West Texas A&M University

Pantex Internship

Final Report

How to Apply RCM

MENG-4097

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Abstract

This summer internship here at Pantex pertained to how one may approach equipment and apply Reliability Centered Maintenance. Reliability Centered Maintenance (RCM), is a strategy for maintenance first used in the 1960's. Within this strategy there are three methods of maintenance, preventative, run-till-failure, and condition based and these will be what a part may be categorized into. When approaching equipment/parts to decide which category they fall into they must go under a five procedures, Criticality, Fault Tree Analysis, Task Analysis, Effectiveness, and Cost.

The pilot project was to test the maintenance strategies on the preventative maintenance [PM's] work orders used on Air Handling Units (AHU) and Dehumidifying Units (DHU) here at the Pantex Plant. This was accomplished by making recommendations on the preventative maintenance work orders.

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Brief History of RCM

Reliability Centered Maintenance (RCM) is a strategy that was first employed by the Airline industry in the 1960‘s. This was due to an increasing cost of maintenance in the 1950‘s warranting a structure or guidelines for the industry to follow to cut down on labor hours and cost. For this, Federal Aviation Administration (FAA) and the Airline industry formed a joint task force using representatives to create a series of preventative maintenance guidelines. From the work of the task force a baseline of maintenance for airlines and manufactures for their aircrafts was created. [1]

Reliability Centered Maintenance is the process of finding the most effective maintenance approach to maximize productivity of a machine or part with the minimum amount of maintenance. The RCM strategy uses several different types of maintenance such as Preventative Maintenance (PM), Real-time Maintenance (RTM), and Run-till-Failure, to increase productivity and decrease down time. [1]

Introduction

Pantex uses a variety of maintenance strategies and the strategy predominantly used is Reliability Centered Maintenance (RCM), which is made up of 3 main type [2]:

A. Preventative
B. Run-till-failure
C. Conditioned based

Of these types of maintenance Pantex uses Preventative and Run-till-failure more often.

A.) Preventative Maintenance

This is a schedule based maintenance that is in place to keep equipment running at optimal production [2].

B.) Run-till-failure Maintenance

Usually a last resort option. The part is continuously used with no up-keep until the part fails. In some cases an RCM analysis may indicate that this is the best option [2].

Figure1 & Figure 2: Before and after Run-till-failure.

C.) Condition Based Maintenance

Condition based maintenance should be done to catch machines that are about to fail or after reaching their design life [2]. The way this is accomplished is by performing a series of tests on the part or placing a monitoring system on the part. These are the types of analysis that may be performed:

- Vibrational Analysis
- Oil Analysis
- Wear Particle Analysis
- Ultra Sound/ Acoustic Emission
- Infrared Thermography
- Motor Circuit and Signature Analysis

Approach

When discerning what kind of maintenance type that should be used several points of view must be taken before the equipment/part can be categorized.

Criticality Level

1. Establish criticality level by understanding the importance of the system and its danger to the rest of the site.
2. Identify components and prioritize failure modes to be avoided

The first question that must be asked is, what is the severity of equipment failure and its impact to the Pantex plant? (1 being the highest)

I. Level 1	II. Level 2	III. Level 3	IV. Level 4	V. Level 5
• Safety & Environmental	• Production Stoppage	• Repair Expense/ Potential Impact	• Effect on other Systems	• System Redundancies

Figure 3: Criticality levels

I. Level 1: Safety & Environmental

- Results in loss of life, body part, or permanent disability
- Resulted in a reportable environmental emission
- Impact on production immediately resulting in a revenue loss
- Results in equipment loss/damage/repair
- No redundant backup systems in place

II. Level 2: Production Stoppage

- Potential injury to personnel
- Potential reportable environmental emission
- Impact on production immediately resulting in revenue loss of Ex: (10K<X<100K)
- Resulting in equipment loss/damage/ repair of Ex: (10K<X<100K)
- No redundant backup systems in place

III. Level 3: Repair Expense/Potential Impact

- Potential for injury to personnel, but temporary barricading is available.
- Potential for revenue loss Ex: (>100K), but adequate stocking is kept during operation.
- Potential repair costs of Ex: (1K<X<10K)
- Minimum redundant backup systems in place

VI. Level 4: Effect on other Systems

- No safety effects
- No reportable environmental emission
- No Impact on production resulting in revenue loss
- Potential repair costs minimal Ex: (<1000)
- Multiple redundant systems

V. Level 5: System Redundancies

- No safety effects
- No reportable environmental emission
- No impact on production resulting in revenue loss
- Little to no revenue loss
- Multiple redundancies

Identify Components:

List all of the components that can fail and cause loss of function. Next, group the components that may fail or loss function, Ex:

- All manual valves
- All control loops
- All local indicators
- Redundant equipment

Identify Failure Mode Types

A failure mode is how a machine failure may occur.

Examples:

- Seizes
- Fails to start
- Fails to close

Next, define the failure mechanisms. What caused the failure mode?

- Corrosion
- Erosion
- Part fails
- Out of calibration`
- Loose connections
- vibration

Fault Tree Analysis

Fault Tree Analysis (FTA), analyzes high-level failures and identifies all lower level sub-system that caused it. This is a hierarchy of systems showing how each part and equipment interact with one another if one were to fail. If a part does fail the operator will be able to see which system is not functioning properly and would then be able to pin point which part is not working [4].

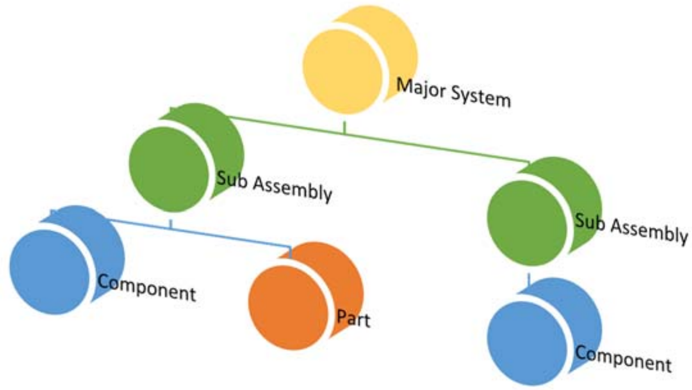

Figure 4: System hierarchy.

Task Analysis

This is an approach that takes into account everything that will be used in a repair, project, or operation. Once this is done they are placed into steps on an operations calendar or timeline [2, 3]. These are the things taken into account:

- Equipment
- Personnel Abilities/Skills
- Time duration
- Tools
- Material

Effectiveness

If this change is put into place how it will benefit safety of personnel, cost, and production [5]. For instance if a new part or machine is placed into effect will the hands on workers actually use the machine/part or will they work around it, because of a certain issue. Next, did the machine/part increase production or create a safer environment.

Cost

Over-all cost of the project, repair, and maintenance [5]. This important because the cost of placing a repair and or new machine is not the initial payment, but also the life of the machine while in use.

Execution

The pilot project was to test the maintenance strategies on the preventative maintenance [PM's] work orders used on Air Handling Units (AHU) and Dehumidifying Units (DHU) here at the Pantex Plant. With the main objectives of this pilot project being:

- RCM Analysis
- Consolidation
- Reduce Redundancies

RESULTS

These are examples of AHU PM's recommendations consolidating the two work orders into one. PM #3007 is an exception for the AHU's, because of this these steps [11, 12, 13] will be placed as a note on the recommended PM. Next PM #2 has two steps that can be reduced into one like PM #3007 in yellow. Finally there are two additional sections that PM #2 has that PM #3007 does not (Blowers belt drive, and Blower Direct Drive), this is an issue because the AHU on PM #3007 was not being properly attended to which can cause there to be more repairs/cost to maintain the machine when it could have been prevented.

PM #3007	PM #2
1. Inspect and lubricate air handling unit bearings if lubrication is required. 2. Verify air handler and bearing set screws are secure. 3. Inspect motor and lubricate motor bearings if required. 4. Clean air handling unit. 5. Inspect and clean drain pan and drain line as needed, if so equipped. 6. Inspect filter to assure proper installation and cleanliness if equipped with filters. 7. Inspect air handler drive belts for wear, alignment and tension. Service as needed. 8. Inspect drive sheaves for wear and tightness of set screws. Service as needed. 9. Inspect for structural damage to motor and blower mountings. 10. Examine electrical items for visible damage. 11. Inspect water sump pump for proper operation and service as needed. 12. Test float switch to verify operation and service as needed. 13. Verify water flow over honey comb. 14. Verify inspection panels and guards are in place and secured. 15. Verify operation of air handling unit.	1. Inspect and lubricate air handling unit bearings if lubrication is required. 2. Verify air handler and bearing set screws are tight and service as needed. 3. Inspect motor and lubricate motor bearings if required and service as needed. 4. Clean air handling unit. 5. Inspect and clean condensate drain pan and drain line as needed, if so equipped. 6. Inspect filter to assure proper installation and cleanliness if equipped with filters. 7. Inspect air handler drive belts for wear, alignment and proper tension if belt driven. Service as needed. 8. Inspect drive sheaves for wear and tightness of set screws if belt driven. Service as needed. 9. Inspect for structural damage to motor and blower mountings. 10. Examine duct flex connections for tears if used on duct work. 11. Inspect for damage to electrical cords, flex conduit, etc. 12. NA 13. NA 14. NA 15. Verify all inspection panels and guards are in place and properly secured. 16. Verify proper operation of air handling unit. **Blowers belt drive:** 1. Inspect structural supports, motor and blower mountings for damage and secure mounting. 2. Inspect belt for proper alignment and tension and wear. Service as needed. 3. Inspect sheaves for wear and tightness of set screws. Service as needed. 4. Lubricate shaft bearings. If not applicable mark "n/a". 5. Inspect electrical conduit and flex for damage. 6. Inspect unit during operation for unusual noise and vibration and verify proper operation. 7. Ensure all panels and covers are in place and properly secured. **Blower Direct Drive** 1. Clean unit of oil and dirt deposits. 2. Inspect structural supports, motor and blower mountings for damage and secure mounting. 3. Lubricate motor bearings. If not applicable mark "n/a". 4. Inspect electrical conduit and flex for damage. 5. Inspect unit during operation for unusual noise and vibration and verify proper operation. 6. Ensure all panels and covers are in place and properly secured.

Figure 5: AHU PM's comparisons.

This is the final AHU PM recommendation.

PM #2

1. Inspect and lubricate air handling unit bearings if lubrication is required.
2. Verify air handler and bearing set screws are tight and service as needed.
3. Inspect motor and lubricate motor bearings if required and service as needed.
4. Clean air handling unit.
5. Inspect and clean condensate drain pan and drain line as needed, if so equipped.
6. Inspect filter to assure proper installation and cleanliness if equipped with filters.
7. Inspect air handler drive belts for wear, alignment and proper tension if belt driven. Service as needed.
8. Inspect drive sheaves for wear and tightness of set screws if belt driven. Service as needed.
9. Inspect for structural damage to motor and blower mountings.
10. Examine electrical items for visible damage.

Note only If applicable steps (11,12, 13). If not continue to step 14.

11. Inspect water sump pump for proper operation and service as needed.
12. Test float switch to verify operation and service as needed.
13. Verify water flow over honey comb.
14. Verify all inspection panels and guards are in place and properly secured.
15. Verify proper operation of air handling unit.

Blowers belt drive:

1. Inspect structural supports, motor and blower mountings for damage and secure mounting.
2. Inspect belt for proper alignment and tension and wear. Service as needed.
3. Inspect sheaves for wear and tightness of set screws. Service as needed.
4. Lubricate shaft bearings. If not applicable mark "n/a".
5. Inspect electrical conduit and flex for damage.
6. Inspect unit during operation for unusual noise and vibration and verify proper operation.
7. Ensure all panels and covers are in place and properly secured.

Blower Direct Drive

1. Clean unit of oil and dirt deposits.
2. Inspect structural supports, motor and blower mountings for damage and secure mounting.
3. Lubricate motor bearings. If not applicable mark "n/a".
4. Inspect electrical conduit and flex for damage.
5. Inspect unit during operation for unusual noise and vibration and verify proper operation.
6. Ensure all panels and covers are in place and properly secured.

Figure 6: AHU PM recommendation.

Conclusions

With applying RCM, corrections, and consolidation of plant PM’s the following results are expected.

1. Maintenance time decreased because instead of having several different PM’s for one machine there will only be one.
2. Increased productivity, the AHU is not being inspected for all the steps that an AHU requires to be checked, therefore the frequency of returning back to the machine is less and then allows the maintenance team to do other PM’s.
3. Reduced cost, the AHU was not being attended to properly and breaking down frequently forcing the maintenance to go to the machine more often therefore requiring more labor hours, and the multiple cost for repairs.

References:

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[3] "Maintenance Task Analysis (MTA) [Suggest Change]." *Statement of Work - Performance Work Statement - Statement of Objectives*, www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=185b16dc-6185-42e4-aa82-d24f1c170869.

[4] "Fault Tree Analysis (FTA) [Suggest Change]." *Statement of Work - Performance Work Statement - Statement of Objectives*, www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=1051da42-b287-4042-b5ab-85bebebadf2d.

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