



# Modeling Networks

- Only snapshot modeling (Steady-State and EPS)
- Assume incompressible, steady and uniform flow
- Two principles to solve hydraulic equations:
  - Conservation of Mass:  
Sum of flow to any node = 0
  - Conservation of Energy:  
Sum of headlosses around any loop = 0



# Model Applications

- Model building is only start
- Many applications for models
- Can be used by
  - Management
  - Planning
  - Engineering
  - Operations



# Modeling to Manage Energy

- Pumping cost large component of Utility's operational expenses
- Simple system easy to optimize
- Complex systems very difficult
- Model assist in:
  - Minimizing energy consumption
  - Minimizing peak energy consumption
  - Responding optimally to emergencies



# Controls

- Initial status
  - Pump OFF
  - Valve active at 50 psi
- Simple controls or operational controls
  - If (Level > 10 ft) then (Pump OFF)
- Complex controls or PLC
  - If (Time > 7pm OR Level < 5 ft) then (Pump 1 ON)



# Running Fire Flow Simulation

- Calibrate hydraulic network model
- Assign fire flow requirements based on land use
- Specify simulation options (Residual Pressure)
- Run fire flow simulation
- Analyze fire flow output results



# Running Pump Energy Simulation

- Pump costs based on:
  - Hydraulics
  - Pump curve
  - Pump efficiency curve
  - Energy rate pattern
- Performed during an EPS simulation



# Causes of Pressure Surge Wave

- Closing or opening a valve
- Startup or shutdown of a pump
- Rupture of a line
- Change in reservoir pressure
- Closing check valve
- Opening pressure relief valve



# Model Size Review

- Number of Nodes (N)
  - Junction
  - Tank
  - Reservoir
  - Pump
  - Valve
- Number of Pipes (P)
- Euler Network Relationship

$P = N + L - 1$  where  $L =$  Number of Loops





# Model Calibration and Maintenance

- What are the model parameters which can be adjusted?
  - Pipe connectivity
  - Nodal elevations
  - Operational controls
  - Pump curves
  - Facility configuration
  - Initial status
  - Demand/Load allocation
  - Roughness coefficient