Electrical Asset Management: *A Guide to Benchmark Methodology and Case Study*

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ELECTRICAL asset management is very crucial in every plant operation to sustain its continuity in operation. Every production plant aspires to operate at the fullest and in flawless mode without technical teething glitches if possible. However, the operation of electrical equipment is unpredictable as most of the equipments are operating in a 'static' nature with inherent hidden risk within it.

The probability of the failure rate for electrical equipment is very low in comparison with other equipment assets in general. However, this does not prevent electrical equipment programme asset failure if poor asset management co-exist within the maintenance organisation. Once the primary and secondary electrical equipment break down, it can put the plant into a catastrophic state, resulting in a long lead time to restart the production line and lost of business opportunities. In an effective plant operation management, a good control on asset management in electrical equipment is encouraged to avoid any mishaps from occurring. Therefore, a benchmarking assessment is recommended to measure the effectiveness of asset management in practice, by benchmarking it with the best performers who are leaders in electrical asset management in its business process units.

This paper will present the benchmarking methodology concept for the post engineering field of electrical asset man-agement by examining equipment reliability and effective maintenance in practice. A case study will be presented to show how this benchmarking assessment methodology is able to assist a business organisation to prepare electrical asset management roadmap strategies that can be incorporated into their electrical asset management in the future. Thus, the plant operation can operate in a safe manner and has effective execution derived reliability strategies in place to mitigate future electrical failure risk.

BENCHMARKING CONCEPT

The simple definition of 'benchmarking' is the process of measuring products, services and practices against those of leading companies. In this context, benchmarking is used to measure engineering maintenance practices in the post engineering field, assessing how asset management organisation is performed and also how to adapt or enhance the way of doing things within an organisation. Once the equipment warranty expires and a lackadaisical asset care attitude towards the electrical asset exists within an

Table 1: Initial composition of composting material

No	Elements	Benchmark Target	Assessment Criteria
1	Asset Class Specific	Other maintenance questions relating to the specific asset class	General data relating to the asset class
2	Effectiveness and Quality Control of Troubleshooting and Repair	Quality effort on fault tracing and repair control to reduce maintenance activities	Asses the effectiveness of troubleshooting skills, and the quality of the repair works carried out and the level and effectiveness of Root Cause Analysis
3	Operational Conditions/Patterns	Operation condition/pattern contribute to maintenance cause effect	Operating beyond equipment operation envelope
4	Vendor Equipment Support Level	Effectiveness of vendor support to the asset class	Asses the performance of the OEM's and Vendors support provided
5	Design Construction and Installation	To gauge the design philosophy approach	Asses the design, manufacturing and installation including purchase policies related to standardisation and life cycle costing
6	Physical Asset Condition	To assess the asset condition for maintenance activities	Asses the asset condition as a result of the maintenance strategies effectiveness
7	Effectiveness of Maintenance	Condition of maintenance activities carried out on the asset class	Review the frequency and quality of the written PM Routines and procedures and reliability data collection such as MTBF, MTTR and *etc*
8	Operations and Maintenance Data/ Information Logging	Accuracy tracking of maintenance information	Review the quality of equipment history and other data collection methods such as CMMS information system storage

This benchmarking tool has been innovated and developed for electrical asset management to assess the reliability practice culture and to gauge maintenance effectiveness execution against the best performers. The eight criteria sum-marise the benchmarking tool that has been defined in Table 1

organisation, the plant asset has a tendency to operate in a high risk condition if the current maintenance has not been revamped since day one of the operation. Therefore, an effective benchmarking assessment study is recommended, which should be carried out by external specialist consultants or in-house global reliability maintenance experts. The outcome of the benchmarking assessment will create a management of change in the maintenance culture by tapping the best practice leaders approach.

BENCHMARKING METHODOLOGY

This benchmarking tool has adapted the qualitative and quantitative methodology and is used to carry out the assessment for each reliability and maintenance of an organisation. In Table 1, each defined element will specify the benchmarking target objective and assessment criteria which has been described in detail and is based on the standard ISO 14224: 2006 [1].

The qualitative methodology uses a formulated tailor questionnaires for each element to ensure that the assessment criteria is achieved. Each electrical asset management asset will consist of 20 to 25 questionnaires. The quantitative methodology tabulation is used to compute the average benchmark performance score from all the elements of the qualitative questionnaires which uses a rating of 0 to 4. Each element is weighted in the percentage contribution and is dependent on the priority ranking of the benchmarking assessment objective. Figure 1 shows the benchmark audit conceptual approach of the Electrical Reliability Maintenance (ERM) tool which has been used in many industries to benchmark against world class performers.

ASSESSMENT AND ANALYSIS

The benchmarking assessment is carried out by a well-trained assessor. He/she shall acquire the following attributed skills:

- Has acquired many years of experience in electrical operation and maintenance of industrial electrical equipment
- Has excellent knowledge in electrical maintenance programme development; *e.g.* Basic Asset Care, Predictive Techniques, Preventive Maintenance Programmes, including reliability assessment
- Is able to identify strengths and weaknesses, *i.e.* opportunities for improvement
- Is able to deliver a structured, comprehensive technical report on the findings and recommendations
- Possess the confidence and background to defend his/her audit findings at any level of the organisation

The benchmarking exercise is divided into two parts in the scope of works. The first phase is to have an interactive discussion on the maintenance practices of the organisation. The second phase is to survey the electrical asset equipment in the field selected at random. Field activities do not involve measurement, however, physical observation is carried out on selected equipment to assess the equipment operation, and it is executed with the following techniques:

Visual

Visual physical inspection of the asset condition; *e.g.* presence of foreign substance (*e.g.* oil, dust), wiring entry and exit, operating panel, reading pane, operating condition and ambient environment

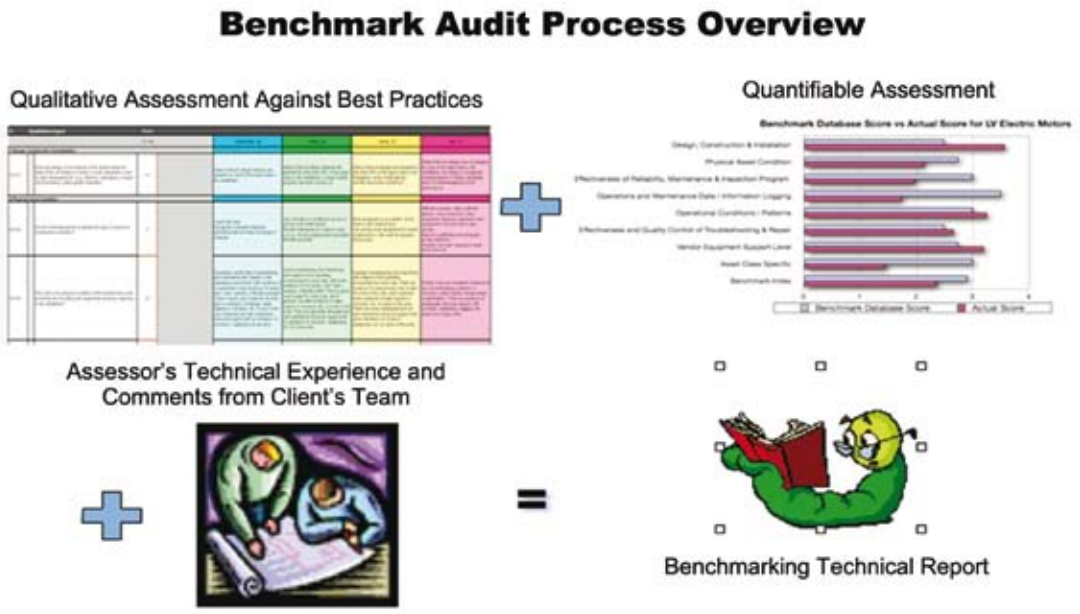

Figure 1: Benchmarking audit process methodology

Listen

Listening to electrical noise and operating mode; *e.g*. humming noise, high decibel, emitting unusual noise

Observe

Observing the electrical asset behaviour; *e.g*. moving parts mechanism, electrical distribution condition, electrical environment location

Feel

Feel or touch the safe surface of the electrical equipment to assess the heat generation, static charge, feel the operating condition surrounding the equipment

After gathering the required information, the assessor will then rate each assessment element with the relevant rating. The score will be computed into the average score after it has gone through the benchmark logic analysis. The assessor will prepare the benchmarking report which will consist of the following contents:

- The position ranking against the best performers
- The reliability and maintenance gap identification of areas of improvement
- Identification of the risk focus areas for immediate action plan
- Map out a three-year asset management roadmap programme strategies for the top management

CASE STUDY

The ERM benchmarking tool has been used to assess one of the Upstream and Exploration fields where the electrical asset has been in operation for more than 20 years. The management has decided to do a benchmarking exercise to measure the effectiveness of the reliability and maintenance practice culture in their business organisation. The management also intended to adopt world class best practice industry in electrical asset care management in its organisation. In addition, this exercise also allows the maintenance personnel to learn from world class practitioners for electrical asset.

This project was completed in 2009 for some of the selected electrical oil and gas platforms, which covered most of the electrical assets. However, this report will only present one asset class, which is the low voltage electric motor equipment, for the purpose of the case study.

I) Non-Field and Field Data Collection

There were about 150 low voltage electric motors that have been installed at the selected oil and gas platforms of which some of them were old and some have been newly replaced at site. Before going to the field activities, an interactive discussion took place with the reliability and maintenance department to scrutinise

Figure 2: Field data collection of low voltage electric motor

the maintenance data capturing process and also history records. With the prior gathered information in hand, the field audit activities were carried out successfully and the identified focus area was set as the target for the assessment. The non-field and field data collection was analysed at the back office between the lead assessor and the other assessors in order to rate the ERM benchmark tool after scrutinising the gathered technical and non-technical facts from the field site.

The whole benchmarking exercise for each asset class took about two days for non-field and field data collection and another two more days to do post data analysis using the ERM benchmarking tools. Figure 2 exhibits samples of the field collection data at site.

Figure 4 shows that the score of the LV motors was below the benchmarking level after inputting the non-field and field data into the standard assessment questionnaire. Therefore, there were gaps in certain areas that will be identified for improvement for this electrical asset. As shown in Figure 5, the output result was tabulated in the plotted histogram bar chart to indicate how far the gap was against the benchmark level.

From time to time, the master benchmark database score will be updated after each audit assignment performed by an assessor if he/she has seen the best performer plant from the audit site. Until now, the current master benchmark database has six data reference points since the benchmark tool was introduced at the end of 2008. The first data point was entered in February 2009 and the benchmark database is updated once a new assignment has been engaged.

2) Benchmarking Report

The short and precise benchmarking report will be prepared with the best practice recommendation to close the identified gap areas after careful consideration of all the important facts. In addition to that, an overall electrical asset management strategies roadmap will be prepared for the consideration of the business organisation which is recommended to be incorporated into their asset management planning strategies in the future. From the benchmarking report, a final exit keynote presentation will be prepared for the top management, detailing the findings and also way forward to improve electrical asset care management in the future.

Figure 4 exhibits some parts of the LV electric motor best practice from the benchmark database library as a reference.

B	Qualitative Input	Score (1 - 4)	WorldClass [4]	Green [3]	Yellow [2]	Red [1]
1-Design, Construction and Installation						
A02-B01	Does the design of the majority of the assets adopt the state-of-the art (based on today's current standards), best-in-class developments? (e.g. stand-by redundancy, modern instrumentation, latest gasket materials)	3.5	State-of-the-art design features are adopted by most of the asset class in the installation.	State-of-the-art design features are adopted by more than 50% of the asset class in the installation; a major retrofit program has been carried out.	State-of-the-art designs are adopted by less than 50% of the asset class in the installation; some modifications / retrofits have been carried out.	State-of-the-art designs are not adopted by most of the asset class in the installation; the design is considered obsolete based on today's standards, and it is disadvantageous to the performance.
2-Physical Asset Condition						
A02-B02	Are the individual pieces of equipment easy to access for maintenance activities?	3	Clean and neat: Equipment modularly designed permitting fast and easy exchange of modules.	Very well laid out. Sufficient access to remove and install spares. Routine maintenance is easy to carry out e.g. remote greasing and lubrication facilities provided.	Most equipment is accessible. Some need to plan replacement. Can access most equipment for routine maintenance. Little need for purpose built access.	Difficult to access, many confined spaces, close proximity to other equipment. Requires significant other equipment to be removed to gain access. Need for scaffolding and temporary access platforms. Possibly 'civil work' required if major plant

Figure 3: Template of the ERM benchmarking tool

XXX	BENCHMARK	UV Motors
Performance Indices	Score	Score
Design, Construction & Installation	2.500	3.000
Physical Asset Condition	2.750	2.286
Effectiveness of Reliability, Maintenance & Inspection Program	3.000	2.000
Operations and Maintenance Data/Information Logging	3.500	2.091
Operational Conditions/Patterns	3.000	3.000
Effectiveness and Quality Control of Troubleshooting & Repair	2.500	2.500
Vendor Equipment Support Level	2.750	3.000
Asset Class Specific	3.000	2.000
KPI Score	2.90	2.39

Figure 4: Output of the Electrical Reliability Maintenance (ERM) benchmarking tool

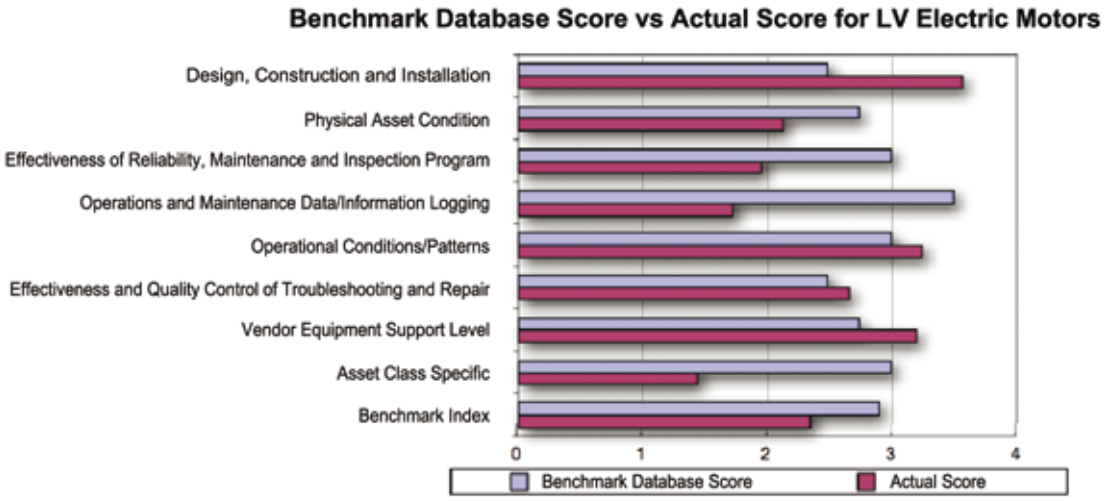

Figure 5: Histogram bar chart representing the LV electrical motor asset class

Assessment Area	Best Practices 'LV Motors'
Physical Asset Condition	- 3 monthly physical inspection program on the motors accessories support condition - Regular 12 or 18 months repainting program for motors housing for corrosion environment condition - Cabling and accessories are kept in good condition and order, no damages are sustained - Grease nipples (where applicable) are protected and kept in good condition - Motor fan and fan cowl are in good condition and working order
Effectiveness of Reliability, Maintenance and Inspection Program	- Execution of lubrication program for motors that require greasing, as per manufacturer's recommendation - Good contamination control, 5-S implementation in motor lubrication program - Maintaining the PM & PdM execution records - Tracking the MTBF for motors > 30kW or related critical services - Updating the PM & PdM task every 5 years based on the history of failure from CMMS - Implement the condition monitoring program (Vibration Analysis) execution on the critical service motor

Figure 6: Partial literature of best practice of LV electric motor in benchmark database

SUMMARY

This case study has demonstrated the benchmarking assessment benefits for electrical asset care. It has met the customer management objective through this benchmarking study. The identified weaknesses and strengths focus asset area for the electrical asset class for certain elements have been captured in this assessment. As a result, this benchmarking assessment has succeeded in convincing the top management to adopt a culture of change towards its electrical asset and in managing the reliability and maintenance organisation by tapping into world class leading companies best practices in electrical asset management.

CONCLUSION

The benchmarking assessment tool will indeed bring great benefits to an organisation if the benchmarking study is properly executed with a defined objective that is set by the external specialist consultant and customers. By knowing how to use the results of the benchmarking study to create a management of change towards the electrical asset and understanding the electrical asset management organisation behaviour, it will produce great results from the outcome of the benchmarking study.

The beauty of the ERM benchmarking tool is in its ability to identify the reliability and maintenance best practice gap, and prepare an effective execution asset management strategies roadmap for the electrical asset in order to extend the life cycle service (LCS) of the electrical asset. The final conclusion is that this benchmarking study can enhance the elec-trical asset in a plant to operate in high dependability condition and also alleviate the liability risk in the asset care which can affect business sustainability operation and corporate image. ■

REFERENCE:

[1] ISO 14224-2006: Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment

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