CHAPTER A.3 — STANDARD EXAMPLES

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CONTENTS

Albert Einstein in the year 1932

INTRODUCTION

In order to illustrate many of the Operational Integrity Management (OIM) concepts and issues discussed throughout this series of books, four simple worked examples are provided in this chapter.

The first example, which is used to illustrate process hazards analysis techniques, describes a simple process involving the flow of liquid in a tank/pumping system. The second example describes a moderately complex piece of equipment: a shell and tube heat exchanger. This example is used to illustrate equipment failure analysis techniques. The third example shows the operation of a piece of equipment (a cooling tower), and is used to illustrate the development of operating and maintenance procedures. The fourth and final example describes a management system. This example is used to illustrate the development and use of risk management techniques.

EXAMPLE 1: PROCESS FLOW

Figure A.3.1 shows liquid flowing into an Atmospheric Tank, T-100. The liquid being pumped is called Raw Material Number 12 — abbreviated to RM-12. It is both flammable and toxic.

From T-100 the liquid is then pumped to Pressure Vessel, V-101, using either Pump, P-101A or P-101B, both of which can handle the full flow (A is normally in service, with B being on standby). The pumps are driven by an electric motor and a steam turbine respectively. The predicted failure rate for Pump A is once in two years, or 0.5 yr^{-1}; the predicted probability that the Pump B will not start on demand is 1 in 10, *i.e.,* 0.1 (this term is dimensionless).

A recycle RM-12 mixes with the fresh RM-12 from the outlet of the P-101 pumps before entering V-101.

The flow of liquid both into and out of T-100 is continuous. The incoming flow varies according to upstream conditions; hence this flow rate is not under the control of the operators responsible for the equipment shown. The flow from T-100 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 manually using 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 A.3.1
Technical Example
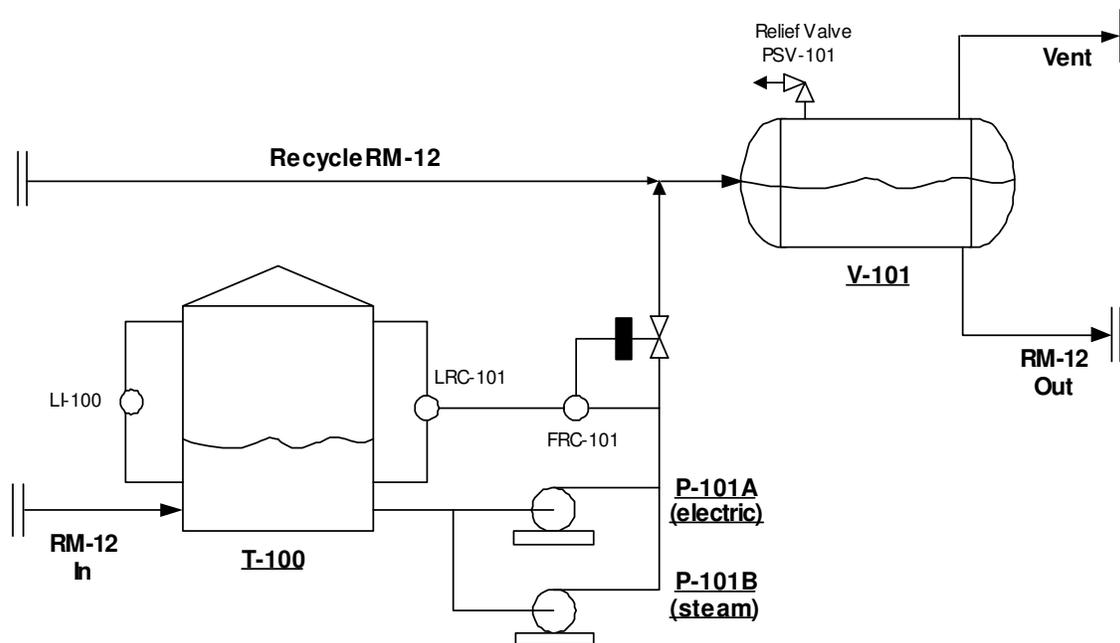
EXAMPLE 2: EQUIPMENT

Figure A.3.2 is a sketch of a shell and tube heat exchanger. Hydrocarbon vapors enter the exchanger on the shell side, and are condensed with cooling water. The baffles inside the shell are shown. Cooling water enters the tube side, and takes two passes along the exchanger, before being discharged as shown. (The tubes are not shown in order to keep the sketch simple). The pressure relief valve, and the drain and vent valves on the shell side are shown.

Figure A.3.2
Heat Exchanger Example
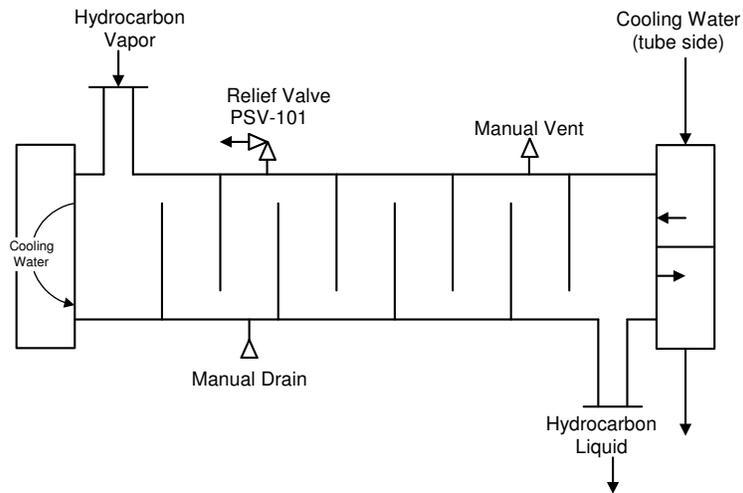
The ways in which this equipment item can fail, and the effect of such failures, is discussed in Chapter C.3 — *Failure Modes & Effects Analysis (FMEA).*

EXAMPLE 3: OPERATIONS

Figure A.3.3
Cooling Tower Sketch
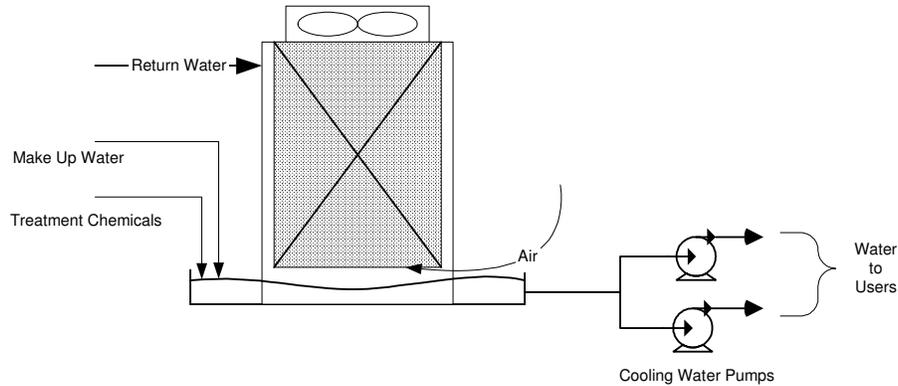
Figure A.3.3 shows a forced draft cooling tower. Warm water from the users enters at the top of the tower then flows down the packing into the basin. Air is pulled into the base of the tower by the fans at the top of the tower. The air flows counter-currently against the warm water. Some of the air evaporates, thus cooling the water. The cooled water is pumped to the users by the cooling water pumps. Make up water and treatment chemicals are added as shown.

This example is used to illustrate the development of operating and maintenance procedures.

EXAMPLE 4: MANAGEMENT WORKFLOW

A basic tenet of this series of books is that the management of an operational integrity program is in fact a *management* program. Some of the major steps in a typical OIM management program are shown in Figure A.3.4. (Details will vary from company to company, and whether the OIM work is for an existing facility, or for a new project, but what is shown in Figure A.3.4 is representative.)

Figure A.3.4
Management Program Example
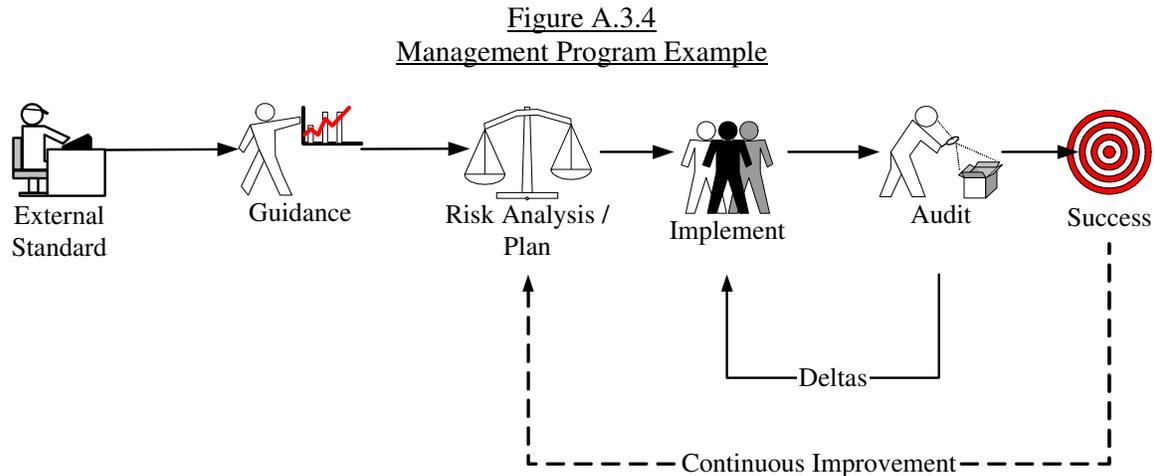
The steps shown in Figure A.3.2 are discussed below.

External Standard

The first step in the program shown in Figure A.3.4 is for an external agency (typically either a government regulator or a company's own corporate group) to set an objective operational integrity standard to be followed by the operating facilities and project management teams. Government safety standards are usually quite general in nature (as they should be) because no standards-setting body can conceive of all the different types of operation that fall under their jurisdiction. Government environmental standards, on the other hand, are usually prescriptive, *i.e.,* they are detailed and rigid.

Corporate standards are generally quite specific because they can be focused on just those operations that the company carries out.

Guidance

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

Some larger companies choose to develop a set of "philosophies" that provide a foundation for many aspects of their work — including OIM. The philosophies, which are guidance documents, provide a basis for more detailed design bases and engineering specifications. Topics covered by philosophies typically include:

- Operations;
- Project Management;
- Maintenance; and
- Loss Prevention

These philosophies can be the foundation of a company standard. Their development and use is discussed in Chapter E.2 — *OIM on Projects.*

Risk Analysis and Plan Preparation

The next step shown in Figure A.3.2 is a risk analysis that will help determine what risks exist, how those risks can be mitigated, and how resources should be prioritized. This topic is discussed in detail in the books in Chapter A.5 — *Risk Analysis.*

The results of the risk analysis are used as the foundation of the OIM Plan, which is prepared at this stage. The plan must clearly align with the external standards provided at the start of the exercise. For example, if the OIM program has to address a particular regulation, then the plan should clearly define how such a requirement is to be met.

Also, as part of the planning process, the OIM team can prepare the audit protocols at this point. The protocols must explicitly address the external standards that the facility has to follow.

Implement

Having prepared the plan the OIM program can be implemented. Further information as to how an OIM program can be implemented is provided in Volume B — *OIM Management.*

Audit / Deltas

No management program is perfect. Gaps between goals and reality always exist. However, no manager likes to own up to such gaps or does not know of their existence so audits are needed. An audit will evaluate results against the plan, and suggest modifications either to the Plan or to the way in which the Plan is implemented.

If the audit finds deficiencies or gaps, the process recycles to the Implement step, as shown in Figure A.3.4. (The word 'delta' is sometimes used to describe the difference between plan and performance because it sounds less critical than the word 'deficiency' or the phrase 'fails to meet'.)

Success / **Continuous Improvement**

Ideally, once the Plan is implemented and has cleared the audit hurdles, management can declare that they have successfully implemented their OIM program. However risk can never be low enough, and improvements can always be made. Therefore, once the program shown in Figure A.3.4 is complete, management should start the process over again — probably at the risk analysis and planning step — in order to achieve even higher levels of safety and economic performance. (Based on lessons learned, management may elect to recycle to the 'Guidance' step, *i.e.,* to develop new approaches to managing the operational integrity management program.)

CONCLUSIONS

The examples provided in this chapter are simple, but they provide a basis for illustrating many of the concepts, techniques and ideas presented through the remainder of this set of books.