CE 400 / CE 500

Process Safety Management

Lecture 21 Hazards Evaluation Class Exercise

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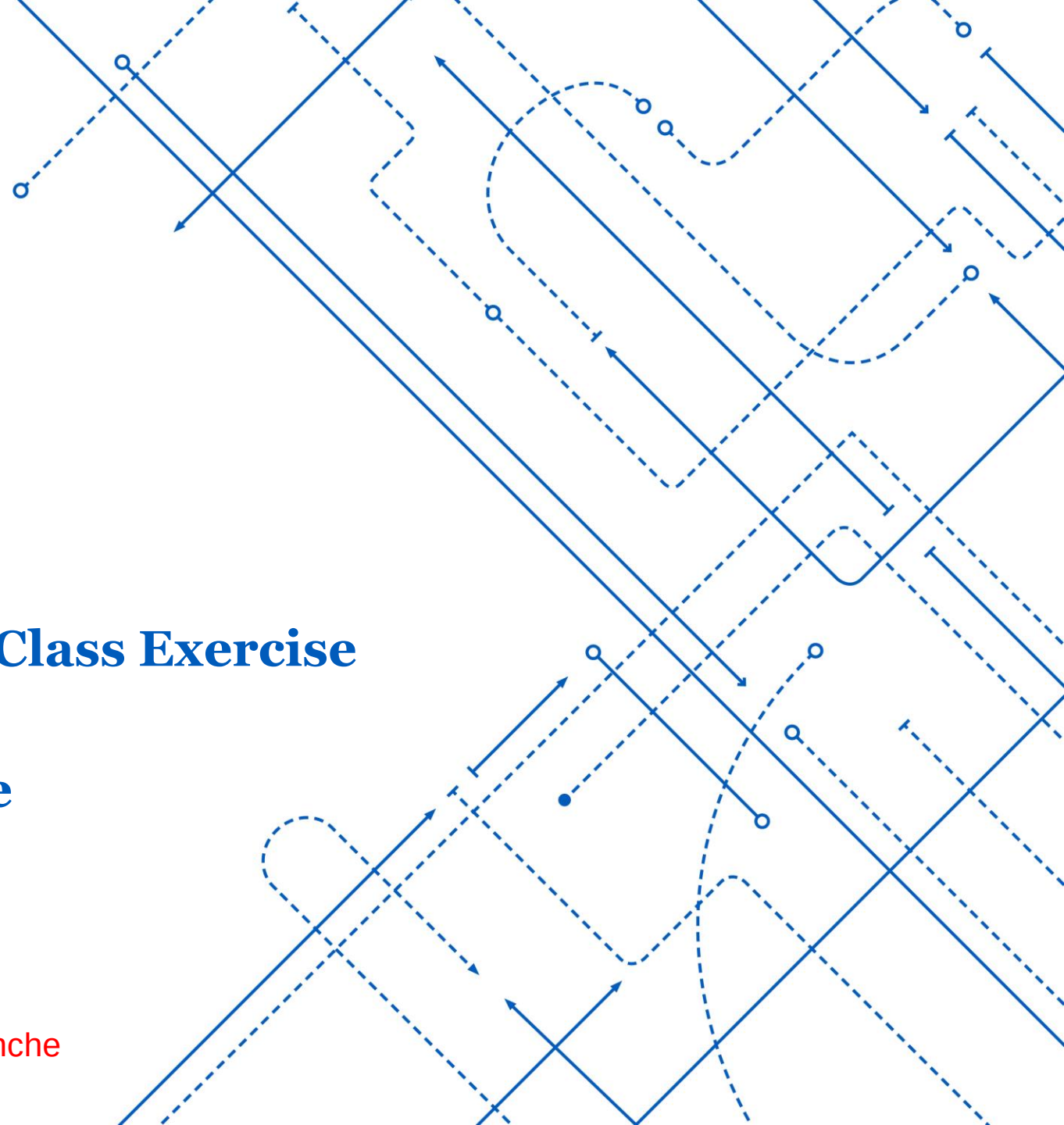
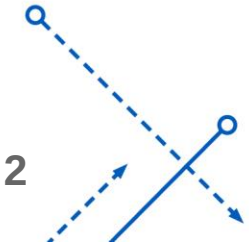
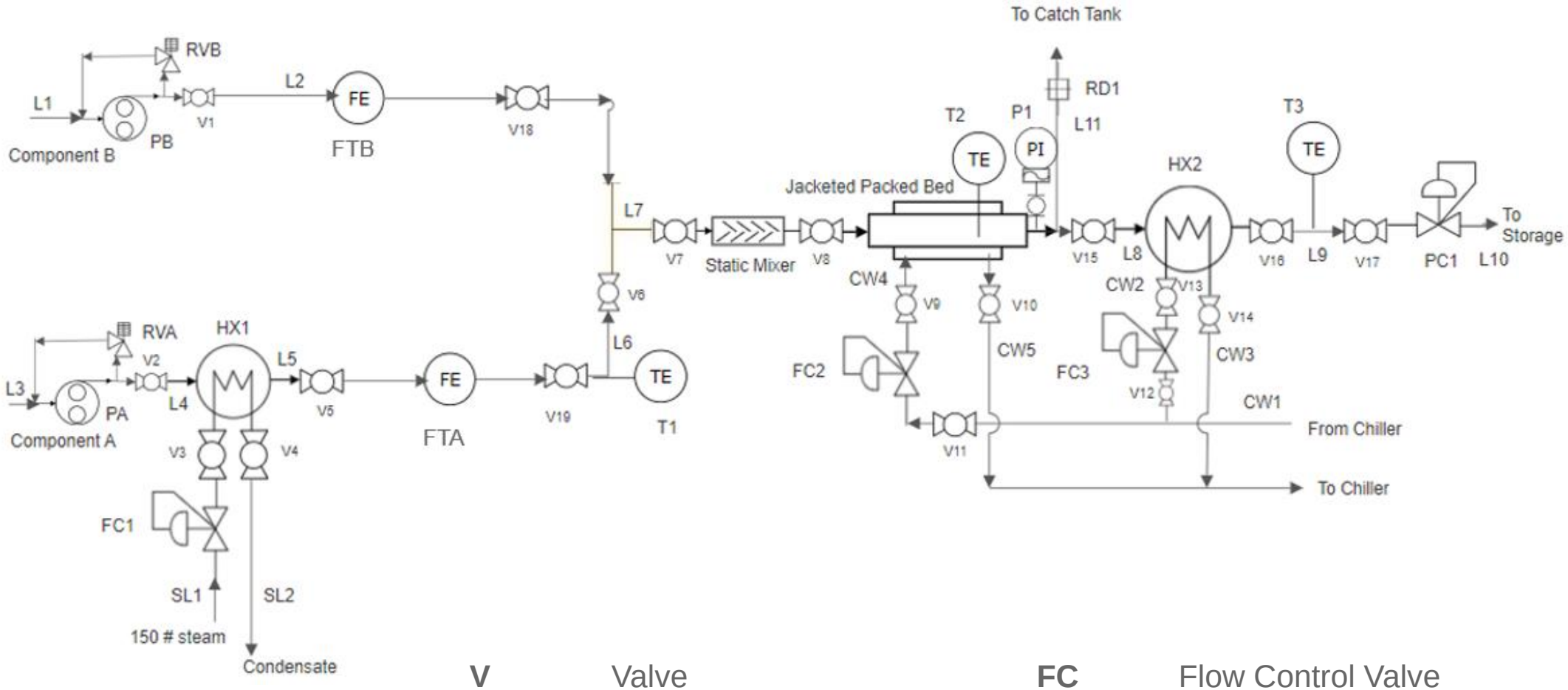


Hazards Evaluation Exercise

- In this lecture we will work through a partial FMEA and HAZOP evaluation of the Process and Instrumentation Diagram on the following slide
- We will see how both methods lead to the same findings
- Two components, A and B, are metered to a static mixer and then into a bed packed with a catalyst where they react to make product C.
- Component A is preheated before mixing
- Reaction is exothermic and packed bed has a cooling jacket to control reaction from running too hot
- Product passes through a heat exchanger to cool to ambient temperature
- Control valve PC1 keeps reaction running at 50 psig



Hazards Evaluation

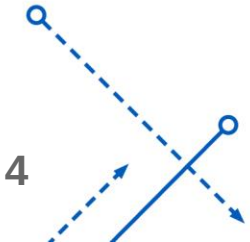


V	Valve	**FC**	Flow Control Valve
P	Pump	**PC**	Pressure Control Valve
RV	Relief Valve	**HX**	Heat Exchanger
FT	Flow Transmitter	**T**	Temperature Probe
P	Pressure Transmitter	**RD**	Rupture Disc

Hazards Evaluation

- Let's go to the FMEA spreadsheet…
- There is not enough information on the previous slides to answer many of the questions….

We NEED to UNDERSTAND our process!

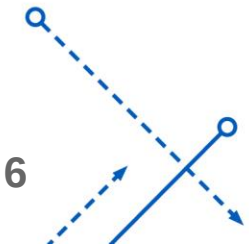


Process Information

- Component B is highly toxic
- Component A is flammable
- Product C is fairly innocuous (non-harmful)
  - You would not want to drink it, but it does not give off harmful vapors nor is it dangerous via dermal absorption
  - Non-flammable
  - It is volatile, meaning it will evaporate and we want to limit the evaporation rate for environmental concerns and also to reduce losses
- None of the reactants nor the product react with water
- Reaction will run almost to completion in the bed if we are in the proper temperature range. If it is too cold the reaction will not start and if it is too hot the kinetic equilibrium will lead to some unreacted material

Process Information

- The reaction is fed with a slight excess of component A over the stoichiometric ratio
  - Unreacted component B will lead to a moderate toxicity of the product
  - The amount of unreacted A left in the product does NOT make the product flammable
- Component A is pre-heated so that the temperature in the bed is high enough to generate the reaction
  - Component A was chosen as the one to pre-heat due to the toxicity of component B
    - At room temperature the volatility of B is low and therefore we don't want to have a stream of pure B at elevated temperature
- Packed bed is cooled to prevent the temperature from reaching a point where the equilibrium conditions lead to significant levels of unreacted component A & B
- Reactor is kept under pressure to prevent cavitation in the packed bed which will damage the catalyst pellets and lead to reduced life of the catalyst
  - The catalyst is expensive



Results

- The Risk Factor for overfilling the Storage Tanks is I
- We need to add more safeguards or upgrade current safeguards

- There is an interlock which apparently does not meet the required reliability to protect against this event
  - We will address this when we cover LOPA and interlock SIL Levels
  - Current interlock shuts off feed pumps
    - One approach would be to add an additional high level probe in the storage tank and add automated shut off valves before the feed pumps that also are closed if high level is detected