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Turnaround Excellence - Key Success Factors

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Abstract: Turnaround Excellence is more than a state of being… it is a journey. Achieving and sustaining excellence is wholly dependent on a site approach of shared accountability towards Turnaround Excellence and must be a continually improving process. Starting well in advance of "feed out", a long range plan must be established that optimizes business economics with turnaround interval, duration, and upstream/downstream interfaces. This strategic plan provides the framework for the development of a Turnaround Premise, which in essence is a performance contract between the business and the facility (or asset team). The Turnaround Premise defines the key parameters of turnaround success as well as expectations for achieving a state of optimum turnaround readiness.

In this technical paper, a compelling case will be presented for aggressively driving towards an optimum state of readiness by showing industry data relationships between turnaround readiness and outcomes. The paper will describe the preparation practices that are critical for achieving optimal readiness. The paper will also focus particular attention to the key deliverables and interfaces of operations, maintenance and reliability plant personnel in the context of turnaround excellence.

The days of plant turnarounds being considered a natural extension of a facility's maintenance cycle are long gone. Many in the Petrochemical, Refinery and Energy industry today can recall this period, where a turnaround, regardless of complexity or significance was approached merely as a "necessary part" of the assets lifecycle. Minimal time was spent preparing, the concept of optimization was reserved only for business feedstock planning, and the use of tools or technology more sophisticated than a "Big Chief Tablet" schedule and a field supervisors' pocket notebook was unheard of.

During this period, it was commonplace for a turnaround to be considered "successful" so long as there were no lost time safety incidents. Of course, back then success was very loosely defined, schedule and cost targets were not challenging, safety performance was the result of reactive incident management, environmental regulations were drastically less restrictive, and reliability metrics were insignificant and rarely met.

In contrast, today's turnarounds are complex events that require entire plant cooperation and focus and involve work scopes that far exceed the traditional "major maintenance" era. Today's turnaround work scopes are often dominated by safety, environmental and reliability improvements, plant expansions and unit debottlenecks.

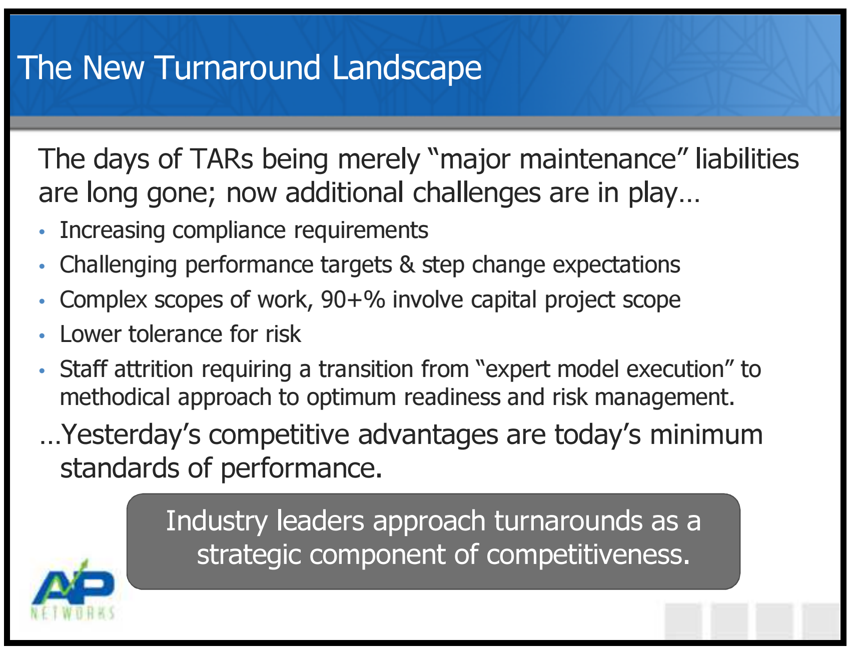

Figure 1

In addition to best-in-class cost and schedule targets, today's turnarounds are exposed to extremely challenging safety, environmental, operability, quality and even community affairs targets. Present day turnarounds are expected to deliver step change performance with each cycle. In order to endure the "*natural selection*" phenomenon, effectively adapting to external influences and continuously improving are the difference between thriving business margins and desperate survival.

Our industry is constantly responding to regulatory pressures, restrictions and constraints. These pressures combined with lower risk tolerance have transformed yesterday's competitive advantages into today's minimum performance standards. In order to satisfy the present day business environment of optimistic targets and single digit margins, turnarounds are a necessary and integral component of the short and long range business planning process. In short… business viability and manufacturing competitiveness is much defined by the ability to predictably deliver superior turnaround performance. As such, industry leaders approach turnarounds as a strategic component of competitiveness.

The industry's turnaround performance statistics show that there is still significant improvement required to achieve predictably competitive turnaround results. In particular:

- 82% of turnarounds do not satisfy all performance expectations; and
- 1 in 4 turnarounds significantly under-perform in more than one success criteria dimension; and are deemed a failure (or "train wreck").

Referring to Figure 2, the average high complexity turnaround exceeds cost and schedule targets by more than 20% with a range of predictability that is +/- 25-40% around the mean.

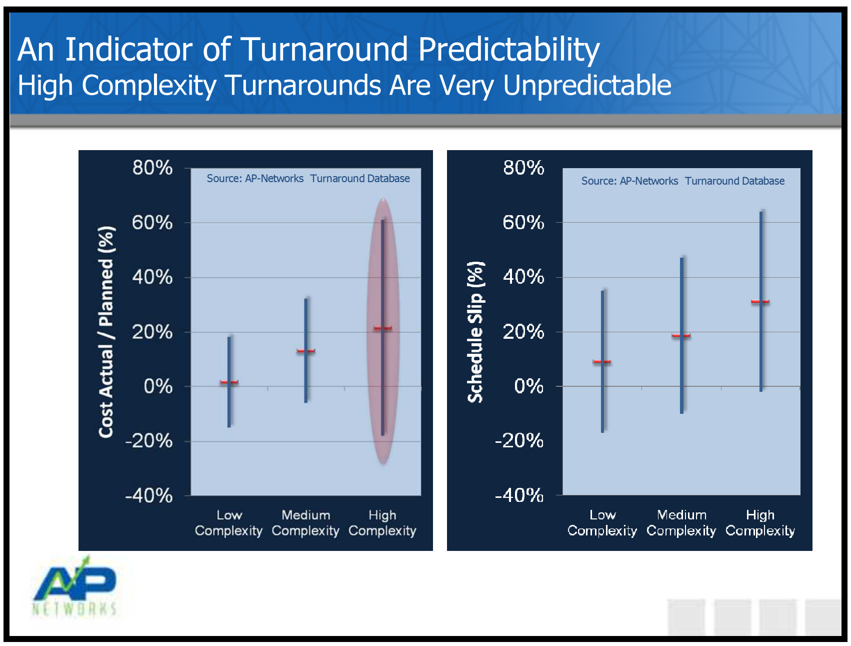

Figure 2

***Note**: AP-Networks' proprietary Complexity Calculator© tool defines turnaround complexity as a function of turnaround man-hours, amount of project capital work and turnaround interval.*

Data shows that the underlying reason for this sub-par performance is that many in the industry simply are not ready to execute the high complexity turnaround. They have not applied the rigor, focus, nor organizational energy required during the preparation phases to achieve an optimal state of readiness.

There is a strong correlation between a turnarounds' state of readiness and its outcomes. Turnarounds that deploy the industry's best turnaround preparation practices are able to achieve high levels of readiness, as measured by AP-Networks' Turnaround Readiness Index (TRI©). As shown in Figure 3, an optimal TRI© increases not only the probability that a turnaround will achieve its targets, but also that it will perform better than others in the industry relative to cost and schedule outcomes.

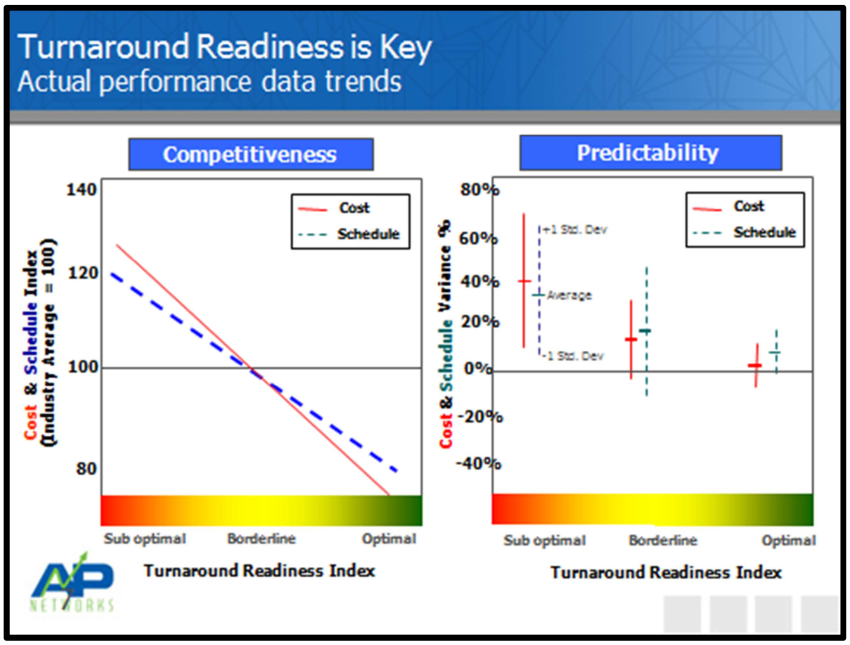

Figure 3

Hundreds of millions of dollars have been expended in recent years to prepare for turnarounds; and noticeable gains have been realized. However, less than adequate performance still riddle the large majority of industry's turnarounds. So if readiness is strongly correlated to outcomes and the industry as a whole has increased the importance of preparations, why are there still so many disappointing turnarounds?

The answer is that while most embrace "the concept" of turnaround preparations, only the industry's leaders have implemented a framework of People, Processes and Tools to ensure high quality preparation deliverables are produced at an intricate level of detail. Lack of such a framework is the "silent killer" that unveils itself during the execution phase as a continual barrage of insurmountable obstacles that overtake even the most capable turnaround execution organizations.

Efficiently preparing with the quality and attention to detail necessary to produce a high level of readiness is the paramount issue facing the turnaround industry today. From our research and industry experience, the solution to this issue involves the following:

1. Well defined turnaround premise;
2. Fully implemented standard turnaround work process;
3. Disciplined capable organization; and
4. Deployment of the industry's best practices.

This paper is written to provide insights into the fourth item – the Industry's Best Practices. However, in order to ensure the context of the full solution is firmly understood, the fundamentals of items one through three must first be summarized.

The turnaround premise is in effect the "contractual terms" for the turnaround steering team that defines the boundaries of the turnaround (Interval, scope criteria, level of acceptable risk, etc); and outlines quantifiable metrics by which success will be measured. In simple terms, the premise document describes how the turnaround will contribute to the strategic objectives of the facility and the business.

Documented in various formats and deployed via different tools, many of industry's leaders have adopted a standard turnaround work process that contains appropriate level of detail and key elements to deliver high degrees of turnaround readiness. Experience shows that the critical success factor for achieving desirable results is much less determined by work process sophistication as it is by the quality of implementation. Effective work process implementation requires far more than a process manual, a training course, and formal rollout session to be successful. It must be fully integrated into an organization's routine business practices and environment. Organization styles vary broadly from matrix, self lead structures to the command and control of yesteryear. As such, effective implementation involves a deliberate strategy designed to gradually weave the process deliverables into the natural work teams' culture; and is often deployed via tools that "bring the process to life" - versus allow it to be yet another dust collecting reference manual on stagnant office bookshelves. Effective implementation is achieved when the turnaround preparation activities become a normal piece of the daily business rhythm at the facility.

Premises and processes are important, but highly ineffective without people. People are the engine that delivers high states of readiness which ultimately enables a turnaround to deliver against its stated premises. An actively engaged management team that heightens turnaround success as a top priority is the difference between a list of plant resources and a disciplined capable organization. Without exception, this fully participative site leadership team is the inspiration that creates and maintains a level of discipline; and is the fuel source that provides the stamina to maintain a "we will win" attitude.

The final key to the solution for sustainably producing predictably competitive turnaround outcomes is to identify and deploy the industry's best practices. Defined as "*a technique or methodology that based upon experience and research has proven to reliably lead to a desired* *result*", best practices are selected among alternatives and implemented because they maximize business value. A critical variant to understand at this juncture is that a best practice is identified by its' technique or methodology; not its' implementation. Proper implementation must be considerate of the unique culture defined by each site's People, Process and Tools environment to assure an effective deployment.

The number of papers, manuals, text books and periodicals that describe one or many of the industry's best practices is unlimited. As such, this paper focuses on seven best practices that affect operations, maintenance and reliability plant personnel in the context of turnaround excellence. Following the outline provided in Table 1, each of these seven best practices are described in greater detail.

Table 1: Best Practice Outline

Practice/Technique/Methodology	**Applicable to…**		
	Ops	Maint	Rel
1. Equipment strategies and performance data	R	R	R
2. Scope development and optimization	R	R	R
3. Oils/Utilities planning	R	I	C
4. Blind/Isolation management	R	I	I
5. Shutdown and startup and decontamination procedures	R	I	I
6. Inspection test planning	I	I	R
7. Quality management	C	I	R

***Note**: "Applicable to…" letters refer to standard RACI definitions. R=Responsible; C=Consult; I=Inform*

1. Equipment Strategies and Performance Data

   Well documented equipment reliability strategies are the cornerstone of modern day reliability-centered asset management programs. These strategies not only document the reliable operating window of each major piece of equipment within the asset, but also describe the unique combination of tasks required to assure economically reliable operations. In addition to routine and non-routine maintenance tasks, equipment strategies also define time-based overhaul tasks and frequencies that must be programmed into turnaround scope definitions and budgets.

   Equipment performance data is a best practice that involves the collection of operating data about the equipment in relation to real time operating conditions. Basic types of performance data to be collected include:

- Operator logbook information using local instrumentation;
- Time-based condition monitoring by certified craftsmen; and
- Operating conditions by process engineers.

Performance data enables equipment performance trending, degradation tracking, end of life predictions, and bad actor analysis. From these sorts of analyses incremental solutions, design changes and/or technology upgrades are developed. Without detailed, trendable equipment performance data, technically sound turnaround work scope decisions are not possible, and turnaround work scope optimization defaults to emotion and organizational rank.

The responsibility to deliver this information varies, depending on the type and timing. However, in general, the reliability department is responsible for defining equipment strategies, the maintenance department is responsible for documenting and being knowledge of equipment condition, and the operations teams are responsible for logging real-time equipment operating data and providing alerting experts when abnormalities are noted.

2. Scope Development and Optimization

Competitive turnaround performance is not possible without an aggressive scope control and optimization effort. A prerequisite to controlling and optimizing scope is to first ensure that it is developed in accordance to industry best practice. In particular, this includes:

- Comprehensive, site wide scope collection effort;
- Descriptive, specific and plannable scopes of work;
- Aggressive screening vs. the scope criteria (documented in the Premise) by the appropriate site department;
- Order of magnitude estimating of each scope item; and
- Closed work list 12 months before feed out (and formal documented scope control is initiated).

Once the work list is closed, all non-mandatory work list items that passed through the initial screening are challenged according to risk tolerance and economic criteria. The best practice is to perform a quantified risk-based scope challenge. Using proprietary tools, external facilitators challenge each discretionary work list item and (with the turnaround team) assign risk factors, likelihood/impact ratings, and business specific incremental economics. The output of this scope challenge, which requires detailed equipment performance data, is a calculated "Mitigation Index" for each work list item. The work list is then sorted from high to low Mitigation Index and the affordable/risk acceptable work scope can then be defined.

Typically about 200 work list items can be reviewed in one week. Experience shows that externally facilitated scope challenges yield an average scope reduction of 15%.

Developing, challenging and optimizing the turnaround work scope is ultimately a collaborative effort that must be shared plant-wide. So, the responsibility for performing this effort completely and consistent with industry best practice is shared among operations, maintenance and reliability departments (as well as others).

3. Oils/Utilities Planning

   An Oils and utilities management plan is a time based schedule of stream dispositions, flow rates, tankage levels, and utility usage for the entire plant - as impacted by the turnaround. Since this plan involves feedstock rates and compositions (in addition to and product rates and mix), its development is typically spearheaded by business planning departments. This plan is typically quite comprehensive and requires information about turnaround duration at the "determining" unit level of detail.

   Once developed and challenged, this plan must be kept evergreen as it forms the basis for how the plant will operate and how suppliers and customers will be impacted by the turnaround. As the turnaround operating procedures are finalized, the utilities portion of the plan is updated to include more granular information about plant utility balances, shed lists, external utility purchase requirements and hydraulic limitations.

   During the shutdown, commissioning and start up phases of a turnaround, the blowdown, flare and slop systems are often over taxed. Hence, these systems must be analyzed for hydraulic limitations and the need for temporary facilities to ensure the operating procedures and plans are feasible. As such, this is a highly technical plan that takes time to develop and should be started during the early stages of turnaround preparations (18 months before feed out).

   Although the input of business planning, process engineering and reliability persons is essential, operations is ultimately responsible for preparing the Oils and Utilities Plan for the turnaround.

4. Blind/Isolation Management

   The ability to flawlessly manage energy and equipment isolation is an essential element for ensuring an incident free turnaround execution. Significant positive strides have been made in the past few years relative to managing energy and isolation.

   The best practice starts with the expectation and commitment to a single list of isolation devices, and the implementation of a comprehensive system for managing insertion/removal or closing/opening of each device - most commonly referred to as Blind/Isolation Management. Since numbering and location of blinds and isolation devices occur during detailed planning of each work list item, the process for managing blinds/isolation must be defined early in the turnaround preparation phase.

Industry practice is to design an intelligent blind/isolation device numbering system that ensures each device/blind location is unique. Then, as work scope planning and operating procedures are developed, the location of each required device is noted on a common set of P&IDs. These locations are then entered into a master blind/isolation database that for each individual record identifies all the turnaround work and operating procedures that require the use of that location/device. Then, as the detailed planning phase is completed, individual blind/isolation lists can be printed and inserted as a final document into each job package.

With this level of attention to detail during planning, the actual turnaround execution is set up for success. The best practice for managing blinds/isolation (including LOTO) during execution is to appoint one operator per shift as the isolation coordinator. The function of this role is to manage the status of each device/location within the blind/isolation management database and to officially authorize the physical change of status of each device (open/close) or location (insert/remove). Although the concept of managing blinds seems simple, this additional level of control has proven highly effective; in particular, for complex situations like:

- Using a single device to isolate/blind for multiple job; or
- Ensuring that properly rated blinds is utilized (especially, important for hydro-testing).

The core purpose of Blind/Isolation Management is to ensure that the all forms of energy are controlled so that mechanical work can be performed safely. Since operations is responsible for controlling the interface between energy sources and work efforts, operations is fully responsible for the Blind/Isolation Plan.

5. Shutdown, Start Up and Decontamination Procedures

Having operating procedures is an OSHA mandate that all US facilities satisfy. However, the best practice for turnarounds is to review and update the procedures that will be exercised and ensure that all operators involved in the turnaround are trained on these procedures and fully aware of the overall operations turnaround plan. To this end, the industry's best typically assign a veteran operations representative to the turnaround team at least 12 months prior to feed out; and one key deliverable that this person produces in the first 6 months is a fully reviewed, updated and endorsed set of operating procedures for the turnaround.

Once developed, the "down" and "up" procedures are summarized and input into the execution schedule as physical activities with duration, resources and logic. Typically summarized into a series of activities with a maximum duration of one shift, these activities are logically sequenced with each other to represent the unit (or systems) shutdown and start up sequences.

Without exception, one best practice that has enabled aggressive turnaround duration improvements is the concept of "systemization". In short, systemization is the process of segregating the turnaround unit(s) in a way that relates to the process flow. In this concept, a system is defined a collection of process equipment and piping that is LOTO'd together. Typically, each system is shutdown, decontaminated and commissioned together and logically tied within the execution schedule to the mechanical work that will occur within the confines of the system LOTO boundaries.

The many process systems are then logically related to one another to represent the sequence of operations "down" and "up" activities. This complex array of tied activities that are grouped into systems and logically tied to feed-out and feed-in milestones enables the identification of "critical path systems". This provides greater opportunity from optimize the turnaround duration as compared to just analyzing the mechanical critical path. This practice of schedule optimization through the application of systemization is shown pictorially in Figure 4.

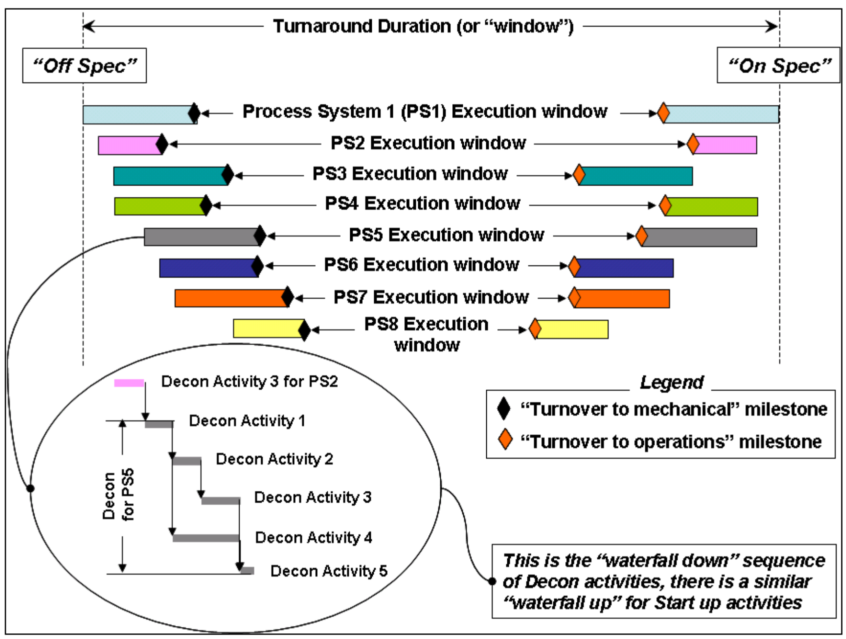

Figure 4

When systemization is fully implemented, the systems as defined by operations are used by the entire turnaround team to manage & control work execution and provide intelligence to the prioritization of Prestart up Safety Reviews (PSSR) and unit recommissioning.

The final component of the procedure best practice is decontamination. This practice has experienced significant enhancements in recent years, and the majority of today's turnarounds are applying some sort of decontamination chemical to assist with the removal of hydrocarbon and/or other hazardous chemicals. Since decontaminating the unit is a dominant component of the shutdown phase of the turnaround, the methods and procedures for providing the safest atmosphere for mechanical work must be defined early (general understanding 12 months prior to feed out).

The decontamination procedure(s) is the final output of several interactive discussions. Development of this complex procedure requires the following minimum participation:

- Operations (and/or decontamination specialist) to provide intimate knowledge of the process configuration and equipment;
- Process Engineering to provide details about the process chemistry, equipment specific contents and to ensure that process specific contaminants (killers) are not introduced/produced during decontamination;
- Reliability Engineering to provide information on the equipment pressure envelope and to ensure that equipment metallurgy will not be adversely impacted during decontamination;
- Decontamination contractor to provide industry experience and information on the decontamination chemicals and decontamination process requirements.

A best practice decontamination procedure prescribes in detail the critical parameters of the decontamination process: minimum/maximum flow rates, temperatures, pressures, injection points and rates, blowdown dispositions, sample points, value positions, process step completion variables (sample results, duration, visual color, etc). Once these are defined in detail, the remaining critical component of a best practice decontamination procedure is a clearly defined responsibility protocol for each step and decision. In particular: What is the decontamination contractor expected/permitted to do, and what is the responsibility of the owner/operator?

As noted above, the development of operating procedures, especially decontamination, requires the input of several parties; however, for turnaround preparation assurance, operations is fully responsible for ensuring that operations procedures are in place, reviewed and representative of turnaround requirements.

6. Inspection Test Planning

Often referred to as inspection scope details, the practice of inspection test planning is one of the key variables that must be well defined in order to have a complete turnaround scope of work. Although not overly complex, the component that differentiates the best from the others is the timely completion of inspection test plans. In particular, the best practice is to provide the full details of any required inspections as part of the work scope prior to scope freeze (refer to Best Practice #2 – Scope Development and Optimization).

Inspection test plans should be prepared for each work scope item that requires any type of non destructive inspection. A well prepared scope-specific inspection test plan contains the following minimum pieces of information:

- Type of inspection method;
- Quantity to be inspected (ft^2, linear footage, size of grid, # components or tubes, # points, etc);
- Location of inspection and access requirements;
- Duration and number of inspection resources;
- Quality control/assurance requirements and/or hold points; and
- Photos (as available/required).

The reliability department, and the inspection team in particular, is responsible for delivering the inspection test plans to the turnaround planning team.

7. Quality Management

Managing quality during a turnaround must start early in the preparation phase and includes two primary components: asset integrity assurance and control/assurance of mechanical work quality ("mechanical" is used to cover all work performed by craft persons during the turnaround).

Relative to asset integrity, inspection and reliability personnel utilize the turnaround to collect data, make repairs and install replacement components in the interest of ensuring the integrity of the operating equipment and compliance to local and federal codes and regulations. For many turnarounds, this is the primary driver for taking the unit(s) out of service in the first place. Best practice is to only include in the scope of work the equipment and scope required to ensure asset integrity that cannot be cost justifiably performed outside of a turnaround. Deployment of mature a Reliability Based Inspection (RBI) program is the key differentiator of a turnaround work scope that is reliably sound and financially responsible from one that is merely regulatory driven and time based.

The second component of turnaround quality management involves the deployment of a comprehensive set of hold points and checks to ensure a high level of craft quality. Best practices for managing quality of mechanical work during the turnaround include:

- Deliberate combination of quality control and quality assurance;
- Collaboration between contractor quality control personnel and owner inspectors;
- Prescription of critical parameters, such as: pneumatic or hydro-test envelopes and pressures, weld procedures, torque values, material specifications, clearances, etc.;
- Appropriate verification steps, such as: hold points, intermediate weld checks, testing checks, torque checks, Positive Material Identification (PMI), measurements, etc.;
- Intentional control requirements, such as: flange tagging, pinging bolts, weld x-ray, visual gasket confirmation, etc.;

- Minimum (random) assurance protocols that escalate if deviations are identified, such as: sampling of gaskets before install, bolt pinging, occasional retest of pressure, etc.;
- Prescribed procedures such as: heat exchanger tube testing, use of temporary materials/gaskets, PSSR, vessel closure, loop checks, turnover of work to operations for commissioning, etc.; and
- Final verifications prior to energizing with hazardous materials, such as: leak testing flanges, low point bleeder checks, testing overspeed trips and other "final element" instrumentation, etc.

The reliability department must fully accept responsibility for implementing a comprehensive Quality Management Plan. Without exception, other departments, such as operations, must contribute to the overall completed plan and it's successful implementation.

Obviously, there are many, many fundamental components of a high quality turnaround execution plan and the sheer number of "basic blocking and tackling" preparation tasks can totally consume an organization. The proven leading indicator of turnaround performance, Turnaround Readiness Index ("TRI"), is a complex measurement of how well the industry's best practices are knitted into the fabric of a disciplined and capable site organization. As described in this paper, optimum readiness does not require perfection in all aspects of turnaround preparation; but does require diligence in four fundamental areas.

In order to maintain pace with (or accelerate ahead of) the evolving minimum standards of performance in today's turnaround industry, owners are urged to articulate their own pathway to turnaround excellence. They must realize that turnaround excellence is so much more than a state of being, and that this "Journey" requires the integration of their fundamental strengths into the continuous improvement program that builds on each turnaround cycle. Owners must demonstrate a relentless commitment to the "Journey" in order to realize predictably competitive turnaround performance.

About the Author:

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Bobby is the Vice President of Turnaround Services and is located in AP-Networks' Houston office. Prior to joining AP-Networks in 2005, Bobby was a direct hire employee of Exxon, ExxonMobil and Lyondell/Equistar for more than 18 years. In addition to numerous maintenance, reliability and operations roles, Bobby served in various turnaround functions spanning from operations preparedness, mechanical planning, event scheduling, project controls, execution management and even corporate procurement management.

In addition to leading AP-Networks' Turnaround Consulting Practice, Bobby is a Recognized Industry Expert in the petrochemical industry, with particular focus in turnaround preparation methodologies, best planning and scheduling practices, and emerging turnaround management principles. Most recently, Bobby has written white papers and delivered presentations on the following topics: *Turnaround Competitiveness: The Secret Ingredient*; *Leading Indicators of Turnaround Performance Outcomes; Turnaround Performance Excellence; Breaking the Barriers of Traditional Learning; Turnaround Benchmarking: The Right Dataset; Turnaround Best Practices and Emerging Trends; and Team Alignment: An In Depth Look*.

Bobby holds a Mechanical Engineering degree from Virginia Tech and his many years of experience as a client with top-tier companies provide a unique perspective on being a leader in a world-class consultancy.