Counter-Terrorism Respiratory Filter Certification
By

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Category
Aerospace/Defense

Products Used
LabVIEW 6.1 for Windows
Data Logging and Supervisory Control (DSC)Toolset
4-FP 1600 Fieldpoint Ethernet Network Modules
8-FP AI 110 Fieldpoint Analog Input Modules
4-FP TC 120 Fieldpoint Thermocouple Input Modules
8-FP RLY 420 Fieldpoint Relay Modules
FP PG 522 Fieldpoint Pulse Output Module
FP CTR 502 Fieldpoint Counter Module
232/4 Four Port Ethernet to Serial Adapter
Brooks Instrument Smart Mass Flow Controllers
Swagelok Pneumatic Valves
Miller Nelson Research Flow Temperature & Humidity Control System
EdgeTech Dew Point Hygrometer
Miran SapphIRe Ambient Air Analyzer
Bionics Intruments Toxic Gas Detector
Interscan Gas detector
Shimadzu Gas Cromatograph
Inova AirTech Instruments Photoacoustic Multi-Gas Monitor
Pharmacia Biotech Syringe Pump

The Challenge
The US Government required a new gas vapor laboratory application to control and monitor the testing of breathing apparatus used by first responders to toxic industrial chemical disasters. Terrorism threats have required the design and validation of respiratory filters with increasing versatility, to protect personnel in the face of potentially unknown dangers. Manual, low-volume, "wet chemistry" techniques do not suffice to test incompatible challenge agents at high throughput rates. A flexible architecture with rapidly reconfigurable user interface was required to accommodate a variable number of flow loops with different components.

The Solution
Data Science Automation developed a generic, flexible and secure "Service Life Testing" application to control and monitor testing of dozens of breathing apparatus simultaneously. Advanced features were utilized to

dynamically create front panel objects for a user-defined number of test cells in each of multiple fume hoods. The solution is based on LabVIEW DSC and FieldPoint and can be configured for use with a variety of detectors and control devices.

Background
A common LabVIEW question that arises during the design of scalable systems is "How can dynamically instantiate front panel objects?" The common answer is "You can't." But, with the power and flexibility of LabVIEW 6.1 event structures coupled with control references, NOW YOU CAN!

Problems
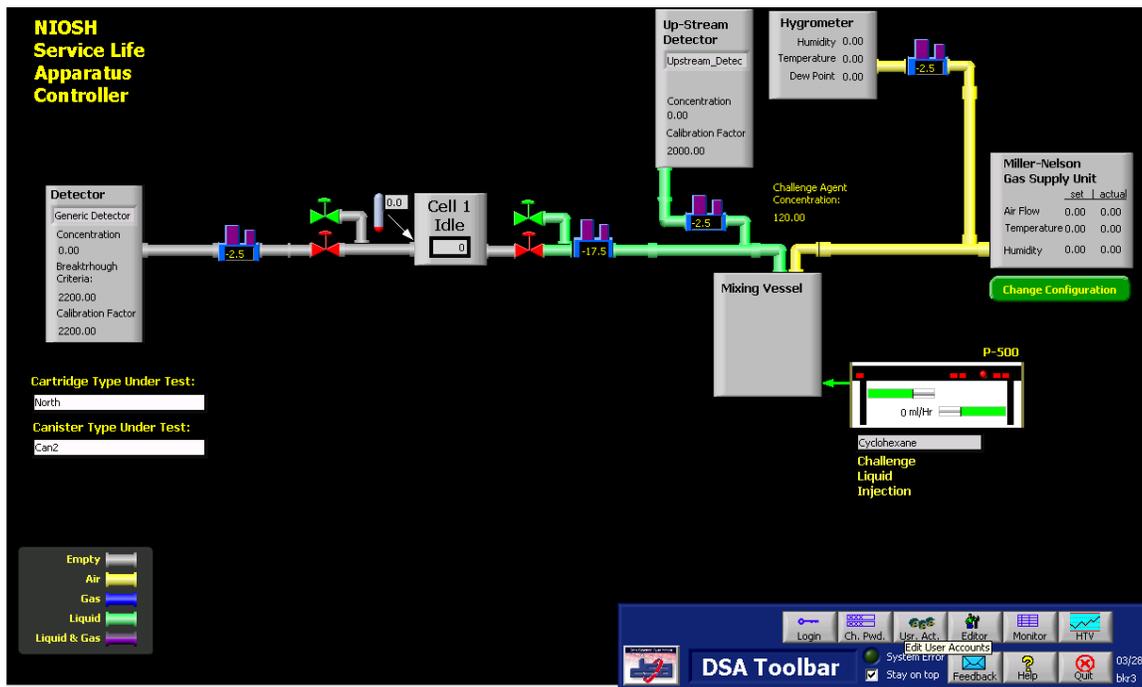An example of an application that utilized this approach is shown in Figure 1a, 1b, and 1c.

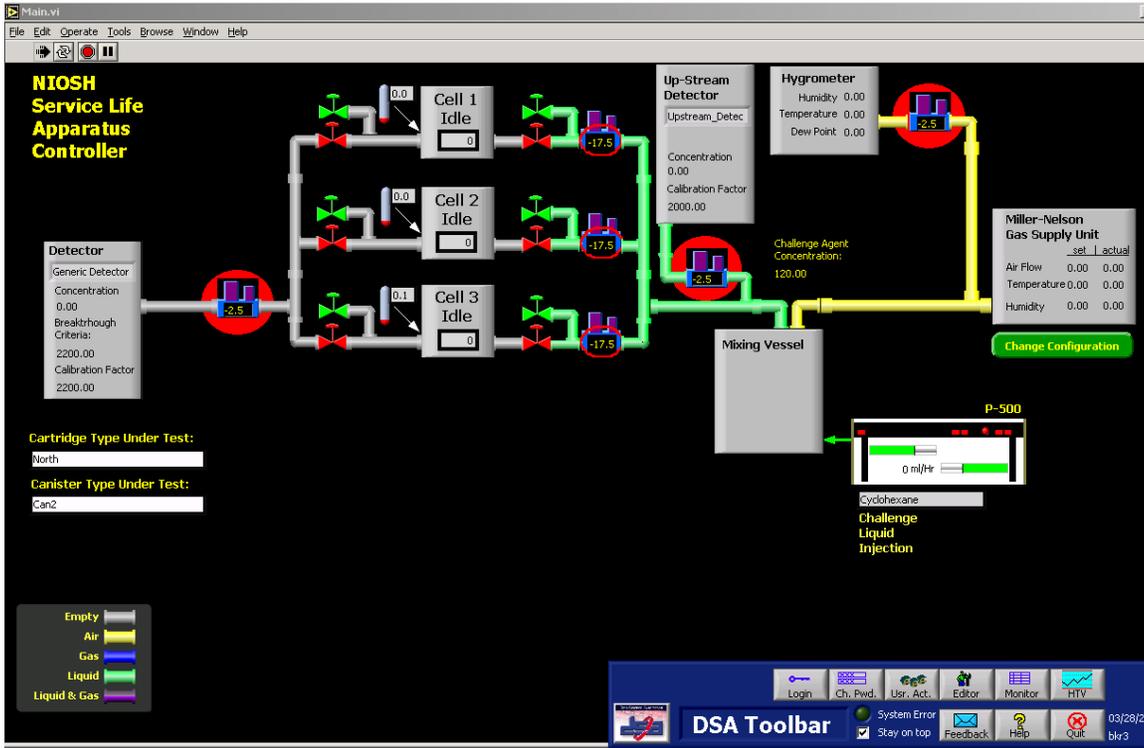**Figure 1a. A Single Cell System with a Liquid Challenge Agent**

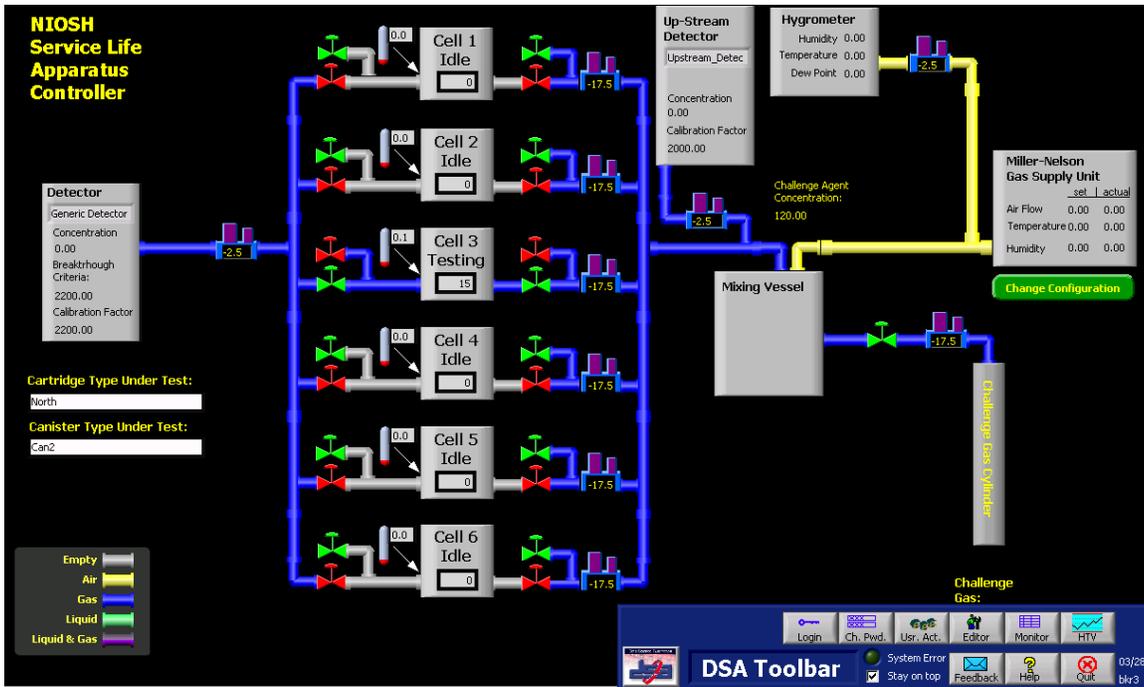**Figure 1b. Three Cell System with a Liquid Challenge Agent**

Figure 1c. A Six Cell System with a Gaseous Challenge Agent

The front panel graphically depicts the flow loop with the various components. This application was developed for a testing laboratory that needed the ability to use an application to control and monitor the testing of many devices. The types of devices that are to be certified by the lab can vary widely so the configuration of the test enclosures (cells) required for each device type could also vary. The second requirement was that a single configurable application be developed that could adapt to the various number of cells that would be involved in each supported fume hood. The application also had to graphically represent the configuration of the associated apparatus and the presence of hazardous materials depending on device configuration.

The graphical representation of the presence of hazardous materials was indicated by dynamically color coding various pipe elements that were drawn using the picture control toolset. In order to handle the large number of devices and variety of challenge agents supported, a multiplexed testing scheme was developed. This allowed many devices to be tested simultaneously using a single set of detectors. In order to maximize the screening throughput, the variable physical configuration and single application solution required that the number of cells be configurable depending on how many cells could be fit into a fume hood.

Prior to the development of the innovative technique described below, this level of flexibility required the creation of surplus objects with visible and position properties set dynamically at runtime to show and position the objects needed on the front panel. This technique was tedious to develop, hard to understand, and led to large, complex block diagrams that where dominated by the functionality of the GUI leaving the operation of the application obscured in a blizzard of property nodes.

The new approach described here allows a developer to use a picture control to support the "Virtual Objects" (VOs). A technique was developed to quickly create a VO from standard LabVIEW front panel Graphical Objects (GOs). The event structure and control references provide two powerful tools that, when combined with a picture control, allows a developer to define a region of the front panel that will be used to support the dynamically created objects. The event structure provides efficient monitoring of the user's mouse clicks and detailed information about the nature of the click. Control references provide a mechanism to capture an object's image after its state is acquired by the application.
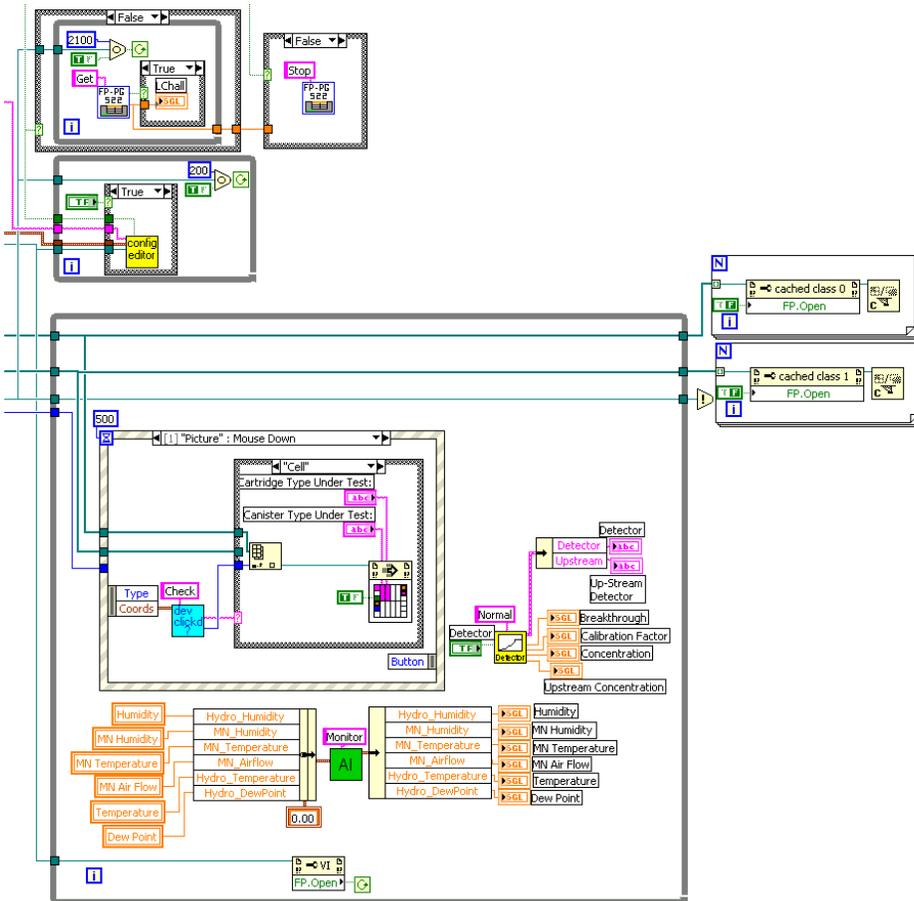Figure 2 shows the diagram of the "Main.VI".

Figure 2. Block Diagram Section Illustrates Simplicity of Control Reference Technique

The first thing to note is that the main control loop occupies a portion of the screen that is appropriate for the application's operation and that there is a noticeable lack of property nodes present in the diagram. The state shown illustrates how the events associated with user clicks are passed to a subVI that determines what VO is associated with the click. Identification of which VO is clicked on determines which case is used to service the click.

Figure 3 shows the front panel of the update display function.
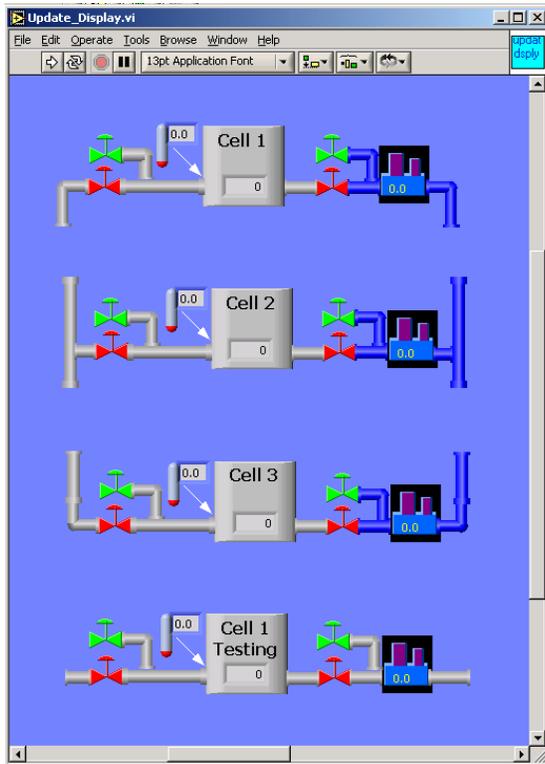
This VI performs two functions. It builds the picture displayed by the Main.VI user interface from the sets of apparatus shown. The other function it performs is that it will initialize the action engine called in Figure 2 with the location of each VO in the picture control. These values define the "sweet spots" associated with each VO. At startup, the Main.vi will assemble a picture that represents the laboratory apparatus that is used by the system and the "click detection" action engine is initialized. When a user clicks on a part of the picture, the set of configured VO is checked to determine if one was clicked. If so, a VI written to support that type of device is called.

Conclusion
From the end-user's perspective, this technique allows a single application and its configuration utility to easily control and monitor the testing of up to forty-two devices in seven different fumes hoods. The networked system architecture allows any station to control any set of test cells in the event of a system failure. Single-unit testing that previously required hours of work by a qualified chemist can now be replicated and conducted simultaneously by a one technician. From a developer's perspective, the implementation of top level vi as the main user interface rather than launching separate custom user interfaces for each configuration is much simpler. Control references allow the graphics processing to be done at the sub-vi level thus simplifying the block diagram.

Future Enhancemets
Two applications currently in development will use a variation on the above technique. One will allow end users of a facility monitoring system to include maps of floor plans with equipment detail pop-ups available via clicks on the control images. This approach will only limit the number of front panel VOs to that dictated by only processor speed and memory capacity to process them rather than the normal 550 limit of GOs.