Try Compressor Train Reliability Audits

Periodic auditing of the state of your compressor reliability management practices is needed if your facility wants to be assured of not being overtaken by the competition. One effective way to conduct such audits is to engage independent reviewers or Subject Matter Experts (SMEs) - at most three - with extensive knowledge and experience of process plant or pipeline operational environments, typically process machinery, i.e. compressor installations, static equipment, instrumentation and electrical (I&E) as well as SCADA[1] technology. The objectives are identification of major gaps in areas of management and equipment hardware. Audit results can be used for benchmarking[2] purposes – see Figure 1. They may cover the following areas:

1. Organizational Structure (positions, mgmt. leadership, resources, skill levels) **(OS)**
2. Physical Assets Plant **(PAP)**
   - 2.1 Major trains
   - 2.2 Critical equipment other than major trains
   - 2.3 General purpose equipment
3. Review of maintenance systems **(PPM)**
   - 3.1 Preventive/Predictive maintenance
   - 3.2 Emergency response
   - 3.3 Turnaround management and execution
   - 3.4 Spare parts management and availability
   - 3.5 Training and skill level
4. Review of operation interfaces **(OI)**
   - 4.1 Autonomous maintenance
   - 4.2 Emergency response
   - 4.3 Training and skill level
5. Performance assurance **(PA)**
   - 5.1 Performance metrics (indicators) and initiatives
   - 5.2 Bad actor programs
   - 5.3 Role of Root Cause Failure Analysis (RCFA)

Interviews. In addition to physical inspection and assessment of site equipment, reliability audits make use of plant personnel interviews to assess the organizational effectiveness and validity of performance metrics. This will usually allow surfacing of management issues that may sap performance efficiencies. Personnel interviewed represent job functions that impact equipment reliability such as equipment engineers, maintenance supervisors, equipment technicians, operators, stores personnel, inspectors and others.

Timing. Effective machinery audits are conducted on a tight time line in order to gain a quick understanding and assessment of plant organizational status and usually identify no more than six major issues that plague the organization. Depending upon the size of the facility the time is a maximum of 3-1/2 days followed by a management presentation and final report preparation on a fourth day.

[1] Supervisory Control and Data Acquisition

[2] Benchmarking is a process used in management in which organizations evaluate various aspects of their processes in relation to best practices or to those adhered to by "Best-of-Class" companies.

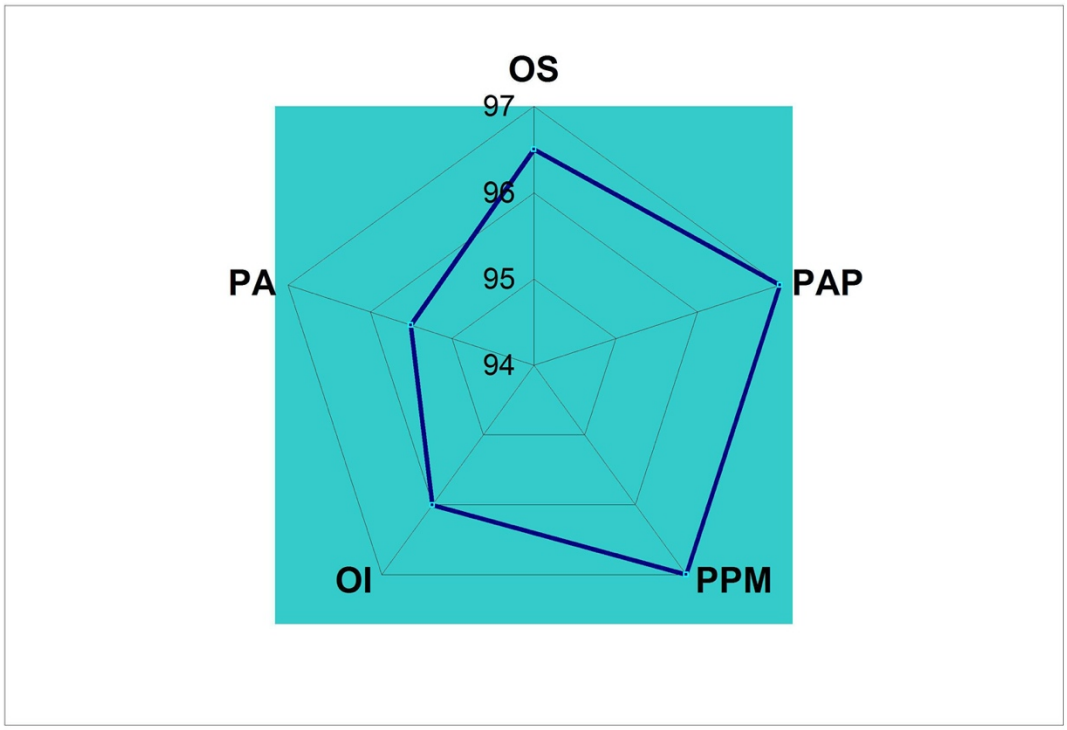

Figure 1. Example of a benchmark radar graph.

To make a reliability audit more effective, it would be well to divide the plant into smaller entities and conduct the audit for these individual units. This also allows meeting the timetable of 3-1/2 days for field reviews and interviews. Examples are reliability audits conducted at utilities, gas plants, refinery units, polyethylene plants, etc.

Preparation. The reviewers spend preparation time prior to the field audit to gain familiarity with the plant and data associated with it. This data is usually provided by the site ahead of the actual audit according to a catalog of required documentation.

Results. Table 1 is an example of the presentation of audit results showing not only gaps, but also advising the client on cost and benefits of necessary changes.

Table 1. Audit Matrix (2) Physical Assets - Example

#	Description Best of Class	Gap / Explanation / Example	Ranking	Action to close gap
2.01	**Hardware** design gaps do not exist **Regular review of industry (API) Machinery Standards** is practiced and equipment brought up to the latest standard as seen necessary and justifiable.	1. Upgrade of machinery condition monitoring 2. Upgrade of *IsoCarbon* ® Seals and other oil shaft seals 3. Replacement of refrigerants not completed 4. No firm schedules identified for above projects	**75**	Management to provide resources to allow above projects to proceed
2.02	**Operators** involved in: 1. Surveillance & housekeeping 2. Health monitoring 3. Performance monitoring Example: Widespread use of hand-held vibration meters, use of PDTs (Portable Data Terminals) for field data logging - instead of log sheets - and tracking	Site visit (XXZ/YYZ) revealing: 1. Average to poor housekeeping around compressor trains (dirt, oil leaks) 2. Blind & broken gauges 3. No instrumentation on compressor thrust balance lines 4. No operator presence during a one-hour visit	**75**	1. Review operating procedures re: routine compressor operation & surveillance tasks 2. Assure joint effort for above by operations & EE departments
2.03	**KPIs[1] visible & stewarded to.** Examples: • Trips/train/year, e.g., 0.33 to 0 • Running average of yearly reliability and availability (SF[2]) by train, by critical set • MTBF / MTBR • % Bad Actors • Machinery cost (% of ERV[3], $/hp (kW)/year) • PM compliance	1. No annual machinery reliability / availability indices / statistics for major machinery being produced 2. No clear indication of Δ % reliability = $ 3. No cause identification for improvement strategies evident	**50**	Machinery group must develop method of automated data capture & machinery reliability/availability indices tracking and make them visible for stewardship

Notes: 1 Key Performance Indicators

2 Service Factor

3 Estimated Replacement Value

Other typical audit results were documented in the following list for client company XYZ:

- There were clear opportunities in such areas as providing guidance and direction in assembling better repair and failure data. XYZ must know its pump MTBF and maintain a running log of "bad actor" pumps.
- The company employed above-average quality reliability technicians and engineers. However, some of these employees were spending time on routine tasks such as collecting general vibration data. Instead, they should be redirected to concentrate more on the value-added task of analyzing excursion data collected by others and developing permanent remedies for equipment at risk.
- Although XYZ had a small number of reliability profes-sionals for a company its size, it was asked to defer adding more personnel until their demonstrated abilities were fully utilized. This can be done by emphasizing value-added

assignments and encouraging them to be resourceful.

- Resourcefulness has many facets. For instance, letting vendors and suppliers provide data on bearing designations, the reliability professional would efficiently restructure these into important component specifications. The latter would enable the purchasing department to buy least-risk, or lowest life cycle cost bearings, mechanical seals, etc.
- Root cause failure identification and analysis (FRACAS)[3] is key to failure elimination. Repeat equipment failures at XYZ indicated that the true causes of equipment distress had not been identified. The obvious recommendation was to arrange for refresher courses. Problem-solving exercises should use XYZ's own examples. Thereafter, RCFA should be institutionalized.
- XYZ was asked to adopt the mindset that repeat failures are as unacceptable as safety incidents. Every unanticipated maintenance event should be seen as an opportunity to upgrade the equipment. Providing answers to the questions, is an upgrade possible? and, if yes, is it economically justified? This should be the primary goal of reliability professionals.

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References

1. Bloch, H.P. and Geitner, F.K., *Maximizing Machinery Uptime*, Elsevier – Gulf Publishing, Amsterdam, Tokyo, 2006, ISBN-13: 978-07506-7725-7.

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[3] Failure Recording and Cause Analysis System