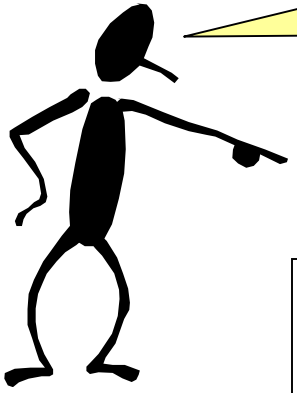
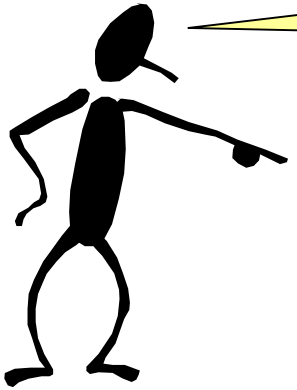
CHAPTER 2 : CONTROL OBJECTIVES AND BENEFITS



When I complete this chapter, I want to be able to do the following.

- **Recognize examples of the seven (7) control objectives in chemical processes**
- **Calculate indicators of variability in a process variable**
- **Be able to calculate the economic impact of variability**

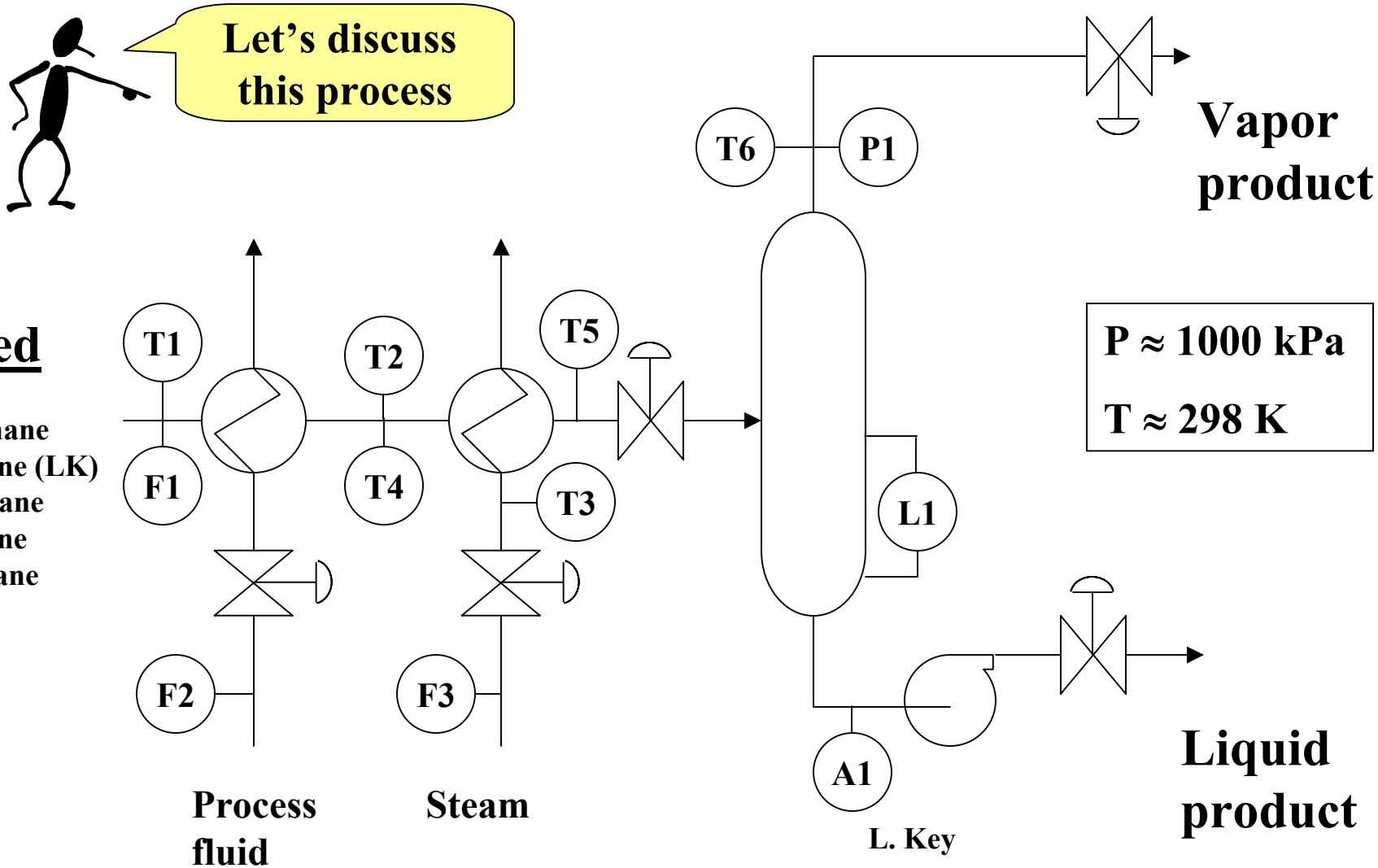
CHAPTER 2 : CONTROL OBJECTIVES AND BENEFITS



Outline of the lesson.

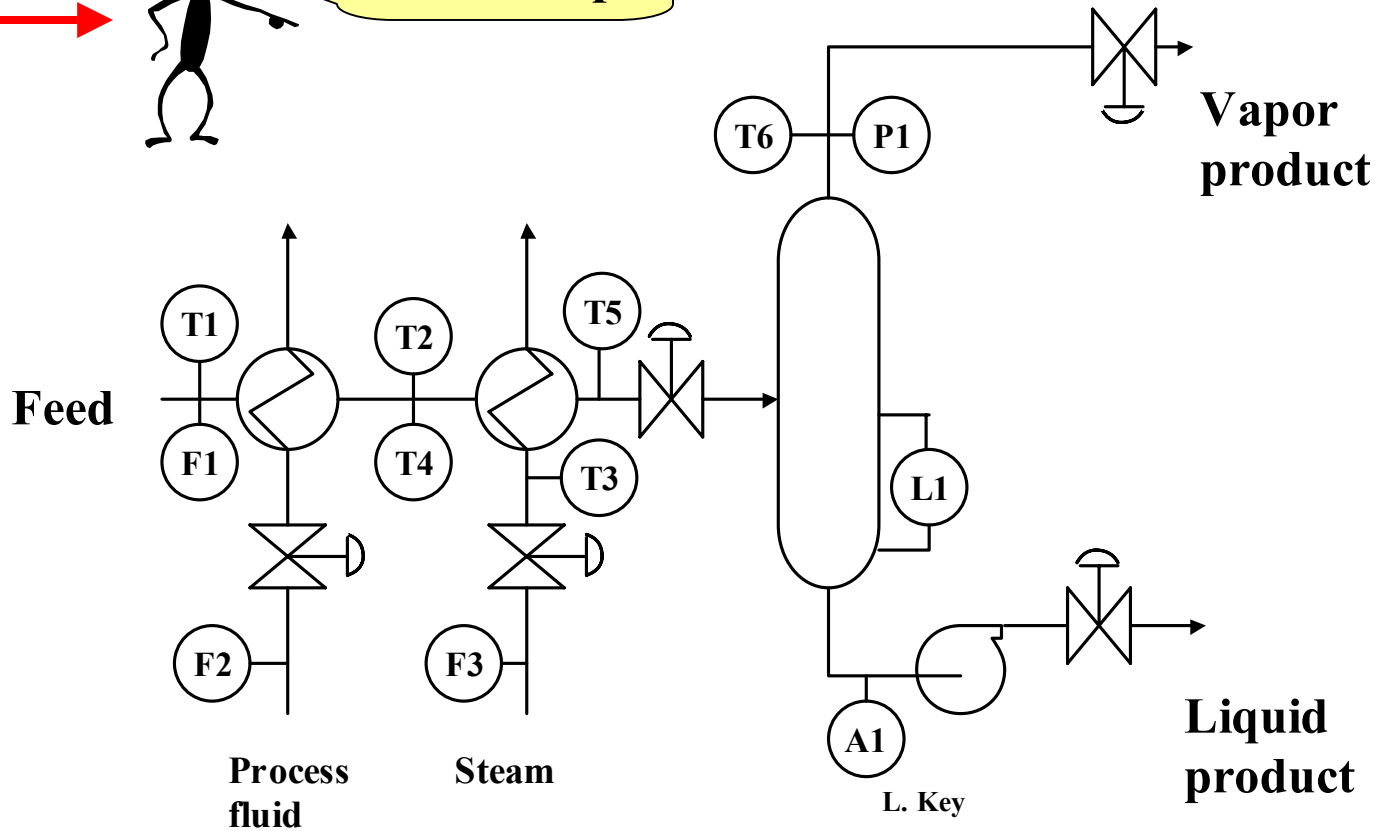
- **Seven (7) Control Objectives**
  1. **Safety**
  2. **Environmental protection**
  3. **Equipment protection**
  4. **Smooth operation**
  5. **Product quality**
  6. **Profit**
  7. **Monitoring and diagnosis**
- **Variability measures**
- **Economic impact of variability**
- **Workshop**

EXAMPLE PROCESS: FLASH SEPARATION



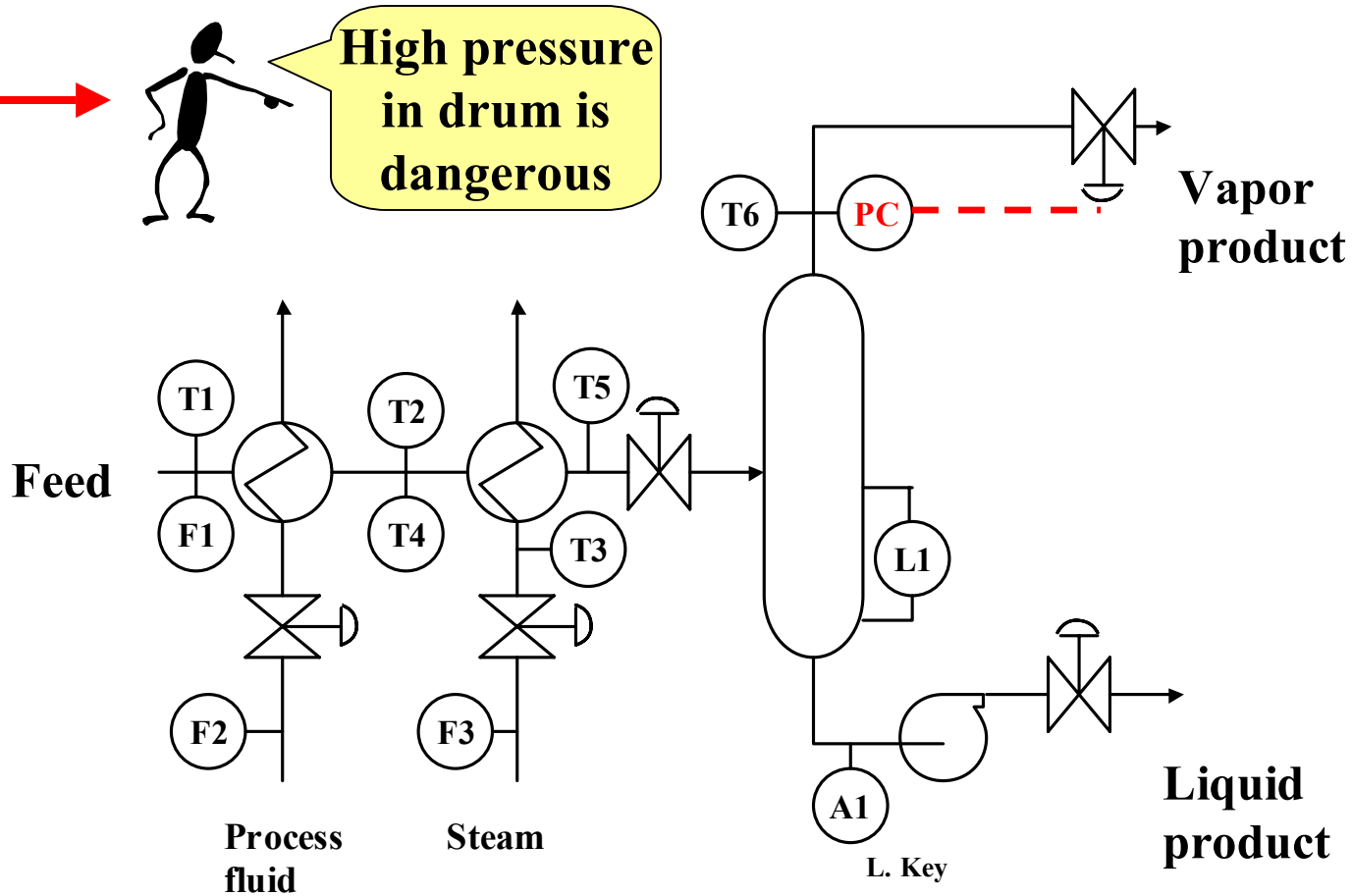
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



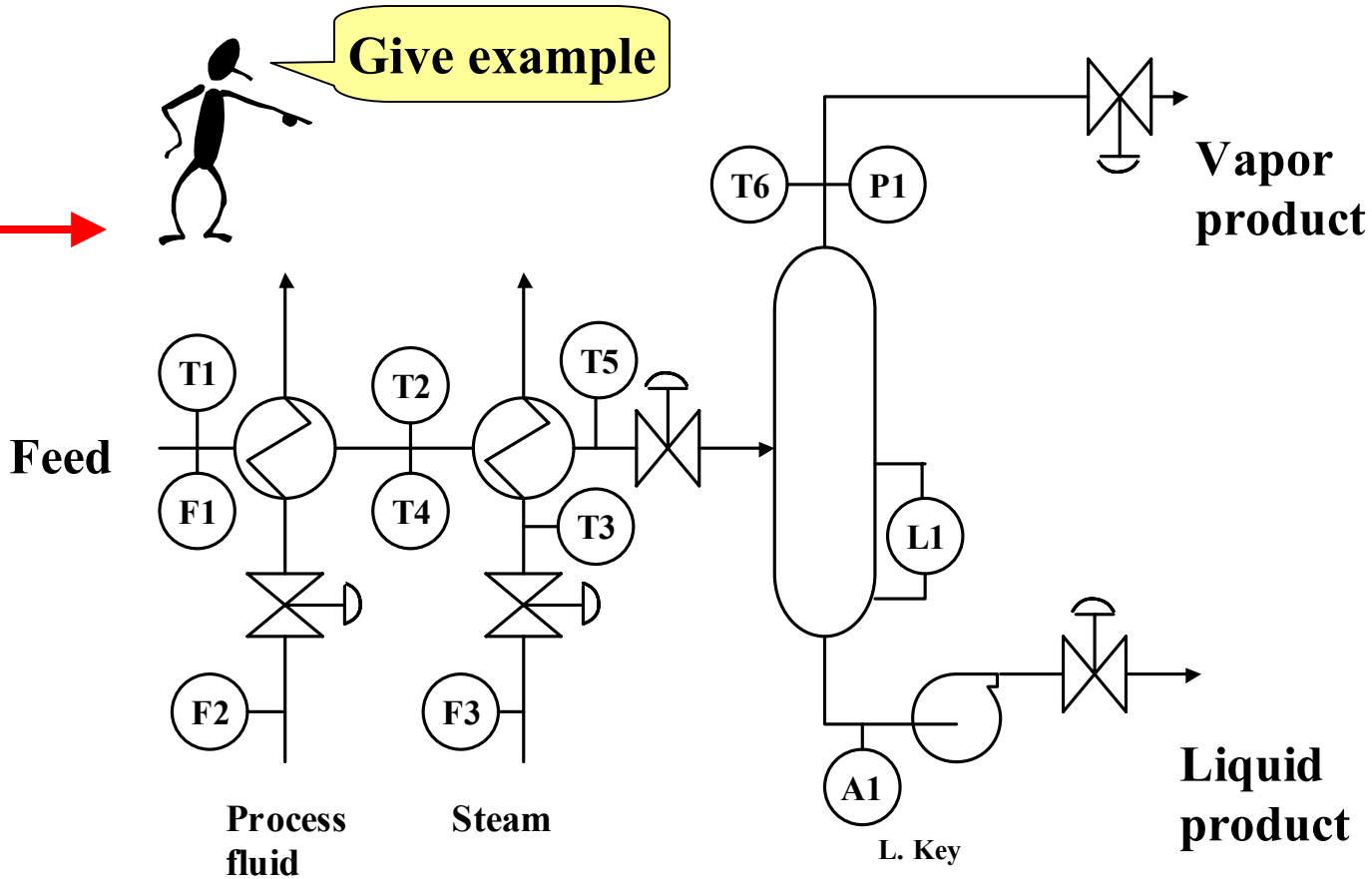
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



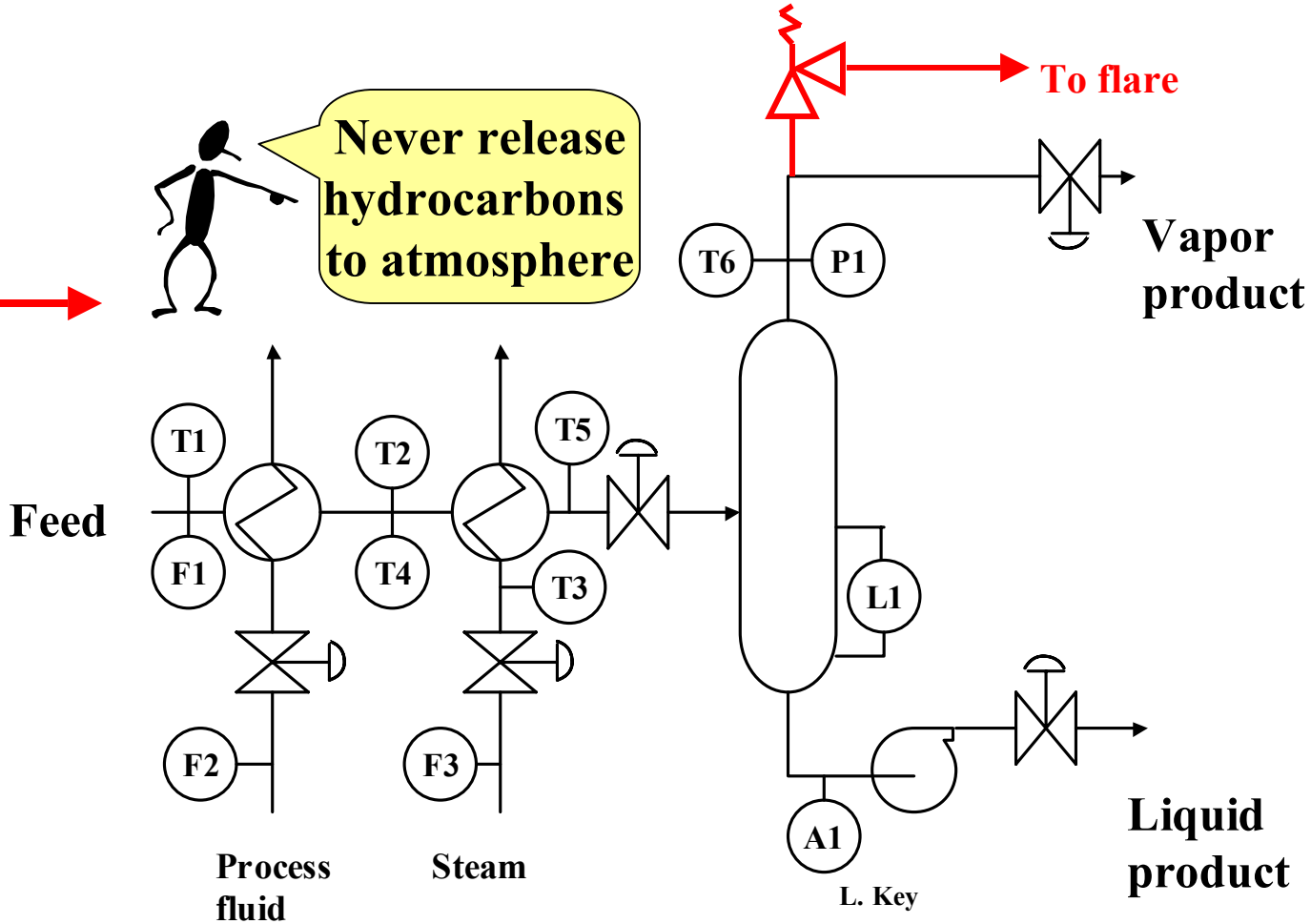
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



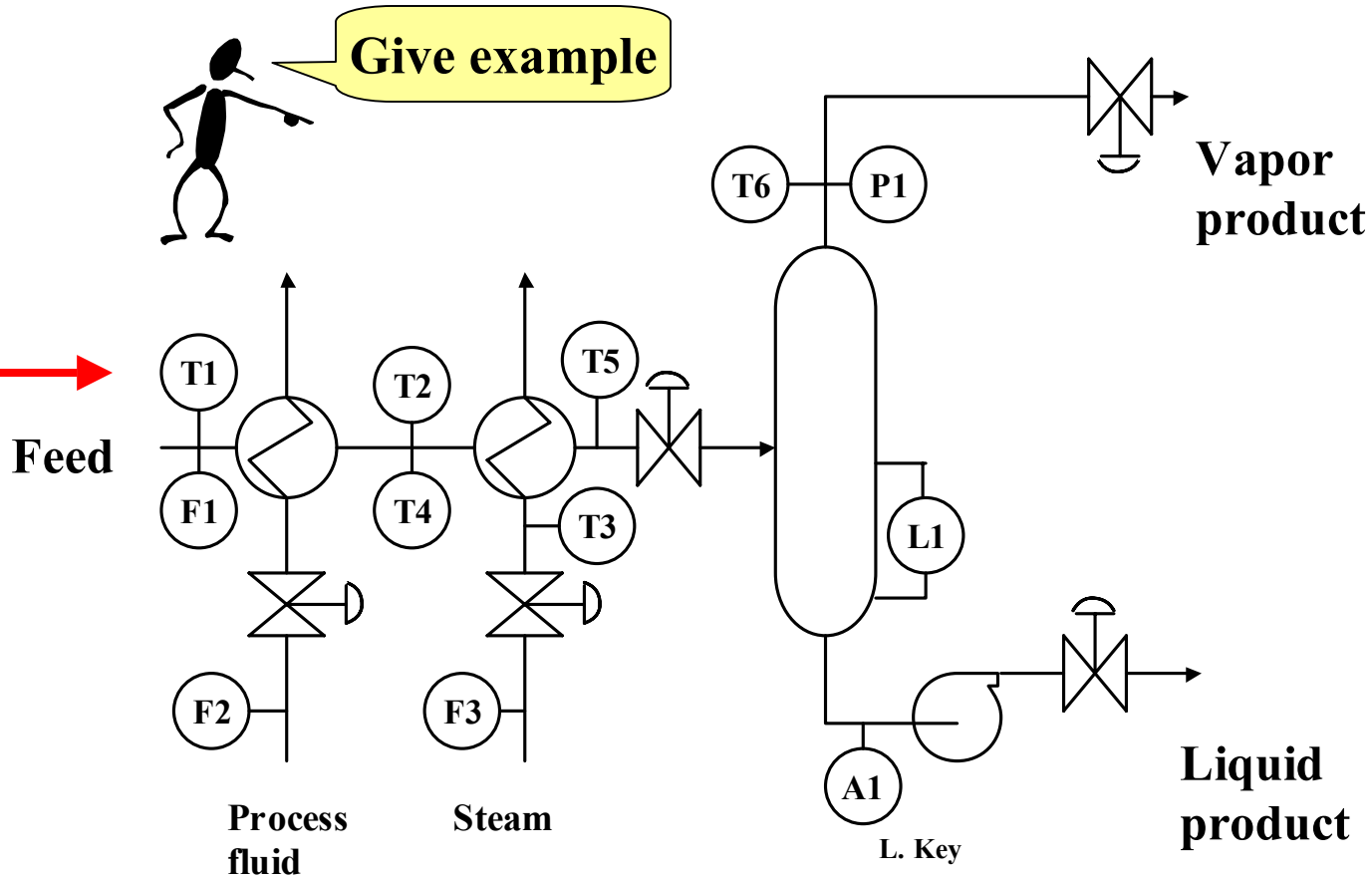
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



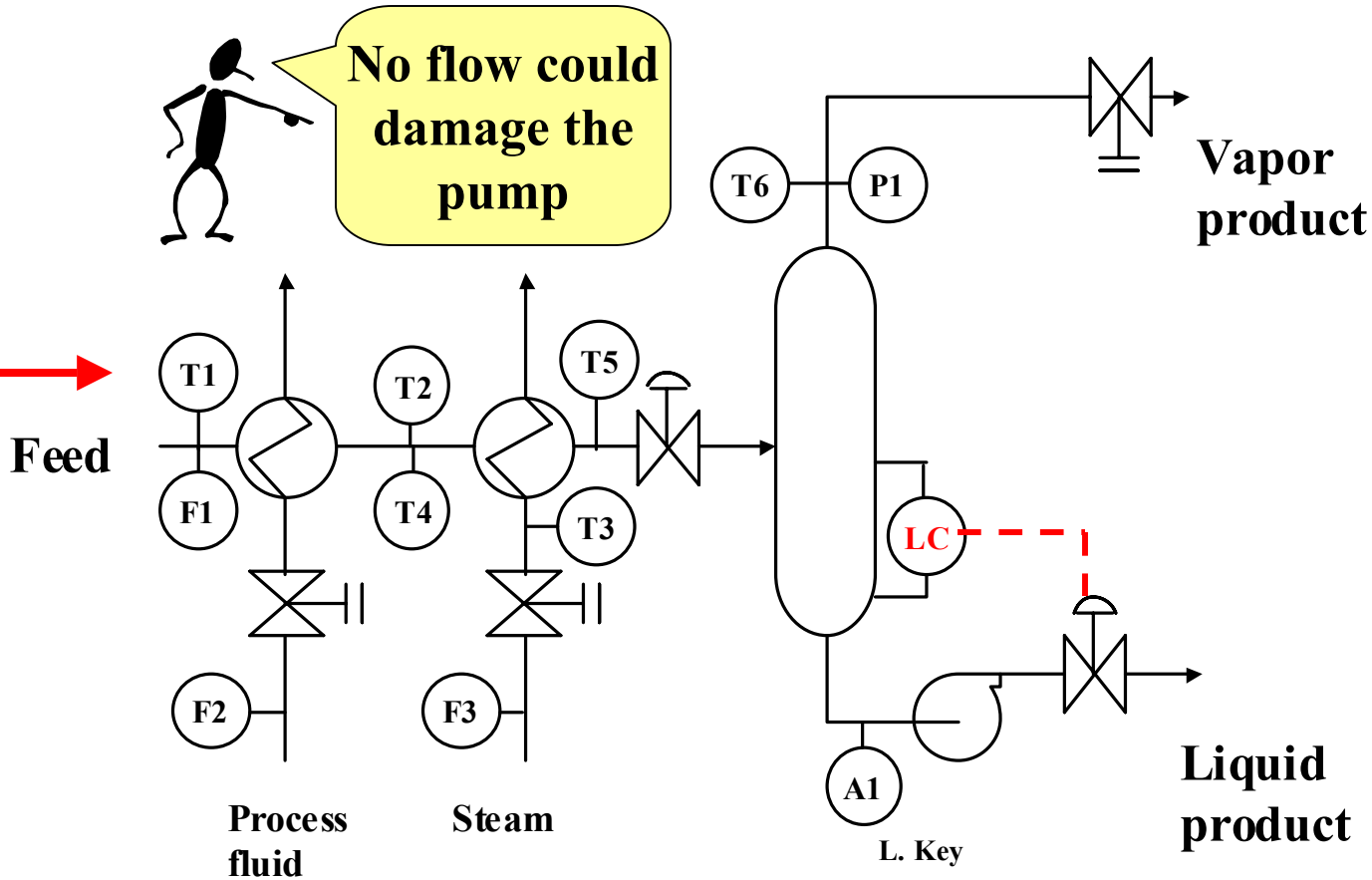
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



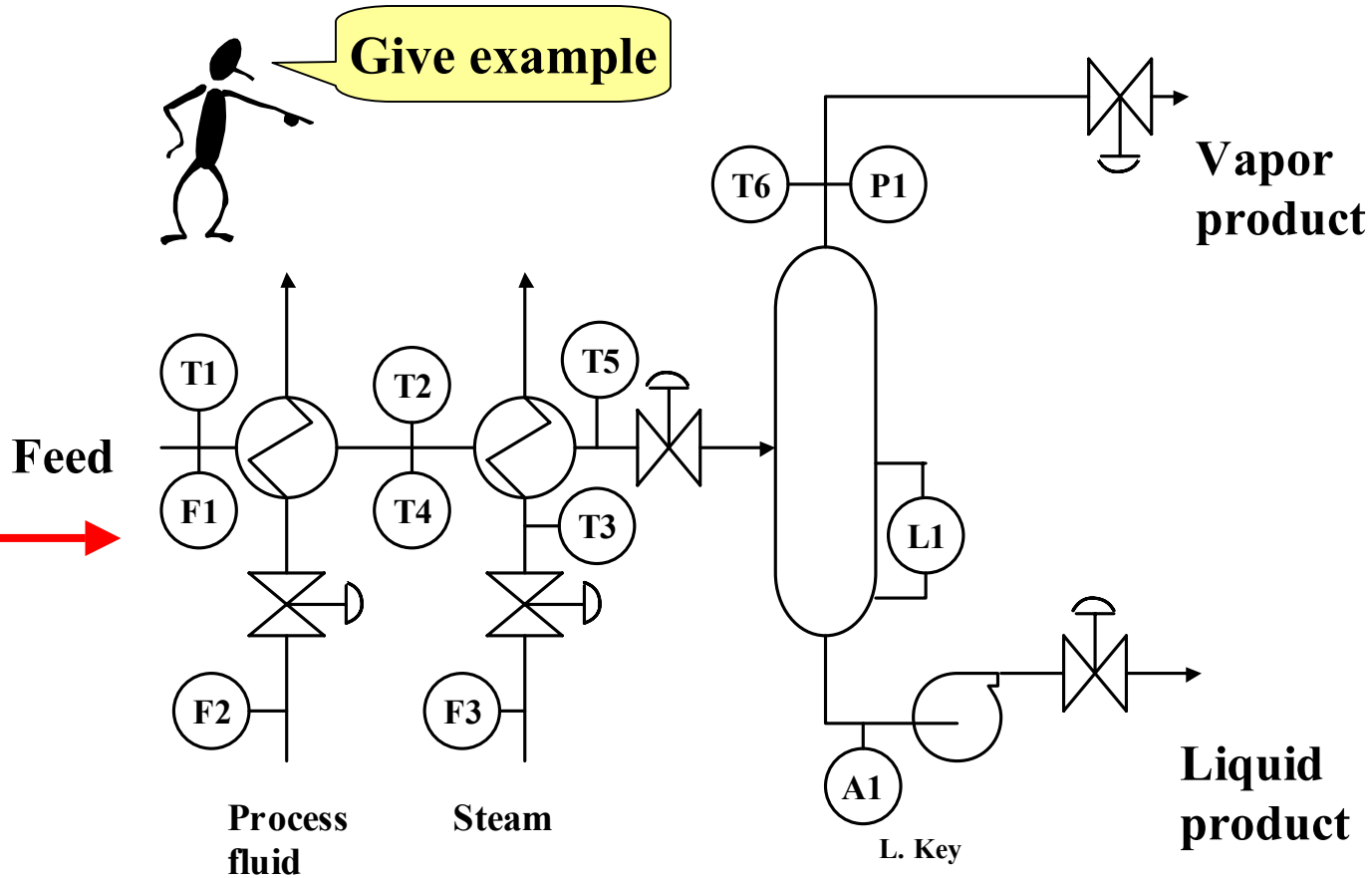
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



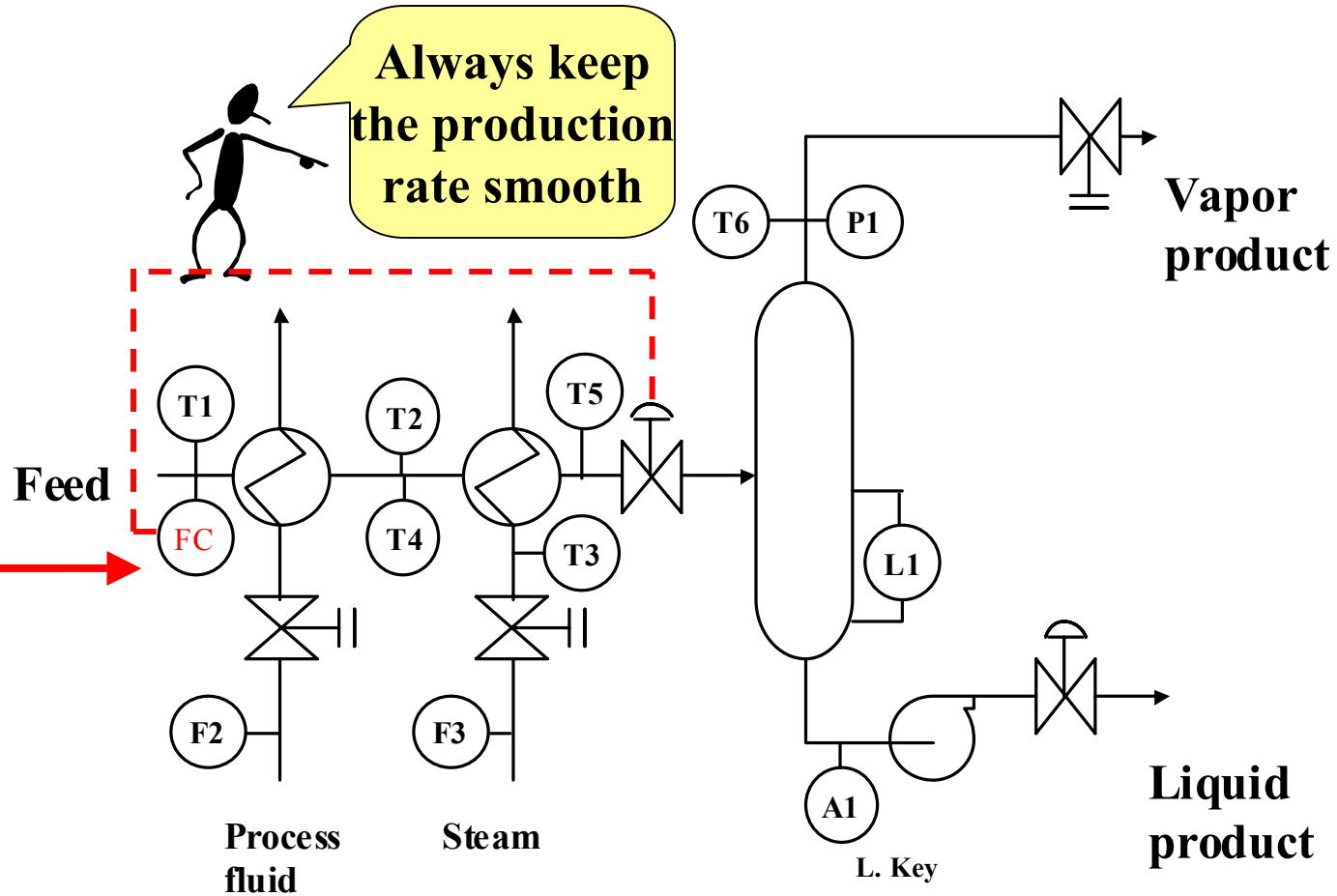
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



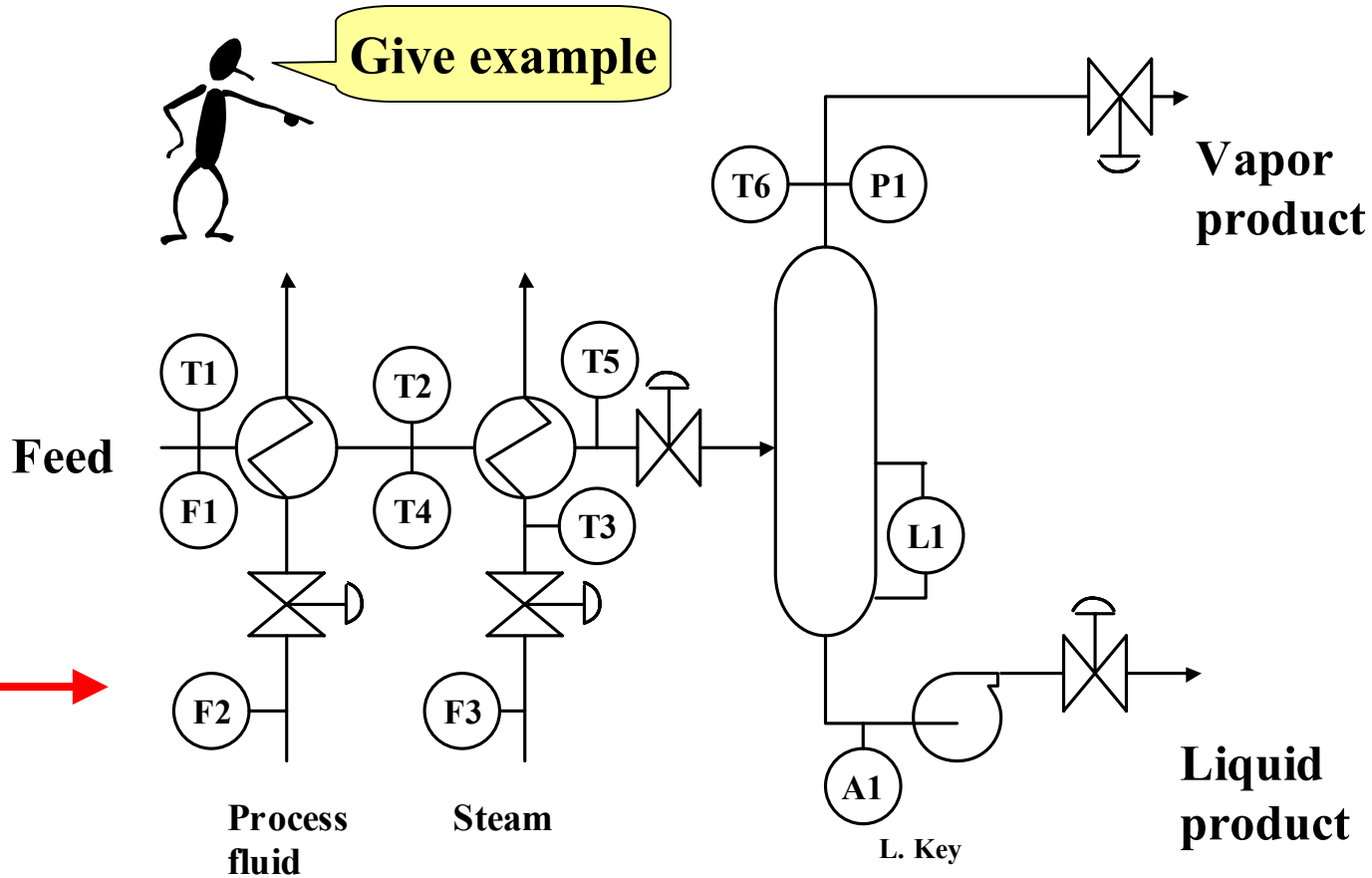
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



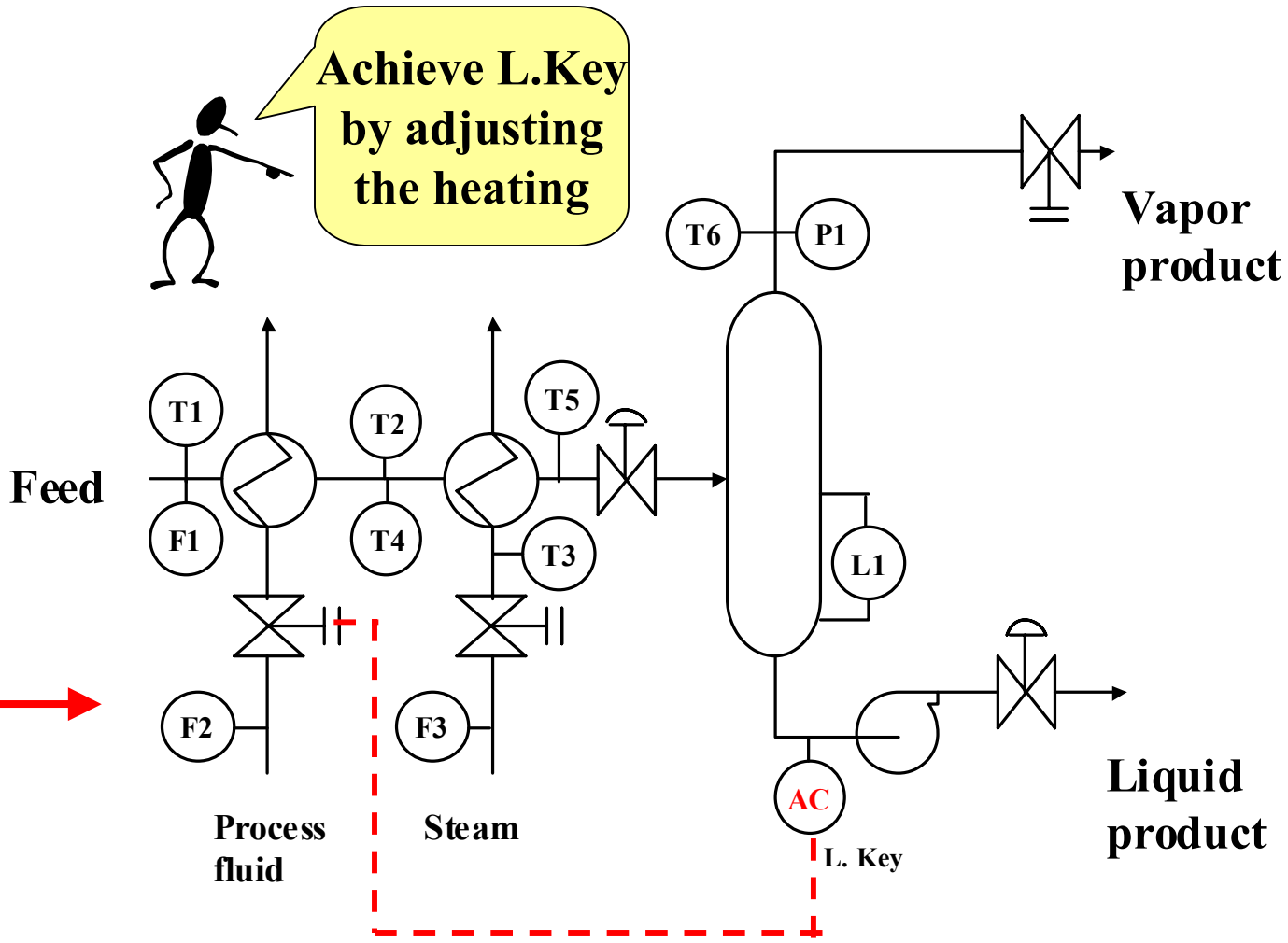
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



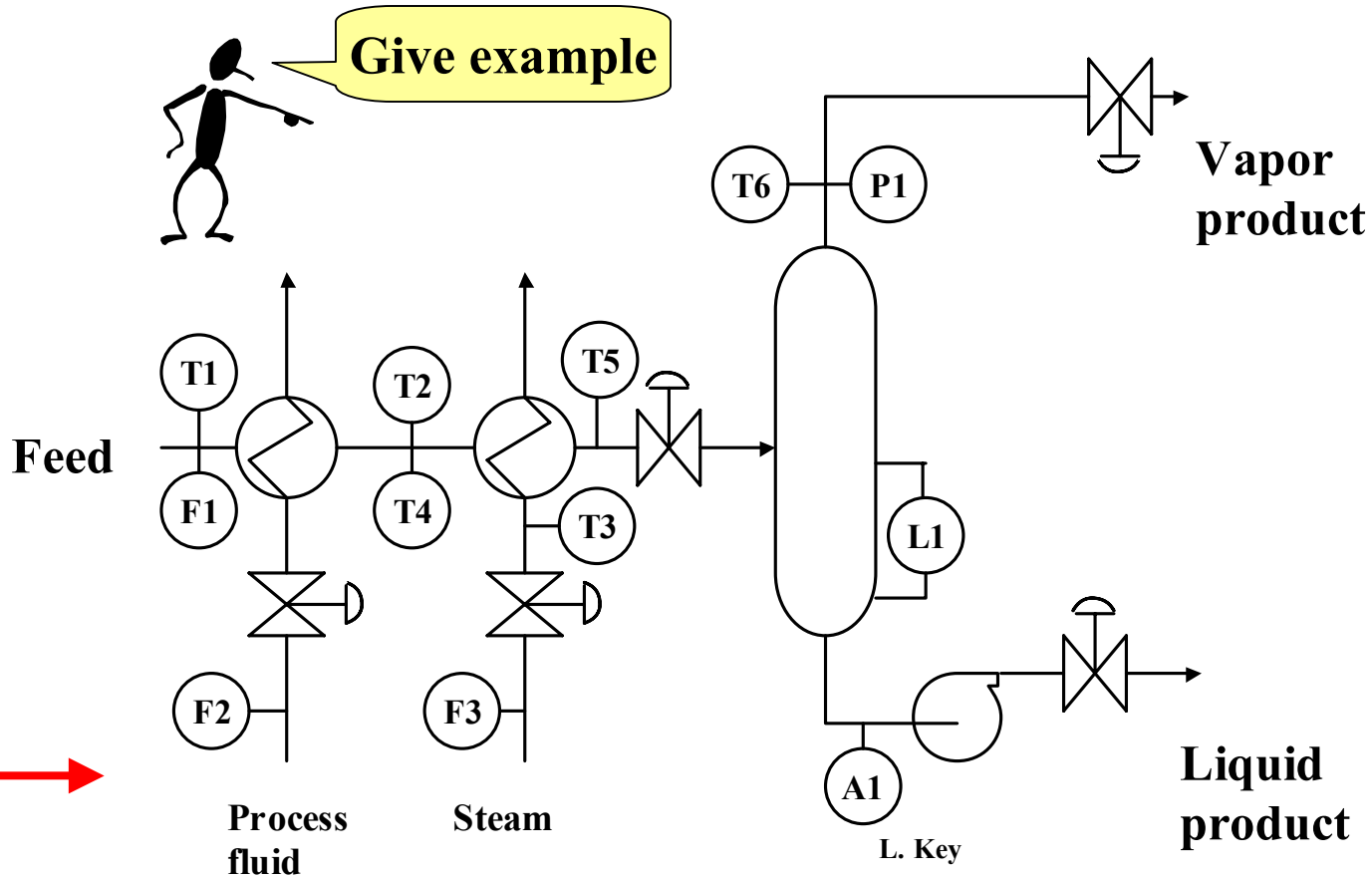
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



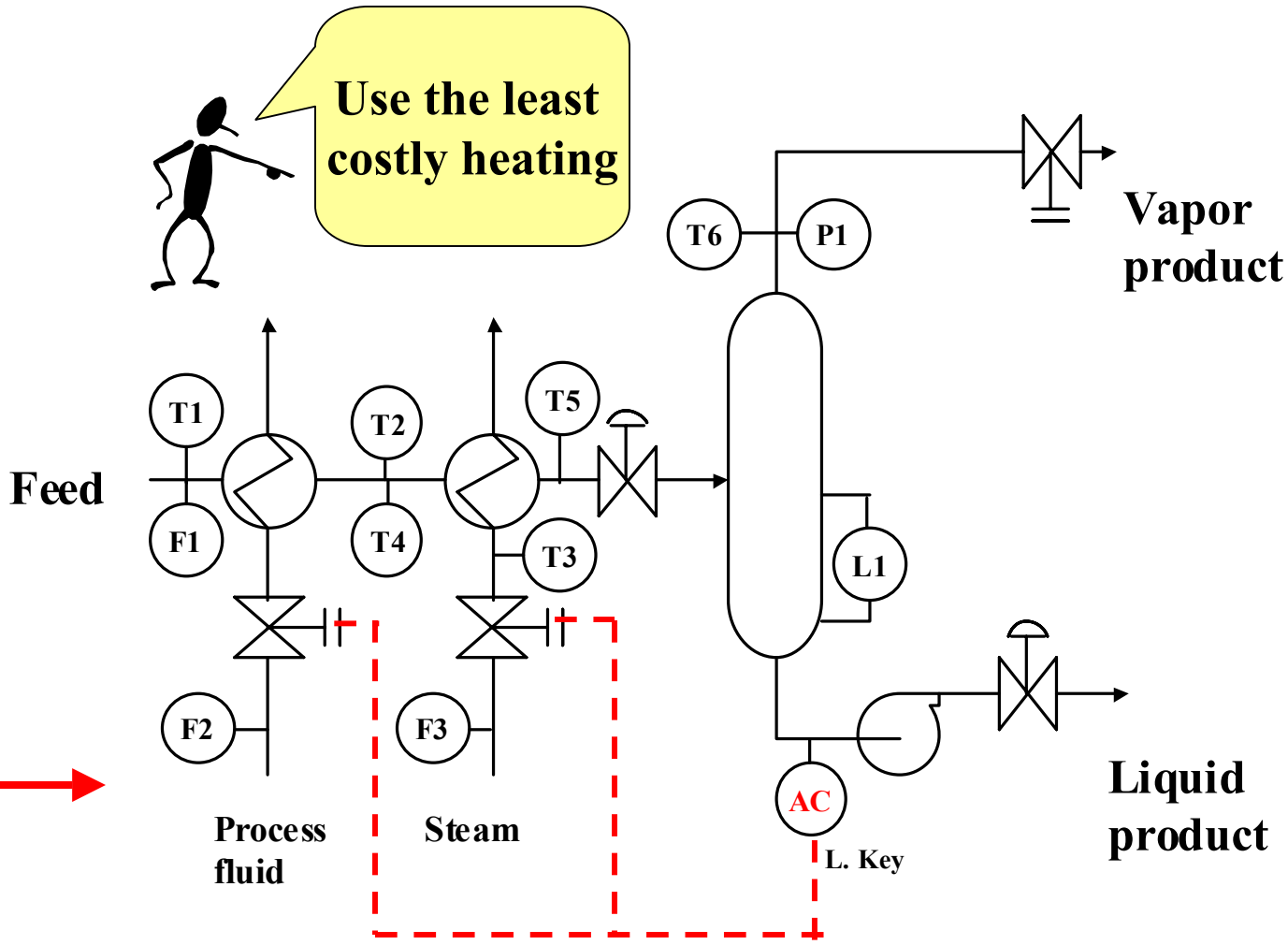
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



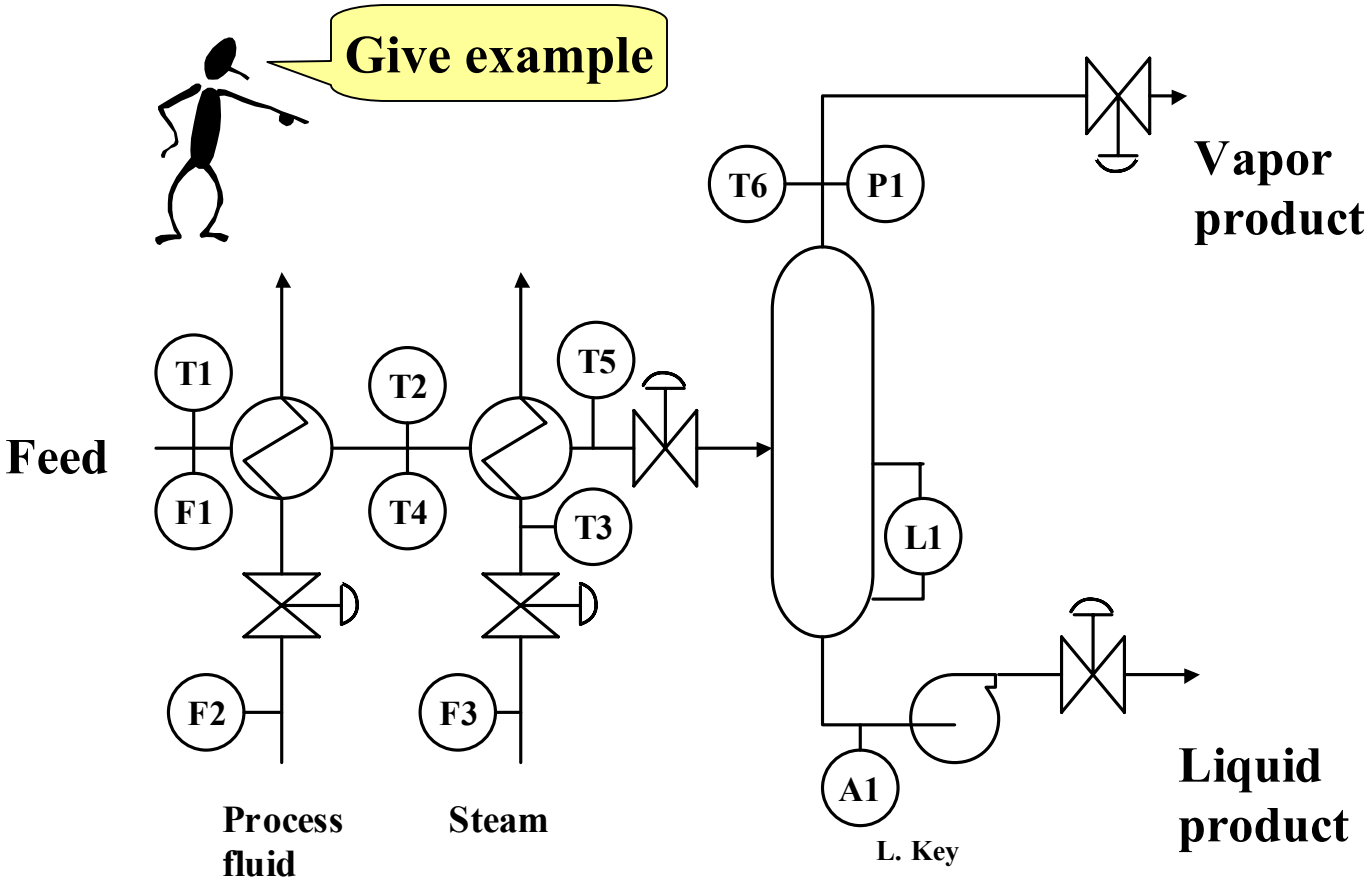
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



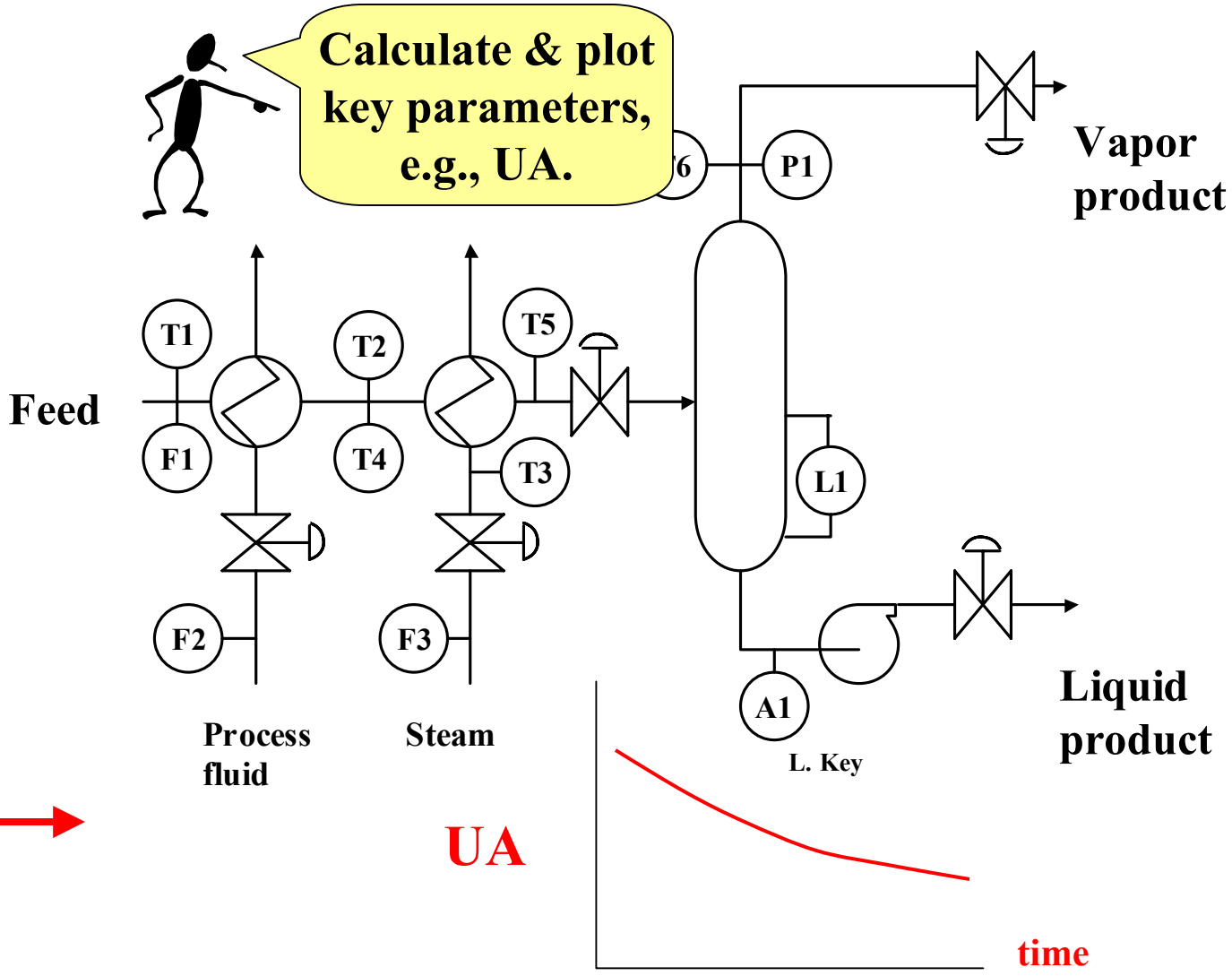
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis



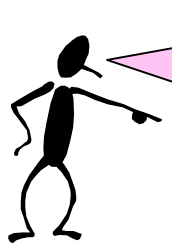
SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis

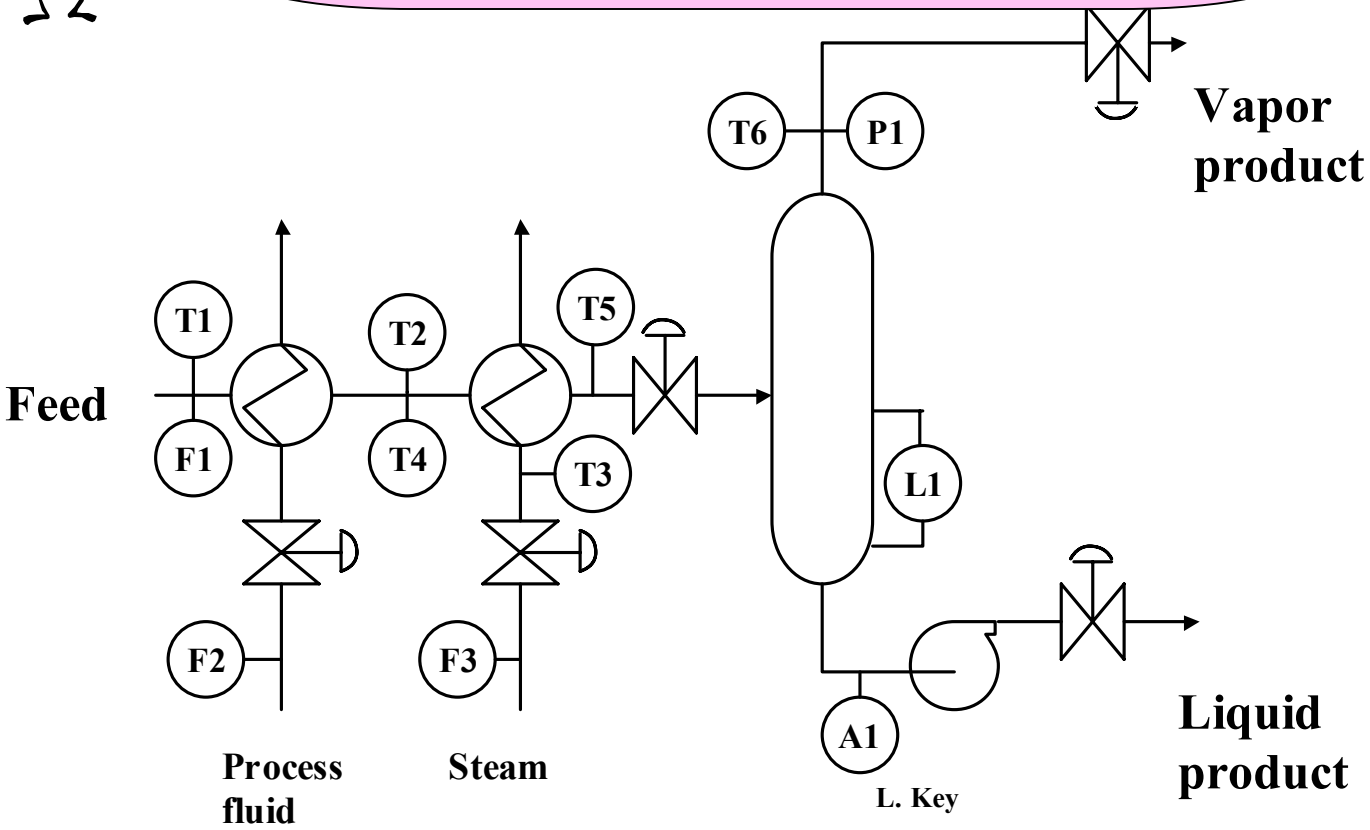


SEVEN CONTROL OBJECTIVES

1. Safety
2. Environmental Protection
3. Equipment protection
4. Smooth operation production rate
5. Product quality
6. High profit
7. Monitoring & diagnosis

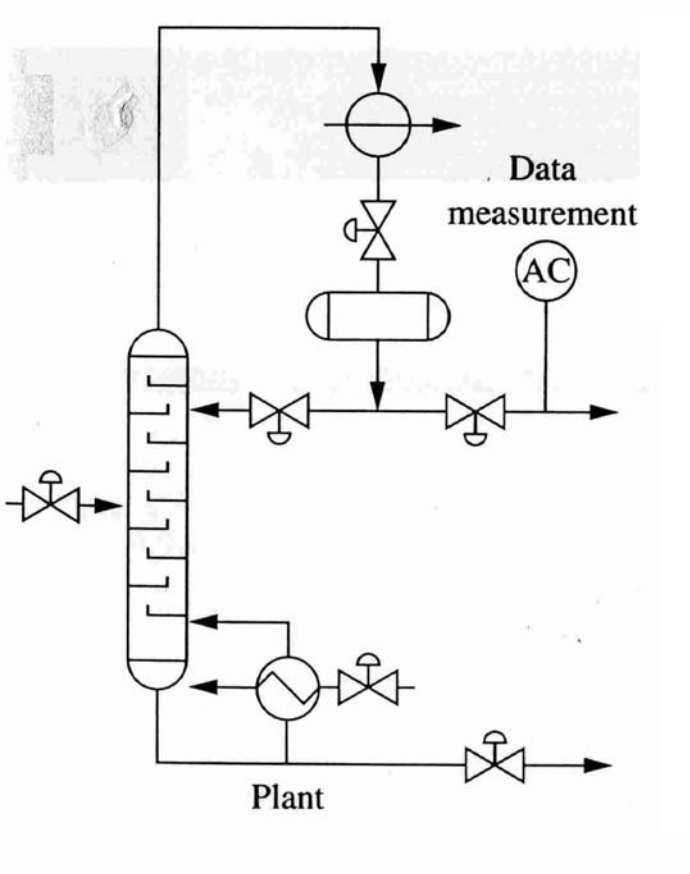


All seven must be achieved. Failure to do so will lead to operation that is **unprofitable or worse, unsafe.**



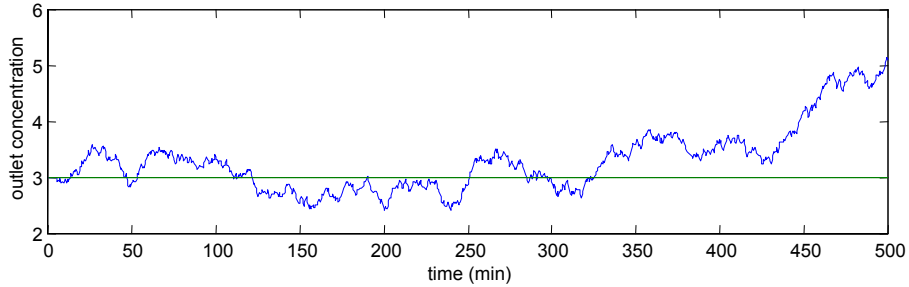
BENEFITS FROM PROCESS CONTROL

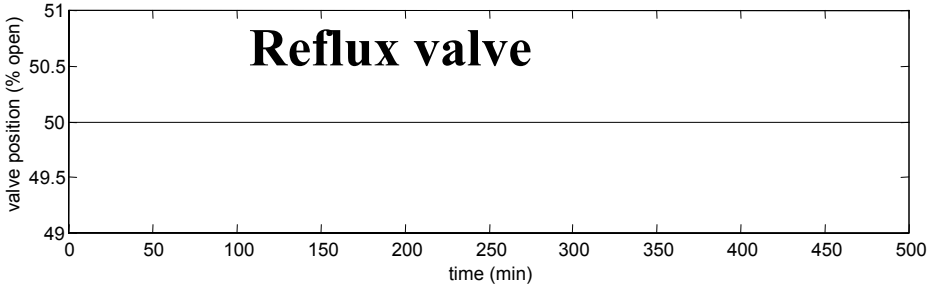
When we control a process, we reduce the variability of key variables to achieve the seven objectives.



Without feedback control

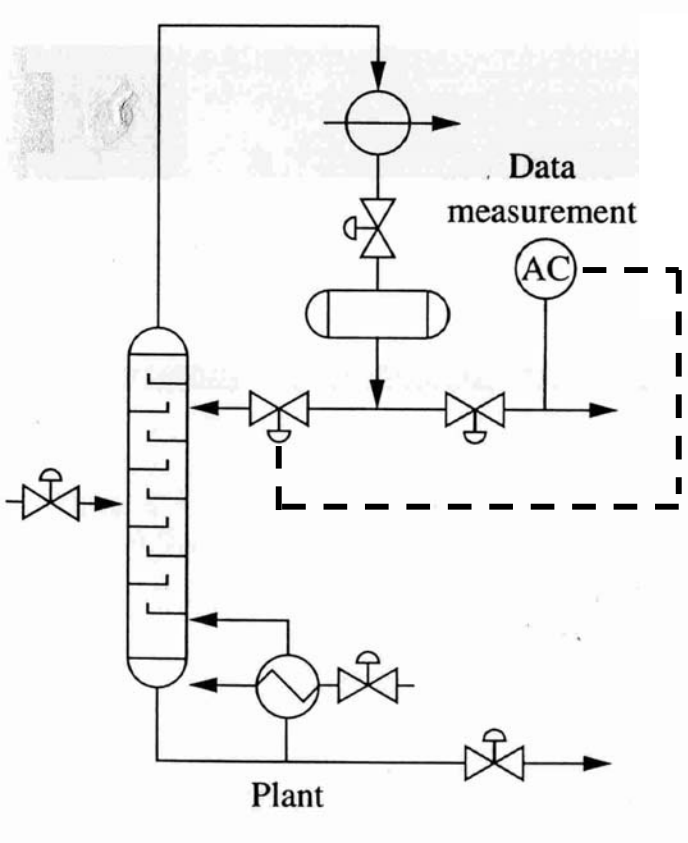
Composition (% H. Key)



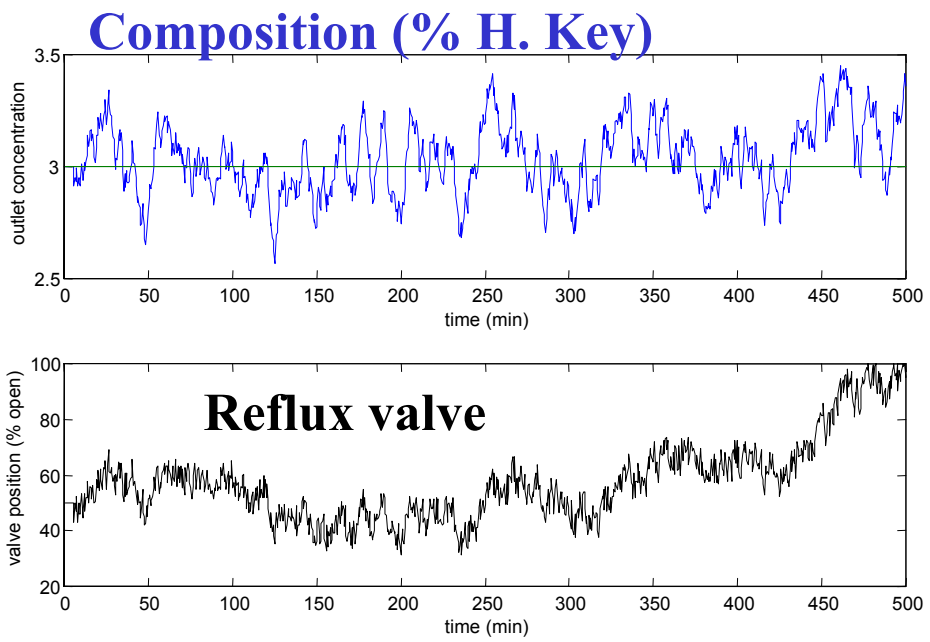


BENEFITS FROM PROCESS CONTROL

When we control a process, we reduce the variability of key variables to achieve the seven objectives.



With feedback control



Variability is moved from controlled to manipulated variable!

BENEFITS FROM PROCESS CONTROL

When we control a process, we reduce the variability of key variables to achieve the seven objectives.

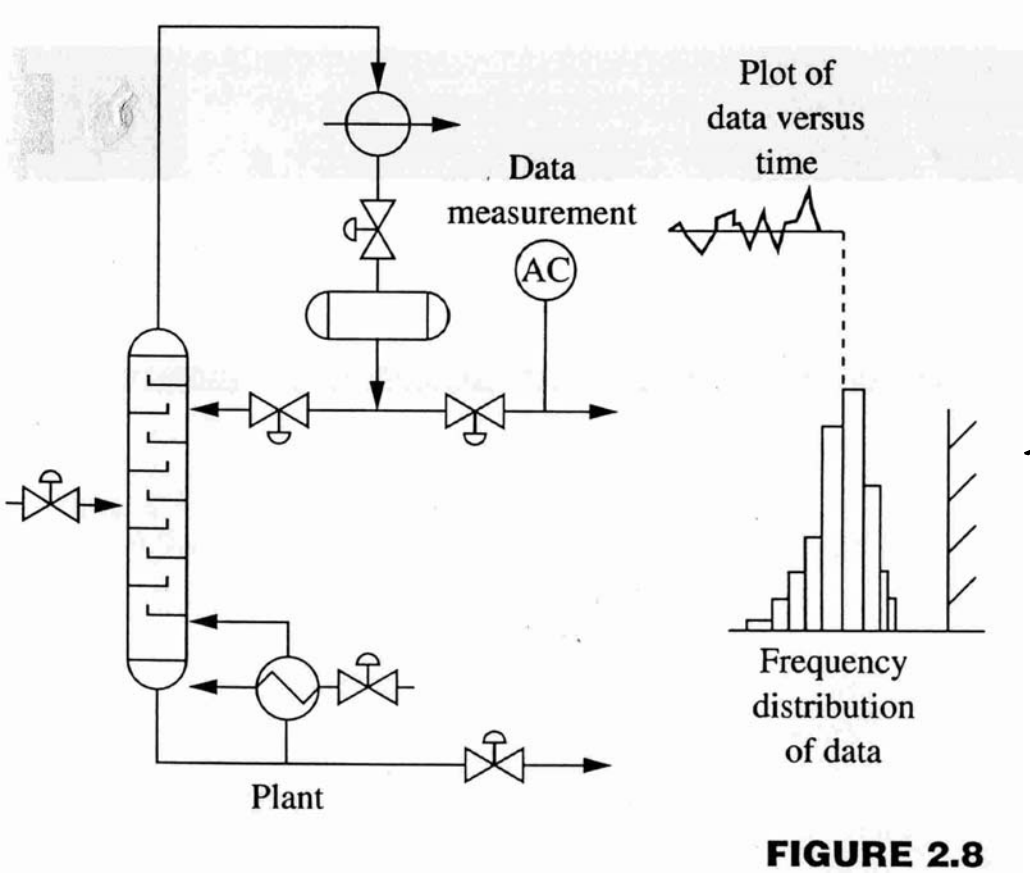


FIGURE 2.8

What statistics can we calculate from this data?

How do we relate variability to process performance?

BENEFITS FROM PROCESS CONTROL

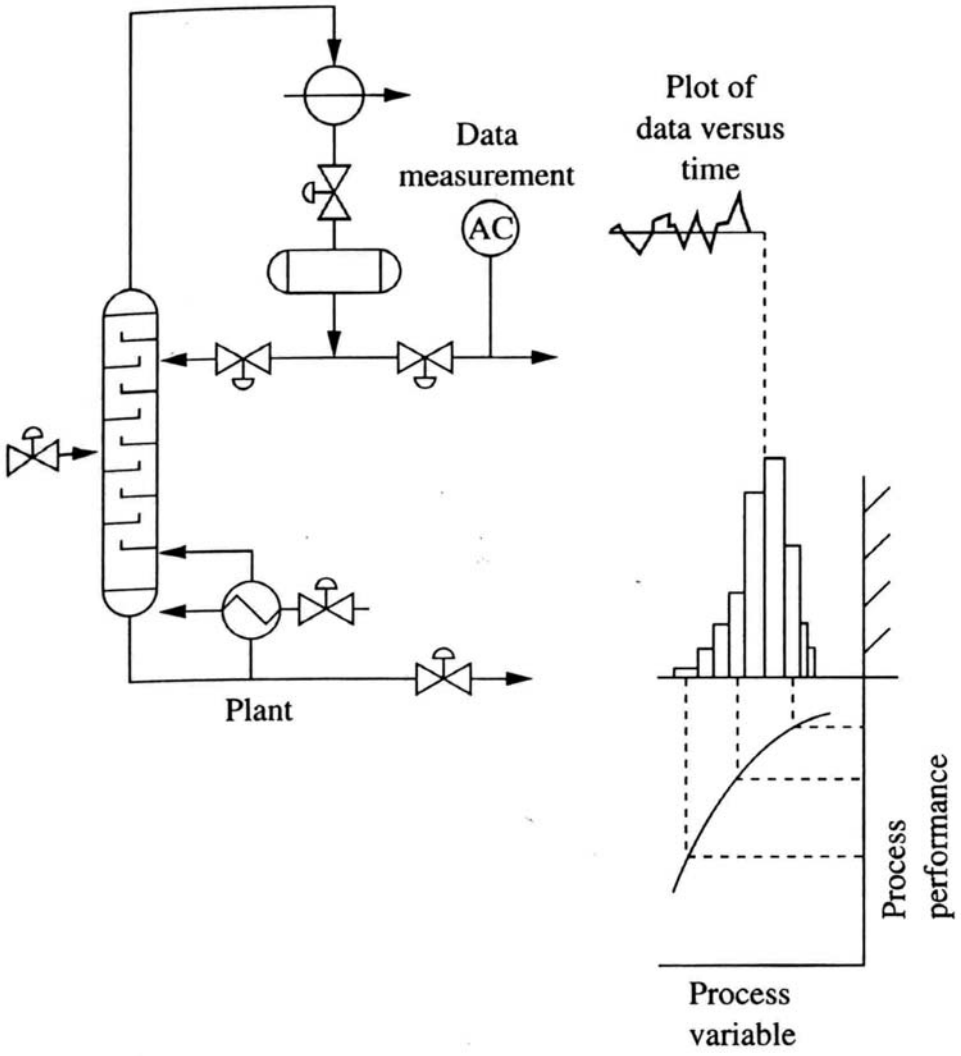


FIGURE 2.10

Process performance = efficiency, yield, production rate, etc. It measures performance for a control objective.

Calculate the process performance using the distribution, not the average value of the key variable!

Example of Benefits of reduced variability for chemical reactor

<u>Goal</u>: Maximize conversion of feed ethane but do not exceed 864C

Which operation, A or B, is better and explain why.

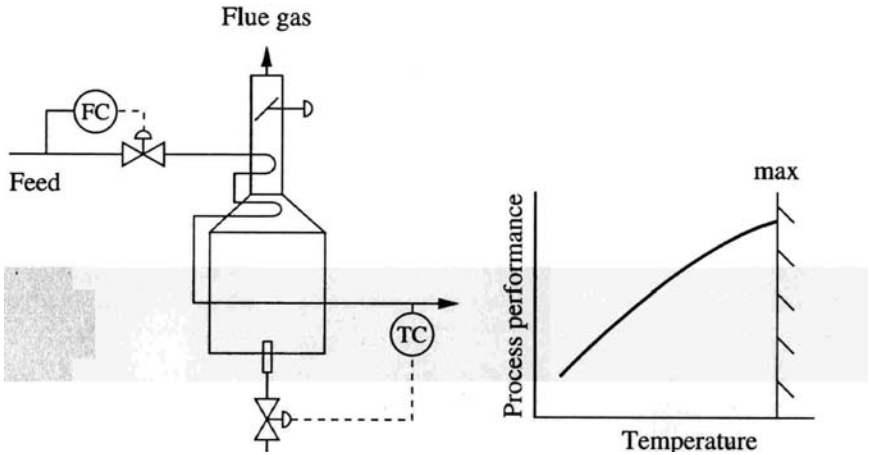
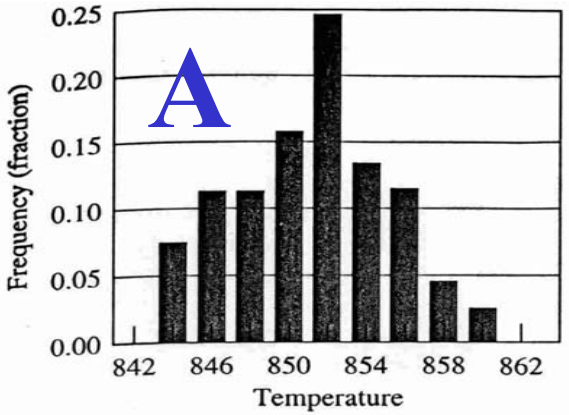
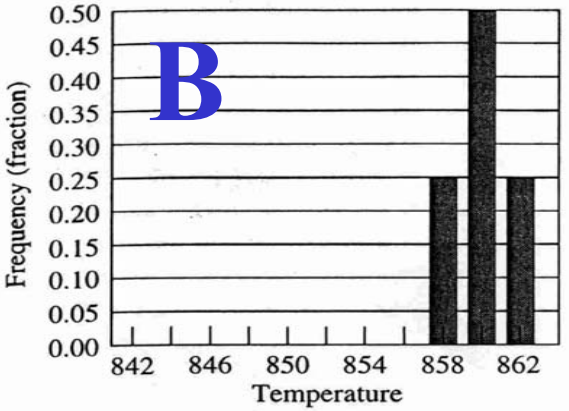


FIGURE 2.5





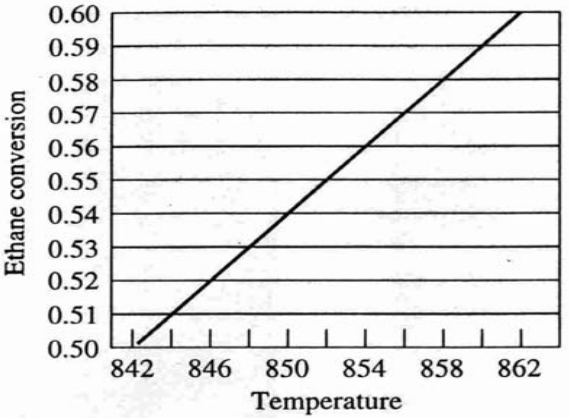
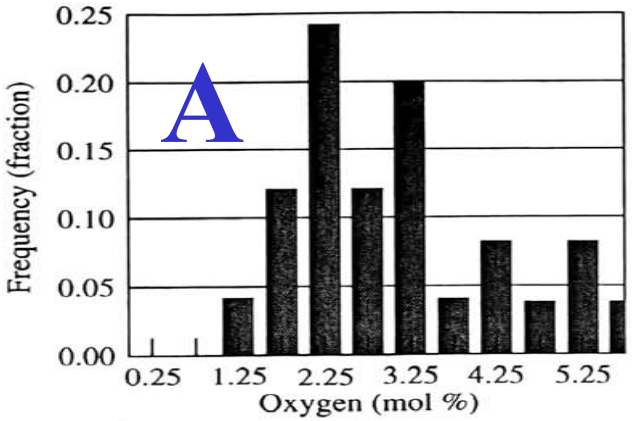


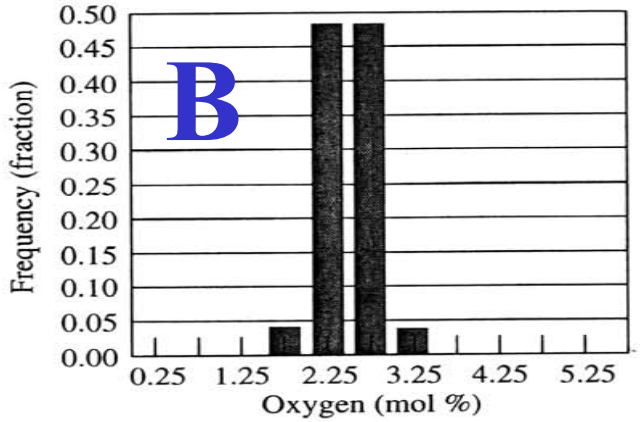
FIGURE 2.11

Example of Benefits of reduced variability for chemical reactor

<u>Goal</u>: Maximize efficiency and prevent fuel-rich flue gas

Which operation, A or B, is better and explain why.





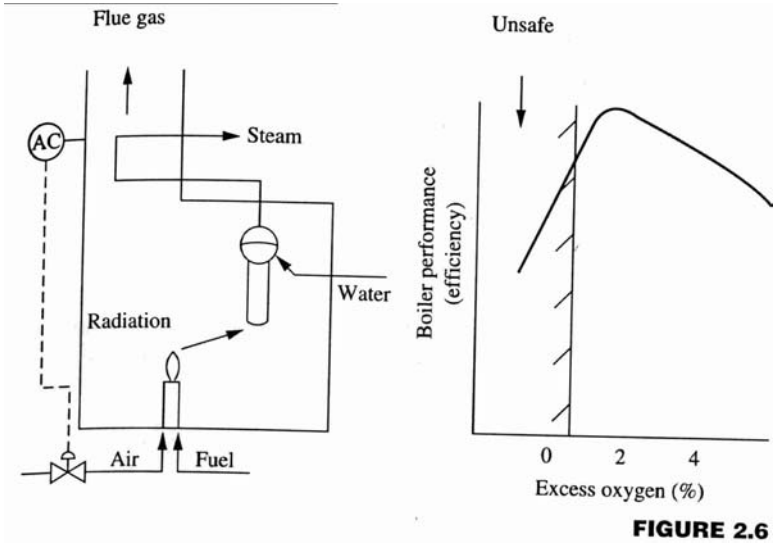


FIGURE 2.6

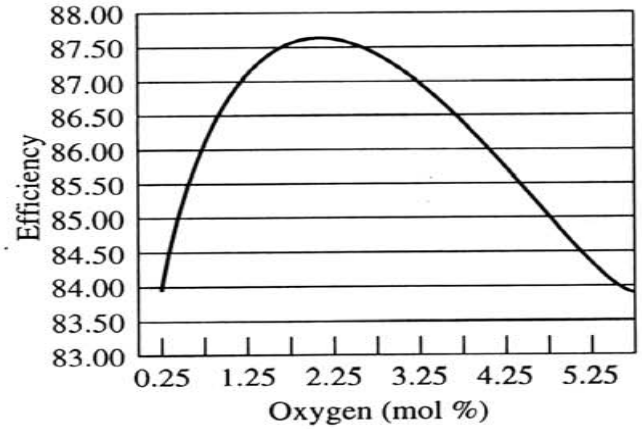
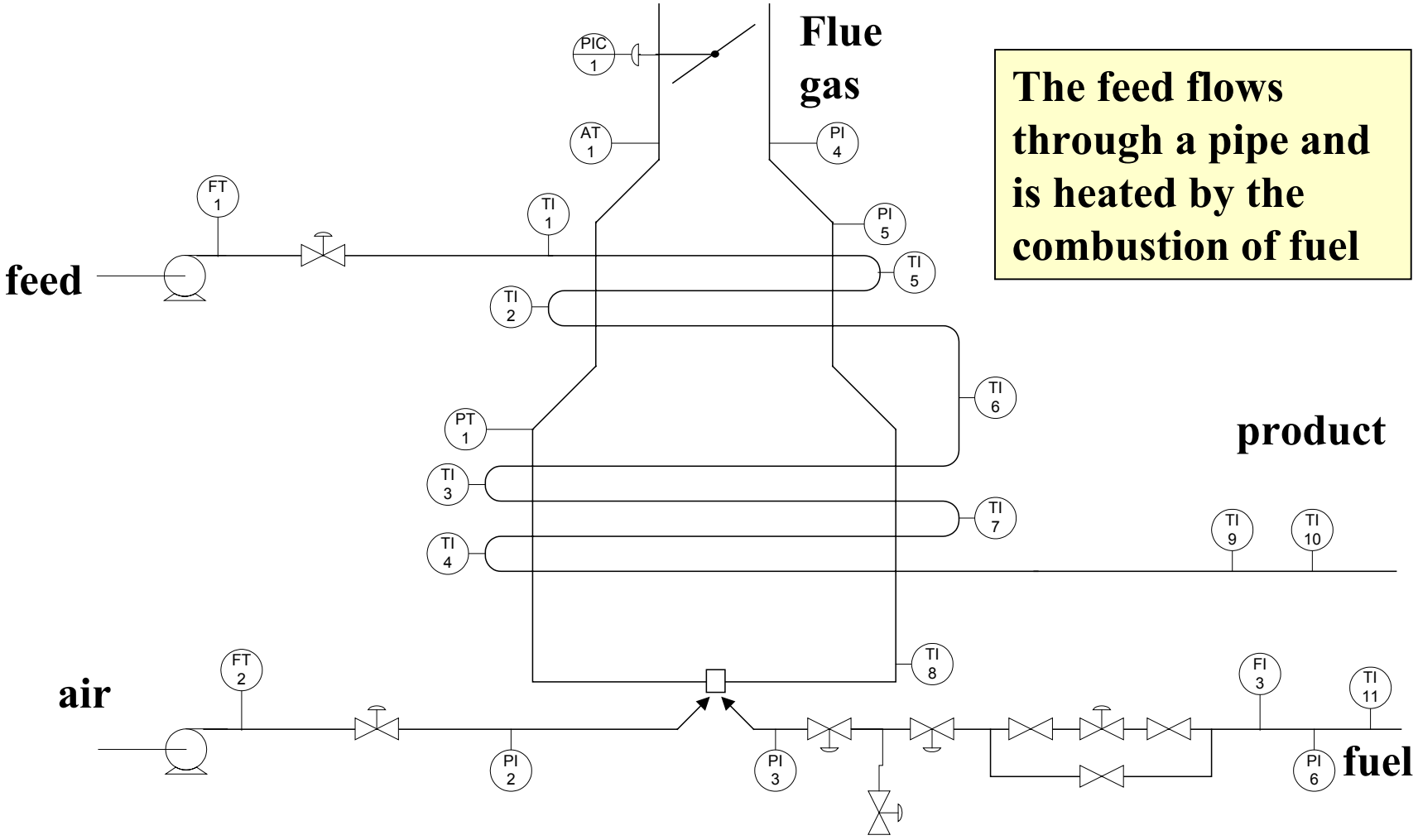


FIGURE 2.12

CHAPTER 2: GOALS AND BENEFITS WORKSHOP 1

Determine one example for each of the seven control objective categories.

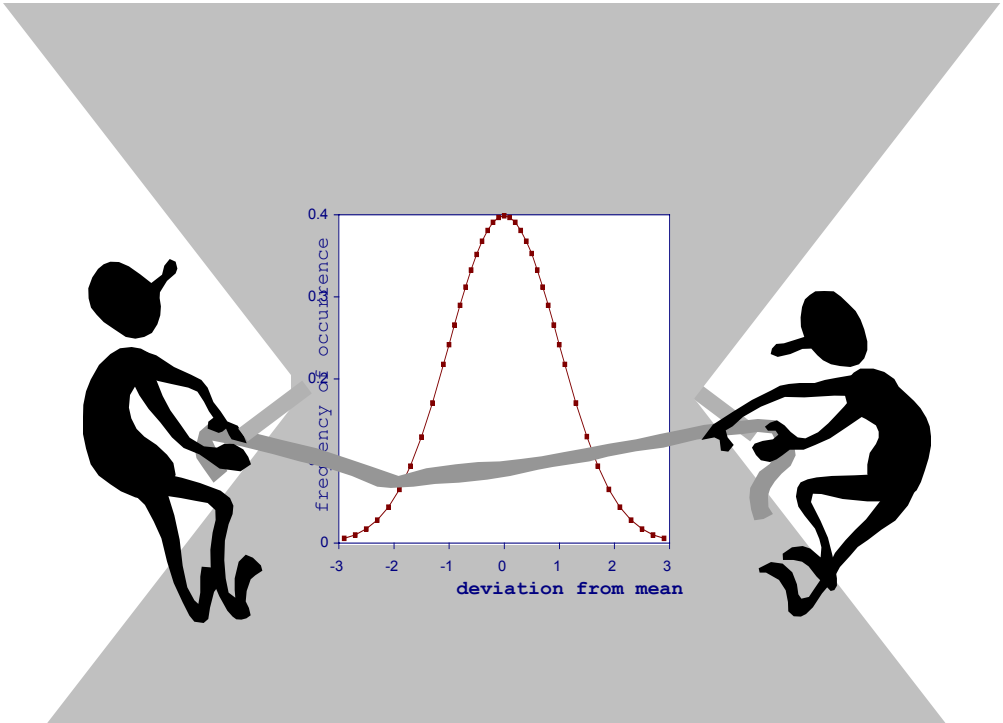


The feed flows through a pipe and is heated by the combustion of fuel

CHAPTER 2: GOALS AND BENEFITS WORKSHOP 2

Two process examples show the benefit of reduced variability, the fired heater reactor and the boiler. Discuss the difference between the two examples. Can you think of another example that shows the principle of each?

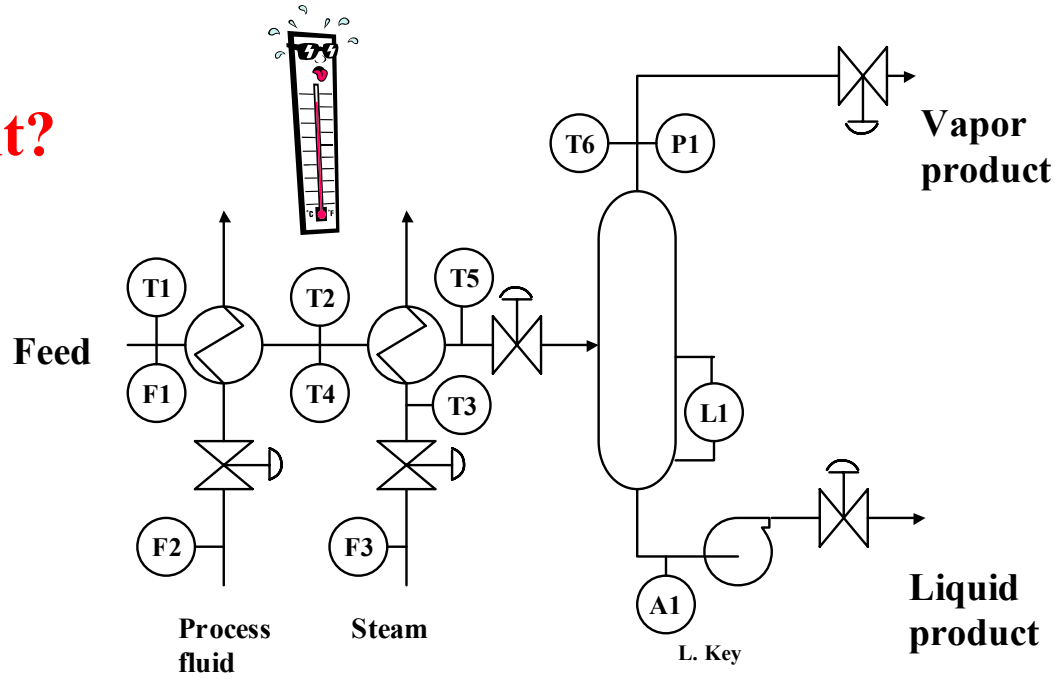
Squeeze down the variability



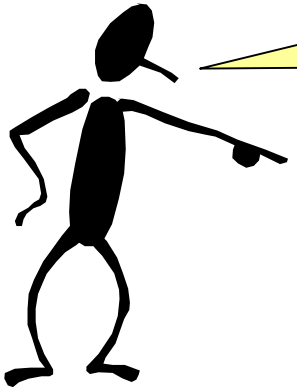
CHAPTER 2: GOALS AND BENEFITS WORKSHOP 3

In both the flash drum and the fired heater examples, temperature measurement is very important. Describe several methods for measuring temperature and recommend the most appropriate for the flash drum example.

How hot is it?



CHAPTER 2 : CONTROL OBJECTIVES & BENEFITS



When I complete this chapter, I want to be able to do the following.

- **Recognize examples of the seven (7) control objectives in chemical processes**
- **Calculate indicators of variability in a process variable**
- **Be able to calculate the economic impact of variability**

Lot's of improvement, but we need some more study!

- **Read the textbook**
- **Review the notes, especially learning goals and workshop**
- **Try out the self-study suggestions**
- **Naturally, we'll have an assignment!**

CHAPTER 2: LEARNING RESOURCES

- **SITE PC-EDUCATION WEB**

  - Instrumentation Notes

  - Interactive Learning Module (Chapter 2)

  - Tutorials (Chapter 1/2)

CHAPTER 2:
SUGGESTIONS FOR SELF-STUDY

1. **Discuss the importance of consistent quality in your decisions to purchase food, clothing, etc.**

2. **A P&I drawing of a distillation process is given in Woods*. Determine at least one example of each of the seven control objectives for this process. Evaluate the control designs given; do they achieve your objectives?**

3. **Find process examples in your previous textbooks and determine the advantage for reduced variability in each. Can you provide quantitative values for the economic benefit?**

*** Woods, D. *Process Design and Engineering Practice*, Prentice-Hall, 1995 (page 2-65).**