NVSI
NEO VISTA SYSTEM INTEGRATORS

User Solution: Environmental Chamber Monitoring and Control

Document Authors: Liam Granger, Christopher G. Relf and Ralph Dick Document Release Date: 4th November, 2003

The National Standards Commission (NSC) performs pattern approval type testing on measuring instruments used for trade purposes in Australia. Part of this process involves the use of temperature and humidity controlled environmental chambers. This project relates to a chamber which in extended form has a volume of $34m^3$. Achieving reliable controlled environmental conditions has proved difficult in the past, as the previous system would require approximately 24 hours to stabilize to 20°C at 50% relative humidity. The previous system was controlled by a hardwired micro controller, and relied on outdated electronic control systems.

The Solution

The NSC requested a general improvement to the environmental control parameters, with database control and comprehensive data logging features, which proved impossible with currently available low-cost off-the-shelf solutions. The NVSI Pty Ltd environmental control solution was written in LabVIEW RT, running in a FieldPoint module FP-2010. Control of system was achieved using several LabVIEW real-time PID controls in order to achieve steady-state temperature and humidity set points. Other hardware used to achieve the solution included several National Instruments components and a custom NVSI temperature and humidity environmental monitoring network node system.

- NI FP-RTD-124, 4 Wire RTD Input Module, 8 Channel, 16 Bit
- NI FP-RLY-420 8-Ch. SPST Relay Output Module
- NI FP-PG-522, 8 Channel Pulse Generator Module
- NI FP-DO-401 Discrete Output Module
- NI FP-DI-330 Universal Discrete Input Module
- NI FP-AI-110 Analogue Input Module, 8-Channel, 16-Bit
- NVSI EnviroMON Ethernet Base, with temperature and pressure sensors

The solution is database driven, leveraging an existing NSC SQL database on site - which interfaces to the code using the LabVIEW database connectivity toolkit. All tables and stored procedures used in this project were created in a generic format to allow a simple transition to other projects with NSC. A GUI developed with Microsoft Access was used to create a test profile.

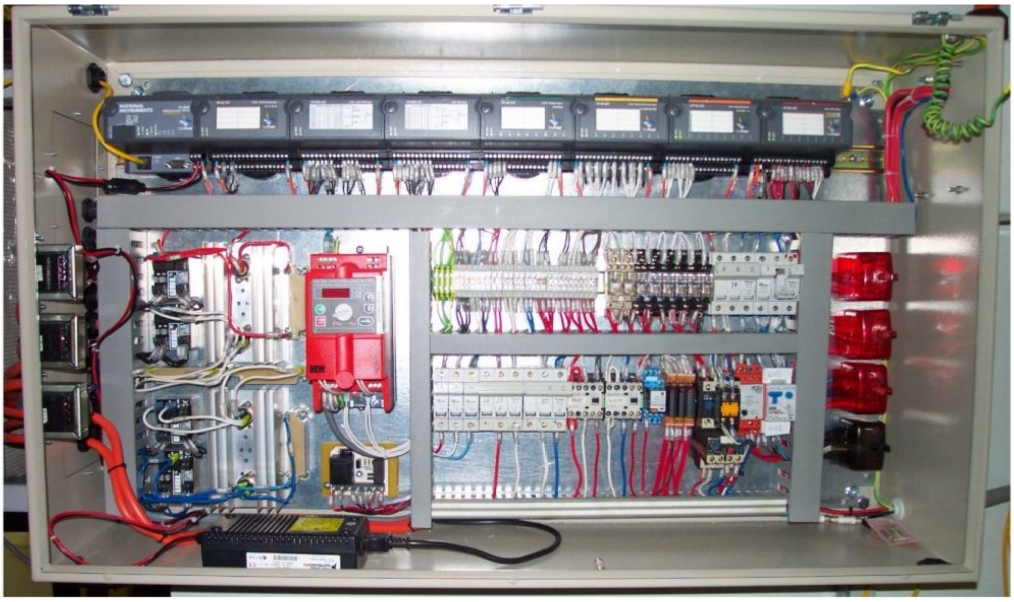
Tests typically consist of several legs, with each leg containing one or more physical parameters (eg: temperature and relative humidity), along with test conditions including wait time, reach time and stability required. The parameters to be recorded are also defined using the GUI, and a database table is dynamically created to store acquired data when a test is selected. Data pertaining to measurement system components (called tags) are also stored in the database. For example, RTD fit curve types and data and raw and reference calibration data are stored in the database and are called up and read in at start-up. Furthermore, a separate application used to manage tag calibration is used to write new calibration values to the database after calibration. This system provides easy access to historical calibration data which is used to for evaluation of component performance and associated measurement uncertainty.

Temperature set points were attained to an accuracy of ±0.1K, an order of magnitude of improvement over the previous system. Some filtering (modified Savitzky-Golai) was included to limit the noise produced by the rapid movement of air within the chamber. Three PID loops were used to set the temperature: one for overall control of the temperature, but with a further two PID loops required for biasing. These biasing loops were present to ensure that there was a temperature differential throughout the physical control system. Biasing of at least 0.5K was present between the heater and the cooler, and further biasing of at least 2K was set up between the return temperature and the heater. This biasing ensured a more constant flow of air over the chamber – removing pockets of warm or cool air, whilst keeping the system loaded to reduce lag time. The relative humidity (RH) set point was met with an accuracy of ±1%, again an improvement of an order of magnitude. Humidity control was achieved using two PID loops - one driving the production of steam, the other controlling the amount of scavenging of water from the chamber using refrigeration. After initial investigation, it was found that using the RH as a process variable within the PID loops was far too sensitive to changes in the temperature (a change of 0.1K equates to a change in relative humidity of approximately 0.5% at room temperature, a challenging task indeed).

The impact of this inherent relationship between temperature and relative humidity resulted in control of the systems being limited to ±0.5K for temperature and ±3% for relative humidity. Whilst these values were within the tolerances required for the project, it was found that the system was fighting itself in order to maintain control. For example: if a minor increase in temperature was required, a corresponding rise in humidity would also be required - achieved through the increase in the refrigeration to scavenge water out of the system. This issue was avoided by converting the RH set point to absolute humidity (AH) - and using this value as the basis for the addition or removal of water into the atmosphere inside the chamber (a change of 0.1K has an almost negligible affect on the absolute humidity, making it much simpler to control). In the example described above, if an increase in temperature was required through the use of increased heating, there would be no change to the AH level so no changes would be made to the level of scavenging required by the refrigeration. Note: if the AH was at the required level and an increase in temperature was required, then the RH level would be slightly below the required level and would rise with the temperature as a result of the heating.

Conclusion

The previous NSC solution was replaced with a real-time Field Point based system, which achieved an order of magnitude improvement in both temperature and humidity monitoring and control, and increased the response time of the system from 24 hours to 30 minutes. The new system is easily configurable using a database front-end, and can be quickly altered using the LabVIEW RT IDE and Field Point hardware.



Neo Vista System Integrators Pty Ltd

Australia
Telephone: 02 9809 7899 +61 2 9809 7899
Facsimile: 02 9809 7499 +61 2 9809 7499

Email: info@nvsi.com.au
Web: www.nvsi.com.au

Address: 35 Devlin Street
Ryde NSW 2112
Australia

Neo Vista System Integrators Pty Ltd
ABN 36 104 387 046 ACN 104 387 046

New Zealand
Telephone: 09 813 0702 +64 9 813 0702
Facsimile: 09 813 0703 +64 9 813 0703

Email: info@nvsi.co.nz
Web: www.nvsi.co.nz

Address: 59B Glenview Road
Glen Eden Auckland New Zealand

Neo Vista System Integrators Pty Ltd
GST 85-612-964

Document Design: Christopher G. Relf
Incidental Graphics: digitalblasphemy.com