Specification of Installation
for

Toxic Gas Monitoring System

REVISION

Rev No.	DCN No.	Change Summary	Release Date	DCN Initiator	Document Owner
1	DCN1281	Initial Release	3-3-16	J. Metzger	J. Metzger

Prior revision history, if applicable, is available from the Document Control Office.

1 PURPOSE AND SCOPE

To establish a standard to follow when designing and implementing TGMS components at SUNY Polytechnic Institute Colleges of Nanoscale Science and Engineering (CNSE) facility.

2 DEFINITIONS

2.1 **AAC** – Area Alarm Controller – Local Panels that contain PLCs that monitor inputs (gas, exhaust and heat detectors) and control outputs (enable and call signals), while displaying their status on local and remote HMI screens. The CUB building, HPM building, NFSX, NFS, NFN, NFE, NFC and NFX area alarms and horns are controlled and monitored by the corresponding AACs, which send signals to the local PLC, located in communication hubs through Ethernet network, which sets off area alarms and horns.

2.2 **ALM** – Alarm

2.3 **AMB** – Ambient

2.4 **BN2** – Bottled Nitrogen – Used in purge applications

2.5 **CDU** – Chemical Dispense Unit

2.6 **CESTM** – Center for Emerging Sciences & Technology Management – Lab 233 has TGMS AAC

2.7 **CH#** - Tool Chamber # (CH1, CH2, etc.)

2.8 **CM4** – Honeywell CM4 Gas Analyzer (Hydride AMB Sensor)

2.9 **CUB** – Central Utilities Building

2.10 **DOD** – DOD Technologies – Gas Detection Manufacturer

2.11 **EMO** – Emergency Manual Off (red push-button)

2.12 **EXH** – Exhaust (ventilation ductwork)

2.13 **FT#** - Exhaust Flow Transmitter # (FT1, FT2, etc.) in CFM

2.14 **FT-IR** – Gas Detection Technology Based on Infrared Spectrum Analysis

2.15 **GD#** - Gas Detector #(GD1, GD2, etc.)

2.16 **GIB** – Gas Interface Box

2.17 **GRC** – Gas Reactor Column Abatement Unit

2.18 **HD#** - Heat Detector # (HD1, HD2, etc.)

2.19 **HEX_ID** – Tool Identification – CNW01, TXI01, etc.

2.20 **HMI** – Human Machine Interface – AAC Screens

2.21 **HPM** – Hazardous Production Material

2.22 **I/O** – Input/Output – Connections to AAC Controller

2.23 **LK** - Leak

2.24 **LS** – Leak Switch

2.25 **NFCCDU** – Chem. and Solvent rooms off NFC HOM corridor

2.26 **NFCGAS** – Gas Cabinets off HPM corridor

2.27 **NFXLPT** – Lateral Pressure Transmitters for Heat, Acid, Base and Solvent Exhausts

2.28 **NFXPURRM** – NFX Purifier Room

2.29 **NFXUPSRM** – NFX Electrical Rooms with Building UPS Units

2.30 **PCS** – Pyrophoric Conditioning System Abatement Unit

2.31 **Physics** – Physics lab 316 on main campus – Has TGMS AAC

2.32 **PLC** – Programmable Logic Controller

2.33 **PM#** - Tool Process Module # (PM1, PM2, etc.)

2.34 **PS** – Power Supply – Also Pressure Switch

2.35 **PT#** - Pressure Transmitter # (PT1, PT2, etc.)

2.36 **Purifier** – Purifier Building in Bulk Gas Farm

2.37 **RTN** – Return to Normal – Point Leaves Alarm State

2.38 **SCADA** – Supervisory Control And Data Acquisition – Communicates with the PLCs and AACs through an Ethernet network on a Fiber Optic Network (Backbone). It also monitors the health of the network and displays alarm information and location. GE Proficy iFix software, which is utilized by the SCADA, provides interactive screens to display an overview of the facility, alarm locations and alarm status. When any TGMS SCADA screen is found to be not 100% functional, contact TGMS services (TGMS technicians at 518-620-6GAS) immediately and notify them of the situation

via email. TGMS screens are located in: NFN, NFC, NFE Security control center, NFS, NFSX and NFX.

2.39 **Scubber** – Abatement Unit

2.40 **SLRY** - Slurry

2.41 **CDU** – Chemical Dispense Unit

2.42 **STR** - Storage

2.43 **TCS** – Thermal Conditioning System Abatement Unit

2.44 **TGMS** – Toxic Gas Monitoring System – Monitors and Controls the use of toxic gas and chemicals in the CNSE facility. TGMS also monitors exhaust flows and heat sensors to ensure safety of work area. When evacuation is required, TGMS sets off strobe lights and horns.

2.45 **TPU** – Thermal Processing Unit Abatement System

2.46 **TRBL** - Trouble

2.47 **UPS** – Uninterruptible Power Supply – Battery Backup Unit

2.48 **VMB** – Valve Manifold Box

2.49 **"w.c.** – Inches of Water Column Pressure

2.50 **WBRK** - Wirebreak

2.51 **WRN** - Warning

2.52 **WWT** – Waste Water Treatment

2.53 For additional definitions and requirements, please reference EHS-00031 and other associated TGMS documents.

3 RESPONSIBILITIES

3.1 TGMS Services Manager

The TGMS Services Manager will be responsible for maintaining and keeping the TGMS Specifications for Installation document up to date.

3.2 TGMS/AAC System Support Specialist & TGMS Technicians

The TGMS Support Specialist and TGMS technicians will be responsible for verifying that all new and existing equipment on site is in line with the specifications put forth in this document.

4 ASSOCIATED DOCUMENTS

EHS-00030 Equipment Decommissioning Policy

EHS-00030-F1 Equipment Decommissioning Safety Sign-Off Checklist

EHS-00031 Toxic Gas Monitoring System Operation and Maintenance

CFM-00008 Instruction for TGMS Modification Sub-Permit

EHS-00072 Specification for Lift Stations

5 DETECTION TYPES

5.1 Exhaust Monitoring

Per EHS-00031 documentation, exhaust monitoring is necessary to monitor for loss of exhaust in areas that would result in hazardous gases being forced into production areas.

5.1.1 Flow Monitoring

1) Flow monitoring will be used in instances when static monitoring does not provide an adequate measurement. These devices will often have openings in their surface to allow for air to move across the surface of the area in question, such as a bottle connection or fittings.

    a. Limitations- The minimum level of flow that can be accurately measured for is 100cfm. The minimum duct diameter is 4 inches.

    b. Devices Monitored- CDUs, Gas Cabinets, VMBs and any devices connected to facilities exhaust with an open environment resulting in a more reliable flow measurement.

5.1.2 Static Pressure Monitoring

1) Static pressure monitoring will be used for most exhaust measurements.

    a. Limitations- The minimum level of static that can be accurately measured for is 0.1”w.c. The minimum duct diameter is 4 inches.

    b. Devices Monitored- Abatement systems, Process pumps, Process Chambers, CVMB’s, Waste Collects, Fume Hoods, Storage units/cabinets, GIBs, and any devices connected to facilities exhaust with a closed environment resulting in a high static reading and low flow.

5.1.3 Warning/Alarm Setpoints

1) Warning and alarm setpoints will be set on the date of testing, at 90/80% of the normal respectively. The normal will be set to the current reading of static ("w.c.) or flow (cfm); so long as exhaust balancing has occurred and a report has been provided to the CNSE TGMS group. Please note: TGMS readings may vary from those measured by contracted balancers due to differences in monitoring technology.

5.2 Gas Monitoring

Per EHS-00031 documentation, gas monitoring is required in the exhaust of equipment using a hazardous production material, in the cabinet or VMB where it is stored, and/or in the exhaust of an HPM generating device, if applicable. The ambient area where the process equipment or support equipment is located also needs to be monitored, on each level that they are present (fab and subfab).

5.2.1 Multipoint

1) Multipoint monitoring can be used in instances where tools require several types of gas detection, or alternative methods of detection don't meet the minimum required Lower Detectable Limit (LDL) for the gas type. CNSE approved multipoint detection include:

    a. Honeywell ACM100/ACM150

        i. Sample lines going to ACM100/150 ports require a check valve/filter assembly for line integrity testing. Needs to be depicted on P&IDs. Located at end of line.

    b. Honeywell Vertex/VertexM

        i. Sample lines going to Vertex/M ports require filter consistent with gas type being monitored: chlorine, mineral acids, and hydrides. Located at end of line.

    c. Honeywell CM4 (Not approved for new tool installs)

    d. DOD CL96

        i. Sample lines going to CL96 ports require filter consistent with gas type being monitored: chlorine, mineral acids, and hydrides. Located at end of line.

    e. DOD CL 2/4/8

        i. Lower point count version of CL96.

2) Devices Monitored- In most instances, low level hydrides and low level mineral acids require monitoring by tape based units based on LDLs.

3) Special Exceptions- Sample points located inside special/controlled access environments should have filters located near the port of the gas detection unit for easy replacement.

5.2.2 Standalone

1) Stand-alone gas detection will be used in instances where multipoint monitoring isn't applicable or advisable or desired. CNSE approved standalone detection includes:

    a. Honeywell Midas
        i. Some detector types require particulate filter before unit.
    b. DOD PS-7
    c. Honeywell MST
        i. Only approved for C4F6 and C5F8 monitoring.
    d. DOD CL1
        i. Used for single point tape applications
    e. Scott Freedom (Not approved for new tool installs)
    f. Riken Pyrometer (Not approved for new tool installs)

2) Devices Monitored- Items requiring gas detection can include, but are not limited to: Ambient areas around process chambers and tool mainframes, ambient areas around pump racks, exhausted process chambers and tool mainframes, exhausted pump skins, LDS units, gas cabinets, gas VMBs, scrubbers, ozone generators, and abatement units. In some instances, CDUs and CVMBs containing chemicals may be monitored, as well as depending upon vapor pressures.

3) Recommended Gas Detectors- Please reference the 'CNSE TGMS Group Recommended Gas Detection Sensor Table' for the list of gases each detector type is approved for. A PDF copy can be requested from CNSE TGMS group.

5.3 Heat Detection

Per EHS-00031 documentation, heat detection monitoring is required in the exhaust of equipment using a flammable or pyrophoric gas.

5.3.1 Dual IR/ UV-IR

1) Pyrophoric gases will require different types of heat/flame detectors due to their properties. Gas boxes, VMBs and gas cabinets containing pyrophoric materials should be outfitted with Dual IR or UVIR detectors. Consult EHS as to what is classified as a pyrophoric material. CNSE TGMS group can determine what sensor is applicable for a given chemistry.

5.3.2 Duct Mounted Thermal Switch

1) Heat detectors will be placed on any device containing flammable or pyrophoric materials including: Gas cabinets, VMBs, CDUs, CVMBs, GIBS, pumps, abatement systems, process chambers, and other exhausted enclosures containing these gas types.

    a. Exception- Process exhaust outlets of scrubbers DO NOT require heat detectors.

2) Devices Monitored- Heat detectors will be placed on any device containing flammable or pyrophoric materials including: Gas cabinets, VMBs, CDUs, CVMBs, GIBS, pumps, abatement systems, process chambers, and other exhausted enclosures containing these gas types.

5.4 **Leak Detection**

Liquid leak sensors will be required in cabinets or enclosures containing liquid line connections regardless of hazard. Drip pans underneath equipment will also require leak detection.

5.4.1 Applications

1) High Level Sensors- While technically not a leak sensor, hi level may be used in equipment such as lift stations to alert ERT members to a nearly full unit.

2) Float Switches- Float switches will be used in instances on equipment where small amounts of liquid are expected to be leaked without hazard.

3) Optical Switches- Optical switches will be used in locations where no leak should occur, due to their sensitivity to liquids. Typically they are installed in tool chambers, mainframes and gas boxes.

4) Tape Switches- Only to be installed with special permission from the CNSE TGMS group, used in instances where the likelihood for a leak exists over a wide area or space.

5) Double Containment Leaks- Typically installed on chemical containing lines running extended lengths from chemical supplies to either VMBs or tools. Sensors should be installed at low points in tubing run to allow for leak to settle. Leak sensors can be installed per Tool Owner request or where EHS deems necessary.

5.4.2 Devices Monitored

1) Lift Stations, Drip pans, CDUs, CVMBs, and LDS units. Any device containing liquid line connections including but not limited to: wet tool mainframes, tool gas boxes, tool chambers and tee boxes.

2) Per EHS -00072 'Specification for Lift Stations', both outer containment leak detection and 'HI-HI' alarms are required for lift station design types A,B and C.

5.5 TGMS Sensors vs. OEM Sensors

While most tools contain their own on board versions of gas, heat, exhaust and liquid leak monitoring; it is the policy of the CNSE TGMS group to not tie into any of these devices for life safety monitoring purposes. This will allow the CNSE TGMS group to own, maintain and repair all types of detection, as necessary. Only special exceptions can be made to this policy and must be approved by the CNSE TGMS group prior to package IFC and tool installation.

5.5.1 G450C model for tool exhaust monitoring

1) G450C tools will be allowed to provide the CNSE TGMS system a set of contacts through which the tools exhaust status can be monitored. This set of contacts will act like any other input to the tools AAC, returning a 24V signal when the tools exhaust levels are met, and breaking the loop when not. Tool Owner is responsible for sensor maintenance and record keeping, which should be submitted to CNSE EHS upon completion.

    a. This model is only for G450C. Any future deviation needs approval from TGMS and EHS VP.

5.5.2 Tool Based Liquid Leaks

1) It is the CNSE TGMS group's policy, that on board tool leak sensors not be used as the detector connected to the tools AAC. This prevents the tool leak sensors from being tripped in the event the tool is powered down. This can only be changed with special exception from the CNSE TGMS group

5.6 AAC Outputs/Tool Inputs

AAC outputs will be defined by the TGMS matrix, as supplied by the TGMS contractor. They will be based on the tool requirements, as defined by EHS and this document. Output functionality will be controlled by relays in the AAC panel that will return voltage supplied by the tool or support equipment when all interlocks are successfully met, and no alarms are active that would disable the associated signal. The support equipment or tool must supply a 24V signal that the AAC can return to enable these outputs

5.6.1 CDU/CVMB Stick Calls

1) A 24V signal will be sent from the supplying CDU/CVMB to the tool/supporting equipment's AAC box. If there are no active alarms disabling that chemical, a relay will be closed in the AAC enabling the chemical to be requested.

5.6.2 Gas Cabinet/VMB Stick Calls

1) A 24V signal will be sent from the supplying GC/VMB to the tool/supporting equipment's AAC box. If there are no active alarms disabling that gas, a relay will be closed in the AAC enabling the gas call.

5.6.3 LDS Enable

1) The LDS unit that supplies the tool with chemical will send a 24V signal to the tool or area AAC. If active alarms for the unit are clear, the units enable signal will be returned via the associated relay, and chemical flow from the device will be enabled.

5.6.4 Tool Enable

1) A 24V signal will be sent from the tool to the AAC box. If no alarms are active the associated relay will be actuated, enabling the tool to run.

5.6.5 Chamber Enable

1) In instances of more fine grain control, individual chambers can be enabled or disabled via the AAC to allow each to run in spite of active alarms on other chambers. As with the tool enable, a 24V signal will be sent to the AAC from the tool, and the chamber will be enabled, if there are no active alarms present.

5.7 AAC Inputs/Tool Outputs

AAC inputs will be defined by the TGMS matrix, as supplied by the TGMS contractor. They will be based on the tool requirements as defined by EHS and this document. Input signals from the tool and other devices are discrete signals that will return a 24V signal supplied by the tool when energized (closed), and break the contacts when de-energized (open). An "open" signal shall indicate the unsafe, abnormal, or not ready state. The "closed" signal shall indicate normal, safe or ready state. This will allow for a fail-safe condition in the event of a loss of power to the tool or support equipment. This is done for isolation of external voltages.

5.7.1 Tool EMO Status

1) Tool and support equipment EMO buttons should be wired in series so any point can trigger EMO. A separate set of dry contacts will need to be provided by the tool for the TGMS contractors to land a supply and return wire for the 24V signal. When the contact is opened (broken) by the tool in the event of an EMO, the AAC will alarm, shutting off the signals defined by the TGMS matrix. This is an EMO status and not in the EMO chain.

5.7.2 Pump/Chiller EMO Circumvent Switch

1) Pump or chiller EMO circumvent switches are used to allow process equipment to be maintained without causing an EMO. HPMs related to the systems where the circumvent switch is attached are turned off/disabled when circumvent is active. The switch operates as other inputs to the AAC and will display at the local screen

5.7.3 Coaxial Pressure/Bottled Nitrogen (BN2)/Purge Gas Pressure Switch

1) Coax, Purge and BN2 pressure switches will monitor the pressures on double containment lines and Purge/BN2 lines going to chambers, GIBs or pumps. The setpoints (minimums) for these pressures will be set on a gauge by the Tool Owner. An alarm will be tripped and signaled at the AAC if the pressure dips below this setpoint.

    a. Vacuum Pressure Jacket- In the event a secondary containment is being monitored, that is kept under vacuum, the alarm will need to be triggered and the reading rises above the setpoint.

5.7.4 Heater Jacket Faults

1) Heater jacket faults will signal if a gas line heating device has faulted or gone offline. The supporting equipment will provide a set of contacts that will return a 24V signal to the AAC panel if the unit is online, and

open if faulted. A temperature switch can be added when no contact for alarm exists on controller.

5.7.5 Gas Cabinet/VMB Ready

1) Supporting cabinets and VMBs will provide a set of contacts for TGMS to land wires on. These contacts will return the 24V signal provided when the cabinet is in a ready state and able to flow gas to the tool.

5.7.6 CDU/CVMB Ready

1) Supporting CDUs and CVMBs will provide a set of contacts for TGMS to land wires on. These contacts will return the 24V signal provided when the cabinet is in a ready state and able to flow chemical to the tool.

5.7.7 Tool/Chamber Ready

1) A tool will need to provide a set of contacts indicating if it is in a ready state to process. These contacts will close and return a 24V signal to the AAC panel if the tool/chamber is ready and open if it is not.

5.7.8 Chemical Request

1) Chemical requests will be sent by a wet tool to the AAC when it wants to flow chemical. The tool returning the 24V signal will cue the AAC to activate a relay output allowing chemical flow to the tool.

5.7.9 Scrubber Signals

1) Scrubber signals can vary from tool to tool depending on the type and number of chambers. However, as with all other AAC inputs, the unit will be provided a 24V signal that should be returned if the unit is online. These signals can include: Scrubber fault, scrubber warning (30 second delay in PLC), and often scrubber bypass signals. Scrubber bypass signals commonly exist for each chamber on a tool.

    a. Combustible Monitoring- Scrubbers utilizing natural gas require combustible monitoring on their exhaust. If the scrubber contains a set of contacts for ‘combustible alarm’ the AAC may be tied into this signal as an AAC input. In the event the scrubber doesn’t contain on board combustible monitoring, an external gas detector will be added to the exhaust line, consistent with the installation used for other stand-alone exhaust gas detection.

    b. Additional Gas Detection- Additional gas detection is not needed on scrubber exhaust lines due to the likelihood of gases in

process exhaust. This will only be added if requested and justified by a Tool Owner/Equipment Engineer and approved by the CNSE TGMS and EHS departments

5.7.10 Ozone Generators and Destruct Units

1) Per EHS-00031, ozone (O3) gas generators should be treated as a gas cylinder cabinet with regards to monitoring.

   a. Enable- As with gas/chemical supply cabinets, an enable signal will need to be sent from the unit to the tools AAC, where upon, the signal will be returned in the event there are no active alarms, enabling the unit.

   b. Gas Detection- Per EHS-00031, in the event ozone is generated in the enclosure and used as a gas, ambient and exhaust gas detection is required as is the standard for all gases with a hazard rating equal to or greater than 3. If ozone is generated and used as a liquid, EHS-00031 only requires a gas detector in the ambient space at fab level.

   c. Destruct Units- O3 destruct units will not require gas detection, as it is not likely that they are 100% efficient and as such would be constantly exposing the sensor to gas. Pressure, heat and door interlocks should be monitored.

6 PREVENTIVE MAINTENANCE

All AAC panels supporting tools, bulk supply areas and any other CNSE facility will undergo a full TGMS test of the existing matrix a minimum of every 18 months, to ensure it still functions as programmed and all components are still online and operational.

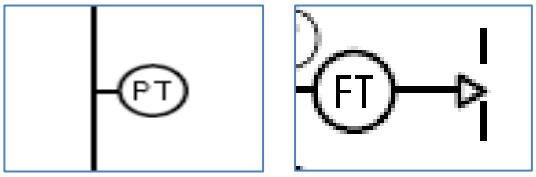
7 RECORDS

The CNSE TGMS department will be responsible for keeping all records indicating initial test dates, PM dates and sensor swap data for all TGMS components.

8 APPENDIX

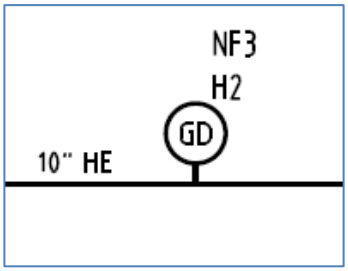
8.1 P&ID Depictions

8.1.1 Pressure and Flow Monitoring

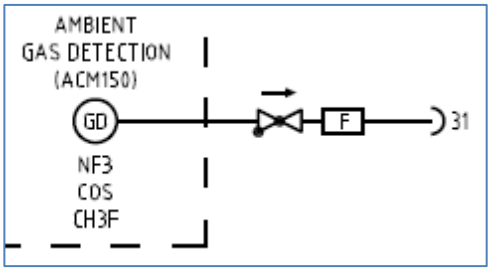


8.1.2 Gas Detection

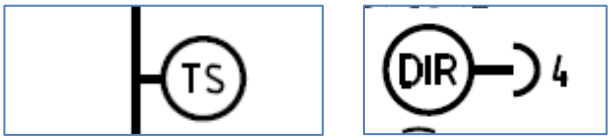
1) Standalone



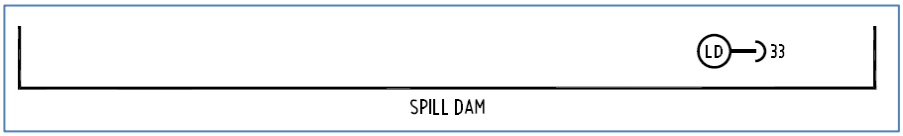
2) ACM100/150



8.1.3 Heat Detection



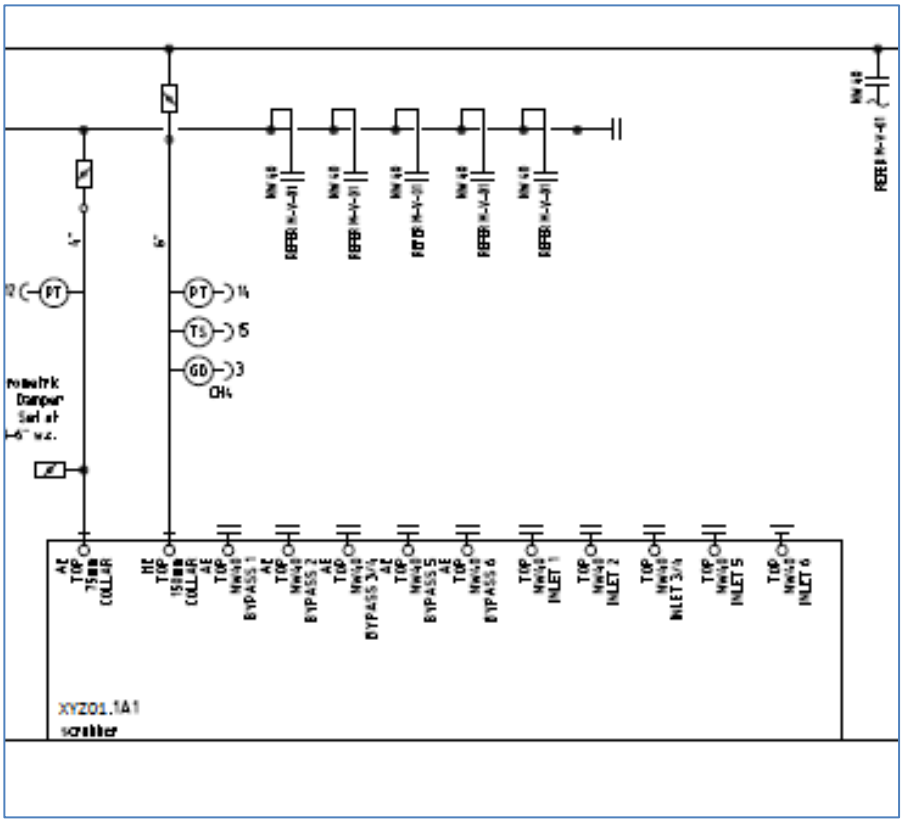
8.1.4 Leak Detection



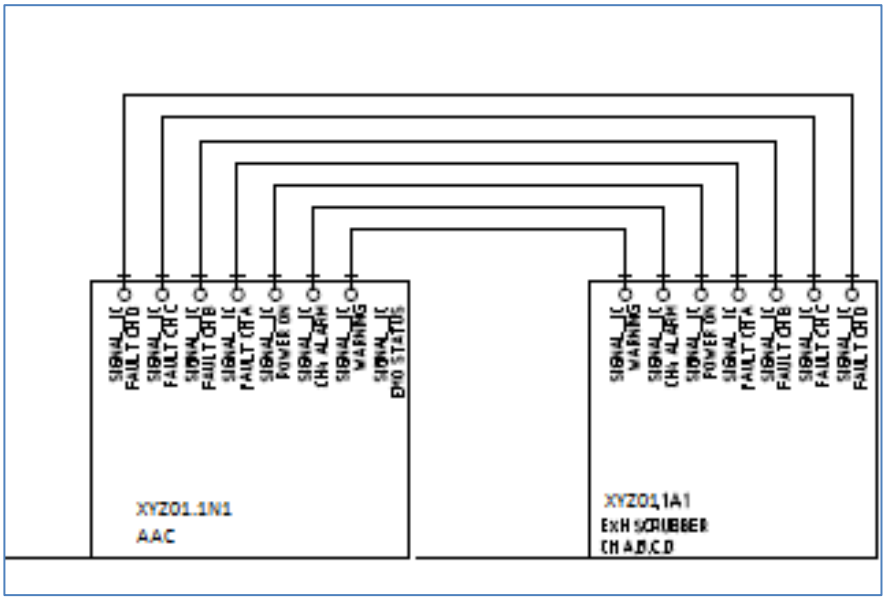
8.2 Sample P&ID Equipment Symbols

8.2.1 Scrubber

1) Mechanical

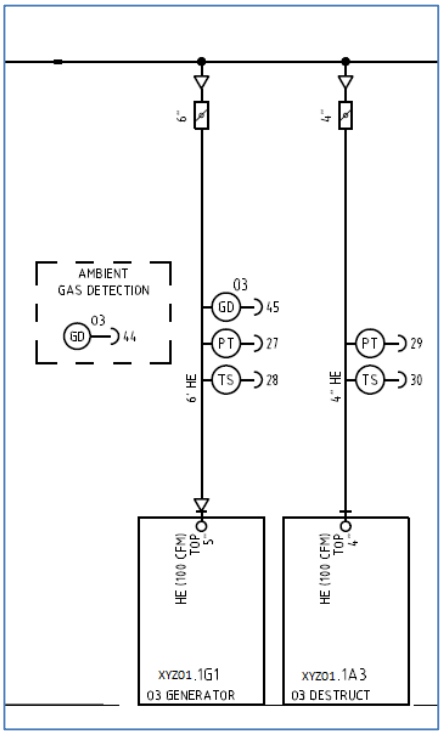


2) Monitoring

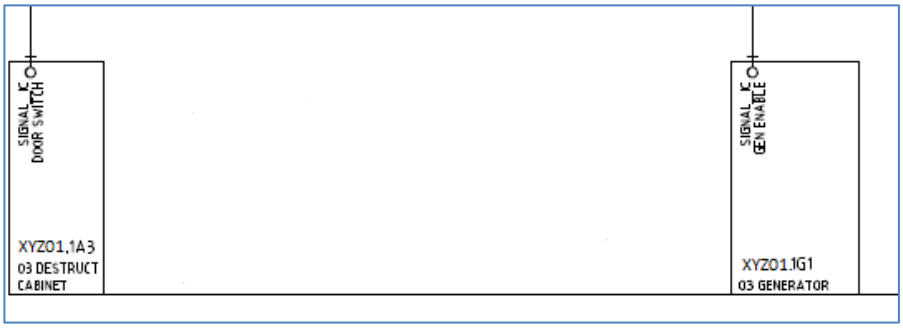


8.2.2 O3 Generator/Destruct

1) Mechanical

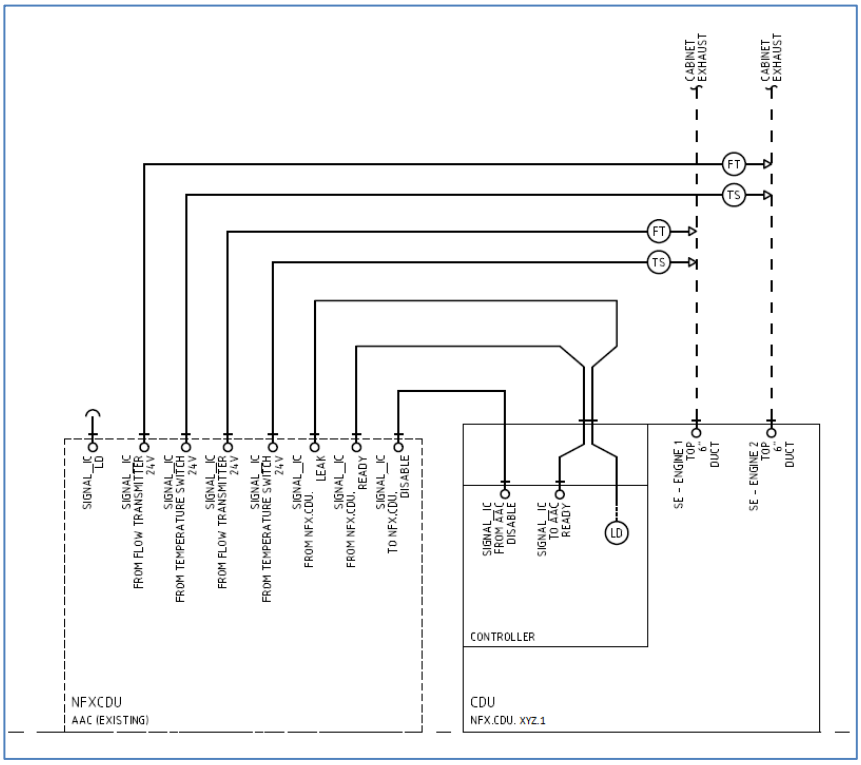


2) Monitoring



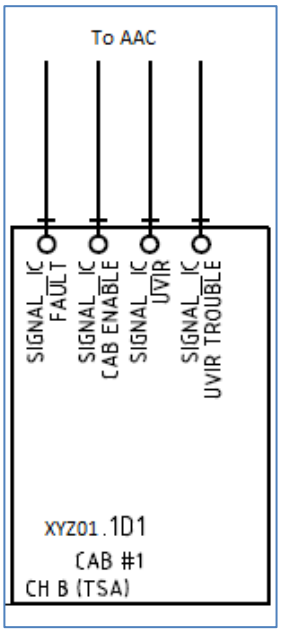
8.2.3 Chemical Dispense Unit (CDU)

1) Mechanical/Monitoring (Typical CDU)



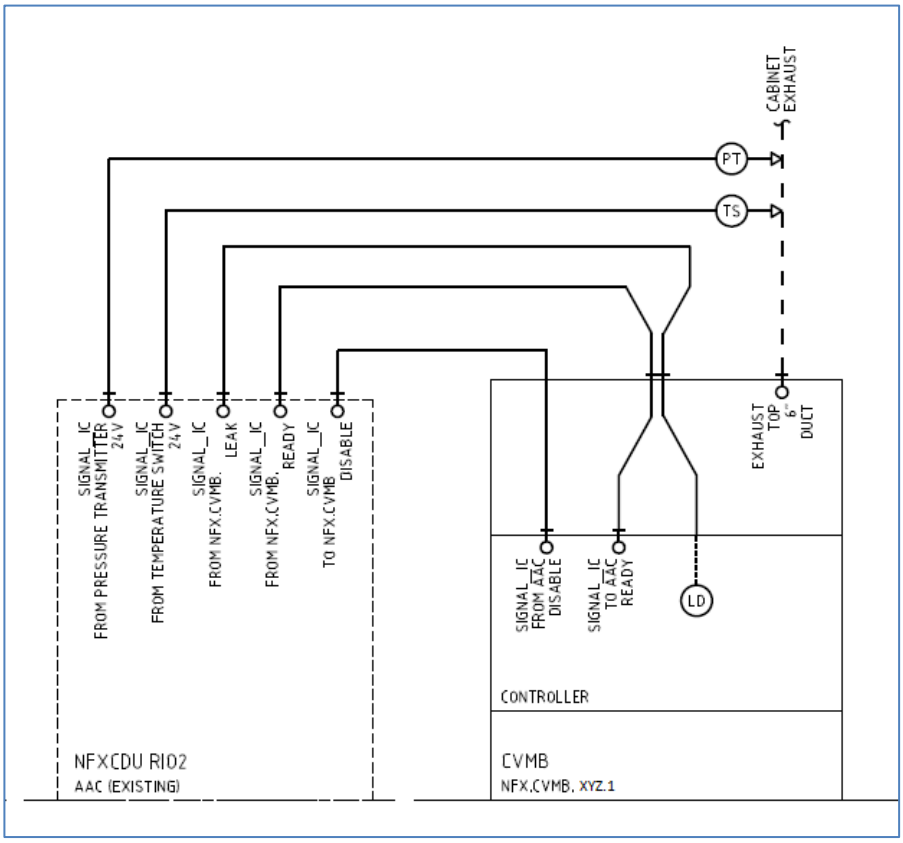
8.2.4 Liquid Dispense Unit (LDS)

1) Monitoring (Pyrophoric)



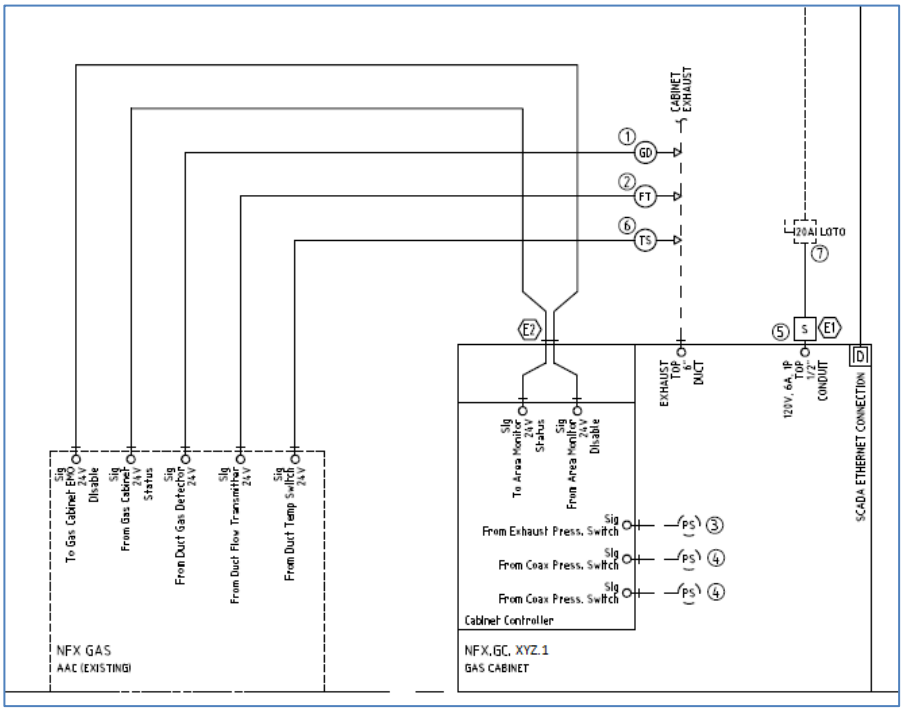
8.2.5 Chemical Valve Manifold Box (CVMB)

1) Mechanical/Monitoring

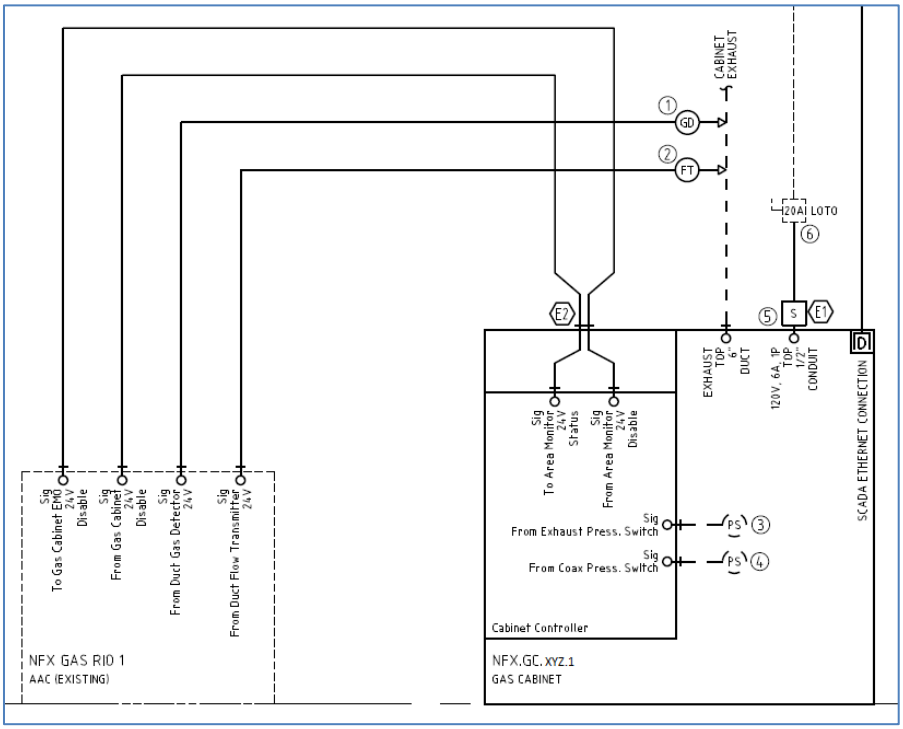


8.2.6 Gas Cabinet (GC)

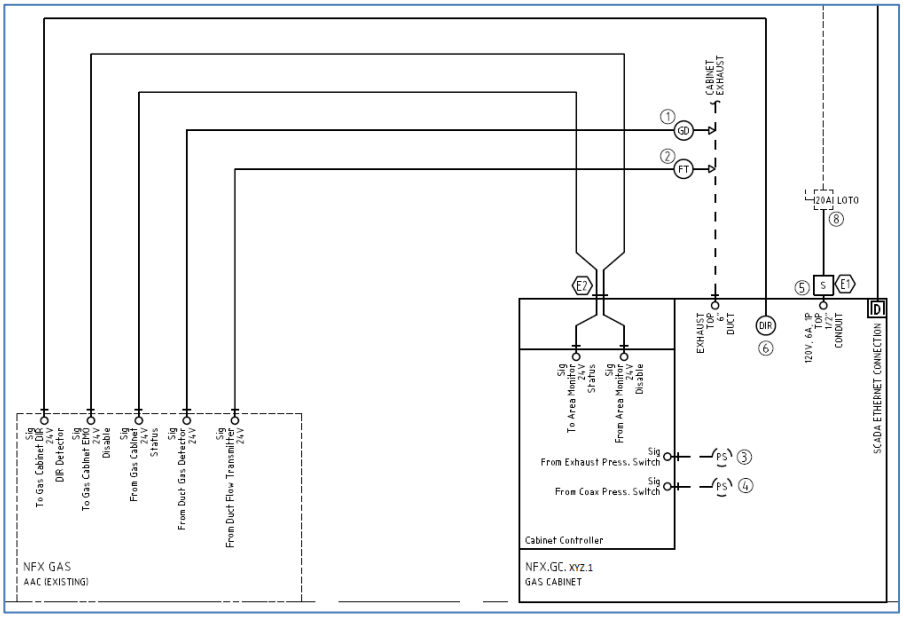
1) Mechanical/Monitoring (Flammable)



2) Mechanical/Monitoring (Toxic)

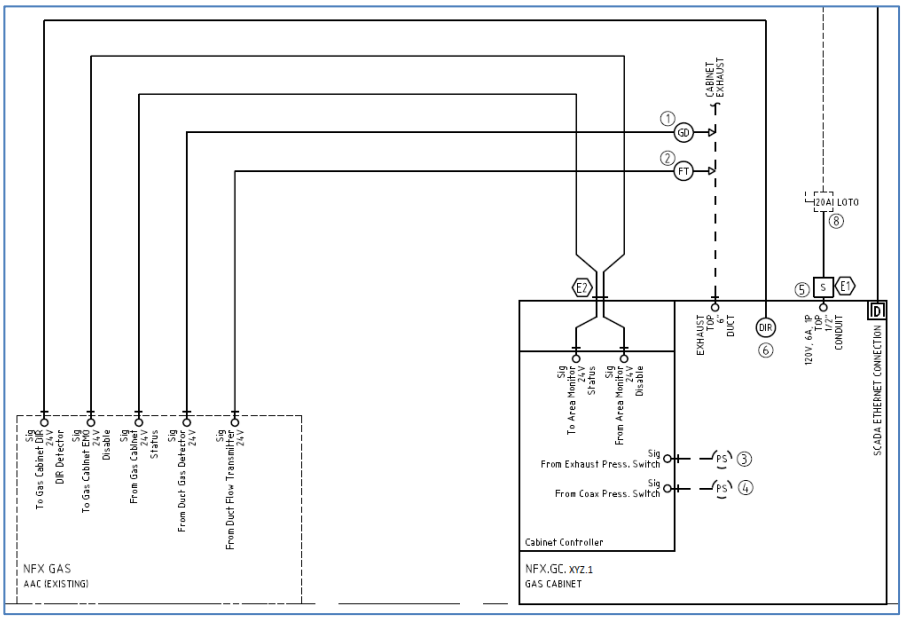


3) Mechanical/Monitoring (Pyrophoric)

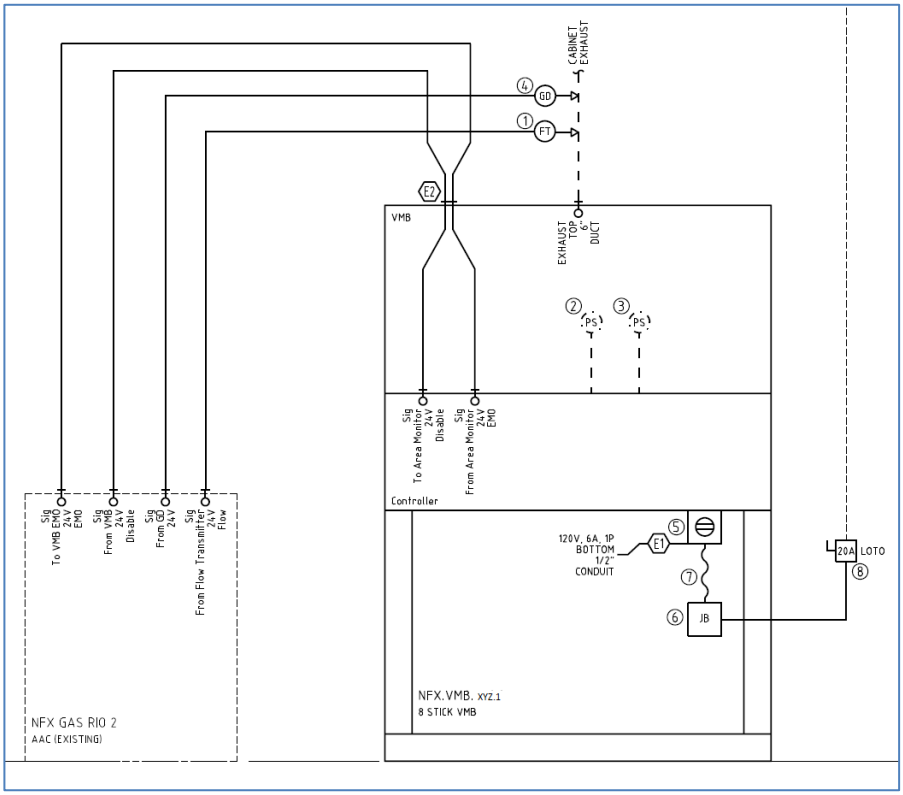


8.2.7 Valve Manifold Box (VMB)

1) Mechanical/Monitoring (Flammable)



2) Mechanical/Monitoring (Toxic)



3) Mechanical/Monitoring (Pyrophoric)