

## Hazardous Gas Monitoring Throughout the Semiconductor Manufacturing Facility

FM Approvals is a business unit of FM Global, a commercial and industrial property insurance and risk management organization. They insure an estimated 40% of the Semiconductor Manufacturers in the world. Class # 7701 is the assessment standard for Tools Used in the Semiconductor Industry.

Copies of the Standard may be obtained by calling 781.762.4300 or log on to [www.FMGlobal.com](http://www.FMGlobal.com).

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**S**emiconductor manufacturing facilities employ a number of hazardous gases in their production processes. Whenever these gases are stored, distributed or used in manufacturing processes, there exists the potential for a hazardous condition. The primary hazards associated with these gases include fire, explosion, and contamination resulting in product loss or unscheduled preventative maintenance. These gases must be continuously monitored to ensure the health and safety of employees, to protect property, as well as to maintain regulatory compliance.

Continuous gas monitoring in semiconductor facilities is a requirement of local and state regulations which are typically based on the Occupational Health & Safety Administration (OSHA), the Code of Federal Regulations, FM Approvals, the NFPA Fire Protection standards, the Uniform Building Code and the Uniform Fire Code. These regulations and standards offer guidelines concerning the proper design, installation and operation of hazardous gas detection systems.

Reliable gas detection and monitoring systems are an essential element of the semiconductor plant's safety system. A variety of systems are available for different monitoring applications. Using the correct system will result in managing gas hazards in the most effective and efficient way. Hazardous gas monitoring systems benefit the semiconductor industry in the following applications:

- Parts per million detection in ventilated gas cabinets, enclosures, process equipment chases and clean rooms
- Flammability monitoring of LFL (Lower Flammable Limit)/ LEL (Lower Explosive Limit) levels in and around process tools
- Area monitoring for toxics and combustibles in storage areas, distribution, delivery piping and equipment chases

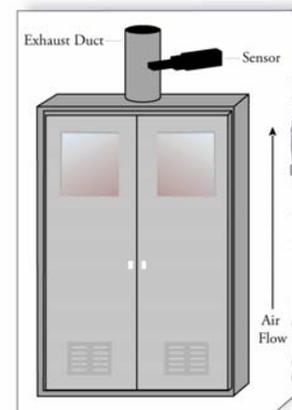
### Parts Per Million Detection in Ventilating Gas Cabinets, Enclosures, Equipment Chases and Clean Rooms

Containers of hazardous gases, both flammable and toxic, are often isolated from

the surrounding environment by safety enclosures (gas cabinets). Some process tools have a gas control enclosure section that serves the same purpose as a gas cabinet. Some of the common gases found include hydrogen, hydrogen chloride, ETO, chlorine, ammonia and oxygen. It is important to monitor these enclosures for leaking gas to save product as well as prevent a toxic condition. The cabinets and enclosures are ventilated to prevent the buildup of any leaking gas. The ventilation dilutes the vapors which quickly mix with air flowing through the cabinet, preventing buildup.

Detecting the diluted leak requires a gas sensor in the low ppm range. Placement of parts per million sensors in the exhaust duct will allow continuous sampling of all air moving through the enclosure. When a leak is detected, the detection system can sound an alarm to notify personnel, and /or close a delivery valve to stop the flow of gas from the cylinder.

Some process tools have gas enclosures that contain the piping jungle carrying hydrogen and toxic gases such as arsine, phosphine, diborane or silane. These gases are introduced into processes in metered quantities to obtain product specifications. Any type of leak could jeopardize the integrity of the lot resulting in loss of product. In addition, many of these gases are highly toxic and require precautions to protect personnel. If a technician opens the enclosure section when a leak is present they would be exposed to the toxic gases. Continuous monitoring and early warning are the best means of preventing both of these accidents.



A clean room is an enclosed contamination-free environment where state-of-the-art manufacturing and assembly take place. Clean rooms range from very small chambers to large scale rooms. Piping carrying process gases are connected to deposition, etching and other process tools. The connections are sources of possible leaks and contamination. Therefore, the air must be continuously monitored for ppm levels of hazardous leaking gas.

Control Instruments parts per million sensors employ electrochemical sensing technology. The sensors are rugged, highly stable and excellent for detecting low parts-per-million concentrations of selected gases in gas cabinets, enclosures and clean rooms. They offer immunity to cross interference, low maintenance, excellent repeatability and long-term stability. These ppm sensors can be calibrated to read a variety of gases including: hydrogen, hydrogen chloride, carbon monoxide and ammonia, among others. Hydrogen also is often employed as a carrier for other gases such as arsine, phosphine and silane. Control Instruments ppm sensor can be calibrated to hydrogen in a variety of ranges, making it useful for the detection of either pure hydrogen or toxic process gases being carried in hydrogen.

### **Flammability Monitoring of LFL/LEL Levels in and Around Process Tools**

Process tools are enclosed areas in which specific wafer processing functions occur. Any process tools handling flammable gases require a hazardous gas detection system to ensure safety and be in compliance to codes. The FM standard states that *“ventilation shall be provided for all tools handling flammable and combustible liquids. Ventilation shall be provided to ensure the atmosphere does not exceed 25% of the LEL (LFL) in the event of the largest possible leak.”*

The equipment contains exhaust ducts to remove the hazardous gases. Detectors are located in each process control cabinet and exhaust plenum to monitor the atmosphere for % LFL/LEL. When an alarm occurs the process is shut down and the gas supply to the tool is turned off. Some of the process tools that need to monitor for flammable gases include furnaces, reactors, alcohol vapor dryers and ion implanters.

Control Instruments Catalytic sensors are typically used to monitor flammable gases and

vapors in the 0-100 % LFL/LEL range. The sensor is a high performance design that offers fast response, high accuracy and long life. It is stable and has superior tolerance to catalytic poisoning agents.

### **Area Monitoring of Storage Areas, Distribution and Delivery Piping**

Hazardous gases are stored and distributed in the semiconductor plant. In these operations there exists the possibility that the hazardous gas could accidentally leak or spill into the surrounding area. Pumps, control valves, manifolds, piping junctions, fittings and connections are some of the potential sources for leaks or spills. With so many opportunities for leakage, continuous monitoring of such hazards is an essential part of keeping the plant safe.

Detector placement should consider the importance of early warning, which is accomplished by placing the sensors so as to favor the probable gas release point while maintaining the ability to protect the total area selected. Sensor selection (ppm or LFL/LEL) depends on the gas hazard present.

### **System Selection**

Monitoring within the semiconductor plant requires gas detection systems that can accommodate a variety of combustible and toxic gas applications with both single and multi-sensor network solutions. The SmartMaxII gas detection system is excellent for both large and small gas detection applications. It is designed to work with Control Instruments' catalytic and electrochemical sensors for LFL/LEL and PPM monitoring. Each SmartMaxII system can continuously monitor and control the readings from as many as four same-type sensors. It is fully equipped with all the alarm, display, and output features you need, including on-board relays for interlocking to alarms, 4-20mA output and RS-485 serial port. The SmartMaxII system can be teamed up with powerful operator interfaces that allow you to view, access, and control multiple remote sensors from a convenient central location. This allows operators and management to remotely request on-line, detailed information regarding the status of the sensors operation, including diagnostics and historical records.

The National Fire Protection Association (NFPA) establishes fire safety standards. NFPA 55 is the standard that provides fundamental safeguards for Storage, Use and Handling of Compressed Gas & Cryogenic Fluids in Portable and Stationary Containers, Cylinders and Tanks.

Copies of NFPA 55 may be obtained from the National Fire Protection Association.

Call toll free to order:  
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