

## Naval Pump Simulation

by

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### Category:

Aerospace/Defense

### Products Used:

LabVIEW 8.0

NI PCI-6221, M series DAQ

SCXI-1000, 4 Slot Chassis

2 - SCXI-1102, 32Channel Thermocouple Amplifiers

SCXI-1303, 32 Channel isothermal terminal amplifier

SCXI-1308, 32 Channel current input terminal block

SCXI-1349, Bracket / Adapter assembly

SHC68-68-EP, shielded cable

CB-50, I/O connector block

NB1 50 pin ribbon cable

GS2-45PO, GS2 Series VFD

4040, DURA pulse Series VFD

### The Challenge:

The customer needed an easy to use application to monitor and log the testing of a naval pump. The system was required to address more than 40 input channels and use analog outputs to provide set points for motor speed control units used to automate the testing. The system also needed to log collected values and alarms for future analysis.

### The Solution:

Data Science Automation used National Instruments LabVIEW and SCXI data acquisition hardware to develop and application that allows the user to work with an interactive screen that looks like the product under test. The application allows the operator to control the test parameters and see the live results of the testing.

### Abstract:

Characterizing the pump's performance allows the customer to produce a superior product. The customer wanted a system that would reduce the amount of time needed to test each pump while it continued to collect as much data as possible for future off-line analysis. The solution needed to be cost effective and robust. Using state machine architecture, the solution provides the required functionality.

### The Details:

The client needed an application to automate the testing of a naval pump in a short period of time.

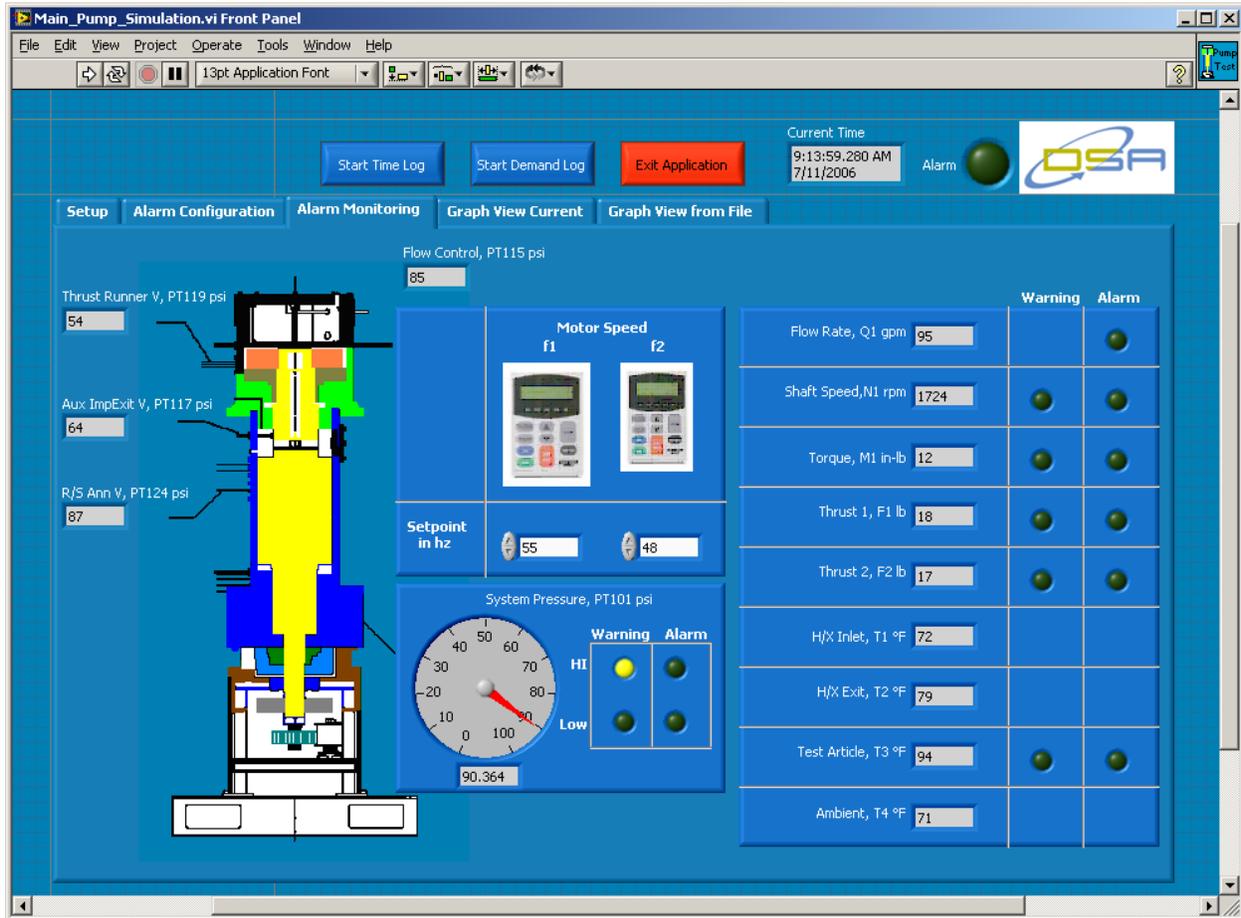


Figure 1. Alarm Monitoring Tab

The criteria for this testing was to monitor and log forty channels of incoming data acquisition. Of the forty channels seven needed to be compared to set points and trigger an alarm if the values went past their limits. The need for three separate logs to be generated at different intervals to maintain the data needed for closer review at a later time was also important. The three logs were a time log to keep a record over long periods of time, a demand log to log events at a much faster interval with a time out to automatically stop the log after a preset time limit, and an alarm log to capture data at the time of an alarm along with a text indicator that the value was in “Alarm” or “OK” for each monitored value. The application would need to provide a motor speed set point for the Variable Frequency Drive (VFD) controllers. The application would also monitor four temperatures.

Data Science Automation was selected to develop automated software to test the navel pump. The application monitors thirty-eight analog inputs and supplies two analog outputs. The analog inputs monitored are; four thermocouples, two load cells, twenty seven differential pressures, one absolute pressure, one flow measurement, one torque measurement, one motor current, and one motor speed. The analog outputs are a motor speed set point provided to the VFDs. The main screen shown in “Figure 1” shows the sixteen primary channels including the seven channels to be monitored for setting alarm conditions. The sixteen channels are; Thrust Runner V, Aux Imp Exit V, R/S Ann V, Flow Control, Motor Speed Feedback VFD 1, Motor Speed Feedback VFD 2, System Pressure, Flow Rate, Shaft Speed, Torque, Thrust 1, Thrust 2, H/X Inlet temperature, H/X Exit temperature, Test Article temperature, and Ambient temperature. The need for the automated test stand to monitor and act on several of these parameters during the testing was very important to determining proper pump functionality. The motor speed needed to be between 1700 and 1800 RPM through out the length of the test. If any of the monitored channels trigger an alarm the motor speed set point to the VFDs are sent a command to shutdown. All of the parameters to be

monitored are set by the user on an alarm configuration tab. Before the comparison of the data to the set points occurs the user must select the “Accept Configuration” button. The set point controls and the accept configuration are shown in “Figure 2”.

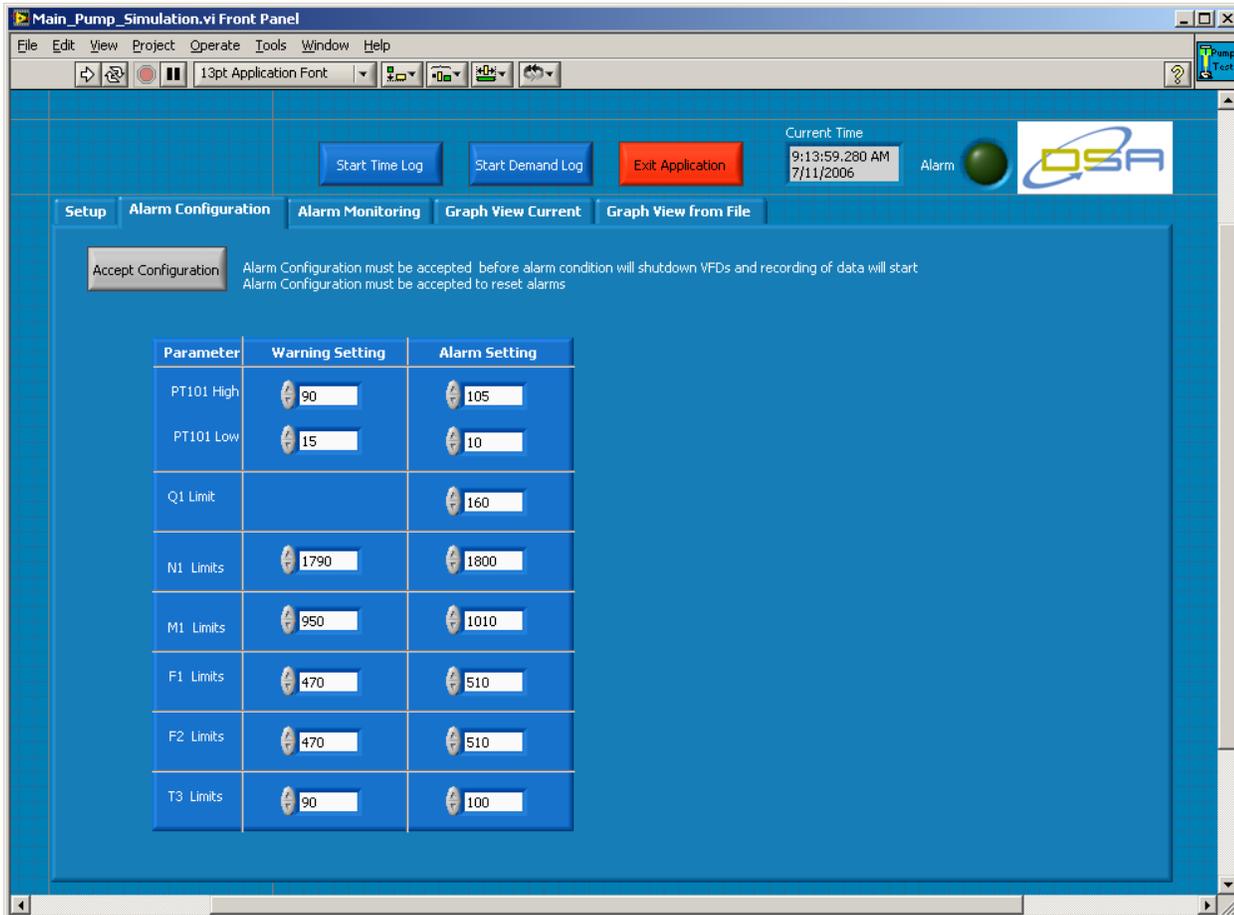


Figure 2. Alarm Configuration Tab

When the application is started the “Setup” tab shown in “Figure 3” is programmatically selected and a popup dialog box appears to inform the user that file paths, notes pertaining to the test, operator, and timing intervals need to be entered and accepted before the test can continue. The file save controls at the top of the application front panel will let the operator start and stop the logging of the test as they feel necessary. The demand log setup on the setup tab has a control to let the user select an amount of time for the log to acquire data before it automatically stops collecting data. The Time log will record data only when the time log button is pressed and will continue to log information until the time log button is turned off or the application is exited.

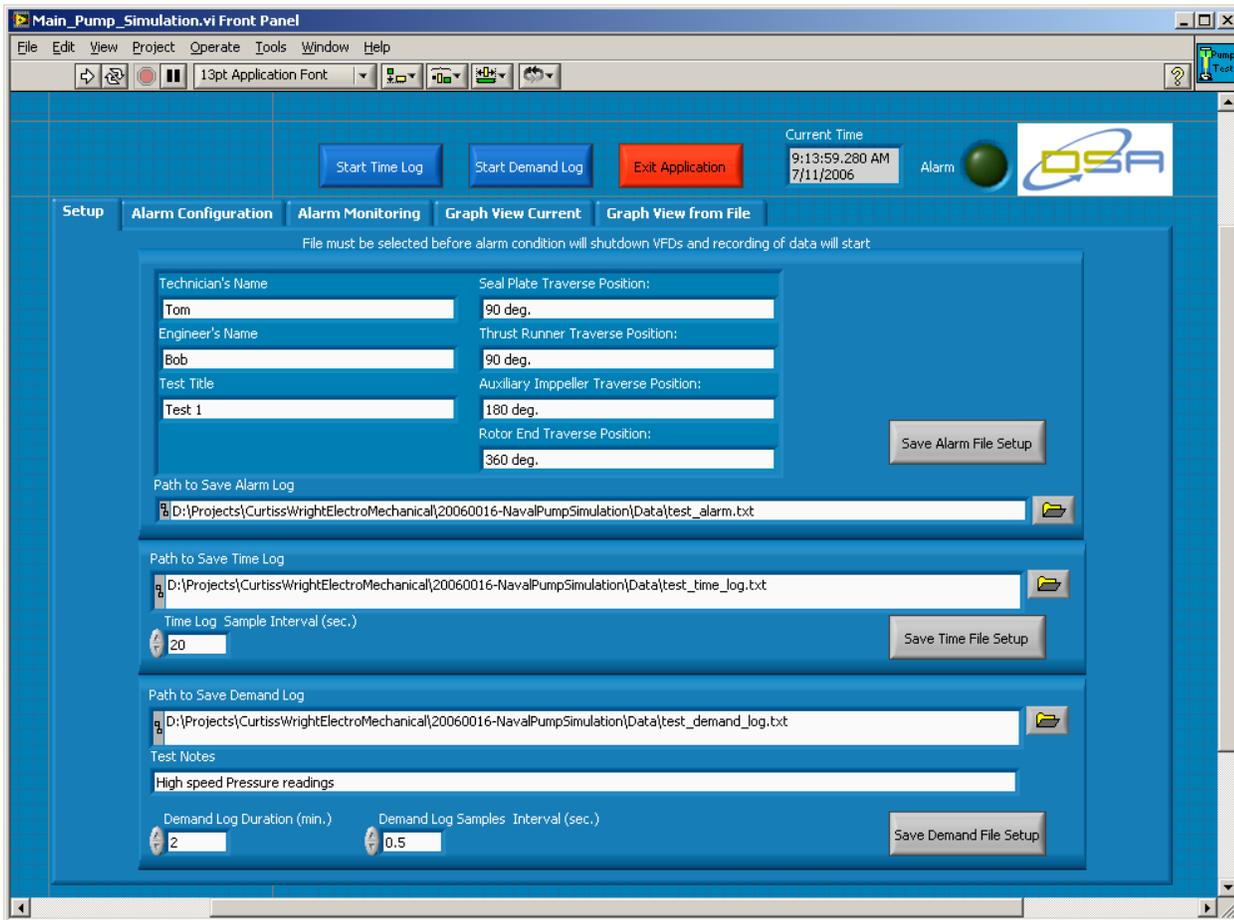


Figure 3. Test Configuration (Setup) Tab

The need to review the data being collected by the operator or a test controller was also necessary to validate design performance. There are two tabs for the operator to select from for this purpose. The first tab is called “Graph View Current” that allows the user to watch a trend of the data being acquired in real time. The second tab selection shown in “Figure 4” is the “Graph View from File” tab that allows the user or operator to select a previously stored file to be displayed as a trend.

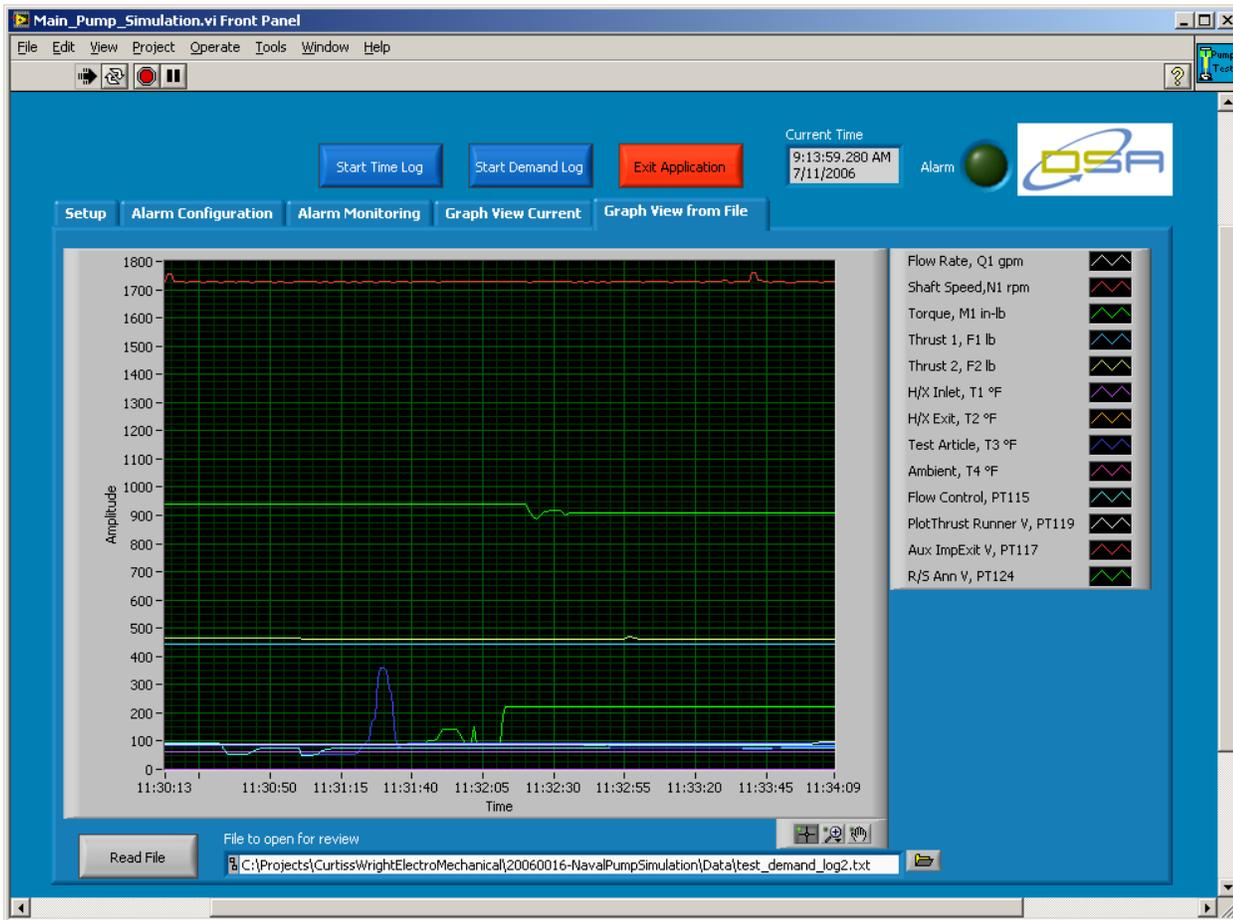


Figure 4. Graphical View of Data File

The operator can select the desired file by using the file path browse button to locate the file of interest then press the “Read File” button. This feature can be used to get a better look at data collected in a past test. The graph palette tools give the user an easy method of zooming in on a particular point of interest.

National Instrument’s software greatly simplified this project with the use of items like the graph palette tools and use of the state diagram editor. The overall architecture for this application was a state machine due to its flexibility and ease of modification for other future enhancements to the application.

### Summary

LabVIEW’s capability to control instruments and conduct data acquisition made the application developed by Data Science Automation a success. The ease of use that LabVIEW offers reduced the overall time to create and document the graphical code used for this application. This was a great help due to the limited amount of time available for this code to be delivered to the customer.