

DAE Mobile Training Team

RELIABILITY CENTERED MAINTENANCE (RCM)

TEST & TUTORIAL

As of 19th Feb 2021



กรมช่างอากาศ Directorate Of Aeronautical Engineering แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM)

แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM) จำนวน 32 ข้อ

1. Maintenance discipline required whom to comply with all written guidance to ensure required repairs, inspections and documentation are completed in a safe, timely and effective manner ?

a. Supervisors

b. Planners

c. All maintenance personnel

d. Executive officers

Maintenance Discipline: Maintenance discipline involves integrity in all aspects of the maintenance process. It is the responsibility of all maintenance personnel to comply with all written guidance to ensure required repairs, inspections, and documentation are completed in a safe, timely, and effective manner. Supervisors are responsible for enforcing and establishing a climate that promotes maintenance discipline. All personnel who fail to maintain maintenance discipline standards will be held accountable.



แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM)

- 2. Which of the followings are DAE Ethics consecutively ?
 - a. Safety, Standard, Operations
 - Responsiveness, Economic.
 - b. Standard, Safety, Operations
 - Responsiveness, Economic.
 - c. Safety, Standard, Economic, Operations Responsiveness, Economic.
 - d. Standard, Safety, Economic, Operations Responsiveness.





์แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM)

- 3. What is the meaning of "Reliability Control" ?
 - a. A system that monitors and maintains components' hard time intervals below a predetermined value.
 - b. A system that monitors and maintains
 components life cycle cost below a
 predetermined value.
 - c. A system that monitors and maintainscomponents' life below a predetermined value.d. A system that monitors and maintains
 - , components "failure rate" below a
 - predetermined value.

- ♦ This new method was called "reliability control".
- <u>"Reliability Control" is a system that monitors and maintains</u>

component "failure rates" below a predetermined value.

 ♦ Components and systems that were not assigned a primary maintenance process of either "Hard Time" (HT) or "On-Condition" (OC) were assigned a primary maintenance process called "Condition Monitoring" (CM)

♦ A component or system maintained under CM does not respond to the
 'HT' or 'OC' process and therefore has no scheduled servicing or

inspection to determine the airworthiness of the item.



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4. From the bath tub curve below, the portion with failures rate are high

and are caused by design and manufacturing problems is called?



- a. wear out period
- b. early failure or infant mortality.
- c. useful life
- d. design life

Failure Pattern Section A-B:

- ♦ This portion is the "early failure or infant mortality" area.
- Failure rates are high and are caused by design and manufacturing problems.



- The remedy is redesign, and improved quality control.
- ♦ After these problems have been overcome the problem remains although at a reduced failure rate level.
- In this case the failures are caused by faulty maintenance practices, errors during re-assembly of the component and installation into the system.



- 5. From the bath tub curve, random failure (B C) is the portion with failures rate is almost constant, then what type of maintenance is recommended for reliability theory ?
- a. HT (Hard Time) or TCI (Time Change Item)
- b. OC (On Condition)
- c. CM (Condition Monitoring)
- d. All of the above a, b and c are correct.

Failure Pattern Section B-C:

• Having passed point B the failure rate becomes substantially

Bath Tub Curve

TIME IN SERVICE

Wear out

- constant, and lower than in the A B area.
- Failures which occur in the B C area are known as "chance or
- random failures", and do not exhibit any fixed pattern.

♦ B – C = Useful Life

The almost constant failure rate in section B - C is of great importance in

Reliability schemes.

♦ Failures which do occur in section B - C are brought about by random

occurrences, such as unexpectedly high transient voltage, vibration etc.

• Depending on the nature of the component, section B - C may be long or short.



- 6. From the bath tub curve, the optimum time
- for overhaul or restore a component is?
- a. just prior to point C
- b. at point C
- c. between point B and point C
- d. before point D

Failure Pattern Section C-D: (continued)

- ♦ It is now obvious that the optimum time for overhaul is just prior to point C.
- We may be familiar with a regulated escalation process using a method, whereby we inch our way along section B - C hoping to stumble on point C by inspecting samples.
- ♦ The establishment of point C by other methods, for some classes of components is another important aspect of reliability schemes.





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์แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM

- 7. Regarding "Preventive Maintenance or Scheduled Maintenance", which of the following statement is correct ?
- a. it can minimize deterioration of inherent reliability, and increase reliability.
- b. it can minimize deterioration of inherent reliability, but not increase reliability.
- c. it can maximize inherent reliability, and reduce maintenance cost.
- d. it can maximize inherent reliability, and prolong useful life.

♦ Reliability is established by:

- \blacklozenge The design of each item and
- The manufacturing processes
- Scheduled maintenance can only minimize deterioration of the inherent reliability, but not improve upon it.
- On-aircraft failures will be minimized through preventive maintenance techniques at a minimum cost.



8. MSG 3 (Maintenance Steering Group 3) is task oriented by identify specific tasks as shown in the figure below. Which tasks are very important to aircraft airworthiness ?

- a. Significant Item (SI)
- b. Significant Item (SI), Zonal Program and Specific Zonal Program
- c. Significant Item (SI) and Structural Significant Item (SSI)
- d. Structural Significant Item (SSI)





9. What do we call a preventive maintenance process which requires a part to be periodically inspected or checked against a physical standard to determine whether it can stay in service and to remove the part from service before failure occurs ? a. Hard Time (HT) or TCI (Time Change Item)

- b. On Condition (OC)
- c. Condition Monitoring (CM)
- d. Overhaul or Restorative

- A preventive maintenance process.
- If requires that a part be periodically inspected or checked against a

physical standard to determine whether it can stay in service.

The purpose of the standard is to remove the part from service, before

failure, during normal operation, occurs.



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10. What do we call a maintenance process which the part or component is allowed to fail, but the failure rate or the performance is monitored by statistical analysis ?

- a. Condition Monitoring (CM)
- b. b. Engine Trend Monitoring (ETM) and Oil Consumption Monitoring (OCM)
- c. c. System Reliability Monitoring (SRM) and Component Reliability Monitoring (CRM)
- d. d. All of the above a, b and c are correct.

- A primary maintenance process where the part or component is not being maintained by the HT or OC process.
- ◆ <u>The part or component is allowed to fail</u>.
- The failure rate is monitored by statistical analysis.



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11. Which of the following statement is correct regarding reliability ?

a. System Reliability Monitoring (SRM) is to find out how manyfailures occurred to each aircraft system within an average of100 flying hours.

b. Component Reliability Monitoring (CRM) is to find out how many failures occurred to significant components within an average of 1,000 flying hours.

c. Engine Trend Monitoring (ETM) and Oil Consumption Monitoring (OCM) are to find out engine performance tendency and oil consumptions compare to standard values (standard baseline) or customized values (generic baseline).

d. All of the above a, b and c are correct.

Statistical performance standards - Alert type programs.

- A performance measurement expressed numerically in terms of PIREPS, component failures etc.
- The system uses control limits or alert values based on accepted statistical methods e.g.. Standard deviation
- The standard may be adjustable to meet seasonal changes etc.



12. What is the objective of reliability data analysis ?a. to recognize the need for preventive action, establish preventive action and determine the effectiveness.b. to recognize the need for restorative action, establish restorative action and determine the effectiveness.c. to recognize the need for corrective action, establish corrective action and determine the effectiveness.d. to recognize the need for new design of a component.

(a) recognize the need for corrective action(b) establish what corrective action is needed(c) determine the effectiveness of that action.

<u>Corrective Action</u>: The actions taken must reflect the analysis and be positive enough to restore performance to an acceptable level in a reasonable time.



13. From the P-F Curve (Potential – Functional Failure) below, which statement is correct ?



a. It is required to find point P and take corrective action immediately.b. It is required to find point P and take corrective action before point F.c. It is required to find point P and close watch until point F.

d. It is required to find point P and send a component to overhaul at point F.





14. From the P-F Curve (Potential – Functional Failure) below,

which statement is correct ?



a. modification of a component cannot increase resistant to failure (strength) and the useful life is not prolong.

- b. modification of a component can increase resistant to failure (strength) and the useful life is prolong.
- c. modification of a component can prolong useful life but the resistant to failure (strength) is not increasing.
- d. modification of a component cannot prolong useful life but the resistant to failure (strength) is increasing.





15. From the P-F Curve (Potential – Functional Failure) below,

which statement is correct ?



- a. retrofit (new design with new material) of a component can increase resistant to failure (strength) and the useful life is prolong.
- b. b. retrofit (new design with new material) of a component cannot increase resistant to failure (strength) and the useful life is not prolong.
- c. c. retrofit (new design with new material) of a component can increase resistant to failure (strength) but the useful life is not prolong.
- d. d. retrofit (new design with new material) of a component cannot increase resistant to failure (strength) but the useful life is prolong.





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16. In aircraft structural design, an SSI (Structural Significant Item) which has "safe life" means?a. that SSI may be replace at a specified hard time.b. that SSI must be replace at a specified hard time.c. that SSI is a fail-safe item.

d. that SSI is a damage tolerance item.

- <u>Safe Life</u>: หมายถึงโครงสร้างมีกำหนดอายุใช้งานที่ชัดเจน เมื่อใช้งานมาถึงอายุที่ กำหนดแล้วจะต้องถอดเปลี่ยน
- Fail Safe: หมายถึงโครงสร้างซึ่งเมื่อเกิดการชำรุดขึ้นแล้ว ยังมีโครงสร้างส่วนอื่นมา ช่วยรองรับภารกรรม (Redundant) แต่ก็จะต้องกำหนดระยะเวลาตรวจ เพื่อให้พบ Evidence of Failure ให้ได้เสียก่อนที่โครงสร้างจะเกิดสภาพ Failure
- <u>Damage Tolerance</u>: หมายถึงรอยร้าวซึ่งอาจเกิดขึ้นและสามารถมองเห็นได้และ ตรวจพบได้จากกำหนดการตรวจตามระยะเวลา ซึ่งการตรวจพบรอยร้าวดังกล่าวจะ พบอยู่ในช่วงที่ยาวนานเพียงพอให้สามารถทำการซ่อมได้ก่อนที่โครงสร้างนั้นจะเกิด สภาพ Failure ขึ้น



- 17. Aircraft structural damages are classified as follow?
- a. Accidental Damage (AD)
- b. Environmental Damage (ED)
- c. Fatigue Damage (FD)
- d. All of the above a, b and c are correct.

The sources of damage to be considered when developing the structural maintenance program are as follows...

- A. Accidental Damage (AD): "Physical deterioration of an item caused by contact or impact with an object or influence which is not part of the aircraft, or by human error during manufacture, operation of the aircraft, or maintenance practices".
- B. Environmental Deterioration (ED): "Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment".
- C. Fatigue Damage (FD): "The initiation of a crack or cracks due to cyclic loading and subsequent propagation".



18. The initiation of a crack or cracks due to cyclic loading and subsequent cracks propagation is called?

- a. Accidental Damage (AD)
- b. Environmental Damage (ED)
- c. Fatigue Damage (FD)
- d. Corrosion Damage (CD)

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- A. Accidental Damage (AD): "Physical deterioration of an item caused by contact or impact with an object or influence which is not part of the aircraft, or by human error during manufacture, operation of the aircraft, or maintenance practices".
- B. Environmental Deterioration (ED): "Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment".
- C. <u>Fatigue Damage (FD): "The initiation of a crack or cracks due to cyclic loading and</u> subsequent propagation".



19. Physical deterioration of an item's strength or resistant to failure as a result of chemical interaction with its climate or environment is called?

- a. Accidental Damage (AD)
- b. Environmental Damage (ED)
- c. Fatigue Damage (FD)
- d. Inherent Damage (ID)

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- B. Environmental Deterioration (ED): "Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment".
- C. Fatigue Damage (FD): "The initiation of a crack or cracks due to cyclic loading and subsequent propagation".



20. Physical deterioration of an item caused by contact or impact with an object or influence which is not part of the aircraft, or by human error during manufacture, operation of the aircraft, or maintenance practice is called?

- a. Accidental Damage (AD)
- b. Environmental Damage (ED)
- c. Fatigue Damage (FD)
- d. Natural Damage (ND)

The sources of damage to be considered when developing the structural maintenance program are as follows...

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้แบบทดสอบ RELIABILITY CENTERED MAINTENANCE (RCM)

21. From the "Reliability Centered maintenance (RCM)", a non significant area inspections dividing or splitting the complete aircraft into zones, is called?

- a. Combustible materials inspection
- b. Electrical Wiring Interconnect System (EWIS)
- c. Zonal inspection program
- d. All of the above a, b and c are correct.

- The remaining "left out" areas are not classified as "Significant" their inspection should be cost effective and uncomplicated general area inspections.
- Non significant area inspections, known as "Zonal Inspections".
- The Zonal Inspection Program is based on a series of General Visual Inspections (GVI).
- The complete aircraft is split into zones and every part of the aircraft is located within a defined zone.
- The Zonal GVI inspection is looking for deterioration of the original installation. This includes corrosion, cracks, chafing, evidence of leakage, evidence of overheat, security and condition of the components contained within the zone.



- 22. From the "Reliability Centered maintenance (RCM)", wiring system inspection and combustible
- materials inspection is called?
- a. Enhanced Zonal inspection
- b. Zonal inspection program
- c. ASIP (Aircraft Structural Integrity Program)
- d. SSID (Supplement Structural Inspection Document)

After some consideration as to the scope of use of the Zonal program by the Air transport Association of America Maintenance Steering Group (ATA MSG) it was proposed that the Zonal program be extended to address some topical issues that were arising at that time in the operation of aircraft.

- The first was the integrity of electrical wires over time and the build up of combustible materials over the operating life of the aircraft.
- Enhanced Zonal Inspection focused at wiring system inspection and combustible <u>materials.</u>
- L-100/130 aircraft (C-130H) has inspection program "EWIS" (Electrical Wiring Interconnect System).



23. Which of the following is the keyword for "Reliability Centered maintenance (RCM)"?

- a. Inherent safety
- b. b. Reliability capabilities
- c. c. Minimum cost
- d. d. All of the above a, b and c are correct.

RCM (Reliability Centered Maintenance): To explain and research the basic concepts, principles, definitions and applications of a logical discipline for development of efficient scheduled (preventative) maintenance program for complex equipment, and on going management of such program. Such program were referred to as reliability-centered maintenance (RCM) program because they centered on achieving the inherent safety and reliability capabilities of equipment at a minimum cost. (Nowlan and Heap RCM 1978)

- RCM Keywords: <u>1. Inherent Safety</u>
 - 2. Reliability Capabilities
 - 3. Minimum Cost

Aircraft Readiness is not RCM Keywords.



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- 24. Which of the following is not the keyword
- for "Reliability Centered maintenance (RCM)" ?
- a. Speed of Maintenance
- b. Aircraft Readiness
- c. Mission Capable Rate
- d. All of the above a, b and c are correct.

RCM (Reliability Centered Maintenance): To explain and research the basic concepts, principles, definitions and applications of a logical discipline for development of efficient scheduled (preventative) maintenance program for complex equipment, and on going management of such program. Such program were referred to as reliability-centered maintenance (RCM) program because they centered on achieving the inherent safety and reliability capabilities of equipment at a minimum cost. (Nowlan and Heap RCM 1978)

- RCM Keywords: 1. Inherent Safety
 - 2. Reliability Capabilities
 - 3. Minimum Cost
- Aircraft Readiness is not RCM Keywords.



25. A mechanic inspects the aircraft tire every day before each flight, what type of maintenance does he perform ?

- a. On Condition Task
- b. Scheduled Discard Task
- c. Scheduled Restoration Task
- d. Failure Finding Task

1. On Condition Tasks: (Predictive or Condition Monitoring). Used where a

clearly defined potential failure period (P-F period) exists for the failure

mode under consideration. For example a tire inspection every day, the

tire stays installed if the wear is not to a certain limit, and is removed if the

wear is at or beyond a certain limit. *The survival of the tire is based on the*

condition it passes the inspection.



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26. A standby inverter is functional check by a mechanic for proper operation during a routine scheduled maintenance, what type of maintenance does he perform ?

- a. On Condition Task
- b. Scheduled Discard Task
- c. Scheduled Restoration Task
- d. Failure Finding Task

4. Failure Finding Task: Used where the task can confirm that all

components covered by the failure mode under consideration, are

functional. For example a standby hydraulic pump that is not normally in use, is intentionally brought on line by perhaps simulating a failure of the main pumps, (pulling their circuit breakers) the performance of the standby pump is then monitored for correct function.



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27. During a C-Check inspection, a mechanic removed an AC Generator and send for overhaul due to time expired, what type of maintenance does he perform ? a. On Condition Task

- b. Scheduled Discard Task
- c. Scheduled Restoration Task
- d. Failure Finding Task

3. <u>Scheduled Restoration Task</u>: Used where a clearly defined age of increased conditional probability of failure exists for the failure mode under consideration and the restoration task restores the components resistance to failure to a level that is tolerable. For example the main landing gear of a B737 built by Manesco, has a restoration life of 12 years or 15,000 cycles which ever is sooner. Manesco have through studies shown that the gears useful life is at 12 years due to environmental effects or 15,000 cycles due to operating stress and the probability of failure rises considerable at this point which is the start of the wear out stage. But by restoration of the gear & its components the inherent reliability of the gear can be restored.



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28. During an A-Check inspection, a mechanic removed and replace a fire extinguisher squib and disposed of it, what type of maintenance does he perform ?a. On Condition Taskb. Scheduled Discard Task

- c. Scheduled Restoration Task
- d. Failure Finding Task

2. <u>Scheduled Discard Task</u>: Used where a clearly defined age of increased conditional probability of failure exists for the failure mode under consideration. For example the passenger life jackets part number P0124W have a discard life of 10 years. The manufacturer has through studies shown that the useful life of the jackets, i. e. the period of time prior to when the wear out stage starts, is 10 years. After that the jackets have a high probability of failure due to the perishing rubber components. The cost of removal, replacing & restoring the jackets will cost more than purchasing a new jacket so the old jacket is discarded.



29. The objective of "Reliability Centered Maintenance (RCM)" is?

a. to maintain continued airworthiness of the aircraft

b. to enhance safety

c. to minimize cost

d. All of the above a, b and c are correct.

RCM (Reliability Centered Maintenance): To explain and research the basic concepts, principles, definitions and applications of a logical discipline for development of efficient scheduled (preventative) maintenance program for complex equipment, and on going management of such program. Such program were referred to as reliability-centered maintenance (RCM) program because they centered on achieving the inherent safety and reliability capabilities of equipment at a minimum cost. (Nowlan and Heap RCM 1978)

RCM Keywords: 1. Inherent Safety

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3. Minimum Cost

Aircraft Readiness is not RCM Keywords.



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30. Low utilization aircraft maintenance program is applicable to?

a. aircraft fly less than 100 flying hours per month or 1,200 flying hours per year.

b. aircraft fly less than 200 flying hours per month or2,400 flying hours per year.

c. aircraft fly less than 250 flying hours per month or 3,000 flying hours per year.

d. aircraft fly less than 300 flying hours per month or 3,600 flying hours per year.

Boeing Document D626A001 the Manufacturers Maintenance Planning Data, derived from the MRBR, for the B737NG details that any operation <u>less than 100 flight hours</u> per months or 1,200 flight hours per year should consider following a low utilization maintenance program.

- It has been the practice in the past that when an operator wished to use an aircraft for missions that do not meeting the operating parameters detailed in the MRBR / MPD to adjust the maintenance schedule tasks from their usage based intervals to those of a calendar based interval.
- For example tasks with an interval of 5000 flight hours intervals, usage based, would have been converted to 3 years intervals



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31. Low utilization aircraft maintenance program concerns aircraft Environmental Damage (ED) due to corrosion, therefore,?

a. maintenance scheduled tasks are based interval to flight cycles based.

b. maintenance scheduled tasks are based interval to flying hours based.

c. maintenance scheduled tasks are based interval to calendar based.

d. maintenance scheduled tasks are based interval to landing cycles based.

Boeing Document D626A001 the Manufacturers Maintenance Planning Data, derived from the MRBR, for the B737NG details that any operation less than 100 flight hours per months or 1,200 flight hours per year should consider following a low utilization maintenance program.

 It has been the practice in the past that when an operator wished to use an aircraft for missions that do not meeting the operating parameters detailed in the MRBR / MPD to adjust the maintenance schedule tasks from their usage based intervals to

those of a calendar based interval.

For example tasks with an interval of 5000 flight hours intervals, usage based, would have been converted to 3 years intervals



32. Aircraft maintenance program should be

reviewed?

a. every year

b. every other year

c. every 3 years

d. every 4 years

 ♦ ผู้ใช้งาน บ.ควรจะต้อง Review Aircraft Maintenance Program อยู่เป็นประจำตาม ห้วงเวลาที่กำหนดไว้อย่างเหมาะสม ซึ่งตามปกติแล้วควรจะ Review ทุก ๆ 3 ปี เพื่อ ตรวจสอบบัตรตรวจของงานตรวจซ่อมบำรุงตามระยะเวลาว่ายังคงมีผลใช้บังคับหรือไม่ รวมทั้งประสิทธิภาพและมีความเหมาะสมหรือไม่ อย่างไร (Applicability & Effectiveness)
 ♦ ทั้งนี้ให้ระลึกไว้เสมอว่า Aircraft Maintenance Program นั้นจะต้องมีการปรับปรุงให้

ทันสมัยอยู่เสมอ เพื่อให้ บ.มีความสมควรเดินอากาศ มีความเชื่อถือได้ และเกิดความ ประหยัด



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