Risk based maintenance – an impartial tool for smart decisions

The more complex the equipment set on a factory, the more difficult becomes to manage maintenance as efficiently as possible. Questions arise like: Am I wasting unnecessary resources on maintenance? Where can I reduce maintenance costs? Should I hire conditioned based maintenance services? On which equipment should I apply conditioned based maintenance techniques? Can I assume corrective maintenance policy? In which equipment can I apply corrective maintenance?

Risk-based maintenance provides tools that lead to the answers mentioned above. Allows to organize the equipment hierarchically according to its risk of failure, which is determined for each equipment and results from the product of two indices, the failure occurrence and the severity.

Occurrence

Occurrence index is related to equipment probability of failure, calculated based on equipment history. The more failures you have, the more likely they are to come back. The table below could be used to, qualitatively, assign an occurrence index value to each failure.

Classification		Description
Frequent	9 a 10	A high probability of occurrence during the equipment operating time interval.
Likely	7 a 8	A moderate probability of occurrence during the equipment operating time interval.
Occasional	5 a 6	An occasional probability of occurrence during the equipment operating time interval.
Unlikely	3 a 4	An unlikely probability of occurrence during the period of operation of the equipment.
Highly unlikely	1 a 2	A failure whose probability of occurrence is essentially zero during the equipment operating time interval.

Another method to assign an index occurrence is to use probabilistic indicators, such as the time between failures. This method removes subjectivity from the qualitative form once it depends only on historical data. This calculation method could be facilitated by the use of a maintenance software, once the software can automate the failure occurrence identification and probability calculations over time.

Severity

Severity index is assigned function of equipment contribution for the objective of the platform where it is inserted. The question that should be used to define severity index is: "if this failure occurs, what will be the impact on the factory objective?"

Classification		Description
Catastrophic	9 a 10	Very important for system operation. Failure will cause the system to stop.

Critical	7 a 8	Important for good operation. Failure will cause system performance degradation and may lead to adverse consequences.
Marginal	5 a 6	Required for good operation. Failure may affect system performance and may lead to consequent system failure.
	3 a 4	Optional for good performance. The failure does not affect system performance immediately. But prolonged failure can cause system failure.
Minor	1 a 2	Optional for operation. The failure should not affect system performance.

Severity index definition for each failure must be done with interview methods to managers, users or system designers.

Risk

The product between occurrence and severity indices results on risk of failure. Then, after the risk calculation, it is necessary to assess the risk values as acceptable, tolerable or unacceptable. These levels are assigned according to the organization's risk appetite. Experience shows that the levels described below are a good balanced reference point:

- Until 10% of maximum risk value: Acceptable risk;
- From 10% to 30% of maximum risk value: Tolerable risk;
- Higher than 30% of maximum risk value: Not tolerable risk;

Table below shows for a maximum risk of 100 different risk values levels.

		Ocurrence Index									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Severiry Risk	**1**	1	2	3	4	5	6	7	8	9	10
	2	2	4	6	8	10	12	14	16	18	20
	3	3	6	9	12	15	18	21	24	27	30
	4	4	8	12	16	20	24	28	32	36	40
	5	5	10	15	20	25	30	35	40	45	50
	6	6	12	18	24	30	36	42	48	54	60
	7	7	14	21	28	35	42	49	56	63	70
	8	8	16	24	32	40	48	56	64	72	80
	9	9	18	27	36	45	54	63	72	81	90
	10	10	20	30	40	50	60	70	80	90	100

Risk based decisions

Knowing the risk of failure to each equipment, different management decisions can be made. Failure risk management strategies varies for each maintenance manager, however, there are some recommendations. Following points present typical maintenance decisions based on equipment risk of failure.

- **Low risk** equipment: optimize maintenance costs and consider implementing corrective maintenance.
- **Moderate risk** equipment: keep current maintenance routines, if possible, slim down the bureaucracy around them and simplify their maintenance management.
- **High-risk** equipment: we can take two steps to lower the risk:

- Reduce **severity index.**

  A low severity failure is a failure which doesn't affect the factory objectives. In this way, the most common method to reduce severity is to duplicate the equipment or provide a redundant equipment.

- Reduce **occurrence index.**

  The way to reduce occurrence index is to reduce the frequency of failures. Condition based maintenance is one of the most advantageous methods to apply in these equipment. Other (very common) method is to increase preventive maintenance routines frequency. It could also be used engineering processes to mitigate the cause of failure. In this field cost-effective should be taken into account.

After the decision, during the equipment operation, occurrence can change and then the risk is recalculated. In this way, monitoring the risk variation is a good maintenance management indicator. Once again, a maintenance software has a fundamental role in order to present these results automatically and in real time for the maintenance management team.

Conclusion

Calculate the risk of failure allows the management to make decisions supported in data. It translates the technical language of equipment reliability for top management. It allows to direct the resources to obtain a park of equipment that serves the organization's purpose in the most efficient way. And all these facts leads to a lean maintenance without unnecessary expenses and without failures that compromise the production.

It was shown that risk-based maintenance management goes side by side with the usage of a good maintenance management software. It facilitates data collection and automates risk calculation, providing the user with easy-to-understand indicators.

It is expected that, in future maintenance software developments could allow to support risk-based maintenance decisions in a more advanced way. The user will be able to understand how their decisions will affect the current risk of their equipment. In this way, managers could choose the most efficient decisions.

João Santos
Mechanical and naval engineer,
maintenance-engineering specialist