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Turnaround/Shutdown Optimization

Plan for the 5 phases of a Plant Maintenance Shutdown

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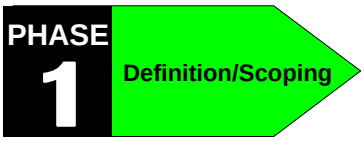
A Turnaround (TA) by definition is a planned, periodic event where one or more processing/production units are temporarily removed from service. In the manufacturing sector, different industries use different terminologies to connote this concept. Some use the phrase Turnaround (TA), some use Shutdowns, while still others use the term Outages. In some industries the duration and scope of the event determines the particular vernacular used.

Regardless of the terminology your industry uses, this event may occur individually or in conjunction with an entire plant shut down. The purpose of the event is typically to perform maintenance such as the inspection and repair of equipment. It is also an opportunity to replace process materials and equipment that are worn out or broken and have reached their useful life. Both of these activities restore the life cycle of the asset base and ensure the safe and efficient operations between TA events. Often this work can only be performed when the processing/production units are not in service.

Phases of a Turnaround

There are five distinct phases associated with a Turnaround. Each phase consists of key elements that must be executed to perfection in sequential order. It is crucial to develop formal processes for each element of each phase. When formal processes are not in place, short cuts tend to happen, best practices and lessons learned get lost and more importantly, key steps or procedures may get skipped completely.



The Definition/Scoping Phase is the foundation for the Turnaround. It is in this phase that the initial planning, scoping and organization of the event occurs. Remember, TAs are not stand alone events, but are high cost, high impact events, which represent the execution of the company strategy over a period of many years.

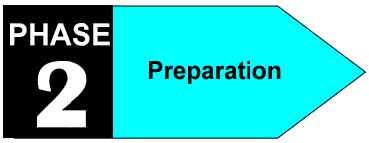
It is important to build a strategy during this stage of how and when TA's are to be executed. Each Turnaround should have a business case developed for justification of the event that includes the key drivers – such as cost reduction or Overall Equipment Effectiveness (OEE) - that make it a necessity and should be strategically linked to the overall company goals.

Senior management must view Turnarounds as an important element in their strategy and should form a steering committee consisting of upper level managers who take responsibility for executing the long-term strategy of the Turnarounds. Assign a TA manager who develops

and manages the organization and resources associated with the Turnaround as well as has full control of the TA thru every phase. The TA Manager also works with the Steering Committee to develop the Key Performance Indicators (KPI's), or a set of measures focusing on those aspects of performance that are most critical for success. Typical KPI's for a TA should focus on safety, cost, schedule, man hours, overtime, task completion, etc.

Also developed during this phase is the Work List, which is the repository of every conceivable item that should be considered for execution and populated from every level in the organization. Some items on the Work List will be mandatory, as dictated by corporate and regulatory entities. Others will be improvement-based, as part of an overall strategy to improve cost or market position. Still others will come from inspections that are conducted to improve Meat Time Between Failure (MTBF) and the Life Cycle of the equipment. Finally Data Analysis is used to find those items "below the surface" that are negatively impacting processes. The CMMS is the final destination or repository for all items generated from the different elements for the Work List. All items that are submitted for the Work List must go through due diligence. The fundamental criteria for items on the Work List is work can only be performed when the unit/process is down.

Finally, a Preparation Plan is developed to identify the cost estimate, schedule, work list, constraints and resources necessary to execute the TA. The Preparation Plan is prepared by the TA Manager and his or her team, submitted to the Steering Committee for approval, and distributed throughout the organization.



Phase 2 preparation begins immediately after approval of the Preparation Plan. In this phase, the details of the plan start to develop prior to the execution of the TA. Environmental, Health & Safety plans are created to promote the health and welfare of the entire workforce. Logistics plans are developed for the reception, storage, protection, issue, and demobilization of every item of material, equipment, services, accommodations facilities and utilities require for the TA. Quality Plans are created for Quality Assurance and Quality Control. Quality Assurance is a program for the systematic monitoring and evaluation of the various aspects of a TA task, service, or equipment/material to ensure that standards of quality are being met. Quality Control measures inspection, testing and engineering, which are used to oversee and positively influence the quality of the work executed.

The Work List developed in Phase 1 must be validated and narrowed. Detailed Work Packages for the finalized Work List are developed. The Work Package includes the job scope, number of craftsman, man hours to execute the tasks and the scheduling of the tasks. It also includes a Standard Job Plan, detailing the operational steps required to execute the tasks with precision. Safety steps, permitting, drawings, photos, etc; are all part of a detailed work package.

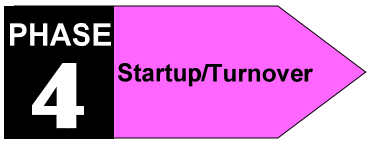
Once the Detailed Work Packages are completed, decisions must be made as to which work will be executed with internal resources and which will be done with external resources. Tasks to be executed with external resources must be properly scoped and sent out for bids. Plans must also be developed as to how these external contractors will be managed. All tasks on the final Work List must be thoroughly vetted for risk and contingency plans created for worst case scenarios. Pre-shutdown work (prefab, specialty, piping, etc.) must be identified and executed. Capital Project work to be executed concurrently with the TA must be fully

integrated into the plan at this time. Once Phase 2 items are completed, we should have a final Work List, a revised schedule and a cost estimate within 10% of our allocated budget. Once again, our Phase 2 package should be approved by the Steering Committee and communicated to the organization upon their approval.

Execution in Phase 3 begins immediately with the shutdown of the equipment. We have prepared diligently in Phase 2 for the known items to be executed. While we have prepared diligently for known items to be executed, in this phase we must also address the "unknown" items that will become apparent as the TA begins. For example, scope changes, or a request to change the agreed scope and objectives that wasn't originally defined to be part of the TA, will occur as we begin to execute our Work List. When developing a Work List for a TA, it is virtually impossible to predict all the things that need to be done. No matter how good the history, or inspection process or data analysis that can be done prior to the TA, there is no substitute for the inspection of the asset base when the equipment is down. However scope change and add–on work can not only be costly but can also impact the critical path of the TA. Each should be carefully scrutinized before proceeding, and there must be a process in place in order to stay on schedule and at budget.

A good deal of resources will also be dedicated to inspecting the equipment while it is down. Items will be found during these inspections and decisions will need to be made whether to execute corrective actions or not. As in scope changes, a process must be in place in order to stay on schedule and at budget. It is a tremendous task to manage all the internal and external resources associated with the TA. The detailed schedule prepared in Phase 2 is one of the best ways to manage resources. By updating the schedule daily, resources assigned to items that finish early can be shifted to items that are behind. Items that can delay the overall schedule (Critical Path items) can be highlighted on the schedule and given special attention. The TA Schedule indicates the status of each individual task to be executed. It is equally as important to track the cumulative impact of all the TA tasks. The KPI's developed in Phase 1 should be employed at this point in order to do so. Items such as: TA Cost – Actual vs Budget; Planned vs. Actual Man hours; Overtime Man hours, Overtime % are all examples of metrics used to track the progress of the TA. These can be represented graphically as well. KPI information is critical and very useful as the TA comes to an end. As the majority of the TA tasks are completed, the same number of resources is no longer required. The KPI's are an excellent tool to determine when to downsize the workforce for maximum cost and efficiency.

After completion of each task on the schedule, testing must be done to validate it's readiness to return to operation. Testing of the equipment after it has been "touched" in some way by Turnaround activities is a critical process prior to startup beginning. Testing activities may be performed by Maintenance Electricians/Instrumentation Technicians, Process Control Technicians, Vendors or even Operations. Finally, after all tasks are completed, the asset base must be returned to as good or better state as it was before the TA.



Startup/Turnover begins after all testing is completed as the last step of the Execution Phase. A final inspection then occurs with Operations, Maintenance and specified third parties where all assets are evaluated for readiness to return to service. When the agreed upon TA work has been completed, punch list items have been reconciled and no outstanding issues impacting Startup remain, a Hand-off to Operation should occur. Hand-off is a process that ensures that all outstanding issues impacting the Startup have been addressed. Startup is essentially an Operational function. However, it should be closely coordinated with the TA team to ensure proper support resources are available. After Startup is complete and the equipment is operational, Ramp-up can begin. Ramp-up is defined as the time interval between Start-up and normal operating run rates and capacities. It is an opportunity for adjustments and to observe equipment that has been installed or "touched" in some way during the TA. Ramp-up is a critical phase and the one most apt for a failure to occur after TA work is complete. When Ramp-up is complete and the operation has stabilized, the final TA Punch List can be developed. The Punch List is a forum for all parties associated with the TA (Contractors, Maintenance, Operations) to walk down the equipment one last time and mutually agree on the items that need to be corrected. It would be ideal if all the items on the Punch List could be completed. The reality is that TA budgetary constraints may prevent completing all items on the list, but it is a good start for the next TA.

Phase 5 begins when all the physical tasks associated with the TA are completed. Demobilization begins immediately following this completion and includes all activities and costs for transportation of personnel, equipment, and supplies not required or included in the Turnaround. This includes the disassembly, removal and site clean up, of offices, buildings and other facilities assembled on the site specifically for this TA. Any TA activity that varies significantly in cost, schedule, technical performance, etc.; should be reviewed using formal Root Cause Analysis (RCA) methodology.

A post mortem meeting should be held to review the Turnaround in its entirety. The agenda should include: EHS Review, Results of KPI's/Metrics, Cost, Schedule, Punch List Activities, Contractor Management, Shutdown/Startup/Ramp Up Issues, Critical Path/Major Tasks Review and Best Practices/Lessons Learned. A best practice is a technique, method, process or activity that is regarded as more effective at delivering a particular outcome than any other

technique, method, process, etc. The idea is that with proper systems, processes, checks and testing a desired outcome can be delivered consistently with fewer problems and unforeseen complications. .

At the end of Phase 5, all outage costs should be reconciled. All Purchase Orders, Work Orders, Service Contracts, etc., should be closed or cancelled. Vendor/Supplier/Storeroom credits should be applied for returned materials and/or equipment. Returned quantities should be logged in CMMS for future planning purposes. The credited amount should be applied to the overall outage cost in the respective area. A Financial Report should be written detailing all costs – broken down by category (labor, materials, parts, etc.) - associated with the outage, so actual numbers may be compared to plan. This provides the opportunity to analyze cost horizontally and vertically across the system.

A final audit should be conducted to assess the performance of each element in each phase of the TA process. Once completed, a final report should be generated summarizing every Phase of the Turnaround. This document should be the basis for updating the mill Turnaround Strategy and the development of the business case for the next TA. In addition, major equipment availability and performance should be reviewed prior to the next outage as a measure of the effectiveness of the previous outage. Typical general topics covered in the Turnaround Report would be: Safety, Quality, Logistics, Work Scope, Financial, TA Metrics, Contractor Performance, Organization and TA Schedule.

Summary

A Turnaround can be an overwhelming and tenuous undertaking if managed as a single, stand alone event. However, if the event is broken down into various phases with detailed, formal processes in each phase it can be managed successfully each and every time. Consistency and repeatability are key in managing a long-term TA Strategy. In the world we live in today, resources are constantly on the move. It is not reasonable to assume that the same TA Team that managed last year's event successfully will be available for next year's TA. However, with good detailed processes in place, the impact of turnover can be minimized substantially.