Petrotrin's Initiatives towards Asset Integrity and Reliability Improvements in the Pointe-a-Pierre Refinery

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Abstract: The Refining and Marketing Division of the Petroleum Company of Trinidad and Tobago Limited (Petrotrin) has participated in benchmarking studies over the past ten years and results were consistently ranked poor. There is significant benefit to be derived if the company can close the gap between its performance and that of the leading refineries internationally. Petrotrin had embarked on several individual initiatives aimed at improving operational effectiveness and efficiency, but these initiatives failed to realise the desired objectives. In 2003, the company engaged the services of international consultants to assist in the development and implementation of a Business Improvement Plan for its refinery at Pointe-a-Pierre. This paper outlines the methodology used in the development of the improvement plan in asset integrity and reliability. Specific areas in management systems, tools, techniques, and enablers will be addressed, and the project governance structure is presented to ensure effective implementation of the plan with the maximum transfer of knowledge thus enabling sustainability.

Keywords: Asset integrity, reliability, performance improvement

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Introduction

The Petroleum Company of Trinidad and Tobago (Petrotrin) is the largest crude oil producing and refining company in the country. Its oil refinery located at Point-a-Pierre is the only one in the country. The company has participated in benchmarking studies via its Refining and Marketing Division. The studies were performed over the past ten years and the results were consistently ranked poorly in many areas including the reliability of refinery assets. In order to sustain healthy growth, there has been a pressing need for change. The Division is required to function at a much higher level of performance.

The management and employees have taken many improvement initiatives to arrive at solutions to the problem, but there never seem to be consistency in effort or results. When the market conditions are favourable, the company makes a profit and *vice versa*. Detailed analyses indicate that although the company's intentions are good, there is no consistency in positive results based on the way business is done. The question being asked was "Do we need external help". In 2002, Petrotrin hired an international consulting firm to perform a study of the functioning of the Refining and Marketing Division and to make recommendations for improvement. The company's management accepted these recommendations, and thus contracted the consultants to follow through with the improvement plans.

The consultants developed a strategy which hinged on the creation of Theme Teams, each of which represented the major departments in the Division. A plan was mapped out for each Theme Team outlining goals for the next three to five years. Strategies were presented for the achievement of each goal with the aim of developing processes with the involvement of all concerned. It was expected that the approach would

initiate and sustain change from the foundations of the systems/processes being targeted, and as such should constitute a fundamental character change in the system in the way things are done. The Asset Integrity and Reliability Team was a Theme Team which constituted five sub-teams in the areas of:

1) Defect Elimination and Risk Based Inspection (RBI);
2) Reliability Centered Maintenance (RCM);
3) Tankage and Test and Inspection;
4) Planning, Scheduling and Organisation; and
5) Contracting, Procurement and Warehousing

Each sub-team was headed by an experienced representative from the relative discipline, and was aimed to identify improvement goals, develop strategies, and form unique Action Groups to set up processes to achieve these goals. It was decided that one of the representatives should lead the Theme Team with a consultant. The accomplishment of the tasks derived from the improvement processes had to be performed by the individuals in the system/process concerned under the audit control of the Theme Team members and the assistance of the consultant group. The major advantage perceived is that the Theme Team members (from both Petrotrin and the consultants) were mandated to massage, motivate and audit the system until the goals were achieved. It was expected that the consultant group would bring their internationally proven best practices into the system. The following gives an overview of the strategies developed by the Asset Integrity and Reliability Theme Team and the workings of various sub-teams.

The Defect Elimination and RBI Sub-team

The Defect Elimination and RBI Sub-team is responsible for broadly implementing Root Cause Analysis (RCA) techniques across various disciplines, stressing defect elimination and RBI. It is also responsible for the reliability of the stationary equipment at the facility.

Defect Elimination

This is a structured approach designed to eliminate failures with emphasis on individual expensive incidents and equipment which experienced repeated failures (i.e. bad actors). A defect elimination programme has typically four phases:

1) The first phase. To capture and prioritise events that cause deviation from the production plan (event logging), and then to identify "bad actors" or equipment that fail too frequently or have a history of expensive repairs. This requires the analysis of historical data on an ongoing basis.
2) The second phase. To analyse the problem through the gathering of facts and the formulation of a problem statement, thus preventing work on the wrong problem.
3) The third phase is an effective, structured RCA process.
4) The fourth phase is the development of a solution that meets with set criteria without creating any new or worse problems.

By reviewing the historical information via the SAP computerised maintenance management system of the company, bad actors are first identified. Abnormal failures are identified (by comparison to industry standards), and the equipment concerned are categorized by their criticality to the system in terms of safety and their potential negative

financial impact. These bad actors are investigated with the intent of promptly finding and resolving the root cause of failure, starting with the most expensive ones first and then working from there.

Simplified RBI

Risk Based Inspection is an RCM approach for both static and pressurised equipment, including piping. There are seven key steps involved in this process. These are: 1) asset integrity database; 2) corrosion loop definition; 3) criticality assessment; 4) confidence assessment; 5) inspection/monitoring planning; 6) task execution; and 7) analysis/review of feedback.

Workshops on defect elimination and RBI techniques are performed by international experts from the consulting firm with key individuals from Petrotrin. The intent is to improve the existing systems/processes and transfer critical skills. Sharing of best practices is a feature of the workshops and the process of developing procedures, which reflects both global best practices and Petrotrin's unique culture, are fully optimised. Action Teams are formed to implement the recommendations. Facilitators from the Improvement Team ensure that the work is performed according to the agreed processes.

The RCM Sub-Team

The RCM methodology is predominantly used for optimising maintenance strategies and covers maintenance activities in mechanical, civil, electrical and instrumentation. This methodology is applied to review activities directed to maintain the function of the

equipment. The deliverables of the RCM analysis are cost-effective, proactive maintenance tasks based on actual operating experience and proven best practices. These tasks are selected to optimise the overall reliability, availability and profitability of the process unit by shifting the maintenance effort from a reactive mode to a more proactive mode.

The consultants have conducted a facilitator training session to share the fundamentals of the approach and basic skills. Subsequently, a production unit was selected for the RCM study and a two-week exercise was conducted. The consultant took the lead in the first week while Petrotrin personnel managed the second week of the workshop. This ensures that a 'safety net' is in place while Petrotrin learns these new techniques. Petrotrin then proceeds with the remaining production units utilising this approach with *ad hoc* support from the consultant.

The Tankage, Test and Inspection Sub-Team

The Tankage Section

The Tankage aspect was considered to be the one that had the immediate impact of the Asset Integrity and Reliability (AIR) Team. Adequate storage facilities of crude and products has an immediate impact on flexibility of operation and on revenues. A Tankage questionaire was used to gather information to develop an overview of the inspection and maintenance activities in relation to the cost-effectiveness in the management of the Tankage Assets in the refinery. The aim was to focus on the areas that were expected to gain the highest benefit. In general, the questionnaire covered: tank assets; tank integrity;

integrity management; tank maintenance management; preventive maintenance and inspection; and performance indicators.

A paper-review of the records of the latest inspection was performed in the company. Ultrasonic thickness measurements and visual inspection were the main techniques covered. Plot plans were viewed with the aim of determining the impact of tank location on the system. Besides, an on-site review of these inspection findings was made by Tank experts with the aim of determining the adequacy of the inspection. Risk assessment matrices were used, and recommendations were presented to the cross-section of Petrotrin's supervisory and management staff, who were responsible for the maintenance of the Tankage Asset in the refinery. A summary of the recommendations for improvements for the Tankage section is given in Table 1.

(Insert Table 1 about here)

Table 1. Proposed improvements in the Tankage Section

The Test and Inspection Section

The Test and Inspection (T&I) activities have a major financial impact on the company's performance. Financial losses due to unplanned plant shutdowns have serious consequences and impact heavily on the company's ability to be competitive in this business. Historical information shows that the company does not have a good reputation for completing these tasks on time and within budget. A T&I Workshop was performed with a cross-section of the personnel responsible for T&I activities. Individuals actively involved in the next two T&I's (#8CDU and the FCCU) were selected to participate. An

interactive exercise was carried out to identify core T&I areas and develop the AS-IS process in the management and execution of T&I's with the help of the consultants. Table 2 shows the core areas identified for the section.

(Insert Table 2 about here)

Table 2. Core areas of Testing and Inspection

The 'AS-IS' process was then examined in detail and was compared to the best practices used by the leading refineries internationally. The deficiencies were highlighted and a 'TO-BE' process was created to arrive at an improved system for managing T&I's from the Conceptual to the Post T&I Review stages. The development of the 'TO-BE' process was a very interactive one, and at the end of the exercise it was felt by all that the process was in fact a workable and powerful one.

Based on the recommendations for improvements for the T&I Section, the existing T&I long-term schedules must be published throughout the system three to five years ahead of time. The dates on this schedule must however be strictly adhered to since non-adherence would impact negatively on the total outcome of T&I's. Besides, a strict policy must be adopted with respect to the inclusion of upgrade/revamp type work on a scheduled T&I. The impact on the timing and the general capability of the system to handle such large volumes of work must be assessed in terms of system improvements versus possible production loss due to delays. When a decision is made and the upgrade/revamp work is to be included, then management has to ensure that the guidelines relative to the preparation for inclusion in the T&I are strictly adhered to. The

milestones with respect to the timing of key activities for completion before start of the T&I, derived from the best practices are given in Table 3.

(Insert Table 3 about here)

Table 3. Milestones of the Test and Inspection Section

Work lists must be submitted in the timeline shown. The work, conducted during an outage, must actually require an outage. It was found that a large percentage of the work completed during past T&I's did not actually require an outage to perform. In order to verify this fundamental requirement, various aspects of the work shall be challenged. When this is finalised, the scope is frozen. A process was developed to allow for emergent work after freezing the work list, but this entails the full definition of the new work, reasons for inclusion and impacts on the timing and economics on the system. There must be a cross-functional committee approval process instead of approval by one individual.

Work execution must be performed in a manner which ensures that the requirements of 'Safety, Quality, Productivity and Timeliness' are strictly adhered to. The non-compliance to any aspects of these requirements must be swiftly addressed. Individuals must observe the rules and regulations and must be responsible and accountable for delivering their results. The shortest possible time must be spent on plant shutdown, decontamination and start-up.

The recording of 'AS FOUND' data when equipment is opened for cleaning/repairs is mandatory in the recording of historical information and for future

investigations. The saying that a picture is worth a thousand words is in fact true and the more photographs one can get from the point before cleaning to the installation phase, the better one can investigate failures and find the root causes. Moreover, the close-out procedure is critical to the analysis of the entire process and sets the foundation for continuous improvement in the future. Active participation is required and objective criticisms must be an integral part of the process.

Planning, Scheduling and Organisation Sub-Team

Petrotrin has a history of firefighting in maintenance. This was attributable to the result of 1) overwork due to un-planned jobs; 2) low productivity giving rise to jobs "taking too long to be completed"; 3) jobs remaining too long in the system resulting in them being either lost or forgotten; 4) historical information not being available thus preventing the performance of good failure analyses; and 5) high levels of plant unreliability. The company has realised the need to harness the existing resources and capabilities of the system and inject a level of proven best practices. The intervention of the consultants has provided the Planning, Scheduling and Organisation (PSO) Sub-team with "just the impact we need". Table 4 shows the objectives and strategies developed for the sub-team.

(Insert Table 4 about here)

Table 4. Objectives and strategies of PSO Sub-team

Several targeted areas for immediate improvement are identified. These are 1) The SAP Computerised Maintenance Management system which weaves a thread

throughout the entire maintenance world and success here means an opening to the right path; 2) The shop work management system, where equipment is repaired on a timely basis and with a quality that allows for no rework, high plant reliability and a higher degree of planned maintenance; and 3) The improved decision-making processes and the way work is done in the Asset Teams with the involvement of the core group (the custodian of the standards). The aim is to mature from the reactive firefighting mode to a proactive one of planned and preventive maintenance practices.

Contracting Procurement and Warehousing Sub-Team

The Contracting Procurement and Warehousing (CPW) Sub-team adopted a similar procedure, as that for the PSO Sub-team. The "TO-BE" process was developed by use of a consultant run workshop utilising international best practices. Again, key performance indices (KPIs) play an important part in the improvement of this sub-team. Several areas for improvement were identified. For instance, the management of spare parts for critical equipment has been enhanced using the analysis of risk assessment and the experience on the plant. These could have the greatest negative impact on safety and/or the bottom line. The aim is to ensure that all spares are available when they are needed (starting with the critical spares). An improved policy guide in the materials management system is made to attain a high impact on the bottom line. Moreover, optimisation of the disposal of obsolete warehouse stocks was achieved. A refined contracts system was implemented to allow for the effective selection of contractors and the optimum response time in the request for contract work. This involves the efficient use of SAP and the formulation of the area type contract.

Conclusions

This paper looks at the development and the implementation of a Business Improvement Plan with particular reference to the area of Asset Integrity and Reliability in the Petrotrin refinery. The methodology in the development of this plan was presented with the aim of effective implementation ensuring the maximum transfer of knowledge. One can see that each sub-team has a specific role to play in Asset Integrity and Reliability of the refinery plants. Although the refinery is still operating with very high maintenance costs as compared with the international community, people are committed to take the initiatives to improve. In summary, several main improvement initiatives are identified and actions are carried out in the following aspects:

- Use of documented standards and procedures.
- Use of accepted calibration and maintenance techniques to ensure that equipment and tools are maintained to the required standards.
- Use of established procedures ensuring that the quality standards are maintained by the mandatory use of documentation**.**
- Use of RBI techniques to arrive at the optimum procedure for maintenance in terms of what should be maintained and when.
- Use of preventive maintenance to ensure that maintenance is only performed when necessary and not on a time based frequency developed on subjective thinking

- Conduct of Root Cause of Failure analysis on equipment failures to establish findings and recommendations which must be implemented according to a set priority system.
- Establishment of equipment history record for both maintenance and operating phases, so that life-cycle costing can be fully optimised. This information must be collated in one location or site by the efficient use of the SAP system.
- Establishment of equipment performance trends so that forecasts can be developed to allow for the adequate development and execution of preventive maintenance tasks.

The consultants interactively work with the company in the optimisation of the existing system and processes, and provide guidance and recommendations on improvements. The intervention of the consultants definitely leads the company on to the "Journey towards Excellence".

Bibliography:

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Table 1. Proposed improvements in the Tankage Section

No.	Recommendations for improvements
1)	The Inspection contractor utilised must be API 653 and EEMUA 159 certified, so that compliance against these codes can be performed for an entire tank facility. The existing contractors utilise the API 650 code which covers tank construction only.
2)	Improve the understanding of tank maintenance by training personnel for initial operator maintenance and have training in the API 653 code understanding.
3)	Optimise the preventive maintenance programme to ensure that Tank Settlement monitoring schemes and modern non-destructive testing techniques (e.g. The PEC technique for thickness measurements of annular plates corrosion while in service) are utilised.
4)	Perform risk assessment of all tanks and ensure that all of the code requirements are met. The collation of all data at one location by use of the SAP computerised programme must be an integral part in the management system; and
5)	Conduct an on-site tankage management training workshop in order to understand and implement better practices.

Table 2. Core areas of Testing and Inspection

Core Areas	Descriptions
1) Strategy	Long-term schedule, T&I premises, key performance indices (KPIs), organisational structure, roles and responsibilities, safety, and contracting, etc.
2) Scope	Work list development, scope freeze, scope challenge, and technical information, etc.
3) Preparation	Detailed scope of works with technical packages, maintenance and operational schedules, critical paths, safety, quality, contracting and procurement issues, etc.
4) Execution	Plant shutdown, decontamination, work execution, progress reports, quality and safety controls, start-up procedure, and hand-over, etc.
5) Close-out	Close-out report, recommendations for next T&I, updating equipment and planning data, etc.

Table 3. Milestones of the Test and Inspection Section

Key Milestones	Revamp (months)	Normal (months)
Development of the T&I strategy	20-24	14-18
Scope challenge (work for T&I)	16-18	8-12
Scope freeze	14-16	7-11
Engineering	11-12	6-10
Procurement	10-12	4-6
Contract award	8-10	4-6
Baseline schedule	2	1
Close-out	1-3	1-3

Table 4. Objectives and strategies of PSO Sub-team

Objectives & Strategies	**Descriptions**
Setting of Objectives	• Achieve high impact performance. • Gain high customer satisfaction. • Work smarter and not harder. • Improve plant reliability and availability. • Have a more positive impact on the bottom-line. • Improve the efficiency of the workforce.
Planned Strategies	• Mapping out the existing "AS-IS" process and accurately recording what has been found. • Define the KPIs which exist in the system and record their effectiveness. • Review these KPIs for suitability and for adding value to the system and modify, with the users, to arrive at more applicable ones. • Develop the 'TO-BE' process utilising the applicable sections of the 'AS-IS' and the proven best practices and the skills of the consultants. • Implement this 'TO-BE' process and perform a tight auditing scheme to check for non-compliance. • Investigate areas of non-compliance and then address root cause. Make the necessary recommendations and develop the implementation strategies to gain full compliance.