National Institute of Standards and Technology
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NBSR SECONDARY COOLANT FLOW CONTROL SYSTEM

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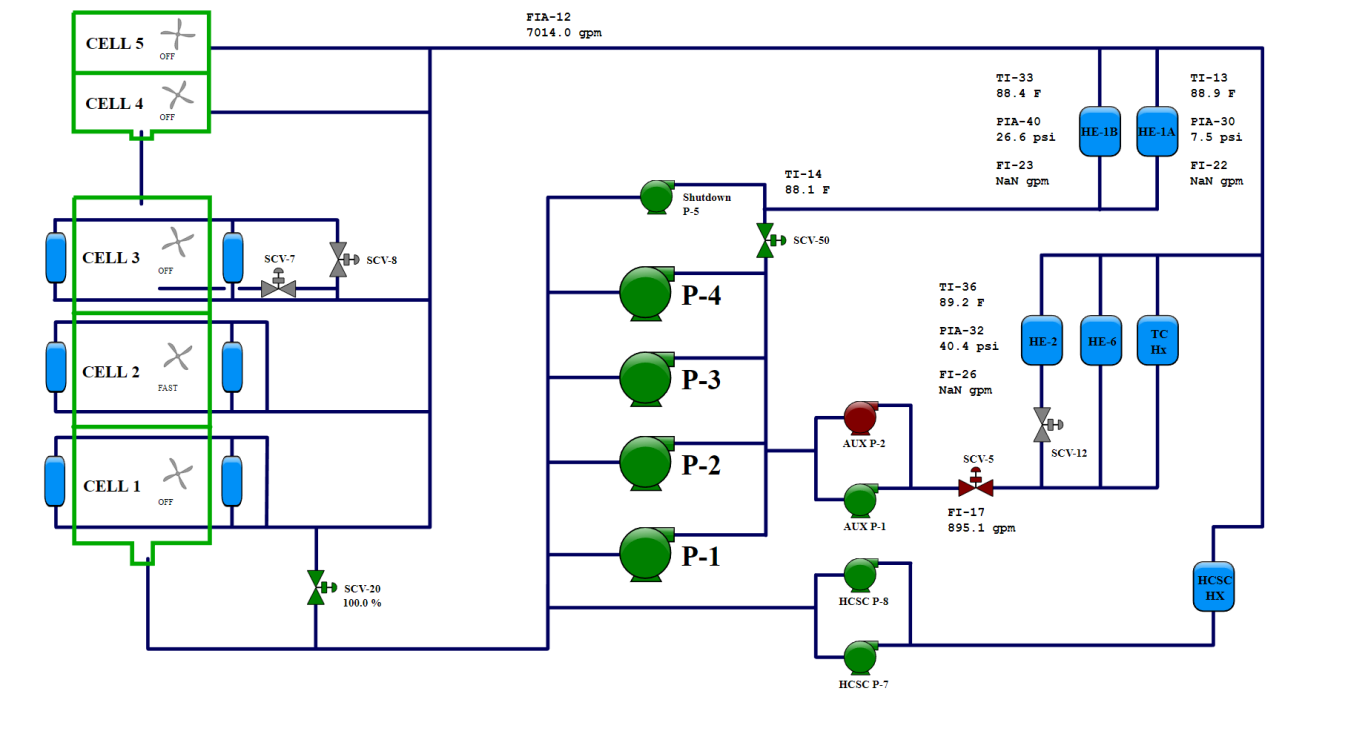
Disclaimer

Certain commercial equipment, instruments, or materials are identified in this study in order to specify the experimental procedure adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the materials or equipment identified are necessarily the best available for the purpose.

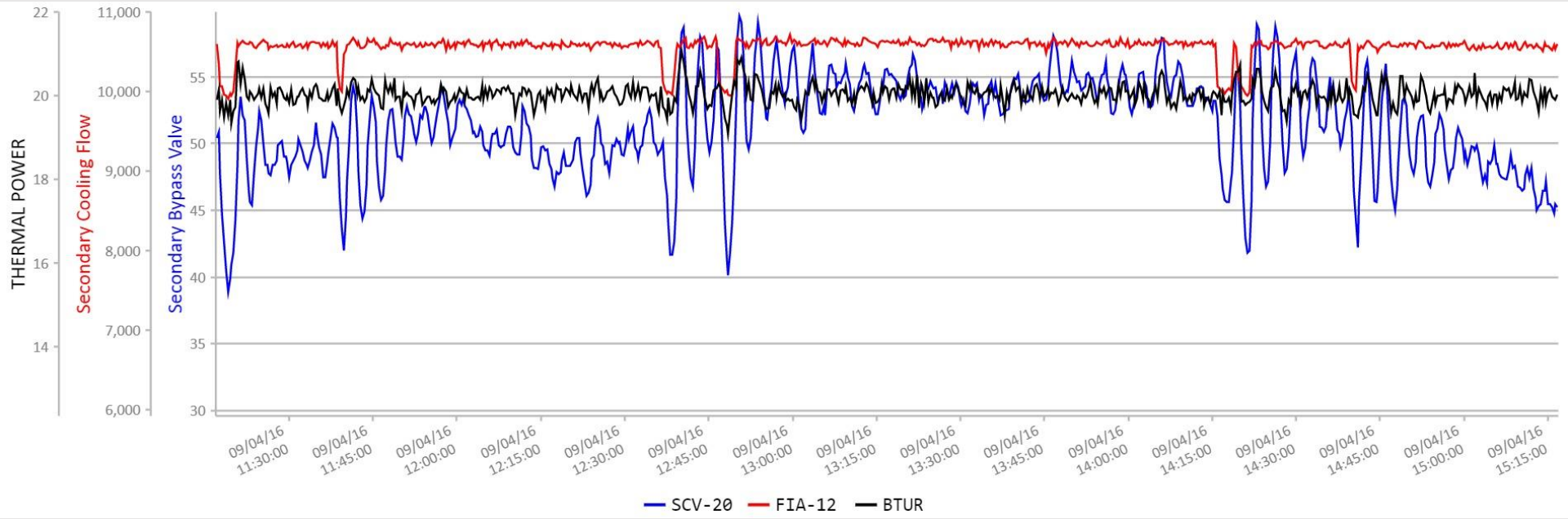
NIST NCNR



Secondary System

- Flow fluctuates when pump speeds are fixed
- Strainers backwashing reduces flow ~600 GPM
- Secondary HE inlet temperature increases
- Primary Reactor inlet temperature increases
- Strainers backwash completes, increases flow back
- Secondary HE inlet temperature decreases
- Primary Reactor inlet temperature decreases
- Instantaneous thermal power indication fluctuates

What is Happening



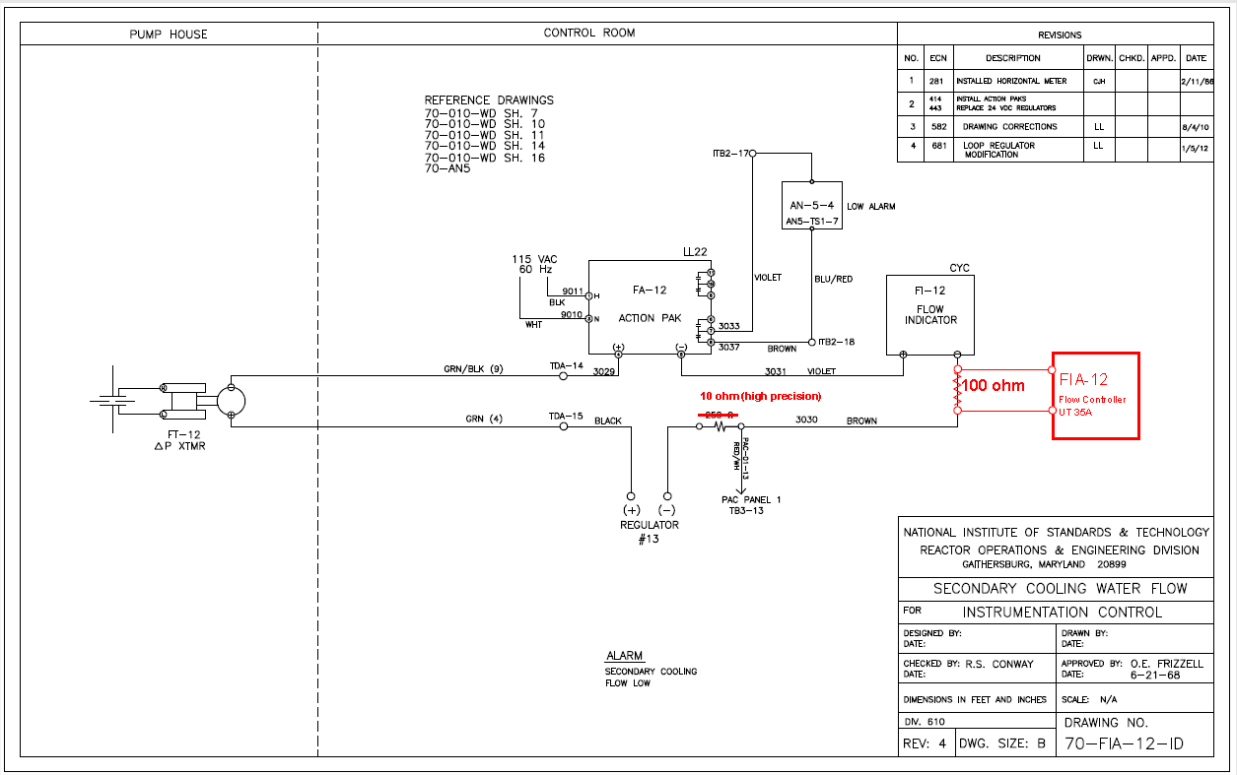
What is Happening

- Measure the VFD frequency deviation required to overcome flow disturbances
- Measure limiting safe operation limits
- Implement Engineering Controls
- Install a PID control system with pump selection
- Perform testing

Solution

- The pumps can only be started/or stopped by manual controls
- RO adjusts total secondary flow set-point on the PID controller.
- RO selects a pump to operate in auto-mode.
- RO uses A/M switch to enable automatic control.
- Secondary scada system monitors PID settings through tcp/modbus.
- The calculated output frequency is transmitted from the PLC analog output module.
- Pump VFD receives the change in its reference signal and adjusts the motor speed.
- system increases/decreases the pump frequency (within 47 Hz to 55 Hz interval) until the secondary flow is within 100 GPM of the set-point. The average standard deviation (σ) in the secondary flow measurement is 50 gpm, a change of 2 σ (68%) assumed to be significant enough for changing pump speed.
- The adjustments for pump speed can only be controlled within the 47 Hz to 55 Hz band by the secondary scada system script and the pump VFD.
- Operator selects which pump to use in auto mode (pump 3 or pump 4). When a pump is selected, the other pump is set to default speed, i.e. 47 Hz.

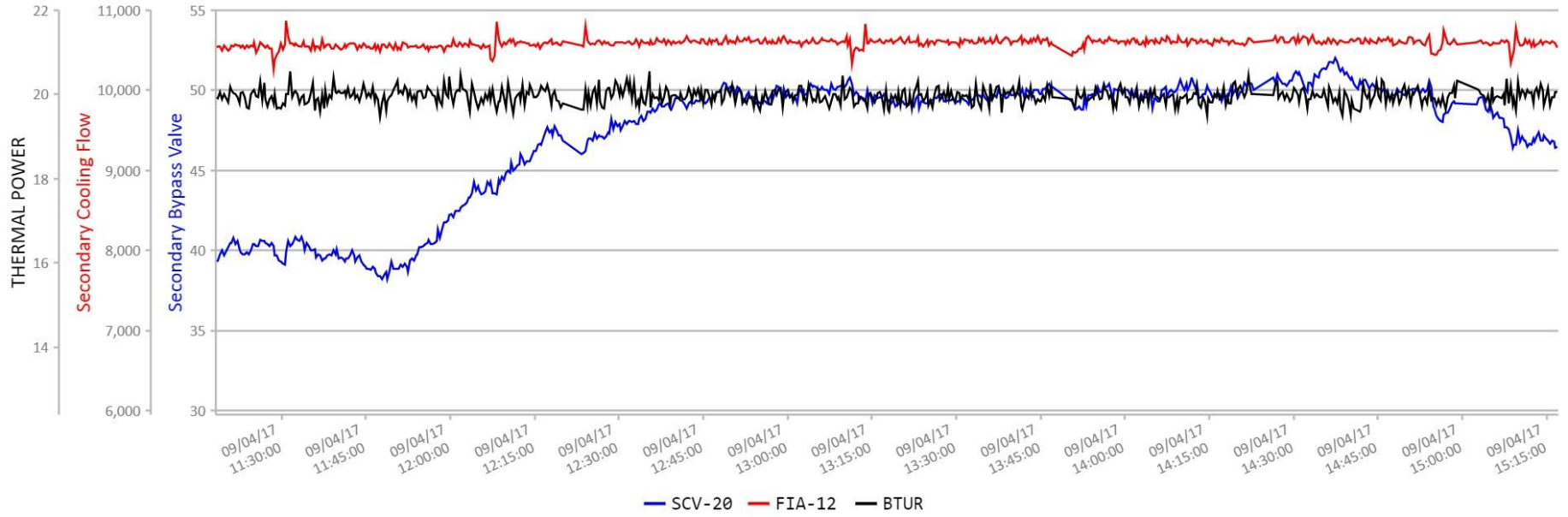
Operating Principle



Flow Control Loop Changes

- 1-23 Motor Frequency – 60 Hz
- 4-14 Motor Speed High Limit (Hz) 56
- 4-12 Motor speed low limit (Hz) 47
- 4-19 60 Hz, Drive max output frequency
- 3-02 Minimum Reference 40 Hz
- 3-03 Maximum Reference 60 Hz
- 3-13 select remote reference?
- 3-15 Reference 1 source select to Analog input 53 (1)
- 6-12 Terminal 53 Low Current 4 mA
- 6-13 Terminal 53 High Current 20mA
- par.6-14 Terminal 53 Low Ref./Feedb. Value 40 Hz
- par.6-15 Terminal 53 High Ref./Feedb. Value 60 Hz

VFD SETTINGS


THERMAL POWER
Secondary Cooling Flow
Secondary Bypass Valve
22
20
18
16
14
11,000
10,000
9,000
8,000
7,000
6,000
55
50
45
40
35
30
09/04/17 11:30:00
09/04/17 11:45:00
09/04/17 12:00:00
09/04/17 12:15:00
09/04/17 12:30:00
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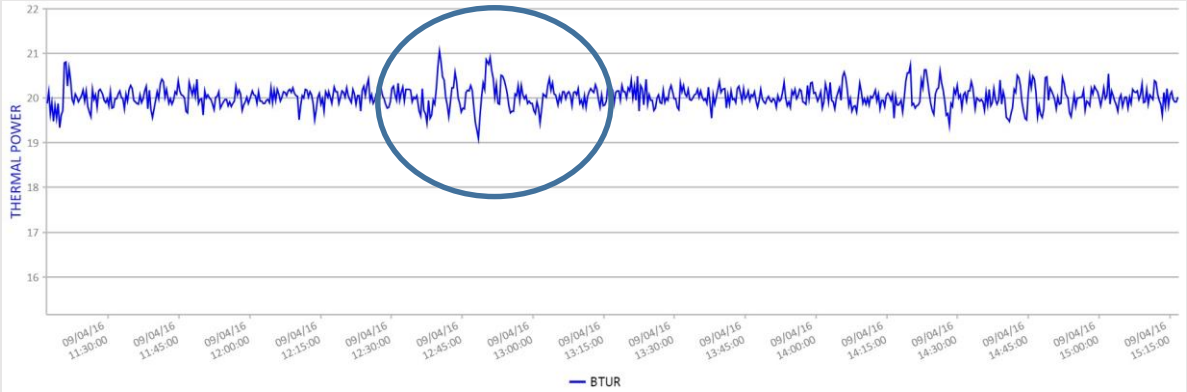
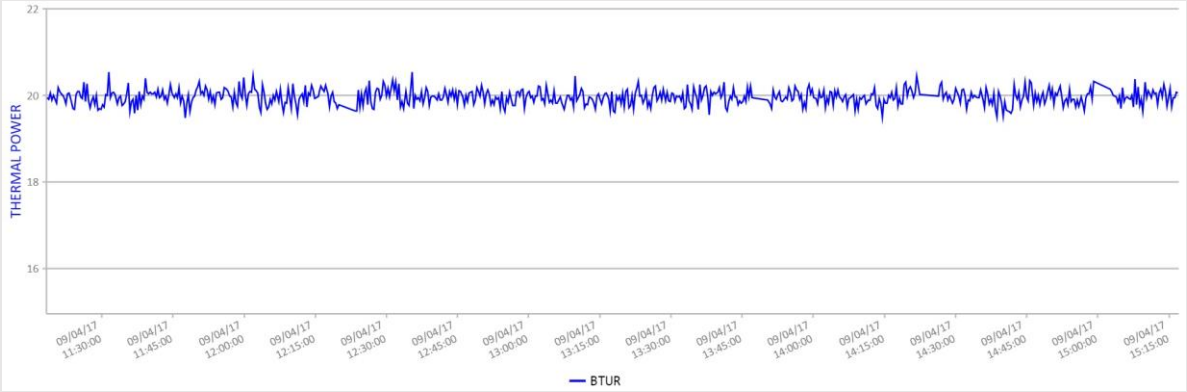
09/04/17 14:15:00
09/04/17 14:30:00
09/04/17 14:45:00
09/04/17 15:00:00
09/04/17 15:15:00
SCV-20
FIA-12
BTUR

RESULT

BEFORE



AFTER



RESULT

- Implemented flow control for secondary loop
- Enables pump selection for auto control
- VFD and flow are limited by engineering controls via VFD limits and scada
- Resolved fluctuations of the thermal power indication

DISCUSSION

- Any questions, comments?????

Thank you for your time