoring system according to code regulations per zone.
3. System design specifics and sequence of operation shall address areas exceeding the maximum allowable quantity per control area and areas with quantities not exceeding the maximum allowable quantity per control area as directed by code.
4. Identify and submit, as required by code, applicable code references for each gas monitoring system designed component, alarm and control function by zone.
5. Combine flammable gas monitoring with hazardous area emergency alarm system.
6. For flammable gases and liquids, the monitoring detection threshold level shall be vapor concentrations in excess of 10 percent of the lower flammable limit (LFL) or other as directed by the code. Sequence of operation shall be as directed by code for each specific hazardous material and code specified use.
7. Compressed gas systems conveying flammable gases shall be provided with approved emergency shutoff valves that can be activated at each point of use and each source.
8. Automatic remotely activated fail-safe emergency shutoff valves shall be installed on supply piping and tubing at the following locations: the point of use, the tank, cylinder, or bulk source and at main zone supplies thus eliminating shutdown of the entire facility upon a detected leak.
9. Fueling systems shall be shutdown in the event of failure of the area ventilation system.
10. Ventilation systems shall be monitored and airflow proven for each specific type flammable gas detection system to provide code directed logic.
11. Gas detection system controlled ventilation airflow shall be proven and provide code specified shutdown and alarm upon failure.
12. Failure of the gas detection system shall result in actions as directed by the code in regards to ventilation, shutdown, annunciation and remote supervision.
13. Emergency shutdown interlocks, monitoring system interlocks and control interlocks shall be provided as defined in code. Additionally logic shall be as follows where applicable:
 - a. Danger level Flammable gas alarm
 - 1) Red beacon and horn at main panel, floor panel and in zone.
 - 2) Monitor and control ventilation and shutdown per code requirements.
 - 3) Zone Dry contact for Security System Input for each specific gas type.
 - 4) Panel indication for device in alarm.
 - 5) Shunt Trip power to room / area.
 - b. Malfunction Alarm Logic shall be as indicated following and in this document
 - 1) Blue beacon and horn at panel.
 - 2) Common Dry contact for Security System Input.
 - 3) Panel indication for specific unit in fault.

- 4) Monitor and control ventilation and shutdown per code requirements.
14. Piping, tubing, valves, fittings and related components shall be designed and fabricated from materials compatible with the material to be contained and shall be of adequate strength and durability to withstand the pressure, structural and seismic stress, and exposure to which they are subject.
15. Emergency shutoff valves shall be identified and the locations shall be clearly visible and accessible and indicated by means of a sign.
16. Where gases or liquids having a hazard ranking of: Health Hazard Class 3 or 4, Flammability Class 4, Reactivity Class 4, in accordance with NFPA 704 are carried in pressurized piping above 15 pounds per square inch gauge (psig), an approved leak detection and emergency shutoff control shall be provided.
17. Where piping originates from within a hazardous material storage room or area, flow control shall be located within the storage room or area. Exceptions are piping for inlet connections designed to prevent backflow and piping for pressure relief devices.
18. Where piping originates from a bulk source, flow control shall be located as close to the bulk sources as practical. Exceptions are piping for inlet connections designed to prevent backflow and piping for pressure relief devices.
19. Equipment, machinery and required detection and alarm systems associated with the use, storage or handling of hazardous materials shall be listed or approved.
20. Where manual alarm and detection systems are required, such systems shall be connected to an emergency electrical system or a standby power system in accordance with the code.
21. Manual alarms and detection systems required shall be supervised by an approved central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location as defined by the AHJ.
22. Training shall be provided for persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used. Responsible person shall be trained specifically to relate pertinent data from system, as liaison to the fire department. Training shall include site system specific written emergency response procedures.

2.7 HIGHLY TOXIC AND TOXIC GAS MONITORING SYSTEM

- A. Gas monitoring system design and provision related to generation, production, storage, use, dispensing, mixing and handling of highly toxic and toxic gases / liquids / materials shall be in accordance with applicable code sections referring to emergency and standby power systems, emergency alarm systems, research and development areas, hazardous materials – general provisions, compressed gases, highly toxic and toxic materials. System shall also incorporate related system design criteria established by DOL 29 CFR; 1910.1000 – 74 and 1910.1200 – 74.
 1. Identify highly toxic and toxic hazardous materials and scheduled use quantities according to code per zone. Define each zone design parameter required.
 2. Design highly toxic and toxic gas / liquid vapor monitoring system according to code regulations per zone.
 3. System design specifics and sequence of operation shall address areas exceeding the maximum allowable quantity per control area and areas with quantities not exceeding the maximum allowable quantity per control area as directed by code.
 4. Identify and submit, as required by code, applicable code references for each gas monitoring system designed component, alarm and control function per zone.

5. Combine highly toxic and toxic gas monitoring with hazardous area emergency alarm system.
6. A gas detection system shall be provided to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit of the gas for which detection is provided. If a treatment system is required; the system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit. Exception: A gas detection system is not required for toxic gases when the physiological warning properties for the gas are at a level below the accepted PEL for the gas and the gas has a health hazard rating of 1 or 2 in accordance with NFPA 704.
7. Emergency shutdown interlocks, monitoring system interlocks and control interlocks shall be provided as defined in code. Additionally logic shall be as follows where applicable:
 - a. Warning level Toxic / Highly Toxic alarm
 - 1) Amber beacon and horn at main panel, I/O panel and in zone.
 - 2) Control ventilation per code requirements.
 - 3) Zone Dry contact for Security System Input for each specific gas type.
 - 4) Panel indication for device in alarm.
 - b. Danger level Toxic / Highly Toxic alarm
 - 1) Red beacon and horn at main panel, I/O panel and in zone.
 - 2) Control ventilation per code requirements.
 - 3) Zone Dry contact for Security System Input for each specific gas type.
 - 4) Panel indication for device in alarm.
 - c. Malfunction Alarm
 - 1) Blue beacon and horn at panel.
 - 2) Common Dry contact for Security System Input.
 - 3) Panel indication for specific unit in fault.
8. Equipment, machinery and required detection and alarm systems associated with the use, storage or handling of hazardous materials shall be listed or approved.
9. Ventilation systems for hazardous areas shall be designed to operate continuously at negative pressure in relation to surrounding area. Provide continuous airflow monitoring alarm for each applicable control area. Alarm initiating device to be rated general purpose per each applicable highly toxic and toxic gas; unless target gas is also flammable and concentration exceeds LEL, then alarm initiating device shall be explosion proof or intrinsically safe. Device input shall alarm as specific trouble to remote supervisory station, or other as defined per code. Applicable codes shall apply.
10. Where manual alarm and detection systems are required, such systems shall be connected to an emergency electrical system or a standby power system in accordance with code.
11. Manual alarms and detection systems required shall be supervised by an approved central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location as defined by the AHJ.
12. Training shall be provided for persons responsible for operation of areas in which hazardous materials are stored, dispensed, handled or used. Responsible person shall be trained specifically to relate pertinent data from system, as liaison to fire department. Training shall include site system specific written emergency response procedures.

2.8 OTHER HAZARDOUS AREA EMERGENCY ALARM SYSTEM

- A. Perform a risk-analysis for areas with a potential to create IDLH conditions for gases or cryogenics that are not toxic or flammable. If required, design a gas monitoring system to warn occupants of IDLH conditions.
1. System design specifics and sequence of operation shall be approved by AHJ.
 2. Identify and submit, as required by code, applicable code references for each gas monitoring system designed component, alarm and control function.
 3. Combine gas monitoring with hazardous area emergency alarm system.
 4. If required, a gas detection system shall be provided to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit of the gas for which detection is provided. Exception: A gas detection system is not required for toxic gases when the physiological warning properties for the gas are at a level below the accepted PEL for the gas and the gas has a health hazard rating of 1 or 2 in accordance with NFPA 704.
 5. Gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station when a short-term hazard condition is detected. The alarm shall be visual and audible and shall provide warning both inside the control area and outside each entrance to the control area where gas is detected. The audible alarm shall be distinct from all other alarms.
 6. Automatic closure of shutoff valves shall be in accordance with the building code. Provide oxygen cleaned where required.
 7. Emergency shutdown interlocks, monitoring system interlocks and control interlocks shall be provided as defined in other similar portions of the specification.
 8. Equipment, machinery and required detection and alarm systems associated with the use, storage or handling of hazardous materials shall be listed or approved.
 9. If determine necessary, provide continuous airflow monitoring alarm for each applicable zone. Alarm initiating device to be rated general, explosion proof or intrinsically safe. Device input shall alarm as specific trouble to remote supervisory station.
 10. Where manual alarm and detection systems are required, such systems shall be connected to an emergency electrical system or a standby power system.
 11. Manual alarms and detection systems required shall be supervised by an approved central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location as defined by the AHJ.
 12. Training shall be provided for persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used. Responsible person shall be trained specifically to relate pertinent data from system, as liaison to the fire department. Training shall include site system specific written emergency response procedures.

2.9 FIELD DEVICES

- A. Airflow Profile Test / Gas Detection Sensor Quantity and Location. Final design to be supported with Airflow Profile Test Report. Provide quantity and location of sensors based on bid documents. It is this system supplier's responsibility after this system has been started up to provide accurate airflow profile testing and report with ventilation system operating under normal and operating under alarm conditions. Contactor shall document recommended locations and quantities of sensors for code inspector approval (see installation, testing and acceptance procedures below). Sensor locations and quantities indicated herein are for reference purposes only and represent at best a minimum quantity of sensors required for this

project. After approved review of simulated airflow test by AHJ, Fire Marshal and project engineer, supplier shall provide quantity of sensors deemed necessary by governing code official. Sensors required above the minimum quantity indicated within the contract documents shall be supplied as an extra to the project. Include an itemized price in your proposal to add each type sensor/transmitter assembly including related panel and field equipment, and installation cost per foot of electrical conduit.

- B. % LEL Catalytic Sensor; Gasoline and Hydrogen. Provide catalytic type diffusion sensors with transmitter for flammable gas measurement of gasoline vapor and hydrogen. Sensors supplied shall be in screw cover housing rated for explosion proof class 1, div. 1 areas. Approvals shall be FM or UL. Sensors shall be capable of one man, non intrusive, calibration with handheld calibrator. Transmitter housing shall be rated for hazardous areas and provide local digital display of concentration in % LEL. Sensor full range shall be 0-100 % LEL with 4-20 mdc output and / or addressable digital highway output. Transmitter shall incorporate a calibration output signal that is transmitted over the same twisted shielded pair of signal wires back to the control panel to indicate the unit is in calibration mode. This will allow bypass of unnecessary alarms when system is involved with routine maintenance. Sensors mounted at ceiling, in trenches or pits, shall use remote dual conduit assembly to separate sensor from transmitter and provide for sensor calibration from ground level. Transmitter shall be located at eye level in an area accessible for ease of calibration. Calibration adapter shall be provided for sensors mounted remotely. Provide 1/4" tubing routed in e.m.t. conduit to sensor connector and route tubing to provide ease of calibration at an accessible location above floor level near transmitter. Tag each calibration tube clearly as to specific calibration gas required and sensor type. Sensors shall not be duct mounted in exhaust or supply air ductwork. Provide Drager Polytron, SafeAir, or MSA UltimaX Series.
- C. PPM / % Electrochemical Sensor; Carbon Monoxide, Oxygen, Nitrogen Oxides (NOx). Provide electrochemical type sensors for measurements of Carbon Monoxide, Oxygen Depletion, and NOx measured as Nitrogen Dioxide and other toxic or highly toxic gases as required. Transmitter shall be supplied in screw cover housing rated for explosion proof class 1, div. 1 areas; UL Approved where required. Sensor shall be robust, accurate and able to operate over the full range of -40F to 150F. Sensor full range shall exceed TLV-TWA ppm or percent levels and provide a 4-20 mdc and / or addressable digital highway output with backlit LCD digital concentration meter to read in PPM or % O2 as required. Sensor will have interchangeable modules that can be calibrated away from the electronics and then inserted into the transmitter. Each sensor shall be specifically calibrated for gas of interest and alarm at lowest possible value to provide early warning detection. Sensors shall provide for "one man" calibration. Transmitter shall incorporate a calibration output signal that is transmitted over same twisted shielded pair of signal wires back to control panel to indicate the unit is in calibration mode. Sensors shall be mounted 5'6" above the finished floor or as required based on the vapor density of the target gas. Transmitter shall be located at eye level in an area accessible for ease of calibration. Sensors shall have an 18 month warranty. Sensors shall not be duct mounted in exhaust or supply air ductwork. Provide Drager Polytron, SafeAir, or MSA UltimaX Series.
- D. Propane (PPM) Infrared Toxic Gas Sensors. Provide dual path infrared type sensors for toxic gas measurements of Propone with no moving parts. Sensor full range shall be user adjustable from 0-850 to 5000 ppm or 0 - .5% by volume and provide a 4-20 mdc and / or addressable digital highway output. Each sensor shall be specifically calibrated for gas of interest and alarm at lowest possible value to provide early warning leak detection. Transmitter shall incorporate a

calibration output signal that is transmitted over same twisted shielded pair of signal wires back to control panel to indicate the unit is in calibration mode. Mount sensor at 12" a.f.f. Sensor shall have five-year warranty. Provide Drager Polytron, SafeAir, MSA ChemGard Series.

- E. Air Flow Switch (AFS). Provide intrinsically safe, explosion proof or general-purpose airflow switches, differential type, as required for monitoring of area continuous and intermittent exhaust and supply fans. Where required switches to be intrinsically safe when used with approved isolator mounted in safe area control panel.
- F. Emergency Ventilation Break Glass Switch (BGS). A clearly identified switch of the break-glass type shall provide off-only ventilation control for use by fire response personnel in areas where flammable, combustible, toxic or highly toxic materials are stored, used, dispensed, or handled in accordance with IFC requirements.
- G. Emergency Alarm Pushbutton / Pullstation (EAPB or ESP). Provide color coded, mushroom style, Emergency Pushbuttons / Pull Stations with Push – Pull action, SPDT switch rated per area requirements. Emergency pushbuttons shall be located at each point of use for flammable, toxic or highly toxic liquids or gas, within the path of egress from each control area and outside each control area, as required by code and at the control panel. Emergency stop pushbuttons (E-Stops) are also required for the engine test cells. Hazardous Material / Gas detection related devices shall be blue and provided with a plastic guard; E-Stops shall be Red or Yellow as identified on the drawings and in the alarm matrix.
- H. Alarm Horns and Beacons. Provide alarm horns and beacons equal to Edwards 102 Series Triliptical stackable flashing LED and steady on with optional tone module inside and outside of each control area / zone and at each entrance into a control area / zone as applicable. Beacons and horns shall be general purpose, NEMA 4x for outdoors, Class 1, Div. 1 or Div. II rated explosion proof as required; red, amber, and blue. In general, Red shall be high level % LEL alarm or high level toxic alarm, Amber shall be warning level for all, and Blue shall be system Malfunction/Trouble. For flammable and hazardous materials, use 2 color stack red and blue. For oxygen deficiency red alarm set point is less than 19.5% oxygen. For toxics, use three color stack amber, red and blue. For toxics, amber alarm at 50% of the PEL and red alarm at the PEL. Classified area shall be other as supplied by Edwards. Outdoor strobes shall be designed for visibility in daylight conditions. All remote visual and audible devices shall be 120 vac and powered from main control panel and emergency power source. Horns in high noise areas shall be rated for the db levels present as required by NFPA and shall be adjustable.
- I. Tagging / Warning Signs / Area Maps. Signs to be pre-approved prior to installation.
 - 1. Hazardous Area Entrance / Exit Signs at Annunciation Devices
 - a. Multi-Color Warning Signs. Provide multi-color lexan screen sign with black lettering at each remote visual and audible alarm warning device and where directed by plans and specifications. Sign size shall be minimum 8" wide and sized to match the height of the visual annunciation device and shall be horizontally aligned so that sign description is adjacent the appropriate beacon color. Tag background colors to match beacon color with black letter description internal to the background color. Tag lettering shall be aesthetically aligned and positioned next to each color alarm beacon so as to clearly identify the beacon function at a glance. Detailed gas type lettering contained within each section of the tag shall be no less than ½"; but 1" where capable.

- b. A separate tag sized 3.5" x 8" shall denote Zone # and Area in Alarm.
2. Area Map. Provide color map, approximately 11"x 17" behind lexan protective frame at each control panel. Map to denote Zone I.D. / Areas being monitored. Include location and identification of input field devices; including but not limited to airflow switches, pushbuttons, sensors, etc. Color code each zone.
3. All warning signs must be approved by Owner Safety Department.
4. Emergency Pushbutton shall denote shutdown or interlock information.
5. Field Devices: Tag all field devices. Anchor tag to wall adjacent to wall mounted devices, suspend with brass security chain adjacent to ceiling mounted devices.
6. Signs shall comply with building code standards.

2.10 CALIBRATION GAS AND HARDWARE

- A. Provide all necessary calibration gas and hardware for system start up, Fire Marshal acceptance testing and owner training.
- B. After system start up and acceptance testing provide two (2) years of calibration complete with calibration gas and hardware kit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. System supplier shall have turnkey responsibility to provide mechanical and electrical installation, provide on-site installation supervision, and properly locate sampling points after review of room air flow and ventilation patterns.
- B. Install control panels and electrical field devices in accordance with applicable codes and manufacturer's printed instructions. Install conduit and wire for all interlocks to each remote system. Make final electrical terminations. Installation personnel shall be trained in the proper installation and application of Gas Detection / Emergency Alarm Systems. Installer must be familiar with division 16 installation practices.
- C. Install all wire, conduit and mounting hardware for interface to other building systems. Final termination into other system shall be by that other system contractor. For example: Security System contractor shall provide all necessary security system hardware, programming of his equipment, final termination, interface drawings, commissioning assistance as required to make a complete operating system. This also applies to Building Automation System Contractor, Fire Suppression, Test Cell Controls, Facility Monitor System, etc. Interlocks to other systems shall be direct connection and not through other systems.
- D. Install all associated piping and tubing for airflow switches, dual condulet assembly calibration adaptor, emergency shutoff valves, etc. as required making a complete and operating approvable system.

3.2 FIELD QUALITY CONTROL

A. General:

1. Prior to project completion and when directed by Owner's Representative, thoroughly test and calibrate each field device and gas detection system for proper operation. Should corrections be required to any system, and after corrections have been completed, system shall be re-tested.
2. Assist MSU EHS and Physical Plant Maintenance Department in development of emergency procedures.
3. Tests shall be witnessed by Owner or his designated representative and a letter shall be submitted certifying system performance.

B. Safety Certification:

1. Furnish Owner with written report certifying that work has been accomplished with results. Provide Safety Certification documentation to the owner including the following: Air Flow Profile Report for each sample point location, Calibration Report with before and after results of each analyzer, Alarm / Interface Report stating all threshold levels, alarm and interface action at each level of alarm with field verification report, Safety Training Checklist, and List of all owner attendees.
2. Near end of warranty period of operation, provide similar service as described above complete with written report. Should a control or device be suspect in its operation or function, this deficiency shall be reported to operating personnel, documented in report, and replaced.

C. Post Construction On Site Service:

1. Each three months after final acceptance until warranty expires; systematically inspect, examine, clean, calibrate and adjust when necessary, gas detection system, back up power supply, transmitters, detector, panels, relays, replace defective sensors, and accessories pertaining to the system.
2. Prior to the end of the first year warranty period provide code required annual alarm operation and shutdown inspection audit with AHJ approved report and certification. Annual inspection report to include: quarterly sensor calibration and alarm setpoint reports for entire year, alarm signaling device and appliance operation matrix verification with prior year, indication of any system modifications since prior inspection, remote alarm initiating device operation, interlock operation, ventilation interlock and alarm operation, code back up power supply test sequence and report, operation of interlocks to 24 hour supervised station, etc. and as required per governing code and local AHJ. Include report for main control panels and all remote system panels. One (1) copy of annual inspection and certification information shall be turned over to the owner and one (1) copy shall be forwarded to the local municipal Fire Marshall / AHJ. Inspection certification to be posted at each system main control panel.
3. Prior to end of warranty period, provide similar service as described above complete with written report. Should a control or device be suspect in its operation or function, this deficiency shall be reported to operating personnel, documented in report, and if under warranty, replaced.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas detection devices. Refer to requirements in Division 01 Section "Demonstration and Training."

END OF SECTION 283600