Section 1: Introduction of Problem
List of problems identified in Utilities Kerteh plant within team members’ span of control

<table>
<thead>
<tr>
<th>No</th>
<th>Problems</th>
<th>Proposed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cooling Tower Efficiency low</td>
<td>Al-Muhuddin</td>
</tr>
<tr>
<td>2</td>
<td>ASU 1 MAC start up vent valve frequent failure</td>
<td>Aisyah</td>
</tr>
<tr>
<td>3</td>
<td>P1-2711 demin backwash sump pump frequent failure</td>
<td>Zamri</td>
</tr>
<tr>
<td>4</td>
<td>MBE Strainer frequent clog at demin plant</td>
<td>Syukri</td>
</tr>
<tr>
<td>5</td>
<td>GT unit B, C &amp; E 88BT Turbine compartment cooling blower frequent breakdown</td>
<td>Farizuddin</td>
</tr>
</tbody>
</table>
1.1 Problem selection

Problem Historical Data Collection

1. Cooling Tower Efficiency low

<table>
<thead>
<tr>
<th>Function</th>
<th>To disperse the heat and cool down the circulating water that had absorbed heat from the heat sources and reduce the temperature and maintain a constant supply pressure of the Cooling Water that travels to the various equipments.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Heated water not cooled down efficiently prior to recirculating to the various equipments</td>
</tr>
<tr>
<td>PONC (MYR)</td>
<td>150,000.00 from cooling tower fan gearbox repair</td>
</tr>
<tr>
<td>Frequency</td>
<td>1 occurrence between July - Nov 2015</td>
</tr>
</tbody>
</table>

Cooling tower at Utilities Kerteh

Cooling tower fan (interior – left, exterior – right)

Damaged cooling tower fan gearbox
1.1 Problem selection

Problem Historical Data Collection

1. Cooling Tower Efficiency low

<table>
<thead>
<tr>
<th>Month</th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>150K</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>150K</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Cost & frequency of incident

Cooling tower gearbox repair Work Order
1.1 Problem selection

**Problem Historical Data Collection**

2. **ASU 1 MAC start up vent valve frequent failure**

<table>
<thead>
<tr>
<th>Function</th>
<th>To regulate discharge pressure and flow during ASU 1 MAC start-up in order to prevent surging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Vent valve silencer accumulated with rain water causing vent valve unable to vent excess air from ASU 1 MAC</td>
</tr>
<tr>
<td>PONC (MYR)</td>
<td>RM 97,685.25 of opportunity loss</td>
</tr>
<tr>
<td>Frequency</td>
<td>1 occurrence between July - Nov 2015</td>
</tr>
</tbody>
</table>

Surging pattern at control system

Start-up vent valve at Utilities Kerteh
1.1 Problem selection

Problem Historical Data Collection

2. ASU 1 MAC start up vent valve frequent failure

<table>
<thead>
<tr>
<th></th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>97k</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>97k</td>
</tr>
</tbody>
</table>

Cost & frequency of incident

ASU 1 MAC trip report

Nurhidayah Binti Ramli

Date of problem: [DD/MM/YYYY]
1.1 Problem selection

Problem Historical Data Collection

3. P1-2711 demin backwash sump pump frequent failure

| Function | The Demin Sump (T1-2711) will receive Effluent from the Demin MMF backwash, MBE-ACF Rinse Wash, CP Rinse Wash, and Demin run-off. The Demin Effluent Transfer Pumps (P1-2711A/B) will pump the effluent and other drainage to the effluent treatment plant. |
| Problem  | Line clogged causing pump damaged |
| PONC (MYR) | 180,000.00 |
| Frequency | 3 occurrence between July - Nov 2015 |
1.1 Problem selection

Problem Historical Data Collection

3. P1-2711 demin backwash sump pump frequent failure

<table>
<thead>
<tr>
<th></th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>20k</td>
<td>20k</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0</td>
<td>40k</td>
<td>20k</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Cost & frequency of incident

Demin backwash sump pump repair Work Order
1.1 Problem selection

Problem Historical Data Collection

4. MBE Strainer frequent clog at demin plant

<table>
<thead>
<tr>
<th>Function</th>
<th>Remove suspended solids and dissolved mineral salts remaining after Reverse Osmosis treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Resin carry over causing strainer clog</td>
</tr>
<tr>
<td>PONC (MYR)</td>
<td>40,000.00</td>
</tr>
<tr>
<td>Frequency</td>
<td>2 occurrence between July - Nov 2015</td>
</tr>
</tbody>
</table>

Clogged MBE strainer
1.1 Problem selection

Problem Historical Data Collection

4. MBE Strainer frequent clog at demin plant

<table>
<thead>
<tr>
<th>Month</th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>0</td>
<td>17.9k</td>
<td>0</td>
<td>22.5k</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>17.9k</td>
<td>0</td>
<td>22.5k</td>
</tr>
</tbody>
</table>

Cost & frequency of incident:

- Jul-15: 0
- Aug-15: 0
- Sep-15: 1
- Oct-15: 0
- Nov-15: 1

MBE strainer flushing Work Order
1.1 Problem selection

**Problem Historical Data Collection**

5. GT B C E 88BT Turbine compartment cooling blower frequent breakdown

<table>
<thead>
<tr>
<th>Function</th>
<th>Remove hot air from Gas Turbine Combustion Compartment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Blower shaft bearing frequently jammed</td>
</tr>
<tr>
<td>PONC (MYR)</td>
<td>RM 268,200.00 for 2 Blower Breakdown and 1 GT Trip</td>
</tr>
<tr>
<td>Frequency</td>
<td>2 occurrence between July - Nov 2015 (Blower Jammed)</td>
</tr>
<tr>
<td></td>
<td>1 Occurrence between July – Nov 2015 (GT Trip)</td>
</tr>
</tbody>
</table>

Turbine blower repair
1.1 Problem Historical Data Collection

5. GT B C E 88BT Turbine compartment cooling blower frequent breakdown

<table>
<thead>
<tr>
<th>Month</th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>32K</td>
<td>236.2K</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>32K</td>
<td>236.2K</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Cost & frequency of incident

Gas turbine trip due to blower breakdown report
1.1 Problem selection

Selected Problem Based on L Shape Matrix

GT B C E 88BT Turbine compartment cooling blower frequent breakdown

**PONC (RM)**

- Cooling Tower: 150,000 RM
- ASU 1: 100,000 RM
- P1-2711: 50,000 RM
- MBE strainer: 25,000 RM
- 88BT: 300,000 RM
1.1 Problem selection
Management Approval

Management Approval (Head of Section) to proceed with 88BT Improvement Works

Provision Cost for 10 Blowers (RM 160K) if the need arises
1.1 Problem definition
Terminologies and Jargon

SURGE
Back flow of a fluid within a closed system

STRAINER
Mesh-type filter

ONLINE
Done while equipment still running

PONC
Price Of Non Conformance

UG
Utilities Gebeng

UK
Utilities Kertih

88BT
Gas Turbine compartment cooling blower; GE standard call name

ASU
Air Separation Unit

MAC
Main Air Compressor
1.1 Problem definition

Problem Definition using 5W1H

**WHAT?**

GT B C E 88BT Turbine compartment cooling blower frequent breakdown

- GT Combustion Compartment:
  - Section in a GT where combustion process occurs resultant from reaction of forced spark with mixture of fuel gas and air (oxygen)
- Cooling Blower:
  - Belt driven cooling blower fan
  - Extraction type (extract heat) from GT combustion compartment
- Frequent jammed:
  - Premature repetitive failure (more than once) before standard overhaul interval
  - Jammed due to DE bearing Damaged
- NOTE:
  - 88BT GE Blower overhaul every 24000 running hours
1.1 Problem definition

Problem Definition using 5W1H

WHY?

GT B C E 88BT Turbine compartment cooling blower frequent breakdown

- Frequent Belting snapped
- Overtighten belt resultant to premature bearing damage
- Blower unable to properly rotate resultant from bearing damage
1.1 Problem definition

Problem Definition using 5W1H

**WHEN?**
During GT on-line, between August to September 2015

**WHERE?**
GT B, C & E

**WHO?**
Maintenance and Operation Team

**HOW?**
Drive end bearing of the 88BT jammed causing the blower assembly to be malfunctioned.
1.1 Problem definition

Problem Background

- For 2015, GT B, C & E experience tripping on Flame Loss due to 3 out of 4 flame scanners sensed “Loss of Flame”
- Early investigation revealed that the flame scanners experience loss of signal due to increased Turbine Compartment Temperature (ATTC) from 60degC to 129degC within 3-hours resultant from insufficient heat removal from Turbine Compartment Cooling Blower (88BT).

Ventilation Air Flow for GT Combustion Compartment Cooling

Location of 88BT Blower at Gas Turbine
1.1 Problem definition

Sequence of events

1. GT Normal Operation
2. 88BT Blower jammed due to bearing assembly damage
3. ATTC Rise due to insufficient heat removal
4. Flame Scanner starts to fail due to high temperature
5. 3 out of 4 Flame scanner fails
6. GT Trip

88BT Blower jammed due to bearing assembly damage

Flame Scanner Location at Combustion Chambers
1.1 Problem definition
Current Data of the Problem

<table>
<thead>
<tr>
<th>Month</th>
<th>JULY</th>
<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
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<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>32K</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16K</td>
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<tr>
<td>Total</td>
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<td>32K</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16K</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Month</th>
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<th>AUG</th>
<th>SEPT</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>PONC (RM)</td>
<td>0</td>
<td>0</td>
<td>236.2K</td>
<td>0</td>
<td>0</td>
<td>236.2K</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>236.2K</td>
<td>0</td>
<td>0</td>
<td>236.2K</td>
</tr>
</tbody>
</table>

Number of occurrence in 2015: 5
Total PONC: RM 520,400.00
1. Project target setting

How Much and By When

1. Zero 88BT Blower tripping and jammed by March 2016 onwards

2. Zero GT unplanned shutdown and tripping due to 88BT Blower defects by March 2016 onwards

3. 0 PONC due to Unplanned GT Startup, Unplanned Blower Overhaul and Revenue Loss

• 88BT Tripped & Jammed
• GT Tripped & Unplanned Shutdown
• PONC due to Unplanned GT Startup, Unplanned Blower Overhaul and Revenue Loss
  • March 2016 onwards
1.1 Project target setting

Target Justification and Basis – Target no 1

Eliminate 88BT Trip and jammed occurrences from average of 1.5 times per month to Zero by March 2016 Onwards
1.1 Project target setting

Target Justification and Basis – Target no 2

Eliminate GT Trip and Unplanned Shutdown from average of once per month to Zero by March 2016
1.1 Project target setting

Target no 2 – Benchmark with International Bodies

GT Tripped & Unplanned Shutdown
March 2016 onwards

Prolong GT Running Hours by reducing low cycle fatigue caused by frequent start-stop event.

“Multi-starts mean the stressed components in gas turbines are now subjected to low cycle fatigue”

Gary Lock, Senior Business Manager at Frazer-Nash Consultancy.
Power Engineering International; Turbine trauma: the risk of the start-stop cycle

“..Significant increase in the strain range for a trip cycle results in a life effects that equates to eight normal start/stop

TIL GER-3620M
General Electric, Connecticut, USA
1.1 Project target setting
Target Justification and Basis - Target no 3

PONC due to Unplanned GT Startup, Unplanned Blower Overhaul and Revenue Loss

March 2016 onwards

• Eliminate PONC of RM 236,200.00 to RM 0 by March 2016 due to:
  ✓ RM 20,000.00 of Fuel Gas cost for GT Startup
  ✓ RM 16,000.00 for additional blower overhaul
  ✓ RM 200,000.00 of Revenue Loss due to reduced Power Export
  ✓ RM 200.00 of additional cost for belt replacement works

“It is paramount that we ruthlessly tackle inefficiencies and simplify the way we do things. This goes far beyond a knee-jerk cost cutting exercise, calling for a fundamental shift in the way we do things which requires a total mindset change.”

President and Group CEO, Datuk Wan Zulkiflee Wan Ariffin,
Understanding Cactus #2: Driving Down Cost Through Simplifying How We Operate
1.2 Project alignment with goals & strategies

Cost Impact of **RM 236,200.00** per GT trip

- RM **20,000.00** of Fuel Gas cost for GT Startup
- RM **16,000.00** for additional blower overhaul
- RM **200,000.00** of Revenue Loss due to reduced Power Export
- RM **200.00** of additional cost for belt replacement works
1.2 Project alignment with goals & strategies

Problem Significance to The Department

DEPARTMENT

- Potential cost impact for repairs
  - Blower overhaul cost: RM 16,000.00 (single Blower)
  - RM48,000 for 3 blowers

Total cost of RM 48K for 3 blowers (RM 16K per blower)
1.2 Project alignment with goals & strategies

Company’s transformation agenda
1.2 Project alignment with goals & strategies

Problem Selection Based on PETRONAS Quality Principles

2 COMPANY

PRICE OF NON-CONFORMANCE
1.2 Project alignment with goals & strategies

Problem Significance to The Nation’s oil & gas industry

3 NATION’S INDUSTRY

Malaysian oil and gas players earnings at risk

BY WONG WEN-MING
1.2 Project alignment with goals & strategies

Problem Significance to Customers

CUSTOMERS

• 88BT breakdown can cause the GT to trip
• If all 88BT for all GT trip, it can cause total Plant shutdown/blackout
• Total PONC caused to customers will be:
  ✓ RM172M for all neighboring plant
1.3 Potential Stakeholders

**List of Stakeholders**

**INTERNAL**
- Operations
- Engineering
- Technical Services
- Human Resources
- Maintenance
- Finance
- Technical Professionals
- Plant OE
- Facilities & Admin

**EXTERNAL**
- Customers from PETRONAS Chemicals Group
- Spot sale customers
- Suruhanjaya Tenaga
- BAKIPC
- Department of Environment
- DOSH
- Local village community
- Contractors & vendors

Relevant stakeholders to the project
1.3 Identified stakeholders

Problem Significance to Internal Stakeholders

STAKEHOLDERS

OPERATIONS
- COGEN plant planned shutdown interrupted due to unplanned shutdown/trip

MAINTENANCE
- Hazardous work for belt replacement activity due to the heat from the turbine combustion compartment
- Interrupts planned work; require daily work re-planning to cater urgent works

TECHNICAL PROFESSIONALS
- Repetitive weekly condition review
- Man-hours utilized can be used for other technical advisory works
1.3 Identified stakeholders

Problem Significance to External Stakeholders

5 STAKEHOLDERS

CUSTOMERS FROM PETRONAS CHEMICALS GROUP (PCG)

- Power and Steam (HHP, HP and LP)
- Industrial Gasses (Nitrogen, Oxygen and Argon)

Partial power and steam from COGEN plant is utilized for ASU Steam Turbine and Compressors. Supply Interruption due to UK COGEN trip may cause loss of production at customer side.

UK, PGB
Cogeneration (COGEN)
Air Separation Unit (ASU)
Section 2: Creative and Innovative Final Solution
2.4 Root Cause Analysis

**Why-why Analysis**

- **88BT** Frequent Trip and jammed
  - **Bearing damaged (DE)**
  - **Belt Premature Snapped**
  - **Grease depletion**
  - **Belt damage due to high Temperature**
  - **Untimely Belt Replacement Works**
  - **Improper Belt Tightening**
  - **Untimely Greasing Period**
  - **Insufficient Greasing**
  - **Insufficient Greasing Amount**
  - **Grease loss from housing due to over-greasing**
  - **Grease Loss due to overheat**
  - **Grease leaked through bearing housing seal**
  - **Grease accumulate inside bearing housing**
  - **No Insulation within Bearing compartment**
  - **No Insulation within Belt Housing**
  - **Wrong Belt Spec Used**
  - **Belt not replaced during PM Works**
  - **Non-Standard belt tensioning method**
  - **Greasing Not Executed during PM Works**
  - **No Fixed amount of grease used**
  - **Grease loss from housing due to over-greasing**
  - **Grease accumulate inside bearing housing**
  - **No Insulation within Bearing compartment**
  - **Wrong Belt Spec Used**
  - **Belt not replaced during PM Works**
  - **Non-Standard belt tensioning method**
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Greasing Not Executed during PM Works</td>
<td>PM Checklist and Work Order Compliance – It was found that PM works is executed timely</td>
<td>N</td>
</tr>
</tbody>
</table>

- **No Fixed amount of grease used**
- **Grease accumulate inside bearing housing**
- **No Insulation within Bearing compartment**
- **Wrong Belt Spec Used**
- **No Insulation within Belt Housing**
- **Belt not replaced during PM Works**
- **Non-Standard belt tensioning method**

**GT 3-Monthly PM Checklist**

<table>
<thead>
<tr>
<th>Unit</th>
<th>PM Window</th>
<th>Greasing Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>10/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTC</td>
<td>21/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTD</td>
<td>24/2/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTE</td>
<td>20/2/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTF</td>
<td>27/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTG</td>
<td>16/2/2016</td>
<td>Done</td>
</tr>
</tbody>
</table>
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>No Fixed amount of grease used</td>
<td>Amount of grease being carefully measured and greasing amount is based on blower spec</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>PM Window</th>
<th>Amount of Grease (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>10/1/2016</td>
<td>35g</td>
</tr>
<tr>
<td>GTC</td>
<td>21/1/2016</td>
<td>36g</td>
</tr>
<tr>
<td>GTD</td>
<td>24/2/2016</td>
<td>35g</td>
</tr>
<tr>
<td>GTE</td>
<td>20/2/2016</td>
<td>35g</td>
</tr>
<tr>
<td>GTF</td>
<td>27/1/2016</td>
<td>35g</td>
</tr>
<tr>
<td>GTG</td>
<td>16/2/2016</td>
<td>35g</td>
</tr>
</tbody>
</table>

Greasing Amount per Cycle
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Grease accumulate inside bearing housing</td>
<td>Bearing housing are filled with Old Grease due to accumulation.</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>As Found Condition during Overhaul</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>Bearing damaged, Bearing Seal detached</td>
</tr>
<tr>
<td>GTC</td>
<td>Bearing damaged, Bearing seal detached, traces of grease within bearing compartment</td>
</tr>
<tr>
<td>GTE</td>
<td>Bearing damaged, Bearing seal detached, traces of grease within bearing compartment</td>
</tr>
</tbody>
</table>

As found Bearing Condition during Defective Blower Overhaul
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>No Insulation within Bearing compartment</td>
<td>Jammed blower As-Found Inspection resulted to no insulation are found within bearing compartment</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>As Found Condition during Overhaul</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>No Insulation found within Bearing Compartment</td>
</tr>
<tr>
<td>GTC</td>
<td>Very thin insulation within bearing compartment</td>
</tr>
<tr>
<td>GTE</td>
<td>Partial Insulation within bearing compartment, very thin insulation</td>
</tr>
</tbody>
</table>

No Insulation within Bearing compartment

No Insulation within Belt Housing

Belt not replaced during PM Works

Wrong Belt Spec Used

Grease accumulate inside bearing housing

Greasing Not Executed during PM Works

No Fixed amount of grease used

Non-Standard belt tensioning method

No Insulation within Belt Housing

Belt not replaced during PM Works

Wrong Belt Spec Used

Grease accumulate inside bearing housing

Greasing Not Executed during PM Works

No Fixed amount of grease used

Non-Standard belt tensioning method

No Insulation within Bearing Compartment
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Wrong Belt Spec Used</td>
<td>Inspection at warehouse as well as reservation checklist shown that the belt used are of correct specification</td>
<td>N</td>
</tr>
</tbody>
</table>

- Greasing Not Executed during PM Works
- No Fixed amount of grease used
- Grease accumulate inside bearing housing
- No Insulation within Bearing compartment
- Wrong Belt Spec Used
- No Insulation within Belt Housing
- Belt not replaced during PM Works
- Non-Standard belt tensioning method

---

Image of receipt showing belt specifications.
## 2.4 Root Cause Analysis

### Verification Using Data/Evidence Collection

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No Insulation within Belt Housing</td>
<td>Jammed blower As-Found Inspection resulted to no insulation are found within belting housing area</td>
<td>Y</td>
</tr>
</tbody>
</table>

- **Greasing Not Executed during PM Works**
- **No Fixed amount of grease used**
- **Grease accumulate inside bearing housing**
- **No Insulation within Bearing compartment**
- **Wrong Belt Spec Used**
- **No Insulation within Belt Housing**
- **Belt not replaced during PM Works**
- **Non-Standard belt tensioning method**

### Unit | As Found Condition during Overhaul
--- | ---
GTB  | No Insulation found within Belting Housing
GTC  | Partial Insulation remains
GTE  | Partial Insulation remains

![Image of No Insulation within Belt Housing Area]
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection and Observation

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Belt not replaced during PM Works</td>
<td>PM Checklist and Work Order Compliance – It was found that PM works is executed timely</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>PM Window</th>
<th>Belt Replacement Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>10/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTC</td>
<td>21/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTD</td>
<td>24/2/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTE</td>
<td>20/2/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTF</td>
<td>27/1/2016</td>
<td>Done</td>
</tr>
<tr>
<td>GTG</td>
<td>16/2/2016</td>
<td>Done</td>
</tr>
</tbody>
</table>

---

- Greasing Not Executed during PM Works
- No Fixed amount of grease used
- Grease accumulate inside bearing housing
- No Insulation within Bearing compartment
- Wrong Belt Spec Used
- No Insulation within Belt Housing
- Belt not replaced during PM Works
- Non-Standard belt tensioning method

**GT 3-Monthly PM Checklist – Belt Replacement Record**
### Root Cause Analysis

**Verification Using Data/Evidence Collection and Observation**

<table>
<thead>
<tr>
<th>No</th>
<th>Root cause</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Non-Standard belt tensioning method</td>
<td>Observation during PM Works showed that the belt tensioning was done manually without using any measuring tool</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Non-Standard belt tensioning method**

<table>
<thead>
<tr>
<th>Unit</th>
<th>PM Window</th>
<th>PIC (Mrot Tech)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTB</td>
<td>10/1/2016</td>
<td>Rashid</td>
</tr>
<tr>
<td>GTC</td>
<td>21/1/2016</td>
<td>Azim</td>
</tr>
<tr>
<td>GTD</td>
<td>24/2/2016</td>
<td>WM Asyrani</td>
</tr>
<tr>
<td>GTE</td>
<td>20/2/2016</td>
<td>Azim</td>
</tr>
<tr>
<td>GTF</td>
<td>27/1/2016</td>
<td>WM Asyrani</td>
</tr>
<tr>
<td>GTG</td>
<td>16/2/2016</td>
<td>Kamaruddin</td>
</tr>
</tbody>
</table>
2.4 Root Cause Analysis
Verification Using Data/Evidence Collection and Observation

Summary of Root Causes:

1. No Insulation within Bearing compartment
2. No Insulation within Belt Housing
3. Grease accumulate inside bearing housing
4. Non-Standard belt tensioning method
2.4 Possible solutions

Possible Solution Analysis for Each Root Causes

Root Cause 1 and 2:
No Insulation within Bearing Compartment and Belt Housing

<table>
<thead>
<tr>
<th>No</th>
<th>Solution</th>
<th>Pro’s</th>
<th>Con’s</th>
<th>Cost</th>
<th>Proposed By</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduce cooling fins within bearing compartment</td>
<td>Allowing heat transfer form hot air within blower casing to atmosphere</td>
<td>Involves design change.</td>
<td>RM 8000.00 per blower</td>
<td>Raja Faeez, Gurcharan</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>Reinstate Insulation as per OEM Standards</td>
<td>Protect internal bearing parts and belt from combustion compartment heat</td>
<td>No standard among all blowers.</td>
<td>RM 3000.00 per Blower</td>
<td>Syukri</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>Replace Insulation Material with new material</td>
<td>Better heat resistance</td>
<td>Current material is adequate, changing to new material requires meticulous justification</td>
<td>RM 5000.00 per Blower</td>
<td>Syukri</td>
<td>N</td>
</tr>
</tbody>
</table>
2.4 Possible solutions
Possible Solution Analysis for Each Root Causes

## Root Cause 3:
Grease accumulate inside bearing housing

<table>
<thead>
<tr>
<th>No</th>
<th>Solution</th>
<th>Pro’s</th>
<th>Con’s</th>
<th>Cost</th>
<th>Proposed By</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use grease with higher heat resistance</td>
<td>Minimal greasing amount/prolong greasing interval</td>
<td>Higher heat resistance may not be suitable for existing bearing (high viscosity)</td>
<td>RM 700 per grease tube</td>
<td>Nuraisyah, Zamri</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>Introduce grease outlet point</td>
<td>• Old grease can flow out of bearing housing during greasing activity, leaving fresh grease inside housing without&lt;br&gt;• Eliminate bearing seal defect recurrence due to over grease</td>
<td>Bearing grease accumulate inside bearing compartment</td>
<td>RM 0.00 (additional task)</td>
<td>Farizuddin Almuhuddin</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>Change Bearing Seal to metal type</td>
<td>Reduced possibility for the seal to detach if overgrease, better heat resistance</td>
<td>May induce more damage into internal part especially bearing inner race and shaft</td>
<td>RM 200</td>
<td>Gurcharan, Raja Faeez</td>
<td>N</td>
</tr>
</tbody>
</table>
## 2.4 Possible solutions

**Possible Solution Analysis for Each Root Causes**

### Root Cause 4:
**Non-Standard belt tensioning method**

<table>
<thead>
<tr>
<th>No</th>
<th>Solution</th>
<th>Pro’s</th>
<th>Con’s</th>
<th>Cost</th>
<th>Proposed By</th>
<th>Result</th>
</tr>
</thead>
</table>
| 1  | Utilize belt tensioning tools | • Standardize belt tensioning works among all units  
• Prevent over tensioning | • Training required to handle tool | RM 6,000.00 | Nuraisyah, Zamri | Y |
| 2  | Change transmission type from belt to chain | • Eliminate possibility of transmission snap  
• Reduce maintenance interval | • Noisy  
• Require design change  
• May incur more damage to other blower parts (motor, pulley) in the event of bearing damage | RM 12,000.00 | Syukri, Raja Faez | N |
| 3  | Change Bearing Seal to metal type | Reduced possibility for the seal to detach if overgrease, better heat resistance | May induce more damage into internal part especially bearing inner race and shaft | RM 200 | Gurcharan, Raja Faeez | N |
2.4 Final Solutions
Summary of Actionable Solution

1. Reinstate Insulation with improved specification and increased thickness
2. Introduce grease outlet point at bearing housing
3. Standardize belt tensioning method using specialized tool
2.4 Final Solutions
Management Approval and Direction

Instruction and Direction by Management (ABT Manager) to lead 88BT Improvement Program Taskforce

From: Ahmad Radzuri B Ismail (GPU/PGB)
Sent: Thursday, February 11, 2016 11:33 AM
To: M Fariduddin Anwar B Mansor (GPU/PGB); Zulfahmie B Jalauddin (GPU/PGB); M Mustaqim B M Noor (GPU/PGB); M Faris M Rusli (GPU/PGB)
Cc: M Nazri B Dollah (GPU/PGB); M Khuyayi B Kuimanirat (GPU/PGB); Rostam B A Gham (GPU/PGB); San’i Ayyraf B M Sofan (GPU/PGB); Zaidi B Salieh (GPU/PGB); Afi B Ismail (GPU/PGB); Zuril Azriz B Adam (GPU/PGB); Shazwani B M Shaha (GPU/PGB); Ahmad Zahirin B M Sharih (GPU/PGB); M Zuhari B Ramly (GPU/PGB); M Suhailin B Bakri (GPU/PGB)
Subject: 88BT Improvement Program

[Internal]
Dear Fariduddin,

You have been appointed to lead overall 88BT Improvement Program.

Please set up meeting to discuss all issues from each discipline and come up with findings, action plan & timeline.
Elec: Zulfahmie
Instr: Mustaqim
MSTAT: Faris
UG Rep: M Zuhari

Target to present to UT Management on findings & way forward by next APM-DE (1st week of March).

Regards,
Ir Ahmad Radzuri Ismail
Manager (Maintenance)
Utilities Kinetech Plant (UK),
Gas Processing and Utilities Division (GPU).

PETRONAS GAS BERHAD
KM105, Jalan Kuantan/Kuala Terengganu, 24300 Kerith, Kemaman, Terengganu Darul Iman, MALAYSIA
T: +60(99) 830 5524
### 2.4 Solution Definition

**Solution Definition #1 using 5W1H**

- **WHAT?**
  - Reinstate insulation with improved specification and increased thickness

- **WHY?**
  - To avoid belt damage due to high temperature

- **WHERE?**
  - Belt housing

- **WHEN?**
  - During blower overhaul

- **WHO?**
  - Maintenance and appointed service provider
  - Check design specification
  - Material selection and measurement at site
  - Appoint service provider
  - Installation of insulation as per OEM
2.4 Solution Implementation

Solution Action Plan #1

Check design specification

Material selection and measurement

Installation of insulation as per OEM

Appoint service provider
2.4 Solution description

Invention Description #1

Ceramic fibre
- Able to withstand high temperature up to 1200 °C.
- Low cost
- Easy to customize to any shape and thickness
2.4 Solution description

**Insulation Material Options**

- **Ceramic fiber**
  - Able to withstand high temperature up to 1200 °C.
  - Low cost
  - Easy to customize to any shape and thickness

- **Cellular glass**
  - Able to withstand high temperature up to 480 °C.
  - Low cost
  - Hard to customize

- **Fiberglass**
  - Able to withstand high temperature up to 540 °C.
  - Low cost
  - Hard to customize
### Solution Definition #2 using 5W1H

| WHAT? | • Introduce grease outlet point at bearing housing |
| WHY?  | • To avoid old grease accumulation in bearing housing |
| WHERE?| • Bearing housing |
| WHEN? | • During blower overhaul |
| WHO?  | • Maintenance and appointed service provider |
| HOW?  | • Check design specification  
• Identifying drill location and measurement  
• Drill outlet point in the bearing housing as per OEM |
2.4 Solution implementation

Solution Action Plan #2

- Check design specification

<table>
<thead>
<tr>
<th>Housing Size</th>
<th>SNL 509</th>
</tr>
</thead>
<tbody>
<tr>
<td>J3 (mm)</td>
<td>10</td>
</tr>
<tr>
<td>Dimensions</td>
<td>N3</td>
</tr>
<tr>
<td>α (degrees)</td>
<td>45</td>
</tr>
</tbody>
</table>

- Identifying drill location and measurement

- Drill outlet point in the bearing housing as per OEM

- Appoint service provider
2.4 Solution description

Invention Description #2

Location of greasing drain point

<table>
<thead>
<tr>
<th>Housing Size</th>
<th>SNL 509</th>
</tr>
</thead>
<tbody>
<tr>
<td>J₃ (mm)</td>
<td>10</td>
</tr>
<tr>
<td>Dimensions N₃</td>
<td>10</td>
</tr>
<tr>
<td>α (degrees)</td>
<td>45</td>
</tr>
</tbody>
</table>
2.4 Solution definition

Solution Definition #3 using 5W1H

WHAT?
- Standardize belt tensioning method using specialized tool

WHY?
- To ensure even tightening during belt tensioning work

WHERE?
- 88BT belt

WHEN?
- During blower overhaul

WHO?
- Maintenance and appointed service provider
- Check belt tensioning requirements
- Site visit and testing
- Appoint service provider with the most suitable tool for the work
- Conduct training for maintenance team

HOW?
2.4 Solution implementation

Solution Action Plan #3

Check belt tensioning requirements

Site visit and testing with potential service providers.

Conduct training for maintenance team

Appoint service provider to source the most suitable tool
2.4 Solution description

_Invention Description #3_

- **Function:** To check the tension of drive belts by means of measuring frequency.
- **Advantages:**
  - Two trouble-free measuring methods: EM: electro magnetic wave; AC: acceleration, integrated
  - Usable also for long center distances by all-time wide frequency range: AC: 1 - 10 Hz; EM: 6 - 600 Hz
  - Easy handling of the measuring head: two red LED points on the belt help to find the correct position
  - For hard accessible belt span: measuring head on flexible goose-neck (EM) or with 250 mm cable (AC)
  - Safe meter-reading by big display; width 43 mm and height 58 mm, illuminated and colored
  - Long running time and environment friendly by high capacity, rechargeable battery (USB) and changeability
  - Chargeable via USB
  - No interference in loud and bright environments
  - Automatic switch-off function
2.5 Expected benefits of the project

Expected Benefits from the Solution

1. Department
   - Elimination of PONC from power import with TNB due to shortage of supply to customers
   - Wastage of budget for unnecessary repairs or overhauls

2. Company
   - Realizing company Transformation Agenda 3ZERO100
   - Inculcate PETRONAS Quality Culture among all staff

3. Nation’s industry
   - Prosperity of Malaysia’s oil and gas industry as pillar of nation’s economy

4. Customers
   - Maintain customers profit margin due to uninterrupted supply of electricity
2.5 Expected benefits of the project

**Expected Benefits from the Solution**

| Internal | • Uninterrupted Planned Shutdown  
|          | • Uninterrupted Proactive and Pre-Planned Maintenance Work  
|          | • Resources may be utilized to other high priority areas |

| External | • Uninterrupted production due to uninterrupted supply  
| Customers | • May focus on maximizing production rather than optimizing loss |
| (PETRONAS Chemicals) | |

| Environment | • Reduced emission due to extra fuel gas burnt during unplanned COGEN startup |

| Community | • Enhance troubleshooting and Networking with Subject Matter Expert within Fraternity |

| Team members | • Enhance troubleshooting and Networking with Subject Matter Expert within Fraternity |
2.6 Uniqueness

Uniqueness of Solution

Solution #1

- Insulation can be reused during future blower overhaul, reducing maintenance cost
- Versatile and multipurpose for spin-off

Solution #2

- Improve bearing and bearing housing life expectancy
- Excellent running condition as new grease is effectively replenished
- Versatile and multipurpose for spin-off

Solution #3

- Versatile, and can be used at all equipment utilizing belt as transmission mode
- User Friendly
Result after implementation

**Checking**

### Blower trip and jammed occurrences

- **Before:** 6
- **Target:** 0
- **After:** 0

### GT Trip occurrences

- **Before:** 3
- **Target:** 0
- **After:** 0

### PONC reduction

- **Before:** RM (1K) 236
- **Target:** RM (1K) 0
- **After:** RM (1K) 0

**TARGET:**

- 88BT Tripped & Jammed
- GT Tripped & Unplanned Shutdown
- PONC
Result after implementation

Checking

TARGET #1: 0 88BT Tripped & Jammed
Result after implementation

Checking

TARGET #2: 0 GT Tripped & Unplanned Shutdown

TARGET

Dec-15  Jan-16  Feb-16  Mar-16  Apr-16  May-16  Jun-16

BEFORE IMPLEMENTATION  IMPLEMENTATION  OBSERVATION  MONITORING
Result after implementation

Checking

TARGET #3: 0 PONC

TARGET

Before Implementation

Implementation

Observation

Monitoring

Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16

RM (1K)

0

20

40

60

80

100

120

140

160

180

200

220
Section 3: Result and Impact
### 3.7 Project cost

*Cost Incurred to complete project*

<table>
<thead>
<tr>
<th>Unit</th>
<th>As Found Condition during Overhaul</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blower Overhaul</td>
<td>RM 48,000.00</td>
</tr>
<tr>
<td></td>
<td>• 3 units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Planned Cost (FY2015/FY2016)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Modification onto bearing</td>
<td>RM 0.00</td>
</tr>
<tr>
<td>3</td>
<td>Reinstate Insulation</td>
<td>RM 9,000.00</td>
</tr>
<tr>
<td></td>
<td>• 3 units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Planned Cost (FY2015/FY2016)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Optibelt TT Frequency Tension Tester (Once-off Purchase, Fixed Asset)</td>
<td>RM 4,500.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>RM 61,500.00</strong></td>
</tr>
</tbody>
</table>
3.7 Impact to department

Finance Department Endorsement

1) DEPARTMENT

Annual PONC Elimination of RM 500,640.00 due to:

- RM 20,000.00 of Fuel Gas cost for each GT unit Startup
- RM 16,000.00 for additional blower overhaul
- RM 200,000.00 of Revenue Loss due to PONC of power import
- RM 200.00 of additional cost for belt replacement works
3.7 Impact to company
Relation of Achievement to PGB Transformation Agenda

✓ 0 Interruption
✓ Increased Product Delivery Reliability
✓ No HSE Incident during site execution
3.7 Impact to company

Relation of Achievement to PETRONAS Quality Principle

PRICE OF NON-CONFORMANCE
3.7 Impact to Nation’s Industry
Impact of Project Towards Company, Industry & Nation

3 NATION’S INDUSTRY

Improvement in productivity, safety and equipment efficiency, aligned with Transformation Agenda

PETRONAS

INDUSTRY

Improvement Upon 88BT Blower Performance and Durability, applicable to all GT Frame 6B Unit using the same cooling mechanism

NATION

Uninterrupted production and supply, thus maintaining nation’s prosperity in Power, Gas & Petrochemical supply chain
3.7 Impact to Customers

Impact of Project to customers at surrounding plant

CUSTOMERS

• Prevented PONC of RM172M to customers as no GT trip that caused total plant shutdown/blackout
3.7 Impact to community

Impact of Project Towards Community

7 COMMUNITY

Enhance Troubleshooting Response among Asset Owner and Maintenance Team

Enhance Networking with Subject matter Expert, Service Provider and Utility Fraternity

Provide Knowledge Sharing platform thus improves Fraternity’s Capability
3.7 Impact to team members

Impact of Project Towards Team Skills and Development

8 TEAM MEMBERS

Promotes Knowledge Sharing among team members and department staff

Enhanced Technical Competency, resultant from Clear Standards and Procedures
3.8: Spin-off
Application of innovation

**FEATURE**

Tension Meter for Condensate Cooler Assembly

**SIGNIFICANCE**

A loose condensate cooler belting assembly will cause belt to snap easily. Uniform tightening will reduce belt snap occurrence.
3.8: Spin-off
Application of innovation

Introduce grease drain line at Grease Trap Device, eliminating the possibility of accidental grease accumulation and clogging issue

**FEATURE**

Grease drain hole at Grease trap device (application at kitchen sink)

**SIGNIFICANCE**

Eliminating the possibility of accidental grease accumulation and clogging issue
3.8: Spin-off
Application of innovation with others

FEATURE
Outdoor, bullet proof and Extreme sportswear

SIGNIFICANCE
Infused heat resistant, fire retardant and bullet penetration padding with ceramic fiber
3.9 Commercialization opportunity

Commercialization

This innovation by PGB team has the potential to improve rotary equipment and bearing maintenance by the introduction of the grease drain hole.

En. Abdul Rahim
Mechanical Engineer
Daya Bumimaju Sdn Bhd

PGB have spot-on identified the need for the grease drain hole which is crucial for the operations and maintenance of their equipment. This effort is very significant and must be replicated by all of our customers.

Mr. Lim Kit Leong
Manager
SKF Malaysia Sdn Bhd

Bubble team have successfully innovated a simple idea into a solid design which have improved our equipment performance tremendously. It has the potential to be commercialized and replicated to other plants.

Tn Hj Fakhirul Anwar Abdullah
General Manager, Utilities
Gas Processing & Utilities Division

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General Manager, Utilities
Gas Processing & Utilities Division
3.9 Commercialization opportunity

Commercialization

Outlet point #1
Outlet point #2
Outlet point #3

Various arrangement testing upon outlet point done with positive results

Drain outlet point can be practically and commercially applied to bearings of equipment with similar application (exposed to high heat)
Eliminate the need of online rectification upon blower trip (rectification during GT Online condition); thus eliminates the major risk of exposing to extreme heat

Reduced burnt Fuel Gas Emission to surrounding via elimination of Unplanned Start/Stop event
Strong profit margin acquired by stakeholders due to uninterrupted power supply and reliable production.
Section 4: Validation
4.11 Validation of achievement

Recognition by Management

FOCUSED RECOGNITION

I want to recognise BUBBLE TEAM for demonstrating:

- Results Matter: [ ]
- Own it: [X]
- Focused Execution: [ ]
- Nurture Trust: [ ]
- Tell Me: [ ]
- Shared Success: [X]

in the following manner:

- Leading a taskforce to resolve issues related to reliability of GT blower 88BT, which involved all disciplines (Mechanical, Electrical, Instrument & Operation).

By doing this, you have positively impacted the following key result(s):

Reliability of COGEN PLANT (3ZERO 100: Zero Interruption)

Given by M Fabir & Norzaini

Date: 10/3/2016

PETRONAS Cultural Beliefs

0

88BT Tripped & Jammed
GT Tripped & Unplanned Shutdown
PONC due to Unplanned GT Startup, Unplanned Blower Overhaul and Revenue Loss
4.11 Validation of achievement
Recognition of Achievement by finance department

MEMORANDUM

To: En. H. Firdaus & KM. Suki
Manager
Management and Financial Accounting
Gas, Infrastructure and Utilities Finance Dept.
Finance (Cost Control)

From: M. Syazni & Naznin Janur
Maintenance
Utility Rent

Reference: UK-87-IKCC-08-2015

Date: 22nd August 2015

ENGAGEMENT OF POTENTIAL SAVING/REVENUE FROM IKE PROJECT: GT 887 MT IMPROVEMENT

Above subject refers to: On behalf of Utility Rent (EKU Bubble Team, IKE). I want to bring to your kind attention the financial calculation below, as part of our project accomplishment.

After several design and maintenance method improvements, we have managed to achieve over RM 35,000 in savings, due to the implementation of the project.

The additional revenue and cost saving are calculated as follows:

- **Additional revenue** = Average number of occurrence per month X cost impact
- **PONC (Power) Impact**
- **Average occurrence per month (Apr-Jun 2015) = 0.12 times/month**
- **Cost impact per occurrence** = RM 200,000
- **Power impact cost impact** = RM 24,000/month

**Additional revenue** = 0.12 X RM 200,000 = RM 24,000/month

**Total Additional Revenue** = RM 24,000/month X 12 months = RM 288,000/year
4.11 Validation of achievement

Recognition of Achievement by customers

Focused Recognition by PETRONAS Chemicals (PCASB) on Longest Hours of Uninterrupted Utility Supply
4.11 Validation of achievement

Team Achievements

Sijil Penghargaan

dengan ini disahkan bahawa

BUBBLE
PETRONAS GAS BERHAD

telah menerima anugerah

EMAS
berempat

KONVENSyen TEAM EXCELLENCE
WILAYAH PANTAI TIMUR 2016
23-24 Ogos 2016
HOTEL PERDANA, KOTA BHARU

[Image of award certificate]

[Image of group photo with award recipients]
Section 5:
Result and Sustainability
5.12 Creation of New SOP
Management Approval of Standardization Efforts

5.12

OE APM MEETING #05/2016
Date: 26th May 2016

MINUTES

<table>
<thead>
<tr>
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<td>M. Abu Bakar Asif (MABA)</td>
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Agenda

1. Site and Safety Tips
2. Opening Remarks
3. Maintenance Performance report
4. TSO highlights
5. Project updates
6. Plant related matters
7. O&M Plant Performance Report

Preparer

1. Fakhrud Arifin B Abdulrah
2. N. Husaini B Haji
3. M. Khuyatul B Kamarulinar
4. M. Fattahuddin Anwar
5. Norul Amira Zaini ABDIN

AGENDA 6:

- O&M Plant Performance Report
  1. Overall, O&M has achieved 100% for TSO reliability and availability, TSO, industrial gas UBD, AEP and plant availability and BURA are in.
  2. O&M team to check and amend items as per below:
     a. To check on CODA reasoning
     b. To include target for the SOG compliance and when EDUBAR report.
  3. O&M team to present on total savings from the previous O&M shutdown.
  4. US to present on May Plant Performance.

- BBT Improvement Program by M. 0. Fattahuddin
  1. Background: Due to failure, cooling fan O&M experienced frequent failure (blower jammed due to bearing damage) and subsequently resulted in O&M shutdown and unplanned safe shutdown for blower replacement.
  2. Root cause identification:
     a. Improper installation and adjustment during BBT overhaul
     b. Non-standardized bearing tightening mechanism (manual method)
     c. OT topping system limitation
  3. Root cause elimination:
     a. Kamusta modified as per original spec
     b. Standardized bearing tightening mechanism
     c. Eliminate System limitation, NaviKai System

Preparer:

- N. Husaini B Haji

Confidential:

- Confidential:

Open:

- Open
5.12

SOP Training & Communication

Attendance of Mechanical Rotating Team during Sharing Session on Updated 88BT Overhaul Checklist and Improvement Activity
5.12 Lessons learnt and best practice communication

Sharing of best practice with All Maintenance Engineers and Planners, involving all Technical background.

Sharing of Lessons Learnt with All Lead Technical Supervisors, gathering more hands-on input for future improvements.
5.12 Evidence of Understanding for Usage of Invention

Improved Maintenance Activity, Using Specific Tool (Belt Tensioning)

Improved and Standardized Servicing, with detailed reporting and proven result (NO Rework)
Evidence of Adoption by Industry Players

5.12

Appointment of Dedicated Service Provider to ensure overhaul is done as per New Checklist
5.12 Evidence of Replication at Other Plant

Action item identified is being replicated for implementation at Utility Gebeng

Close Out Report for 88BT Blower Overhaul in Utility Gebeng, utilizing standardized SOP
5.12 Continuous Monitoring

Daily Monitoring reported in Plant Performance Daily report by Shift Supervisor

Daily ABT Motor Ampere reading trend recorded by ABT Team, showing stable running ampere from April 2016 until September 2016
5.12 Sustained Result

**Checking**

TARGET #1: 0 88BT Tripped & Jammed

- **TARGET**
  - **BEFORE IMPLEMENTATION**
  - **IMPLEMENTATION**
  - **OBSERVATION**
  - **CONTINUOUS MONITORING**
5.12 Sustained Result

Checking

TARGET #2: 0 GT Tripped & Unplanned Shutdown

TARGET

BEFORE IMPLEMENTATION

IMPLEMENTATION

OBSERVATION

CONTINUOUS MONITORING
5.12 Sustained Result

Checking

TARGET #3: 0 PONC

Target

BEFORE IMPLEMENTATION

IMPLEMENTATION

OBSERVATION

CONTINUOUS MONITORING
5.12 Observation of Achievement for the Coming Months

**GT 88BT Amp**

- **Before Implementation**
  - Lower amp limit: 11 amp
  - Upper amp limit: 16 amp

- **After Implementation**
  - Lower amp limit: 11 amp
  - Upper amp limit: 16 amp

More stable 88BT Motor Amp after implementation

**Air Temperature Turbine Compartment**

- **Before Implementation**
  - Max temp: 72degC
  - Min temp: 39degC

- **After Implementation**
  - Max temp: 56degC
  - Min temp: 40degC

Reduced overall ATTC after implementation
Section 6: Lessons Learned
## 6.13 Identification of Lessons Learnt

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<tr>
<th>Challenge</th>
<th>Causes</th>
<th>Way Forward</th>
<th>Action by</th>
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<tr>
<td>Difficulty to choose project that meets ICC requirement</td>
<td>Lack of knowledge regarding ICC</td>
<td>Attend QC Tools training</td>
<td>Team Member Facilitator</td>
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<td>Duration of project – uncertainty</td>
<td>Work Load (Core Job)</td>
<td>Conduct session at a fixed duration, date and venue</td>
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<td>Data Analysis, Filed Work</td>
<td>Work Load (Core Job)</td>
<td>Divide Task among Team Members</td>
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<td>Preparation of slides</td>
<td>Lack of IT Know-how</td>
<td>Attend training, get assistance from IT Team</td>
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6.13 Identification of Lessons Learnt

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<th>Average Assessment</th>
<th>Before</th>
<th>After</th>
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<td>8.6</td>
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<td>9.4</td>
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<td>ICT Skills</td>
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Members Table:

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Scale
- Excellent: 8 – 10
- Good: 5 – 7
- Average: 3 – 4
- Poor: 1 – 2

Legend
- B = Before
- A = After
6.13 Team Members Capability Improvements

- Identify larger Scale initiative for more impactful project
- Team members to attend all available MPC Events, equipping self with adequate skills
- Team members to attach to Green Field Project at other Business, to expand technical knowledge
6.14 Results sharing with stakeholders

Results Sharing

- Monthly alignment meetings
- Info TV at reception area
- Networking Meetings
- Annual engagements - Iftar, Majlis Hari Raya
- Friendly match and games with stakeholders (golf, bowling, futsal etc)
- Customer Site Visit to UK plant
Conclusion

BUBBLE has successfully solved the problem:

GT unit B, C & E 88BT Turbine Compartment Cooling Blower
Frequent Breakdown

And achieved the following milestones:

- Improvement in safety and prevent incidents
- Prevention of Price of Non Conformance to the company
- Overall savings in repair cost
- Develop new knowledge to staff & contractors
- Increased confidence in managing projects among team members
- Baseline and reference for PETRONAS & mechanical fraternity
The End