IPEC Project Systems *presents…*

Shutdown, Turnaround and Outage Best practice eBook Series

Volume I: Reliability Asset Management Phase
Book I: Business Needs

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IPEC Project Systems and STONAVIGATOR™ provides industry with Shutdown, EPC, Outage and Engineering, Procurement and Construction products, services and training. Visit our website for more information: www.ipecsystems.com.my

Dear Subscriber,

I'm pleased to present to you the first of a series of eBooks related to Shutdowns, Turnarounds and Outages for the manufacturing industry, sharing best practices and lessons-learned to help you improve your STO project performance. Over the years, I've accumulated a wealth of knowledge and experience through lessons-learned across a wide variety of industries on five continents, in numerous countries. During that time, I was fortunate to have worked with some of the best people in the business of Shutdowns, Turnarounds, Outages and Reliability Asset Management, on some of the most challenging projects. Now, my passion for transferring knowledge through blog posts, training materials, instructing, coaching and mentoring has led me to create this series of eBooks to sum up my career achievements and to help you achieve excellence in Shutdown, Turnaround and Outage Performance Management.

In the coming months I'll be working with IPEC Project Systems to publish five volumes—covering each phase of a STO project from Reliability Asset Management to Closure—with 12 monthly issues of best practice and lessons-learned for the critical Functional Areas necessary for STO Performance Management.

In this issue, we'll focus on the Corporate Long Range Business Plan in conjunction with a Reliability Asset Management Program to help you forecast expenditures while maintaining Process Availability to match market demand, legal requirements and resource availability for Shutdowns, Turnarounds and Outages.

I sincerely hope you enjoy this issue as much as I've enjoyed creating it. I believe there are numerous opportunities to improve how we plan and execute STO projects, to improve safety, cost, downtime, quality and worker performance—the key performance measures that we all strive to exceed through sharing of knowledge and learning from others—while establishing High Process Availability and High Equipment Reliability at the Lowest Risk/Cost.

Sincerely,

Ej Lister

Chapter 1: Know Thy Industry, Starting With the Corporate Long Range Business Plan

> *"In the long history of human kind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed."*
>
> *–Charles Darwin*

The purpose of this series is to educate people involved in Shutdowns, Turnarounds and Outages (STO) around the world best practices that it took me decades to learn. It's my hope that you can benefit from my experience in a much shorter time than it took for me to do so.

In this chapter, we'll start with a quick overview of the fundamentals of STO. If you're new to the industry, hopefully this will be a help to you. If you've been in the industry a while, maybe you'll be surprised by some of it being new to you. Truly, collaboration among professionals makes for an unending source of new knowledge and success.

The Basics of the Corporate Long Range Business Plan

The Corporate Long Range Business Plan is a means by which an Organization defines and monitors its future goals, objectives and commitments with respect to Process Availability and Market Demand, while managing risk, cash flow, expenditures and legal obligations.

It sounds like a lot, and, in fact, it is. But we're about to narrow the focus.

The Corporate Long Range Business Plan is a vehicle for integrating, modifying and refreshing significant corporate and operating initiatives. One of the major initiatives—and our focus for the purposes of this book—is the execution of Shutdowns, Turnaround, Outages, Maintenance/Inspection and Capital Projects.

High Performance Organization (HPO)

The Corporate Long Range Business Plan of a High Performance Organization takes into consideration three important principles: Methodology, Technology and People.

We'll be looking at these one at a time to get a better understanding of how each one plays an indispensable role in your success in this industry.

Methodology

A methodology is a solution to a challenge, with specific phases, best practice procedures, techniques and tools. Its foundations lay across a business process where interconnected activities are scheduled, resourced and controlled to produce a service or product when needed.

Your life is already filled with your methodologies. You know the way you like to organize your closet, which route will get you to your destination the quickest, and the best way to cook your favorite dish. You're constantly coming up with tips and tricks to make your daily life easier, even though you probably don't write down a manual for yourself. Still, you stick to what you know works—your process. To manage and control Shutdowns, Turnarounds and Outages a formal process must be followed.

Knowing where you are, where you're going, and how you're going to get there is the key to navigating and controlling all aspects of your STO Project. The challenge of navigating a STO Project is solved with a formal process, which guides its users through complex risk/cost benefit analysis, strategic and detailed planning, and dynamic scheduling to effectively reduce scope, while increasing efficiency (worker wrench-time) to reduce risk, cost and schedule duration.

My time learning the ins and outs of this industry has led me to develop a comprehensive methodology that can be applied to virtually any STO process. Throughout this series, I'll be sharing this methodology with you so that you can also benefit from my experience.

Technology

When working on any large Turnaround, the methodology you use is critical to repeatable success. But think about how much information is created and processed to plan and perform a Shutdown, Turnaround, or Outage. There are thousands of forms, approvals, and regulatory compliances that have to be tracked and managed.

Having a methodology means having a system, but systems constantly evolve—and for good reason! Think about libraries, and those old card catalogues they used to have: filing cabinets filled with thousands of index cards. This was a highly vulnerable system, as even one card out of place could cause untold confusion. Just like libraries, our industry *has* to evolve in how it maintains all of the information associated with STO projects. That is where technology comes in.

Technology is a way to implement your methodology using an automation platform that leverages computing power. Technology ensures that each stakeholder is notified, when appropriate, and that everyone has access to information when they need it and in the form in which they need it.

It tracks each user's actions, all the while ensuring that the methodology and compliance with best practices is followed with rigor. Technology helps everybody know what they are responsible for, when it is due, and what is next on the list. In addition, once the job is planned, technology can help you manage the turnaround, print job tags, ensure that equipment is delivered to the right place, and that every worker knows what to do and what critical parameters to measure (such as torque values), etc.

Technology makes it easy to have complete visibility to the entire lifecycle of each turnaround that is required. It helps you have repeatable success!

People

Shutdowns, Turnarounds and Outages are complex, risky projects requiring skilled and competent people to plan, execute and control. Training, therefore, is vital. Many of the training programs available are focused on Project Management, ERP and CMMS Technology. This is useful but not really sufficient to enable your people to effectively and efficiently navigate STO projects. You must invest in your people to establish a High-performance Culture capable of navigating changing conditions without losing sight of the Corporate Vision.

STOP (Shutdown, Turnaround and Outage Preservation)

STOP—Shutdown, Turnaround and Outage Preservation—establishes High Process Availability through the execution of planned activities meant to reinstate Asset and Process Integrity.

The Spanish phrase *Paradas de Planta* translates to "Stopping the Plant." In other words, production is halted long enough to engage in cleaning, inspecting, repairing and maintaining to ensure a safe and reliable production facility for a predetermined run duration.

STOPs are scheduled as part of the 5-10-20-year business plan, where each STO project cycles through its scheduled frequency to meet the business needs. Several broad-based considerations exist within the Corporate Long Range Business Plan, one of which is the 5-10-20 year plan, annually updated by integrating new STOP projects and their related budget forecasts.

STOP Budgets

Before starting any project, it's important to have a good idea of what it's going to cost you. If you only had $200, you wouldn't hand it to your mechanic and tell him or her to work on your transmission until the money ran out. The repair would not get completed. It's the same principle in STO. You need to be sure you can cover all the work that needs to be done, including a cushion for any unexpected costs.

Budget amounts are derived from AFE/Work Order information identified through the Reliability Asset Management Program. Budget forecasting is developed in accordance to Risk/Cost Benefit Analysis:

- Asset Integrity and Performance
- Process Integrity and Performance

As the cycle progresses, external factors may impact STO and/or the forecasted budget. Projected STO projects are a significant influence on the Corporate Long Range Business Plan. The factors that necessitate STO projects must be carefully evaluated.

Asset Integrity and Performance

The scope and frequency of future STO projects are defined by the Reliability Asset Management Team by way of feedback from their Key Stakeholders: Operations, Maintenance and Technical. These determinations are made by recognizing:

- That sound remaining equipment service life is at least twice as long as the duration until the next STO (based on credible historical and condition-based data).
- That on-stream service durations for equipment should not produce any significant deterioration in Process Availability
- Budget forecasts are set by Corporate Management and the Facility Reliability Asset Management Team. As the 5-10-20 STO project cycle continues, adjustments are made up until the next STO project cut-off date. Contingencies originally applied to the budget forecasts will be affected by:
- Workscope Development by the Reliability Asset Management Team.

Process Integrity and Performance

Other criteria affecting the Corporate Long Range Business Plan through STO projects mainly affect schedule. These factors are:

- Inter-Plant Process Unit Coordination
- Changing Regulatory and Legal Requirements
- Capital Projects

- Multi-Facility Process Unit Outage Coordination
- Short Term Considerations such as Marketing Issues

Potential factors affecting each STO Project are reviewed annually by the Reliability Asset Management Team using Risk/Cost Benefit Analysis.

EMS/WBS

Enterprise Management System (EMS)

The establishment of a Corporate Long Range Business Plan is based on an Enterprise Management System (EMS). The EMS must demonstrate when its production facilities require STOP integration to ensure Process Availability to meet market demand, while meeting regulatory compliance and satisfying shareholders. This is where Inter-Plant Coordination and Multi-Facility Coordination is taken into account, including competitors' facilities. The need to incorporate the STOP Methodology between EMS/WBS and the Corporate Enterprise Project System (EPS) using Risk/Cost Benefit Analysis is essential; e.g., SAP to Primavera™ P6 using STO Technology.

Work Breakdown Structure (WBS)

At the Facility Level of the Corporate EMS, a well-established WBS is essential. All STO projects are established at the EMS Level, with their individual production assets assigned to their appropriate WBS Level to ensure Budget and Expenditure Forecasts (BEF) and Process Availability Targets (PAT). The Corporate Long Range Business Plan must be created to the lowest level of WBS: Production Assets (Equipment Tag + Line Numbers), which correlates to a Cost Centre and its Budget Forecast.

STOP Terminology

Shutdowns

Shutdowns are defined as scheduled or *unscheduled* events executed to ensure Process Integrity, e.g., cleaning, catalyst replacement. Shutdowns may be executed at Work Breakdown Structure Levels: Plant, Area, Unit/Train, System/Sub-system, or Asset (Equipment).

Turnarounds

Turnarounds are scheduled (there is no such thing as an unscheduled Turnaround) events for Asset Integrity compliance, e.g., pressure vessels, safety relief valves, piping. Turnarounds may be executed at Work Breakdown Structure Levels: Plant, Area, or Unit/Train.

Outages

Outages are scheduled or unscheduled events for Maintenance or Project Work that cannot be done on-stream, e.g., overhauls, upgrades. Outages may be executed at Work Breakdown Structure Levels: System/Sub-system, or Asset.

Maintenance

Maintenance refers to the activities performed where no loss of production occurs (Process Availability is not affected). Maintenance activities may be scheduled or unscheduled events.

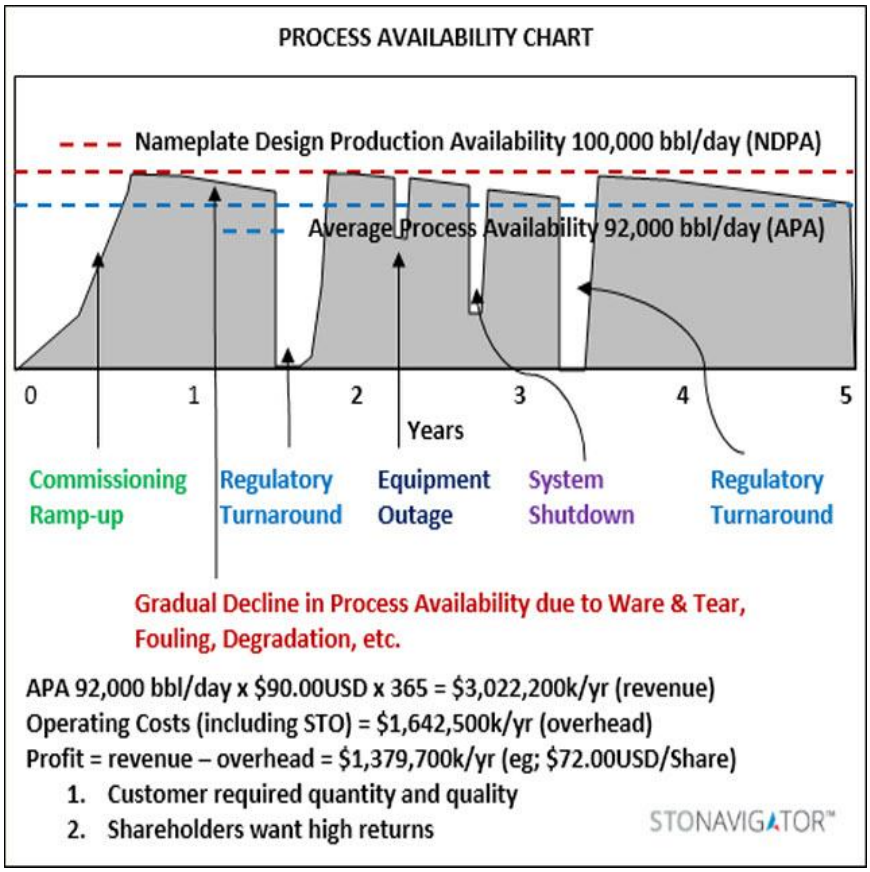
Preservation

Process Availability + Equipment Reliability at the Lowest Risk/Cost.

Establish a Corporate Long Range Business Plan

Once the above information is understood, a Corporation can assemble its Key Stakeholders (Senior Management, Accounting, Commodity Brokers, Marketing, Exploration, Engineering, Reliability Asset Management, Risk Management, Investors and Partners) to establish a Corporate Long Range Business Plan. A formal Methodology is used in conjunction with Technology to schedule the Plan using Risk/Cost Benefit Analysis.

A typical scenario would include SAP (EMS) with STOrm® and Oracle Primavera™ P6 (EPS) integration to represent a 5-10-20 year plan. Strategic Planning is at the heart of this exercise, using known values, while mitigating unknown values to meet the business needs, ensuring compliance to regulatory policies. The final Corporate Long Range Business Plan would calculate a projected Process Availability with Budget Forecasts based on the following illustration.



Now, as we reach the end of chapter one, you should have a basic understanding of STO. As we move on, you'll be learning more about what's involved in successful Shutdown, Turnaround and Outage execution.

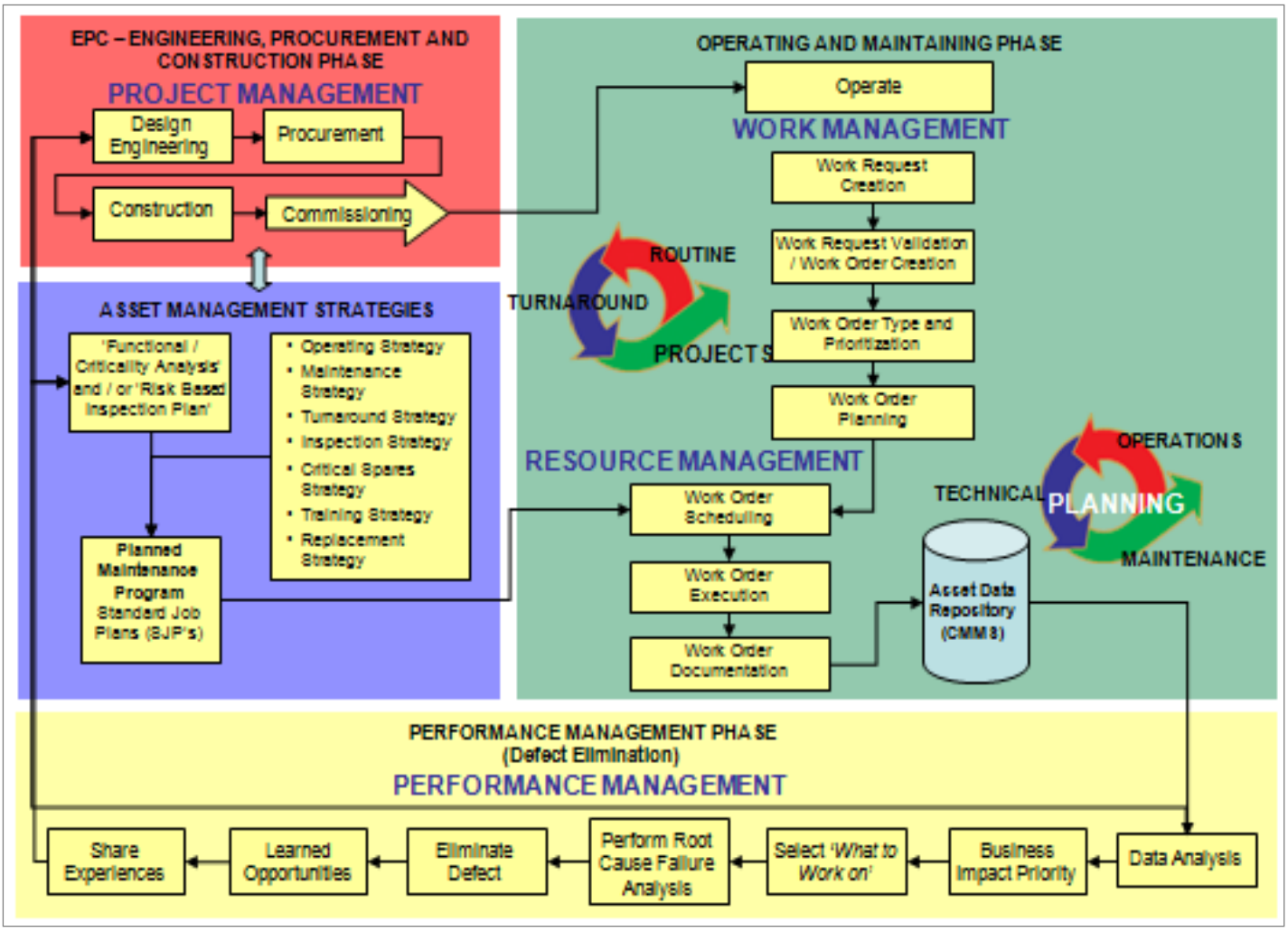
Chapter 2: Understanding Your Reliability Asset Management Program

"Plans are only good intentions unless they immediately degenerate into hard work."
–Peter Drucker

In the Shutdown, Turnaround and Outage industry, our work is never done. With that in mind, the way we plan for and approach work is what makes or breaks our success. In order for STO to be successful, a thorough assessment is required. This is where the Reliability Asset Management Program comes in.

A High Performance Organization controls its expenditures and manages the integrity of its physical production assets using a Reliability Asset Management Program; a model for establishing the scope of work for STOP through Risk/Cost Benefit Analysis.

Through the use of FMEA/CA (Failure Modes & Effects Analysis/Criticality Analysis), RBI (Risk Based Inspection) and Strategic Planning, only work that is necessary to sustain High Process Availability at the Lowest Risk/Cost is scheduled for each STO project.



Reliability Asset Management Team

The Reliability Asset Management Team is made up of Senior Managers from Operations, Maintenance and Technical. Their primary focus is High Process Availability at the Lowest Risk/Cost.

Think about when you approach a yellow light. The risk of speeding up is running the light and getting a ticket (for the sake of argument, let's say there are no cars around, so you don't need to worry about getting into an accident). The risk of stopping is being late for an important meeting. Which risk is more likely to happen? Which one would cost you more?

Weighing questions and options happens in any decision making process. STO is no different. What does make STO different is that the potential risk likelihood is often high, and the potential costs are astronomical.

By following a formal Methodology supported by the best Technology (CMMS/STOrm®) using Risk/Cost Benefit Analysis, the scope of work for each STO project (Routine Maintenance is also managed and controlled in this manner) and the budget forecasts and AFEs are controlled, measured and reported against pre-determined Key Performance Indicators related to 1) Process Availability, 2) Equipment Reliability and 3) Cost (Safety is factored into all Risk/Cost Benefit Analysis decisions).

Process Availability

Process Availability is the length of time that a manufacturing process is capable of producing on-spec product at designed rates (nameplate throughput, e.g., 100k bpd). High Process Availability is the most significant *Business Needs* priority next to Lowest Risk/Cost, given that revenue generation and profits are vital to sustainability and future growth.

The Reliability Asset Management Team's—along with the Corporate Management's—greatest challenge is to operate safety and reliably, with the least amount of waste and expenditures to maintain High Process Availability. This is where Methodology, Technology and People play a vital role. No amount of Technology can make up for a lack of Methodology or competent People. A High Performance Organization recognizes this, ensuring a balance of these three principles.

Given that STO projects are necessary to ensure High Process Availability, the goal is to execute them with the least amount of waste, expenditure and downtime. Only when best practices, along with a formal Methodology supported by the best Technology and the most competent People, can a company be assessed as a High Performance Organization—a first quartile producer, as it were.

Equipment Reliability

Equipment Reliability is the probability that a production asset (equipment) will perform its intended, designed purpose for a pre-determined duration, and that it will be available when required. Equipment Reliability is dependent on standard operating procedures (SOPs) and strategic maintenance procedures. Many of the production assets in a manufacturing facility cannot be maintained during normal operating conditions; hence, STO projects are a necessary Business Need.

Risk/Cost Benefit Analysis

No manufacturing company can meet High Process Availability + High Equipment Reliability at the Lowest Risk/Cost in the absence of Risk/Cost Benefit Analysis. Although many companies generate high revenues

through production, their profit margin is affected by waste, inefficiencies, poor management decisions and a lack of competent people.

Using Risk/Cost Benefit Analysis as an integral part of a formal Methodology ensures each STO project successfully achieves its Key Performance Indicators, resulting in a sustainable and reliable manufacturing process for a defined run duration.

Risk/Cost Benefit Analysis looks at the probability and consequence of performing STO activities in order to establish an effective scope of work and a manageable budget. Through analysis by the Reliability Asset Management Team, assessing probability and consequence from an operational, maintenance and technical view ensures each STO scope of work has been approved without emotion or personal preference. Risk/Cost Benefit Analysis is performed each day, as work is identified by all Stakeholders, including Routine Maintenance.

Work Order Management

All work performed on physical production assets to maintain Asset Integrity or Process Integrity require an AFE (Approval for Expenditure) in the form of a Work Order prior to Planning, Procurement/Contracting Scheduling and Execution. The AFE may first be generated as a Work Request, which is then sent to the Reliability Asset Management Team for approval using Risk/Cost Benefit Analysis. Approved AFE/Work Orders are categorized and scheduled for their appropriate STO project as part of the 5-10-20 year plan, or assigned to Routine Maintenance the work can be done without scheduled downtime (STO).

Approved Work Orders will then be assigned to Planning for cost estimates to assist with establishing a STO budget before Engineering, Procurement/Contracting or Scheduling are involved. It's not unusual for a Facility to have 10 STO projects scheduled on the Corporate Long Range Business Plan over 5-10-20 years, making it possible to forecast expenditures, sales and exploration/feedstock requirements.

The Work Order System (CMMS) must be tied to the corporate EPS in its Scheduling Program through a formal Methodology Management System. This is easily done through the Technology of STOrm™.

Once you have your plan in place, the last big challenge is the age-old question: "It works in theory, but will it work in practice?" It's not enough to have a good plan. You also have to be diligent enough to execute the plan, track your progress, and measure your results. But before any of that can happen, there are several other factors to take into account.

In each of the remaining chapters, we'll be taking a briefer and more focused look at what these factors are, and what is involved in each of them.

Chapter 3: Regulatory and Legal Requirements

"Laws are the sovereigns of sovereigns."

--Louis XIV

In our industry, it's important to remember that your agency is not operating in a void. There are outside forces that must be accounted for, just as there are internal ones. Several sections of the Organization's business are regulated and controlled by external Agencies and Societies as a means of imposing consistent and respectable standards of operation to the industry.

As amendments and revisions are developed by legal and regulatory institutions, facilities are obligated to consider if and how they will be implemented. There are times when additions or changes to regulations, laws and standards may affect turnaround budgets and/or schedules.

Regulatory controls are introduced by:

- Organizations such as OPEC
- Industrial and manufacturing Codes and Standard Societies such as API, ASME, AINSI, ASTM etc.
- Governments as regulations related to Safety, Environment or Social Responsibility
- Controls imposed by Insurance Underwriters
- Collective Agreements negotiated by Union Labour Groups

The considerations for implementation of Regulatory and Legal amendments are normally performed by jurisdictional Stakeholders. When notified of additions, revisions or alterations to existing practices, the following are considered:

- Is the regulation a legal requirement?
- Are Safety, Environment or Social Responsibility affected?
- Will Asset Integrity be impacted?
- What are the effects on Process Integrity?

As new Codes, Laws, Rules or Standards are communicated to the Facility, there is a need to determine their credibility and examine their short and long term impact upon the Organization. A majority of new regulations are introduced to the Stakeholders that manage related disciplines (e.g. Engineering are the first to be made aware of amendments to sections of the ASME Code).

Under normal circumstances, changes are quite subtle and, provided they originate from a credible source and prove a benefit, can be easily introduced. When the impact of proposed amendments is unclear, an evaluation should be performed and the results reviewed with management. The following guidelines are typical for implementation of significant changes.

Regulation pertaining to Legal Requirements

There is seldom any question whether these types of regulations become a commitment. For significant issues, it is still necessary to measure the impact potential. Legal issues requiring technical interpretation are channelled through the Engineering and Reliability Asset Management Team. Evaluations are made by:

- Determining the frequency with which the new regulations would affect the Facility.

- Estimating the cost and benefits derived by accepting the changes.
- Reviewing whether existing regulations can be "grandfathered" over the new requirements.
- Examining whether alternate choices have been offered.
- Providing a phase-in schedule for the new regulations.

Regulations that Impact Safety, Environment and Social Responsibility

SESR (Safety, Environment and Social Responsibility) directives are normally enacted by Government-established organizations such as OSHA (Occupational Safety and Health Act) or EPA (Environmental Protection Agency).

- In determining cost impact, whether it be through material cost or labour, the SESR Manager may collaborate with the Reliability Asset Management Team in order to determine the cost of implementing new regulations.
- Benefits may be determined by researching historical data provided by Insurance Underwriters or Medical Establishments etc.

Regulations Affecting Asset and Process Integrity

Engineering Groups will likely seek support from material/equipment manufacturers or contractors to determine impacts of costs, delivery dates or schedules to satisfy new regulations. Determining benefits of the regulation changes may require consultation with Inspection or Corrosion and Materials Groups.

After reports have been prepared by the Reliability Asset Management Team, they are reviewed with Senior Management. There may be a further need to seek approval from Corporate. Once approved:

- The Reliability Asset Management Team prepares an implementation Plan and Schedule.
- Communicates the implications of the new regulations to all affected Groups.
- Enters the regulation amendments on the Intranet
- If the regulations are Policy related and approved by Corporate, their effect on the Long Range Business Cycle is determined. If need be, the 5-10-20 Corporate Long Range Business Plan, and budgets, is adjusted accordingly.

Making accommodations for new legal and regulatory requirements can seem burdensome at first. But keep in mind that those laws and regulation are put in place for a reason. One of the most important reasons is safety. By following the mandates that come from the agencies mentioned in this chapter, you protect your organization's name and the people associated with it.

Chapter 4: Short Term Considerations

> *"You can design and create, and build the most wonderful place in the world. But it takes people to make the dream a reality."*
>
> *--Walt Disney*

As a STO project date draws nearer, it is important to consider some factors that may impact effective performance, whether it be through disruption of the Plan or effect on the Schedule. There are many stakeholders involved from various departments. True success requires a coordinated effort.

Short Term considerations are thought of generally as those that may result within 6 months of the planned STO project date. The considerations may provide benefits that may be worth pursuing, or looming constraints whose effects must be eliminated or alleviated.

The Reliability Asset Management Team, in conjunction with Stakeholder Managers, must retain a focus on issues related to their day-to-day responsibilities.

- *Supply and Marketing* Groups retain an awareness of Feed or Finished Product issues that must be resolved to prepare for the scheduled Outage, or they may discover opportunities that are financially rewarding.
- *Material Management* continuously monitors any changes to delivery dates of critical items and report any slippage in delivery dates.
- *Execution Management* considers workforce availability and access to outside services.
- *Operations and Process Engineering* monitor significant Process factors that may expedite or delay the Feed-Out Date.
- *Project Management* monitor progress of their Project(s) to assess and confirm STO project readiness.

Short Term considerations are important because accounting for them is part of a successful methodology. Some likely Short Term considerations are as follows:

Supply and Marketing

- Assess the availability of feedstock or any significant price changes as a justification for modifying the Corporate Long Range Plan with respect to the STO Schedule.
- Investigate future inventories or pricing of finished product to take advantage of cost margins and ensure that market demands can be satisfied.
- Investigate any potential disruptions to shipping and transport systems for Feed and Finished Product.

Materials Management

- Confirm delivery dates for critical (long term delivery items) maintenance materials or fabricated equipment items.

Execution Management

- Evaluate the potential for labour disruption based on Collective Bargaining Agreements or Facility issues.

- Investigate possibility of local workforce shortages based on other construction or STO project activities occurring at the same time.
- Confirm availability of specialty resources such as catalyst services contractors.
- Update the availability of special equipment such as high capacity cranes.
- Monitor significant vibration trending information for critical rotating equipment.

Process Operations and Engineering

- Monitor deterioration levels of process systems that have suspected fouling, channelling or mechanical defects to ensure they can meet STO project dates.
- Assess activity levels of catalysts and reaction / filter beds to ensure that the Units can maintain product specifications up to the STO project date.

SESR (Safety, Environment and Social Responsibility)

- Monitor emission levels to ensure satisfactory performance of the Plant.

Capital Projects

Larger construction or revamp Projects require a series of tie-ins to be installed during STO projects.

- The Project Execution Group affirms that Pre-STO project progress will be advanced enough to support STO project activities.

Managing Short Term Considerations

Any potential benefits or constraints that are identified are brought forward to the Turnaround Management Team. The Team may perform Risk/Cost Benefit Analysis to define some contingency actions and support the pursuit of opportunities.

In attempting to justify altering the STO project Plan or Schedule, for sake of financial advantage, the Reliability Asset Management Team should:

- Carefully consider all the implications to implementing proposed changes by accepting feedback from all Stakeholders.
- Consult with Senior Management to confirm their agreement.
- Set a time limit for implementing the change resulting from the Short-Term Consideration.

Likely detrimental issues should be carefully assessed to set contingency or compromise action plans. Various scenarios should be evaluated to address each potential event. Corrective actions may invoke changes to the scope or work for each STO project Schedule or both. After all contingency scenarios have been reviewed,

- Preferred response plans should be recorded.
- Action Plans should be developed with assigned responsibilities as part of the STO Methodology.

Short Term Considerations are part of a good methodology, but it takes the right people to anticipate and handle them.

Chapter 5: Asset Integrity and Performance

> *"Information technology and business are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without talking about the other."*
>
> *--Bill Gates*

Technology has been changing the way we do business since the invention of the wheel. The integrity of these assets is what determines how efficient our business is. As part of the Corporate Long Range Business Plan, one of the most noteworthy pursuits within the Organization is the preoccupation to Asset Integrity and Performance.

Ensuring that Facilities are mechanically reliable enables and sustains the production of quality products while ensuring that costs remain consistently reasonable. The most significant benefit, however, is a Facility environment that is non-detrimental to the worker and surrounding community.

- Awareness to Asset Integrity and Performance must be projected through all levels of the Organization at all times.
- Initiatives directed to optimizing Integrity and Performance must be suitably proactive and consistent so as to minimize preventable failures or production inconsistencies.
- The initiatives must be constantly monitored and evaluated with the view of exposing deficiencies, implementing enhancements and measuring results (Continuous Improvement).

Although Integrity issues are projected strongly by Corporate leaders, mechanisms must exist for support and feedback from all Stakeholders.

Corporate

- Organizational leaders have an obligation to commit reasonable budget amounts to turnarounds, based on previous planned outages and the "Lessons-learned" as a result.
- They must constantly display an awareness to changing Regulatory and Legal requirements.
- Capital expenditures must be reserved to support Facility upgrades and sustain modern initiatives.
- New Standing Instructions, Procedures, Guidelines and Directives must be communicated universally.

Senior Management

Senior Managers best display their allegiance to Facility integrity by a strong commitment of their people to Reliability. No other group displays greater pre-occupation to a sound respect of static equipment than the Technical Group.

Technical

Their typical input to Asset Integrity and Performance is as follows:

- *Plant Engineering* are responsible for familiarization and interpretation of universal Codes and Standards. Any Plant alterations, restorations and replacements involving pressure envelopes, significant temperatures or complex mechanisms are scrutinized by this Group.

- *The Corrosion and Materials Group* keep abreast of testing and monitoring processes, rehabilitative procedures, and material and product advancements as a means of maximizing equipment life. They are a strong support for the Inspection and Plant Engineering Group.
- *Project Engineering* apply their knowledge of construction practices to advancing the performance capability of equipment and designing new installations.
- *The Inspection Group* use available tools, instruments, processes and procedures as a means of documenting and monitoring the condition of serviceability of equipment as well as any restorations and modifications to which it is subjected. By documenting historical data, Inspection are capable of projecting repairs or replacements of equipment or equipment components. They manage Quality Assurance and support and monitor Quality Control of fabrication.

Process Operations and Engineering

- Although Process Integrity is discussed separately from Mechanical Integrity, both Operations and Process Engineering may be engaged in monitoring of equipment mechanical serviceability. In many instances, the manner in which process conditions change, are a reflection of defective equipment or disrupted components.

Maintenance

- The Maintenance organization is committed to sustaining equipment integrity on-stream as well as during turnaround intervals. The Quality Control that they input into their work ensures performance reliability.
- On-stream Maintenance Asset Reliability initiatives revolve around the concept of Reliability Centered Maintenance (RCM), or the process used to determine the maintenance requirements of any physical asset in its operating context. RCM is supported by Preventative Maintenance, Predictive Maintenance and Performance Based Maintenance programs.

SESR (Safety, Environment and Social Responsibility)

- Although a healthy, safe and clean environment is generally the result of an equipment reliable Facility, it should also be realized that the Personal Protective Equipment (PPE) standards promoted by SESR enable the workforce to readily perform their duties in a confident manner.
- In the event of accidents, emergencies or releases to atmosphere, the response programs developed by SESR minimize Facility damage and expedite containment, allowing a swifter return of equipment to a performance reliable standard.

In this industry, the importance of asset integrity can never be overemphasized. Asset integrity and maintenance holds consequences not just for your bottom line, but for your company's reputation, the local environment and, in some cases, entire ecosystems.

Chapter 6: Process Integrity and Performance

"Experience is the teacher of all things."

--Julius Caesar

Processes are determined by experience, as are the changes made to them over time. In addition to ensuring that Facility equipment is structurally reliable, the Organization retains a constant awareness to Process capabilities. After production targets have been negotiated (through agreements such as OPEC), Corporate Long Range Business Plans consider demands of the marketplace for raw and treated or refined product.

The capabilities of each Facility is evaluated with a view of meeting future supply targets. Adjustments are naturally applied for STO projects and contingency downtime windows. In order to meet and constantly improve production targets from each Facility, there is a need to assess and optimize Process Integrity and Performance.

STO project intervals are critical to sustaining and enhancing Process Integrity and Performance. As custodian of the scope of work, the Reliability Asset Management Team is ideally positioned to record proposals and recommendations aimed at throughput optimization. It is critical that the scope of work that Operations submits to the Reliability Asset Management Team is accurately reviewed and scrutinized. Along with Process Engineering, Operations should enlist the services of Inspection, Maintenance, Corrosion and Materials and Plant Engineering where required, in order to provide sound recommendations.

Within the STO Project Plan, typical Process related work scope is as follows:

- Corrective work as a result of equipment fouling, deterioration and failure.
- Modifications aimed at improving control of process streams, avoiding disruptions during on-stream change-outs and reduction of fouling.
- Product enhancements by altering operating conditions such as temperature, pressure and contact mediums.
- Minor and Major Projects aimed at debottlenecking, throughput improvements and Unit operability.
- Measures to meet new product component specifications and emission limits.

Recognizing Process improvement opportunities can take many forms, and it is important to ensure that mechanisms exist to identify, record and investigate various issues. The means by which deficiencies or potential obstacles may be identified are:

- Normal process constraints
- Changes in pollution and emission Standards
- Legislated limits on product components
- Corporate demands for additional products or modified throughputs
- Test runs performed by Technical Services
- On-stream surveys performed by Inspection and Process Engineering
- Testing activity strengths of catalysts and contact mediums
- Performance of Heat Duty and flow tests on various systems
- Routine testing of Emergency Systems

The most typical measures for promoting Process Integrity and Performance by means of STO projects are outlined below together with some relevant considerations.

Corrective Work

- Valve Repair and Replacement

Lists should describe the nature of the defect, specific valve location, and valve size and type. After the final list has been approved by the STO Management Team, it should be reviewed by Plant Engineering to ensure that they fall in line with the most current Engineering Piping Specifications.

- Instrumentation Repairs

These may include the restoration of heater skin temperature thermocouples, analyzers repairs, PLCs, etc.

- Cleaning of Equipment as a Result of Fouling or Plugging

The isolation of equipment specifically for fouling can be costly and should be properly supported. Process Engineering can provide valuable assistance through heat studies and flow calculations. Inspection can supply historical data associated with past outages.

- Correcting Suspected Internal Equipment Damage

Typical disruptions may include thermocouple failures, tower tray damage, deteriorated demisters, leaking exchanger tubes, disturbed grid sections and channeling through catalyst beds.

Process Modifications

- Providing product enhancements by installation of on-stream analyzers or monitors.
- Reduction of fouling by altering flow patterns, removing dead legs or chemical injection.
- Paralleling of systems to allow on-stream swing-over, change-outs and bypasses.
- Equipment Debottlenecking
- Upgrade of reaction mediums such as catalysts, sieves and chemical treatments.
- Equipment design alterations to upgrade or modify product streams.

Capital Projects

- Minor modifications to remove Unit bottlenecks or introduce complimentary process systems.
- Major Projects to enable significant production modifications

Finally, once you move past the Process Assessment and into the actual project itself, be sure to pay attention to anything you notice that did not make it into your assessment but should be included in the next one.

Chapter 7: Inter-Plant Coordination

"Coming together is a beginning; keeping together is progress; working together is success."
--Henry Ford

When contributing to the 5-10-20 year STO budget cycle (as part of the Corporate Long Range Business Plan), each Facility sets its STO project intervals to respect Asset and Process Integrity. In preparing STO project schedules within each Facility, various factors have to be considered in order to optimize the effectiveness of the STO project and minimize the interruptions to performance.

In creating long range Turnaround plans and schedules:

- Plant areas are divided according to their processing relationships.
- Geographic proximity are considered in setting STO project areas.
- Unit areas are combined to keep the scope of the STO project manageable.
- Consideration is given to the seasonality of certain product requirements in establishing calendar dates for turnarounds.
- Segregation of utilities such as electrical power, cooling water, air and steam is evaluated.
- Where possible, standalone Units are overhauled as separate mini STO projects.
- Product storage capabilities allow suitable contingency for STO project downtime window.
- Utility equipment, common to multiple Areas is adequately spared so as to allow its maintenance outside of STO projects.
- After Units are combined to form a STO project area, their sequence for Feed-in and Feed-out is effectively scheduled to develop the STO project downtime window.

In combining Units to form STO project areas, considerations should be prioritized as follows.

<u>What are the scope limitations for facility STO projects?</u>

- The local workforce available for STO projects.
- Availability of qualified supervision.
- Capabilities of outside resources
- The limitations related to logistics.

<u>What dependencies exist between various units?</u>

- Feed / Product dependencies.
- Dependency of Treatment Processes
- Battery Limit Blinds
- Storage Capacities supporting Unit segregation.
- Benefits of Segregation

<u>What are the geographical issues?</u>

- Distance and Travel
- Safe access and egress

- Proximity to hazards from operating Units
- Limitations related to Logistics

What issues have to be resolved regarding supply of utilities?

- Utility Segregation available
- Temporary Services Required / Available

How are unit outages sequences to optimize Performance and downtime?

- Downtime window duration established and applied to schedule

What are the seasonal demand for unit production?

- Calendar periods that are suitable.

After Facility STO project areas are developed and tentative downtime window intervals defined, significant improvement opportunities are identified.

- A Risk/Cost Benefit Analysis is performed on various scenarios.
- Improvements are identified and implemented.
- The results of the improvements are applied to Inter-Plant Coordination
- The 5-10-20 year STO budget cycle is altered accordingly.

Chapter 8: Plant Changes or Plant Expansion Projects

"We shape our buildings; thereafter they shape us."
--Winston Churchill

Plant changes are implemented through the requirement for process modifications, revamp of systems or to meet demands for additional or re-sized throughput capacity. Capital (CAPEX) Projects may be initiated to support Asset Integrity, Process Integrity or productivity demands as defined by the Corporate Long Range Business Plan.

Most significant Capital Projects require interface with STO project intervals in order to perform internal equipment modifications and facilitate the completion of tie-ins. When integrated into STO projects, it normally follows that:

- STO project equipment subjected to CAPEX work is coordinated by the STO Manager during the downtime period.
- CAPEX projects are planned so as to minimize their impact on the STO project downtime window. Maximum loading is applied to Pre and Post STO project phases.
- STO project and CAPEX project Planners interface regularly in order to effectively blend scope of work with labour, equipment and resources.
- Execution Supervision should remain consistent through all STO project Execution Phases.
- Just as labour costs are segregated and controlled between STO project and CAPEX project activities, so should be the costs for equipment rental, store materials and consumables.
- STO Management should form part of the "Punch-listing" and "Turnover" effort on shared Equipment.
- Test pressures for shared equipment should satisfy STO project and CAPEX project requirements.
- CAPEX project Management should participate in STO project audits.

As new CAPEX project initiatives are identified:

- The extent of STO project interaction should be established.
- The Execution responsibility should be determined for all Phases.
- CAPEX project Supervision should be linked to STO project personnel having similar responsibilities.
- CAPEX project Management should participate as a part of the STO Management Team.
- Under normal circumstances, the STO Manager is responsible for coordinating CAPEX project activities during the downtime window. The only exception would be if the CAPEX project scope of work was exceptionally large when compared to that of STO project work, in which case the CAPEX Project Manager would assume control.
- Operations, Safety and Execution Supervision should resolve which construction activities can be performed during STO Pre/Post phases.
- Pre STO project construction progress should be advanced as far as possible.
- Blinding, decontamination, and cleaning should be coordinated to meet CAPEX project and STO project needs.

- For refurbished equipment, Inspection should update changes to critical dimensions in their Production Asset Register (PAR).
- Inspection files should be initiated for new equipment along with initial actual dimensions.
- CAPEX project upgrades should be reflected in determination of equipment inspection intervals.
- Planned Job Packages should be updated to reflect changes to existing equipment.
- If necessary, Operations should update blinding and isolation procedures.

Chapter 9: Multi-Facility Coordination

"If you don't drive your business, you will be driven out of business."
--B.C. Forbes

For larger Organizations, it is not only necessary to effectively schedule Units within a given Facility, but the 5-10-20 year Corporate Long Range Business Plan for STO projects must respect the supply and movement of feedstock and product inventories throughout the supply and marketing landscape.

When considering the coordination of STO projects through a diverse network of Facilities, the following factors should be evaluated:

- Where Units in two or more Facilities have the capability to provide the same product, STO projects are naturally staggered to support acceptance of feed supplies and delivery of product.
- The STO project budget cycle should allow sufficient time to establish contingency inventories prior to execution.
- Maintenance Outages should also be implemented for associated support facilities such as production equipment and storage / transportation networks.
- The coordination of support materials such as regenerated catalysts (stored inventories) must also be considered.
- STO project cycle schedules should support any opportunities for sharing of resources such as supervision, special equipment and maintenance facilities.

In integrating Facility Outages into the Corporate Long Range Business Plan, the most common consideration is the consistent supply of product or product components to customers. The following factors have to be considered:

- What preparations and contingencies are required with suppliers of feedstock?
- Which alternate facilities have the capability to produce similar specification product?
- What supply balance will best satisfy marketing needs with minimal interruption to the Organization?
- What are the geographic constraints to transportation?
- What preparations (at different Facilities) are required to meet product requirements?
- What lead time is required for preparations?
- What maintenance requirements have been identified on supply, transportation and handling systems?
- Are there any opportunities for product swapping with competitors?
- What local opportunities exist for sharing of STO project planning and execution resources? How can the availability of these resources be enhanced through scheduling of turnarounds in the Corporate Long Range Business Plan?