

Simulation-based Training Systems

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What is a pipeline controller training simulator?

It's like a flight simulator but for a pipeline

Controllers operate a computer-based virtual pipeline simulation

Controllers are tasked to recognize and respond to (ab)normal events in the simulation and return the virtual pipeline to equilibrium

Just like flight simulators, there are various levels of complexity (= cost!) that can be incorporated



Why install a training simulator?

New pipeline, unfamiliar operations

Existing pipeline, new controllers

Protect your assets with educated controllers

- **Equipment**
- **Operating efficiency, product contamination**

Protect your other  assets

- **Public confidence, environmentalists**
- **Mitigate incident liability, federal oversight**

Legislation

- **Operator Qualification (1999), implemented by 2002**
- **Response to Pipeline Inspection, Protection, Enforcement, and Safety (PIPES) Act (2006)**

OQ, October 2002, 49 CFR195 Sub-part G

The rule focuses on controllers being qualified to perform "covered tasks". To determine if any one task is covered under the rule, a four-part test is applied:

1. Is the task is performed on a pipeline facility?
2. Is it an operations or maintenance task?
3. Is the task is being performed as a requirement of the rules governing transportation of natural gas or hazardous liquids by pipeline?
4. Does the task affect the operation or integrity of the pipeline?

The COOQs prepared the industry broth (API 1161)

Cited Methods for “Qualification”

Written examination

Oral examination

Work performance history review (now obsolete)

Observation during:

- Performance on the job
- On the job training
- **Simulations**

“Other forms” of assessment

PIPES Act 2006, Section 19

Not later than June 1, 2008, the Secretary of Transportation shall issue standards that implement the following recommendations contained in the NTSB's report entitled "Supervisory Control and Data Acquisition (SCADA) in Liquid Pipelines" and adopted November 29, 2005:

- 3) Implementation of standards for pipeline controller training that include simulator or noncomputerized simulations for controller recognition of abnormal pipeline operating conditions, in particular, leak events.

www.nts.gov/publictn/2005/SS0502.pdf

PIPES Act 2006, Section 19

API & AOPL responded to PHMSA with:

- Existing OQ requirements at tasks 43 and 44 already address the skills control room operators are to demonstrate, many of which are met through **simulator** use. We anticipate that PHMSA's own work on examining controller certification issues will also inform any response to this recommendation.

www.api.org

- About Oil and Natural Gas
- Industry Sectors
- Pipeline
- API-AOPL Comments to PHMSA regarding NTSB Recommendations on Control Room Operations

So you want a training simulator – now what?

We've been through some of the “why”s

Now let's consolidate these into requirements

What assets do you control?

- A couple of pipelines < 300 miles total?
- Many pipelines > 1,000 miles total?
- Somewhere in between?
- How many controllers do you have on staff?

It costs real money to build these things

- Shape your requirements to your likely budget
- Can the pipeline models be used for something else?
Facility planning? Surge analysis?

Building your requirements

How “real” is the virtual pipeline reality presented to the controllers in the training environment?

The controller interface?

- hardware / software configuration

How many concurrent training sessions?

- just one controller?
- a classroom full?

What’s under the hood?

- pipeline model scope
- control environment
- simulation functionality

How do you maintain the environment?

The controller interface to the virtual pipeline

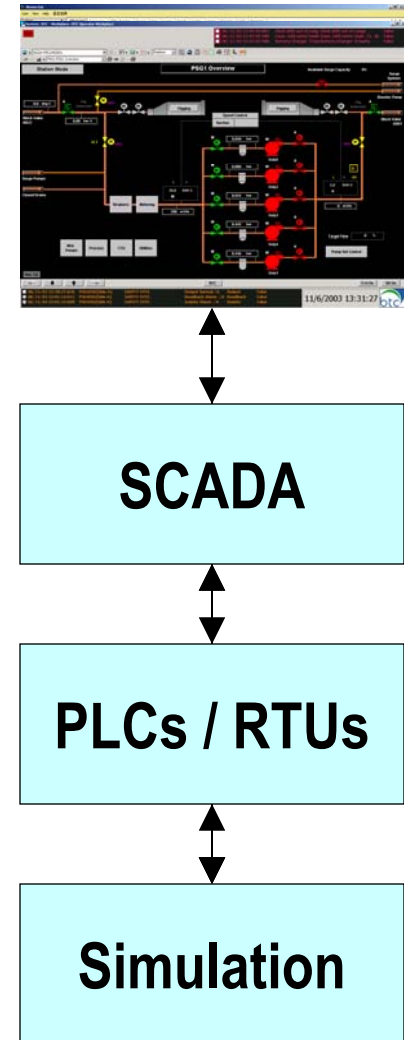
Will a graphical interface that “looks like” your SCADA suit your needs?

- look and feel
- screen navigation
- alarm management
- control environment

Do you use a **duplicate** of the control center SCADA host system?

Do you use a **duplicate** of the field intelligence (PLCs / RTUs)?

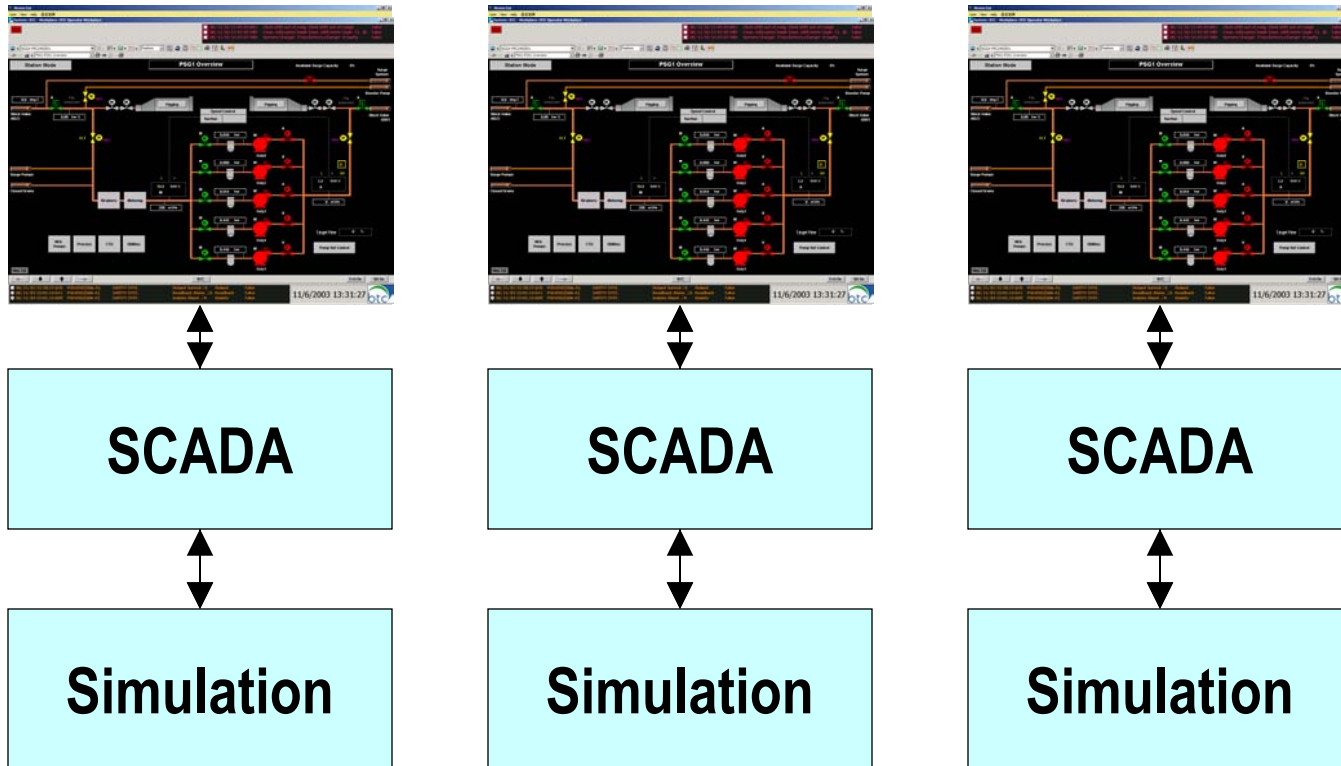
- “you’ve got to be kidding me!”
(J. McEnroe)



Concurrent training sessions

Do you want classroom training?

If so, you need to provide the same controller interface to all trainees

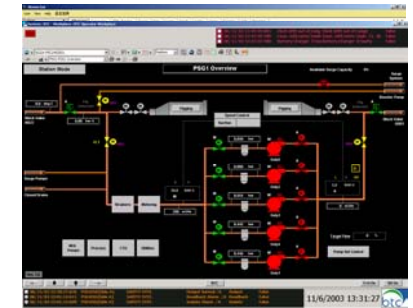
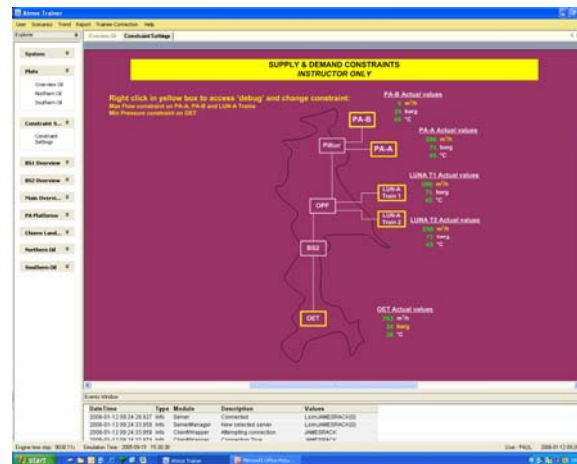


Instructor interface

How are training sessions initiated?

- controller, self taught review
- instructor, formal test

The more IT components involved, the more complex the session setup will be



SCADA

Simulation

Session initiation

Just a couple of further comments here if you elect to install a training simulator coupled to a duplicate of your SCADA system:

Time-based functions of your SCADA

- **What happens if you run the simulation at a multiple of real-time ?**

History. Most control desks will have a trend of, say, the last hour of pipeline data

- **What happens when the training session starts ?**
- **Where does that history come from ?**

What's inside that "simulation" box ?

There's a hydraulic model simulating the equipment and what's going on in the pipeline

Is this a model of your actual pipeline ?

Is this a model of a generic pipeline ?

Is this a model of a generic pipeline that includes challenging aspects of your own operation ?

- flying switches
- elevation changes
- product blending

Do you extend the model into adjacent tank farms ?

What's inside that "simulation" box ?

Control simulation capability is critical (if you're not using actual PLCs in your training simulator configuration!)

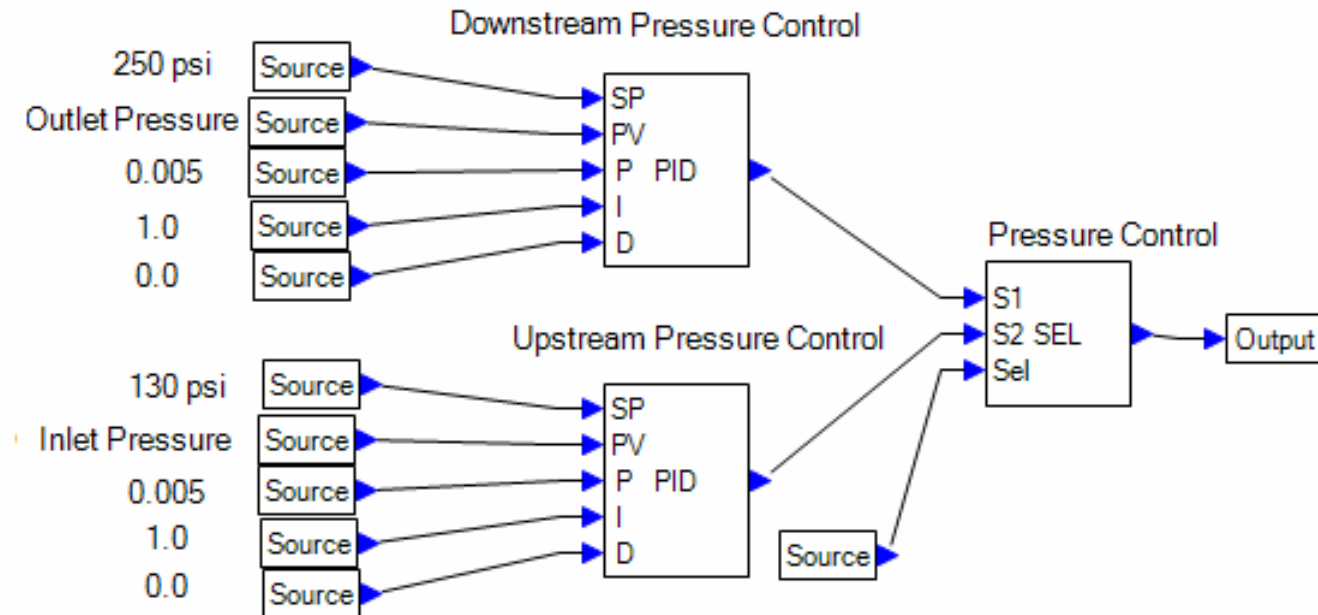
What fidelity of field control simulation do you need?

- **station control – absolutely**
- **MLBV control – most probably**
- **cause & effect simulation - possibly**

Station control - absolutely

Station control automatically regulates the discharge pressure at the station

It will likely involve control of pumps and / or actuator-controlled valves



MLBV control – most probably

Controllers will likely issue SCADA commands to open and / or close MLBVs

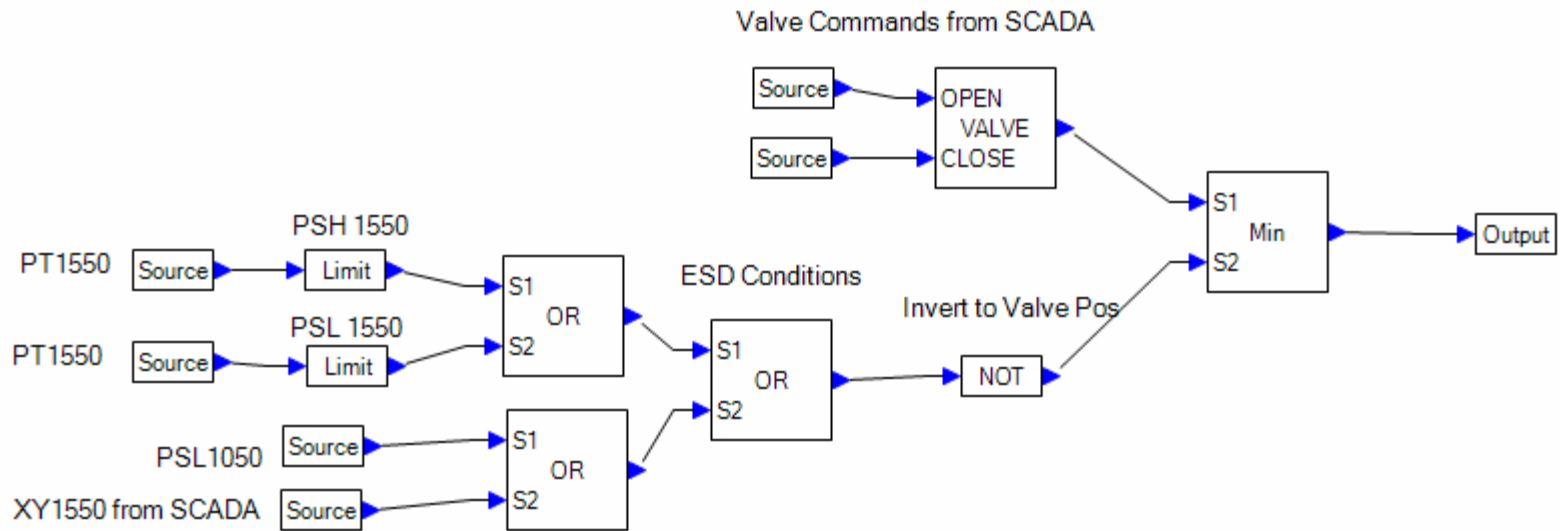
The necessity to include these in a training simulation environment depends on your operating procedures

For example, in the event of a suspected release do your procedures specify:

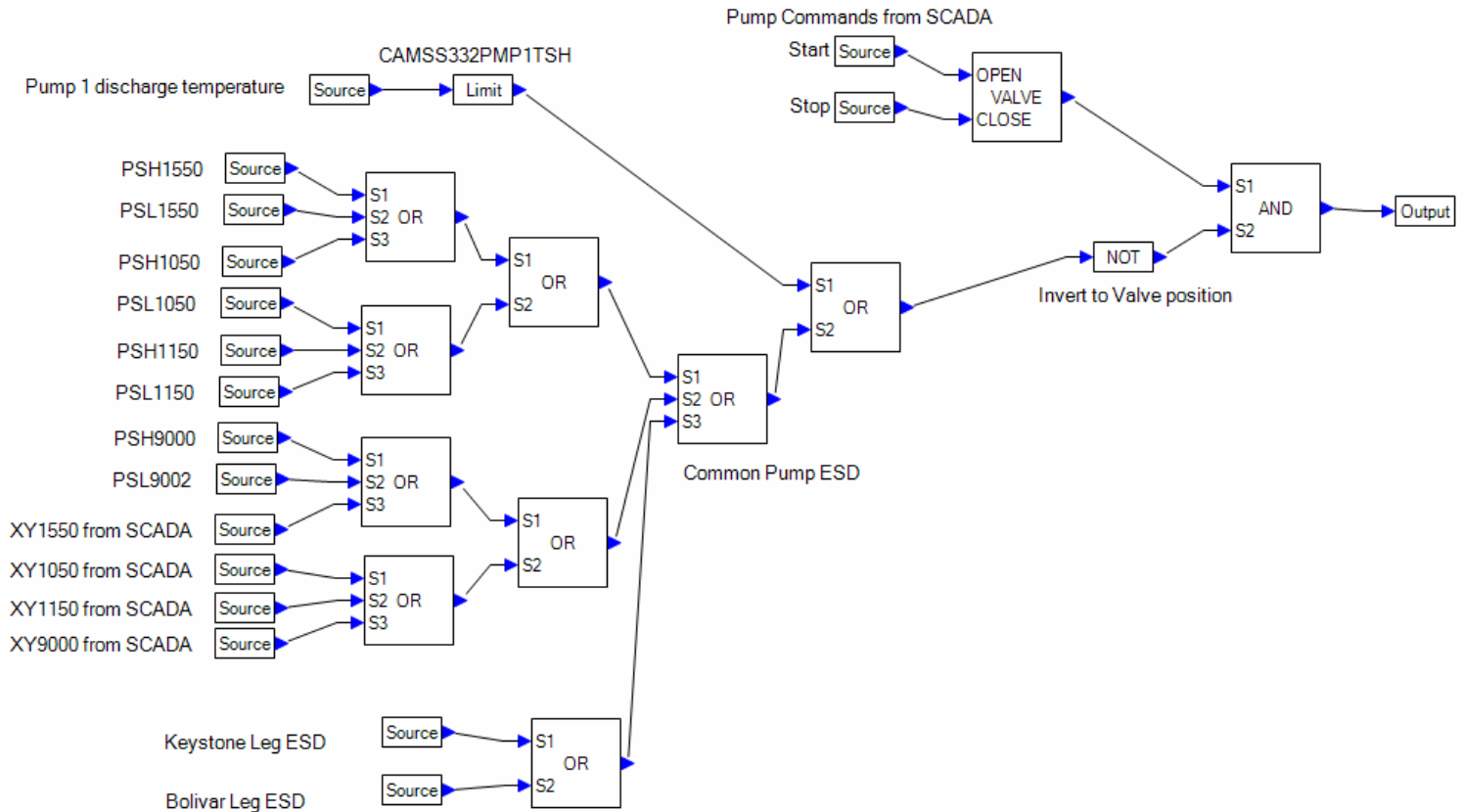
- manually shut down all stations and close all MLBVs, or
- **shutdown station upstream of the release, THEN wait for the suction pressure at the downstream station to approach minimum, THEN close selected MLBVs, or**
- just hit the PANIC button

MLBV control with overrides

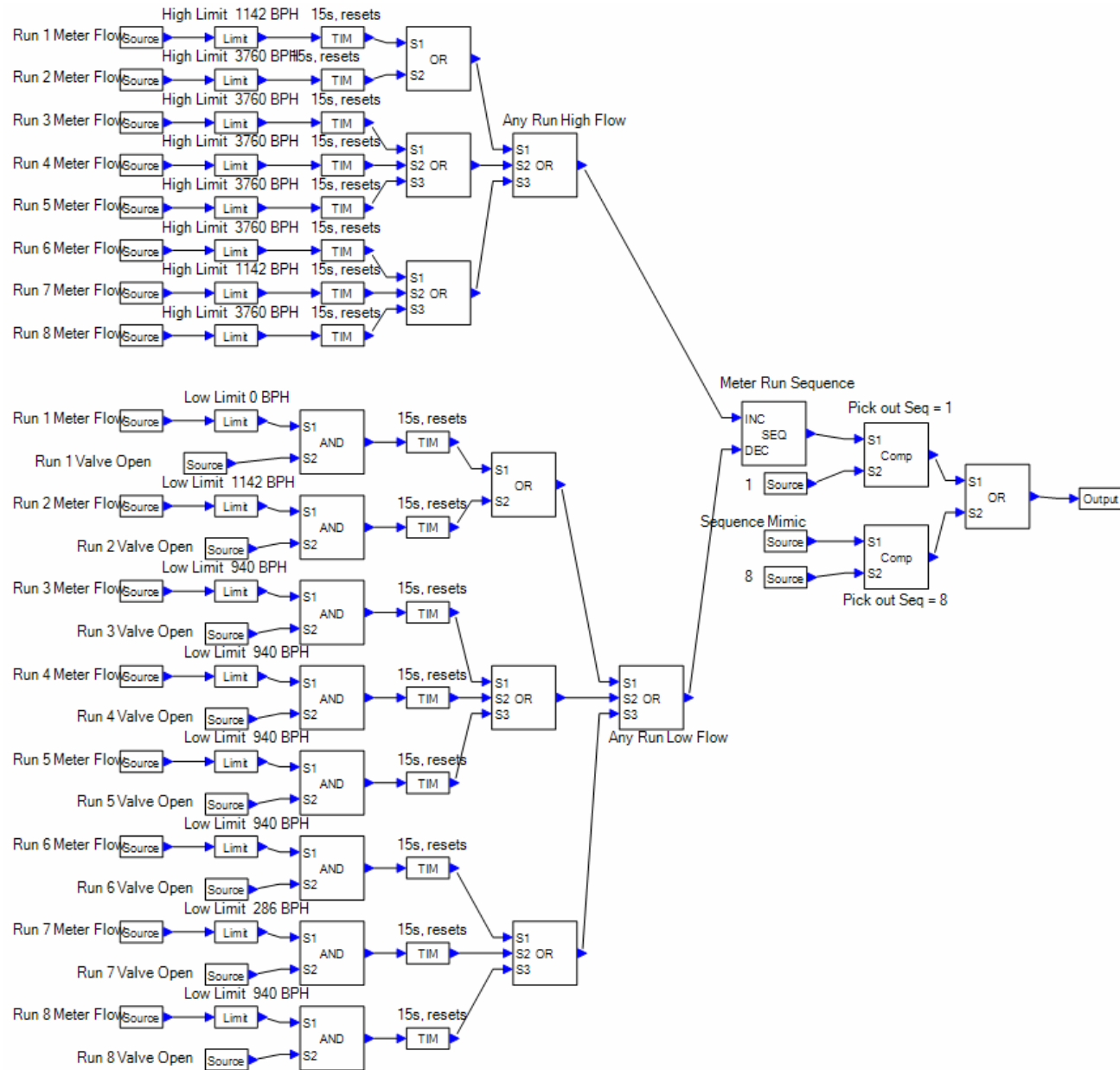
In this case, logic is built into the simulation to override operator action in the event of an emergency



Pump control with ESD logic



Meter run switching logic



Applications in the training environment

In your operational environment, controllers have specific applications to help them with their job

- leak detection
- batch tracking
- flow path verification
- tank farm management

Do you provide these same applications in the training environment ?

Are they third-party applications or embedded in SCADA ?

Do you provide “non-SCADA” actions in the training scenarios ? (phone interaction, written logs)

Scenarios in the training environment

Mechanical

- small release
- large release
- pump failure
- MLBV failure

Communications

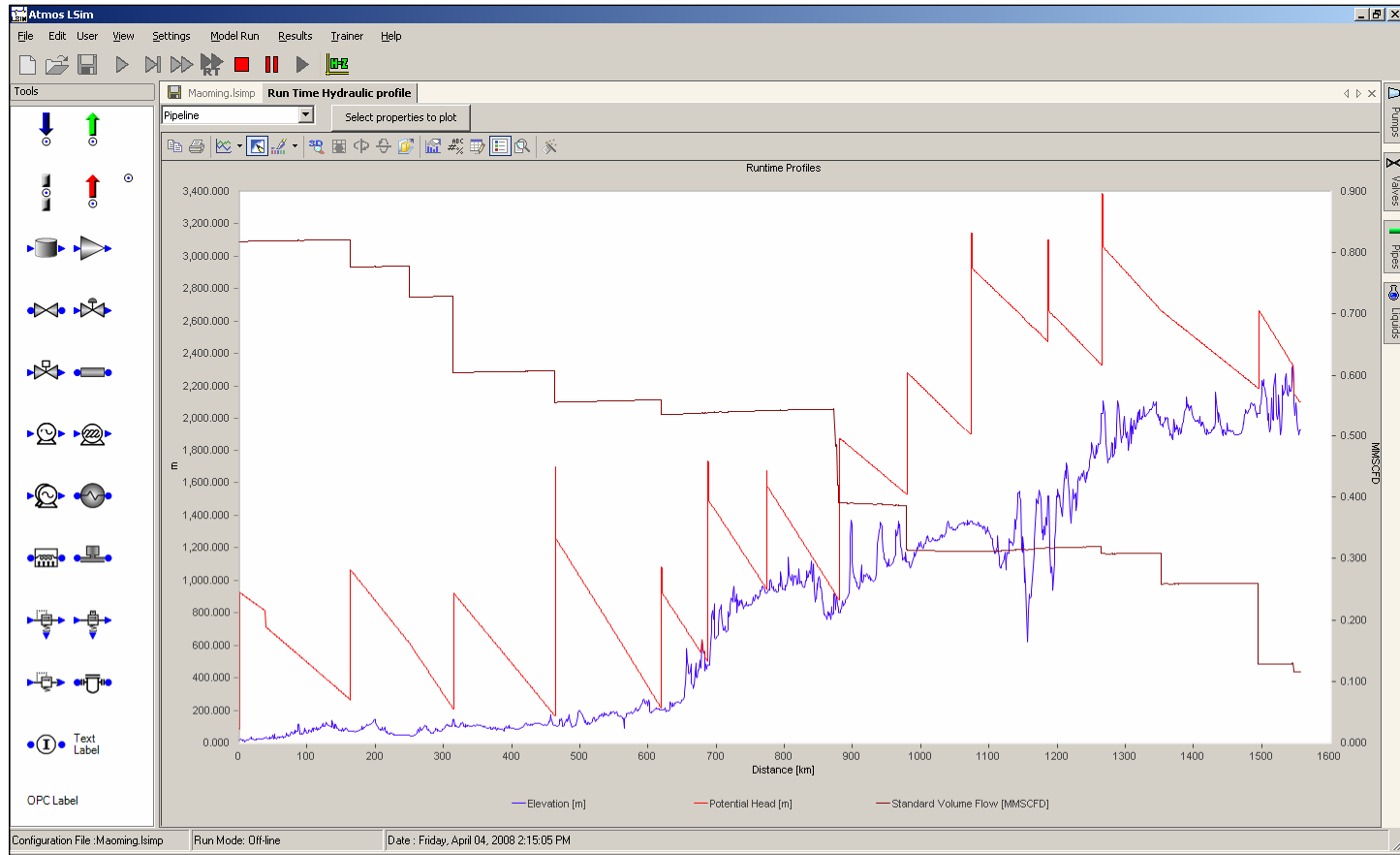
- measurement failure
- communications loss

Operations

- station or line start-up and shut-down
- contamination mitigation
- local station alarms (intruder, fire, etc)

Don't forget to use the native simulation GUI

Looking inside the virtual pipeline can be educational



System maintenance

If you're presenting the training environment as a true duplicate of your operating environment, make sure you keep it current

If the training system diverges from the actual system, the controllers will likely dismiss it

Get controllers involved with the system through the whole system lifecycle: design, build and maintain

How well did (s)he do? - Scoring systems

Make sure any test is reasonable !

Supervisor review for formal (qualification) tests

Score based on actions taken ?

- what screens were viewed after the incident ?
- were the correct actions taken ?
- were the correct operations procedures followed ?

Scoring

- numeric scoring system (eg. 90% is a passing grade)
- polarized scoring (pass/fail)

Can the training system capture these criteria ?

- SCADA interaction

More questions than answers !

Use actual SCADA GUI or a generic GUI ?

Use actual or generic pipeline ?

Level of control system fidelity ?

Applications availability ?

Maintainability ?

Scoring system ?

Involve your controllers in the whole process

get their buy-in

Simulation-based training systems

Questions and comments ?