



Motor System Maintenance and Management

Part 1

KPI's and the Electrical Maintenance Checklist

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This presentation is the first of a ten part series on Motor System Maintenance and Management for industrial and manufacturing facilities. In this presentation, we will be discussing the first of seven Key Performance Indicators, or KPI's, that measure a world-class maintenance and management program.

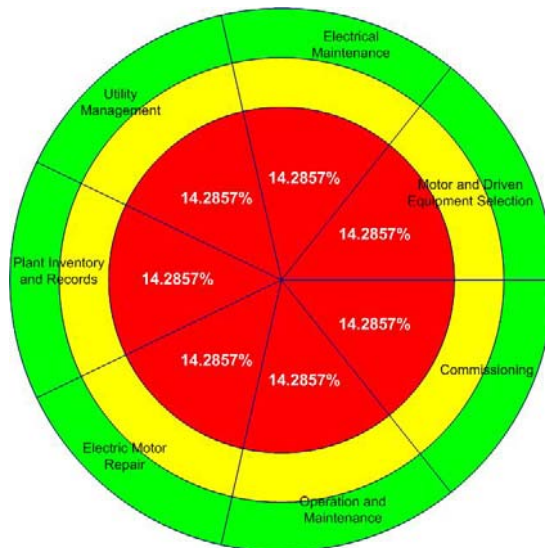
The presentation and materials come from twenty years of motor-system maintenance and management research and development by Dr. Penrose and other industrial and manufacturing resources.

My name is Dr. Penrose and I am the president of SUCCESS by DESIGN and the executive director of the institute of electrical motor diagnostics. I have over 20 years in the reliability and maintenance industry including specializing in the development of motor system maintenance and management programs. In this presentation, we will explore many of the questions that I use when evaluating and establishing programs.

Each of the KPI's and questions related to this evaluation should be answered by the motor system maintenance and management team. The team must consist of: At least one senior or executive manager, the associated operations managers, reliability managers, purchasing, maintenance personnel and representatives from associated equipment and repair vendors.



Seven Key Components



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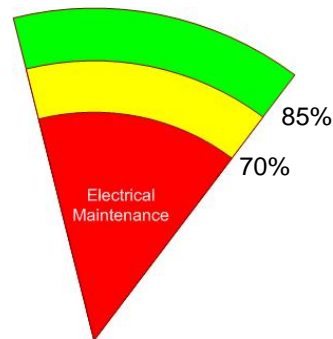
There are seven key components to the development of a world-class motor system maintenance and management program. These components include:

- Electrical Maintenance
- Motor and Driven Equipment Selection
- Commissioning
- Operation and Maintenance
- Electric Motor Repair
- Plant inventory and records
- Utility management

Within each area, the points are weighted to 100% with less than desirable being under 70 percent and world class being over 85 percent.

Electrical Maintenance

- Eight Parts to Successful Electrical Maintenance:
 - Drawings (10%)
 - Maintenance (20%)
 - Arc Flash and PPE (10%)
 - Load and Power Quality (10%)
 - Root-Cause-Analysis (10%)
 - Electrical Work Procedures and Safety (20%)
 - Emergency Repair Plan (10%)



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Electrical maintenance is the first key component that must be in place prior to putting together the program. Within the electrical maintenance program there are eight parts to successful electrical maintenance. These include:

- Maintenance of drawings and manuals;
- General maintenance practices related to electrical maintenance;
- Arc flash and personal protective equipment;
- Electrical load and power quality monitoring;
- Root cause analysis programs;
- Electrical work practices and the company safety program; and,
- The maintenance emergency repair plan.

Each part to this KPI is weighted by importance.

Drawings

- Do updated as-built drawings exist and are they available? (3pts)
- Are all relevant equipment instruction manuals available? (3pts)
- Is there a process in place that ensures the manuals and drawings are maintained in a current condition? (4pts)

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The first component relates to drawings. Each question must be answered honestly and may require the motor management team to provide answers to all questions.

The first section relates to documentation and drawings:

- Do updated as-built drawings exist and are they available? (3pts)
- Are all relevant equipment instruction manuals available? (3pts)
- Is there a process in place that ensures the manuals and drawings are maintained in a current condition? (4pts)



Maintenance: Each Question = 2.5pts

- Is there a documented maintenance program and does it have a valid basis (ie: RCM)?
- Is the program being vigorously followed?
- Is there a procedure in place that updates the program based on changes to plant equipment or processes (ie: MER)?
- Does the program identify critical equipment?
- Are there adequate work control procedures that prevent mistakes when work is done on critical systems and equipment?
- Does system design provide redundancy so all critical equipment can be maintained without a shutdown?
- Does the program ensure that maintenance test results are trended and used to update and improve the maintenance program?
- Is there a program in place that ensures periodic evaluation of possible equipment replacement considering maintenance data trends, availability of replacement parts and unplanned shutdown costs?

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For the section on maintenance, each question is worth 2.5 points:

- Is there a documented maintenance program and does it have a valid basis (ie: RCM)?
- Is the program being vigorously followed?
- Is there a procedure in place that updates the program based on changes to plant equipment or processes (ie: MER)?
- Does the program identify critical equipment?
- Are there adequate work control procedures that prevent mistakes when work is done on critical systems and equipment?
- Does system design provide redundancy so all critical equipment can be maintained without a shutdown?
- Does the program ensure that maintenance test results are trended and used to update and improve the maintenance program?
- Is there a program in place that ensures periodic evaluation of possible equipment replacement considering maintenance data trends, availability of replacement parts and unplanned shutdown costs?

Training Program

- Is there a formal technical training program in place? (1.7pts)
- Do training records exist? (1.7pts)
- Is there a process in place that ensures training records are maintained in an up-to-date condition? (1.6pts)
- Is there a process in place that identifies and arranges for needed training? (1.6pts)
- Is there a process in place that ensures the training program is periodically reviewed to identify needed changes? (1.6pts)
- Is there a process in place that ensures personnel have the proper test/monitoring equipment and that it's periodically calibrated? (1.8pts)

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For the training program:

- Is there a formal technical training program in place? (1.7pts)
- Do training records exist? (1.7pts)
- Is there a process in place that ensures training records are maintained in an up-to-date condition? (1.6pts)
- Is there a process in place that identifies and arranges for needed training? (1.6pts)
- Is there a process in place that ensures the training program is periodically reviewed to identify needed changes? (1.6pts)
- Is there a process in place that ensures personnel have the proper test/monitoring equipment and that it's periodically calibrated? (1.8pts)

Arc Flash and PPE

- Has an arc-flash study been performed and are specific PPE requirements posted at each panel, switchgear, etc.? (5pts)
- Is there a process in place to ensure studies and PPE requirements are updated when system or utility supply changes are made? (5pts)

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For the arc flash and personal protective equipment, each question is worth five points:

- Has an arc-flash study been performed and are specific PPE requirements posted at each panel, switchgear, etc.? (5pts)
- Is there a process in place to ensure studies and PPE requirements are updated when system or utility supply changes are made? (5pts)



Load and Power Quality

- Is there a load monitoring program in place? (3.3pts)
- Is there a power quality monitoring program in place? (3.3pts)
- Is there a process in place that takes appropriate action when overloads or power quality problems develop? (3.4pts)

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For electrical load and power quality:

- Is there a load monitoring program in place? (3.3pts)
- Is there a power quality monitoring program in place? (3.3pts)
- Is there a process in place that takes appropriate action when overloads or power quality problems develop? (3.4pts)



Root-Cause-Analysis: Each Question = 5pts

- Is there a program in place that ensures equipment failures, unplanned outages and unusual events are investigated to determine root-cause?
- Is there a process in place that ensures root-cause information is used to effectively improve operations, facility design, maintenance procedures, and personnel training programs to avoid or minimize future unplanned outages?

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For root-cause-analysis, each question is valued at five points:

- Is there a program in place that ensures equipment failures, unplanned outages and unusual events are investigated to determine root-cause?
- Is there a process in place that ensures root-cause information is used to effectively improve operations, facility design, maintenance procedures, and personnel training programs to avoid or minimize future unplanned outages?



Electrical-Safe Work Procedures

- Are electrical work procedures included in the safety manual? (3.4pts)
- Is there a formal and active program for updating the safety manual? (3.3pts)
- Are accidents and near-misses documented and is there a process in place that ensures actions will be taken to update procedures or take other corrective actions? (3.3pts)
- Are workers trained on safety manual procedures? (3.3pts)
- Do workers comply with manual procedures? (3.3pts)
- Is there a periodic audit of workers to confirm compliance with safety manual procedures? (3.4pts)

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For electrical safe work practices:

- Are electrical work procedures included in the safety manual? (3.4pts)
- Is there a formal and active program for updating the safety manual? (3.3pts)
- Are accidents and near-misses documented and is there a process in place that ensures actions will be taken to update procedures or take other corrective actions? (3.3pts)
- Are workers trained on safety manual procedures? (3.3pts)
- Do workers comply with manual procedures? (3.3pts)
- Is there a periodic audit of workers to confirm compliance with safety manual procedures? (3.4pts)



Emergency Repair Plan

- Do electrical maintenance personnel have an emergency repair plan that identifies or lists the critical equipment? (10pts)

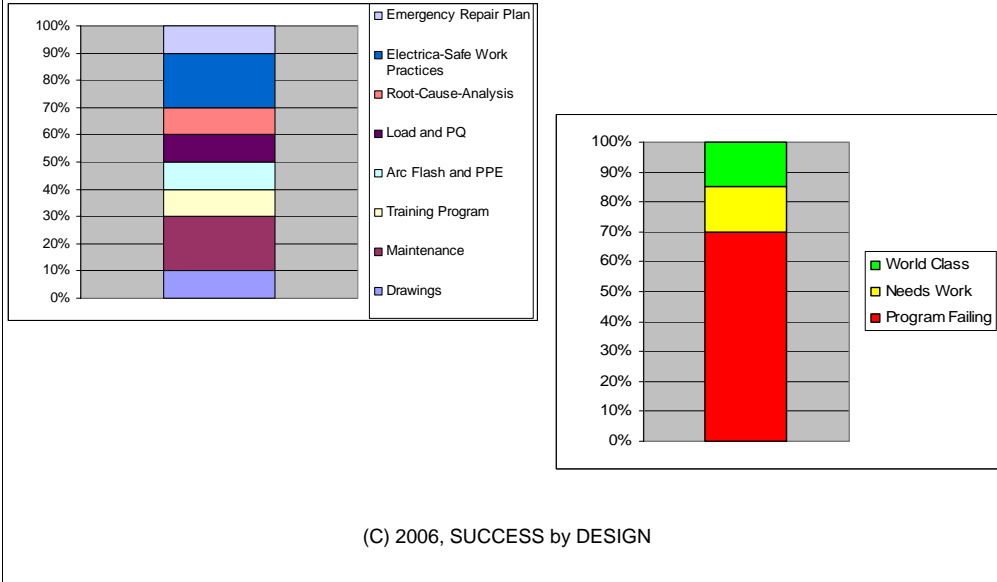
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And a full ten points set aside for the emergency repair plan for equipment:

Do electrical maintenance personnel have an emergency repair plan that identifies or lists the critical equipment? (10pts)



Electrical Maintenance Conclusions



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All of the points are added together and the total should be above 85 for world class, above 70 for an acceptable program that requires work and below 70, the program must be repaired prior to implementing a motor management program. Scores above 70 will identify both management and maintenance commitment to reliability.

In our next presentation, we will start working on the KPI's directly related to the motor system itself.



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SUCCESS by DESIGN provides training and reliability services in such areas as:

- motor system maintenance and management programs,
- condition-based maintenance and reliability-centered maintenance,
- PM optimization,
- maintenance effectiveness reviews,
- Industrial assessments,
- Energy and alternative energy projects,
- And more

For additional information, contact SUCCESS by DESIGN

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