

Living RCM Certified®

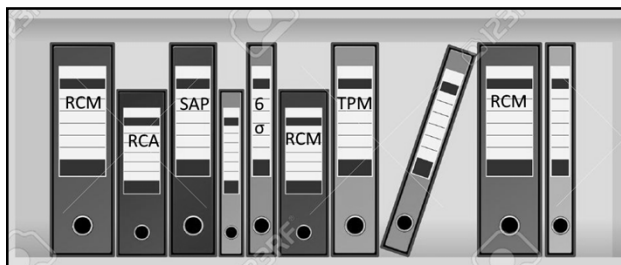
Module 03en

1. The Nature of Data
2. Living RCM practice
 1. Ex. # 1 → Failure
 2. Ex. # 2 → Potential failure
 3. Ex. # 3 → Suspension
 4. Ex.# 4 → Feedback (New Failure Mode)
 5. Edit, accept (reject) feedback
 6. RCM feedback dashboard

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1

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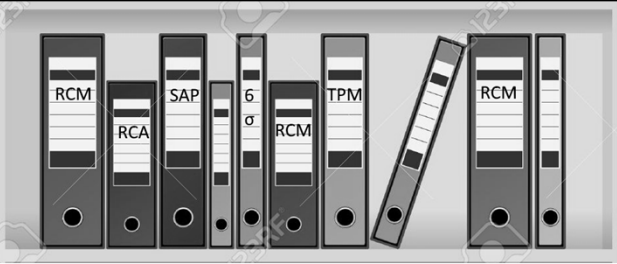


After spending time, expense, and mental energy building the Initial RCM knowledge base, most organizations, once having uploaded the PM plan to the EAM system, relegate the analysis to the shelf, so to speak, to gather dust.

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2

2



That's a pity, because the valuable RCM thinking process, logic, and rationale underlying the organization's failure management policies tend to fade into distant memory.

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3

3

Line of sight

ISO 55000

Emergency Shutdown (ESD) System v6.0

1. Unit ESD

1. Able to isolate the unit in the case of an emergency

1. Cannot isolate the unit

1. Unit suction/discharge valves Fails to close caused by n/a

2. Able to depressurize the unit in the case of an emergency

3. Able to stop all systems required, according the matrix, in the case of an emergency

4. Able to initiate the trip sequence

5. Not to trip spuriously

2. Plant ESD

3. Master ESD

4. Fire ESD

Failure Mode

Unit suction/discharge valves Fails to close caused by n/a

(From RCMCost):

Effects

Parkway C has a single inlet and a single outlet. This is an SOP valve. Power is supplied by a solenoid, hydraulics, mechanical problem. In the winter, it could be due to the cold up, ice in the valve itself. If you've been running, chances are that the valve will not become frozen, although this is not always true. The valve itself, the operator or the power gas could be the reason for the failure. If the unit does not isolate, it will trip the Plant ESD after 90 seconds. There will be an alarm, noises and lots of gas coming out. In the case of an emergency, by the time you troubleshoot for the error, you will be unable to react due to the 90 second time frame.

Summary:

Corrective Task: Troubleshoot

Skills: Mechanic

Est. Downtime(h): 8

Consequence

Hidden

Mitigation Tasks

Type	Description	Interval	Skills	Time(h)
Condition based	Check regulators, reliefs, limits, solenoids and connections. Check power gas pressure switch (L92).	1 yr	Controls technician	
Time(age) based	Check valve is possible.	1 yr	Controls technician	
Time(age) based	Ensure it operates and meets its limits. Replace filters, check oil and hydraulic.	1 yr	Mechanic	
Failure detection	Unit running at idle and verification of all ESD systems working. This is applicable for all ESDs.	1 yr	Mech+Op+Tech	

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4

4

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Living RCM Certified® continues on,
where the **initial** RCM process stops.

Two critical problems left unresolved upon completing
an initial RCM analysis.

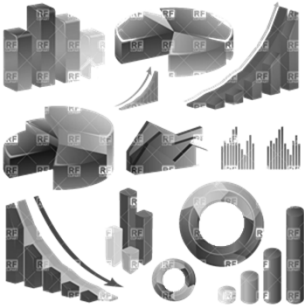

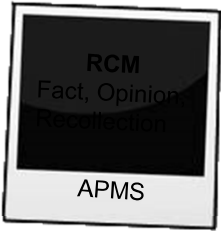
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5

5

1. Change

1. Data quality



Non-analyzable

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6

6

What is data?

What data precisely do we need for purposes of **analysis**?
And for making optimal maintenance **decisions**?



There are three major categories of data and a number of subcategories.

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7

7

1. Age (“event”, “life”, or “history”) data

1. The beginning of a life cycle

2. The ending of the life

1. By failure
 1. Potential
 2. Functional
2. By suspension

3. Non-rejuvenating event

2. Condition data

1. Measurements and inspections

2. Process data

1. Internal variables
2. External variables

3. Business data

1. The cost of a failure C_F

2. The cost of prevention C_p

The nature of physical asset management data

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8

8

Non-rejuvenating event

A non-rejuvenating event is a **maintenance action** that seemingly improves our condition data but does not actually restore any **life** to the equipment.

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9

9

Non-rejuvenating event

A non-rejuvenating event is a **maintenance action** that seemingly improves our condition data but does not actually restore any **life** to the equipment.


e.g. Oil changes, alignment, balancing, cleaning, adjustment, calibration, etc.

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10

10

External and internal condition variables



Internal Variables
Vibration – Motor current – Oil debris analysis, ...:

External variables on the other hand monitor abnormal stresses on the system, that may eventually, and predictably, provoke a failure that has **not yet initiated**.

External Variables
Transient overloads, Humidity, Shocks, Ventilation failure, etc:

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11

11

3.2 Living RCM

Objectives


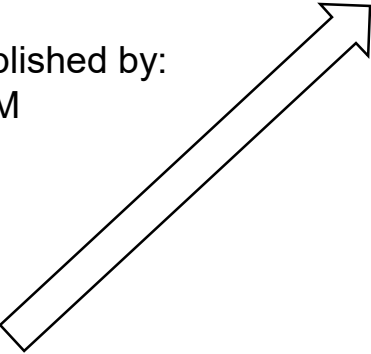
1.RCM knowledge referenced and updated

2.Analyzable data capture

Are **not** accomplished by:

- Initial RCM
- EAM

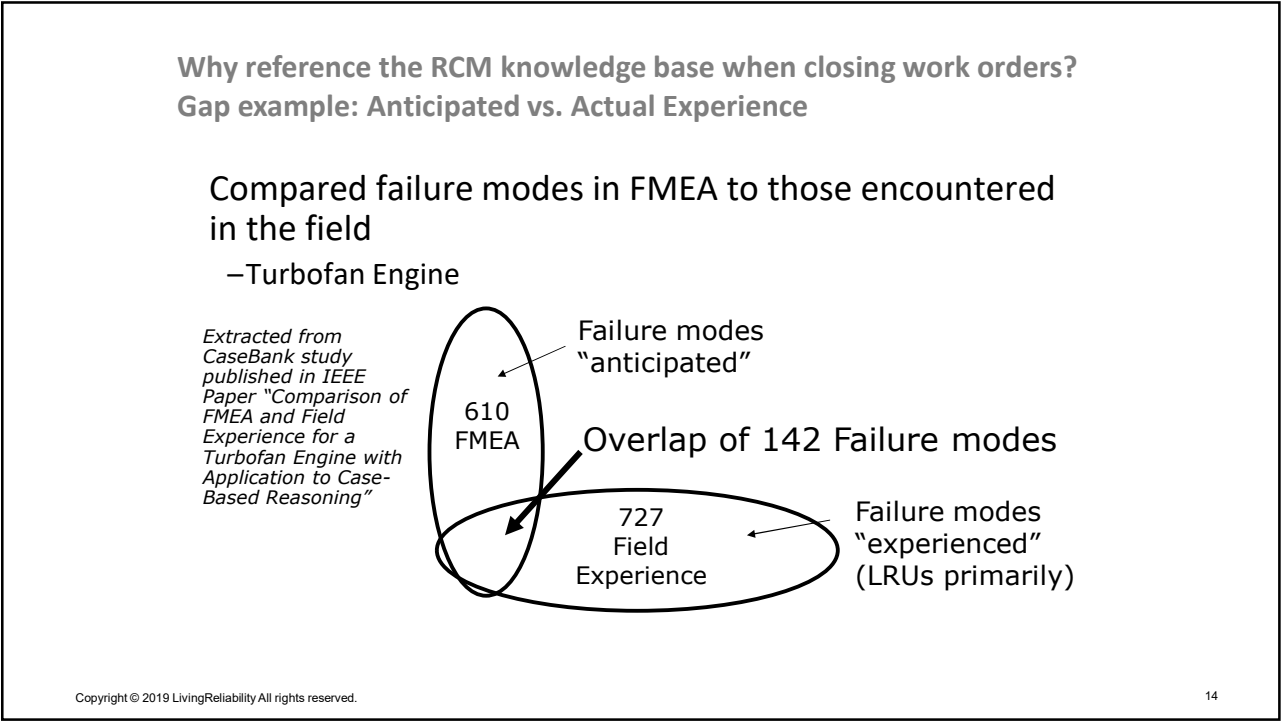
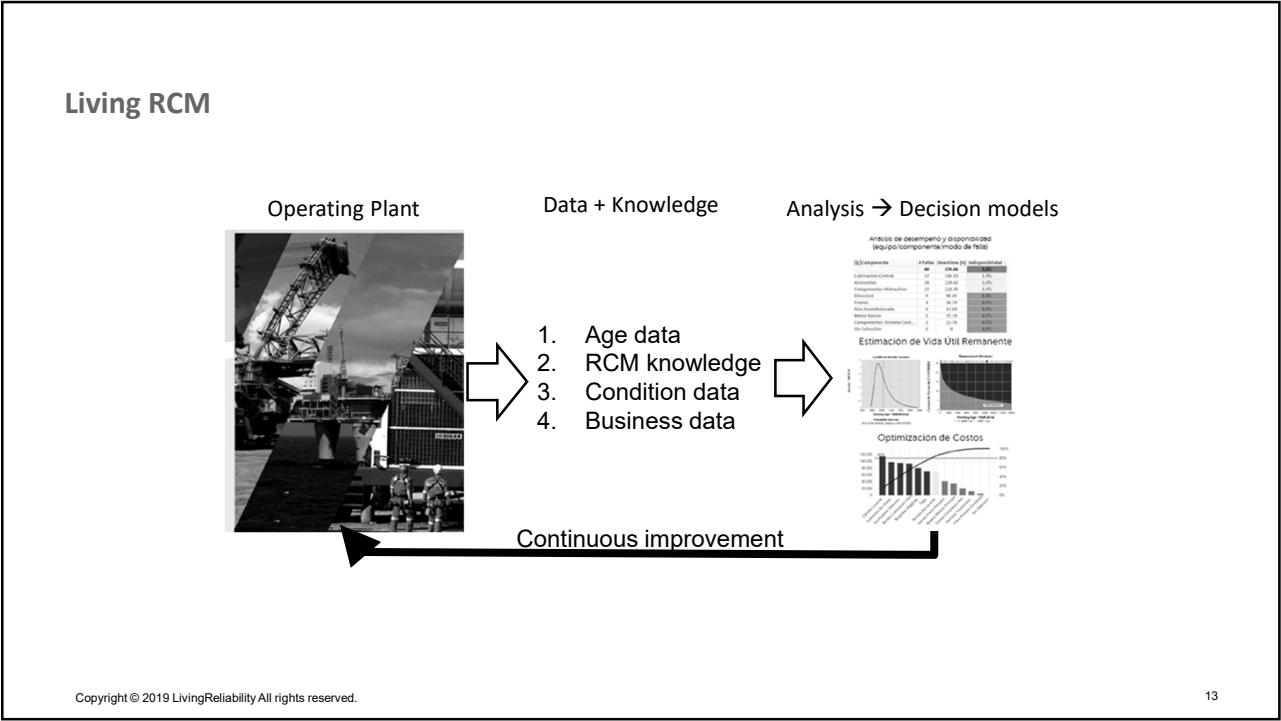
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12

12



Ensures:

- ## Practice



Theory



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15

15

<https://forms.gle/tmbfeg7fX3iQYkTh7>

1 point

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16

16

LRCM exercises

<https://206.189.168.145:8181/mesh/>




Fleets: Hydraulic shovel Hitachi EX3600-	Equipment	Work orders (Ex1,Ex2,Ex3,Ex4)	Users	Passwords
LRCM G1	LRCM_G1	LrcmG1Ex1, LrcmG1Ex2, LrcmG1Ex3, LrcmG1Ex4	Group1	livingrcm1
LRCM G2	LRCM_G2	LrcmG2Ex1, LrcmG2Ex2, LrcmG2Ex3, LrcmG2Ex4	Group2	livingrcm1
LRCM G3	LRCM_G3	LrcmG3Ex1, LrcmG3Ex2, LrcmG3Ex3, LrcmG3Ex4	Group3	livingrcm1
LRCM G4	LRCM_G4	LrcmG4Ex1, LrcmG4Ex2, LrcmG4Ex3, LrcmG4Ex4	Group4	livingrcm1

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17

17

Hitachi EX3600 hydraulic shovel



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18

18

2. Hydraulic System

1. Suction, supply and return system

2. Lift system

1. To lift arm with unloaded bucket from ground to maximum rise in from 7.7 to 8.7 sec

1. Does not lift

1. Lift control lever Damaged caused by n/a

2. ELU module Fails caused by n/a

3. Lift control lever Cable fails open caused by n/a

4. DQR valve Stuck caused by Foreign matter

5. Make up valve Missing caused by n/a

6. EHC right proportional valve Solenoid exit 9 fails to switch caused by n/a

7. EHC proportional valve Spool stuck caused by n/a

Failure (Exercise 1)

Maintenance receives a call from operations indicating that → Shovel arm does not lift

Technician arrives and realizes that: the command does not get to the front attachment. The fault code indicates a communication error between the control lever and the control panel.The lever is damaged.

Please complete Work Order LrcmGnEx1 (n = group number)

1. Log in to Mesh with GroupN, livingrcm1

2. DAS Tab.

3. Work order Code LrcmGnEx1

4. Actions: LRCM Analysis icon

5. Keywords "Control lever". Search

6. Right click Lift control, Select, View. Assure your self that this is the one. X

7. Right click 1. Lift control, Select, Functional failure

8. Tab: Failure Mode Selection tab to check.

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19

19

Session start

Username: * Group1

Password: * *****

Log In

Language: English | Spanish

Fleet Administration

DAS

Downtime Administration

Fleet: ALL

Code: cmG1Ex1

Equipment: LrcmG1Ex1

Category: LRCM_G1

Default: DEFAL

Actions

Undo

Clear

Work Order Code: LrcmG1Ex1

Fleet: Hyd

Hierarchy

Failure Mode Selection

Control lever

Search

Hydraulic shovel Hitachi EX3600-

1. Engine system (0)

2. Hydraulic System (0)

1. To lift arm with unloaded bucket from ground to maximum rise in from 7.7 to 8.7 sec

1. Does not lift (0)

1. Lift control lever Damaged caused by n/a

2. ELU module Fails caused by n/a

3. Lift control lever Cable fails open caused by n/a

4. DQR valve Stuck caused by Foreign matter

5. Make up valve Missing caused by n/a

6. EHC right proportional valve Solenoid exit 9 fails to switch caused by n/a

7. EHC proportional valve Spool stuck caused by n/a

Failure Mode

Lift control lever Damaged caused by n/a

(From RCMCode)

Effects

The front attachment lift command does not respond. There is an error code indicating communication failure between the lever and the ELU in the control panel. The equipment is stopped. Time to change the control lever and put into operation 4 hours.

Summary

The front attachment lift command does not respond. There is an error code indicating communication failure between the lever and the ELU in the control panel. The equipment is stopped. Time to change the control lever and put into operation 4 hours.

Corrective Task

Replace lever

Skills

Inspector

Est. Overhead: 4

Consequence

Operational

Mitigation Task

Type	Description	Interval	Skills	Timely
No scheduled maintenance	Run to failure			

View

Select

Feedback

Potential Failure

Functional Failure

Suspension

Failure mode selection made successfully

Work Order Code: LrcmG1Ex1

Fleet: Hydraulic shovel Hitachi EX3600- LRCM G1

Description: Shovel arm does not lift

State: Reparando

Equipment: (LRCM_G1)- EX3600_LRC

Hierarchy

Failure Mode Selection

Pending Feedbacks

User Feedbacks

Selection Date	Description	Effects	Event Type	Selected By
16/10/2019 09:15:57 PM	Lift control lever Damaged caused by n/a	The front attachment lift command does not respond. There is an error code indicating communication failure between the lever and the ELU in the control panel. The equipment is stopped. Time to change the control lever and put into operation 4 hours.	Functional Failure	Group1

20

20

20

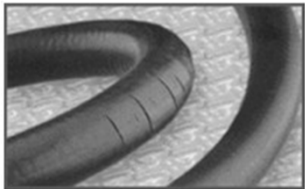
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10

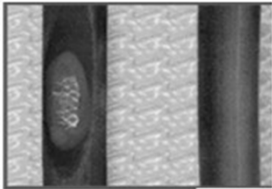
Suspension v.s. Potential failure

Consistent reporting of distinct instances of failure, potential and, and suspension requires an organizational consensus and the development of standards for failure declaration. This is the main purpose of the **image gallery** associated with a failure mode.

Suspension: preventive renewal of a part or failure mode that still has an indefinite amount of life left.



Potential Failure: Failure is imminent. If nothing is done about it the organization will incur the full consequences of failure. When conducting reliability analysis (Weibull, PHM) a potential failure is treated as a failure.

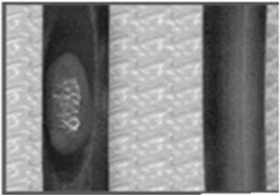


21

Selecting an anticipated failure mode (potential failure)

Potential failure (Exercise 2)

A team of technicians, during pre-300h visual inspection, they found a fuel hose system with significant wear and knew that if not replaced would soon fail. So they decided to change the hose. Please complete the Work Order LrcmGnEx2



Hydraulic shovel Hitachi EX3600- LRCM G1 v6.3

- 1. Engine system
 - 1. Engine
 - 2. Peripheries
 - 3. Lubrication system
 - 4. Air intake and exhaust system
 - 5. Cooling system
 - 6. Electronic control system
- 7. Fuel system
 - 1. To contain the fuel
 - 1. Does not contain
 - 1. Fuel pump Seals fail caused by n/a
 - 2. Fuel hose Fails caused by n/a
 - 3. Fuel hose Fails caused by Friction or rubbing
 - 4. Fuel Filter Seal fails caused by n/a
 - 5. Injector Seal fails caused by n/a

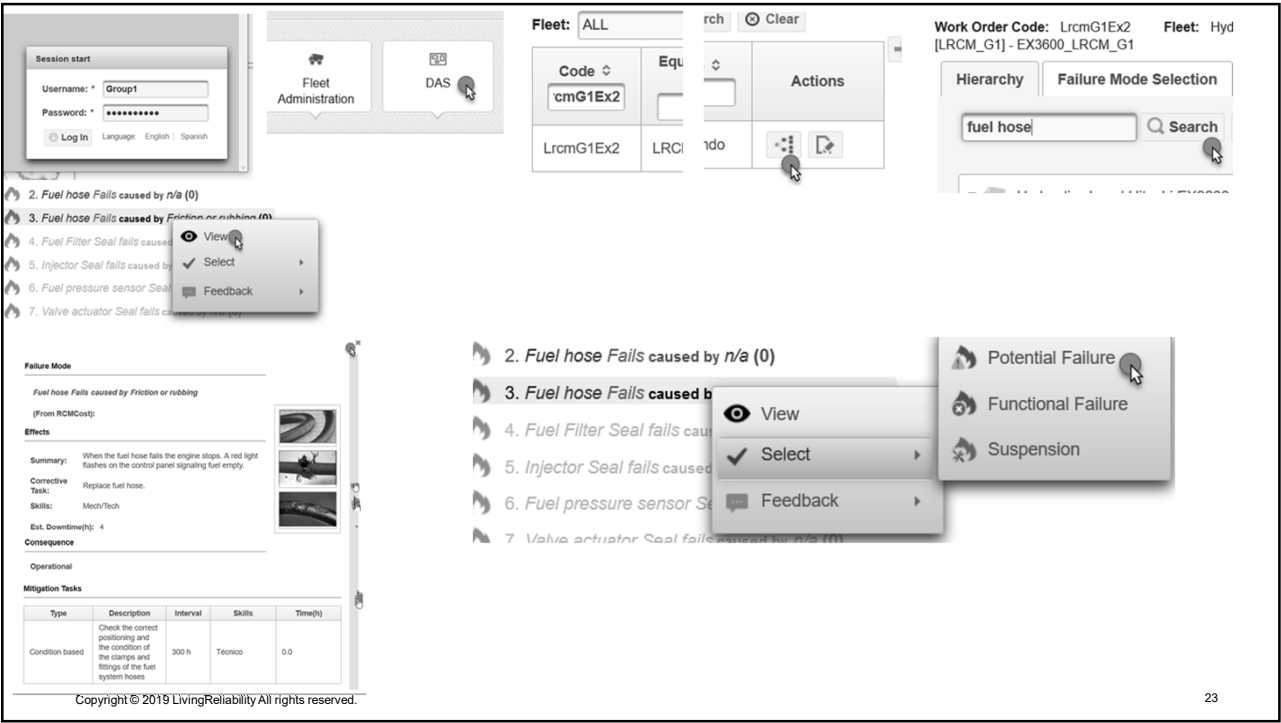
1. DAS Tab.

2. Work order Code LrcmGnEx2, Hit LRCM Analysis icon

3. Keywords "fuel hose". Search

4. Right click "3. Fuel hose Fails caused by Friction or rubbing" Select, Potential failure

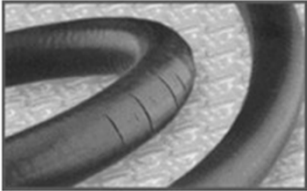
22



23

Suspension (Exercise 3)

The same team of technicians were doing another preventive visual inspection for the 300h PM. This time they found the fuel hose with some scoring but no significant wear (the hose can last for at least another year) but decided to change the hose "just in case". Please complete the work order LrcmGnEx3.



1. DAS Tab.
2. Work order Code LrcmGnEx3, Actions: LRCM Analysis icon
3. Keywords " fuel hose". Search
4. Right click "3. Fuel hose Fails caused by Friction or rubbing" Select, Suspension

Selecting an anticipated failure mode (suspension)

Hydraulic shovel Hitachi EX3600- LRCM G1 v6.3

- 1. Engine system
 - 1. Engine
 - 2. Peripheries
 - 3. Lubrication system
 - 4. Air intake and exhaust system
 - 5. Cooling system
 - 6. Electronic control system
- 7. Fuel system
 - 1. To contain the fuel
 - 1. Does not contain
 - 1. Fuel pump Seals fail caused by n/a
 - 2. Fuel hose Fails caused by n/a
 - 3. Fuel hose Fails caused by Friction or rubbing
 - 4. Fuel Filter Seal fails caused by n/a
 - 5. Injector Seal fails caused by n/a

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24

24

DAS, LrcmGnEx4, (n=1,2,3,4) RCM icon, ...

Failure modes not anticipated in the RCM analysis

(Exercise 4 – RCM knowledge feedback)

Group1: Case 1

Search, Right click on "1. Cabin temper ...", Feedback, Append, Failure Mode, ...

- Air conditioning does not cool the operator sufficiently. The operator decides to take the equipment down as a safety precaution. Technician arrives and finds that the air conditioning compressor/motor **v-belts** are worn and probably slipping. (WO LrcmG1Ex4)

Group2: Case 2

Search, Right click on "Work area not illum...", Feedback, Append, Failure Mode, ...

- Operator reports no **lighting** is projected onto the work area, elects not to operate the shovel for safety concerns. Technician arrives and finds the **work lights** burned out. (LrcmG2Ex4)

Group3: Case 3

Search "ladder", Right click on "Cannot raise ... (under "Accessories)", Feedback, Append, Failure Mode, ...

- Operator reports that he cannot raise or lower the **ladder** (staircase) and the equipment is down.
- Technician arrives and finds that the **solenoid** valve is stuck mechanically in the neutral position.

Group4: Case 4

Search "does not lift", Right click on it, Feedback, Append, Failure Mode, ...

- Operator reports crack in the boom of **lift** system, the operator decides not to continue operating the equipment for safety considerations. Technician arrives and finds large crack in the boom that makes it mandatory to cease operation. Realizes that this was caused by inattentive operation. (Hint: Failure mode is not "Boom cracks" but "Breaks" or "Fractures")

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25

25

2. To maintain the temperature inside the cabin between 17 to 24 degrees Celsius. (0)

1. Cabin temperature strays outside of 17 to 24 degrees Celsius range. (0)

1. Air conditioning unit Pump hydraulic motor worn caused by n/a (0)

2. Air conditioning unit Hydraulic motor worn caused by n/a (0)

3. Air conditioning unit Hydraulic motor shaft shears caused by n/a (0)

4. Air conditioning unit Motor shaft keyway worn caused by n/a (0)

Feedback

Append

Modify

Remove

Failure Mode

Feedback: New failure mode

Feedback on Functional Failure - 1. Cabin temperature strays outside of 17 to 24 degrees Celsius range. - Append Element

Failure Mode

Part: Air conditioning unit

Damage: V-belts damaged

Cause: n/a

Effects: Air conditioning does not cool the operator sufficiently. The operator decides to take the equipment down as a safety precaution. Technician arrives and finds that the air conditioning compressor/motor v-belts are worn and probably slipping. (WO LrcmG1Ex4)

Consequence: Health Safety Environment

Select this?: Functional Failure

Justification: * I suggest that operator check belt tension weekly. Technician.

Save

Cancel

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26

26

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Feedback management

In this exercise, the **Reliability Engineer** verifies/edits/accepts the feedback from technicians in the field.

Session start

Username: *

Password: *

Log In

Language: English | Spanish

Feedback Manager

Knowledge Base - Feedback Manager

Select text to retrieve feedback:

Request Date:

No pending feedbacks for this

Hydraulic shovel Hitachi EX3600- LRCM G1

Hydraulic shovel Hitachi EX3600- LRCM G2

Hydraulic shovel Hitachi EX3600- LRCM G3

Lubrication system

Pala Hidráulica Hitachi EX3600 Grupo 1

Pala Hidráulica Hitachi EX3600 Grupo 2

Pala Hidráulica Hitachi EX3600 Grupo 3

Start Session

Process Feedback

Feedback on Functional Failure - 1. Cabin temperature strays outside of 17 to 24 degrees Celsius range. - Append Element

Hydraulic shovel Hitachi EX3600- LRCM G1 v1

1. Engine system

2. Hydraulic System

3. Accessories

1. Hydraulic system main staircase

2. Sistema Hidráulico Del Wiggins

3. Cabina de Operador

4. Sistema Supresor de Incendio

5. Sistema Centralizado de Grasa

6. Air conditioning

1. To supply 82.7 lpm up to a max

2. To maintain the temperature ins

1. Cabin temperature strays

3. To indicate conditioned air temp

4. To allow turning air conditioning

5. To allow setting conditioned air

6. To slightly pressurize the cabin.

Information

Action: Append Element

Type: Failure Mode

On node: 1. Cabin temperature strays outside of 17 to 24 degrees Celsius range.

Request Date: 03/01/2018 06:16:48 PM

Contributed By: Group1

Select this? Functional Failure

Justification: * This failure mode was not included. Tension and visual inspection should be done weekly.

> Next

ature strays outside of 17 to 24 degrees Celsius range. - Append Element

31 v1

Edit Information

Part:

Damage:

Cause:

Effects: * When the v-belts slip, the air conditioning unit is unable to deliver the required cooling. For safety reasons the operator must stop the unit. It takes about 4 hours to troubleshoot and correct this by replacing the belts, adjusting the tension, and alignment.

Consequence: *

< Back

Approve

Reject

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27

27

The approval process can take place in a meeting

Facilitator / Analyst / Engineer / Supervisor

Operator

Technician

SME as required

Continuous improvement activities in the living RCM meeting to review feedback.

1. Incorporate new information from the field

2. Analysis of the feedback

3. Add failure modes originally overlooked but actually occurred

4. Upgrade effects analysis with relevant details

5. Update the consequences

6. Update the mitigation

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28

28

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14


Case History - Identification of an undocumented failure mode

Failure Mode: Hose (engine cooling system) rubbing due to clamp maladjusted.

Stoppage Duration: 3h, MTBF =1 year

Fleet: 165 trucks

Marginal loss: \$ 600 / h*



When this failure mode occurs, the production losses are:

$$Loss \times Production_{total} = 3h \times 600 \frac{\$}{h} = 1800\$$$

The potential failure was found in 20% of the fleet:

$$Loss \times Production_{total} = 1800\$ \times 33 = 59400\$$$

Does not include cost of maintenance

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*Assumes operation at full capacity

29

29

Dashboard

Gro up	Username	Password
1	Groupxx1	liviNGrcm1
2	Groupxx2	liviNGrcm1
3	Groupxx3	liviNGrcm1
4	Groupxx4	liviNGrcm1

1. www.glikcloud.com, Log in with Groupxxn and Password

2. Murray Wiseman

3. RCM Dashboard

4. Knowledge Management

5. Question 1: Read 21 from purple slice of pie chart

6. Click on the purple slice and hit ✓.

7. Question 2: Look at the table and read 5 for the ESD system

8. Clear all the filters by hitting X on the black bar.

9. Question 3: Read Mesh Admin from the bar chart.

Dashboard exercise questions:

1. How many suggestions were there to modify a failure mode?

2. Which equipment had received the most suggestions to modify a failure mode?

3. Who contributed the most failure mode modifications?

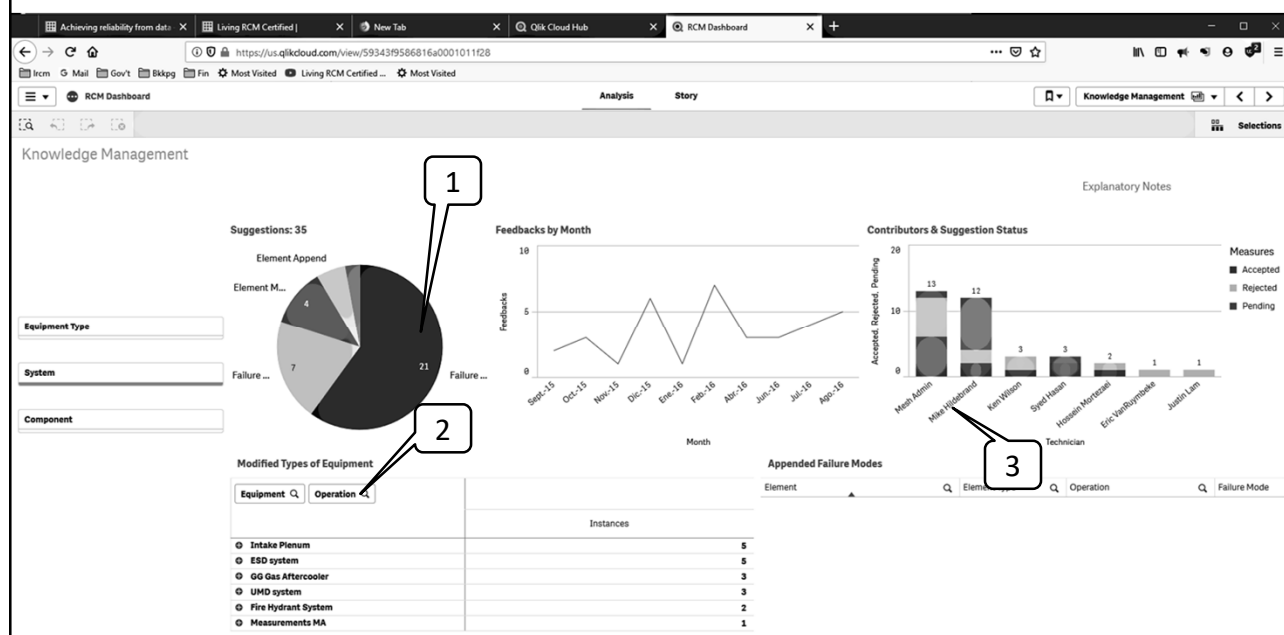
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30

30

Dashboards

(Exercise 5 – Continuous RCM knowledge growth performance measurement)



31

3.2 Quiz 2 Living RCM

<https://forms.gle/kyatrgkkAKQR9qh7>

1. For the purposes of analysis and continuous improvement purposes a work order should capture which information? *

- ☐ Whether a failure mode ended its life by functional failure, potential failure, or preventive renewal (suspension).
- ☐ Any divergence between the the RCM analysis and the technician's observations and insight regarding the failure mode.
- ☐ Any comment by the technician as to the effectiveness of the current mitigating task and its frequency.
- ☐ All of the above.
- ☐ None of the above.

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32

32