CARMAN

A Consensus based Approach to Risk MANAGEMENT

Integrating training, procedures and risk assessment
Why don’t people comply with procedures?
Types of non-compliance

Data from the power generation industry indicates that 46% of incidents involve the failure of personnel to follow instructions.

• Unintentional non-compliance (human error—e.g. procedures factually incorrect, operator distracted, so misses a step, procedures ambiguous)

• Intentional non-compliance (‘violations’, ‘circumventions’, ‘bad habits’)

A question of culture

• In general, there is a tendency for organisations to blame the individual rather than look for the systems causes of non-compliances

• Even when the individual deliberately disobeys the procedures, there may be good reasons…..
Definition of Violation/Circumvention

A person deliberately chooses a course of action which is different from the official procedure....

...even though the correct official procedure is known
Absence of credible and agreed working practices: A central cause of Violations

- A true violation can only exist if a credible and agreed standard method of work exists
- Usually major disparities between informal and formal procedures
- Why does ‘Working to Rule’ mean that everything stops?
Some Reasons for Procedures Violations

- Seen as largely to protect the management rather than support the worker.
- Detailed step by step procedures seen as inappropriate and unnecessary for experienced workforce.
- Desire for autonomy and control.
- Procedures seen as impractical.
- Over-complex.
- Reasons for compliance not known.
What is CARMAN?

• A process which develops best practices to control risks based upon both formal and informal knowledge and expertise

• Captures expertise

• Involves active participation of people at the ‘sharp end’ in analysing working practices and identifying risks

• Develops job aids which complement expertise rather than trying to replace it
Phase 1: Develop Best Practice

**Tools**
- Criticality Screening
- Task Analysis
- Error analysis
- Formatting guidelines

**Stages**
- Generate Task Inventory
- Document Current Practice
- Agree Best Practice
- Document Best Practice

**Inputs**
- Operator Input (inc Technical Input)
- Consensus Group (inc Technical Input)

**Reference Best Practice**

Phase 1: Develop Best Practice

**Reasons why**
How the Consensus Process Works

**Task Experts**
People who do the job

**Facilitator**
(System user peer group)

**Training specification**

**Best Practice**
Agreed by all

**Job aids**

**Consensus meeting**

**Facilitators talk to all system users who describe current practice**

**Differences**

**Technical questions**

**Proposed best practice**

**I see a problem**

**Technical experts**

**We do it this way!**

**Practical realities**

**Risks controlled**

**Best Practice**

Agreed by all
How the Reference Best Practice is used

- Training content
- Hazards & Risks
- Step by step procedures
- Job aids (Brown book replacement)
### Reference Best Practice documentation format

<table>
<thead>
<tr>
<th>Task analysis information</th>
<th>Potential hazards / consequences</th>
<th>Training issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of task</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.1.1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start up P3004B after maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PLAN:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do 1 to 3 in order</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When UZA 430 is healthy, Do 4 When P3004B is running, Do 5 If P3004B is Noisy AND OR Vibrates AND OR Leaks, Do 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Pre start up checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do 1.1 to 1.3 in any order</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Ensure vents and drains are closed and blanked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Ensure pump de-spaded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Ensure pump is energised</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who</th>
<th>Hazard</th>
<th>Add. Info.</th>
<th>Generic skills</th>
<th>Specific knowledge</th>
<th>Level of support</th>
</tr>
</thead>
<tbody>
<tr>
<td>FO</td>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FO</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FO</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Task analysis section

<table>
<thead>
<tr>
<th>Task analysis information</th>
<th>Potential hazards / consequences</th>
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</tr>
</thead>
</table>

#### Unit No.

**Definition of task**

U30

3.5.1.1.3

Start up P3004B after maintenance

**PLAN:**

*Do 1 to 3 in order*

*When UZA 430 is healthy, Do 4 When P3004B is running, Do 5 If P3004B is Noisy AND OR Vibrates AND OR Leaks, Do 6*

**Task**

1. Pre start up checks

*Do 1.1 to 1.3 in any order*

- 1.1 Ensure vents and drains are closed and blanked
- 1.2 Ensure pump de-spaded
- 1.3 Ensure pump is energised

- **Rev A**

- **Who**

- **FO**

- **FO**

- **FO**
## Risk and Hazard Information

<table>
<thead>
<tr>
<th>Task analysis information</th>
<th>Potential hazards / consequences</th>
<th>Training issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazard</strong></td>
<td><strong>Description</strong></td>
<td><strong>Additional Information</strong></td>
</tr>
<tr>
<td><strong>Severity Level</strong></td>
<td><strong>Description</strong></td>
<td><strong>Potential consequences</strong></td>
</tr>
<tr>
<td>High, medium or low</td>
<td>e.g. failure to open suction valves will stop pump start up</td>
<td>Quality, personal injury, plant damage, etc.</td>
</tr>
<tr>
<td></td>
<td>Any further explanation (location of equipment, etc.)</td>
<td></td>
</tr>
<tr>
<td>Training &amp; Support Issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task analysis information</strong></td>
<td><strong>Potential hazards / consequences</strong></td>
<td><strong>Training issues (Task and subtask competencies)</strong></td>
</tr>
<tr>
<td><strong>Generic skills required</strong></td>
<td><strong>Specific knowledge required</strong></td>
<td><strong>Level of support required</strong></td>
</tr>
<tr>
<td>Source of skills: Training courses (including refresher training) Degree of experience with the task</td>
<td>–Location of plant items such as pumps –Valve line-ups –Reference data-temperature, pressures</td>
<td>–No written instruction –Job aid –Full procedure</td>
</tr>
</tbody>
</table>
Benefits of Basing both Procedures and Training on the Reference Best Practice document

• Provide a common basis for the development of procedures, job aids and training

• Documents the how and the why of task steps (risk and hazard information)

• Provides information to decide on level of support required (Risks, complexity, frequency of exposure)
Benefits of Basing both Procedures and Training on the Reference Best Practice document

- Reduces resource requirements: same data can be used as basis for procedures, training content and competence assessment
- Prioritisation of training & procedures effort based on level of task risk
- Procedures and job aids can be integrated in training
Define training needs, competency standards & assessment methods

Determine level of online support

Prepare Job Aids

Specify training needs, competency standards & assessment methods

Prepare training programme

Reference Best practice

Job Aids

Implement

Decision Table
## Decision Aid to Determine Level of On-line Support

<table>
<thead>
<tr>
<th>Task Criticality</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Familiarity</td>
<td>Task Complexity</td>
<td>Frequency</td>
<td>Infreq</td>
</tr>
<tr>
<td>Low</td>
<td>NWI</td>
<td>NWI</td>
<td>JA</td>
</tr>
<tr>
<td>Medium</td>
<td>NWI</td>
<td>JA</td>
<td>SBS</td>
</tr>
<tr>
<td>High</td>
<td>JA</td>
<td>JA</td>
<td>SBS</td>
</tr>
</tbody>
</table>

- **No Written Instruction required (NWI)**
- **Job Aid required e.g. checklist/memory aid (JA)**
- **Step by Step instruction required (SBS)**
Examples of job aids

• Checklists indicating sequence of actions
• Graphical representations of geographical information
• Critical reference values
• Reminders and memory aids
Furnace Trip Job Aid

How long is furnace likely to be down?

Temporary unit shut down

More than 1 hour

Attempt to re-light furnace

Commence furnace start-up procedure

Reset 98-DEA-80

Light pilot flame

Did pilot flame light?

Yes

Return Unit to normal

No

Is hot oil temperature above 150°C?

Yes

No

Reduce feed

Column temperature and reflux to manual

Stop hot oil to columns 5 and 7

Bypass column 6 steam raisers

Stop tank 7 and 8 import

Rundown to off grade

Maintain column levels

Reduce column reflux rates

Stop overhead pumps as condenser levels fall
Training and Competency Aspects of CARMAN

• Training programmes must be based on Best Practices developed by the CARMAN Consensus process

• Generic competencies must be supplemented by job specific skills based on documented best practices
  – Implications for multi-skilling
  – Implications for moving employees between jobs
Training and Competency Aspects of CARMAN

- Job specific training is required to ensure that best practices are preferred practices
- Explicit training is essential
- "Sitting with Nellie" perpetuates inadequate practices
- Trainer must ensure that personnel understand why Best Practices are preferable
Phase 3: Maintaining Best Practice

Reference Procedure

Job Aids

Training programme

Implement

Feedback from operational experience

Update
Maintaining best practice through culture change

- CARMAN develops an open culture - people are more willing to discuss problems
- Consensus groups develop collective responsibility for Best Practice - no blame attached to individuals
- Best Practice is therefore frequently updated on the basis of feedback via Consensus groups
Maintaining Best Practice

- Encourage and use feedback from users
- Maintain channels of communication with the sharp end via facilitator
- Reapply CARMAN to generate new practices and supporting job aids & refresher training:
  - plant/equipment changes
  - changes in working practices
  - operational experience
  - regulatory change
Summary of Recommended Strategy

- Start with the most critical tasks (from Task Inventory & Criticality analysis)
- Develop Reference Procedures for the Critical Tasks (depending on resources)
- Develop Job aids, training and competency specifications to control risks
- Proceed to other tasks as resources become available
- Builds a participative safety culture by directly involving personnel in developing best practice
- Develops job aids which complement competency
- Develops standardised and auditable working practices
- Integrates procedures with training and competency
- Facilitates learning lessons by breaking down barriers to communication
- Raises awareness of risks

Summary of CARMAN benefits
Case Study
Large Oil and Chemical Site

• Series of dangerous near misses (flare line nearly ruptured)
• Highlighted compliance to procedures as problem area
**CARMAN Implementation**

- Benchmark survey across whole site
- Two pilot studies
- 7 production implemented CARMAN
  - Facilitator trained on each unit
  - All personnel received awareness training
- Some engineering departments included
- Site Standing Instructions included
Facilitator collects information and develops provisional best practice. Shifts review methods for performing tasks and reviewed by each shift & modified if necessary. Developing Best Practice by Consensus.
## Results of applying CARMAN over a 3 year period

<table>
<thead>
<tr>
<th>Opinions: Procedures are…</th>
<th>Improvement over 3 year period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inaccurate</td>
<td>+4%</td>
</tr>
<tr>
<td>Unworkable</td>
<td>+52%</td>
</tr>
<tr>
<td>Not best practice</td>
<td>+19%</td>
</tr>
<tr>
<td>Out of date</td>
<td>+4%</td>
</tr>
<tr>
<td>Too complex</td>
<td>+21%</td>
</tr>
<tr>
<td>Information inaccessible</td>
<td>+3%</td>
</tr>
<tr>
<td>Identification difficult</td>
<td>+17%</td>
</tr>
<tr>
<td>Location difficult</td>
<td>+8%</td>
</tr>
<tr>
<td>Not aware they exist</td>
<td>+18%</td>
</tr>
<tr>
<td>Don't understand why they are necessary</td>
<td>+52%</td>
</tr>
</tbody>
</table>

Statistically significant changes
Other Benefits

- Plant start-up time substantially reduced
- Reduced effluent emissions
- Improved safety record
- ~500,000 pounds saving in first year
Conclusions

• Culture has changed so that generally tasks are performed as documented
• Company is able to maintain a competent workforce covering existing and new personnel
• Safety issues raised go far beyond procedures, training and competence