CONTRACTOR MANAGEMENT
Developing successful partnerships to boost shutdown efficiency

Shutdowns and Turnarounds 2009 Conference

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CONTRACTOR MANAGEMENT
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CONTRACTED SERVICES DELIVERY
PROCESS MANAGEMENT
Developing successful partnerships to boost shutdown efficiency
4.1 General Requirements

**NOTE 1:** Processes needed for the quality management system referred to above include processes for management activities, provision of resources, product realization and measurement, analysis and improvement.

**NOTE 2:** An “outsourced process” is a process that the organization needs for its quality management system and which the organization chooses to have performed by an external party.

**NOTE 3:** Ensuring control over outsourced processes does not absolve the organization of the responsibility of conformity to all customer, statutory and regulatory requirements. The type and extent of control to be applied to the outsourced process may be influenced by factors such as:

a) the potential impact of the outsourced process on the organization’s capability to provide product that conforms to requirements;

b) the degree to which the control for the process is shared;

c) the capability of achieving the necessary control through the application of clause 7.4 (Purchasing).
Problems with Customer Requirements

– Operations (Customer)
  • Safety during shutdown
  • Reliability in operation
  • Maintain budget
  • Maintain schedule
  • Flawless start-up
  • Ramp to full production
  • No rework
  • etc

– Maintenance
  • Records of all jobs
  • Improve job procedures
  • Improve shut process
  • Improve shut planning
  • Improve materials management
  • Improve purchasing
  • etc

What are the priorities; what is the importance of one over the other?
How do you know that you have satisfied the ‘customer requirements’?
How good do you need to be?
Meeting **Safety** Requirements with 3Ts

- **Best of the Best**
- **Excellent**
- **Poor**
- **Irresponsible**
- **Culpable**
- **Manslaughter**

- **TARGET**
- **TOLERANCE**
- **TEST**

- **Not a scratch**
- ‘X’ Bandaids
- ‘X’ MTIs
- ‘X’ LTIs
- ‘X’ Maimed for Life
- ‘X’ Deaths
Meeting **Reliability** Requirements with 3Ts

- **Best of the Best**
- **Excellent**
- **Good**
- **Poor**
- **Irresponsible**
- **Culpable**

**TARGET**

**TOLERANCE**

**TEST**

- No Vital Parts Fail During Mission
- Down 1 shift/yr
- Down 1 hr/mth
- Down 1 shift/mth
- Down 1 shift/wk
- Down 1 wk/mth
ISO 9001 Section 7 – Product Realisation explains the design process requirements.
Creating the Shutdown ‘System’

SHUT OUTCOMES
- Safety during shutdown
- Reliability in operation
- Maintain budget
- Maintain schedule
- Flawless start-up
- Ramp to full production
- No rework
- etc

SHUTDOWN PLANNING
- Worker Competencies
- Contracted Worker Competencies
- Own Worker Competencies
- Job Procedures
- Materials Management
- Project Management
- Etc

PRE-SHUTDOWN
- Preparation
- Handover
- Tasks
- Activities
- Proof-Tests
- Compliance

REQUIREMENTS
- Handover on-time
- All equipment clean
- Safe confined space entry
- etc

DESIGN IN
- Customer Satisfaction

DESIGN PLANNING
- Necessary Processes

DESIGN PRE-SHUTDOWN
- Tasks
- Activities

DESIGN PROOF-TESTS
Cascading Objectives that Tie Directly Back to the Overall Customer Requirements

**Customer Requirements**

- Safety = Zero LTIs
- Operational Reliability = 24mth zero breakdown
- Flawless Start-up = Ramp to 100% capacity

**Shutdown Targets**

- Safety = ??
- Equipment Reliability = ??
- Financial = ??
- Commissioning = ??

**Shutdown Targets for Contractor A**

- Safety = ??
- Equipment Reliability = ??
- Financial = ??
- Commissioning = ??

**Shutdown Targets for Contractor B**

- Safety = ??
- Equipment Reliability = ??
- Financial = ??
- Commissioning = ??

**Shutdown Targets for Contractor C**

- Safety = ??
- Equipment Reliability = ??
- Financial = ??
- Commissioning = ??

**Shutdown Safety Plans**

- Daily pre-start toolbox talks
- Risk analysis of each equipment performed
- Buddy-up for Take-5 pre-job hazard analysis on all work orders

**Equipment Reliability Plans**

- Off-site competency tests or vital skills retaining
- Pumps 3 yrs MTBF
  - New pumps purchased comply with API 682 seal for 3 yrs uninterrupted run
  - Compressors 4 yrs MTBF
  - Detailed and reviewed procedures for vital parts
- Control valves 8 yrs
  - Detailed and reviewed procedures for vital parts

**Project Financial Control Plans**

- Fully estimated schedule
- Contractors on fixed price with incentive reward

**Plant Commissioning Plans**

- Do what commissioning can be done as part of job
- Pre-commissioning test plans developed
- Operations write & review Commissioning Plan
- Operators start-up equip
  - Operators zero check instruments
The Odds are Against Doing it Right!

Only one way to disassemble

40,000+ ways to incorrectly reassemble!

Source: US Federal Aviation Authority, ‘Maintenance Human Factors Presentation’ CD
Machines are Components in Series

Electric motor drive end bearing
Calculating Equipment Reliability

Reliability is the **chance** that an item will last long enough to do its duty

\[ R_{\text{series}} = R_1 \times R_2 \times R_3 \times ... R_n \]

\[ R_{\text{series}} = 0.999 \times 0.999 \times 0.999 \times 0.999 \times 0.999 \times 0.999 \times 0.999 \times 0.999 = (0.999)^9 = 0.993 \]

\[ R_{\text{series}} = 0.999 \times 0.999 \times 0.999 \times 0.999 \times 0.5 \times 0.999 \times 0.5 \times 0.999 \times 0.999 = 0.25 \]

\[ R_{\text{series}} = 0.99 \times 0.99 \times 0.99 \times 0.99 \times 0 \times 0.99 \times 0 \times 0.99 \times 0.99 = 0 \]

“Any poor, all poor”

“Any fails, all fails”
The Table confirms that ‘human element’ error is real and **unavoidable**. We do not perform well when tasks are structured in ways that require care and we perform especially badly under complicated non-routine conditions. Add stress into that mix and you get disaster.

## The Story in Human Error Rate Tables

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simplest possible task</strong></td>
<td><strong>Error rate (per task)</strong></td>
<td><strong>Everyday yardstick</strong></td>
</tr>
<tr>
<td>Fail to respond to annunciator</td>
<td>~5 sigma</td>
<td>0.0001</td>
</tr>
<tr>
<td>Overfill bath</td>
<td>0.0002</td>
<td>0.0001</td>
</tr>
<tr>
<td>Fail to isolate supply (electrical work)</td>
<td>0.0003</td>
<td>0.0005</td>
</tr>
<tr>
<td>Read single alphanumeric wrongly</td>
<td></td>
<td>0.0005</td>
</tr>
<tr>
<td>Read 5-letter word with good resolution wrongly</td>
<td></td>
<td>0.0005</td>
</tr>
<tr>
<td>Select wrong switch (with mimic diagram)</td>
<td></td>
<td>0.0005</td>
</tr>
<tr>
<td>Fail to notice major cross-roads</td>
<td></td>
<td>0.0005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Routine simple task</strong></th>
<th><strong>Error rate (per task)</strong></th>
<th><strong>Everyday yardstick</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Read a checklist or digital display wrongly</td>
<td>~4.5 sigma</td>
<td>0.001</td>
</tr>
<tr>
<td>Set switch (multiposition) wrongly</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Calibrate dial by potentiometer wrongly</td>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td>Check for wrong indicator in an array</td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>Wrongly carry out visual inspection for a defined criterion (e.g. leak)</td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>Fail to correctly replace PCB</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td>Select wrong switch among similar</td>
<td></td>
<td>0.005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Complicated non-routine task</strong></th>
<th><strong>Error rate (per task)</strong></th>
<th><strong>Everyday yardstick</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fail to notice adverse indicator when reaching for wrong switch or item</td>
<td>~4 sigma</td>
<td>0.005</td>
</tr>
<tr>
<td>Fail to recognize incorrect status in roguing inspection</td>
<td>0.006</td>
<td>0.003</td>
</tr>
<tr>
<td>New workshift – fail to check hardware, unless specified</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>General (high stress)</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Fail to notice wrong position of valves</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Fail to act correctly after 1 min in emergency situation</td>
<td></td>
<td>0.03</td>
</tr>
</tbody>
</table>

In failure rate terms the incident rate in a plant is likely to be in the range of $20 \times 10^{-6}$ per h (general human error) to $1 \times 10^{-6}$ per h (safety-related incident).
Reliability Properties for Arrangements

• Series

\[ R_{\text{system}} = R_1 \times R_2 \times R_3 \]

\[ R = 0.95 \times 0.95 = 0.9025 \]

• Parallel

\[ R_{\text{system}} = 1 - [(1 - R_1)(1 - R_2)(1 - R_3)] \]

\[ R = 1 - [(1 - 0.6)(1 - 0.6)] = 0.84 \]
Work is a Series Arrangement of Tasks

Each task can be made more certain if we can include redundancy and turn it into a parallel arrangement?
A Vital Reliability Requirement

Shaft Tolerances for Bearing Adapter Sleeves

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Tolerance h9</th>
<th>Form IT5</th>
<th>over</th>
<th>incl</th>
<th>high</th>
<th>Low</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>18</td>
<td>0</td>
<td>-43</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>30</td>
<td>0</td>
<td>-52</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>50</td>
<td>0</td>
<td>-62</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>80</td>
<td>0</td>
<td>-74</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>120</td>
<td>0</td>
<td>-87</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>180</td>
<td>0</td>
<td>-100</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>250</td>
<td>0</td>
<td>-115</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>315</td>
<td>0</td>
<td>-130</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>315</td>
<td>400</td>
<td>0</td>
<td>-140</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>500</td>
<td>0</td>
<td>-155</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>630</td>
<td>0</td>
<td>-175</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>630</td>
<td>800</td>
<td>0</td>
<td>-200</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>1000</td>
<td>0</td>
<td>-230</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>1250</td>
<td>0</td>
<td>-260</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td></td>
</tr>
</tbody>
</table>

As an example, the measurements for a 150 mm shaft might look like this:

<table>
<thead>
<tr>
<th>Plane</th>
<th>0°</th>
<th>45°</th>
<th>90°</th>
<th>135°</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane A</td>
<td>149.98</td>
<td>149.99</td>
<td>149.98</td>
<td>149.99</td>
<td>149.99</td>
</tr>
<tr>
<td>Plane B</td>
<td>149.97</td>
<td>149.94</td>
<td>149.98</td>
<td>149.95</td>
<td>149.96</td>
</tr>
<tr>
<td>Plane C</td>
<td>149.98</td>
<td>149.98</td>
<td>149.95</td>
<td>149.99</td>
<td>149.98</td>
</tr>
</tbody>
</table>
1) This shaft is not to be used... but what if you didn’t know that until the machine was stripped during a shutdown?

Would your shutdown management process handle the ‘discovery’ and still deliver the customer requirements of ‘Reliability in Operation’ with the machine back in service within the shutdown schedule?

2) This shaft will be used... unless you ensure the problems with the shaft are surely identified so corrective actions can be taken.

How does your shutdown management process guarantee that will always happen?
Is This Okay for Your Machines?
What Risks will You Accept
Competency: The ability to achieve the desired results.
Qualified: The appropriate education, training and skills to perform a job.

They are not the same!

Competence is about what people can deliver ... the demonstrated ability to use knowledge, skills and behaviours to achieve the results required of the role.

#1: It means delivering the required outcomes
#2: It requires meeting set performance standards
#3: It is shown by the ability to perform the whole role in the work environment – a real and demonstrated capability
ISO 9001:2008 on Competency

Clause 6.2.1 “Personnel performing work affecting conformity of product requirements SHALL be competent on the basis of appropriate education, training, skills and experience.”

Clause 6.2.2a “The organisation SHALL determine the necessary competence for personnel performing work affecting conformity to product requirements.”

Clause 6.2.2b “The organisation SHALL where applicable provide training or take other actions to satisfy these needs.”

Clause 6.2.2c “The organisation SHALL ensure that the necessary competence has been achieved.”

Clause 6.2.2d “The organisation SHALL ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives, and.”

Clause 6.2.2e “The organisation SHALL maintain appropriate records of education, training, skills and experience.”
Helping People to Get it Right

**FITTING OF TAPERED BORE SPHERICAL ROLLER BEARINGS**

1. **Leveing bearing and Respect for Vertical Clearance Space**
   - When supplied with housings they will usually be less than clearance space.
   - Use ball nut or block for maximum stiffness.
   - Use ball nut or block for maximum stiffness.
   - Use ball nut or block for maximum stiffness.

2. **Measuring bearing radial clearance with feeler gauges**
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**Consolidated Bearing Company**

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Addressing Skills Requirements

...so you can meeting reliability, safety, flawless start-up, and all the other requirements

<table>
<thead>
<tr>
<th>Customer Requirements</th>
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<tbody>
<tr>
<td>Safety = Zero LTIs</td>
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<td>Flawless Start-up = Ramp to 100% capacity</td>
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- Specify **necessary skills** to do a task to the minimum standard needed to meet Requirements

- For a **vital skill** to successfully meeting Requirements have evidence of ‘skill competence’

- If necessary **parallel those who have adequate skills with ‘equipment competent’** people

- Don’t use those who haven't the **necessary skills** e.g. structural steel installers fitting bearings
CONTRACTED SERVICES DELIVERY PROCESS MANAGEMENT

Developing successful partnerships to boost shutdown efficiency

ISO 9001 Requirements

Specify Your Requirements For the Contractor to Provide

Partnership Converts Requirements to Specific Performance Targets with Minimum Tolerance

Partnership Identifies Standards that Always Deliver Minimum Performance

Verify Contractor’s Processes Always Deliver Minimum Performance

Partnership Supplements with Risk Management Strategies, Skills and Practices

Delivery Improvement Loop

Design Improvement Loop

ISO 9001 Requirements
The Power of a Shared Vision