HP | Plant Turnarounds and Project Management

Phase-gate process for optimal turnaround performance: Long-range turnaround planning

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Processing facilities require periodic turnarounds (TARs)—a shutdown of the process unit or groups of process units for cleaning, inspection, repairs, modifications and upgrades. While the cost of these inspection and maintenance activities is a major component of the facility's operating expense, the lost production value from the downtime is usually much higher. The volume of TAR work in a limited physical space and within a compressed timeframe presents challenges for securing the required qualified workforce and ensuring quality control and health, safety and environment (HSE). For these reasons, excellent TAR planning is critical for successful outcomes.

Emulating the phase-and-gate work process typically used for major capital projects provides a good framework for conducting TAR planning and preparations. For each phase, a set of defined products, reviews, metrics and required approvals are identified. Optimal time windows are established for completing each phase, based on workers' experience in the facility location.

Facility leadership teams, including leaders from operations, maintenance, projects, strategic planning, and health, safety, security and environment (HSSE) functions, should participate in phase-gate reviews and approval decisions.

The number of decision gates, approval levels, planning lead times and other details should be developed by each facility's organization, based on several key factors:

- Size and scope of the TAR
- The TAR facility's complexity
- The TAR facility's location (remote vs. near an industrial center)

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- Percent of capital work and control systems modifications—considered high risk TAR activity
- The size and structure of the facility's organization, including embedded contractors.

FIG. 1 provides a process flow diagram and considerations for typical deliverables for each TAR phase.

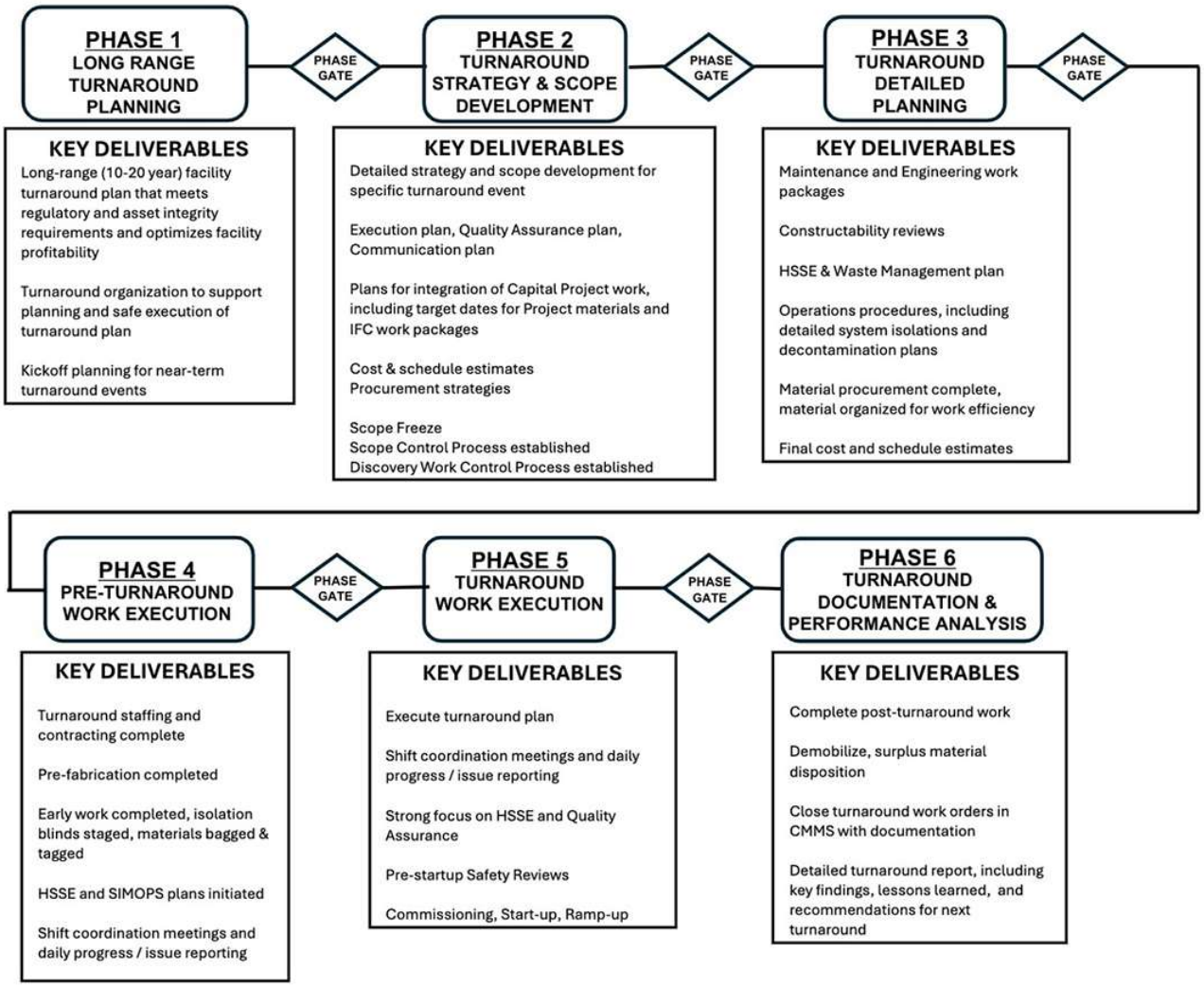

FIG. 1. TAR phase-gate process flow.

Phase 1: Long-range TAR and business planning. Best practice facilities establish and update 10-yr to 20-yr long-range TAR plans as part of their annual business planning process. Such long-range plans cover multiple TAR cycles for all facilities and allow for optimal TAR groupings, projecting product purchase requirements and budgeting for long-range TAR expenses.

During the business planning process, teams should be established to kick off detailed planning activities for TARs in the near term (2 yr–3 yr).

Typical Phase 1 deliverables include an updated long-range TAR plan, as well as the following for specific TARs for which planning is beginning:

- Establishing and holding regular meetings of steering and guidance review teams

- Assigning a TAR Event Manager and staffing the core and execution teams
- Establishing process and personal safety philosophies and TAR key performance indicators (KPIs)
- Drafting and approving the TAR charter and philosophy
- Identifying TAR compliance requirements
- Identifying TAR asset integrity scopes
- Identifying TAR improvement projects
- Initiating a work list
- Identifying long-lead materials
- Identifying Class 1 cost estimates (± 50%)
- Developing the initial schedule, including business planning assessments
- Drafting the initial appropriation request for approval.

Phase 2: TAR strategy and scope development. The TAR team must develop a detailed strategy, scope, cost and schedule for TAR events in Phase 2.

The Phase 2 deliverables include:

- A completed review of high-value lessons learned
- Business and oil planning teams' signoff on the TAR plan
- The establishment of the planning and scheduling team
- The creation of an information management plan and cost management plan
- The development of a pre-TAR inspections plan, as well as the initiation of inspection work
- Finalizing process-based cleaning scopes
- Drafting work orders
- Completion of the capital projects integration plan, including detailed scope and delivery dates for materials and issued for construction (IFC) drawings and documents
- Developing and executing a communications plan
- Identifying the execution team and drafting an overall execution plan
- Drafting a quality management plan
- Putting in place a lessons learned capture process and risk/mitigation management process
- Developing and initiating a contracting strategy/plan
- Completion of material procurement plans and ordering all long-lead time materials
- Developing a Class 2 estimate/schedule (± 30%)
- Completion of scope challenge workshops
- Initiating a TAR scope freeze, including capital expenditure (CAPEX) projects
- Putting a scope change process (with elevated approvals) in place.

The TAR's scope is frozen at the end of Phase 2, and scope control processes are put in place. Three aspects of scope control are recommended, with metrics established for each:

1. **Control for additional maintenance scope:** Facility and TAR leadership should emphasize defining maintenance scope as completely as possible prior to scope challenge meetings and scope freeze. A maintenance scope added after the scope freeze may be required due to issues or failures that occur after the scope freeze date. Such scope additions should require cost and labor estimates, risk analysis and elevated approvals.
2. **Control for CAPEX project scope:** CAPEX project growth is recognized as a common cause of cost and schedule deviations for TARs. Project TAR scope should be limited to activities that require the

and schedule deviations for TARs. Project TAR scope should be limited to activities that require the facility to be down, and this scope must be clearly and completely defined prior to scope freezing.

3. **Control for discovery work scope during TAR execution:** Processes for rapidly evaluating and deciding courses of action for discovery work during TAR execution should be in place, and should require cost and labor estimates, risk analysis, schedule impact analysis and elevated approvals.

Phase 3: TAR detailed planning. Detailed work planning and procurement of materials is the focus of Phase 3. CAPEX and maintenance work packages should be developed ratably during this phase, and the creation of detailed deliverable schedules may be required for CAPEX projects and complex maintenance work scopes. Operations shutdown, cleanup, a pre-startup safety review (PSSR), commissioning and startup detailed procedures are integrated with the TAR schedule.

Key deliverables for Phase 3 are:

- Completion and issuance of engineering packages
- Putting in place the execution team, including contractor leaders and quality assurance/quality control (QA/QC) teams
- Finalizing the HSSE plan
- Completing all constructability reviews
- Finalizing the execution plan and ordering all materials
- Beginning the material bagging and tagging process, as well as executing a preservation program, as required.
- Completion of waste management plans and other environmental requirements
- Defining work permitting and lockout/tagout (LOTO) processes
- Completion of detailed isolation and LOTO plans and advanced permit to work (PTW) preparations
- Establishing updated operating procedures for unit shutdowns, decontamination and startups—this schedule should be integrated with the TAR plans
- Increasing the frequency of TAR communication meetings and risk/mitigation work sessions
- Completion of Class 3 estimates/schedule (± 10%)
- Executing contracts
- Establishing all TAR finance team members
- Approving the final appropriation request.

Phase 4: Pre-TAR work execution. Pre-TAR work is often started months before the facility is shut down, with offsite prefabrication, mobilizing material and equipment to site, and onsite work that can be started while the facility is operating. Careful coordination between the TAR execution team and site operations coordinators is needed for safe simultaneous operations (SIMOPS), energy isolation and PTW control, and ensuring laydown and pre-work do not interfere with safe operations.

Phase 4 deliverables and activities include:

- Finalizing the staffing plan and filling positions
- Pre-TAR work in progress and on schedule
- Completion of all pre-fabrication should be completed before Phase 4, including CAPEX project pre-work
- Erecting all early scaffolding, and staging isolation blinds onsite

- Bagging and tagging materials
- Daily field personnel safety, TAR shift and SIMOPS coordination meetings should be in progress
- Training plans for contractors should be put into action
- Shift-by-shift progress tracking and reporting should be running.

Phase 5: TAR work execution. Shutdown, decontamination and isolation of the unit(s) should progress in Phase 5. In the initial days of this phase, most of the TAR execution teams' work will be to support operations decontamination and safe isolation steps that were planned in detail in Phase 3.

Issues inevitably arise during TARs, and it is critical to have resources and experienced experts available to review issues and rapidly develop solutions to keep the TAR on schedule.

Key activities in Phase 5 are:

- Shutdown unit(s) and complete cleanup, decontamination and isolations, as planned
- Execute the TAR plan/schedule
- Execute the HSSE plan
- Continue execution shift meetings:
    - Personnel safety
    - TAR progress/issues resolution process
    - SIMOPS
- Daily concise management reporting (HSEE, progress, critical path, budget, issues and resolutions)
- QA/QC plan execution, including a robust flange management program
- Strict blind and isolations management (controlled by the operations team)
- Pre-commissioning checks and PSSRs
- Deisolation (controlled by the operations team)
- Commissioning, startup and ramp-up
- Waste management follow-up/disposal.

Phase 6: Post-TAR activities, documentation and performance analysis. Post-TAR activities continue after the unit is back in operation to remove equipment and materials, finalize painting and insulation, and complete other work that can be done while the unit is operating. Continued attention to work permitting and SIMOPS are especially important at this time, recognizing that the workforce may be fatigued.

Detailed documentation of TAR activity is a best practice. While equipment records systems should contain details of inspections, repairs and modifications, a narrative summarizing TAR progression, inspections, repairs and recommendations for the next TAR is invaluable input for the future. Lessons learned should be documented in a concise way to be usable for future teams.

Key Phase 6 deliverables include:

- Cleanup and demobilization (continue SIMOPS process for post-TAR work)
- Surplus material disposition
- TAR equipment inventoried, processed and stored

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- TAR work orders closed
- Completion of post-TAR report, including:
  - HSSE results
  - Work execution results, including summary of inspections and repairs, and a clear definition of work deferred to the next TAR
  - Schedule and budget results
  - Startup and initial post-TAR operations performance
  - Contractor feedback
  - Document lessons learned
- Document process improvements
- Audit the TAR completion.

Metrics and KPIs. KPIs are commonly used during the TAR execution phase, but often not established and reviewed for earlier phases of TAR planning and development. Establishing competitive targets and monitoring associated metrics in planning, scope development and detailed preparation phases are critical to a TAR's success. Creating a balanced mix of metrics with lagging indicators (monitoring outcomes) and leading indicators (monitoring actions that influence outcomes) is most effective (**FIG. 2**).

FIG. 2. Effective metrics drive improved performance. Illustration courtesy of Roman Tingle.

Facility leadership teams should ensure that performance targets are set, routinely review metrics to assess progress toward the desired outcomes, and provide appropriate feedback and consequences (positive or negative). Metrics without serious reviews and consequences are of little use for reinforcing good progress or for making course corrections when needed.

FIG. 3 provides a table of commonly used TAR metrics. HP

Category	Measure	Description	Formula	Unit of Measure	Target
Planning	Activity Tracking Tool	Measures level of preparation per activity.	Percent completion per activity.	%	>90%
Planning	Work List Freeze date	Key measure when ensuring sufficient time for Engineering, Fabrication and Mobilization.	# of days prior to execution start date.	Days	120 days
HSSE Input	STOP Cards	# STOP cards conducted during execution.	Actual # STOP Cards / # Man hoursx100.	%	>3%
HSSE Input	Safety Meetings	# Safety Meetings conducted during execution.	Actual # conducted vs. Planned	%	100%
HSSE Input	Safety Inductions	# Safety Inductions completed prior to execution.	Actual # conducted vs. Planned	%	100%
HSSE Output	HIPO (High Potential Incident)	# HIPOs during pre-TAR & execution.	# HIPOs.	#	0
HSSE Output	# Days Away from Work Cases (DAFWCs)	# DAFWCs during pre-TAR, execution and Post-TAR.	# DAFWCs.	#	0
HSSE Output	# First Aid Cases	# First Aid cases during pre-TAR and execution.	# First Aid cases.	#	0
HSSE Output	# Near misses	# Near Misses during pre-TAR and execution.	# Near Misses.	#	0
HSSE Output	# Recordable spills	# Recordable Spills during pre-TAR and execution.	# Recordable Spills.	#	0
HSSE Output	Safety Critical Equipment (SCE) Backlog reduction	SCE Backlog reduction as a result of the TAR. All 'TAR related' SCE work orders and PMs due before the scheduled TAR completion date plus 6 months to be complete by the end of execution.	Number of TAR related SCE Work Orders & PMs due before the scheduled TAR completion date plus 6 months, outstanding on completion of the TAR	#	0
Quality	Leaks	QA/QC measure by recording # leaks on disturbed joints during pressure testing and re-commissioning of equipment.	# Leaks vs. # disturbed closures	%	0
Quality	Re-work	# required re-work during or following TAR related activity (as stated on activity tracking tool). Includes all disciplines, e.g. Mechanical, Electrical and Instrumentation.	# Rework incidents vs. # Activities	%	<5%
Scope Control	Scope challenge workshop completed before scope freeze	Completion of interactive scope challenge activity to remove unnecessary scope and scope that does not require TAR	Scope Challenge date vs. Scope Freeze Date	Date	
Maintenance Scope Control	Maintenance Scope growth after scope freeze	Measures effectiveness of scope definition and scope control process	# additional Maintenance scope items added after scope freeze Estimated Labor Hours for additional Maintenance scope vs. Total Estimated Labor Hours	# %	0 <2%
CAPEX Project Scope Control	CAPEX Projects Scope growth after scope freeze	Measures effectiveness of scope definition and scope control process	# additional CAPEX scope items added after scope freeze Estimated Labor Hours for additional CAPEX scope vs. Total Estimated Labor Hours	# %	0 <2%
Discovery Work Scope Control	Discovery Scope during Turnaround	Measures effectiveness of scope definition and scope control process	# discovery scope items added during Turnaround execution Estimated Labor Hours for discovery worked vs. Total Estimated Labor Hours	# %	0 <5%
Schedule	Overall TAR Duration	Measures effectiveness of TAR preparation and accuracy of the execution plan. Includes ramp down and ramp up duration.	Total duration of the TAR (full rate through to first gas/oil).	Hours	
Schedule	Actual vs. Planed TAR Duration	Measures effectiveness of TAR preparation and accuracy of the execution plan.	Actual duration of the TAR (from production cessation through to first gas/oil) vs. Planned (as stated at end of Phase 3 Detailed Planning)	%	90-105%
Schedule	Operations Shutdown / Cleanup / Startup Window Duration	Measures effectiveness of Operations TAR preparation and accuracy of the procedures and execution plan.	Actual duration of the TAR shutdown / cleanup / startup activity vs. Planned (as stated at end of Phase 3 Detailed Planning)	%	90-105%
Schedule	Actual vs. Planned Mechanical Window Duration	Measures effectiveness of TAR preparation and accuracy of the execution plan.	Actual duration of the TAR Maintenance window vs. Planned (as stated at end of Phase 3 Detailed Planning)	%	90-105%
Manpower	Direct Execution Man-hours	Measures size and scale of the TAR.	Does not include Supervision, Operations, or support staff e.g. store men, forklift drivers, cleaners, etc.	# Man-hours	

FIG. 3. Commonly used TAR metrics.