August 2017, Jakarta

GEOTHERMAL POWER PLANT MAINTENANCE & RELIABILITY

Course: Operators of Geothermal Power Plant

Hosting by: PPSDM EBTKE, Jakarta

NANANG KURNIAWAN

Overview

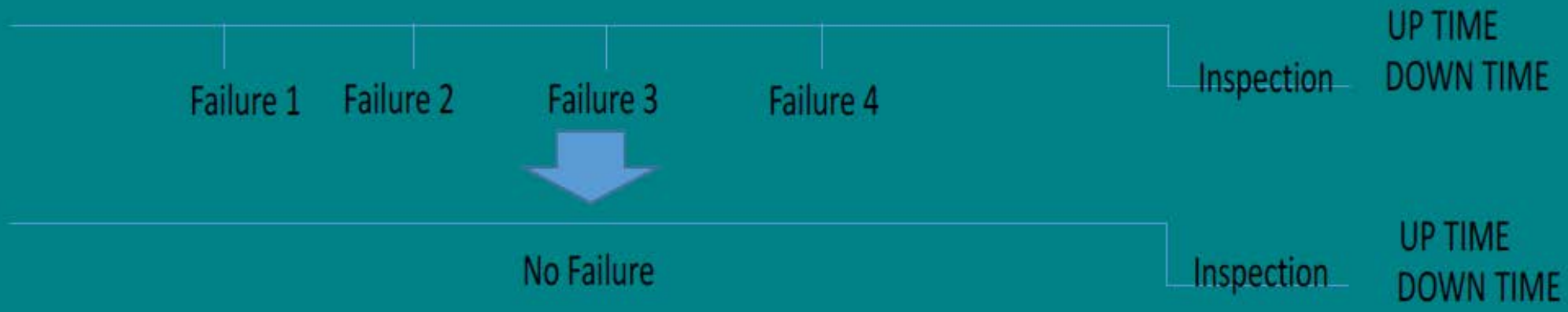
- Reliability
- Maintenance
- Type of Maintenance
- Reliability Centered Maintenance
- Maintenance of Main Equipment

RELIABILITY

- **Availability:** Probability that the system is operating properly when it is requested for use.
- **Reliability:** Probability of the equipment could continuously operate with out any failures

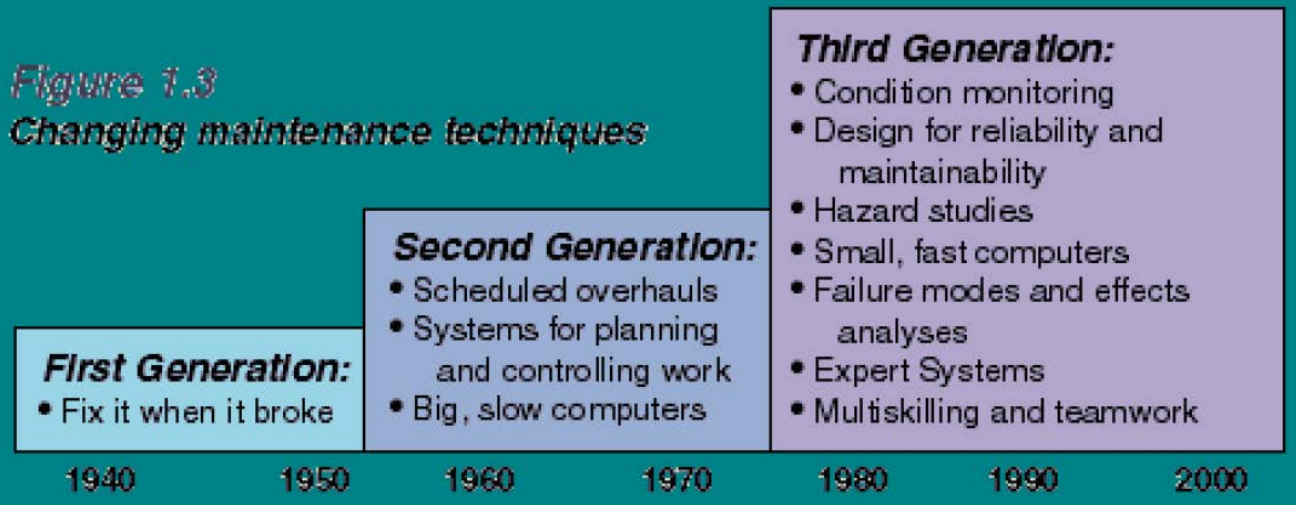
$$R_{(t)} = e^{-\lambda t} = e^{-(t/m)}$$

- m or MTBF=total running hour/number of fail



MAINTENANCE

Maintenance (Moubray,1997): The series of activities to ensure that physical assets could continuously do what their users want them to do



Source: Moubray, 1997

TYPE OF MAINTENANCE

PROACTIVE:
- CONDITION MONITORING
- PREVENTIVE MAINTENANCE
  - RESTORE/REPAIR
  - REPLACE

REACTIVE:
- CORRECTIVE MAINTENANCE
- FUNCTIONAL CHECK

RELIABILITY CENTERED MAINTENANCE

By 1960, research on the preventive maintenance approach by FAA and the commercial aviation industry show that:

- ✓Many cases overhauls had little or no effect on overall reliability and safety
- ✓No change in safety or reliability when overhaul intervals changed
- ✓Changing parts too early consumed component life and re-introduced infant mortality failures.

- In 1978, based on the commercial aviation research, Nowlan and Heap wrote a report for the US National Defence in which the term RCM was first coined.
- Stan Nowlan continued his research and in 1983 started his collaboration with John Moubray to adapt RCM to industry. This gave rise to RCM2.

RELIABILITY CENTERED MAINTENANCE

Reliability-centered Maintenance(RCM): aprocess used to determine the maintenance requirements of any physical asset in its operating context

RCM Process

- What are the functions and associated performance standards of the asset in its present operating context?
- In what ways does it fail to fulfil its functions?
- What causes each functional failure?
- What happens when each failure occurs?
- In what way does each failure matter?
- What can be done to predict or prevent each failure?
- What should be done if a suitable proactive task cannot be found?

MAINTENANCE OF MAIN EQUIPMENT –OVERHAUL

- Due to the steam composition a natural production, the possibility of oxide scale, erosion, corrosion, wearing and damage on GPP equipment due to deformation is immense. A scheduled overhaul as a part of Preventive Maintenance Program are conducted regularly to restore it to the initial condition

- VIDEO

MAINTENANCE OF MAIN EQUIPMENT -OVERHAUL

Preventive Maintenance are conducted to clean, repair and replace parts/equipment

Shutdown well

LOTO

Actuator Inspection

Separator Inspection

Orifice Inspection

Top Valve Inspection

MAINTENANCE OF MAIN EQUIPMENT –CdM

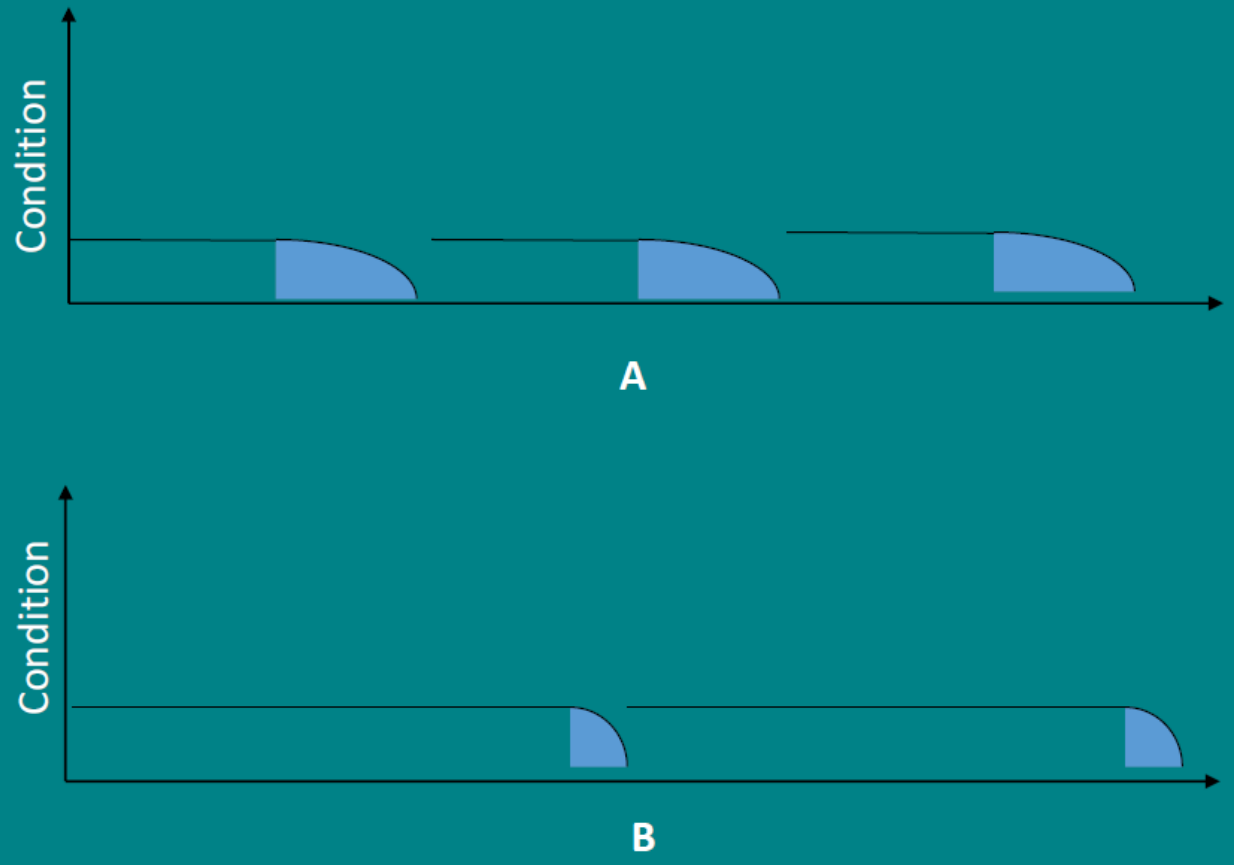
Condition Monitoring is performed to predict failures & reduce failure consequences

No	Equipment	Technology		Standards
1	Mechanical Rotating	Vibration Analysis, Oil Analysis, Ultrasonic, Thermography	 	ISO 10816-2, ISO 7919-2, OEM, ASTM D445, ASTM D664, ASTM D4951, ASTM D6304
2	Mechanical Non Rotating	Thickness (Ultrasonic)		ASME VIII, API 510, OEM, ANSI B31.1, API 581,
3	Generation System	Vibration Analysis, Ultrasonic, Partial Discharge	 	ISO10816-2, Mobil, IEEE142, OEM
4	Electrical System	Ultrasonic, Thermography, DGA test, BDV test, WTC test		ISO10816-2, Mobil, IEEE112, IEEE142, OEM, IEEE112, IEEE27, IEEE Std C57. 104-1991, IEEE 60156
5	Protection System	Thermography	 	IEEE27
6	Control System	Exaquantum, Environmental Analyzer, Oscilloscope		ISA 71.01, 71.02, 71.03, OEM
7	Field Instrument	Hart, Calibrator P/T		ISA-TR75.04.01, ISA 26, ISA 7.0.01, ISA 75.13, ISA 75.25.01

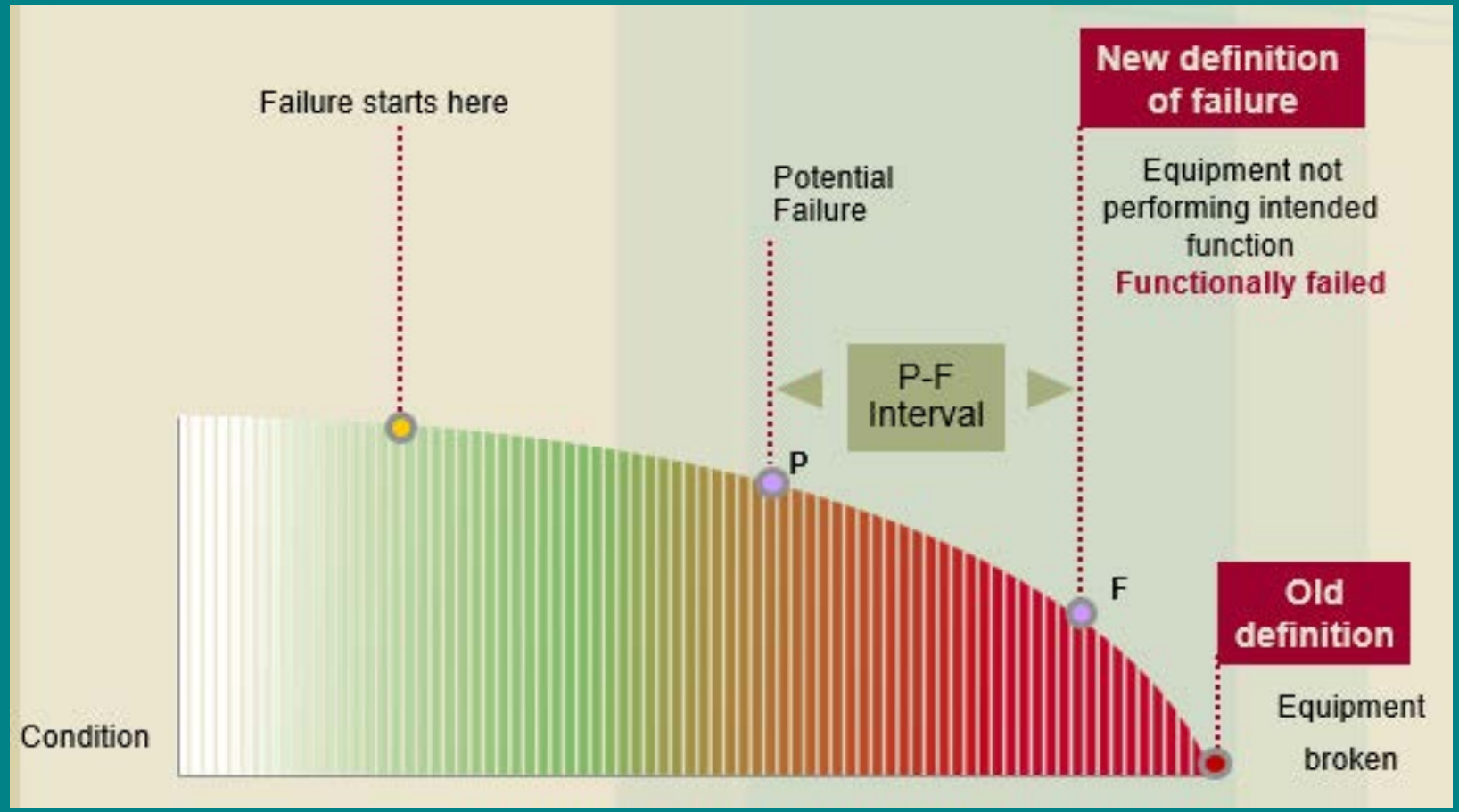
New Maintenance Paradigms

- #1
- “It doesn’t fail so often, therefore, I don’t need to check it so often”
- #2
- “We need to check our critical equipment more often than our non-critical equipment”
- #3
- “We monitor our equipment MTBFs carefully so that we can determine how often we should overhaul/replace equipment”
- #4
- “Condition Based Monitoring(Predictive Maintenance) and Failure-Finding Tasks(Functional Test) are one and the same”

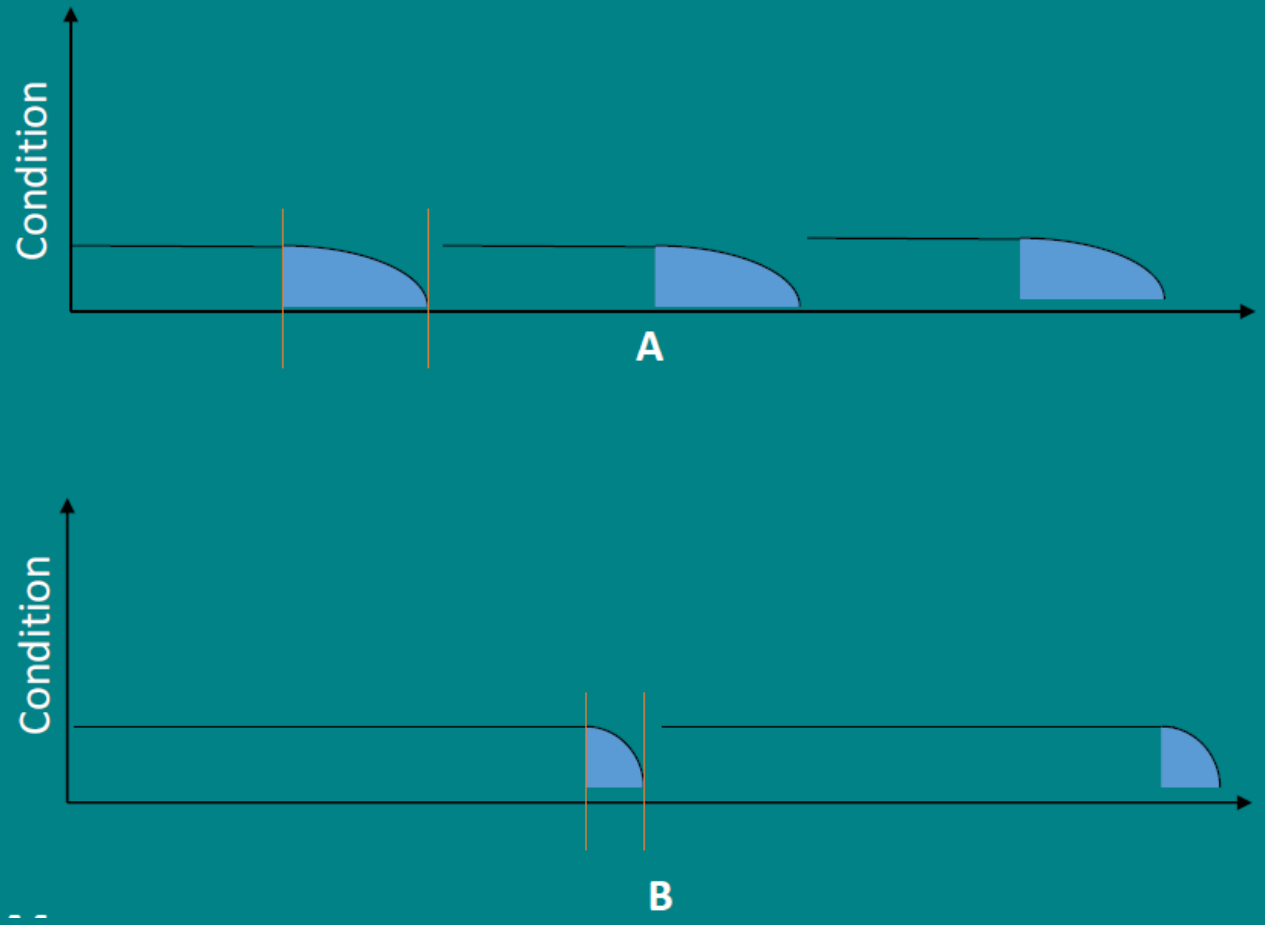
#1 “It doesn’t fail so often, therefore, I don’t need to check it so often”



#1

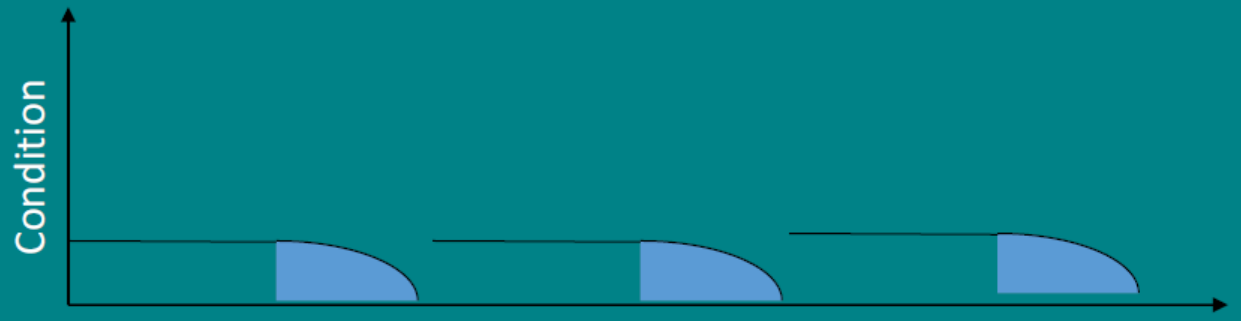

Failure starts here
Potential Failure
New definition of failure
Equipment not performing intended function
Functionally failed
P-F Interval
P
F
Old definition
Equipment broken
Condition

#1

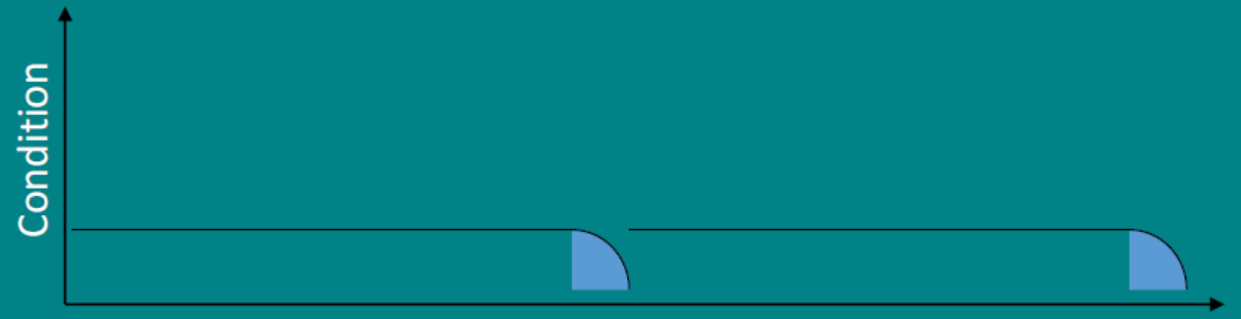


CdM: The task interval is not determined by how often the equipment fails. The task must be carried out within the P-F interval if the failing of equipment could be predicted.

#2 “We need to check our critical equipment more often than our non-critical equipment”

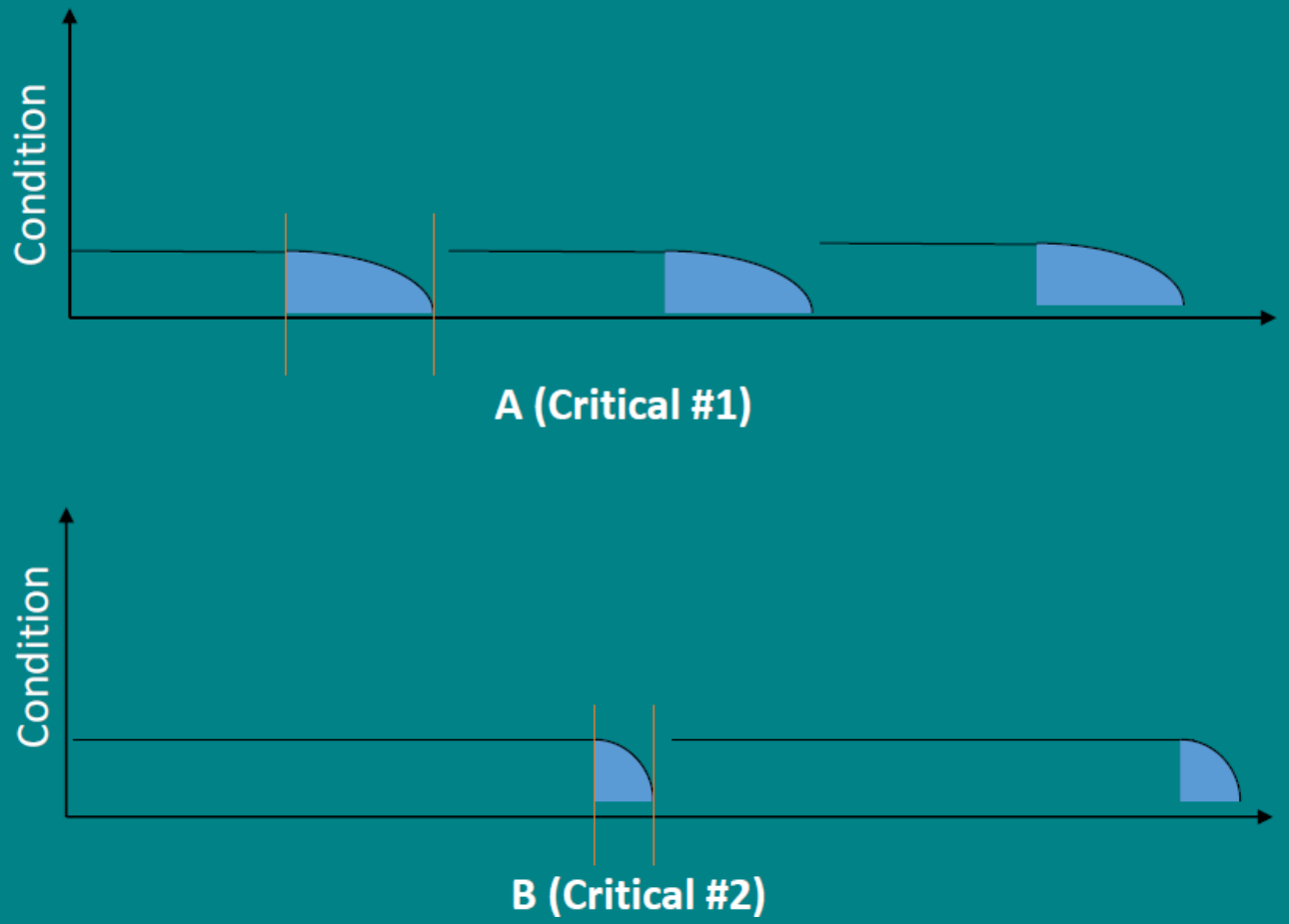


A (Critical #1)



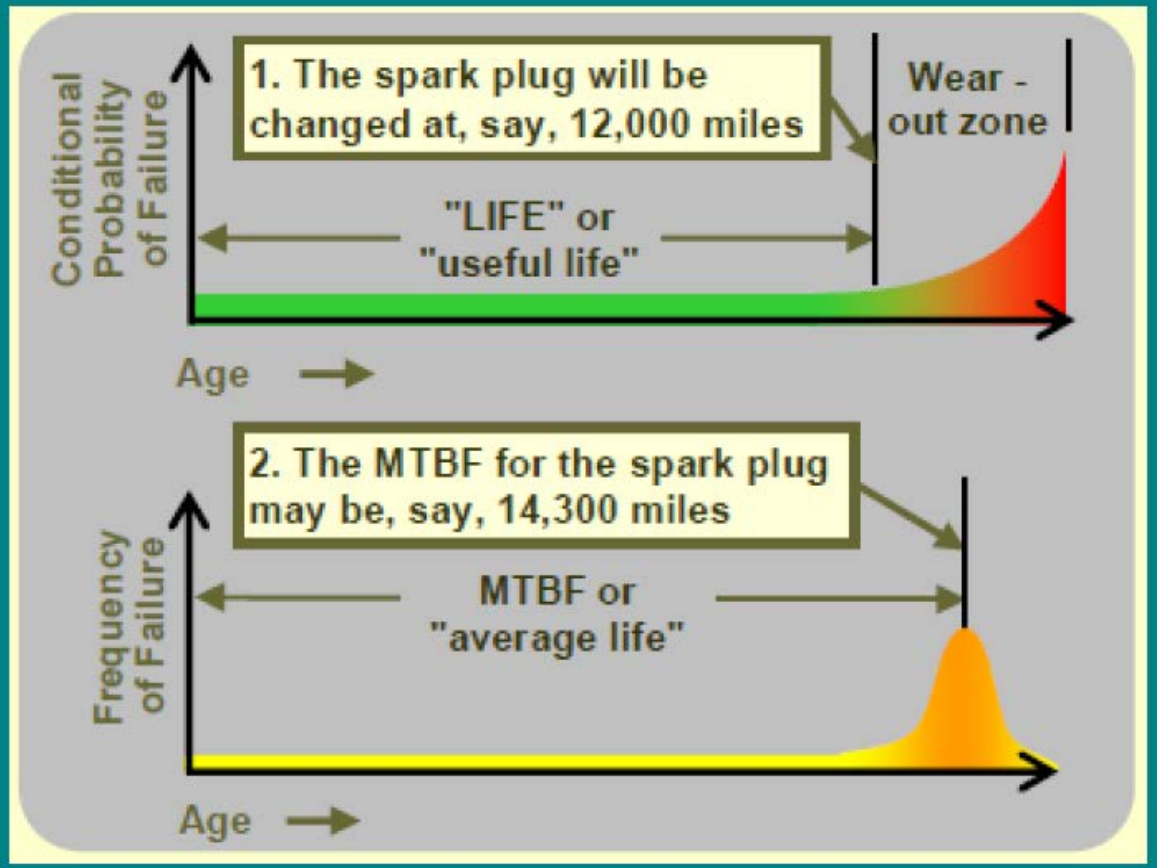
B (Critical #2)

#2

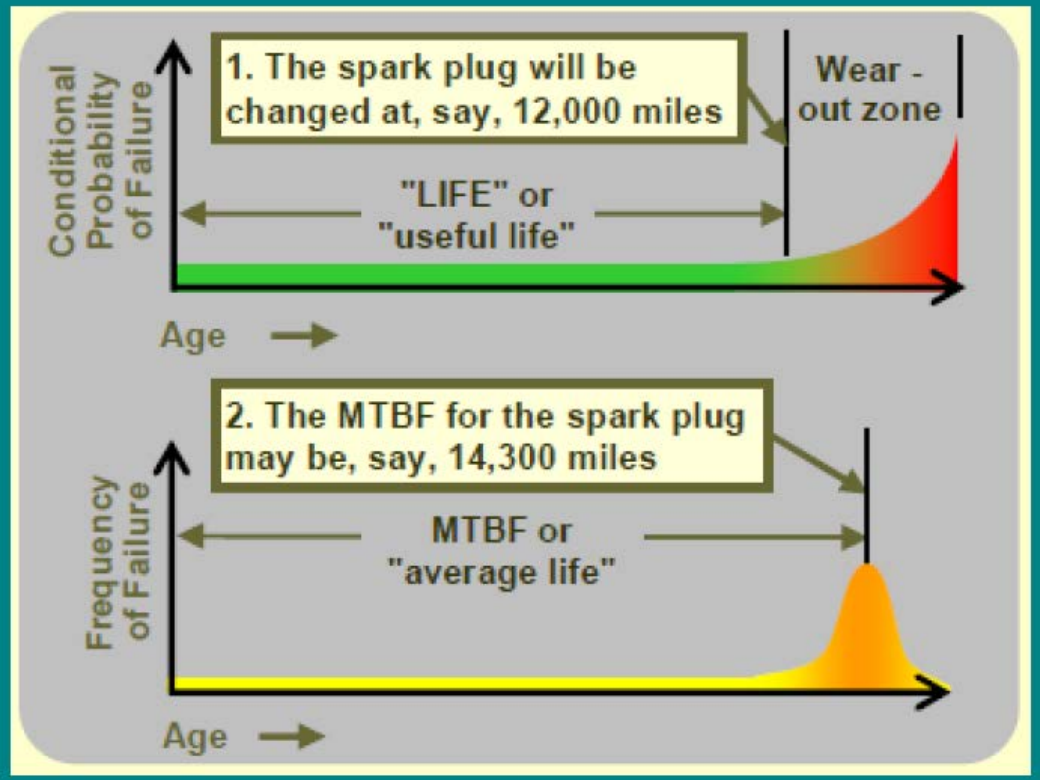


CdM: The task interval is not determined by how often the equipment fails and its criticality as well. The task must be carried out within the P-F interval if the failing of equipment could be predicted.

#3 “We monitor our equipment MTBFs carefully so that we can determine how often we should overhaul/replace equipment”

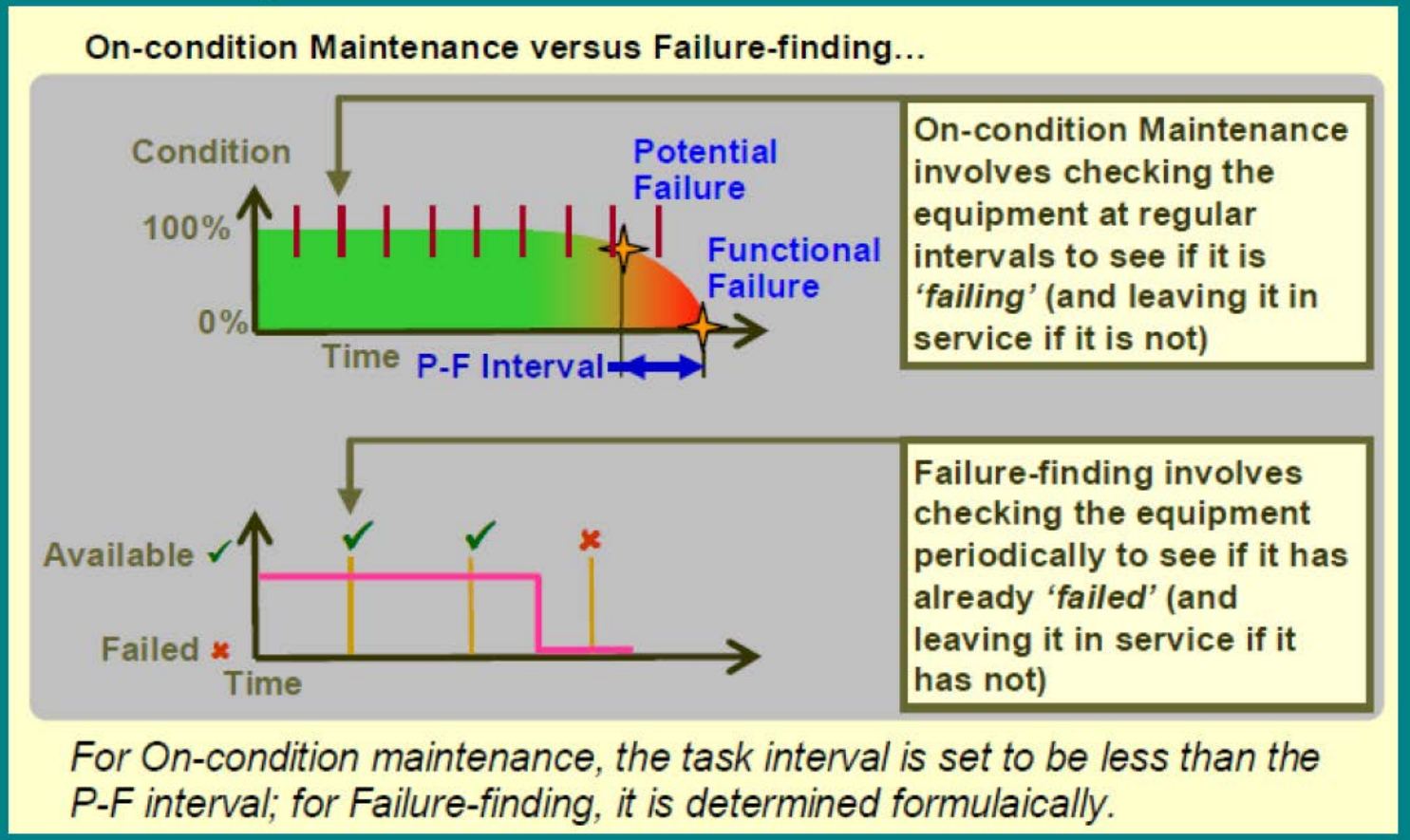


#3



- PM: Useful Life and MTBF are different figures and must not be confused. The equipment will be replaced before it enters the wear-out zone. The task interval is determined by the “useful life”.

#4 “Condition Based Monitoring(Predictive Maintenance) and Failure-Finding Tasks(Functional Test) are one and the same”



THANK YOU