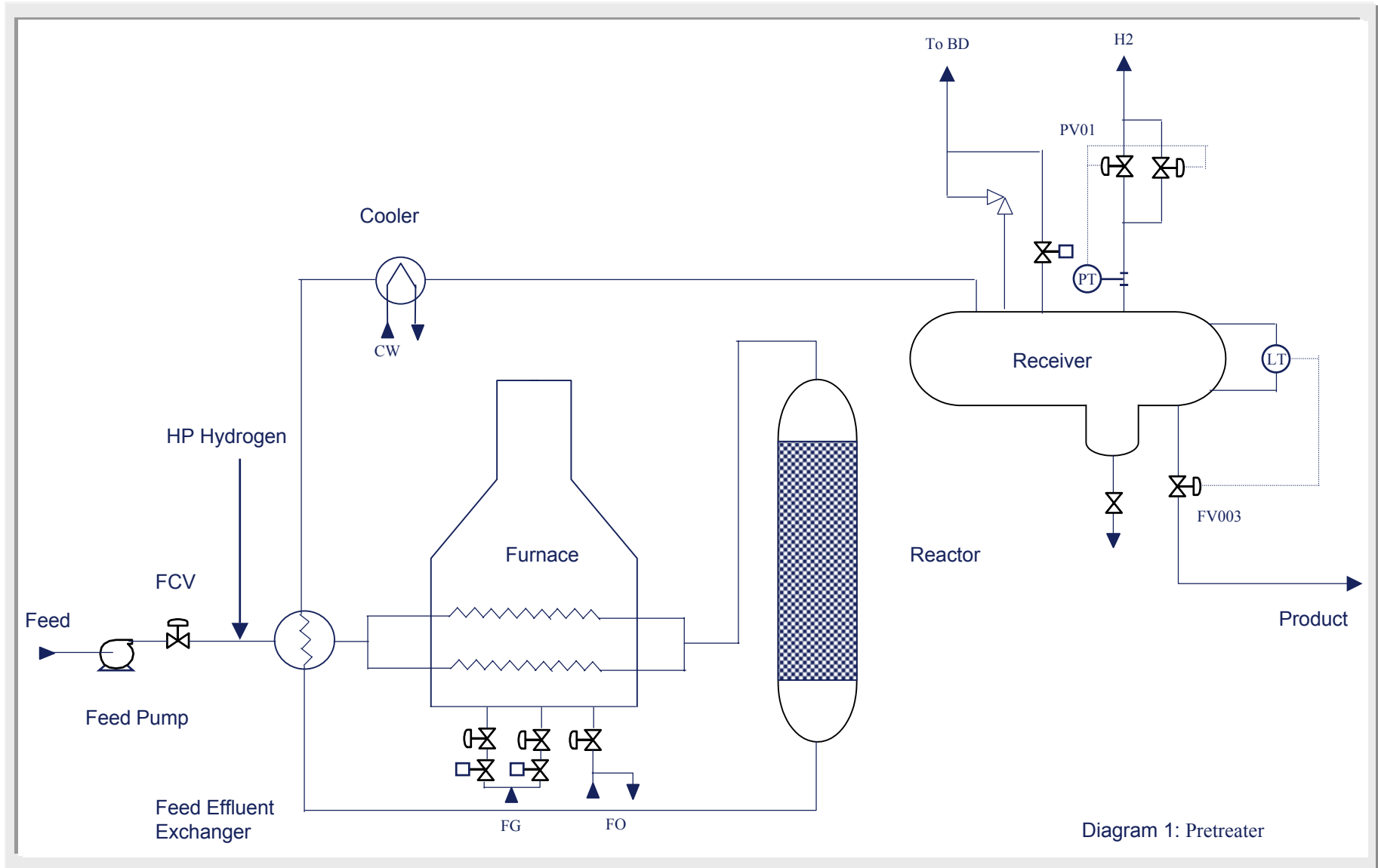


Diagram for Exercise 2





Interpreting the HAZOP record

- Try to complete the following HAZOP sheet to record hazards associated with rupture of process piping. Use enter answers you consider to be credible

Plant Section	Item	Deviation	Cause	Consequence or Implication	Indication or Protection	Question or Recommendation
Lead Reactor	Feed Inlet	Reverse Flow	1. Feed pump fails	1. Reactor pressure causes reverse flow	1. Check valve on pump discharge	?
			2. Heat Exchanger Tube rupture	2. Overpressure of exchanger shell side	?	?
			3. Furnace Tube Rupture	?	?	?



Interpreting the HAZOP record

- Try to use the following HAZOP sheet to record hazards associated with rupture of process piping. Complete the record using a made up example which you consider to be credible

Plant Section	Item	Deviation	Cause	Consequence or Implication	Indication or Protection	Question or Recommendation
Lead Reactor	Feed Inlet	Reverse Flow	1. Feed pump fails	1. Reactor pressure causes reverse flow	1. Check valve on pump discharge	1.1 Automatic start of standby feed pump on FAL 1.2 Regular inspection check valve
			2. Heat Exchanger Tube rupture	2. Overpressure of exchanger shell side	2 Design specs of exchanger shell	2 Install PSV if necessary e.g. if an existing exchanger is to be used
			3. Furnace Tube Rupture	3 Fire in furnace as reactor contents ignite	3.1 Tube skin temp 3.2 O2 analyser 3.3 FAL on tube	3. Review ESD/ need for reactor blow down



Interpreting the HAZOP record

- Two options are suggested (this is OK provided each is properly identified so that the recommendations can be evaluated separately later)

Plant Section	Item	Deviation	Cause	Consequence or Implication	Indication or Protection	Question or Recommendation
Lead Reactor	Feed Inlet	Reverse Flow	1. Feed pump fails	1. Reactor pressure causes reverse flow	1. Check valve on pump discharge	1.1 Automatic start of standby feed pump on FAL 1.2 Regular inspection check valve

- 1.1 is the 'design' solution It is conventional on some types of equipment such as boilers for feed water supply but rarely used by refinery designers even on critical services
- 1.2 is a typical 'maintenance ' response. Check valves are a source of worry in some plants and can be overlooked in a turnaround



Interpreting the HAZOP record

- Harder because you needed to answer in two columns

Plant Section	Item	Deviation	Cause	Consequence or Implication	Indication or Protection	Question or Recommendation
Lead Reactor	Feed Inlet	Reverse Flow	2. Heat Exchanger Tube rupture	2. Overpressure of exchanger shell side	2 Design specs of exchanger shell	2 Install PSV if necessary eg if an existing exchanger is to be used

- Normally you expect the exchangers to be designed to consider tube rupture. Typically the difference in shell/tube design pressures should not exceed 150%
- If this is not the case (perhaps the plant has been revamped) PSV protection is typically added. This must be sized for tube rupture not just for fire



Interpreting the HAZOP record

- The line has been completed for the typical alternatives found to protect against furnace tube rupture

Plant Section	Item	Deviation	Cause	Consequence or Implication	Indication or Protection	Question or Recommendation
Lead Reactor	Feed Inlet	Reverse Flow	3. Furnace Tube Rupture	3 Fire in furnace as reactor contents ignite	3.1 Tube skin temp 3.2 O ₂ analyser 3.3 FAL on tube	3. Review ESD/ need for reactor blow down

- The consequence of rupture is (additional) fire in the furnace box. Flames might come out from a register or inspection port
- Various protections have been suggested. The O₂ detector is using an existing item to detect a small leak. Skin temperature (if fitted) may not be reliable. To work FAL must be on each furnace pass (preferred protection)
- Try to check the operator's knowledge of these emergency procedures which will differ for small leak and full rupture