**Tutorial - Condition Monitoring of Rotating Machines** Nov 20

Rotating Machines

Q1 Distinguish between *critical*, *essential* and *important* assets.

Q2 Consider the asset pyramid shown below:

1. For each level in the asset pyramid, provide examples of applications for rotating machines that fall into the categories.
2. Provide your justifications.

Critical

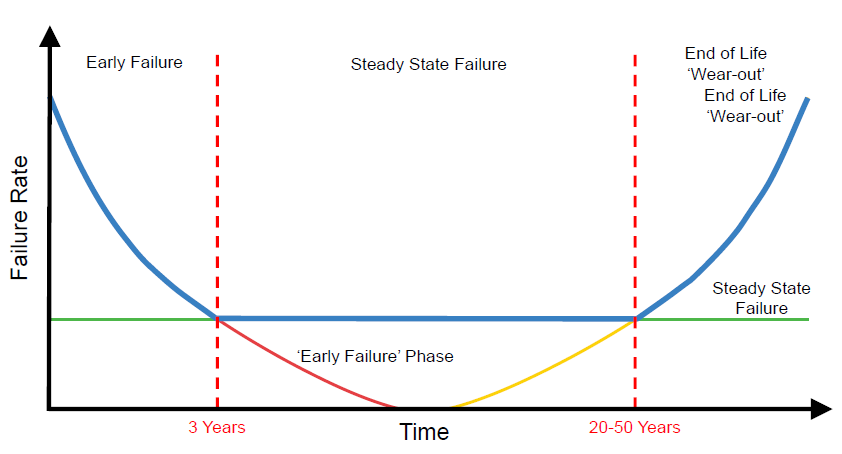
Essential

Important

Secondary

Non-essential

Q3 Describe and explain the 3 regions and causes of the bathtub curve shown below. What is the significance to condition assessment?



Q4 State and describe *three* categories of faults that occur in induction motors.

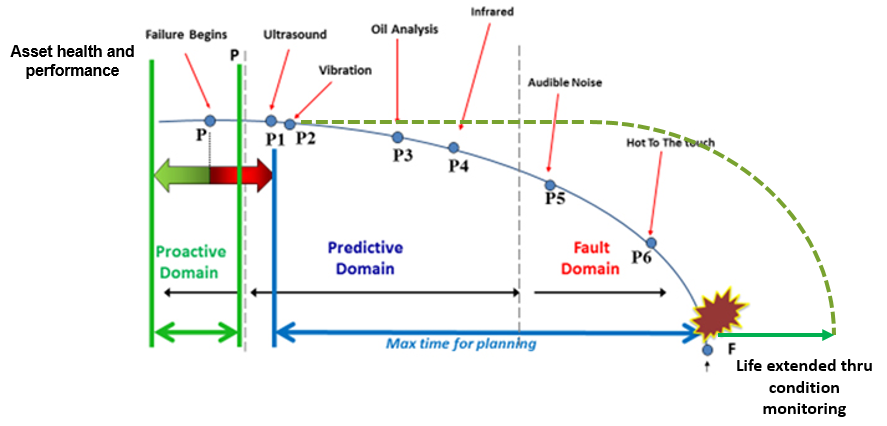
Q5 In relation to failure statistics in rotating machines, distinguish between generators and induction motors.

Q6 i. Identify and briefly describe the three most common faults of induction motors.

ii. For each provide their main causes and effects of the fault.

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Q7 Name the type of plot illustrated in the diagram below. Explain the importance and the points raised by the diagram:



Q8 Provide a comparison between, *reactive-* and *predictive-maintenance*.

Q9 To prevent unscheduled failure, condition monitoring can be used to assess the condition of the rotating machines.

1. List the goals and advantages of using condition monitoring.
2. What are the downsides?
3. For each of the following monitoring techniques provide a discussion of: the principle of measurement and its application to the condition assessment of rotating machines; the type and choice of sensors used, the reliability of the measurement, the application of standards, and the integration to an overall condition monitoring (CM) system.
   * + - Thermal
       - Vibration
       - Motor Current Signature Analysis
       - Partial Discharge
       - Oil Analysis
       - Acoustic Emissions

Q10. From signals produced by a high frequency current transformer attached to a generator stator winding, there are indications that a fault exists. Outline the information that you would consider to be important to an asset manager prior to his making an assessment of the stator?

Q11. Explain the significance of the statement; “There are challenges to obtaining plant-wide monitoring that includes even small machines and non-critical applications. One of the major inhibiting factors is the ratio of condition monitoring cost to equipment cost, which is crucial to the acceptance of using monitoring to guide maintenance for a large fleet of electrical machinery.”

Q12 In the grid shown in Fig Q.12 below, induction motors are classified in terms of rated voltage and downtime costs. Complete the grid by identifying which monitoring technique(s) plant operators would tend to use for each. In your answer you should briefly explain your reasoning, identify if more than one technique would be considered in an integrated monitoring solution, and indicate what effect load would have on the choices made.

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|  |  |  |  |
| --- | --- | --- | --- |
|  | | **Downtime Costs** | |
| Low | High |
| **Rated Voltage** | < 11kV |  |  |
| ≥ 11kV |  |  |

**Fig Q.12**

***Directed Reading:***

*1. "Induction Motor and Faults", Chapter 2, S. Karmakar et al., Induction Motor Fault Diagnosis, Springer Science+Business Media Singapore 2016. - Found in GCULearn.*

*2. "Wind Turbine Condition Monitoring: State-of-the-Art Review, New Trends, and Future Challenges", P.Tchakoua et al., Energies 2014. - Found in GCULearn.*

*3. “Rotating Electrical Machine Condition Monitoring Automation—A Review”, Machines 2017. Found in GCULearn.*