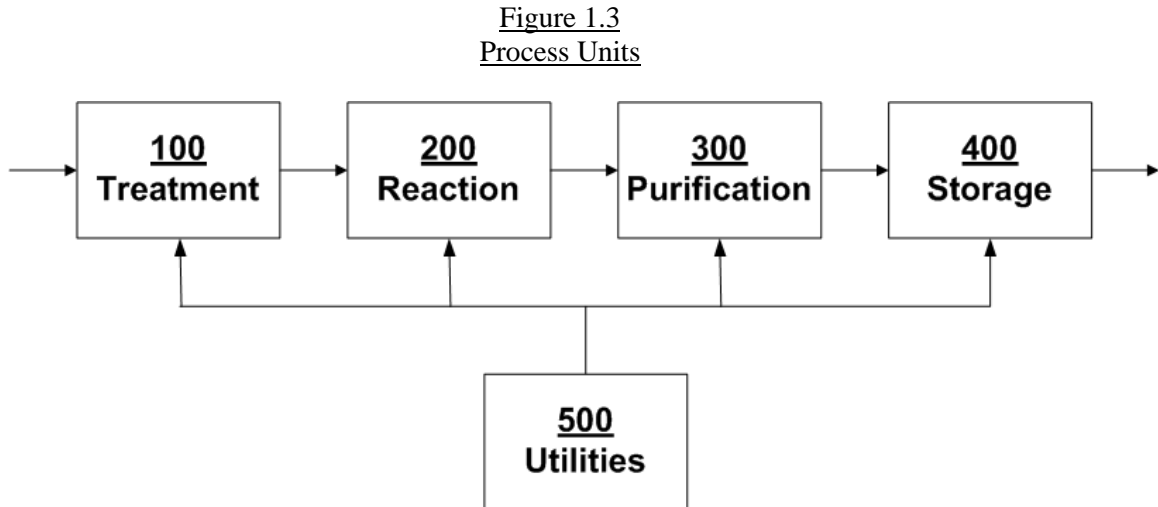


## EXAMPLES

Throughout this book the examples shown below are used to illustrate the concepts and ideas that are presented. They are referenced at the appropriate points of succeeding chapters.

### Example 1 — Facility Design

A process consists of four operating units and a utilities section. A schematic of the system is shown in Figure 1.3.



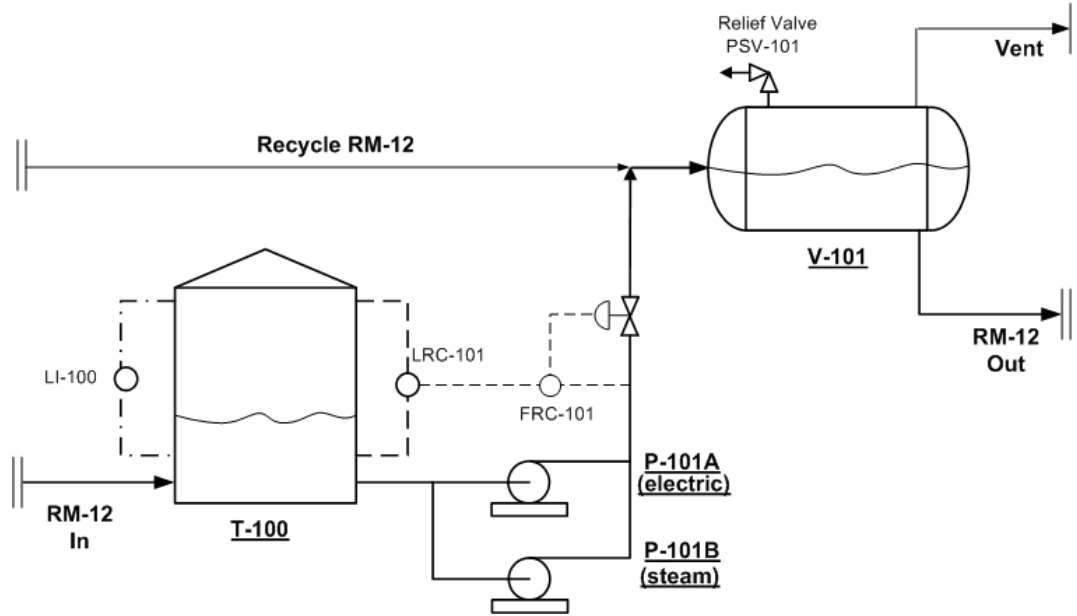
### Example 2 — Process Flow

Figure 1.4 shows part of Unit 100 from Figure 1.3. Liquid flows into an Atmospheric Tank, T-100. The liquid, which is both flammable and toxic, is called Raw Material Number 12 — abbreviated to RM-12. From T-100, RM-12 is pumped to Pressure Vessel, V-101, using Pump P-101A or P-101B, either of which can handle the full flow (A is normally in service, with B being on standby). The pumps are driven by a steam turbine and an electric motor respectively.

The flow of liquid both into and out of T-100 is continuous. The incoming flow varies according to upstream conditions and is outside the control of the operators responsible for the equipment shown. The flow rate from T-100 to V-101 is controlled by FRC-101, whose set point is cascaded from LRC-101, which measures the level in T-100. The level in T-100 can also be measured with the sight glass, LI-100.

V-101 is protected against over-pressure by safety instrumentation (not shown) that shuts down both P-101 A/B, and by the relief valve, PSV-101.

**Figure 1.4**  
**Process Flow Example**



Failure and repair times for the pumps are provided in Table 1.5.

**Table 1.5**  
**Failure and Repair Times**

Item	Failure Rate, yr <sup>-1</sup>	Failure Rate, hr <sup>-1</sup>	Probability of Failure on Demand	Mean Downtime (MDT), hr
P-101A	0.5	0.000057077	—	8
P-101B	—	—	0.1	3

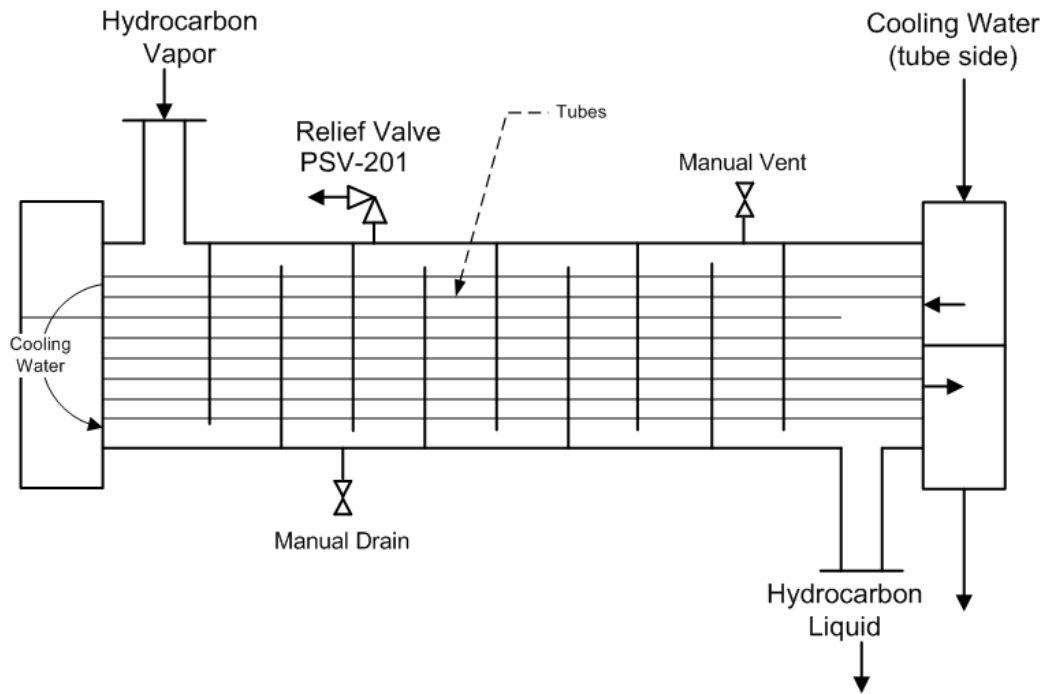
Summarizing Table 1.5 in words:

- P-101A (which is the pump that is normally in operation) is expected to fail twice a year. It takes eight hours to repair.
- When P-101A stops working, P-101B is started. It is expected that P-101B will fail to start on demand once in ten times. If P-101B does not start immediately its anticipated repair time is three hours.

### Example 3 — Heat Exchanger

Figure 1.5 shows a shell and tube heat exchanger. Hydrocarbon vapors enter the exchanger on the shell side where they are condensed by cooling water which runs through two passes of tubes. The pressure relief valve and the drain and vent valves on the shell side are shown.

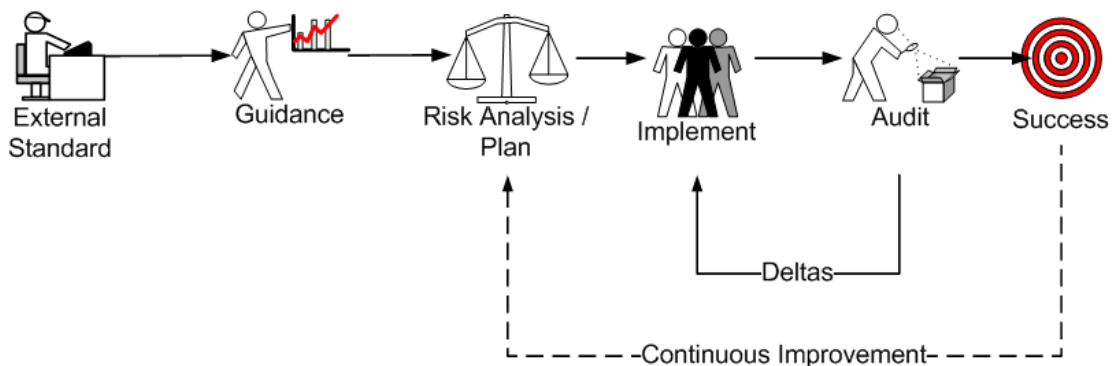
Figure 1.5  
Heat Exchanger Example



**Example 4 — Risk Management Workflow**

The third example is used when discussing the management of risk. Figure 1.6 illustrates the major steps in the development of a representative risk management program.

Figure 1.6  
Risk Management Workflow Example



***External Standard***

The first step in the development of a risk management program is to check for the existence of standards from an external agency — generally either a government regulator or a company’s own corporate group). Regulations are broad in scope. Corporate standards are likely to be more specific because they focus on just those operations that the company carries out.

### ***Guidance***

Because external standards do not generally provide enough detail to actually develop and run a risk management program additional nuts-and-bolts guidance is needed. Such guidance can be internally generated or it can be provided by outside experts and consultants.

### ***Risk Analysis Plan and Implement***

The next step is to conduct a risk analysis that will help determine what risks exist, how those risks can be mitigated, and how resources should be prioritized. Planning is followed by implementation.

### ***Audit / Deltas***

No management program is perfect. Gaps between goals and reality always exist. In order to systematically identify the gaps, audits are needed. If the audit finds deficiencies or gaps, the process recycles to the implementation step. (The word 'delta' is sometimes used to describe the difference between plan and performance because it sounds less critical than words such as 'deficiency' or 'failure'.)

### ***Success / Continuous Improvement***

Ideally, once the plan is implemented and has been audited management can declare that they have successfully implemented their risk management program. However risk can never be low enough; improvements can always be made. Therefore, once the program has been completed, management should start the whole process over again — usually at the risk analysis and planning steps — in order to achieve even higher levels of safety and economic performance.