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The Value of Risk-based Asset Management

With the forming of ISO Technical Committee 251, it's clear that asset management will soon have a standard. Now is the time to educate ourselves about the value that optimized asset management creates. Based on the release of ISO 9001, Quality Management Systems – Requirements, there is a valid expectation of hype, confusion and a large outpouring of funds as companies work to achieve compliance. Luckily, like quality management, asset management is about identifying, mitigating and eliminating risk.

Formalizing, documenting and validating our asset management plan seems like a significant undertaking. Since the planning committee is using BSI PAS 55 as a starting place, it is likely that the core of the specification will remain valid. Part 2 of this specification provides the guidelines for application and also includes seven items that can be reviewed by an organization to see how they compare to the key 28 elements of part 1. Using LCE's Reliability Excellence methodology, along with best practices in risk-based asset management, we have developed a self-assessment tool that you can use to evaluate the maturity of your asset management in preparation for the ISO standard.

Plan, Do, Check, Act, Figure 1, is the foundation of continuous improvement and is also the foundation of an optimized asset management system. Developing a management plan that accounts for risk, and therefore cost, brings a significant advantage to the bottom line. Asset management is a basic corporate responsibility, and yet no real standards will exist until sometime between 2012 and 2013.

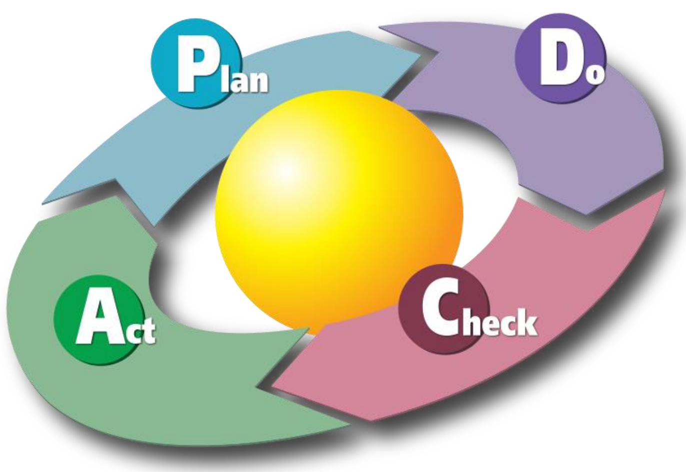

Figure 1. The Plan – Do – Check – Act Cycle.

It is certain that the new standard will illustrate the importance of transaction-level business processes, such as production and maintenance planning and scheduling. It will also require clearly communicated performance monitoring to maximize corporate resources and profitability. Typically, corporate objectives, business processes and information systems are not well integrated. This tends to hide some of our limiting factors and risks and prevents us from optimizing our asset performance.

Consider the risk associated with drilling in the Gulf of Mexico and the complexity of the asset deemed to prevent blowouts below. The report referenced in Figure 2 stated that the investigation team found indication of potential weaknesses in the testing regime and maintenance management system for the blowout preventer.

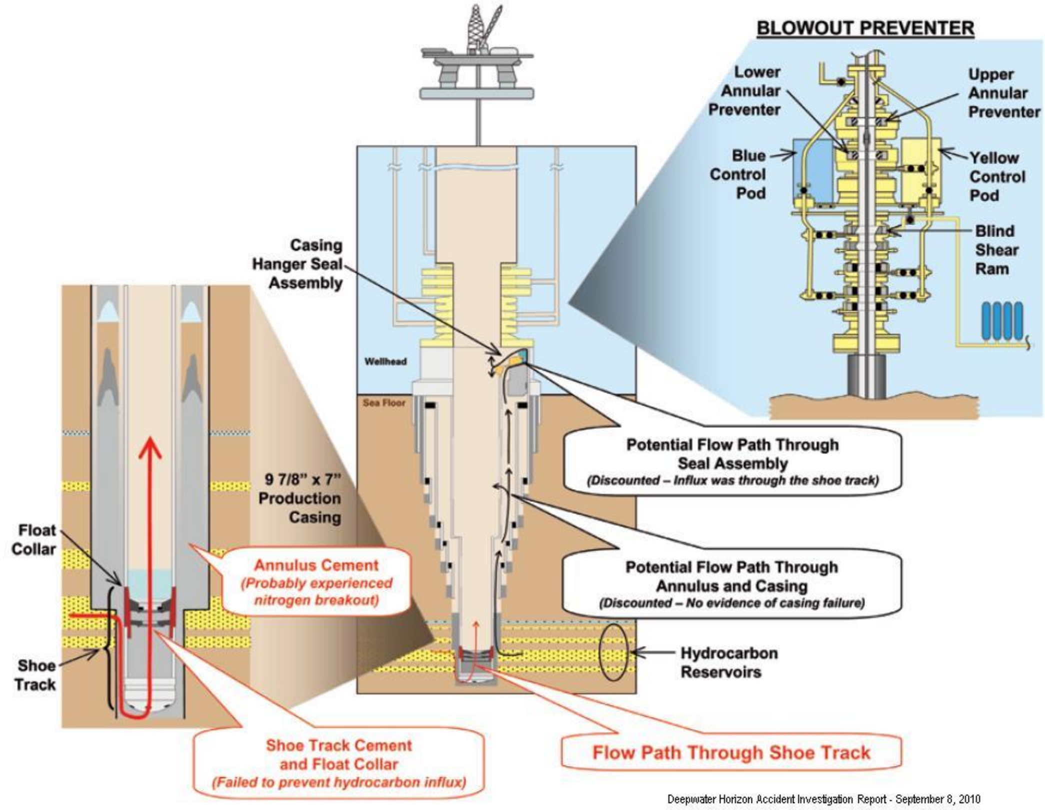

Figure 2. Illustration from the Deepwater Horizon Investigation Report.

These findings emphasize the value in an optimized asset management system and the importance of risk management as a significant component of that system. To identify gaps that could compromise an asset management strategy, the PAS 55 specification includes seven review areas:

- Organizational Strategic Plan
- Legal, Regulatory and Mandatory Requirements.
- Identification and Evaluation of Asset, Management Risks,
- Existing Asset Management Practices, Processes, and Procedures
- Asset and Asset System Performance
- Investigation of Incidents, Accidents, and Emergencies
- Management Systems, Competencies, Internal and External Resources

LCE's Risk-based Asset Management Model

Considering the huge impact to the environment along with the health, safety, and reputation of the companies involved, a risk-based asset management strategy that provides transparency to risk is essential for an organization's survival. This is impossible without a formalized asset management system in place. The four phases in LCE's Risk based Asset Management Model, Figure 3, is necessary for risk management and creating operational stability.

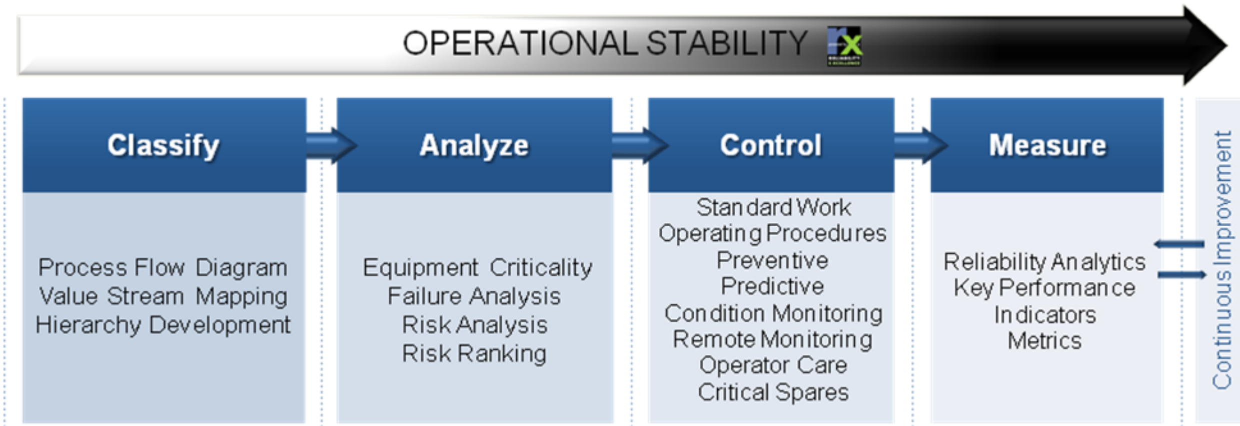

Figure 3. LCE's Risk-based Asset Management Model

<u>Classify</u>:
Once we understand our strategic plan and corporate objectives and how our asset management system supports them, we must classify our assets. This requires us to have an understanding of the logical flow and how value is created through the systems, processes, lines, etc. Value stream mapping, Figure 4, documents the material and information flow from inception to disposition of product. The map captures each step of the process with defined parameters used to trend performance. Value stream mapping help us understand where the value lies in a sequential process flow. It is the first step in waste elimination and it provides two features required for developing our risk-based asset management strategy: the performance measures at each process and the logical approach to hierarchy. Whether we use value stream mapping, process flow charting, or some other lean or industrial engineering tool, the idea here is that we clearly define each process in a logical manner that has a set of design specifications that we can use to identify trends. Once we accomplish this we can develop a logical sequence to catalog our assets.

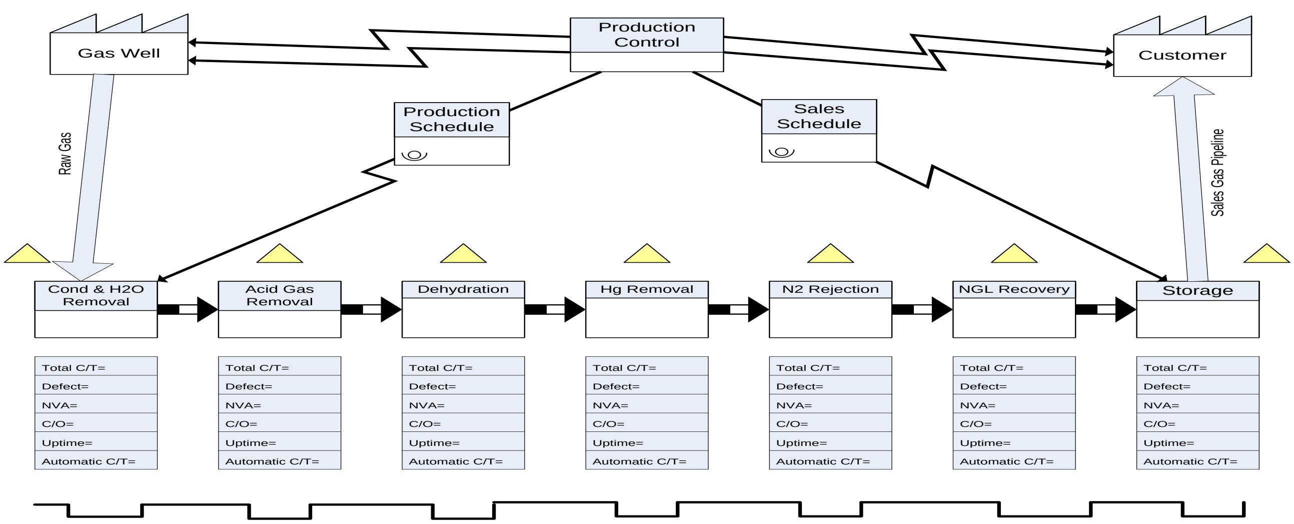

Figure 4. Example of a Value Stream Map

Once we have a documented diagram to refer to, we can then catalog assets by assigning them to asset types. Asset types allow logical groupings of like assets, similar functional failures and control strategies. At this point we must choose a model to map the relationship between the assets. The most common model is hierarchy, which is a parent-child relationship like in a refinery. Next is a matrix model which has significant interfaces between the assets such that a parent-child relationship cannot be considered such as in distillation. The third model is the network model used for linear assets such as pipelines and railways.

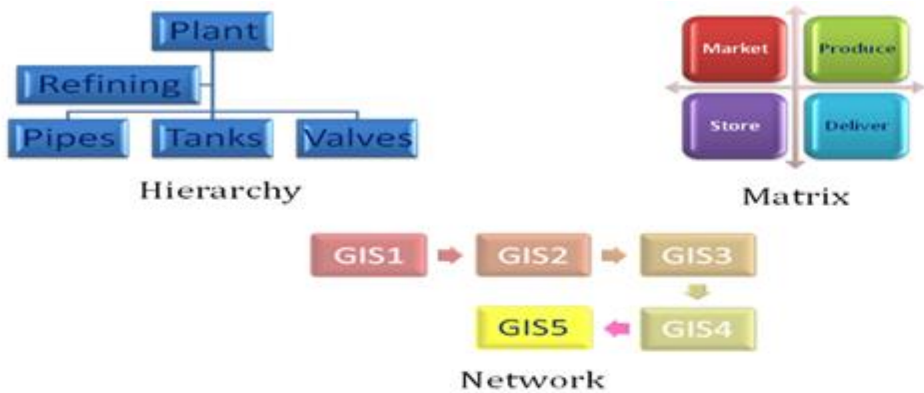

Figure 5. Asset Relationship Models

Analyze:

Once we have cataloged our assets, we then focus on developing the methodology for applying a criticality analysis to our assets. This should involve a cross-functional team of stakeholders in the value stream. The benefit of the value stream mapping and defined taxonomy will quickly be realized during this process.

When developing our method for applying criticality, Figure 6, it may be wise to first look at the system level (routinely considered level 5.) This will then allow us to prioritize the systems to apply a more thorough analysis to the component or asset level (level 7.) This analysis should consider impact to corporate objectives, replacement asset value, impact to value stream, impact on reputation, single point failure, and impact on EHS regulations and requirements.

The overarching principle regarding equipment criticality analysis is that it aligns with corporate objectives and is accepted as the method to assign priority. A strategy must be selected to establish a criticality scale. The best practice in establishing this scale is to have both a qualitative and quantitative dimension to leverage both the experience of seasoned professionals and that of published standards and specifications for our industry. This allows qualitative assessments to be validated by quantitative industry data. From here, characteristics of the criticality scales can be determined. Each characteristic should then be weighted using a scale from 0 to 10 to identify significance to the business. The greater the scale, the easier it will be to accurately identify “critical” assets; however, the total score possible should not exceed 100. By setting a limit of 100, you are reinforcing the “weight” of each characteristic.

Level 5 (System or Process)	**Level 7 (Asset)**	Operational Severity	Safety Severity	Environmenta l Severity	Single Point Failure	Maintainability	Reliability	Spares Lead Time	**Sum of Criteria**	**Asset Criticality**
Atmospheric Distillation	**Desalter**	5	3	6	10	3	4	1	32	**4.57**

Atmospheric Distillation	**1 A Heat Exchanger**	4	5	3	5	4	4	2	27	**3.86**
Atmospheric Distillation	**1 B Heat Exchanger**	4	5	3	5	4	6	2	29	**4.14**
Atmospheric Distillation	**Tower**	8	7	4	10	7	6	10	52	**7.43**
Atmospheric Distillation	**Reflux Drum**	5	5	3	10	3	7	3	36	**5.14**
Atmospheric Distillation	**Condenser**	5	3	3	10	5	2	3	31	**4.43**

Figure 6. Criticality Analysis Data Table.

Establishing an equipment criticality will allow us to establish the priority to which risk ranking can be applied. A risk table or some other risk analysis method can be used to then perform risk analysis. The quantitative risk assessment and the risk assessment matrix are two widely accepted methods.

The quantitative risk assessment uses failure rate data to develop mean time between failure probabilities for specific asset types or classes. There are software companies that will sell you accelerators or tables for generic asset types, much like those tables used by companies that sell life insurance. But just as in dealing with health, the data does not directly correlate to a specific facility or industry, nor does it take into account the specific operational envelope of the equipment. Further analysis is required, much like that of the physical exam required prior to receiving coverage. Another option is to develop this data in-house. Although extremely tedious, it is possible to collect this data. Best practice work order processes and their execution, along with reliability analytics, are required to collect relevant historical data. With proper historical data available, this method may be used for the risk assessment. If proper historical data is not available, you need an experienced professional to help you perform a quantitative risk assessment.

Another common practice is to apply a risk assessment matrix to the asset catalog to determine the severity and occurrence of failure. By highlighting the assets which pose the highest risk, the matrix also helps guide decision-making on how corporate resources will be applied to improve safety or lessen the uncontrolled release of environmental or health hazards. This also adds significant value early on in the application design review of a capital project involving a new plant, new processes or changes to existing processes. Figure 7 provides a simple, visual method to determine at what point additional controls should be evaluated.

The risk assessment uses risk severity and likelihood of occurrence to provide a grading matrix. From the combination of severity and occurrence, a risk level can then be defined as high, medium or low. This risk level is then used in combination with the criticality analysis to create a risk ranking.

Severity	**5**	**5**	**6**	**7**	**8**	**9**
	4	**4**	**5**	**6**	**7**	**8**
	3	**3**	**4**	**5**	**6**	**7**
	2	**2**	**3**	**4**	**5**	**6**

	1	1	2	3	4	5
	0	1	2	3	4	5
	Occurrence					

Figure 7. Risk Assessment Matrix.

This risk ranking is then used to define what level of failure analysis will be performed. Reliability-centered maintenance is a proven and very meticulous method to answer the following questions:

- What are the functions and associated desired standards of performance of the asset in its present operating context? (Functions)
- In what ways can it fail to fulfill its functions? (Functional Failures)
- What causes each functional failure? (Failure Modes)
- What happens when each failure occurs? (Failure Effects)
- In what way does each failure matter? (Failure Consequences)
- What should be done to predict or prevent each failure? (Proactive Tasks and Task Intervals)
- What should be done if a suitable proactive task cannot be found? (Default Action)

Due to resource constraints, it is not possible to perform this level of analysis for each asset within the master data file. Therefore, risk ranking can be used to determine the analysis to be put in place to provide the most cost-effective deterrent or detection method for managing our assets. An example of an appropriate distribution and application of risk ranking appears below.

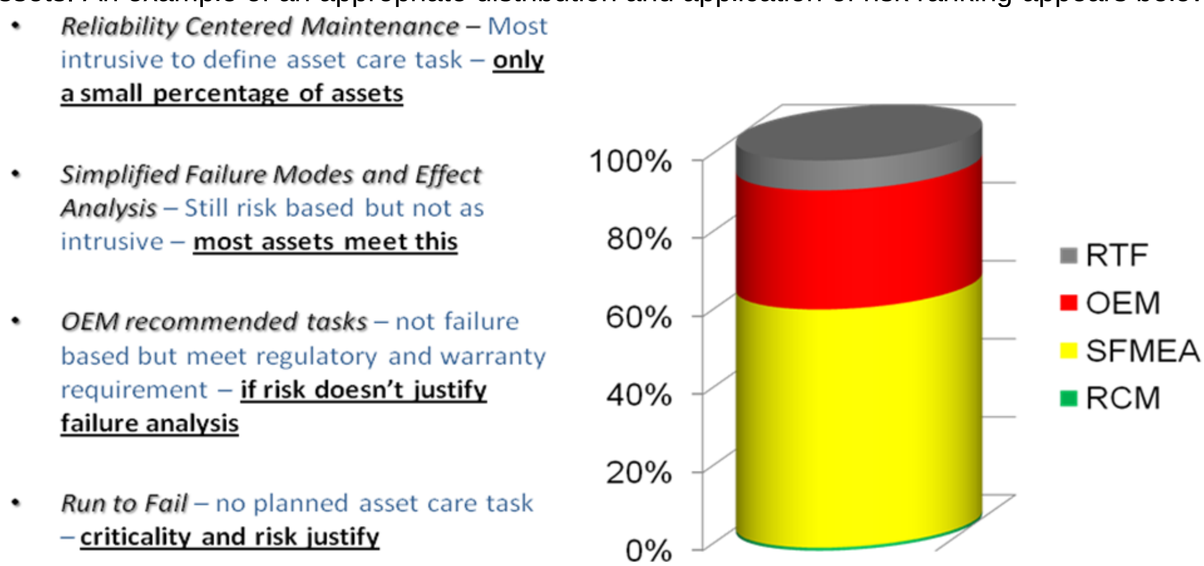

Figure 8. Distribution and Application of Risk Ranking.

Control:

Control strategies include preventive tasks, predictive tasks, remote monitoring, condition monitoring, operating procedures, rebuild, replace, redesign criteria, operator care, and critical spares, to name a few. All should be documented in standard work procedures and define the risk and failure that they are mitigating. Once the predominant failure modes are identified, we can then define the control strategy to eliminate or mitigate that failure to reduce the risk.

Examples include time-based inspections to take core samples for chlorides of insulated carbon-steel piping or process intelligence used in a process line to trend asset health. For all control strategies it is important that the processes are mapped and the interfaces are identified. More and more data is available every day and a system can quickly be overwhelmed without clearly defining requirements and supporting management of information.

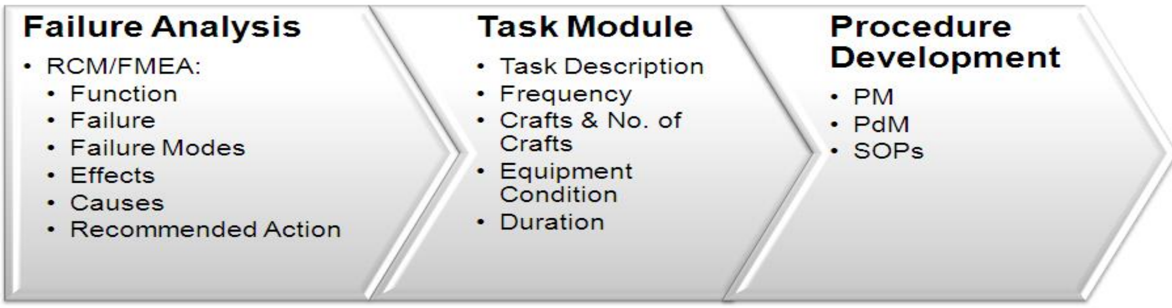

Figure 9. Control Strategy Development Process.

When mapping our control solution, we must take into account all the required operational integration of our management information systems. This helps ensure that we are leveraging the intelligence accurately. It also helps us understand the possible vulnerability of this data to lack of a Management of Change process to ensure integrity of the configuration and the data. Now more than ever, our reliability and operations professionals must join with our information technology professionals to ensure the linkages of our data entry, storage and reporting are consistent and well-defined, from pumps and compressors, to programmable logic controllers, to the distributed control system, to our process intelligence, then to our enterprise asset management system and finally all the way up to the general ledgers and balance sheets managed within our enterprise resource planning application.

Consider that each time we purchase a vibration monitor, install a sophisticated piece of equipment, invest in a best-in-breed enterprise asset management system, or purchase software to manage our mechanical integrity program we add another layer that must be modeled or integrated into our asset management system. A significant value in the EAM software is the ability to create catalogs based on asset type. As in Figure 10, asset catalogs identify common attributes, failure types, cause codes and task lists that will allow a work order to be created for breakdowns that will adequately capture the valuable equipment history that we need in our relentless pursuit of continuous improvement.

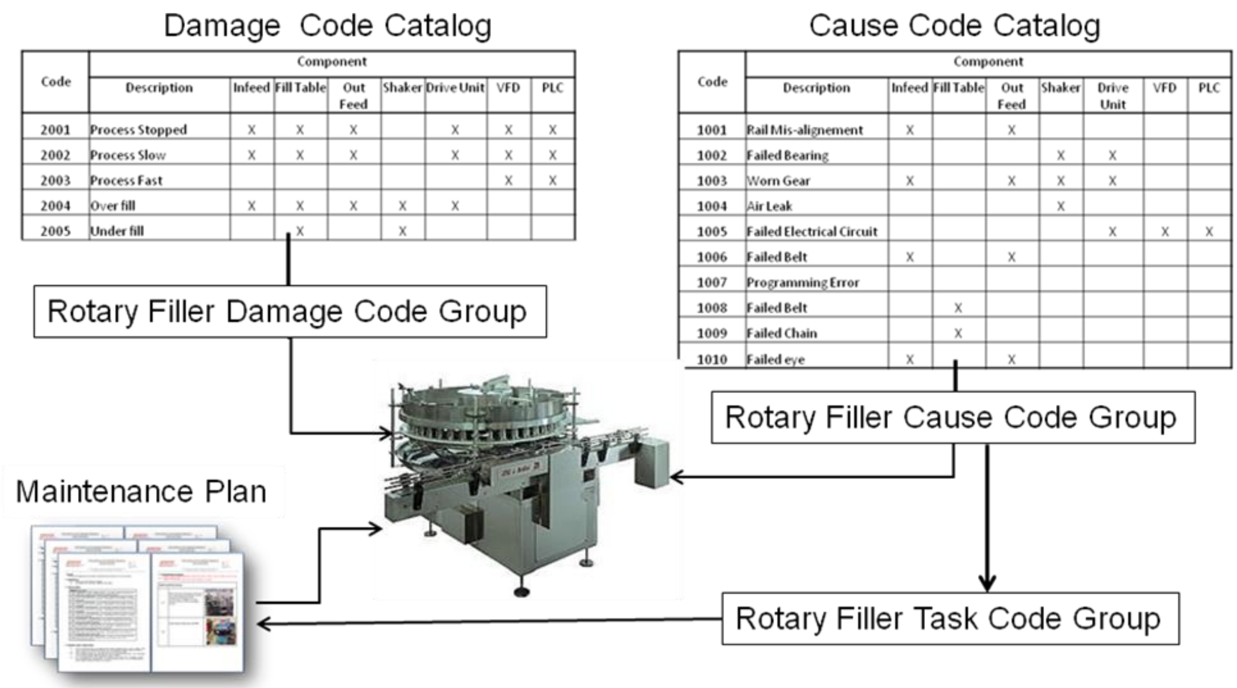

Figure 10. Example of an Asset Catalog

<u>Measure:</u>

Once the management information system is configured to capture the information necessary to develop the appropriate queries and reporting needed, we have the means to effectively identify our opportunities. The metrics we use as part of our performance monitoring should closely tie to our strategic plan and corporate objectives. Work order history is a key source of our measurement activities.

First off, let's look at work orders that are generated due to breakdowns. If the hierarchy allows drill down to sufficient detail to link the maintainable asset to a set of failure codes that an operator can easily distinguish and are specific to the asset type, we can measure conditions that are related to the failure. Next, we need a way to measure the financial impact of the failure on our marketing plan. Given a rate of value the asset contributes, and the lost availability, we can measure the lost market opportunity. Another consideration is the cost to complete the repair. The labor, material, and contract support expended make up the additional cost of down time.

By using the time stamps in our management information system, we can also accurately capture the mean time between failure and the mean time to repair, which are the two of the most meaningful reliability indicators. Another key consideration is in closing the work order and capturing the information obtained by the maintenance and reliability professional doing the work. Some level of root cause will be performed to identify why the failure occurred and this should be coded specific to the asset type. This cause code will allow us to understand what contributed to the failure.

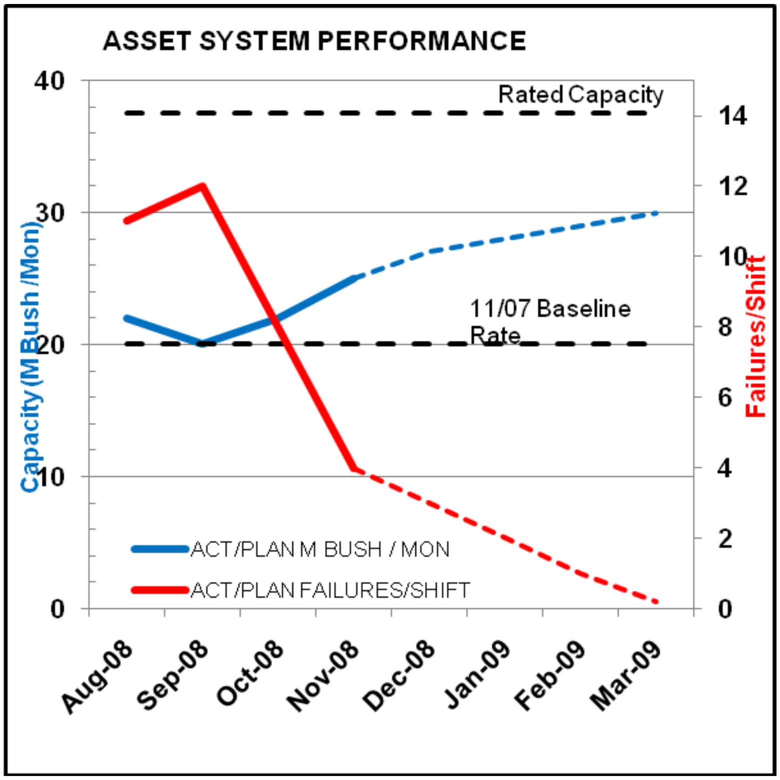

Figure 11. System Performance Curve

Work orders used to perform preventive tasks require several components to facilitate review. The tasks that are being performed on the asset must be specific to the asset type and clearly define what failure mode the task is identifying, mitigating or eliminating. The costs associated with these tasks should appropriately reflect the preventive activities and create a method to link to corrective work generated from these tasks. The first item allows us to compare and trend the cost of preventive activities to that of corrective activities and the second item allows us to capture the corrective work generated from preventive activities. Both these items provide a method to measure the effectiveness of the control strategy.

The final and most important element of the preventive tasks is to have specified parameters and defined thresholds and the requirement to collect data that can be trended to determine the health of the asset. This provides the two way communication in the control strategy and moves the task from static to dynamic.

Why Implement a Risk-based Asset Management Strategy?
Fundamentally, in a risk-based asset management system you collect relevant information based on importance to the value stream and use this information to make fiscally responsible decisions that will in turn create greater value to the organization. The four phases in the risk-based asset management model are critical for the success of this strategy. When you couple this strategy with business processes that support best practice, seamlessly integrated to leverage critical information to make decisions, and supported by a corporate culture driven to the relentless pursuit of continuous improvement, you can achieve results like these:

- Personnel have recognized the value of continuous improvement and have demonstrated their belief with their actions.

- Limiting factors have been identified and reduced by orders of magnitudes.
- Substantial capital investments have been avoided by improving capacity and availability
- Significant reduction in cost of products sold

These benefits result in significantly improved operational stability along with substantial financial improvement.