
Developing a Totally Integrated, Ethernet-Based, Hazardous Gas Detection System

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Cree, Inc., (Cree) is the world leader in the development, manufacturing, and marketing of electronic devices made from silicon carbide (SiC). Over the past decade, Cree has experienced dynamic growth. We have grown from our first 19,000-square-foot facility to our current 250,000-square-foot manufacturing facility, with additional facilities under construction. As our square footage has increased, our gas detection system has also grown in both the number of monitoring points and in technology.

In 1996, Cree investigated upgrading its existing gas detection system for the 19,000-square-foot manufacturing and research facility. We were looking for a system that would have the ability to expand and to handle multiple gas types at a single control point. At the time, we were monitoring for Hydrogen, Hydrogen Chloride, Ammonia, Silane, and Nitrogen Trifluoride. We needed to monitor all of these gases in the low parts-per-million (ppm) ranges to maintain our high safety standards.

We began the process by analyzing our needs. Manufacturing personnel, facilities, and equipment engineering were brought in to develop a short list of desired features. Obviously, the system had to be dependable, accurate, and cost efficient. In addition to these, we developed the following list of desired features:

- **Central, user-friendly control panel** with a digital gas concentration display and alarm annunciation;
- **Password protection** of system parameters;
- **Easy, low-cost calibration;**
- Ability to **bring in information from sensors** provided by other manufacturers;
- **Zoning capabilities;**
- **Diagnostics** and output data;
- **Multiplexing** for lower installation costs;
- Ability to **upgrade technology;**
- Ability to **expand** with little down time, and;
- System **flexibility.**

Near the end of 1996, we contacted three vendors regarding our need for a satisfactory hazardous gas-detection system. After the bidding process, Cree selected the Sierra

Monitor Corporation (SMC) Sentry System. The SMC system utilizes gas-sensor modules within production and gas-storage areas to detect gas leaks. It then relays this data to the controller via a two-way, digital communications link. The two-way link allows the technician at the controller to visually observe the gas read-outs and to modify the sensor's calibration or turn it on and off, as needed. The microprocessor controller also enables us to easily set up the system parameters, alarm setpoints, calibration schedules, and sensor information and then password protect these parameters so that only authorized individuals can access these programmable functions.

The controller is considered "intelligent" because it retains key data and calibration details from previously programmed sensors, even if the system is shut down for maintenance or relocation, as has been performed on several occasions.

The initial system installed in the first quarter of 1997 included nine Sentry controllers mounted in a free-standing floor cabinet with a printer network to provide data record information we needed to maintain safety. The printer provided pre-formatted reports for each sensor point, calibration information, and alarm logs

The gas sensors for Hydrogen %LEL, Hydrogen ppm level, and Hydrogen Chloride communicated directly with the controller via a three-conductor, shielded, 18-gauge cable. The gas sensors for Silane and Nitrogen Trifluoride communicated with the controller using a converter that interpreted the analog signal and recommunicated it digitally to the controller.

By 1998, we were moving into the new manufacturing facility and it was time for this new hazardous gas-detection system to prove that it could expand with Cree. The system had to move into the new facility in stages, as manufacturing came on line. With the move to the new facility, Cree had several significant requirements: preventing disruption of gas detection and evacuation alarms as the system was being moved from one facility to the next; minimal downtime with the move; and low removal and installation costs.

- **One at a time** – The configuration of the initial system allowed us to move one room/area at a time. As we relocated, we were able to disconnect the area sensors we needed without disrupting the entire system. For controllers that contained multiple areas, we mapped sensor locations on installed, new controllers. In this manner, we did not lose coverage for the sensors "left behind".
- **Minimal downtime** – The smart sensors, combined with the intelligent controller, made it quick and easy to move the gas detection system into the new facility. We added 10 more controllers to the original nine. The smart sensors already knew their sensor number and gas type. As each sensor was attached to the communications bus, the sensor number and gas type was sent to the controller. Since the installers did not have to painstakingly trace back each wire from each sensor to each control terminal, installation was fast and easy. The menu-driven

configuration on the large multi-line display made it easy for the installers to configure each sensor in the system.

- **Low installation costs** – The unique, two-way digital communications bus for this gas-monitoring system greatly reduced installation cost. Instead of running eight, 3-conductor, shielded cables from each controller to each sensor, the installation crew only had to run two, 3-conductor, twisted cables from each 8-point controller to the respective sensor group. Then each sensor was tied into this common bus to interface with the controller. Instead of 8 connections at the controller there were usually only two.
- **Zone alarms** – Initially we were satisfied with a “common” alarm output signal, in which 8 sensors tripped one relay. This was an effective system when all the gases were contained in one room. However, with the move to the new manufacturing facility, where there were multiple rooms with gas sensors, we needed to provide more than one alarm relay per controller. We were able to achieve this goal by adding an individual alarm relay panel connected to each controller.

The intelligent gas-monitoring system lived up to our initial expectations. The multiplex installations, easy sensor configuration, simple menu-based setup, and zone programming insured easy transition into the expanded manufacturing facility.

By 1999, the manufacturing facility was continuing to grow, with plans for further expansion. We needed to expand our hazardous gas detection system to meet our initial plans for an expanding plant-wide system.

Cree needed to address several critical points in taking the existing hazardous gas monitoring system into the future. First, with our additional square footage and sprawling campus, we were concerned about response time. Although many of our sensors were located in the main manufacturing building, we had expanded to three floors with a somewhat remote EH&S office. Second, we had to maintain the confidentiality of our process. An elaborate schematic of sensor locations was not practical or available to our emergency response team (ERT) members.

In addition, with the facility growing larger and larger, we found that the relay boards used much more cable harnessing than anticipated. We called Sierra and requested a programmable relay board, and they provided us with the commander. The commander, an intelligent PLC, enabled us to program any sensor on any of the various controllers to trip a designated relay. The commander initializes the proper relays for alarm outputs or equipment shutdown. Both the controller and the commander are located in a central area within the building.

The key to any hazardous gas detection system is information. Individual sensor elements are designed for monitoring specific gases, but vary little from one manufacturer to another. One critical requirement was to make sure that the data from each of those individual sensor elements was available to the decision-makers quickly and efficiently in an easy to understand format. Consequently, EH&S needed the capability of remote annunciation and system accessibility.

The answer to our concerns was an integrated, Ethernet-based system. We decided to accomplish this integration by using the pre-existing, plant-wide, Ethernet backbone to relay the data from the controllers to a central control system. We believe that most plant monitoring systems in the future will need to be accessible over the Ethernet backbone. SMC provided a communications bridge as our link to the Ethernet. The bridge provides a serial communications link “bridging” the data received from the controller to other devices, allowing, for example, data to be relayed to visualization software on an individual PC or a network. Such software includes Wonderware, LANworks or Intellution FIX.

The bridge accepts the modbus output from the Sentry controller and converts it seamlessly to an Ethernet protocol. With the communications bridge, the hazardous gas detection system appeared as another node on the Ethernet bus.

The gas monitoring system controllers have Modbus serial output that provides a full range of detailed information about the operation and status of the controller and the smart sensors. In fact, over 600 data points -- including concentration, alarm conditions, system setup, and calibration data, to name a few --are available from each controller. This data is provided to visualization software using either Wonderware or LANworks interface. The visualization software is a series of graphical screens that enables the operator to quickly and easily determine where the alarm is located, the type of gas, and precise amount of gas released in the detection area. Whenever a system is in alarm, we will receive the information quickly and be able to make the appropriate, informed decision.

Summary

In developing an integrated gas detection system, Cree started with a gas risk management system, Sentry from Sierra Monitor. Building on this foundation, we will be able to utilize an Ethernet backbone structure to provide remote, accurate information to the EH&S staff and ERT members.

As Cree expanded to meet new challenges, the gas detection system provided:

- Zone alarm configuration with input from different gas types;
- Minimal downtime as we moved into our new manufacturing operation; and
- Low installation costs as we added more and more smart sensors and intelligent controllers.

And finally, as we expand into an Ethernet-based, hazardous gas-detection system, our goal is to create a totally integrated system that gives us flexibility, prompt and accurate data, remote access and control, and the ability to interface with other safety and control systems.

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