CE 400 / CE 500

Process Safety Management

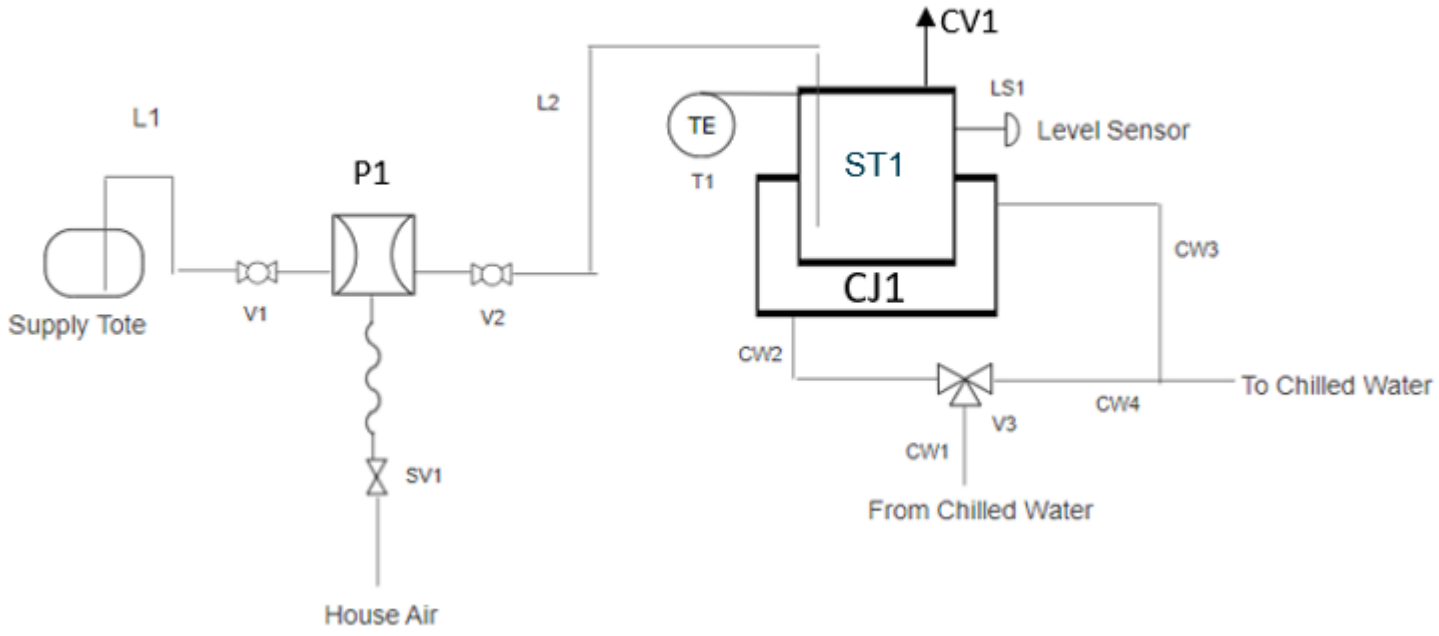
Lecture 20 Hazard Evaluation Methods II

Instructor: David Courtemanche

University at Buffalo
Department of Chemical and Biological Engineering
School of Engineering and Applied Sciences

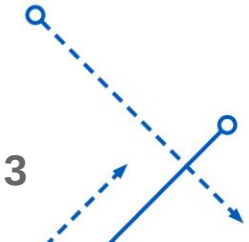
Example of Methods

- Simple system:
  - Material comes in 300 gallon tote
  - Transferred to tank by diaphragm pump and kept cool by jacket on tank



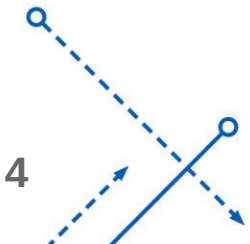
What If

- What if tote is empty?
  - Fail to transfer material
  - What does that lead to?
- What if valve V2 is closed?
  - Fail to transfer material
  - Diaphragm pump will not overpressurize line
- What if tank overfills?
  - What are the consequences of Loss of Containment
    - Do we have secondary containment?
- What if temperature is too high in tank?
  - Might there be a reaction?
  - What will the effect be downstream in the process?



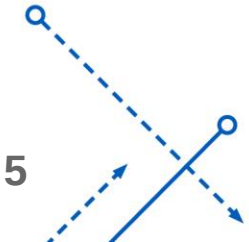
HAZOP

- Supply tote
  - Contents other than
  - Level Empty
  - Level too high
- Line L1 (also same questions for L2)
  - Flow – too high, too low, no flow, reverse flow
  - Pressure – too high, too low, no pressure
  - Temperature – too high, too low
  - Composition – concentration too high, too low, wrong components
- Tank
  - Level too high, too low, no level
  - Temperature too high, too low
  - Pressure too high, too low



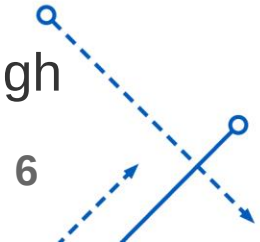
FMEA

- Tote
  - Tote empty
  - Tote wrong material
- Valve V1
  - Closed when should be open
    - Starve pump – no flow
  - Open when should be closed
- Diaphragm Pump
  - Off when should be on – no flow
  - On when should be off – overfill tank
  - Running too fast/slow – na for this style pump



FMEA, continued

- Valve V2
  - Open when should be closed
    - Line will leak when disconnected
  - Closed when should be open
    - Block off flow – no flow in line L2
    - Diaphragm pump will not overpressurize line L2
- Temperature Probe T1
  - Reading higher than actual temperature
    - Cooling water will flow and cause actual temperature to be low – what are consequences?
  - Reading Lower than actual temperature
    - Cooling water will not flow and cause actual temperature to be high – what are consequences?
  - Reading not updating – flow will stay in constant state and temperature will drift high or low
  - No reading sent – need to know what control system will do

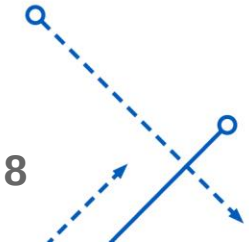


FMEA, continued

- Level Probe LS1
  - LS1 sends high signal when level is not high
    - Flow to tank will stop
  - LS1 fails to send high signal when level is high
    - Possible LOC from overfilling tank
- Valve V3
  - Pointing to recycle when it should point to jacket – temperature will get too high
  - Pointing to jacket when it should point to recycle – temperature will get too low
- Jacket
  - Chilled water leaks into tank
  - Tank contents leak into chilled water
- Note that questions regarding temperature of chilled water would be addressed on drawing for the chilled water system
- Be sure to include general LOC questions due to leaking lines

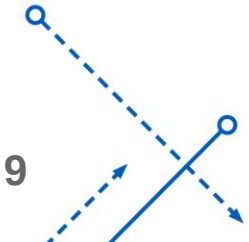
Comparing the Methods

- Overfilling tank
  - In “What If” we need to think of that as a possibility
  - In HAZOP “Level too High” is on list of Deviations
  - In FMEA it would come up due to:
    - Level Probe failing
    - Pump “On when Should be Off”
- Loss of Flow to tank
  - In “What If” we need to think of that as a possibility
  - In HAZOP “No flow” on list of deviations for line L2
  - In FMEA it would come up due to:
    - Valves V1 or V2 “Closed when should be Open”
    - Pump “Off when Should be On”



Comparing the Methods

- Tank Temperature Too High
  - In “What If” we need to think of that as a possibility
  - In HAZOP “Temperature too High” is on list of Deviations
  - In FMEA it would come up due to:
    - Valve V3 pointing to recycle when if should point to tank
    - Temperature probe T1 reading low



Comparing Methods

- The same scenarios will show up no matter which method you use
- “What If” is somewhat out of favor due to its lack of structure, but sometimes it picks up things missed on the other methods
- I like that when using FMEA the potential causes for the deviations are explicit
- I recommend choosing HAZOP or FMEA and supplementing with “What If” and checklists
  - Cross checking HAZOP and FMEA might not be a bad idea