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Turnaround Planning

New Approaches for Petrochemical Plants

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The rotating equipment maintenance business is changing globally and most significantly in North America. The environment has changed from ‘hardly any new plants within a decade’ to ‘several new major plants in a year’, from ‘peak oil scenario’ to ‘shale oil abundance’. At the same time, the industry is losing a generation of experts; engineers and specialists. The turnaround cycles have been extended from historically 3 - 5 years to up to 10 years and is further limiting individual experience which is a significant factor. Consequently, there are maintenance team members in place for many years, before they experience the first major turnaround event. More often staff is promoted into new positions and thus have not had the opportunity to contribute what they have learned in a second event. Therefore the risk of experiencing poor results is increased in all key aspects of the turnaround: Safety, quality, schedule and costs.
All these aspects require a closer look at how turnarounds are being planned and executed. This paper provides an overview of the 5 key tactical requirement areas including the associated tasks, and some key ingredients for success. It further addresses some of the risks involved in large turnaround execution and potential mitigation methods.

What happened the last few years

Over the past years the petrochemical business was on the downslope with relatively few new plants brought on stream. There were multiple overhaul strategies, some more, and some less successful. Focus was placed on quality; first supported by ISO9001, then health, safety and environment (HSE) supported by OHSAS 18001 and similar standards. However, for schedule overruns and 'unforeseeable' quality and cost issues, good excuses where easily at hand.

At the same time, HSE requirements are now more rigorously enforced and require a dramatic increase in effort to achieve the required results. The many behavior based programs such as "Toolbox talks", "last minute risk assessment" and training requirements consume significant working time in an already busy workday.

Loss of containment remains a critical area. Flange leaks were almost expected in the past (it always happens) nowadays this is clearly not acceptable anymore. Professional rotating equipment contractors now have detailed procedures in place to avoid the possibility of flange leaks on casings, guards and piping.

The rotating equipment complexity hasn't changed much over the past two decades. The internals of compressors and steam turbines by and large hasn't really changed from a maintenance point of view. However, electronic controls are being installed and upgraded for quite some time, and often they are standardized products to facilitate easy maintenance and upgrades. The traditional oil seals are upgraded in many plants to the state of the art dry gas seals. For new units, the biggest change is the increase in maintenance size and weight. Former big plants at 800MTA plants would involve lifts up to 30 - 35 tons, today's 1500MTA plants feature maintenance lifts up to 60 and more tons. This requires new tools, new procedures and better trained staff. On a side note: the construction of new plants is now even more challenging with lifts up to 350 tons.

Turbomachinery engineers are scarce resources already. These years see a large generation of experts leaving the maintenance environment. Field engineering talent is even harder to obtain. Young people are more attracted by banking and real estate or IT; rotating equipment engineering is not perceived as "sexy". The limited resources with less experience now need to be split across more plants with bigger machines, with more stringent requirements regarding HSE, quality and time constraints.

The current approach with mixed and often unclear responsibilities between customer supervisor, OEM technical advisor and labor contractor may not work anymore. Overhauls within mega plants cannot be based on 'tradition' and historical 'war stories' any longer.

The New Approach

The integrated event has been proven to be a successful model. Integrated means, that a dedicated project management team owns the whole event, including all of the project and maintenance aspects. The “project management team” includes customer, contractor and supplier leaders that work together as a team. The new approach requires specific decisions during the strategic planning phase. This includes carefully defining the shared responsibilities at all interface points between the participants. Detailed interface elements ranging from parts to repairs, services and supplies, HSE plan, quality plan, schedule and cost should all be considered when forming the strategic plan. The choice between lumpsum (fixed time, fixed scope and fixed price) versus time and material (T&M) is important too, but not a “game changer”. It is a way to contractually define specific responsibilities, but in either case, shared responsibilities at interfaces remain to be carefully defined and planned.

There are 5 key tactical areas that will be covered in more detail in this paper. Thorough and careful definition in these areas will provide the foundation for a successful turnaround of rotating equipment in a large plant.

1. Early planning & preparation
2. Cooperation and communication
3. Formation of the execution team
4. Contingency planning
5. Change management

Each of these areas must be treated differently.

1. Early Planning & Preparation

- Management team selection
- Job scope, overview and details
- Definition of responsibilities (DOR)
- Determine logistics challenges
- Assign ownership (Procedures, Acceptance Criteria, etc.)

Early preparation means to start planning the event 12 – 18 month ahead of the project or turnaround. The project management team must first be selected and assigned (contracted). This team typically consists of the contractor Project Manager that ultimately runs the project and, depending on the size of the

project, a Project Planner. This phase defines the responsibilities (DOR), the basic logistics, the scope of work, etc.

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Appendix C Division of Responsibilities (DOR)

	Description of task	Comment	AST	Client
A)	**Machinery & Permits**			
1	Shutdown of machinery			X
2	Blinding and purging units to acceptable TLV (MAK)	Measurement criteria mutually agreed		X
3	Lock-out, Tag-out			X
4	Provision of daily work permits			X
B)	**Site Organization**			
1	Calling for kick-off meeting		X	
2	Calling for preparation meeting		X	
3	Daily shift handover meetings		X	
4	Daily progress report and HSE performance		X	
C)	**Logistics**			
1	Provision of rental cars/trucks	For project management team	X	
2	Provision of crew buses		X	
3	Provision of mobile cranes (incl. operator)	Size to be defined during Phase A		X
4	Provision of 5 ton forklift (incl. operator)	Size to be defined during Phase A		X
5	Provision of 60 ton low bed trailer & truck (incl.	Size to be defined during Phase A		X
6	Provision of Sleepers, Pallets, etc.	To be defined Phase A		X
7	Recertification of Overhead crane	Verify certification		X
D)	**Tools, Special Tools & Consumables**			
1	Provision of lifting beams	Verify certification		X

Figure 1: Excerpt of DOR

For example, the logistics of handling the turbine and compressor diaphragms only highlights what we are talking about: 50 – 60 turbine and 60 – 80 compressor diaphragm halves will need to be removed, cleaned, inspected and non-destructive testing (NDT), possibly repaired/replaced/coated and refitted. Because of size/weight, every manipulation of each diaphragm requires a crane. This needs to be properly planned in order to minimize distraction on other activities on bearings, seals, rotors and valves, etc. that must be conducted at the same time. Of course, the project management team needs to closely follow the location and progress steps of each and every item, to ensure on-time re-assembly of the units. Cleaning procedures, cleaning material and acceptance criteria need to be pre-defined and accepted by the customer. While diaphragms are really a simple element in the overhaul process, this logistics aspect provides a good overview on the scope of the detailed planning that is involved.

Figure 2: Logistic exercise: Handling of Diaphragms

The ownership and source of all documented procedures, acceptance criteria, and the interfaces required for each document must be defined and agreed to by the management team in the early planning. The actual development of the documents will come later in the planning process

2. Cooperation & Communication

- Clarify responsibilities
- Set communication protocols
- Establish “chain of command”

- Define the “real time” decision process
- Identify “knowledge transfer of expertise”

It is of key importance that the customer and the contractor project management team work together as an integrated team during the planning phase and through-out the event. Clear responsibilities and communication protocols must be pre-defined and agreed upon. The project manager and the customer must always be in position to resolve critical decisions together, on the spot. During a tight project schedule, hours count, and the activities cannot be put on hold to wait for decisions that may not be available during the night or in a different time zone.

Both, the customer and the contractor, have a shared role in this element. On the one hand the project manager ideally benefits from the customer’s detailed knowledge of local resources. On the other hand, the customer can benefit from the contractor’s experience from performing work at many different sites under many different conditions. This “knowledge transfer” must take place in an established trusted way, to be simple and fast.

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Appendix D — Communication Plan

Lead	Attendee(s)	Content/Agenda	
A) Daily Progess Meeting			
Project Manager	AST SV AST HSE AST TA Client PM Client SV Client HSE Contractor SV	Daily Project Communications: Agenda: 1. HSE minute 2. HSE update last shift 3. HSE focus next shift 4. Technical issues last shift 5. Technical focus next shift 6. Progress last shift 7. Planned progress next shift 8. Planned hold/witness points of the day 9. Logistic requirements from Client - Transportation needs - Mobile crane, forklift needs - Contracted services (blasting etc.) - Parts requirements 10. Any other business	Frequency: Daily, fix time before shift start Duration: max. 30 minutes Note: information only, discussions to be outside one to one Documentation: Daily Report
B) Daily Toolbox Talks			
AST SVs	AST SR AST MS AST HSE Client HSE	Toolbox Talk typcial Agenda: 1. HSE minute 2. HSE update last shift 3. HSE focus next shift 4. Planned activities of the day 5. Risks involved and mitigation 6. Concerns from the crew	Frequency: Daily, fix time, at shift start Duration: max. 30 minutes Documentation: Toolbox Talk document signed-off by attendees
C) Ad-hoc critical communication			
AST PM	Client PM	All critical communication - HSE updates - Technical issues	Frequency: As and when required

Figure 3: Excerpt Communication Plan

Simple templates should be jointly developed that suit the needs of the management team as well as the execution team for communicating the “right information” and the “right time” in an efficient manner.

3. Formation of the Execution Team

- Team sizing
- Staff experience and diversity
- Briefing of work sequence and goals
- Set tooling requirements

A large petrochemical turnaround can easily require a team peak of 50 – 80 staff and possibly more. Today, there are very few (if any) contractors that can provide an experienced turnaround team with their own in-house staff. Putting together a strong team from Project Manager to Supervisors to Millwrights from diverse backgrounds is essential to success.

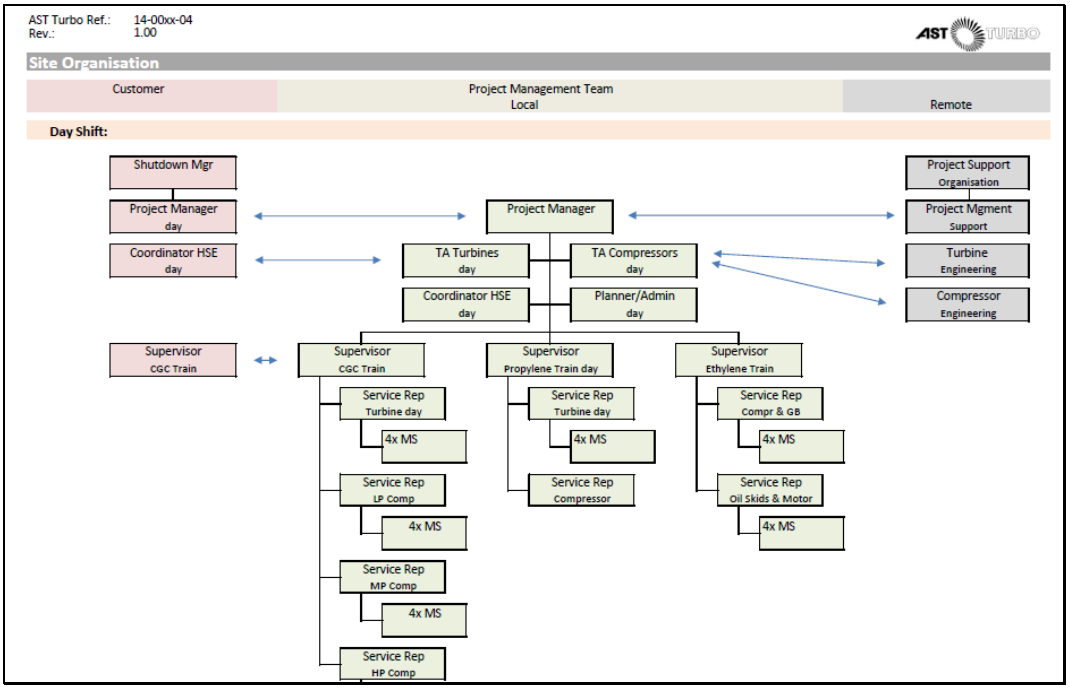

Figure 4: Excerpt Site Organization

The strongest team is formed when all members are handpicked with known capabilities from previous projects. Individuals are assigned to tasks that suit their skills and talents best. A significant risk is the overstaffing of jobs. Too many people on certain tasks tend to blur responsibilities, which can lead to poor quality and low productivity.

It is important that all team members are properly briefed, where the specific expectations of the turnaround are communicated. This involves HSE briefing, logistics, scope of work, quality plans, key areas that may vary from other events,

time and plan. It is essential that both, the contractor and customer personnel, receive the same detailed messages, and fully understand the planned work sequences and expected goals.

Obviously, the Project Manager becomes the key person in the turnaround. This personality must not only develop planning and preparations but also lead the whole turnaround team, always bearing in mind the areas of: HSE, quality, schedule and cost. He/she must be given the power to make decision quickly technically and commercially with essential customer input where required, as stated before.

Although turnarounds are often seen as repeat events, every turnaround has its own characteristics and activities that need to be tailored accordingly. Planning and preparation can be built up from templates, however typically the task sequences vary from event to event due to changing content and past lessons learned. The final job specific templates used must be agreed to and supported by all parties based on the particular job at hand.

For example, in the past, tools were available in gang boxes and 20ft containers. Nowadays, the tooling is provided in lean systems. Only the tools that are required (e.g. imperial vs. metric) are put on the decks. Tool control systems are in place. The tools are provided in ideally sized chests to have them available near the units where they are used. More than one set may be required for certain planned parallel activities. All rigging equipment comes load tested and fully certified. Precision measurement tools are provided in fully calibrated condition. Special logistic devices such as diaphragm racks may be specifically prepared to streamline diaphragm handling.

Figure 5: Safe and efficient logistics: Diaphragm Racks

Putting together the right sized overall team with sub-teams that each have the right mix of experience and diversity requires an experienced project manager.

The integrated event management team must have full confidence in this key individual.

4. Contingency Planning

- Identify and address known “show stoppers”
- Qualify and arrange local resources
- Include the “discovery phase” in the basic plan

An area that is of outmost importance is the contingency planning. This includes known areas of uncertainty as well as items that may be discovered during the overhaul process. Experience provides an overview of what can go wrong.

For example, overhead cranes are used heavily only during turnarounds, and can often suffer from standby damages resulting in break downs when they are needed most. Scheduling and performing maintenance checks and adjustments during shift change or lunch breaks is often a good investment.

Parts or tooling that require adjustment: this typically requires local machining capability and capacity, which should be pre-arranged.

It is only prudent to think about what can go wrong ahead of time and locate local sourcing facilities that are prepared to support to overcome the problems.

Figure 6: Costly alternative: top half lift through compressor house roof

Every Turnaround has a “discovery phase” when the equipment is being opened and disassembled. The plan should include and recognize when this phase starts

and when it ends, so that proper focus can be place on resolving the unanticipated internal damage or repairs that must be completed before the equipment can be reassembled and closed. The plan must be flexible enough or have sufficient contingencies built-in to handle the unanticipated but necessary work. This typically requires approved repair procedures in place, or resources to develop and approve the necessary procedures, and again the needed processing capability and capacity.

5. Change Management

- Inform people about the integrated event
- Parts handling, transfer of custody
- Change of traditions and procedures

The last area to address here is the importance of change management within the customer's organization. This area goes beyond approving and documenting a change to the equipment. The management of change concerning people includes, the handover of significant responsibility to the contractor that needs to be carefully planned; concerned local staff needs to be brought on board of the new concept to avoid counter activities. For example in the past, spare parts would be handed out when needed. In the new concept, all spare parts out of the warehouse are transferred to the contractor's custody ahead of the shutdown and accounted for throughout the turnaround. All remaining spare parts are then handed over to the customer at the end of the project. While the decision, if a part is changed, is still done mutually during the job, the contractor owns the logistics to bring the right component to the deck at the right time.

Likewise, any change to the customer's traditional logistics must be managed. This could include everything from safety checklists, to quality form sign-offs to purchasing of consumable materials. All these details are important to meet the schedule.

Summary

Overhauling a single compressor or a compressor train is simple and usually can be done with one supervisor with a handful of properly skilled resources.

Overhauling a large petrochemical plant is more complex to address. Meantime between maintenance are prolonged, thus large turnarounds become a rare event for most plants. Aggravating circumstances are retiring workforce, increased number of installations, more challenging HSE requirements, increased quality expectations and last but not least budget constraints.

There are multiple activities in a crowded place, many simultaneous tasks that are dependent on each other. Extended runtime between turnarounds require more attention to details that can only be realized with proper planning.

The integrated approach that assigns significant responsibilities to a lead contractor has proven to be a successful model. Attention to details, early planning and preparation are important ingredients for successful turnarounds. Meeting of minds, and defining clear responsibilities between customer, contractor and suppliers are other important aspects that should not be underestimated. To complete large turnarounds safely, with high quality results, in a short time window, a resourceful and integrated project management team is required that is experienced to anticipate and plan for contingency items.