Major turnaround in an Olefins Plant: A Process Safety point of view

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Abstract

This work aims to present, in a practical approach, the application of Process Safety basics principles and management elements to the major turnaround of an Olefins Plant in the year 2011. This application can be understood and emphasized in the various stages of a turnaround: planning, pre-turnaround, shutdown and decontamination, maintenance itself, commissioning and startup of the plant.

1. Introduction

The process safety management in an industrial plant is a critical success factor for companies integrated in a global market.

The equipments should have maximized performance and operational runlenght without compromising process safety.

The challenge for excellence performance drives companies to use management tools for resources optimization with increasing in operational and safety performance. Performing planned turnarounds are essential to ensure the process plant mechanical integrity and also a runlenght with safety, reliability and availability required by the company's business plan.

The joint application of PSM principles intended to guarantee a Turnaround with Safety, Quality, Time and Cost appropriate.
2. Turnaround

The turnaround occurred in Braskem Basic Petrochemical Unit of South Brazil (BPU-RS) in an olefins plant, started up in 1999. The ethylene cessation production starts on October 26 and started up in November 26, 2011.

More than 3000 people are directly involved, 400 own people and 2600 contractors.

2.1 Main goals:

- Lost time injuries and Process Safety Accidents: Zero
- Shutdown and plant startup with no environmental contamination and minimum wastewater and solid wastes.
- Shutdown and plant startup with minimum hydrocarbon losses (flaring)

2.2 Planning Structure:

About 40 people formed a multidisciplinary team involved in planning for pre and turnaround actives. The planning activities started 18 months before.

Figure 1. Organization chart of Turnaround planning team

2.3 Equipment scope:

A total of 817 equipments and accessories had maintenance and inspection with more about 20000 tasks performed.
### Table 1. Distribution of Equipments Scope

<table>
<thead>
<tr>
<th>MAIN EQUIPMENTS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL VALVES</td>
<td>366</td>
</tr>
<tr>
<td>PSV/TSV/RV</td>
<td>210</td>
</tr>
<tr>
<td>HEAT EXCHANGERS</td>
<td>114</td>
</tr>
<tr>
<td>VESSELS</td>
<td>59</td>
</tr>
<tr>
<td>TOWERS</td>
<td>20</td>
</tr>
<tr>
<td>PUMPS</td>
<td>20</td>
</tr>
<tr>
<td>REACTORS/ DRYERS</td>
<td>13</td>
</tr>
<tr>
<td>COMPRESSORS</td>
<td>6</td>
</tr>
<tr>
<td>STEAM TURBINES</td>
<td>3</td>
</tr>
<tr>
<td>TANKS</td>
<td>3</td>
</tr>
<tr>
<td>FLARE</td>
<td>1</td>
</tr>
<tr>
<td>FURNACES</td>
<td>1</td>
</tr>
<tr>
<td>COOLING WATER HEADER (Underground)</td>
<td>1</td>
</tr>
<tr>
<td>COOLING TOWER</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>817</strong></td>
</tr>
</tbody>
</table>

#### 3. PSM perspective applied to turnarounds

In the graph below we can see the turnaround process through 8 steps:

**Figure 2. Turnaround steps (Source: Shell Global Solutions)**
As a main application of PSM concepts, we also need to understand the turnaround as a major change.

**Figure 3. Management of Changes perspective applied for Turnaround**

Following are listed the main tools, actions and activities developed according PSM elements.

### 3.1 Risk/ Hazard analysis:

Analyse, minimize and communicate risks is essential for a good result in terms of safety but also business. The application of this concept including the tasks risk analysis, permanent and temporary modifications that will be implemented, simultaneous operations that will occur and also business risk analysis.

#### 3.1.1 Simultaneous operation

In this turnaround, in order to guarantee a higher degree of safety during the pre-turnaround activities, a new procedure for simultaneous operation was created. Simultaneous operations include those with potential to:

- Cause a large release of hazardous material;
- Blocking or making unavailable safety / emergency systems;
- Blocking main access for emergency control;
- Blocking of escape routes.
Figure 4. Flowchart for simultaneous operation authorization

Task

Verification List (Doc 1)

Y

PHA

Define strategy for task execution e control

Simplified Emergency Response Plan (IF required in PHA)

SIMOPS book

Work plan training for workers and operators

N

PTW flow

Task is consider “Simultaneous Operation”?

Work plan

ERP

PHA, ERP

SDD

SIMOP audit
3.2 Contractors:

The process for contractor’s selection is complex and difficult, since it represents a general balance between safety, quality, time and cost. After hiring, training of new employees in the future scenario of the services should begin. This includes among others the risk communication, both in terms of activities that will soon be held and adjacent areas of risk (process safety risk), local safety regulations, emergency plans, strategies, quality control.

Also it’s important to do a specific event, where the main selected contractors show a specific own Safety Plan, sharing the best practices.

3.3 Mechanical Integrity:

Ensure the mechanical integrity of assets is the main objective of a turnaround. To achieve this goal are necessary activities such as internal and external inspection of equipment and pipelines, cleaning the inside of vessels, towers, reactors and heat exchangers, inspection of valves, instruments and electrical and electronic circuits, pressure testing equipment, among others, activities that would require the interruption of the production process.

Normally the Mechanical Integrity premises should include the basis by which related work will be developed, based on the following:
1. Local regulations, Risk Based Inspection (RBI) or other type of analysis driven scope for process units.
2. Time interval based integrity scope for utility systems. No overdue inspections for the anticipated run length
3. No overdue relief valves for the planned run length
4. No piping circuit to exceed retirement thinning by next anticipated shutdown normally using extrapolated corrosion rates.
5. All “temporary repairs” individually evaluated and corrected.

3.4 Permit to work (PTW):

Create safety systems/ tools that match both objectives, achieve HSE goals established and allow an appropriated degree of productivity is always a difficult equation. We have to consider in a turnaround different types of risks:
- Pre turnaround and post turnaround: normally you apply the PTW systematic, but with emphasis in SIMOPS due to works such as scaffold assembly, temporary piping construction etc.
- Turnaround: in order to guarantee an adequate level of productivity, normally other types of PTW must be adopted such as Transfer of ownership, Controlled permit area etc.

For turnaround the big challenge is to proper address the Confined Space work. Simultaneously around 60 confined spaces needs a Work Permit.

3.5 Operating procedures: specifically designed for which steps of a turnaround: Shutdown, decontamination, commissioning and startup of the plant.

During a turnaround, a lot of time is used in planning and detailing the strategy of shut down, decontaminating, commissioning and startup.
Due to peculiar characteristics of each turnaround, operating procedures must be created and / or revisited to achieve specific goals such as: perform shut down and start up with lower losses of products to flare system, minimizing emissions of HC's into the atmosphere (occupational issues).

The review procedures should provide for the temporary alignment used and the temporary operations to be performed to achieve the level of cleanliness expected when the release of the plant (release from operations).

3.6 Pre-startup safety review: creation of specific check-lists to assess process safety in operating systems prior startup.

The pre start up safety review aimed to ensure that the necessary conditions for a safe start up of the plant were met.

We created three checklists, one focusing on operating systems, other for emergency control systems and finally, one with an emphasis on mechanical integrity.

![Figure 5. PSSR process](image)

3.7 Incident investigation: creating workflow for reporting as well as a systematic for incident investigation.

Aligned with PSM requirements, all incidents must be investigated to identify the chain of events and causes so that corrective measures can be developed and implemented. The challenge in turnarounds is to create a system that allows a fast enough treatment of events.

3.8 Emergency Planning and Response:

It is necessary to develop and improve emergency pre-plan due the increasing of people, as well as new incidents scenarios. Specific Crisis Management Plan for the event.

3.9 Audits: compliance audits for planning and maintenance itself.

During the planning period were performed two audits of the preparatory activities for the turnaround, by the company Shell Global Solutions.
We created 04 types of audits: safety tour management, focused technical inspections, internal audit and external audit contracted third party.

5. Results

As a result of application of these principles the Olefins 2 - 2011 Turnaround have, after more than 1,000,000 man-hours, the following results:
- 1 recordable case (Restricted work activity)
- ZERO process safety incidents (PSI definition according CCPS)
- Quality and Budget indicators achieved

6. References