

Module # 1.1.2

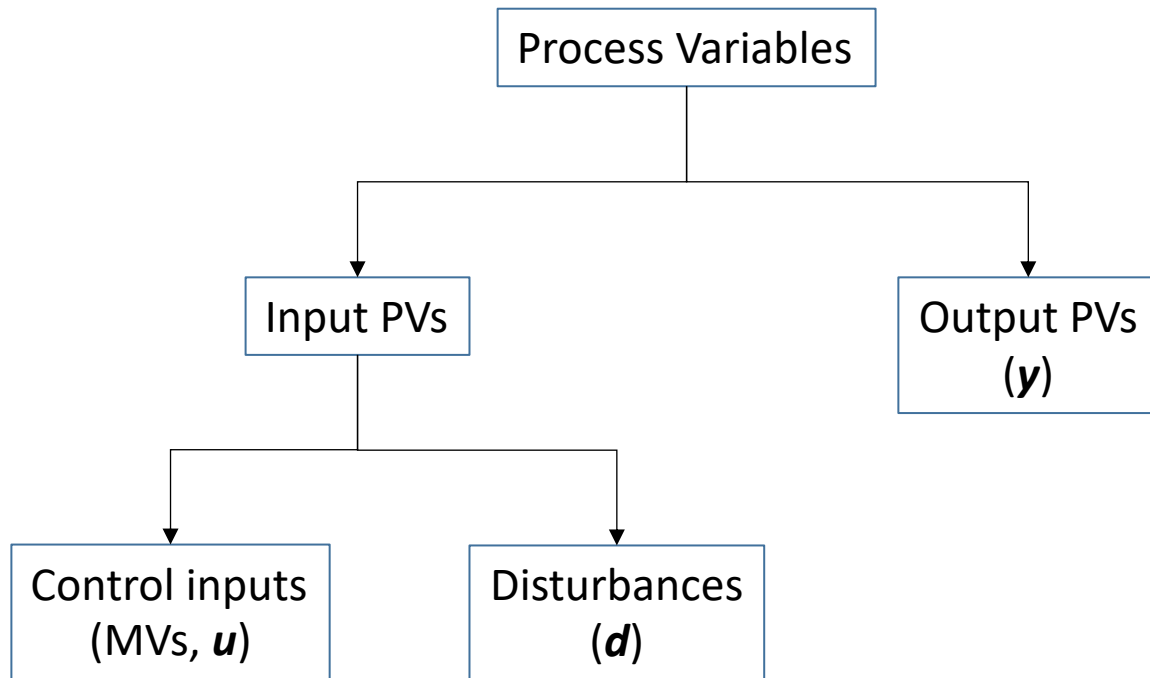
# INTRODUCTION

# PVs and Their Classification

*Lectures on*

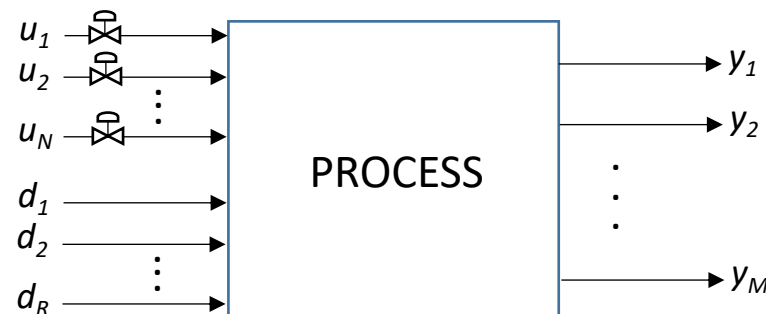
**CHEMICAL PROCESS CONTROL**  
Theory and Practice

# PV Classification



Input PVs affect output PVs through cause-and-effect relationships

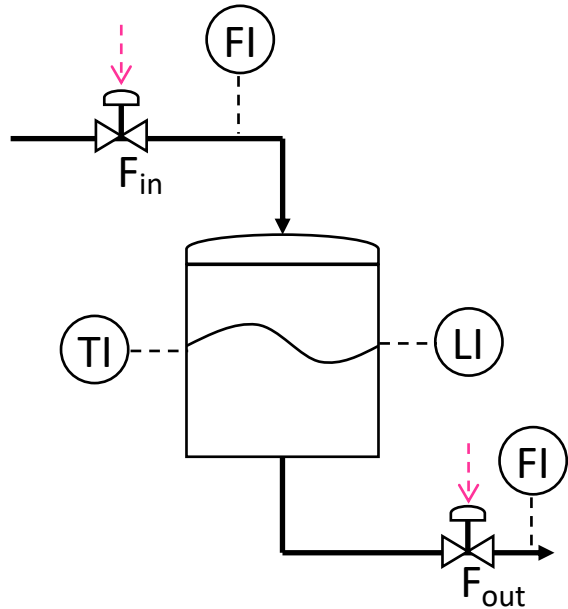
An MV with 'strong' effect on a PV can be adjusted to control the PV



$$M \gg N$$

Output PVs:	Several. May be designed
MVs:	Limited. Fixed by process design

# Simple Liquid Tank PVs



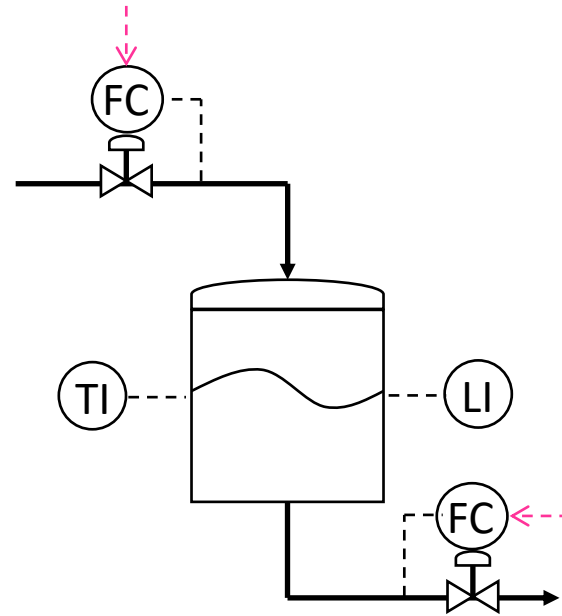
PVs:  $POS_{Fin}$ ,  $POS_{Fout}$ ,  $F_{in}$ ,  $F_{out}$ ,  $T_{tank}$ ,  $LVL_{tank}$ ,  $T_{in}$ ,  $T_{out}$  etc

Input PVs:  $POS_{Fin}$ ,  $POS_{Fout}$ ,  $T_{in}$

Output PVs:  $F_{in}$ ,  $F_{out}$ ,  $T_{tank}$ ,  $LVL_{tank}$ ,  $T_{out}$

Specified:  $POS_{Fin}$ ,  $POS_{Fout}$

MVs: None



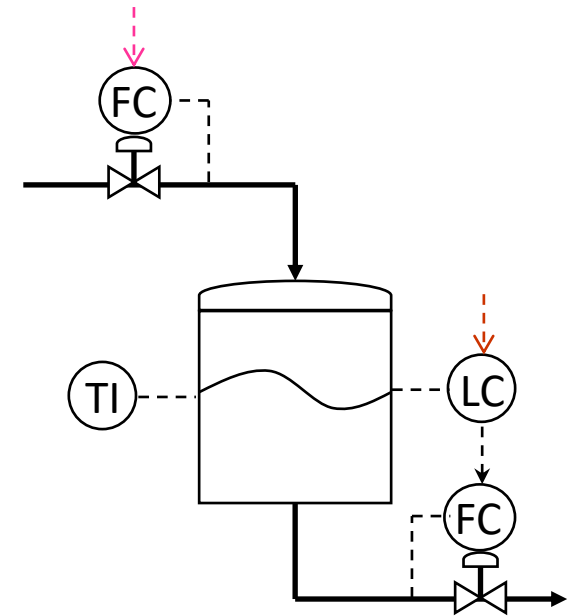
PVs: Previous +  $F_{in}^{SP}$ ,  $F_{out}^{SP}$

Input PVs:  $F_{in}^{SP}$ ,  $F_{out}^{SP}$ ,  $T_{in}$

Output PVs: Previous +  $POS_{Fin}$ ,  $POS_{Vout}$

Specified<sub>CVs</sub>:  $F_{in}^{SP}$ ,  $F_{out}^{SP}$

MVs:  $POS_{Fin}$ ,  $POS_{Fout}$



PVs: Previous +  $LVL_{tank}^{SP}$

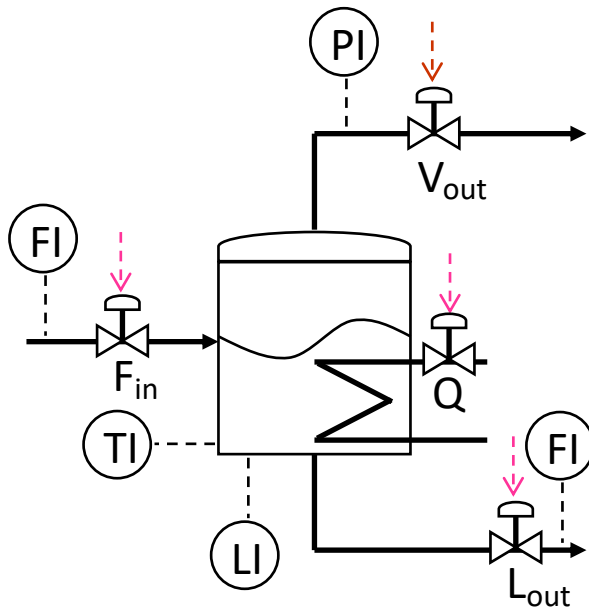
Input PVs:  $F_{in}^{SP}$ ,  $LVL_{tank}^{SP}$ ,  $T_{in}$

Output PVs: Previous +  $F_{out}^{SP}$

Specified<sub>CVs</sub>:  $F_{in}^{SP}$ ,  $LVL_{tank}^{SP}$

MVs:  $POS_{Fin}$ ,  $F_{out}^{SP}$

# Flash Drum PVs



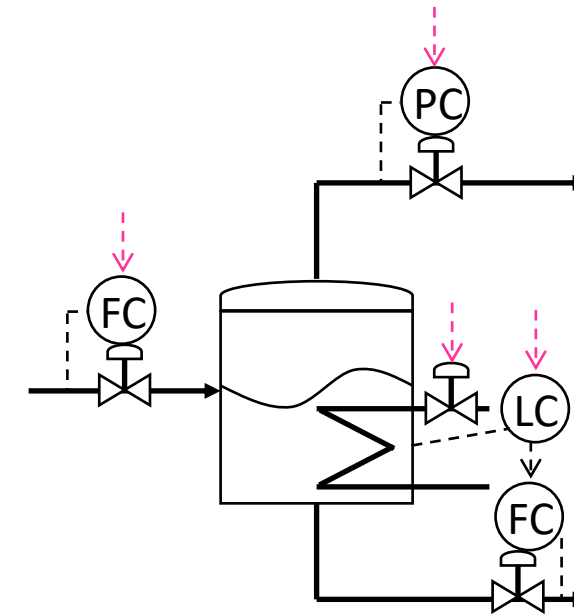
PVs: POS<sub>Fin</sub>, POS<sub>Vout</sub>, POS<sub>Q</sub>, POS<sub>Lout</sub>, F<sub>in</sub>, V<sub>out</sub>, L<sub>out</sub>, Q  
 z<sub>Fin</sub>, x<sub>Lout</sub>, y<sub>Vout</sub>, T<sub>tank</sub>, LVL<sub>tank</sub>, T<sub>Fin</sub>, T<sub>Vout</sub>, P<sub>tank</sub> etc

Input PVs: POS<sub>Fin</sub>, POS<sub>Vout</sub>, POS<sub>Lout</sub>, POS<sub>Q</sub>, T<sub>Fin</sub>, P<sub>Fin</sub>, z<sub>Fin</sub>, Q<sub>loss</sub>

Output PVs: F<sub>in</sub>, P<sub>tank</sub>, T<sub>tank</sub>, LVL<sub>tank</sub>, L<sub>out</sub>, V<sub>out</sub>

Specified: POS<sub>Fin</sub>, POS<sub>Lout</sub>, POS<sub>Vout</sub>, POS<sub>Q</sub>

MVs: None



PVs: Previous + F<sub>in</sub><sup>SP</sup>, P<sup>SP</sup>, LVL<sup>SP</sup>, POS<sub>Q</sub>, L<sub>out</sub><sup>SP</sup>

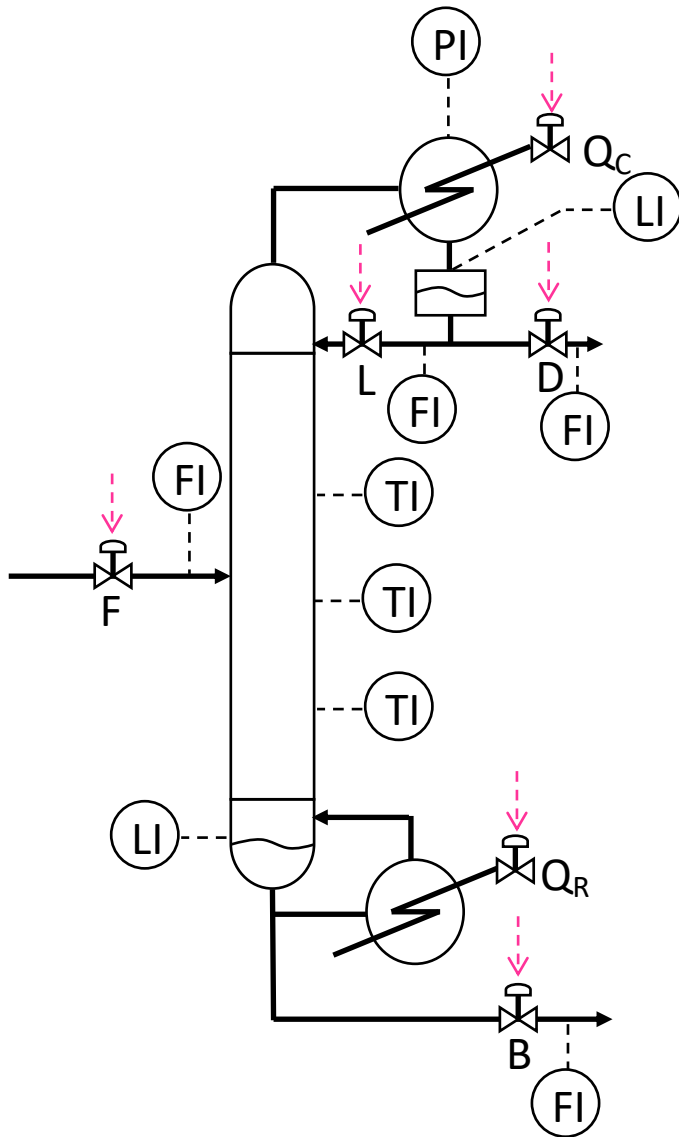
Input PVs: F<sub>in</sub><sup>SP</sup>, P<sup>SP</sup>, LVL<sup>SP</sup>, Q<sup>SP</sup>, T<sub>Fin</sub>, P<sub>Fin</sub>, z<sub>Fin</sub>, Q<sub>loss</sub>

Output PVs: Previous + POS<sub>Fin</sub>, POS<sub>Lout</sub>, POS<sub>Vout</sub>, POS<sub>Q</sub>, L<sub>out</sub><sup>SP</sup>

Specified<sub>CVs</sub>: F<sub>in</sub><sup>SP</sup>, P<sup>SP</sup>, LVL<sup>SP</sup>, POS<sub>Q</sub>

MVs: POS<sub>Fin</sub>, POS<sub>Lout</sub>, POS<sub>Vout</sub>

# Distillation Column PVs



PVs:  $POS_F$ ,  $POS_L$ ,  $POS_D$ ,  $POS_{QC}$ ,  $POS_B$ ,  $POS_{QR}$ ,  $F$ ,  $L$ ,  $B$ ,  $D$ ,  $Q_C$ ,  $Q_R$ ,  $Q_{loss}$ ,  $z_F$ ,  $T_F$ ,  $P_F$ ,  $P_{col}$ ,  $T_{trays}$ ,  $x_D$ ,  $x_B$ ,  $LVL_C$ ,  $LVL_R$ , etc

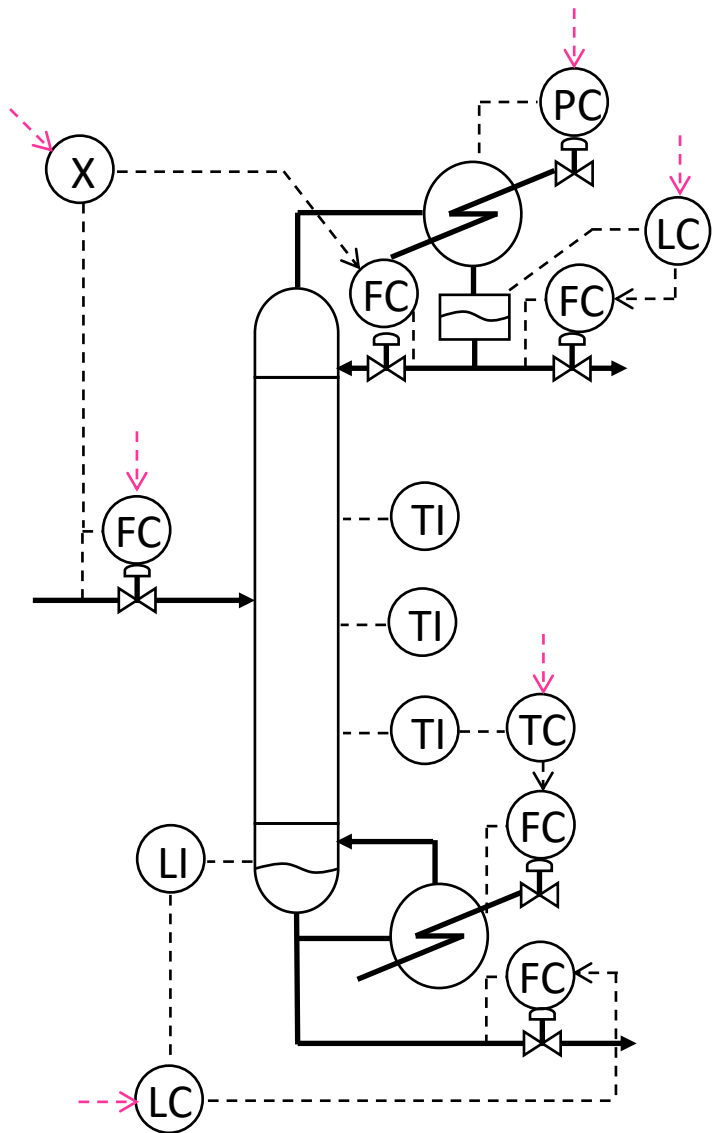
Input PVs:  $POS_{Fin}$ ,  $POS_{Vout}$ ,  $POS_{Lout}$ ,  $POS_Q$ ,  $T_{Fin}$ ,  $P_F$ ,  $z_{Fin}$ ,  $Q_{loss}$

Output PVs:  $F_{in}$ ,  $L$ ,  $B$ ,  $D$ ,  $P_{col}$ ,  $LVL_C$ ,  $LVL_R$ ,  $T_{trays}$

Specified:  $POS_F$ ,  $POS_L$ ,  $POS_D$ ,  $POS_B$ ,  $POS_{QC}$ ,  $POS_{QR}$

MVs: None

# Distillation Column PVs



PVs: Previous +  $P^{SP}$ ,  $F^{SP}$ ,  $LVL_C^{SP}$ ,  $LVL_R^{SP}$ ,  $T_{tray}^{SP}$ ,  $[L/F]^{SP}$ ,  $Q_R^{SP}$ ,  $L^{SP}$ ,  $D^{SP}$ ,  $B^{SP}$

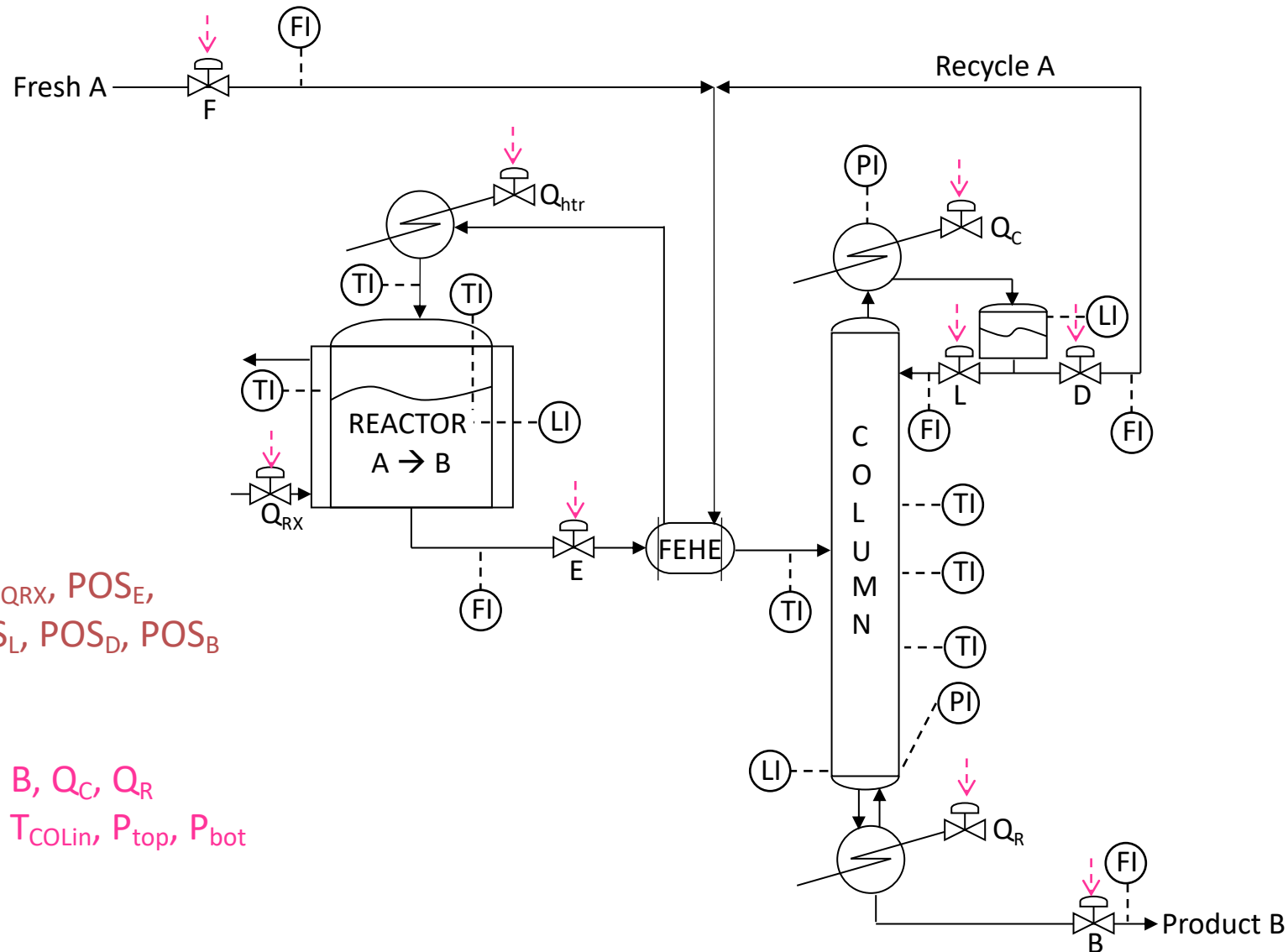
Input PVs:  $P^{SP}$ ,  $F^{SP}$ ,  $LVL_C^{SP}$ ,  $LVL_R^{SP}$ ,  $T_{tray}^{SP}$ ,  $[L/F]^{SP}$ ,  $T_F$ ,  $P_F$ ,  $z_{Fin}$ ,  $Q_{loss}$

Output PVs: Previous +  $Q_R^{SP}$ ,  $L^{SP}$ ,  $D^{SP}$ ,  $B^{SP}$ ,  $POS_F$ ,  $POS_L$ ,  $POS_D$ ,  $POS_{QC}$ ,  $POS_B$ ,  $POS_{QR}$

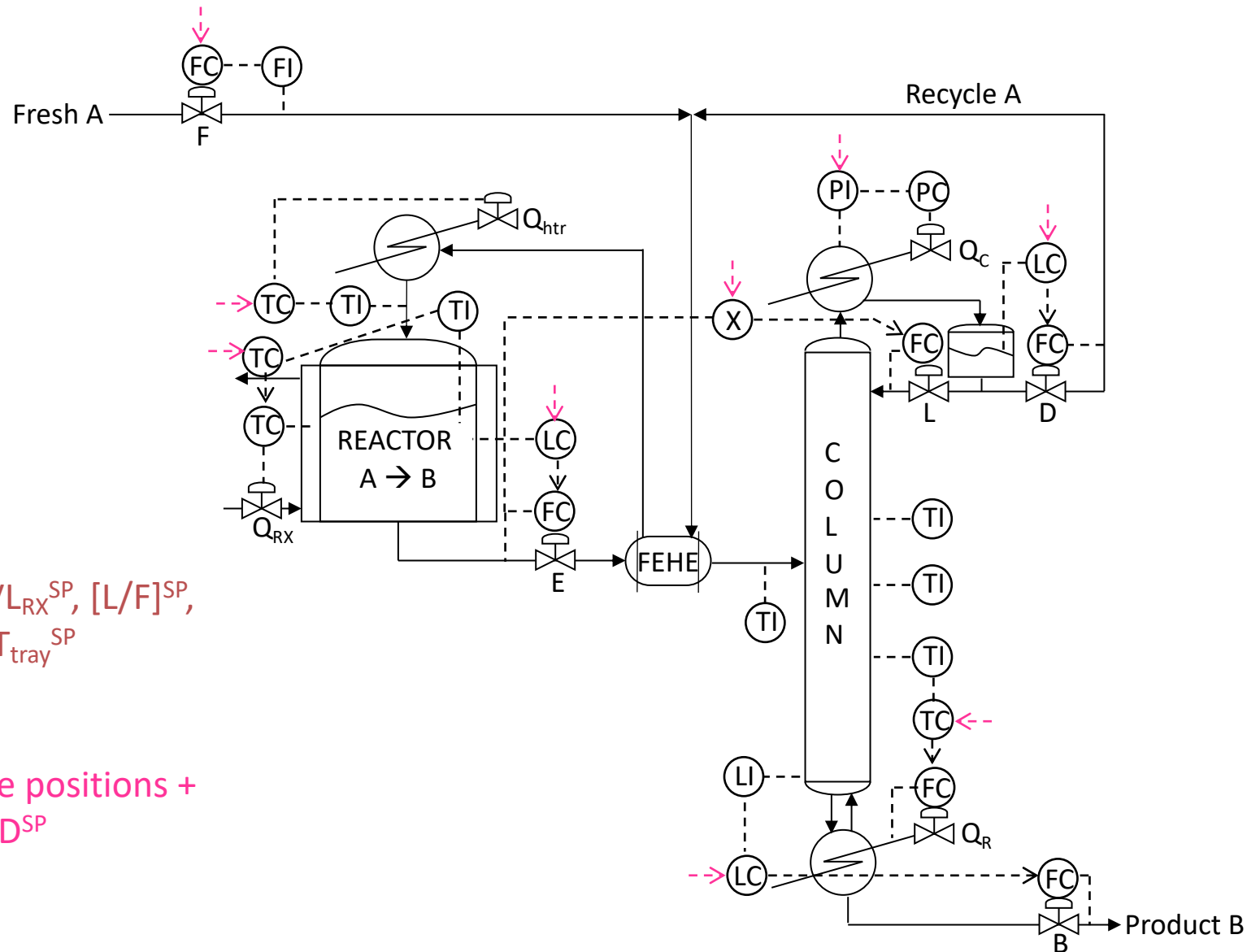
Specified<sub>CVs</sub>:  $F^{SP}$ ,  $P^{SP}$ ,  $LVL_R^{SP}$ ,  $LVL_C^{SP}$ ,  $T_{tray}^{SP}$ ,  $[L/F]^{SP}$

MVs:  $POS_F$ ,  $POS_{QC}$ ,  $B^{SP}$ ,  $D^{SP}$ ,  $Q_R^{SP}$ ,  $L^{SP}$

# Toy Process PVs



# Toy Process PVs



## Specified<sub>CVs</sub>

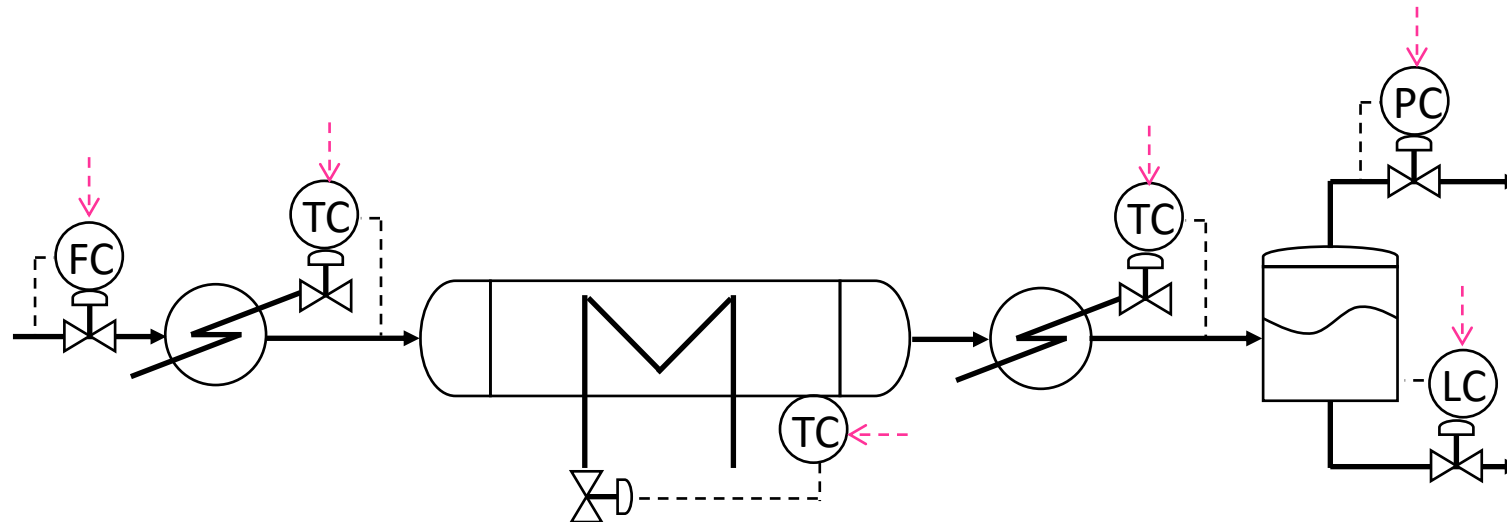
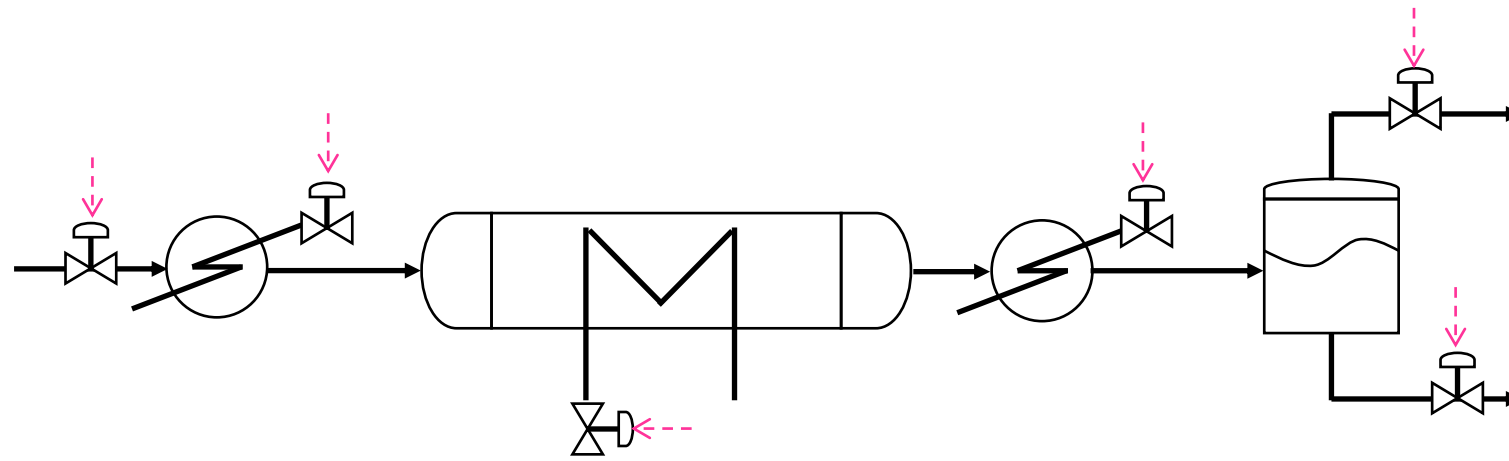
$F^{SP}$ ,  $T_{RXin}^{SP}$ ,  $T_{RX}^{SP}$ ,  $LVL_{RX}^{SP}$ ,  $[L/F]^{SP}$ ,  
 $P^{SP}$ ,  $LVL_C^{SP}$ ,  $LVL_R^{SP}$ ,  $T_{tray}^{SP}$

## Output PVs

Previous + all valve positions +  
 $T_J^{SP}$ ,  $F_E^{SP}$ ,  $Q_R^{SP}$ ,  $B^{SP}$ ,  $D^{SP}$



# Identify and Classify Relevant PVs



# Summary

- Several PVs in any process
  - Causal or input PVs
    - MVs and disturbances
  - Effected or output PVs
    - Potentially infinite output PVs
    - May be controlled using MVs
- # of MVs is fixed and limited
  - Limits # of outputs that can be controlled
  - Choose what is controlled 'wisely'
  - Process understanding is key
- A control system creates new relationships between PVs
  - Classification of PVs depends on the control system implemented
  - Alters dynamic characteristics of the process by variability transformation