Developing a World Class Maintenance Strategy for a One – Off Design

James Ross
Maintenance Coordinator

John Holmes
Managing Consultant,
Mainnovation Inc.
Introduction James Ross

- Oklahoma State University graduate with degree in Natural Gas Compression
- Worked as a pipefitter/boilermaker in refineries
- Worked as a Maintenance Tech
- Experience with predictive maintenance tools (Ultra Probe 10000, Windrock 6320, Flir Gasfinder camera, Flir P640 thermal camera, Olympus Videoscope, etc.)
- Currently Maintenance Supervisor for LNG and CNG Equipment
Introduction John Holmes

- Maritime Academy graduate with a degree in Marine Engineering
- Worked aboard deep water drill ships and oil tankers
- Experience in construction, operation and maintenance of power generation facilities
- Experience consulting for power generation, oil & gas, manufacturing, pharma and steel to develop, enhance and improve maintenance and asset management programs
- Current chair of the Georgia Chapter of the Society for Maintenance and Reliability Professionals
Agenda

1. LNG Fueling Stations
2. Main Project Driver
3. Developing a World Class Maintenance Strategy
4. Lessons Learned
The properties of natural gas as a fuel, the reliability of NGVs and the fuel delivery system make natural gas a safe alternative to gasoline.

1) The liquid natural gas (LNG) is brought in by tanker truck and transferred into the storage tanks.
2) The LNG is held to the proper temperature and pressure.
3) The LNG is transferred from the holding tanks to the main delivery tank.
4) The LNG is then forwarded to the dispensing units.

The properties of natural gas as a fuel, the reliability of NGVs and the fuel delivery system make natural gas a safe alternative to gasoline:

- All natural gas fueling stations must be built to federal safety standards.
- Natural gas, compressed or liquefied, will evaporate into the air in the event of a leak or rupture, unlike gasoline that will pool on the ground creating a fire hazard.
- CNG vehicles have stronger fuel storage cylinders than gasoline fuel tanks.
Project Introduction

• This was a green field project, this type of plant had not been built before
• Therefore there was minimal or no running history of this type of equipment to form the basis of the maintenance strategy
• Therefore a standardized best practice approach was required to mitigate the risk
Agenda

1. LNG Fueling Stations

2. Main Project Driver

3. Developing a World Class Maintenance Strategy

4. Lessons Learned
Based on the potential risk of explosion or fire and the impact to safety and the business, the dominant value driver was identified as Safety, Health and Environmental (SHE).

How can this be qualified if there is not currently data available to quantify the value?

- Confidence of the personnel and management of the program
- Knowledge of the asset health trending
- Reliability engineering data to support further analysis
Where the Project Focused
Agenda

1. LNG Fueling Stations
2. Main Project Driver
3. Developing a World Class Maintenance Strategy
4. Lessons Learned
Data Collection and Hierarchy Setup

- Equipment was manually walked down
- Referenced available P&ID Drawings
- Collected nameplate data
- Created an intuitive location and system based hierarchy
- Adopted a standardized naming taxonomy

**Additional Potential Improvements**

- Restructure the existing hierarchy to allow for proper levels
- Add additional equipment template forms for common equipment
- Develop the go forward plan for document control, linked to outside or housed within
Value Driven Reliability Engineering

1. Rank Criticality & select items to analyze
2. Define / Optimize Maintenance Plan
3. Implement & Execute Maintenance Plan
4. Evaluate Performance
VDM RE Roadmap

1. Rank criticality & select items to analyze
   - 1.1 Confirm dominant value driver
   - 1.2 Perform criticality ranking
   - 1.3 Align appropriate risk matrix
   - 1.4 Select key objects, approach & objectives

2. Rank criticality & select items to analyze
   - 2.1 Train team in RE techniques
   - 2.2 Prepare & collect data
   - 2.3 Perform analysis
   - 2.4 Validate results vs. objective

3. Implement & execute maintenance plan
   - 3.1 Clustering & leveling
   - 3.2 Detailed job description
   - 3.3 Initiate PM in EAM
   - 3.4 Train & execute plan

4. Implement & execute maintenance plan
   - 4.1 Install measurement tool (KPI dashboard)
   - 4.2 Install meeting structure
   - 4.3 Set SMART equipment targets
   - 4.4 Refresh ranking performance killers
# Criticality

## 1. Rank criticality & select items to analyze

1.1 Confirm dominant value driver

1.2 Perform criticality ranking

1.3 Align appropriate risk matrix

1.4 Select key objects, approach & objectives

### Risk Discovery

<table>
<thead>
<tr>
<th>Category</th>
<th>Factor</th>
<th>Rating</th>
<th>Comments</th>
<th>Category Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Potential For Injury - Equipment Operating</td>
<td>50</td>
<td>unlikely</td>
<td>420</td>
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<tr>
<td></td>
<td>Severity of Injury - Equipment Operating</td>
<td>10</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential For Injury - Under Repair</td>
<td>50</td>
<td>unlikely</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severity of Injury - Under Repair</td>
<td>100</td>
<td>OSHA Recordable</td>
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<tr>
<td></td>
<td>Potential For Fire/Explosion/etc.</td>
<td>200</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical Safety Device</td>
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<td>no</td>
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</tr>
<tr>
<td>Environmental</td>
<td>Potential For Spill/Release/etc.</td>
<td>500</td>
<td>Notice of Violation</td>
<td>1510</td>
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<tr>
<td></td>
<td>Pollution Control Device</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Environmental Impact</td>
<td>800</td>
<td>Nationwide Media Coverage</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Repair Costs</td>
<td>300</td>
<td>$10,001 - $20,000</td>
<td>1210</td>
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<tr>
<td></td>
<td>Spare Parts Availability</td>
<td>200</td>
<td>7 to 14 Days</td>
<td></td>
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<td></td>
<td>Outside Resource Availability</td>
<td>400</td>
<td>&gt; 3 Days</td>
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<tr>
<td></td>
<td>Replacement Cost of Asset</td>
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<td>$10K</td>
<td></td>
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<tr>
<td></td>
<td>Potential For Hidden Failure</td>
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<tr>
<td>Operations</td>
<td>Downtime Impact</td>
<td>1000</td>
<td>&gt; 3 Days</td>
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<tr>
<td></td>
<td>Potential to Cause Slowdown to Process</td>
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<tr>
<td></td>
<td>Regulatory Requirements</td>
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<tr>
<td></td>
<td>Failure Frequency History</td>
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<td>annually or greater</td>
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<tr>
<td></td>
<td>Delivery Impact to Customer</td>
<td>300</td>
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<td></td>
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</tbody>
</table>

[Mark item for more detailed analysis]

Overall Rating: **4560**
FMEA Analysis

2. Rank criticality & select items to analyze
   - 2.1 Train team in RE techniques
   - 2.2 Prepare & collect data
   - 2.3 Perform analysis
   - 2.4 Validate results vs. objective

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System Hierarchy

<table>
<thead>
<tr>
<th>Name</th>
<th>Reference Number</th>
</tr>
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<tbody>
<tr>
<td>Truck Offload</td>
<td>HCV-001</td>
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<tr>
<td>TRUCK OFFLOAD SUCTION VALVE</td>
<td>1350</td>
</tr>
<tr>
<td>TRUCK OFFLOAD SAFETY VALVE</td>
<td>1350</td>
</tr>
<tr>
<td>TRUCK OFFLOAD PUMP</td>
<td>P-001</td>
</tr>
<tr>
<td>TRUCK OFFLOAD PUMP PRESSURE</td>
<td>PT-001</td>
</tr>
<tr>
<td>TRUCK OFFLOAD PUMP TEMP</td>
<td>TF-001</td>
</tr>
<tr>
<td>TRUCK OFFLOAD PUMP MOTOR</td>
<td>MTR-001</td>
</tr>
<tr>
<td>TRUCK OFFLOAD DISCHARGE FILTER</td>
<td>F-01</td>
</tr>
<tr>
<td>TRUCK OFFLOAD BLOCK VALVE</td>
<td>HCV-003</td>
</tr>
<tr>
<td>TRUCK OFFLOAD CHECK VALVE</td>
<td>CV-001</td>
</tr>
<tr>
<td>OFFLOAD DISCHARGE SAFETY VALVE</td>
<td>PSV-352</td>
</tr>
<tr>
<td>TANK 1</td>
<td>7220</td>
</tr>
<tr>
<td>TANK 1 RAPID SATURATION FILL SPARGER MANUAL VALVE</td>
<td>V-1-TK1</td>
</tr>
<tr>
<td>TANK 1 LIQUID WIDRAWAL MANUAL VALVE</td>
<td>V-2-TK1</td>
</tr>
<tr>
<td>TANK 1 TOP FILL MANUAL VALVE</td>
<td>V-3-TK1</td>
</tr>
<tr>
<td>TANK 1 PRESSURE BUILD INLET REGULATING VALVE</td>
<td>V-4-TK1</td>
</tr>
<tr>
<td>TANK 1 PRESSURE BUILD OUTLET VALVE</td>
<td>V-5-TK1</td>
</tr>
<tr>
<td>TANK 1 VAPOR VENT VALVE</td>
<td>V-6-TK1</td>
</tr>
<tr>
<td>TANK 1 VAPOR SHUTOFF VALVE</td>
<td>V-7-TK1</td>
</tr>
<tr>
<td>TANK 1 VENT REGULATOR SHUTOFF VALVE</td>
<td>V-8-TK1</td>
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<tr>
<td>TANK 1</td>
<td>820</td>
</tr>
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</table>
Migrating the output to the CMMS

3. Implement & execute maintenance plan

1. Functional decomposition & description
2. Functional failure
3. What are the results of the defined failure?
4. What is the root cause & failure mode?
5. In what way does the failure matter?
6. How to prevent or predict the failure?
7. What to do if no preventive action is suitable?

3.1 Clustering & leveling
3.2 Detailed job description
3.3 Initiate PM in EAM
3.4 Train & execute plan

**RE Roadmap**
- Validate the results
- Clustering and leveling of all tasks into PM plans
- Detailed job descriptions for selected tasks / PM’s
- Implement PM’s in EAM system
- Train mechanics
- Execute the plans

**Results of RCM and beyond**
- Maintenance program
- Preventive Maintenance
- Predictive Maintenance
- Shutdown / line stops
- Corrective Maintenance
- Modifications
- Resources
- Spare parts
- Schedule / LTAP
- Asset Based Budget

**The seven basic questions**
Evaluate performance

4. Implement & execute maintenance plan

4.1 Install measurement tool (KPI dashboard)
4.2 Install meeting structure
4.3 Set SMART equipment targets
4.4 Refresh ranking performance killers

- Total of 5 KPI’s are used
- Mix of leading and lagging indicators
- Easy to understand
- Automatically developed in real-time

Open Work Orders by Type

Proactive, 15.97%
Project, 0.84%
Reactive, 36.97%
PM, 46.22%

All Open Work Orders

Facility Name

CHG STATION
LNG FACILITY
MFG-0001
MPS-0003
MST-0003
RPS-0002
CHG STATION

WOs

0 6 12 18 24 30
Agenda

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4. Lessons Learned
**Project Summary**

- Configured eMaint data record structure
- Configured user access and appropriate security levels
- Created KPI’s to monitor the performance of the maintenance program now in place
- Defined the job role descriptions
- Added a CMMS position to the organization
- Established the role of gatekeeper
- Performed an equipment walk down to generate the asset breakdown structure (ABS)
- Created applicable equipment FMEA’s
- Developed the preventive and predictive maintenance tasks
- Created the basic work management workflow
Thank you for your attention!