SECTION 28 35 00_TOXIC GAS MONITORING SYSTEM

This document identifies the minimum design, installation, testing and quality levels for new Toxic Gas Monitoring Systems (TGMS) being supplied to any University of Delaware facility. The Architect/Engineer shall include all of these minimum requirements within the content of the bidding documents and ensure that all minimum requirements are complied with through completion of the project.

PART 1 GENERAL

1.1 SUMMARY

A. The need for a (TGMS) shall be determined by the types and hazards of gases used in the proposed laboratory or process. All gases that are determined to be hazardous as per the University of Delaware Compressed Gas Plan Appendix H will require toxic gas monitoring.

B. The intent of the system shall meet the minimum code requirements as specified, but in addition, shall meet the specific level of life safety and protection as required by the University of Delaware in these minimum requirements.

C. The system shall be designed in a modular fashion to ensure future expansion capability. Furthermore, the TGMS is integrated into the University of Delaware's life safety systems and is intended to provide a high degree of toxic gas release detection, alarm notification and selected control outputs. Currently, this design is intended to provide the University of Delaware with a high degree of reliability and NO unwanted alarms.

D. The University would prefer to have a single building wide TGMS. The designer of the system shall consult with the Sustainability Energy and Engineering Department (SEE) and the Department of Environmental Health and Safety (EH&S) to identify the specific type of system being proposed. Types of signaling systems and method of occupant notification will be determined at the time of consultation with the Environmental Health and Safety Office.

1. Exception: Laboratories or locations in building without TGMS backbone may have stand-alone TGMS with future capability to tie into building wide TGMS.

E. The design, installation, workmanship, testing and documentation of the system must be of the highest quality. The design team includes University Fire Marshal, the University Chemical Hygiene Officer, and an assigned SEE Engineer shall be the final judge of quality issues and their decision is final. If bidders or any interested parties have a concern with these conditions, they shall note their concerns in writing at the time of pre-bid meetings and at the time of bid submission.

F. The TGMS for each building shall be a stand-alone system and interface with the existing building fire alarm system as well as installation of a separate Keltron 923 or Keltron Net 9000 Transceiver to be interconnected to the University of Delaware's Remote Signal alarm
receiving station located at the Department of Public Safety, 413 Academy Street, Newark, Delaware. The Keltron systems can also be directly connected to for reporting purposes. The Manager of Electronic Services will coordinate all Keltron System programming.

1. Exception: Standalone TGMS in buildings without a building-wide TGMS may tie directly into building fire alarm system.

G. The TGMS shall be complete in all respects for operation and interface with building equipment related to or desired to be controlled by the TGMS system. All work shall be coordinated with the University of Delaware’s Department of Maintenance and Operations, SEE, PPD. The TGMS contractor/designer shall include in his/her design all work necessary to interface building automation systems, fire alarm systems, smoke management and other code specified supervisory functions. Any equipment, wiring, installation or other work necessary to finish all interface and output wiring or equipment shall be included in the design and subsequent bid packages.

1. Exception: Standalone TGMS in buildings without a building-wide TGMS may tie directly into building fire alarm system. Standalone TGMS shall perform all necessary local shutdown functions.

H. Prior to the start of any design or installation, the Contractor and Vendor shall have a “kick off” meeting with the following in attendance:

1. Contractor’s actual wire and device installer(s) for the project. This is the actual mechanic(s) that will be performing the work.
2. Actual Vendor engineer, programmer and designer.
3. University Representatives of their choice (including and not limited to Environmental Health & Safety, Maintenance & Operations, Sustainability Energy and Engineering and Project Manager).

1.2 CODE COMPLIANCE

A. The Toxic Gas Monitoring System shall at a minimum comply with the following codes:

1. FM: FM Global approvals and standards
2. NFPA 2 Hydrogen Technologies Code
3. NFPA 45 Standard on Fire Protection for Laboratories Using Chemical
4. NFPA 55 Compressed Gases and Cryogenic Fluids Code
5. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
6. UL: Underwriters Laboratories compliance for all electronic devices
10. International Building Code, Current Edition Adopted by City of Newark or County Building Department
13. University of Delaware Chemical Hygiene Plan and Guidelines for Safe Use of Compressed Gases
15. All Applicable OSHA Standards

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. All equipment, components, wiring, design, and the installation of all items as described or implied in this document shall meet all the appropriate requirements in the codes, standards and guidelines as listed.

B. All equipment, components, wiring, design, and installation of all items as described or implied in this document shall be UL listed and approved for the use intended.

C. All equipment, components, wiring, design, and installation of all items as described or implied in this document shall be reviewed and approved by listed code authorities. The Contractor shall be responsible to submit all design documents and obtain all approvals from each listed code authority only after the submissions have been reviewed and approved by the Owner. No submission will be made to a code official until the Owner has approved the shop drawings. Code Authority review required for this project at a minimum, shall include:

1. Appropriate AHJ; City of Newark Fire Marshal’s Office, State Fire Marshal’s Office.
2. University of Delaware Environmental Health and Safety Office.

D. The Contractor shall be responsible for all submission costs and the Contractor shall be responsible for obtaining all required approvals, permits, and acceptance inspections/approvals from all legal and/or required agencies, inspection organizations and insurance groups as listed in these specifications.

1.4 COORDINATION

A. The Contractor shall fully coordinate the design, equipment, devices, installation, wiring and connection of all toxic gas monitoring systems with the Owner and/or their authorized representative and all other related contractors throughout each developmental stage of the project.

B. The contractor shall fully coordinate the installation of all systems with other contractors and other work in progress or proposed progress at the time of Contractors design and installation. It shall be the Contractor’s responsibility to communicate with the Owner’s on-
site representatives and identify all other work or trades which will require coordination with the fire alarm system design and installation.

C. The Contractor shall include in his schedule key times to notify the Project Manager for periodic inspection of the system installation. The University requires an inspection of the installation at the following points of:

1. Shop drawing development.
2. 25% of rough in wiring installation.
3. Device and panel installation.
4. Pre-acceptance inspection by Environmental Health and Safety Office (Fire Protection), Department of Maintenance and Operations (Electronics Manager), and other representatives as necessary.
5. Final acceptance testing.

1.5 SUBMITTALS AT TIME OF SHOP DRAWINGS & SHOP DRAWING FORMAT

A. All shop drawings shall be approved by University Fire Marshal and Chemical Hygiene Officer and when applicable Owner Representative prior to installation. Submit two copies of all shop drawings prior to equipment delivery and installation of wiring. Each shop drawing must be approved by the University Fire Marshall, Chemical Hygiene Officer and when applicable, the Owner Representative prior to equipment delivery and installation.

B. All shop drawings shall show proposed wiring diagrams point-to-point with labeled terminal and splice points, data sheets, equipment ratings, layout, dimensions, conduit, wire mold, material type and finishes.

C. Submitted material list shall indicate proposed manufacturer’s name and design/installation data for all systems and materials listed, specified, or intended for use by the Contractor.

D. The Contractor shall be required to submit the following series of drawings:

1. Shop drawings.
2. Panel drawings.
3. Schematics of all auxiliary devices and auxiliary system connections such as HVAC, etc.

E. Contractor shall be responsible for providing all shop, panel, schematic, and as-built drawings preferably in a Computer Aided Drafting (CAD) format version 2019 or newer. Drawings should be multiple-colored ink on high quality, white bond plotting paper of a standard size sheet as agreed upon with the Owner and shall include the following parameters:

1. Submission made using an acceptable CAD system capable of producing the electronic media in current version of AutoCAD.

F. The Owner shall own all electronic media and original drawings addressed under this specification. The Owner shall have the right to modify, reproduce, distribute, and use the
electronic media and original drawings in any fashion or for any use that the Owner may desire.

G. The Contractor and manufacturer shall retain a copy of all as-built drawings and documentation as discussed in these specifications. The Contractor and manufacturer shall not have the right to use any digital media, drawings, documentation, or other material describing or relating to the fire alarm system without the express written permission of the Owner.

H. Show locations of Toxic Gas Monitoring control panels, Touch Screen Controllers, and documentation cabinets on drawings to ensure adequate space is available.

I. Ensure drawings and specifications agree with respect to type of cable specified and that cable specified is suitable for the environment of the specific project.

J. Contractor shall produce and provide electrical schematic diagrams of any electrical connections between the Toxic Gas Monitoring System and building and or laboratory equipment. These drawings shall be submitted at the time of shop drawings and as-built drawing submission.

K. As part of this project and included within the base bid cost, the Contractor shall provide the Owner with “as-built” drawings for the TGMS system showing all features as described in these specifications in their entirety, in an “as-built” status. All changes and/or corrections to the approved shop drawings made during installation and testing shall be documented and shown on the final as-built documents.

L. As built drawings shall be in pdf format. The Contractor should also supply AutoCAD format for background plans.

M. The Contractor shall provide one complete set of documentation for onsite use. This can be installed into the contractor provided documentation cabinet.

Note: It is the intent of this section to ensure that a complete and adequate set of documentation exists on-site and is available to service technicians, inspectors, and fire department. No documents or other items will be permitted to be stored inside of any fire alarm control equipment or other enclosure.

N. All shop drawing submissions shall include the following:

1. A narrative description of the TGMS. The narrative description shall include an exact English description of all signaling arrangements, detection arrangements, output, and supervisory functions.

2. The sequence of operations for the TGMS including all alarm events and notifications.

3. TGMS alarm/response matrix.

4. All panel drawings shall show power and battery calculations for the system. Panel drawings shall show all wiring, ribbon, and other cable point connections. Show any field or manufacturer modifications to include dip switch set-up positions, jumpers and snipped components including wire color coding and labeling.
5. The system drawings shall have a plan view of each floor and a detailed riser diagram.

6. Actual wire, wire mold and conduit runs with anticipated methods of matching backgrounds or concealment of wire and conduit. Conduit and wire mold placement must be approved by the Owner.

7. System annunciation descriptors for each alarm, trouble, and supervisory output signal. Such descriptors shall be in “plain English” for each alarm, trouble, and supervisory output signal. The English annunciation descriptors shall use actual terminology used at the project building to include floor names and point of compass designations un-coded. Contractor shall confirm descriptors with the Owner’s on-site representative prior to shop drawing submission.

   Note: Code numbers, zone numbers or abbreviated text will not be approved without exception. Submission of coded, zoned, or abbreviated text will be rejected at the time of shop drawing submission without cause or comment! If bidder does not understand this requirement, seek clarification from the Owner prior to bid submission. Only complete and understandable English descriptors for fire alarm point and trouble annunciation will be approved.

8. Contractor shall show all exposed conduit (if any) at the time of shop drawings and received approval of the Owner. All exposed conduit must be clearly labeled on shop drawings by use of heavy weight pen markings and color.

9. Be prepared to submit one (1) actual sample of each type of device intended for installation as requested. If devices differ from area to area, then two (2) actual samples of each type of device labeled for the specific area must be submitted. These items include but are not limited to the following:

   1. Gas Sensors
   2. Audio Alarm Devices
   3. Light Stacks
   4. Excess Flow Valves
   5. Gas Shut Off Valve with Indicator
   6. Flame Arrestor
   7. Gas Regulator/Back Plate
   8. Proof of Exhaust Flow Switch
   9. Gas Cabinet Light Stack
  11. Touchscreen HMI panels
  12. Relays and Contactors
  13. Conduit and Pipe
  14. Wiring
  15. Junction and Back Boxes
16. Din Rail Compression Terminal Blocks
17. Weather Proof Enclosures
18. Water Tight Junction Boxes
19. Mounting Plates
20. Detail drawing and sample of each wiring connection to all devices and any proposed splice connections.
21. Wire mold and back box (if applicable).

P. Shop drawings shall include original design notes for basis of design.

Q. Gas detection device calibration procedures including description of methods used to calibrate gas detection device, description of instruments and devices used in calibration and description of test gases used to calibrate the gas detection devices. The University of Delaware Fire Marshal shall review and approve the gas detection device calibration procedures prior to gas detection device calibration.

1.6 SUBMITTALS AT TIME OF ACCEPTANCE TESTING

A. Prior to acceptance test submit manufacturer’s descriptive literature of actual equipment installed and the following:
2. Equipment and device operating instructions manual.
3. Equipment maintenance and programming manuals.
5. Parts lists.
6. Spare equipment and parts equipment and inventory list.
7. Testing and maintenance schedule as per requirements of these specifications.
8. As built drawings, sequence of operations and Alarm/Response Matrix

B. For testing and documentation submittal requirements, see Testing and Documentation, Part 5 in these standards.

1.7 WARRANTY

A. The successful Bidder shall be responsible for all warranty and guarantee issues regardless of subcontractors, vendors or others operating as subcontractors under the successful Bidders contract. Bid submission documents shall include a document executed by the successful Bidder’s senior corporate or company officer indicating that the successful Bidder understands that he/she is solely responsible legally and financially to the Owner for compliance to warranty and guarantee issues as follows:
1. All system equipment shall be guaranteed for a period of one year from date of final acceptance of each system in accordance with Part 5 of these standards.
2. All raceways and wiring are guaranteed to be free from inherent mechanical or electrical defects for one year from the date of final acceptance of the systems in accordance with Part 5 of these standards.

3. Regardless of typical manufacturer or Contractor provided warranties and guarantees, the base bid price shall include all fees for warranty or guarantee cost to include parts, labor, shipping, stocking, overhead, markup or other costs associated with performing work under the warranty or guarantee agreement. It is the intent of this section that the entire system will be warranted and guaranteed from any fault (other than an act of God or acts by someone other than the alarm system Contractor). If anything goes wrong with the system, the Contractor shall repair/correct at no cost to the Owner with components, parts and workmanship that are NEW, not rebuilt, or reconditioned parts or equipment. If this intent is not clear or understood by the Bidder, the Bidder shall seek clarification from Owner prior to bid submission.

B. As part of the successful bidder’s warranty package, the successful bidder shall submit at the time of system acceptance under Part 5 of the standard, a schedule of maintenance, testing, and service as prescribed by these specifications and referenced standards, for the first-year warranty period, The cost for the first-year maintenance and testing shall be listed as an alternate on the bid form.

C. All warranty service that impairs the function of the toxic gas monitoring system shall be provided within four hours of notification to the Contractor. Cost for this service shall be included in the original bid.

D. All warranty services that do not impair the function of the toxic gas monitoring system but is obligated under the warranty shall be performed within 24 hours of notification to the Contractor unless otherwise approved by the Owner.

1.8 QUALIFICATIONS

A. Contractor shall be licensed electrician with the State of Delaware. Contractor shall have personnel on staff who specialize in the engineering, design and programming of toxic gas monitoring systems and have a minimum of five years of documented experience with the design and installation of the actual system and devices being installed.

B. Equipment manufacturer shall be a company specializing in NFPA/IFC toxic gas monitoring systems with a minimum of ten years of documented experience.

C. All qualification documentation shall be submitted at the time of bidding and verified at bid acceptance.

D. Contractor shall assign to the project a project manager who is experienced in the installation of toxic gas monitoring systems. The Project Manager shall be assigned to the project as his primary responsibility. The Project Manager shall be dedicated to the design, installation, and successful completion of a complete and working system. The Project Manager shall demonstrate qualification through experience and/or education to the satisfaction of the Owner.
E. All qualification documentation shall be submitted at the time of bidding and verified at bid acceptance.

PART 2 PRODUCTS

2.1 CABLE, RACEWAYS, BOXES, PANELS, TERMINALS & ELECTRICAL DEVICES

A. All cable, raceways, boxes, panels, terminals & electrical devices shall comply with the University of Delaware Standard 28 31 00; Fire Alarm and Detection Systems.

2.2 GAS DETECTION DEVICES

A. Manufacturers: (Whenever possible match other gas detection devices in the building)
   1. ENMET Creative Gas Solutions
   2. DoD Technologies Inc.
   3. Honeywell Midas Gas Detector
   4. Other detectors that are pre-approved by the University of Delaware

2.3 GAS CABINET SAFETY DEVICES

A. Proof of Exhaust Switch:
   1. Ashcroft
   2. Dwyer
   3. Proof of exhaust switch shall monitor differential pressure and shall send an alarm to the TGMS upon loss of differential pressure.

B. Gas Regulator:
   1. Matheson
   2. Concoa

C. Air Actuated Shut Off Valve:
   1. Matheson
   2. Concoa
   3. Provide for each cylinder containing a toxic or flammable gas. Provide with an open/shut indicator

D. Excess Flow Valve and Switch: Shall be located in each outgoing line of a gas cabinet used for housing flammable gasses.
   1. Matheson
   2. Concoa
E. Flash Back Arrestor (for flammable gases only): Shall be located in each outgoing line of a gas cabinet used for housing flammable gasses.
   1. Matheson
   2. Concoa

F. Back Plate:
   1. Matheson
   2. Concoa

G. It is the University of Delaware’s preference to have all the gas delivery safety devices for toxic and flammable gases to be supplied and assembled, by the same manufacturer, as a manifold and mounted on a back plate.

2.4 INITIATING DEVICES – GENERAL REQUIREMENTS

A. Emergency Manual Off (EMO) Push Button – Located inside each laboratory by the exit. Owner’s choice based upon contractor submittal approvals. The emergency shut down button shall have a yellow body with a red button. The contractor shall provide a clear, hinged on top, ascending cover to protect the button from accidental engagement.

2.5 SIGNALING DEVICES

A. Strobe Beacon Light Stack with Audible Alarm (Inside & Outside Laboratory) - where noted on drawings: Owner’s choice based upon contractor submittal approvals. Style and type shall be visible notification appliances with a red strobe beacon. Red strobe beacon to indicate a level 2 alarm. Contractor shall provide wall mounted visible appliance assembly. Where strobe beacon lights are shown on the drawing to be mounted on walls, the strobe beacon light shall be mounted at a minimum of 80” and a maximum of 90” above the finished floor.

B. Gas Cabinet Light Stack: Located at all gas cabinets. Gas cabinet light stack shall be comprised of the following:
   1. 0-100 psig pressure gauge to indicate pneumatic air pressure.
   2. Green indicator light to indicate the gas cabinet is in operational state.
   3. Red indicator light to indicate gas cabinet is shut down and in alarm.
   4. Audible signal speaker.
   5. Local gas cabinet shut down button.

C. Transmission of Signals: All TGMS control panels shall have the ability for a signal contact ID that is compatible with a Keltron LS 922 IP Transceiver for transmissions to UD PD remote station alarm receiving center (Keltron LS-7000), unless otherwise approved by UD EH&S.

2.6 TOUCH SCREENS, PANELS & PANEL DEVICES
A. Touch Screen HMI’s
   1. Touch Screen HMI’s shall be located in the corridors of laboratory buildings where toxic and flammable gases are being used on consistent basis. One touchscreen HMI shall be located in the fire command center, when provided.
   2. Touch Screen HMI’s shall be installed in lockable stainless steel enclosure, preferably recessed into the wall. Touch screen shall be accessible from the hallway without the need to open the enclosure. Touch screen HMI processor and input/output (IO) ports access shall be restricted by key access into the lockable steel enclosure.
   3. Touch Screen HMI shall provide graphical representation of all elements in the TGMS and shall indicate all devices in alarm.

B. Panels
   1. All panels shall be compliant with NFPA 72 and UL 864.
   2. Panels shall include all relays needed for a functioning TGMS. All relays shall comply with NFPA 72.
   3. Alarm contacts to indicate a TGMS evacuation level alarm to the building fire alarm system.
   4. Building fire alarm contacts indicating a building fire event and a need to shut down all gas cabinets.
   5. Trouble contacts to indicate TGMS trouble that causes lack of full coverage.
   6. Panel shall be provided with a BACnet interface to communicate with building’s BAS system. This interface shall send alerts via text messaging or e-mail.

C. All TGMS shall be assigned to a dedicated AC circuit and surge protection as prescribed by the UD Fire Alarm Design Standard. In “New Construction”, and when existing conditions allow, the dedicated circuit will have generator secondary power.

D. Uninterruptable Power Supply (UPS): The TGMS shall be supplied with an UPS. The UPS shall be able to provide temporary power until the building’s emergency power is engaged.

E. Surge Protector – The TGMS shall be supplied with a surge protector to protect the TGMS from transient voltage spikes.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install system in accordance with Manufacturer’s instructions, code requirements and these specifications.

B. All devices, boxes and conduit shall be installed plumb and level.
C. Install EMO’s with push button at 48 inches above finished floor. Install audible and visual devices as noted on drawings. All wall mounted visual devices shall be mounted no less than 80 inches above finished floors.

D. All devices shall be securely mounted with approved back box. All back boxes shall be recessed in walls or of an approved surface mount, wire mold type. Standard back boxes and extension rings with knockouts are not permitted when location requires surface mounted box. Contractor must use a finished back box suitable for painting. Only approved and appropriate type of conduit connectors shall be used for connection to back boxes.

Note: It is the intent of this section to only allow recessed TGMS device installations in wall and ceilings of finished spaces. Wire mold and surface mounted conduit will only be permitted by the Owner on a case-by-case basis at the time of shop drawings. Contractor shall bid the project to exclude surface mounted wiring and devices and approach surface mounting on an individual basis only. All surface mounted devices, conduit or wire mold shall be clearly shown on the drawing in a color specified by submittals details previously listed in this specification.

E. The installation and termination of all wiring, raceways, terminal strips and electrical devices shall comply with University of Delaware Standard 28 31 00 Fire Alarm and Detection Systems Designs and Installations.

F. All system devices, panels and junction boxes shall have a unique identifier number which shall be:

1. Labeled on each device, panel and junction box with a durable label capable of surviving environmental conditions.
2. Labeled on all drawings.
3. Labeled on all parts lists and required testing documentation.
4. The unique identifier numbering system shall be approved by the Owner at the time of shop drawing submittals.

Note: The intent of this requirement is to have each, and every device and component (except panel components) installed with a logical and unique number whereby all inventory, documentation and life effort can be tracked by the unique number. Device labels shall be designed and installed to have a survival life of 10 years.

3.2 ELECTRICAL SERVICE FOR INSTALLATION OPERATIONS

A. The contractor Shall utilize a reliable primary and secondary power supply as per NFPA 72 Chapter 10. Power must be supervised by the fire alarm control panel. Use of any existing electrical service must be approved by UD Maintenance and Operations Electrical Manager. Use of wall outlets/receptacles is not permitted.

B. When electrical service is not available, the contractor shall provide their own electrical supplies from generators or another suitable service.

C. Contractor shall provide all necessary cords, leads, generators and other necessary equipment required to perform installation, testing and demolition work.
3.3 TGMS CONTROL PANEL INSTALLATION

A. All field wiring within the fire alarm control panel shall be dressed and cornered. Wiring shall be run parallel with 90-degree bends for directional changes. Wire straps if applied shall not compress wiring jackets.

B. All field wiring shall be terminated in a junction box located above or beside the main TGMS control panel. The junction box shall be provided with terminal strips and segregated into four parts as follows: 1) power, 2) initiating, 3) Signaling and 4) Other. The junction box cover shall be hinged and operable with a standard screwdriver or keyed device.

3.4 VISUAL STROBE BEACON SYNCHRONIZATION

A. All visual strobe beacon devices that are within the same viewing area must be in synchronization. The contractor and equipment vendor shall provide a design and installation that meets the requirements of NFPA 72, Section 7.5.4.3.2.

PART 4 ALARM ACTIVATION SEQUENCE

4.1 SEQUENCE OF OPERATION

A. Level 1 Alarm: A Level 1 Alarm shall be initiated by the following conditions:
   1. ½ of the Threshold Limit Value (TLV) for a toxic gas. Value may be sensor dependent. Contact EHS for exceptions.
   2. 10% of the Lower Explosive Limit (LEL) for a flammable gas.
   3. Ambient oxygen levels fall below 19.5% O2 by volume of ambient air.

B. Upon triggering a Level 1 alarm, the TGMS shall shut down the gas delivery system, engage the strobe beacon and send text messages to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) personnel.

C. Level 2 Alarm: A Level 2 alarm shall be initiated by the following conditions:
   1. Threshold Limit Value (TLV) for a toxic gas. Value may be sensor dependent. Contact EHS for exceptions.
   2. 20% of the Lower Explosive Limit (LEL) for a flammable gas.
   3. Ambient oxygen levels fall below 18.5% O2 by volume of ambient air.

D. Upon triggering a Level 2 Alarm, the TGMS shall shut down the gas delivery system, engage strobe beacons and audible alarms, send text messages to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) personnel, activate building fire alarm and send a signal via the Keltron to Public Safety.

E. Loss of Exhaust: A loss of exhaust alarm shall send a text message to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) and shut down gas flow/not allow gas to flow until exhaust differential pressure is confirmed.
F. Excess Flow: Upon sensing excess flow through the gas system after a 10 second delay the TGMS shall shut down the gas flow/not allow gas flow, activate strobe beacon and send a text message to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) personnel. Excess flow after 40 second delay, sends a signal to Public Safety, activates a general fire alarm in the building, and sends text message to EHS and M&O.

G. Flash Back Event: A flash back event shall shut down gas flow, engage strobe beacons and audible alarms and send text messages to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O).

H. Emergency Manual Off (EMO) Push Button: Upon depression of the EMO, the TGMS shall shut down the gas delivery system, engage strobe beacons and audible alarms (Lab Only), send text messages to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) personnel, and send a signal via the Keltron to Public Safety.

1. Exception: Standalone TGMS in buildings without a building-wide TGMS may tie directly into building fire alarm system. Standalone TGMS shall perform all necessary local shutdown functions.

I. Local Gas Cabinet Shut Off: Upon depression, the TGMS shall shut down the gas delivery system, engage strobe beacons and audible alarms, send text messages to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O) personnel, and send a signal via the Keltron to Public Safety.

1. Exception: Standalone TGMS in buildings without a building-wide TGMS may tie directly into building fire alarm system. Standalone TGMS shall perform all necessary local shutdown functions.

J. Maintenance and Trouble: The detectors shall be continuously monitored via the TGMS to detect and alarm target gases and any detector faults. The TGMS shall report all faults from the detectors via text message to UD Environmental Health & Safety (EH&S) and Maintenance & Operations (M&O).

1. Exception: Local alert (i.e., amber light) if standalone TGMS system.

4.2 TGMS – ADDITIONAL REQUIREMENTS

A. Spare Parts. Contractor shall include in the base bid the cost to provide all manufacturer’s recommended spare parts and devices. At a minimum, the Contractor shall provide at the final acceptance test the following spare parts and devices:

1. One (1) of each type of gas detector.
2. One (1) full set of gas detector cartridges.
4. One (1) Touch Screen HMI.
5. One (1) of each type of relay.
6. One (1) of each type of contactor.
7. One (1) strobe beacon light/horn stack.
8. One (1) complete gas cabinet light stack.
9. One (1) control panel power supply and associated panel fuses.

B. All spare parts shall be listed on all inventory lists and each spare part shall be labeled for the specific system or component it is intended.

C. All secondary power supplies (batteries) shall be calculated in accordance with NFPA 72 and manufacturer’s recommendations and shall include design spare capacity. Battery size shall be increased by 20% above minimum calculation.

4.3 SPECIAL CONDITIONS

A. Contractor shall conceal all conduit and wiring above ceilings where applicable. The decision to allow exposed conduit shall be made by the Owner at the time of shop drawings. Any exposed conduit or wiring shall be clearly annunciated by the Contractor through the use of color code or other annunciation method on the shop drawings so that it can be easily identified during shop drawing review.

B. If wire mold is approved and installed for this project, it shall be metallic and fastened flush to the wall surface without spaces under the wire mold. Any spaces created by wall surface deviations such as mortar joints and like transitions shall be filled with an appropriate paintable caulk. All wire mold shall be uniquely marked on the shop drawings to show all locations proposed for use.

PART 5 ACCEPTANCE, TESTING AND DOCUMENTATION

5.1 GENERAL

A. All toxic gas monitoring systems, component parts, and supervisory functions shall be subject to acceptance testing to be conducted by the Contractor. The system shall be completely operational, finished, and ready for acceptance testing in accordance with the anticipated project schedule.

B. The Owner shall be notified at least 15 working days prior to acceptance testing with the specific date, time and system being tested.

C. All approvals (except for the acceptance test approval) required by these specifications shall be completed and submitted with the notification of acceptance test date as required under 5.1.B.

D. All as-built completed drawings required by these specifications shall be completed and submitted with the notification of acceptance test date as required under 5.1.B.

E. All Contractor field testing and manufacturer testing documentation as required by these specifications shall be submitted with the notification of acceptance test date as required under 5.1.B
F. Contractor shall provide the Owner with three complete manuals of “the specific” toxic gas monitoring system being tested. The manuals shall document all components of the system identified by unique number, consistent with the shop drawings and “as-built” drawings.

G. Contractor shall provide all items identified under Sections 5.1.C, 5.1.D, 5.1.E and 5.1.F in bounded and labeled three-ring binders with zippered ends. The binders shall be labeled on the cover as follows:

1. University of Delaware, “Name of Building”, i.e. Spencer Laboratory Toxic Gas Monitoring System.

2. The binder shall identify all rooms that are monitored by the toxic gas monitoring system.

3. Each section of the manual shall be arranged with section tags and documentation as follows:
   a. Project Cover sheet listing project name, contractor, vendor and consultant.
   c. Service Directory.
   d. Approvals. Include:
      1) Copy of Fire Marshal Application for fire protection plan review, completed and marked paid.
      2) Copy of Fire Marshal’s Office plan approval form.
      3) Original of TGMS Certification of Installation.
      4) Copy of Fire Marshal’s System Inspection and Final Approval Form.
   e. Narrative of system description and operation. Include original design notes for basis of design.
   f. System installation and service manual. (Note that these are two separate documents.)
   g. Equipment inventory list, with unique identifier labels for each device. Include equipment data sheets.
   h. Parts list of all components, modules, devices, wiring harness, and cross referenced with unique identifier number/label.
   i. Divider section labeled “Punch List Items”.
   j. Manufacturer/vendor system testing. This section shall contain all installation, check-out and acceptance testing data as per these specifications.
   k. First year warranty and test schedule.
   l. Wire list.
   m. Alarm and Supervisory Zone Descriptor. As worded using actual plain English descriptors.
   n. As-built drawings. To be installed in protective clear plastic sleeves. One drawing per sleeve.
o. Electronic copy of AutoCAD or other acceptable format as-built plans.

p. All documentation listed in this section shall include a digital copy on a “thumb-drive” device included with each binder. This includes all as-built drawings, PDF & Native File (Word, Excel, etc.) copies of manuals, approvals and items as listed in section 5.1.G (c) through (n).

H. At the conclusion, the Contractor shall document each part or test result from the acceptance test in a form suitable for installation into the required three-ring zippered binder. It is recommended that the test data collected in the acceptance be performed and documented during Contractor’s system check-out and documented in binder prior to delivery to The Owner.

I. The Owner acceptance of system shall not be completed until all faults, malfunctions and documentation as required by these specifications have been completed, delivered and verified by the Owner.

5.2 TOXIC GAS MONITORING SYSTEM TESTING

A. The toxic gas monitoring system shall be tested in accordance with the guidelines set forth in these specifications and NFPA 72. All testing shall be documented in a report form to the Owner and in accordance with section 5.1.F of these specifications. A written copy of testing documentation shall be provided to the fire marshal at time of acceptance testing. Documentation and testing shall consist of each item noted in NFPA 72 and the following:

1. Stray voltages between circuit conductors and ground. Verify compliance on as-builts.

2. Ground faults on all conductors other than those intentionally and permanently grounded should be tested for isolation from grounding using an isolation testing devices such as a “megger”. Documentation of “megger” testing shall identify each conductor in note form on as-builts or in ledger form identifying tested conductor and test results.

3. Short circuits on all conductors other than those intentionally and permanently connected together for conductor-to-conductor isolation. To be verified on as-builts.

4. Measure and record on as-builts loop resistance with each circuit pair short-circuited at the far end of the circuit with an ohm meter and record the resistance on each circuit as shown on the as-builts.

5. Verify that all contactors are operating properly.

6. Verify that all relays are operating properly.

7. Verify that the following devices are working properly:

   a. Light Stacks.

   b. Gas Cabinet Light Stacks.

   c. EMO’s

   d. Excess Flow Valves.

   e. Shut Off Valves including verifying indication of loss of flow.
B. TGMS Commissioning and Debugging: Prior to Owner’s Acceptance Testing the TGMS contractor’s engineer, programmer and field technician shall commission the TGMS including de-bugging all programming including the following:

1. All programming shall be functionally tested to determine if the system is operating as per the TGMS alarm/response matrix.

2. All gas monitoring devices shall be calibrated as per the manufacturer’s recommendation.

3. Test individual devices to verify they respond as per the TGMS alarm/response matrix. Devices shall be tested as per the manufacturer’s recommendations.

4. Verify touch screen HMI screens have accurate graphical representation of the system components.

5. Test of individual inputs and outputs for intended function and supervision. Testing includes providing test gases for each type of TGMS sensor in a manner that verifies low and high point settings individually.

6. Test to verify the functional operation of complete Toxic Gas Monitoring System under the following conditions:
   a. Normal operational condition.
   b. Alarm condition.
   c. Under primary power failure.

7. Test and demonstrate proper coordinated interfaces with HVAC, fire alarm systems and any other interfaced system or device, under the following conditions:
   a. Normal operational condition.
   b. Alarm condition.
   c. Under primary power failure.
   d. Output function features.

8. Test interface with Keltron system. Determine if the correct responses for each event is transmitted through the Keltron to Public Safety as per the alarm/response matrix.

9. Confirm and document that all alarm point annunciation descriptors are correct, in compliance with shop drawings, presented in plain unabbreviated English, and are annunciated to all remote annunciators as required by these specifications.

10. Upon completion of Contractor testing commissioning and debugging, The contractor shall provide written confirmation that all devices and programming are functioning as per the alarm/response matrix.

C. Upon completion of TGMS testing, the Contractor’s respective (Engineer, Programmer & Field Technician) shall conduct functional and instructional tests for The Owner under the guidelines of Section 5.1 and 5.3.

D. Acceptance testing shall be specified by the contractor (see requirements 5.2.A). The Contractor shall develop an outline for approval by The Owner, but at a minimum, the testing shall be as follows:
1. Confirm all documentation has been received:
   a. As-builts – Check Accuracy
      1) Alarm/Response Matrix
      2) Plan Views
      3) Riser Diagram
      4) Panel Drawings
      5) Battery Calculations
      6) Electronic Documentation Transmitted
   b. Manual – Check Content
      1) System Descriptions
      2) Parts List
      3) Spare Parts Inventory
      4) Device Cut Sheets
      5) Schedule for first year’s maintenance and testing in spreadsheet form to include: Gas, Lab #, Sensing, Sensor & Range, Sensor Name, Panel, Detector #, Cartridge #, Sensor Expiration Date, Date in Service, Last Calibration Check, Alarm Level 1% or PPM, Alarm Level 2% or PPM, Future 1 Year Calibrations Schedule
      6) Testing Documentation of Devices and System

2. Inspect panel for installation, power, etc.

3. General walk-down of devices to identify any missing device or obvious problems.

4. Test alarm and annunciation circuits for audio level with dB measurements. Test shall provide an audible alarm with each device on alarm during acceptance testing, hit alarm silence and go on.

5. A test (as directed by UD Fire Marshall) of all gas detection devices, light stacks, audible alarms, gas cabinet light stacks, EMO’s, excess flow valves, and shut down valves for function, supervision and proper installation.

6. Confirm all communication of all alarm and fault notices in plain English descriptors via text message/e-mail and Keltron.

7. A random inspection of junction boxes, terminal/splice point boxes, conduit, wiring and general installation features. Goal of inspection is review of installation for workmanship and specification issues.


9. Additional test as required by individual system design or arrangement.

10. All sensors shall be at least one year from expiration at acceptance testing.

E. Verify interface with the fire alarm system is working as per the alarm/response matrix.
F. Verify interface with Keltron notification system is working as per the alarm/response matrix.

G. Verify that all text messages, e-mails and Keltron notifications are being transmitted and received.

H. At the conclusion, the Contractor shall document each part or test result from the acceptance test in a form suitable for installation into the required three-ring zippered binder.

5.3 OWNER INSTRUCTION

A. Contractor or Manufacturer shall provide the Owner’s representatives with a minimum of two, two hour classes of formal instruction on the operation, maintenance, service and testing of the toxic gas monitoring system, devices and related building interfaces. The instruction shall be scheduled after acceptance testing but prior to final payment. An additional minimum 1 hour class of instruction on general system operation only for lab managers and end users as designated by Owner.

B. Contractor and/or Manufacturer shall provide to the Owner an instructional outline for each class with all visual aids. All classes shall be structured consistently with traditional educational standards with performance objectives and testing for all participants. Each student shall receive an instructional certificate indicating number of hours of instruction and satisfactory completion of the course. Owner may video tape class for future use.

5.4 DOCUMENTATION

A. Prior to acceptance testing the Contractor shall purchase and install a documentation cabinet adjacent to the primary fire alarm panel. This documentation cabinet shall be keyed alike with the fire alarm panel and shall be large enough to contain a complete set of documentation as described in these specifications. The cabinet shall be the same color and match the fire alarm panel.

PART 6 DEVICE LABELING AND SOFTWARE

6.1 DEVICE DEMARCATION

A. Each and every alarm initiating device, supervisory device, monitoring device, control panel and junction box shall be provided with a unique number which shall be intended to specifically identify that item uniquely within its parent system. The unique number shall be clearly marked on the face of the device so as to be visible from 10 feet from a normal visual position. The type and style of unique label shall be approved by the Owner prior to installation. It shall be a type of label that will survive for a minimum of 10 years under installed conditions.
B. The unique number shall be an identifier within a logical system and numbers shall be assigned in a logical and systematic order.

C. The unique number shall be shown on all shop drawings and other documentation that annunciates, describes or documents said item. This would include inventory listing, materials lists and manuals submitted under Part 5 - Requirements.

D. All TGMS devices (i.e. touch panels, gas detectors, strobe beacon light stacks, EMO’s) shall be clearly labeled on the wall next to the device as TGMS devices. For Example:
   2. Strobe Beacon Light Stacks: Shall be labeled Toxic Gas Monitoring System alarm.
   3. Gas Detectors: Shall be labeled as a Toxic Gas Monitor and for type of gas monitored.

6.2 SOFTWARE & PROGRAMMING

A. Copies and adequate explanatory documentation of all software and programming used in the fire alarm system shall be provided to the Owner within 30 days after acceptance testing approval.

B. The Owner shall own all software and programming that is part of the operational, updating, renovation and maintenance need of the system.

C. If it is a condition of the Contractor or Manufacturer to require licensing of any software or programming, the Contractor and/or Manufacturer shall provide such licensing to the Owner as part of this project. Cost of such licensing shall be itemized in the bid package.

D. The Owner shall have the right to modify, use or reproduce for his own use, any software or programming which is part of this project.

PART 7 WARRANTY AND FIRST YEAR SERVICE

7.1 TGMS WARRANTY

A. TGMS Contractor shall own a one year parts and labor warranty on all TGMS components and programming. The one year warranty shall be itemized in the bid package.

7.2 TGMS FIRST YEAR SERVICE

A. TGMS Contractor will be responsible for supplying first year maintenance on the entire toxic gas monitoring system. This shall include all routine maintenance and calibration as per the component manufacturers’ recommendations.

7.3 TGMS CONTRACTOR DOCUMENTATION REQUIREMENTS
A. During the warranty period the TGMS Contractor shall provide all testing of the TGMS system and components as required by all regulations including testing mandated by the NFPA. This shall include a total system test and validation one year after the TGMS was formally accepted by all AHJ’s.

B. TGMS Contractor shall document all maintenance, repairs, testing and calibration performed during the warranty/first year service time period including updated spreadsheet as listed in section 5.2.D.a.