

# DESIGN CONSIDERATIONS FOR ANALYZER ENCLOSURE SYSTEMS

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## **Introduction**

Designing an effective enclosure system for analytical equipment is imperative to ensure measurement accuracy and proper protection for the equipment and for personnel. A proper enclosure system is designed to be resistant to changes in weather and is rated for the proper hazardous area classification (i.e., Cl. I, Div. 2, Groups C, D). Consideration should be taken for ease of installation, accessibility, and maintenance of the equipment within the enclosure.

## **Why Choose an Enclosure System**

Natural gas analyzers are extremely sensitive equipment. Providing a climate-controlled enclosure that protects it from the environment can preserve electronics and even increase analytical accuracy. As one example, a gas chromatograph increases its repeatability from .25 BTU/scf to .125 BTU/scf per 1000 Btu/scf if installed in a controlled environment. Analyzer technicians also benefit from an enclosure system, as it can provide personnel protection while servicing the equipment.

Another key benefit of an enclosure system is that it allows for pre-assembly and testing in a controlled shop environment. This means that when the system arrives on-site, it can be more of a "plug-and-play" installation, reducing setup time and costs.

## **Criteria for Enclosure Design**

Before selecting or designing an enclosure system, five key factors should be considered:

- Installation Location
- Electrical Considerations
- Safety
- Communication & Control
- Physical Constraints

## **Installation Location**

Depending on the end user's location, a climate-controlled building or cabinet may be a necessity for the equipment to function properly. For example, the environmental temperature rating of a gas chromatograph is -4 to +140°F (-20 to +60 °C). In northern climates that regularly see temperatures below this, an enclosure should be designed to maintain the proper temperature. Building design must also take into consideration the structural criteria of the location (floor load, wind load, roof load, seismic requirements).

In milder climates, fully enclosed buildings may not be necessary. Instead, simpler structures like open-air shelters or "bus stop"-style covers can provide sufficient protection from rain, snow, and direct sunlight while keeping costs down.



**Figure 1 - Analyzer Shelter**



**Figure 2 – Open Air Shelter**

## **State Regulations for Modular Buildings**

Individual states may have specific requirements governing the design and construction of modular buildings. Many states operate commercial modular building programs for non-residential structures that are manufactured off-site and transported to their final location. These programs generally require independent third-party plan reviews and inspections during fabrication and after construction. The review process confirms that the building has been constructed in accordance with the approved design documents and applicable building, electrical, and energy codes. Manufacturers must also maintain approval

within the state's modular building program. Following successful completion of all required reviews and inspections, a state certification label is issued and affixed to the building prior to shipment.

### Ensuring Code Compliance

One tool used by modular building fabricators to ensure compliance is a web-based application, COMcheck. COMcheck allows simple reporting for proving compliance with local energy codes for envelope, lighting and mechanical systems — even limiting the number of lumens allowed per square foot.

The International Energy Conservation Code (IECC) has requirements for motion-activated lighting. Lighting must automatically turn off if a building is unoccupied. In hazardous rated environments this causes cost adders for integrators and packagers. Below is a map published by ICC depicting the states that have adopted specific International Energy Conservation Codes. Building fabricators must follow individual state requirements.

### The Importance of State-Specific Compliance

Each state has its own set of requirements, and failing to meet them can lead to significant delays and costly modifications. There have even been cases where buildings had to be retrofitted on the side of the road before being allowed to enter a state due to missing certifications. To avoid these issues, manufacturers must thoroughly understand and follow the specific regulations of each state where their buildings will be installed.

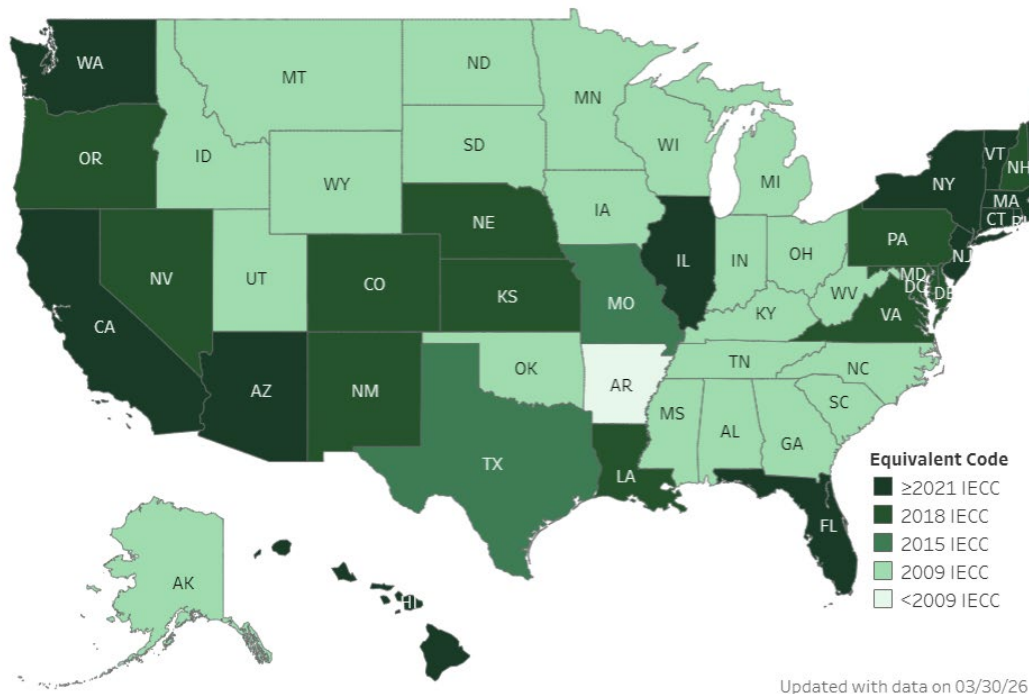


**Figure 3 – IECC Adoption by State**

### Electrical Considerations

Enclosure design must also take into consideration the power requirements available from the site. Analyzer equipment generally is either 120 VAC, 24 VDC or 12 VDC. Depending on the analyzers in the specific package, different electrical installs are possible.

The first consideration is what power the end user has available at the installation site.

Some customers will supply a 480 VAC single- or three-phase power feed. In this case a transformer is necessary to step down the feed to either 240 VAC or 208 VAC.

If the end user is feeding the integration directly with a 240 VAC or 208 VAC feed, then a breaker panel will be necessary. This will allow branch circuits to be distributed within the package.

On smaller packages end users will regularly feed individual 120VAC circuits to the unit. In this case all that could be needed is a junction box with a terminal strip and a way to locally isolate power to the equipment. The power can be distributed from the junction box to the individual devices.

Some analyzers function on 24 VDC or 12 VDC. In these cases, a 120 VAC to 24 VDC (or 12 VDC) power supply must be included to power the equipment properly.

In any scenario, the load of all equipment within an enclosure system must be considered and communicated to the end user, so that the feed can be correctly sized.

While selecting equipment, it is imperative to ensure it meets or exceeds the area classification of the installation location. Most of the area classification seen in this industry will be Class I, Division 1 or Division 2. In certain cases where hydrogen is present in the gas stream or is used as part of the support gas system, equipment may also be required to meet Group B.

## Hazardous Area Ratings

Hazardous area classification is one of the primary factors influencing the design of analyzer enclosures and analyzer buildings. Natural gas and hydrocarbon processing facilities routinely contain flammable gases and vapors that may be released during normal operation, maintenance activities, or equipment failures. As a result, electrical systems associated with analyzer installations must be designed for the specific area classification assigned to the site.

The NEC categorizes hazardous locations by the type of material present and the probability that an ignitable atmosphere may exist. Figure 4 summarizes the Classes, Divisions, and Groups commonly encountered in industrial facilities. While multiple classifications exist, analyzer installations are most commonly associated with Class I locations due to the presence of flammable gases and vapors.

The assigned hazardous area classification affects numerous enclosure design considerations, including equipment certification requirements, electrical installation methods, ventilation strategies, purge and pressurization systems, and maintenance access. Proper application of these requirements is critical to maintaining personnel safety and reliable analyzer operation throughout the life of the system.

| NFPA 70 NEC Hazardous Locations Classes, Divisions and Groups |                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Class                                                         | Division                                                                                                                                                                                                                                                                    | Group                                                                                                                                                                                                                                                                                                   |
| I – Flammable gases or vapors may be present                  | 1 – Ignitable concentrations of hazards exist under normal operation conditions and/or where the hazard is caused by frequent maintenance or repair work or frequent equipment failure<br>2 – Ignitable concentrations of hazards exist under abnormal operation conditions | Group A – Acetylene<br>Group B – hydrogen, butadiene, ethylene oxide, propylene oxide and acrolein<br>Group C – Ethylene, cyclopropane and ethyl ether<br>Group D – Acetone, ammonia, benzene, butane, ethanol, gasoline, hexane, methane, methanol, methane, naphtha, natural gas, propane and toluene |
| II – Combustible dust may be present                          | 1 – Ignitable concentrations of hazards exist under normal operation conditions and/or where the hazard is caused by frequent maintenance or repair work or frequent equipment failure<br>2 – Ignitable concentrations of hazards exist under abnormal operation conditions | E – Combustible metal dusts: aluminum, commercial alloys and magnesium<br>F – Combustible carbonaceous dusts: carbon black, charcoal, coal and coke dusts<br>G – Other combustible dusts: Chemicals, flour, grain, plastic and wood                                                                     |
| III – Easily ignitable fibers or flyings may be present       | 1 – Ignitable concentrations of hazards exist under normal operation conditions and/or where the hazard is caused by frequent maintenance or repair work or frequent equipment failure<br>2 – Ignitable concentrations of hazards exist under abnormal operation conditions | Not Applicable                                                                                                                                                                                                                                                                                          |

**Figure 4 – Hazardous Location Classifications**

## Designing for Hazardous Areas

In some applications, both classified and non-classified equipment must be housed within the same analyzer building. A common solution is a two-room building design that incorporates a vapor barrier wall to separate the classified analyzer room

from a general-purpose electrical room. The classified room typically contains analyzers, sample conditioning equipment, and other devices exposed to the process environment, while the general-purpose room houses equipment such as UPS systems, flow computers, network equipment, PLC panels, and electrical distribution panels.

Separating these systems provides both safety and economic benefits. By limiting the size of the classified area, facilities can reduce the amount of specialized hazardous-location equipment required while maintaining the integrity of the analyzer installation. This approach can significantly reduce project costs, simplify maintenance activities, and improve access to critical electrical and control systems.



**Figure 5 – Two-Room Building**

### **Safety**

Housing gas analyzers inside self-contained shelters can bring about some inherent safety concerns that must be mitigated. API RP 500 has recommendations to ensure enclosed structures are adequately ventilated. API defines adequately ventilated as 6 air changes per hour. These recommendations include the use of:

- HVAC systems
- Gas leak detectors to monitor for hazardous leaks
- Exhaust fans to evacuate the gas from the enclosed room
- Strobe lights and sirens for visual and audible alerts
- Sample shutoff valves to stop gas flow

### **Gas Leak Detection and Response**

Equipment can vary based on the shelter design and user preference. Gas detectors are used to detect gas leaks in the shelter. If a leak is detected, systems are often designed for the following to occur:

1. Activating the exhaust fan
2. Triggering strobe lights and sirens
3. Shutting off the sample supply via a solenoid

### **Natural Ventilation as an Alternative**

There are also recommendations in API that define naturally ventilated enclosed areas. Inlet and outlet vents can be sized to provide the required air changes through natural thermal forces, without the need for mechanical ventilation.

By carefully considering these safety measures, analyzer enclosures can be designed to minimize risk while ensuring compliance with industry standards.



**Figure 6 – Gas Detector**



**Figure 7 – Strobe Light**



**Figure 8 – Exhaust Fan**

### **Communication & Control**

How will your system communicate with the facility? Most modern analyzers include various communication methods. The different signals below not only give you a live measurement but also can tell you the health of the device.

- Modbus over Serial or Ethernet connections
- Analog Outputs (4-20 mA)
- Discrete Outputs for faults and alarms

### **Signal Routing and Integration**

In many instances the signals from the various analyzers run directly to a flow computer. In other installations all the signals will be brought to a central junction box within the enclosure. This allows for a single point of connection for the site. From here, how the site handles it can vary widely.

- Remote Sites: At remote facilities where the analyzer enclosure is the only structure, data is often transmitted via radio or SCADA networks, connecting to flow computers for off-site monitoring.
- Larger Plant Sites: At larger facilities, analyzer signals are typically wired back to a central control system, where operators can monitor data from a dedicated control room.

By selecting the proper communication method and signal routing strategy, facilities can ensure seamless integration of analyzer data into their broader monitoring systems.

### **Physical Constraints**

In addition to the factors discussed throughout this paper, the points below must be considered when determining the physical design of the enclosure:

- Budget
- Site space constraints
- Size and quantity of analyzers
- Sample handling and support systems

### **Budget and Space Constraints**

Budget and site space constraints will quickly determine whether a full-blown climate-controlled building is feasible. Open-air shelters and free-standing cabinets are naturally more economical and have a smaller footprint. These enclosure styles can also eliminate the need for the large HVAC systems and certain safety equipment.

That said, many customers highly value the increased accuracy, reliability and maintainability of analyzers installed in a walk-in enclosed shelters.

### **Equipment Layout and Accessibility**

No matter the enclosure type, understanding the dimensions of the analyzers and support equipment (i.e. regulators, gas cylinders) is crucial when designing the space to avoid overcrowding and allow for efficient servicing. Support gases for the analyzers are often installed outside the enclosure to maximize interior space.

## **Sample Handling and Lag Time Considerations**

When determining enclosure location, the objective should be to minimize sample transport distance while maintaining a representative sample throughout the entire sampling system. Sample line sizing, flow rate, operating pressure, and sample system volume all influence lag time and should be evaluated during the design process. To support optimal analyzer performance, enclosure designs can often be customized to accommodate installation closer to the sample extraction point. Depending on site requirements, this may include the use of compact analyzer shelters, clamshell enclosures, wall-mounted systems, or other reduced-footprint designs that allow analytical equipment to be located near the process while still providing the environmental protection and hazardous area features required for reliable operation.

In addition to transport time considerations, maintaining the sample above its hydrocarbon dew point throughout the sample path is critical to preserving sample integrity. Strategic enclosure placement, combined with proper sample system design, can help reduce lag time, improve analyzer response to changing process conditions, and support more accurate and representative analytical measurements. GPA 2166 identifies transport time as an important consideration in sampling system design, recognizing that excessive lag times can reduce the responsiveness and usefulness of analytical data.

## **Conclusion**

Designing an effective analyzer enclosure system requires a balance of safety, functionality, compliance, and cost. From power and ventilation requirements to communication systems and physical layout, each design choice can directly impact the performance, reliability, and maintainability of the analyzers. By evaluating site constraints, equipment needs, and regulatory requirements, facilities can implement a solution that ensures accurate measurements, streamlined maintenance, and long-term operational efficiency. Whether opting for a walk-in shelter, open-air structure, or hybrid design, understanding these considerations upfront leads to a safer, more cost-effective analyzer enclosure system.

## **References**

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