STANDARDIZED EQUIPMENT RELIABILITY AND INTEGRITY PROCESS TO ACHIEVE WORLD CLASS PERFORMANCE

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Abstract

This paper (part 2) provide a systematic, staged approach to deploy and execute standardized *Equipment Reliability and Integrity Process, Sub-processes and Procedures* that enable operation and maintenance of facilities to sustain reliability, integrity and Incident Free Operation (IFO) at Oil and Gas Company. The Equipment Reliability and Integrity Process (ERIP) procedures are executed in five stages, minimum performance levels must be achieved in one stage prior to moving to the next stage. Procedures are executed in a prescribed order referred to as stages. ERIP is a Base Business initiative designed to arrest the natural rate of production decline. This is brought about through identifying the opportunities and solutions for optimizing reserves management, improving the reliability of facilities, and optimizing the capacity of existing facilities. Performance is first verified by the Business Unit through self assessment then through formal Global Upstream validation. It has been determined through benchmarking studies of competitors, that company can deliver superior returns by effectively managing its asset base and standardizing processes across its operations. Standardization of common processes holds great promise and can help company achieve its objectives. This ERIP is applicable for the company that has more than one subsidiary.

Keywords: Metrics, Standardize, Operational Exellence (OE), Validation Process (VP), Measurement and Verification.

1. Introduction

1.1 Company profile

CVX is a major partner in Indonesia's economy and an active member of the community. Through wholly owned subsidiary PT CPI. PT CPI is the largest producer of Indonesia's crude oil. PT CPI is searching for new oil and natural gas reserves from central Sumatra to offshore East Kalimantan to West Papua. PT CPI continue to innovate with new technologies that are used to sustain and enhance production from existing reservoirs. CVX subsidiary, CVX Geothermal Indonesia, Ltd., helps make CVX one of the world's leading producers of geothermal energy.

The majority of CPI's Sumatran production in 2013 came from fields in the Rokan PSC. Duri, the largest field, has been using steam flooding technology to improve production since 1985 and is one of the world's largest steam flood developments. In 2013, steam injection was deployed in 77 percent of the field. PT CPI continued to implement projects designed to sustain production, increase recovery and improve reliability from existing reservoirs. In producing areas of the Duri Field, 238 production wells and 78 steam-injection and observation wells were drilled in 2013. Development also continued in the northern region of the field. First production from the North Duri Development Area 13 expansion project came in the second half of 2013. The project is expected to ramp up through 2016.

In 2013, 41 production wells were drilled in the Minas Field, and work continued to optimize the waterflood program there. In 2013, PT CPI completed a pilot project that used a chemical injection process to further improve the recovery of light oil in the Minas and surrounding fields. The results of that project are being studied. In 2013, three exploration wells were drilled on the island of Sumatra. One was successful. More exploration and appraisal drilling is planned for 2014.

1.2 Problem formulation

When projects do not address ERIP requirements, an undue burden is placed on the Operations team to close maintenance system gaps. This has a negative impact on the SBU ERIP deployment efforts and the facility reliability. Ensure operational assurance plans incorporate the required Reliability / Integrity studies and lean on qualified contractors to provide quality deliverables aligned with ERIP program. The focus is on Phase 5 operations and work to ensure the project meets the ERIP program requirements.

Since 2005, PT CPI already standardizes the ERIP by following the direction from CVX Corporation. The CVX Upstream Base Business Equipment Reliability & Integrity Process (ERIP) Asset Integrity Network will champion efforts for implementing and sustaining the Asset Integrity requirements for equipment throughout Upstream. The purpose of the ERIP Asset Integrity Network is to ensure the effective and timely development and deployment of standard integrity processes and to foster open communication including sharing ideas, information, opportunities, and best practices that result in improved execution across Upstream.

2. Conceptual Framework

2.1 Theoretical Framework

Standardization means creating uniform performance measurement across various divisions or locations. The expected results are processes that consistently meet their cost and performance objectives using a well-defined practice. Standardization, thus, reduces the risk of failure. Through standardization, individual business units can share expenses, and will benefit from a company-wide business process management (BPM). Corporate-wide development of business processes lowers the total expenses, using economics of scale. A company can establish standards across various divisions and geographies. The three levels of the Enterprise Service Architecture are subject to standardization:

- Strategic positioning, and Strategy
- Business processes
- Information technology.

Standardization of performance measurement intends to improve performance and to give management more control over operational performance. The most popular measure for performance is the cost of executing the process. Although it is no less important, the quality of the results is less often considered. Finally, the impact on other business processes needs to be considered, such as the ability to apply the standard performance measures and, thus, compare a unit's performance with others. Advantages from standardization, beyond direct cost and quality improvements, include:

- The process becomes more reliable; variations in quality shrink,
- Less expenses in development of innovative new practices, and less expenses in the administration of processes,
- Comparing the performance between different units of an organization becomes easier,
- Process standardization is an important prerequisite for the standardization of IT systems.

Qualitative Criteria for Standardization

It is often the business environment – the way the company does business with government bodies, customers, vendors, etc. – that imposes variations in requirements. A typical violation of requirements occurs when a company attempts to squeeze a Make-to-Order operation and a Make-to-Stock operation into one single standard. Make-to-Order and Make-to-Stock are different ways of doing business, and the business processes need to be different. Here is a checklist to detect conditions when business processes should not be standardized without carefully looking into the details:

- Strategy considerations: Different strategic positioning make it difficult to standardize the supporting business processes. Example: One company has a low cost product line and another one targeting the high end. This impacts many business processes in the value chain, and standardization may not be beneficial.

- Business processes: Consider all processes of the extended value chain.
- Information technology. Business process design has a major impact on the configuration of IT.

Quantitative Criteria for Standardization

The costs and benefits of process standardization can be quantified, provided performance metrics are in place. Assume that for a given process there are a number of existing variants. Should a new process variant – the standard – substitute for the existing ones ? The cost and benefit components for standardization are:

- The performance difference between the existing process variants and the new standard process variant: Process performance is quantified in terms of reaching process objectives. Process objectives are derived from the objectives of the respective process chain. In some cases the individual process improves, while other processes in the same value chain suffer. Therefore, the performance difference needs to be measured on the level of the end-toend process,
- Expenses for developing and rolling out the standard process variant,
- Savings that arise from maintaining just one rather than several variants of the same process.

The total of list above represents the benefit from standardization.

2.2 Design of Problem Solving

Performance measurement is a topic that is often discussed but rarely defined. Literally it is the process of quantifying past action, where measurement is the process of quantification and past action determines current performance. Organizations achieve their defined objectives that is, they perform by satisfying their stakeholders' and their own wants and needs with greater efficiency and effectiveness than their competitors. The terms efficiency and effectiveness are used precisely in this context. Effectiveness refers to the extent to which stakeholder requirements are met, while efficiency is a measure of how economically the firm's resources are utilized when providing a given level of stakeholder satisfaction.

This is an important distinction because it not only identifies the two fundamental dimensions of performance, but also highlights the fact that there can be internal as well as external reasons for pursuing specific courses of action. Take, for example, one of the quality-related dimensions of performance - product reliability. In terms of effectiveness, achieving a higher level of product reliability might lead to greater customer satisfaction. In terms of efficiency, it might reduce the costs incurred by the business through decreased field failure and warranty claims. Hence the level of performance a business attains is a function of the efficiency and effectiveness of the actions it has undertaken, and thus performance measurement can be defined as the process of quantifying the efficiency and effectiveness of past action. Once this definition has been established, then a second immediately follows. A performance measure can be defined as a parameter used to quantify the efficiency and/or effectiveness of past action.

A company or business unit may decide, for example, that the level of customer satisfaction with its products and services is a relevant and important performance measure. It is a frequently used business effectiveness measure. However, the aspects of customer satisfaction about which the company or business unit wishes to collect data such as, say, the product in use, its packaging, its on-time delivery, its after-sales service, its value for money, and so on are potential component parts of the measure and are its performance metrics. A performance metric is the definition of the scope, content and component parts of a broadly-based performance measure.

The following metrics will be tracked to confirm that the intent of the Equipment Reliability and Integrity Process is achieved and being sustained.

Metric Name	Intent	Formula for Calculation	Frequency of Data Capture
Major/Critical Rotating Equipment Availability	Measure time major/critical equipment is in a state of being able to perform function	Hours in month – (Scheduled Maintenance + Forced Outage) / Hours in month	Monthly
Major/Critical Rotating Equipment Reliability	Measure time major/critical equipment is in a state of being able to perform function inclusive of Planned/PM downtime. Indicates volume of PM applied relative to level of Availability.	Hours in month – Forced Outage / Hours in month	Monthly
Equipment Lost Production Opportunity	Capture the production loss impact associated with failures and maintenance at the equipment level.	Sum of all production losses (BOEG) planned and unplanned captured on Work Orders closed within the month.	Monthly CMMS Query
Percent PM Compliance	Measure adherence to PM strategies and completion of PM's on schedule.	Number of PM's completed by due date in month / Number of PM's completed in the month	Monthly CMMS Query
Percent Proactive Work	Measure progress towards percentage of work that is scheduled and completed prior to failure vs. reactive work after failure has occurred	Number of closed PM, PdM, and corrective work orders prior to failure at end of month / Total work orders closed in month excluding support & optimization work orders & Shut Down Work orders	Monthly CMMS Query
Percent Break in Work	Measure progress towards scheduled work vs. Unscheduled work	Number of priority 1 & 2 work orders generated in the month / Total number of work orders generated	Monthly CMMS Query
Percent Schedule Compliance	Measure adherence to 7 day Maintenance schedule	Number of Scheduled Work Orders (or WO tasks) completed in month/ Number of Scheduled Work Orders (or WO tasks) in month	Monthly
# Worst Actors Resolved	Document resolution of worst actor corrective actions. Reinforce behavior to resolve worst actors.	Total Worst Actors with all corrective actions implemented	Monthly

Table 1: Metrics

Performance is first verified through self-assessment and then through formal validation. Formal validation of performance may be performed during a scheduled Base Business review or during an independent event referred to as a "peer stage validation". Reviews and ERIP advisor facilitated self-assessments are performed on a scheduled basis as part of the overall Base Business process while peer stage validations are scheduled at the discretion of the BU with consideration for the availability of ERIP Advisors and peers. In either case, validation will be conducted utilizing the standard scoring template. Validation will be conducted utilizing the standard scoring template. An assessment of performance in prior stages will be included in any stage validation or assessment. The following flow chart depicts the steps required for validating performance.

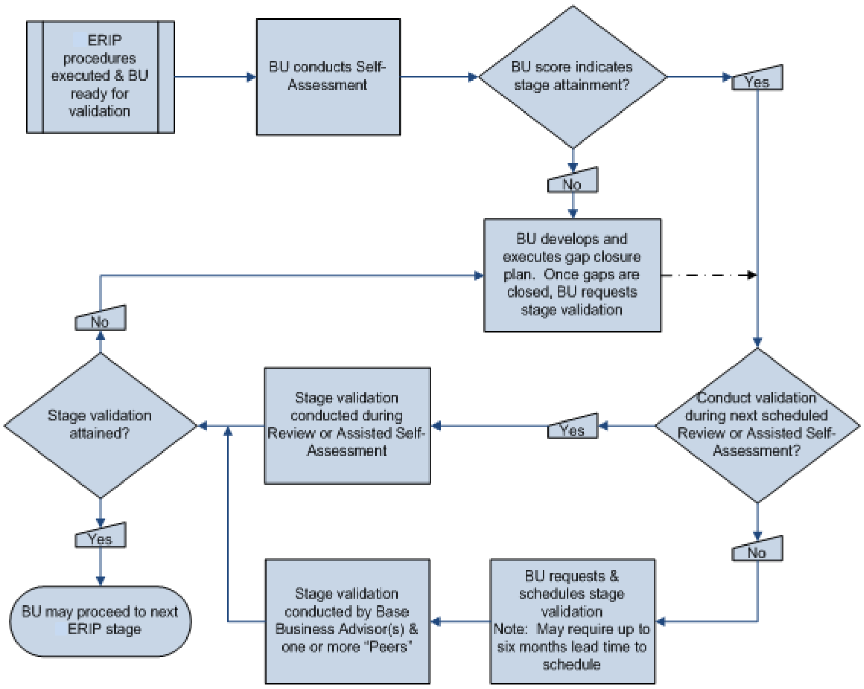

Fig. 1: *Flow Chart for Validating Performance*

3. Methodology

Defining what a performance measurement system constitutes, however, is not as straightforward. At one level, a performance measurement system is simply a set of performance measures which are used to quantify the efficiency and effectiveness of past actions. The shortcoming of this definition is that it ignores the fact that the performance measurement system encompasses a supporting infrastructure. Data have to be acquired, collated, sorted, analyzed and interpreted. If any of these data processing activities do not occur then the measurement process is incomplete and informed decisions and actions cannot subsequently take place. Thus a more complete definition is: a performance measurement system enables informed decisions to be made and actions to be taken because it quantifies the efficiency and effectiveness of past actions through the acquisition, collation, sorting, analysis and interpretation of appropriate data.

Five Base Business Standardized Processes which support improved reliability, production and business performance across the CVX Global Company:

- Well Reliability and Optimization
- Facilities Optimization
- Equipment Reliability and Integrity (ERIP)
- Integrated Production System Optimization
- Lean Sigma

ERIP is organized into sub-processes and procedures. Procedures should be implemented in a prescribed order referred to as stages. There are five stages. Acceptable performance levels must be achieved prior to moving to the next stage. Performance is first verified through self-assessment and then through formal validation. Formal validation of performance may be performed during a scheduled Base Business review or during an independent event referred to as a "peer stage validation". Reviews and ERIP advisor facilitated self-assessments are performed on a scheduled basis as part of the overall Base Business process while peer stage validations are scheduled at the discretion of the BU with consideration for the availability of ERIP Advisors and peers. In either case, validation will be conducted utilizing the standard scoring template. An assessment of performance in prior stages will be included in any stage validation or assessment.

The following Equipment Reliability and Integrity Process roadmap pictorially depicts the staged approach to executing the currently identified procedures.

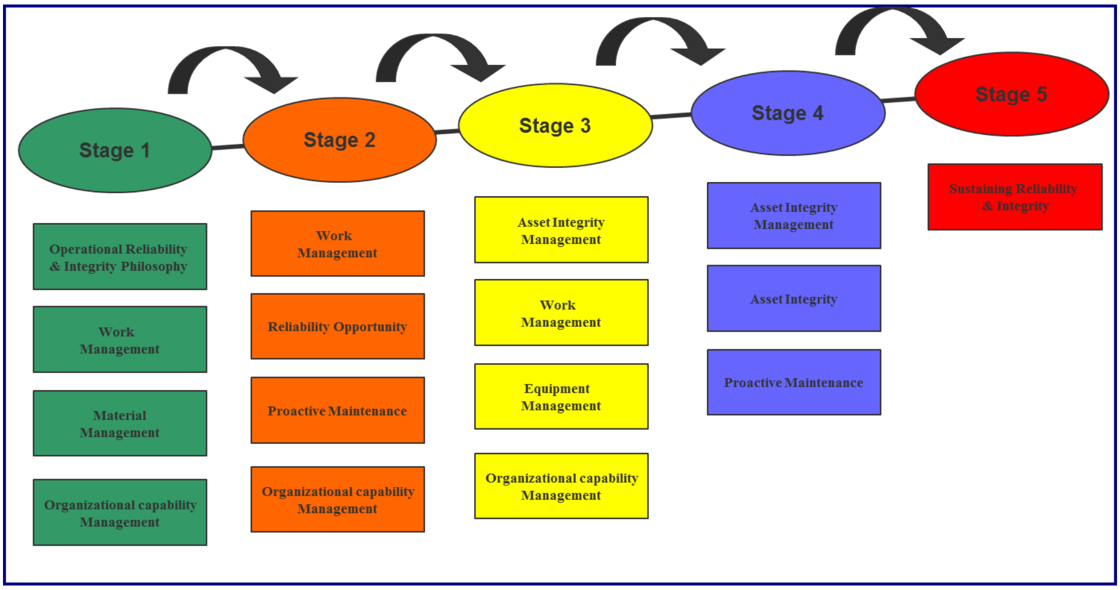

Fig. 2: *Equipment Reliability and Integrity Process, Sub-processes and Procedures*

A brief description of each sub-process and the procedures within the process is provided below:

3.1 Operational Reliability & Integrity Philosophy

A process to ensure Business Unit (BU) personnel understand the reliability and integrity philosophy for operation and maintenance of facilities to sustain or improve reliability and integrity and prevent incidents, including linkage to Operational Excellence (OE).

Intent

The intent of this procedure is to:

- Develop brochure and poster describing the Operational Reliability & Integrity Philosophy.
- Deploy Reliability & Integrity Philosophy and OE to the organization.
- Deploy the following Reliability University courses.

Metrics

No metrics associated with this procedure

Validation Process

- During Review or Peer Validation sessions, interviewees will be questioned about knowledge of Operational Reliability Philosophy and Operational Excellence.
- Validate Reliability & Integrity Philosophy postings in prominent locations

3.2 Work Management

A process is in place to prioritize, plan, schedule and complete necessary maintenance for all structures, equipment and protective devices. Process includes:

- Proactive maintenance of equipment and protective devices through use of surveillance and condition monitoring results.
- A structured project planning approach for facility shut-ins, turnarounds and significant maintenance projects to reduce downtime and ensure efficient use of resources.
- Prioritization, planning and scheduling to manage work on structures, equipment and protective devices.

3.3 Material Management

The Material Management sub process is closely linked to and supports the Work Management procedures and ensures the right level of focus on inventory and spare parts management to enable reliable operations of facilities and equipment. Inventory/Spare Parts Management within ERIP ensures availability of identified spare parts in the correct quantities and quality to support the BU's operational objectives in the following ways:

- Ensure safe operation of all facilities and equipment.
- Minimize environmental risk.
- Improve and optimize reliability and availability of equipment and facilities.
- Maximize maintenance cost-effectiveness.
- Remain consistent with continued economic operation.

Intent

The intent of this procedure is to:

- Develop and implement a set of procedures to manage inventory and spare parts, including consigned inventory.
- Establish Supply Chain Management (SCM) role in reliability improvement.
- Establish reliability focus in the inventory management process through linkage with other Stage 1 ERIP procedures including CMMS – Enterprise Asset Management (EAM) system, Work Order Management, Planning & Scheduling, Equipment Criticality Assessment
- Ensure availability and quality of critical spare parts
- Ensure capture of material costs in equipment history
- Enable effective parts planning and projections in support of planning and scheduling
- Establish common objectives for the Maintenance and Inventory groups
- Establish the foundation for ongoing effective optimization of inventory.

Metrics

- Percent Critical Equipment with equipment parts lists developed.
- Number of critical equipment work orders waiting on parts.
- Lost Production Opportunity –associated with work orders waiting on material.

Validation

- Adequate level of organizational awareness
- Global Enterprise Asset Management model adherence – linkage between Computerized Maintenance Management System (CMMS) and Inventory Management, level of material cost capture in work orders
- Confirm implementation of required procedures, qualitative performance assessment
- Critical Equipment Parts Lists 75 percent completed, evident continued progress
- Parts criticality ratings in system (per level of Equipment Parts Lists completion)
- Metrics accurately reported

3.4 Reliability Organizational Capability

A training program is in place, for Equipment Reliability and Integrity Processes, to ensure that employees have the skills and knowledge to perform their jobs competently, in an incident-free manner and in compliance with all applicable laws, regulations, company policies, and requirements. The program shall include:

- Identification of training needs for leaders, supervisors, and other employees,
- Initial, ongoing and regular refresher training, and
- Documentation and assessment of training effectiveness.

3.5 Reliability Opportunity Analysis

A process is in place to identify and resolve:

- The significant few Facility / Business Unit-wide equipment, work process and/or human reliability opportunities that cause significant incidents or performance gaps, and
- Other repetitive or recurring failures, to improve reliability and reduce maintenance costs.

Typical tools used to identify solutions include Root Cause Analysis (RCA), Reliability Centered Maintenance (RCM) and Lean Sigma.

3.6 Proactive Maintenance

This process is used to identify critical structures, equipment and work processes. Possible failure modes and effects are analyzed and steps are taken to prevent the failure or mitigate the effects.

3.7 Asset Integrity Management

A process is in place for preventing high consequence or low probability events on critical systems and equipment. The process apples to equipment and systems where the likelihood of these events is low but the potential consequences warrant a more rigorous approach to management of these assets. Initial focus in Stage 3 is on establishing management practices and implementing them on fixed equipment and structural systems. The scope of the sub-process is expanded in Stage 4 to include additional systems, lower consequence equipment and developing Upstream standardized methods for Asset Integrity Management.

3.8 Equipment Management

Equipment Management supports many of the other sub processes with focus on standardization and use of maintenance repair procedures. Standardized repair procedures for critical equipment are essential to achieving designed equipment performance and run time.

Intent

The intent of this procedure is to:

- Ensure that an efficient, effective and documented repair procedure is in place for all critical equipment repetitive repairs or where business needs dictate.
- Ensure the collective knowledge of the organization and where applicable the Original Equipment Manufacturer (OEM) recommendations are utilized.
- Ensure the best known methods, precision techniques and right decisions are applied to the repair of the equipment to improve Mean Time Between Failures (MTBF) and Mean time to Repair (MTTR).
- BUs utilizing external shops and other 3rd parties have an obligation to provide repair procedures, repair specifications or at a minimum review the providers repair specification. Repaired material shall be inspected in accordance with specification upon receipt.

3.9 Sustaining Reliability and Integrity

The intent of this procedure is to ensure the long-term sustainability of reliability and integrity

4. Research Finding

The Business Unit (BU) Operational Excellence (OE) Process Sponsor and BU OE Process Advisor shall review and verify that all five parts of the OE process are effective in fulfilling the OE Expectations and OE process purpose. The review shall be performed at least annually.

The Process Sponsor shall verify adherence and identify non-conformance to the Process as designed and documented. As required, the following areas will be reviewed to verify adherence and identify non conformance to the Process:

- Documents and records.
- Demonstrated competence.
- Process leading and lagging metrics.
- Adherence to Roles and Responsibilities.

In addition, the Base Business Team will be responsible for identifying and documenting opportunities for Process improvement through the Review Process as well as the analysis of Base Business metrics and data. The BU OE Process Sponsor and BU OE Process Advisor shall verify adherence and identify nonconformance to the OE process as designed and documented. A documented audit of the OE process shall occur annually and shall be based upon the following:

- Documents and records
- Milestone schedule
- Demonstrated competence at the point of execution
- Process leading and lagging metrics
- Benchmarking data, where applicable

Prioritize OE process performance gaps, nonconformities and unfulfilled OE Expectations which are identified as part of the OE process measurement and verification step. Each BU shall consolidate process improvement opportunities and use them to develop an action plan that is linked with the annual

business plan. The Action Plan will address prioritized Process gaps of this and other Base Business Processes. In some circumstances, improvement activities may extend over several years
Here is sample data of monthly Scorecard and Peer Validation Assessment of Equipment Reliability and Integrity Program (ERIP):

Metrics	AA	BB	CC	DD	EE	Progressing	Meets	Mature
Global Fields Data: C1's	89%	99%	99%	57%		<90%	90 - 95%	>= 95%
Global Fields Data: All Equipment	46%	28%	80%	20%		<90%	90 - 95%	>= 95%
CMMS Data Quality: Work Orders written to Systems	28%	23%	31%	36%		>15%	10 - 15%	<=10%
CMMS Data Quality: Z Codes	6%	5%	5%	9%		>15%	10- 15%	<=10%
CMMS Data Quality: SOM/Z003	187	6	181	0				
CMMS Data Quality: P1 & P2 Work Orders (Break in Schedule)	9%	7%	10%	11%		>20%	15 - 20%	<=15%
CMMS Data Quality: Proactive Work	65%	68%	55%	74%		<79%	80 - 89%	>90%
CMMS Data Quality: Work Orders where LPO is recorded	92%	86%	99%	93%		<70%	70 - 80%	>=80%
Schedule Compliance	88%	86%	88%	88%	88%	<70%	70 - 80%	>=80%
% of Work Completed Outside the Schedule	35%	46%	37%	16%	21%	>25%	20 - 25%	<=20%
CMMS Equipment without Criticality	0,9%	1,3%	0,4%	0,8%		>2%	1% - 2%	<1%
Route completion	97%	92%	96%	99%		<80%	80 - 95%	>=95%
PM Completion	82%	92%	60%	97%	96%	<86%	86-95%	>95%
Annual Schedule Compliance (on quarterly basis)	95%					<75%	> 75%	< 85%
Worst Actors Identification Sessions On Schedule	7	1	2	4		>60 Days Overdue	<60 Days Overdue	On Schedule
Worst Actors with RCA's	100%	100%	100%	100%		<75%	75-85%	>=85
Lean Sigma Reliability Opportunities Identified	20	5	12	1	1	<2	2 - 3	>3
Lean Sigma Reliability Opportunities Identified (accrued financial benefit)	15.55 MM	0.39MM	15.122MM	0.027 MM	0.011MM			
RCM's rate of progress on track for completion target	10	4	3	3		<4	4-5	>=6
RCM Implementation	98%					<80%	80% - 90%	>=90%

Table 2: ERIP Scorecards

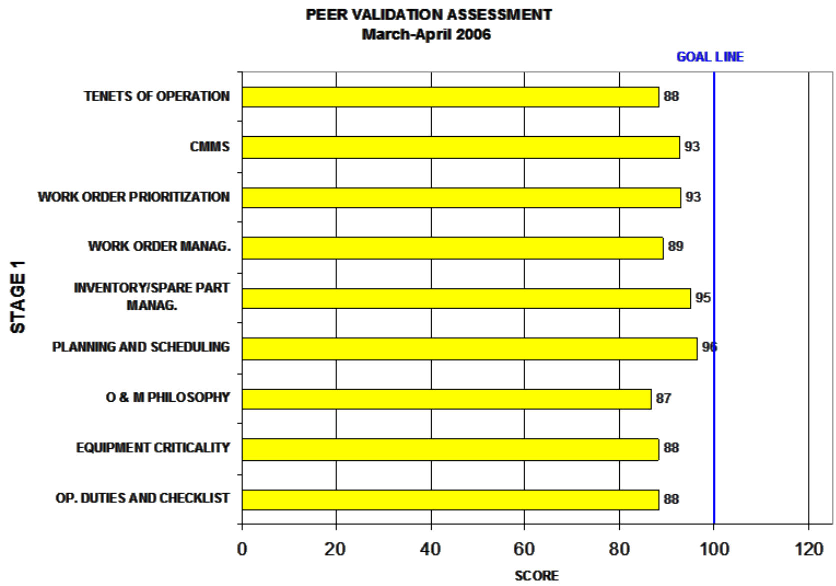

Fig. 3: Peer Validation Assessment

This Process applies to all existing assets under CVX operational control included PT CPI. It is applicable to equipment, work processes and tools. Standardization can greatly improve process performance, lower the costs for process maintenance, and give senior management more control over the operations. Each BU should continue to execute procedures or portions of procedures as appropriate for their specific business needs even if they fall outside the verified level of stage progression. The intent of the staged approach is to build upon the foundation laid in early and prior ERIP stages.

5. Conclusions and Recommendations

Standardization can greatly improve process performance, lower the costs for process maintenance, and give senior management more control over the operations. Standardization need senior management support. Management establishes standardization criteria and ensures that the focus remains on the overall performance improvement. A competence center can manage standardization as a part of its portfolio of process improvement projects. IT standardization follows process standardization, not vice-versa.

6. Acknowledgements

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