Design and Implementation of Detector Signal Simulator Templates for the Development and Testing of the Hall C Neutral Particle Spectrometer's Phoebus Alarm System

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For the development and testing of the Phoebus alarm system of the Hall C Neutral Particle Spectrometer (NPS), a detector signal simulator created using templates that simplify the design, implementation, and customization of the simulator has been implemented. Each of the 12 templates is dedicated to a particular signal type.

The NPS hardware interlock system [1] [2] reads the detector's environmental and cooling signals. Configured as an EPICS client, the hardware interlock system transmits the process variables (PVs) via the network, using EPICS Channel Access (CA), to the hardware interlock system's EPICS softIOC server, which hosts the PVs and makes them available on the network via EPICS CA. The Phoebus alarm system, an EPICS client application, monitors PVs on the network sourced by EPICS input/output controllers (IOCs) for alarm conditions.

For stand-alone testing of the Phoebus alarm system [3], a server hosting the hardware interlock system's EPICS PVs based on the detector signal simulator has been designed, developed, and implemented. The simulator, a host-based EPICS softIOC, resides within the test station development computer and operates on the Phoebus alarm test station [4], Fig. 1.
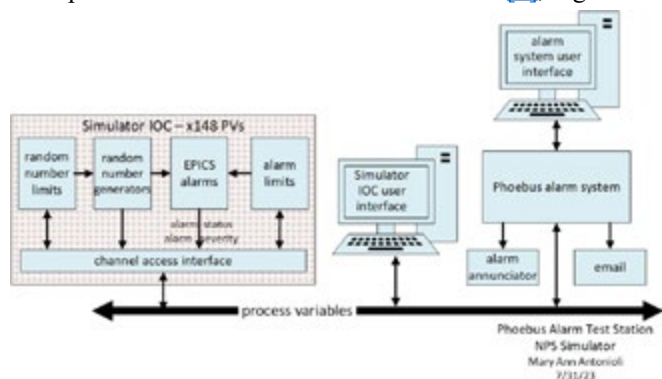

FIG. 1. Phoebus alarm test station, NPS simulator.

For developing the EPICS databases, templates were designed with the Visual Database Configuration Tool (VisualDCT)—a graphical design environment written in Java, which enables developers to view and edit the data connections between EPICS records within the database.

The crystal array thermocouple template [5] has a group of EPICS records that are common for the generation of all the 112 thermocouple PVs and contains the initial parameters for the generation of the simulated thermocouple signals—temperature range, minimum value, and signal data rate—and the PV alarm limit values of HIHI, HI, LOW, and LOLO.

In all, 12 templates, Table 1, support the generation of 148 simulated detector signals.

Template name	Signal type	PV qty
Crystal Thermocouples	temperature	112
Detector Frame Temps	temperature	4
Detector Frame Humidity	humidity	4
Detector Frame Dew Points	dew points	4
Electronic Zone Coolant Temps	temperature	8
Crystal Zone Coolant Temps	temperature	4
Hall Temperatures	temperature	2
Hall Humidity	humidity	2
Hall Dew Points	dew points	2
CZ and EZ Chiller Temps	temperature	2
CZ and EZ Chiller Flow	flow	2
CZ and EZ Chiller Pressure	pressure	2
	total	148

TABLE I. Detector simulator templates.

Upon starting the signal simulator softIOC, the application startup script uses the 12 database templates and a text substitution file, which contains the number of signals to be generated for each template and the specific PV alarm information needed to create the database. After the creation of the database, the startup script initializes the database and starts the simulation of the detector signals, Fig. 2, enabling the software test of the alarm system.

The controls and monitoring for the simulator softIOC, EPICS PV alarm limits, and the monitoring of PVs for alarms is integrated into the user interface screen, Fig. 3. For each of the 148 simulated detector signal values displayed on the screen, there are 14 control or monitoring PV values. Each of these PVs can be edited to adjust the simulated signal values, set EPICS alarm limits, and monitor the alarm status and alarm severity. The alarm system has been tested [6] by checking whether the system reacts correctly to alarm conditions generated by the simulator.

In conclusion, for the development and testing of the Phoebus alarm system, a detector signal simulator created using templates that simplify the design, implementation, and operations has been implemented and tested successfully.
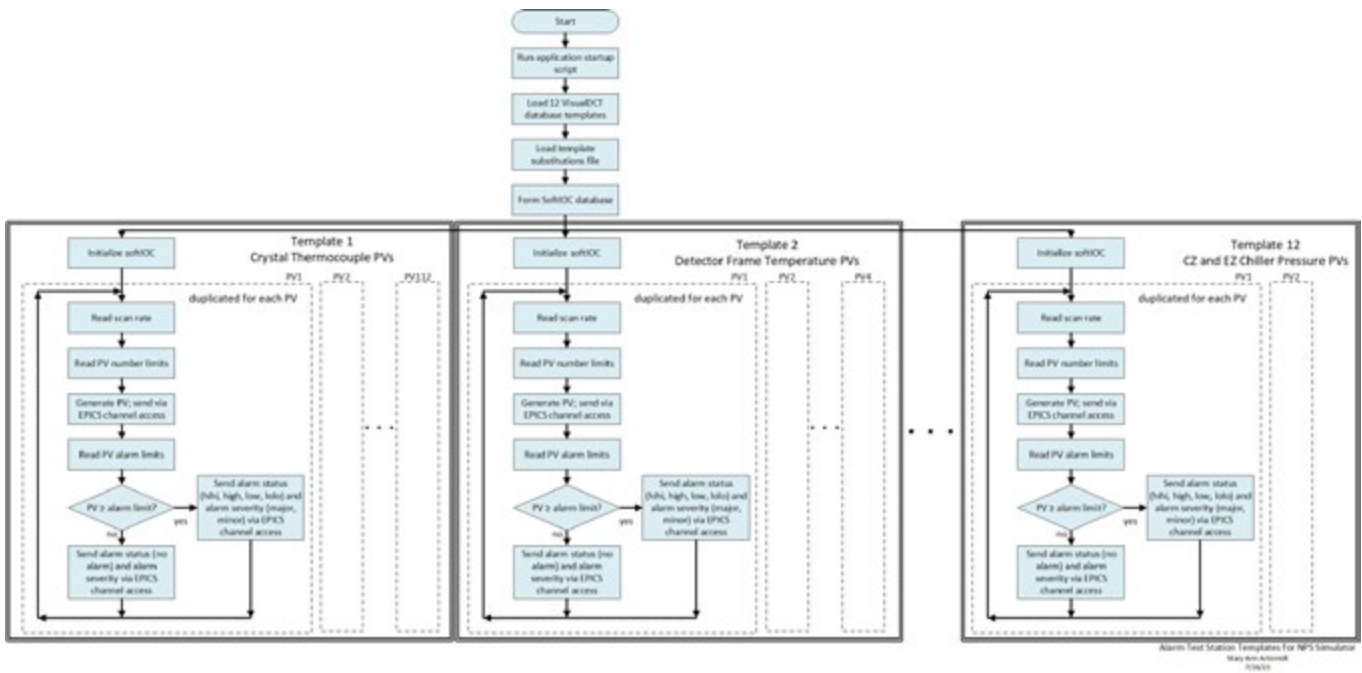
FIG. 2. Signal simulator templates.

FIG. 3. Simulator softIOC and alarms user interface.

[1] P. Bonneau, et al. *Hardware Interlock System for the Hall C Neutral Particle Spectrometer*, DSG Note 2021-15, 2021.

[2] P. Bonneau, et al. *Program for the Hardware Interlock System of the Hall C Neutral Particle Spectrometer*, DSG Note 2021-21, 2021.

[3] P. Bonneau, et al., *Proposal to Implement Alarm System in Control System Studio Phoebus for the Hall C Neutral Particle Spectrometer*, DSG Note 2021-37, 2021.

[4] P. Bonneau, et al., *Development of the EPICS Software Input/Output Controller for Testing the Phoebus Alarm System of the Hall C Neutral Particle Spectrometer*, DSG Note 2022-06, 2022.

[5] P. Bonneau, et al., *Detector Signal Simulator for Testing the Hall C Neutral Particle Spectrometer's Phoebus Alarm System*, DSG Note 2023-23, 2023.

[6] P. Bonneau, et al. *Testing of the CS-Studio Phoebus Applications and Alarm System Core Programs*, DSG Note 2023-06, 2023.