Consolidated Edison Company of New York

Water Hammer Predictor Model Update

Presented by:

Dowlatram Somrah, ME, PE

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Agenda

- Presenter Introductions
- Con Edison Steam System Overview
- Trap Operations
- Monitoring External Water Conditions
- Physical Testing
- System Modeling
- Model Overview
- Benefits

Presenter Introductions

Dowlatram Somrah, ME, PE

- Section Manager – Steam Distribution Engineering
- Education
  - Cooper Union – Undergraduate and Graduate Engineering Programs

Jimmy Tsang, ME

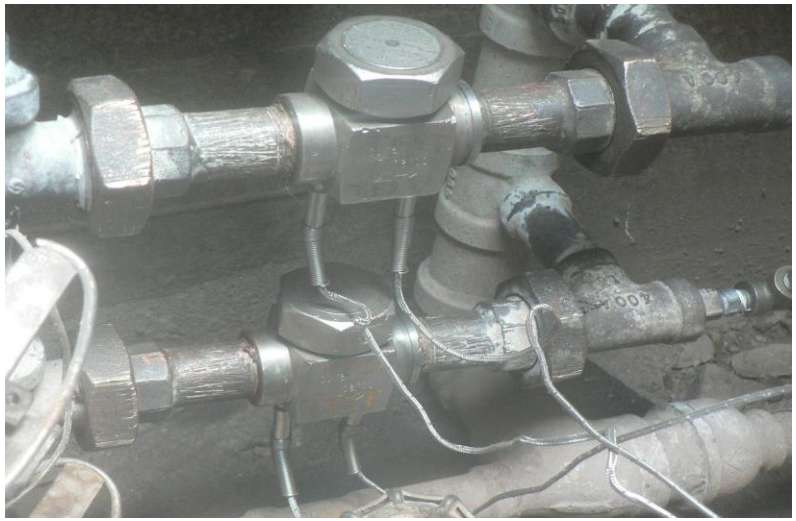
- Senior Engineer – Steam Distribution Engineering
- Education
  - Cooper Union – Undergraduate and Graduate Engineering Programs

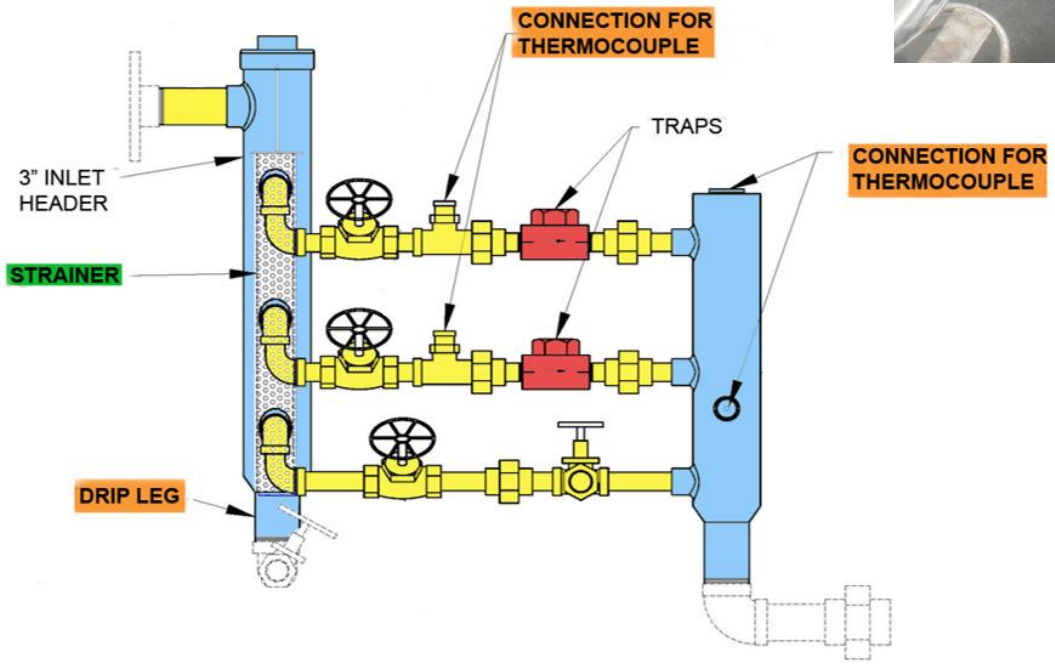
Con Edison Steam System Overview

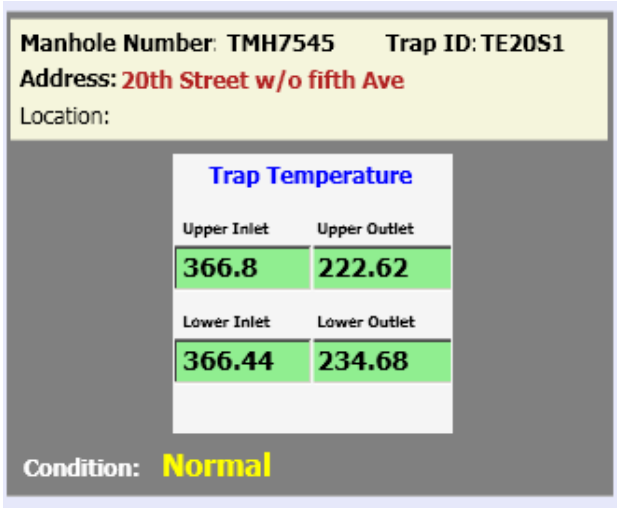
- 106 miles
- Peak 9,600 Mlb/hr
- 23.5 billion lbs/2016
- Thermal losses

Trap Operations

- 835 trap stations
- Monitor status – cold
- Amount of condensate

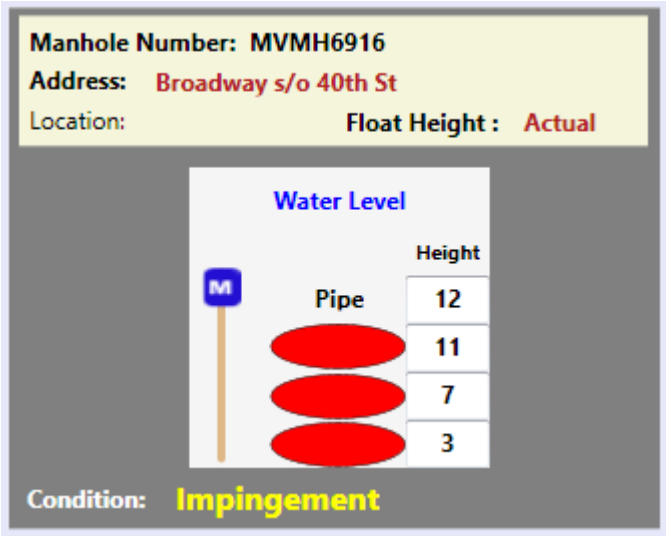






Monitoring External Water Conditions

- Impingement/submerged mains
- Vapor condition
- Increased condensate generation



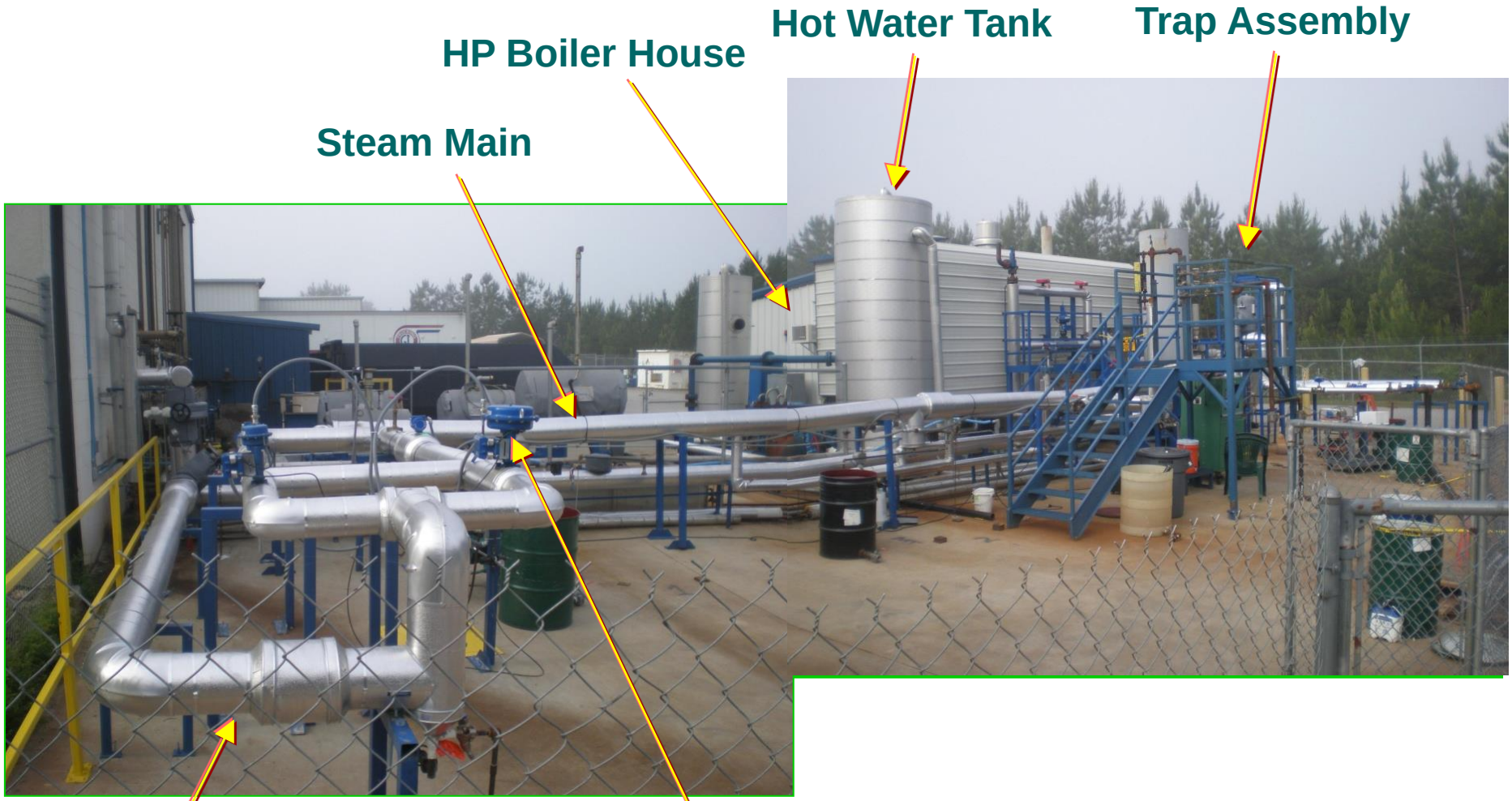
Moderate Vapor

Flooded Manhole

Physical Testing

- **Geometrical configurations**
  - **Straight pipe – slopes from 1° to 5°**
  - **Pair of 22½° elbows**
  - **Pair of 45° elbows**
  - **Pair of 90° elbows with h/d = 2 to 12**
  - **Bends with shallow to steep angle changes**

Physical Steam Testing



System Modeling

- New water hammer model online - 8/17/2016
- 3.7 miles of distribution piping
  - Two send out mains
  - System geometry
  - Real time field measured values input
- Theory – multiphase flows
- Empirical data calibration
- Calculates
  - Steam velocity
  - Condensate build-up

Water Hammer Predictor Model Overview

- Pilot model piping
- Boundary Conditions
- Flow Direction

Water Hammer Predictor Model Detailed View

- Sub-model area
  - Pipe geometry – plan and profile
- Customer loads
  - Service connections
- Manholes
- Trap stations
- Liquid hold up plot

Benefits of Water Hammer Predictor Model

- **Real time calculated values system wide**
  - **Condensate build up**
  - **Pressure**
  - **Temperature**
  - **Steam velocity**
- **Supplement field measured values**
  - **Trap stations**
  - **Manholes susceptible to flooding**

Water Hammer Predictor – Pressure Plot

- Pilot area
- Pressure values
  - Inputs at plants
  - Field measured values at boundaries
  - Calculated values

Model – Pressure and Temperature Profiles

- Sub-model area
  - Pipe geometry – plan
- Pressure profile
  - Calculated values
- Temperature profile
  - Calculated values

Model – Mass Flow Profile

- Sub-model area
  - Pipe geometry – plan
- Mass flow
- Condensate flow

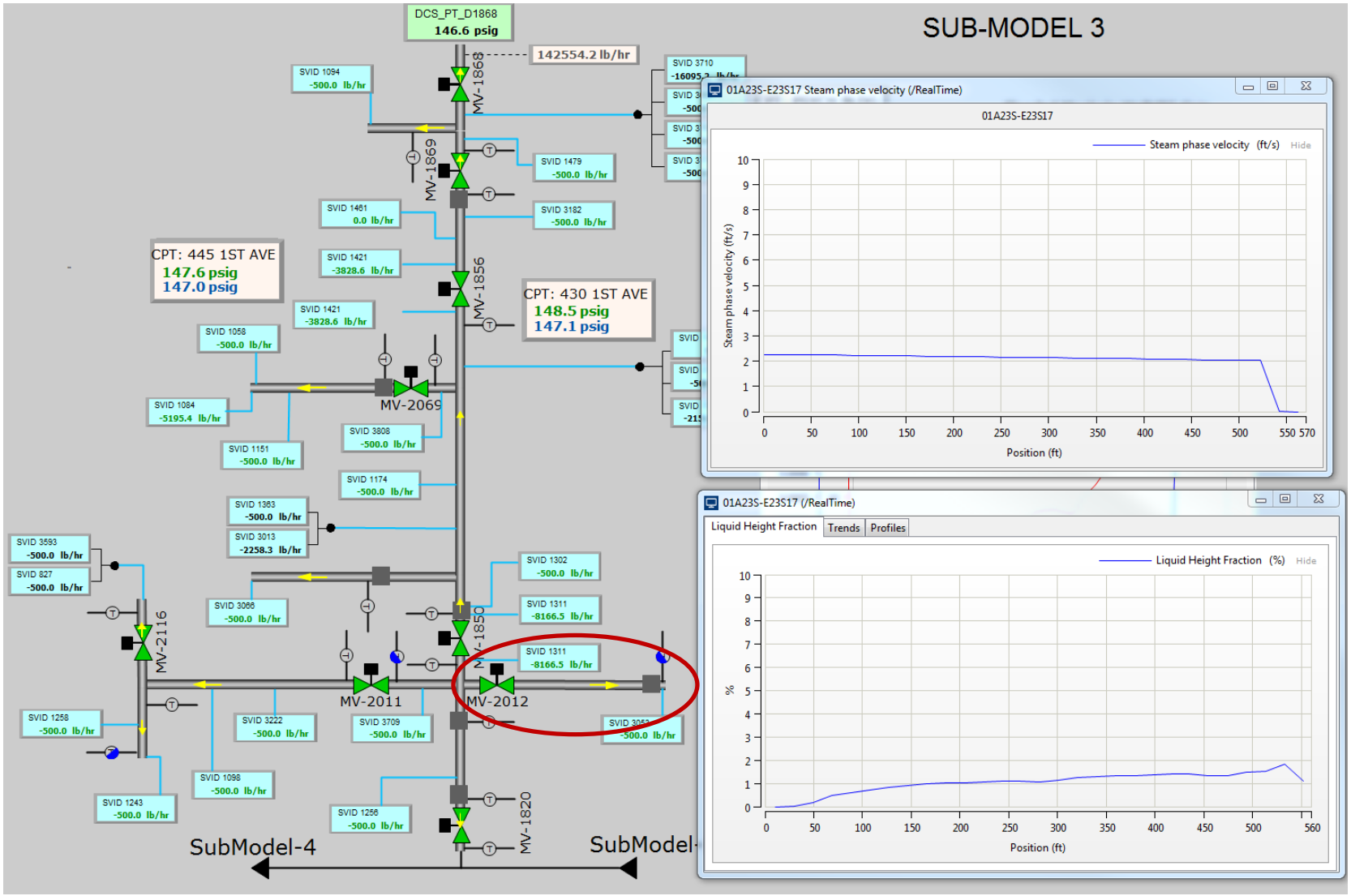
Benefits of Water Hammer Predictor Model

- Potential new alarms
  - Low velocity
  - Condensate build up
- Complement trap monitoring
- Improve confidence in alarms
- Improve response to mitigate high risk conditions

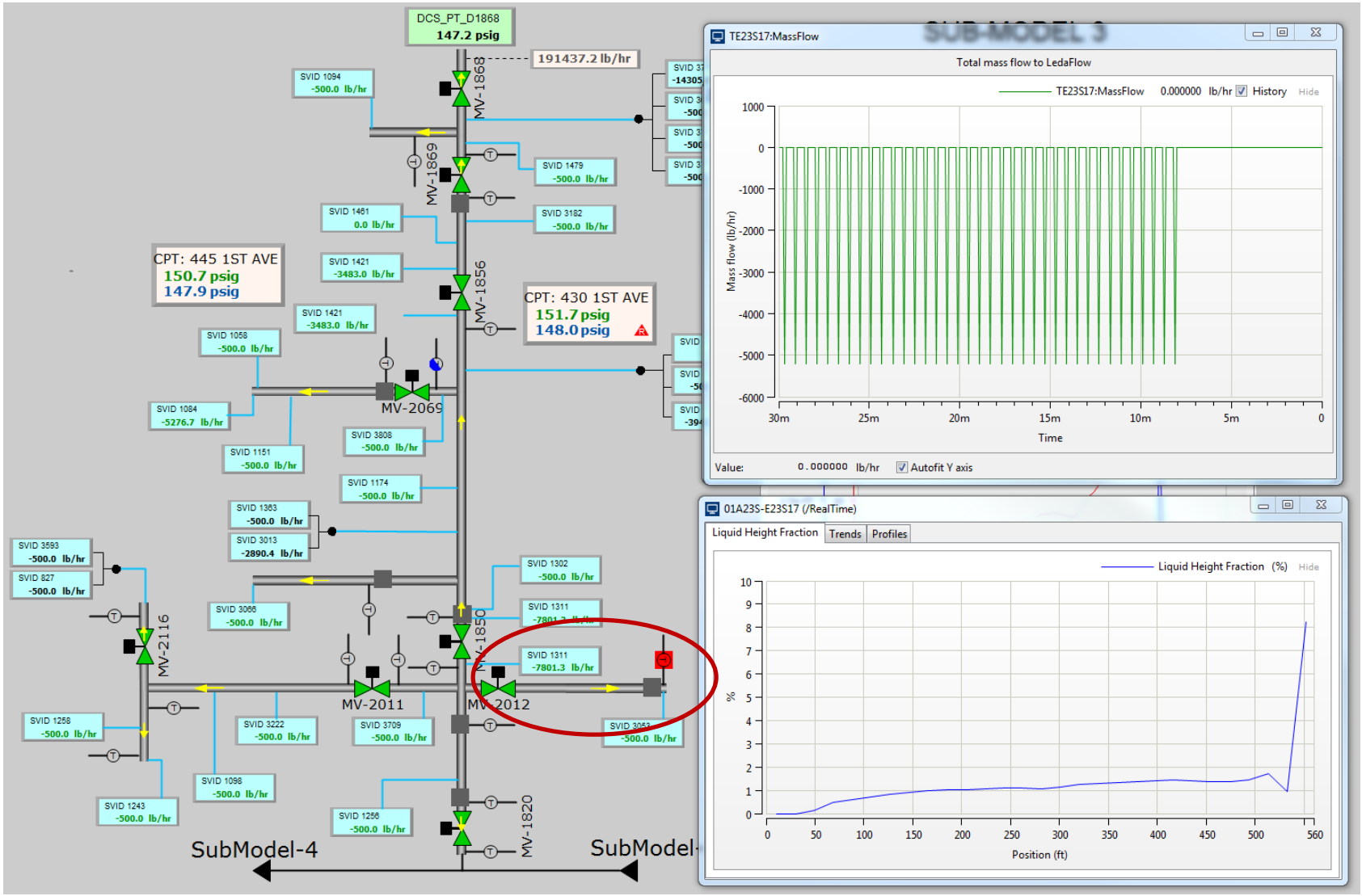
Water Hammer Predictor – Velocity Plot

- Pilot model area
  - Pipe geometry – plan
- Pressures
  - Inlet and boundaries
- Velocity profile
  - Low velocity

Model – Velocity and Liquid Profiles



Model – Simulated Cold Trap



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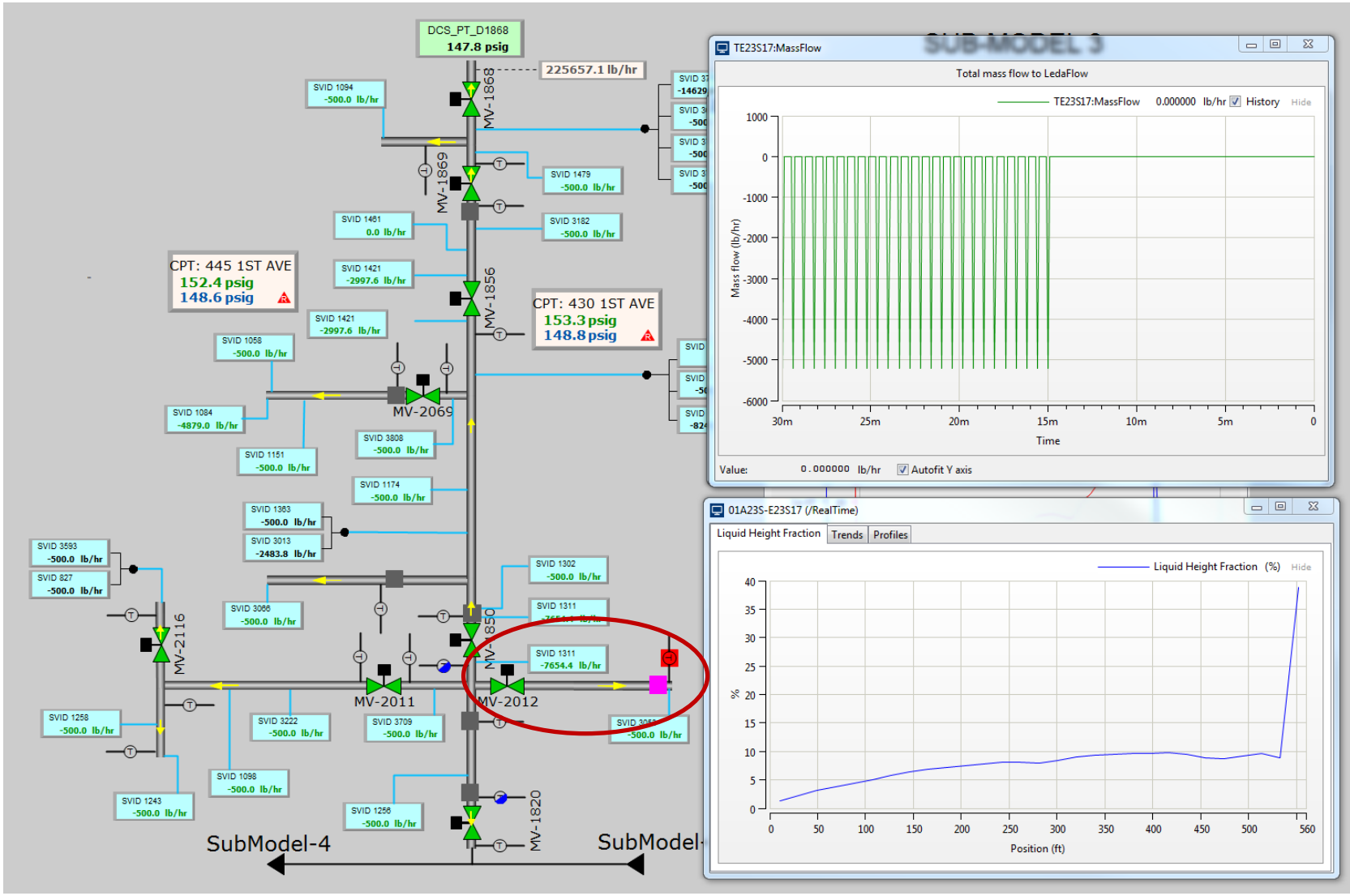
Benefits of Water Hammer Predictor Model

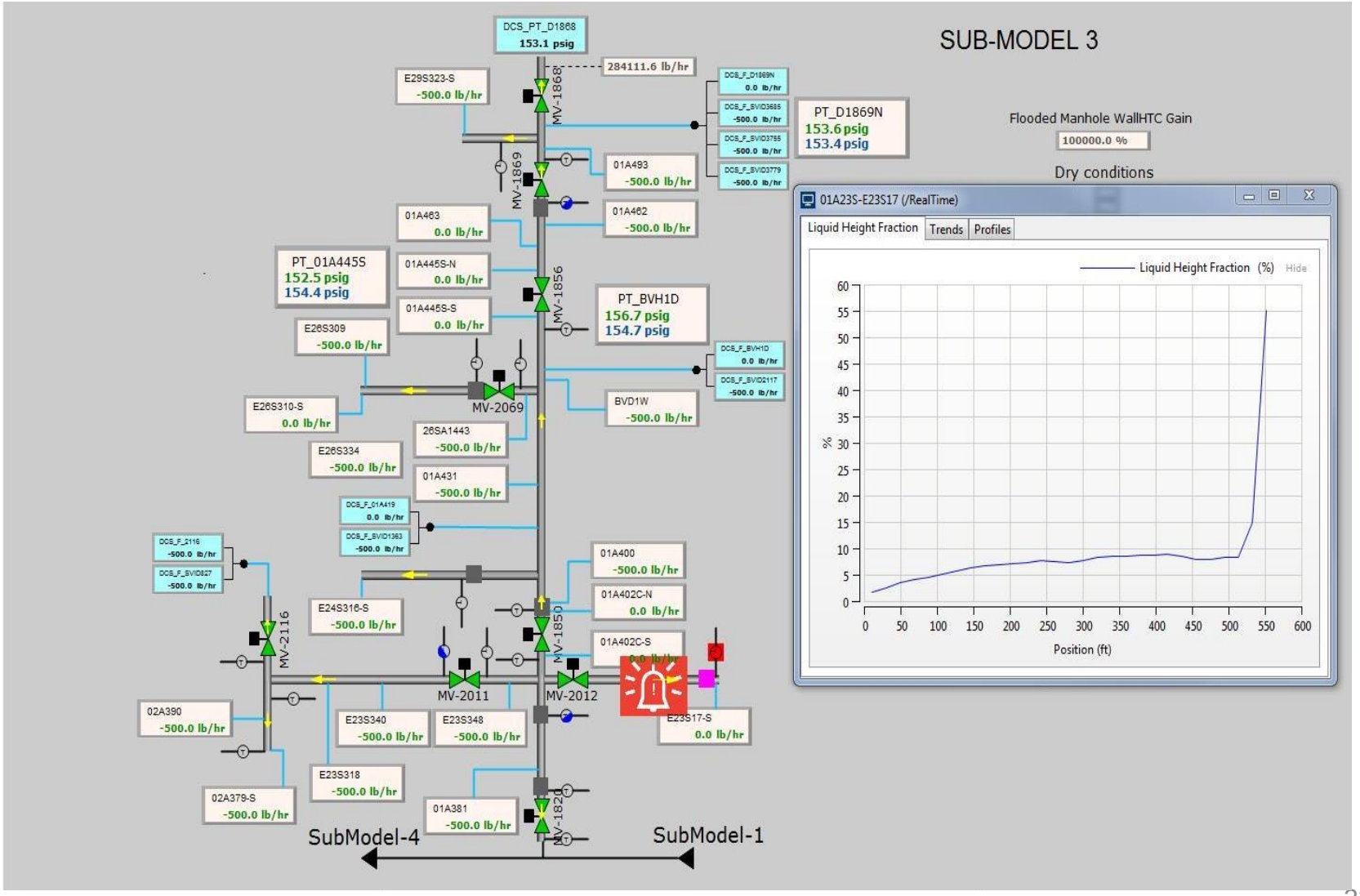
- **Conditional based simulation**
  - **Pipes segmented by flood zones**
  - **External water level monitoring**
  - **Integrated with remote monitoring**
  - **Different heat transfer coefficients**

System Map Showing Food Zones

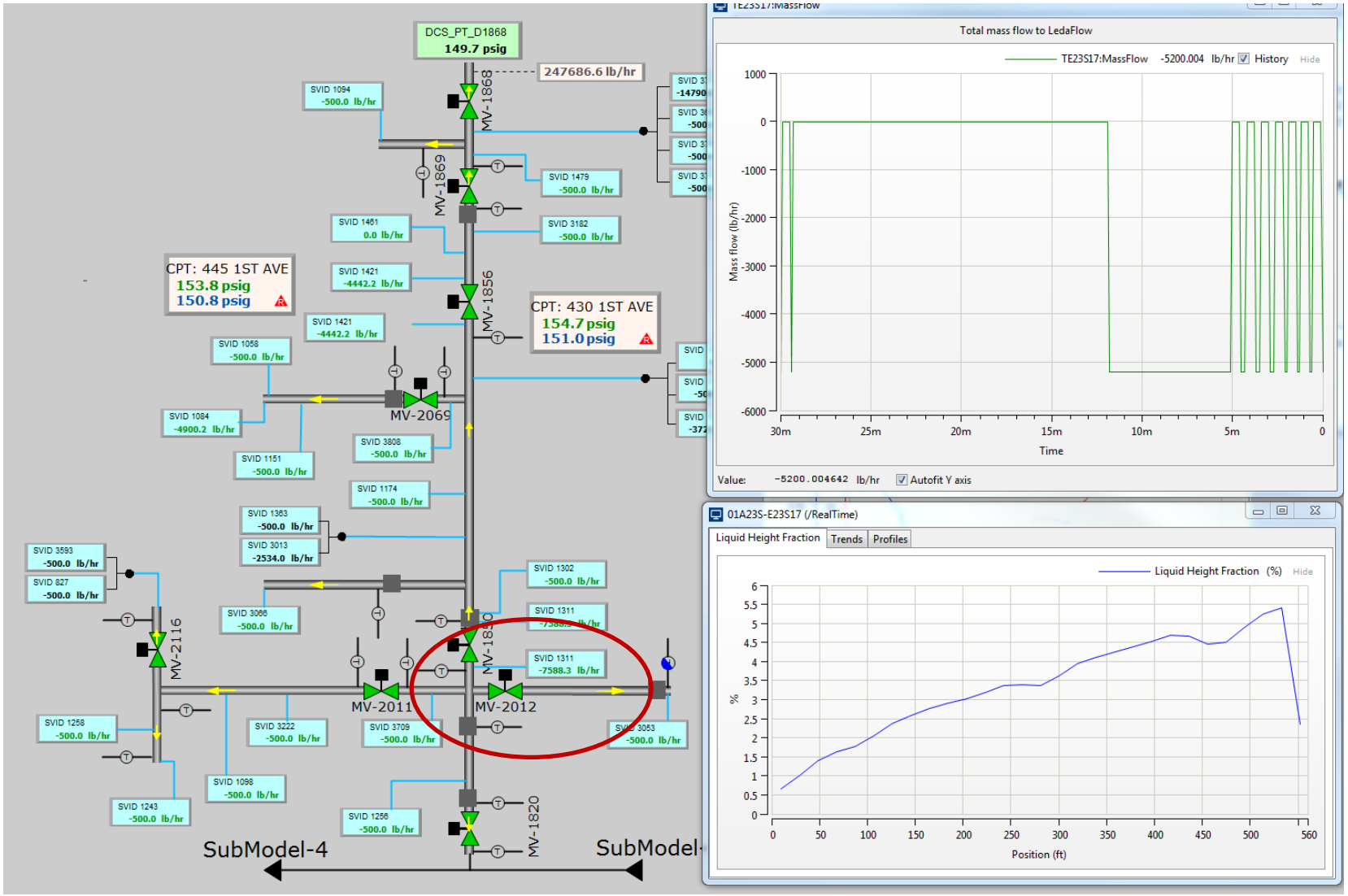
Model – Simulated Flooded MH & Cold Trap



Model – Simulated Water Hammer Alarm



Model – Simulated Restoration From Alarm



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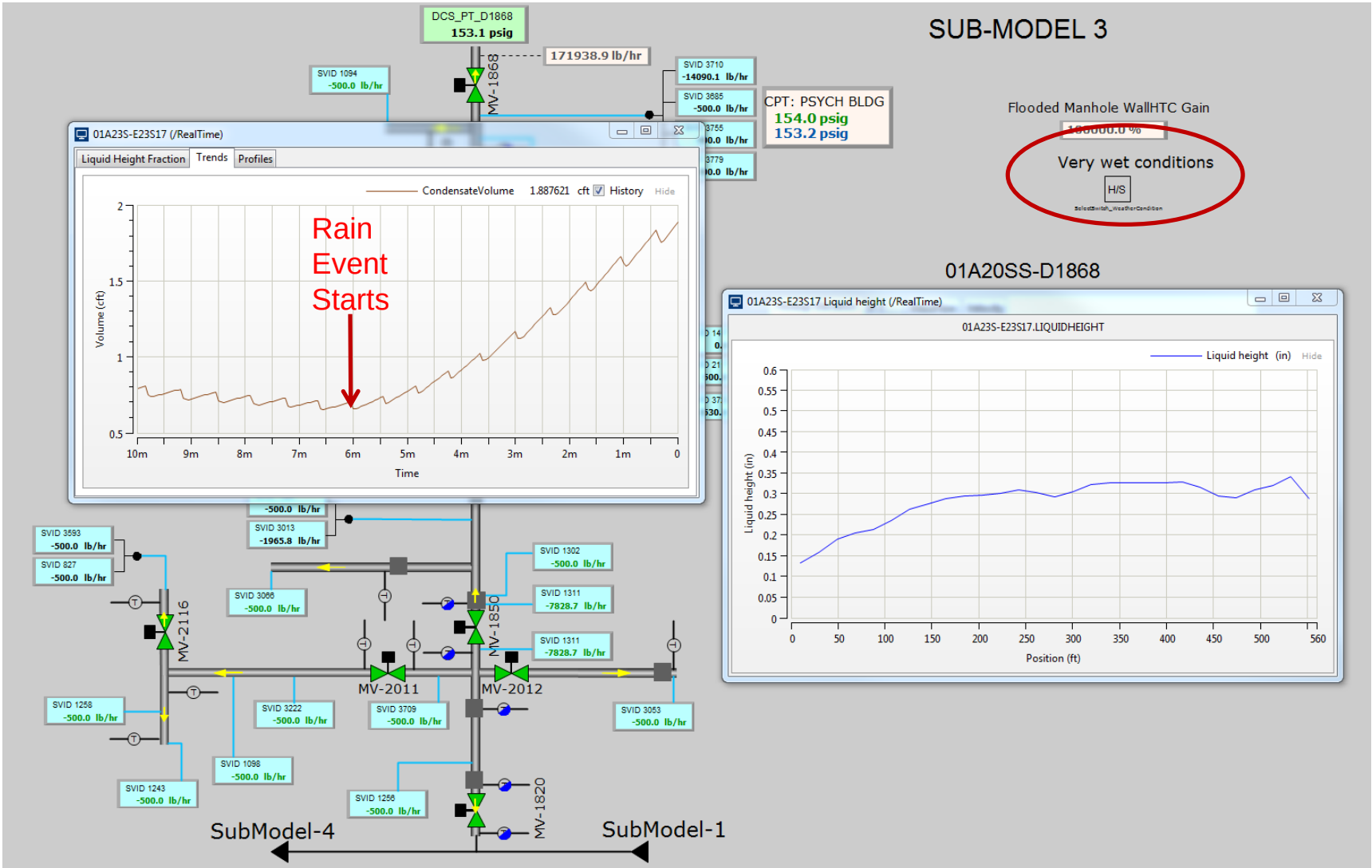
Model – Simulated Rain Event



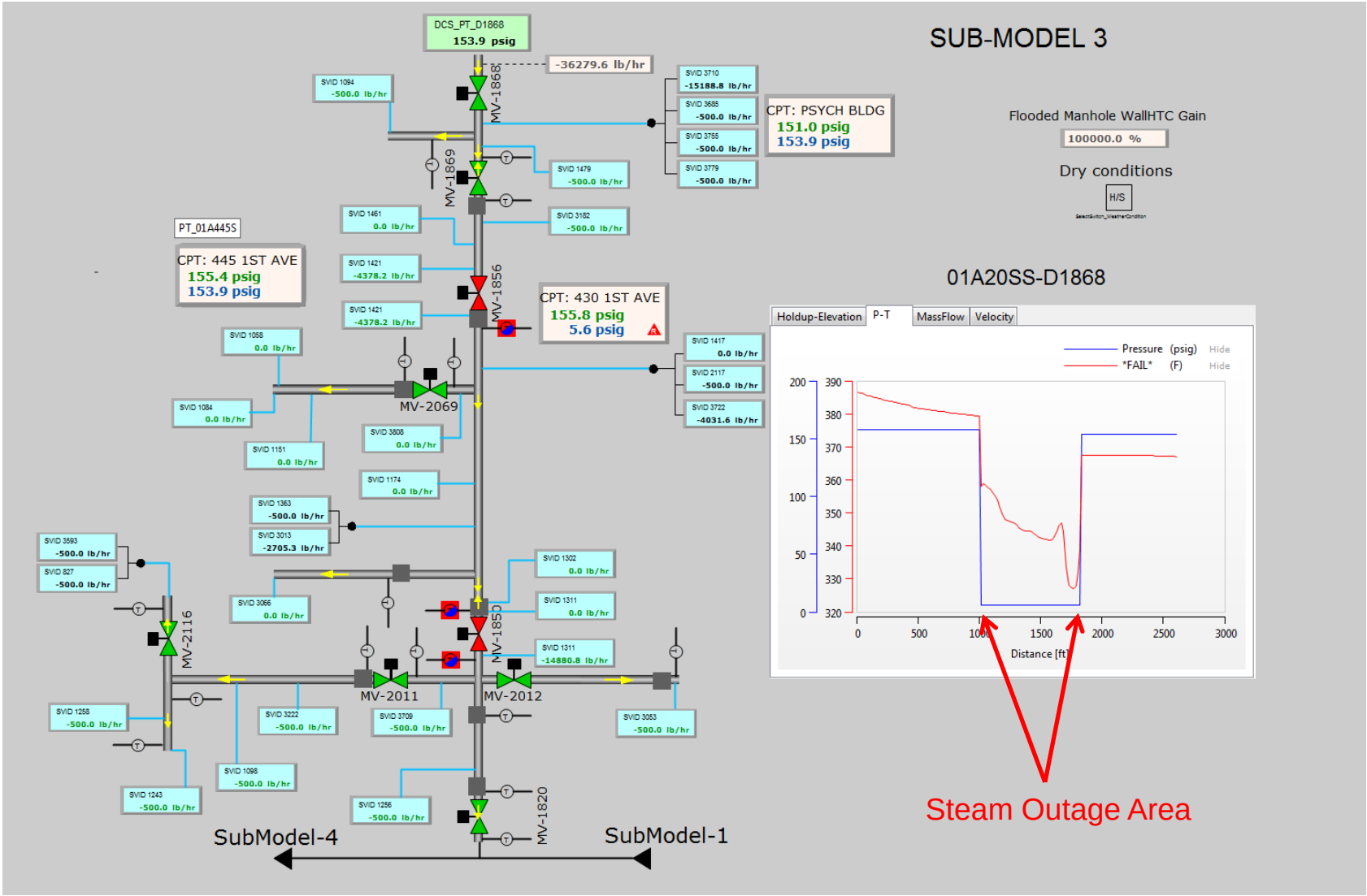
Benefits of Water Hammer Predictor Model

- Contingency analysis
  - Plan work outages
  - Improve system dispatch
- Steam Mimic
  - Pressure distribution
    - Operate with a packed system
    - 13 psi differential

Model – Simulated Steam Main Outage

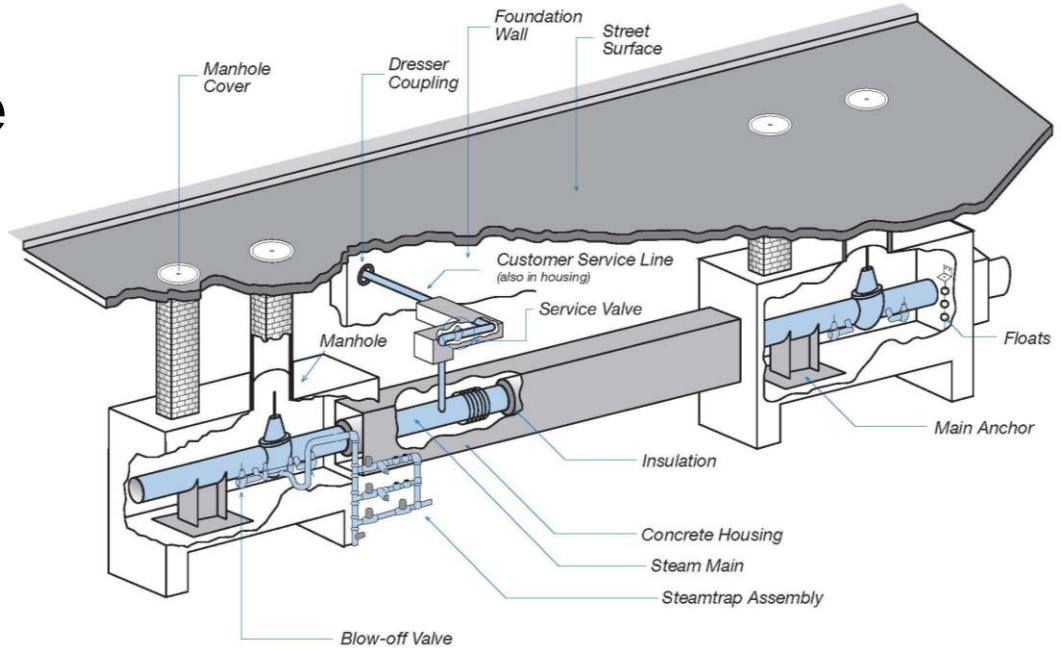
- Pilot model area
- Steam main outage
  - Two main valves closed
- Pressure profile
  - Low pressure in outage area

Model – Simulated Steam Main Outage



Benefits of Water Hammer Predictor Model

- Reduce low velocity in susceptible areas
- Predict high risk conditions
- Improve response time



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