# Are You Ready for Your Next Turnaround?

## Guide to Effective Turnaround Planning

VISIT E2G.COM
CONTACT OUR TEAM SALES@E2G.COM
TECHNOLOGY FORWARD
P: +1.216.283.9519
EQUITY ENGINEERING

# Make the Right Decisions at the Right Time to **Maximize Your Return.**

Turnarounds (TARs) are one of the most significant portions of a plant's yearly maintenance budget, and the level of readiness directly impacts the bottom line. Operation teams plan for production loss during the outage; however, there is an incredibly high probability that the shutdown window will lengthen due to unexpected damage or unplanned maintenance. On average, 66% of TARs finish late and are over budget by 10% or more. In fact, 40% of TARs exceed budget by 30% or more, costing facilities millions of dollars. Plants will realize large economic advantages when TARs finish on time and on budget.

This Turnaround Planning Guide provides several strategies that support the successful planning, execution, and post-mortem of your next TAR. Equity Engineering offers proactive TAR support to help you deliver a TAR on time and on budget, plus improve equipment reliability and reduce operational risks.

## Estimated Average TAR Outage Costs

**15-year average** +

**$17.50 USD of profit margin per barrel of crude** +

**145,000 bpd production rate** =

**$2.5 million/day ($105,000/hr) in lost production**

A shift in maintenance scope may extend the TAR, which results in lost opportunity/production costs plus any added maintenance costs.

## What's the Difference?

TAR and shutdowns are not interchangeable; rather these two terms are unique and provide their own set of benefits to a plant. A TAR cannot occur without a shutdown; however, a shutdown can occur without a TAR.

### SHUTDOWNS

- Shutdowns are the complete halt to production and operations at a unit or plant
- Many shutdowns are unplanned and occur after an equipment failure or an accident
- Planned shutdowns are turnarounds
- Allows for internal inspection of pressure vessels, tanks, and other components

### TURNAROUNDS (TAR)

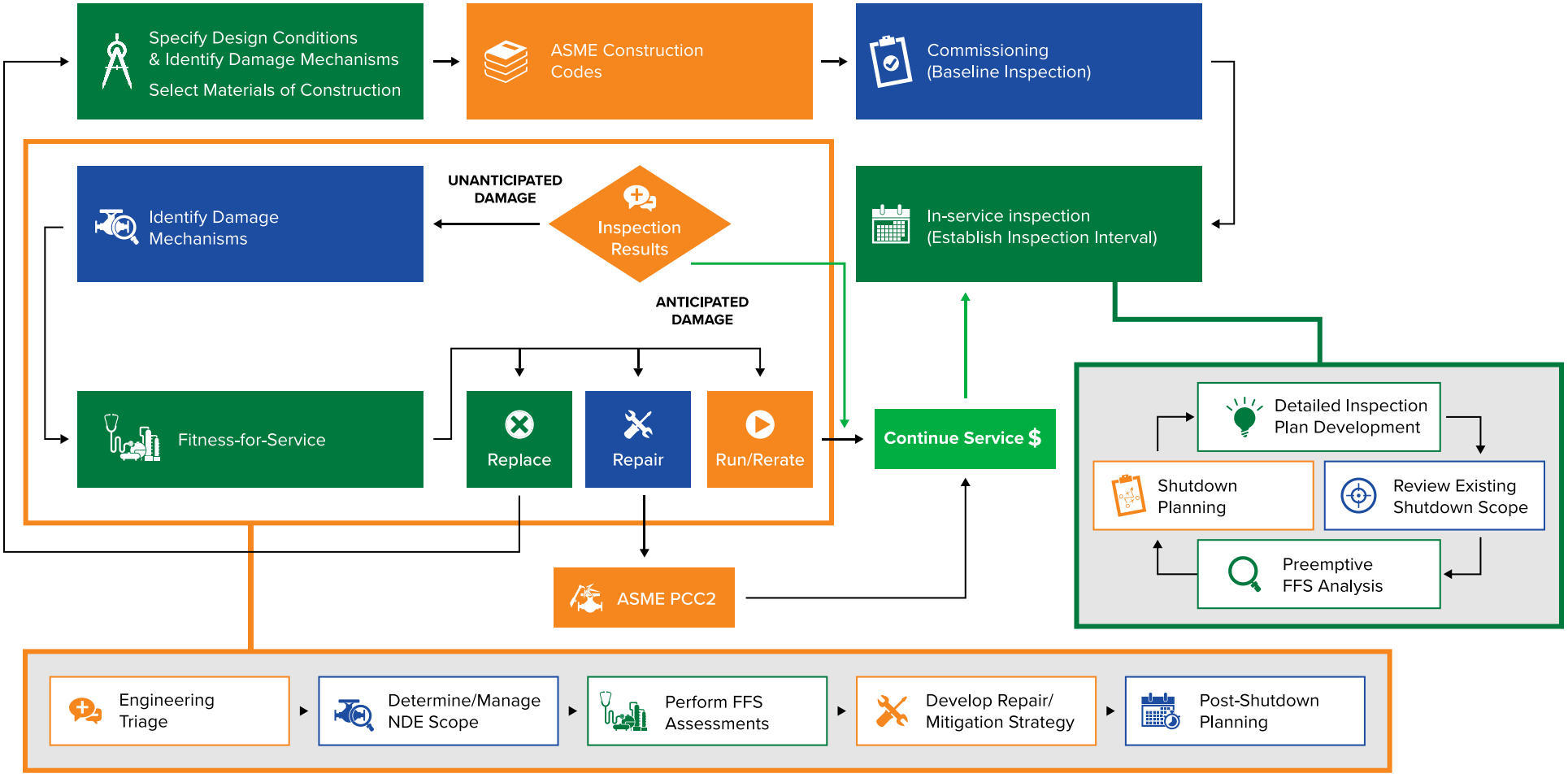
- Scheduled shutdown to perform maintenance, repairs, and retrofits on a unit or the entire plant
- Typically performed every 3-5 years
- Resolve maintenance issues and improve the efficiency of the plant
- Help fix or prevent problems before becoming a costly outage or accident
- Results in plant returning to peak performance levels when production begins again

# Invest in **Reliability.**

TARs are an investment in the reliability and future performance of your plant's assets. Implementing a three-step strategy with a problem-solving team will help you plan and execute a successful TAR.

**Pre-Turnaround Planning** » **Turnaround Execution** » **Post-Turnaround Planning**

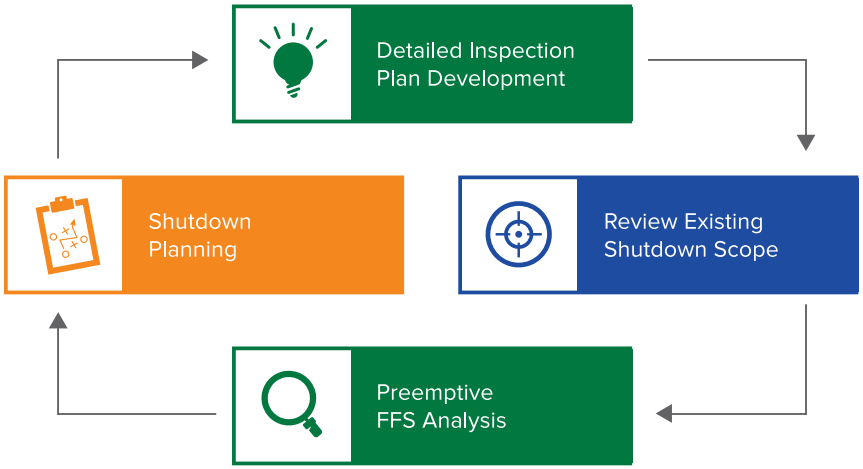
The lifecycle management diagram provides a visual representation of the various stages of equipment life and alignment with different industry codes and standards.



# Pre-Turnaround **Planning**

When evaluating the scope of work, the first premise that should be challenged is “what assets am I inspecting, and why?” The overall cost impact to the facility can be managed by minimizing the unplanned work scope and proper planning to minimize the overall downtime required to complete the work scope. Additionally, if TARs are executed properly, then the frequency of unplanned shutdowns should greatly diminish, again supporting the annual budget in addition to improving safety.

Many modern mechanical integrity (MI) programs will rely on risk-based inspection (RBI) to determine what assets will require inspection for a specific TAR. In general, a plant will aim for a maximum allowable risk target (often company-specific), and if a piece of equipment is approaching the allowable risk target, then an inspection will be performed.




## READ MORE

“Industry Insights: The Importance of Pre-Turnaround Reviews” by Paul J. Kowalski and Brian L. Jack

In this article, you’ll learn how RBI helps to manage the costly impact of turnarounds through proper pre-planning to minimize the overall downtime.

## BEST PRACTICE:

Begin TAR planning **several years before** the scheduled shutdown to minimize any unplanned work scope and reduce the overall downtime.

# Pre-Turnaround Planning

| Services | Description | Benefit |
|---|---|---|
| **Conduct Damage Mechanism and Integrity Operating Window (IOWs) Reviews** | Complete at least 18 months before the scheduled TAR to:<br>• Identify needed metallurgy upgrades or design changes<br>• Minimize surprises or costly work scope additions during the TAR | • Minimize risk of process leaks and unplanned shutdowns<br>• Improve inspection effectiveness and TAR planning |
| **Review Existing Turnaround Scope** | Engineering team to review TAR plan and consider:<br>• Opening, inspecting, and cleaning the correct vessels<br>• Contingency plans to address any potential issues | • Increase the effectiveness of the TAR<br>• Confirm the existing inspection plans will be effective and use the appropriate technology |
| **Assess Inspection Plan** | • Review and evaluate the inspection plan for each component prior to the inspection date<br>• Determine if inspection plan is intrusive or non-intrusive, and note that any intrusive inspections may also require confined space entry and other permits before the TAR<br>• Prioritize inspection plan to highest-risk locations | • Preventing “unnecessary” inspections can save money and reduce personnel time<br>• Streamline maintenance and inspection actions during the actual TAR |
| **Proactive/Preventative Fitness-for-Service (FFS) Analysis** | FFS analysis should include:<br>• Minimum Pressurization Temperature (MPT) assessment to guide de-pressurization/shutdown procedures and consider future start-up<br>• Critical flaw sizes available for equipment to give go/no-go sizes to inspection – Local Thin Area (LTA) assessments to give guidance for “crack removal allowance”<br>• Minimum required thickness ($T_{min}$) with delivery in software for quick FFS | • Reduce lost revenue by improving start-up and shutdown time<br>• Guide inspection personnel for effectively managing the identified damage<br>• Minimize risk of crack-like flaws (e.g., brittle fracture)<br>• Fill in the gaps for developing inspection plans and establishing remaining life for damage mechanisms not covered by RBI programs |

# Developing IOWs **at a Facility**

## Integrity Operating Windows Program Requirements Checklist

Well-developed IOWs support good communication across all departments in a facility. IOWs proactively prevent loss of containment or unplanned showdowns by identifying the operating limits that allow process unit operation for long or short periods of time while avoiding significant mechanical integrity damage. Use this checklist to develop clearly written IOWs.

### BEST PRACTICE:

CCDs and IOWs are reliability tools that help move a plant organization from **reactive to proactive**.

## Does Your Written IOW Procedure Include These Elements?

| | Y | N |
|---|---|---|
| Will the IOWs be implemented by a multidisciplinary team of SMEs? | ☐ | ☐ |
| Have the roles, responsibilities, and qualifications been identified for each team member? | ☐ | ☐ |
| Have the required data and information been reviewed? | ☐ | ☐ |
| Is the depth of design and operation analysis clearly outlined? | ☐ | ☐ |
| Is the IOW program integrated with existing process safety management (PSM) and other operational programs? | ☐ | ☐ |
| Is there a clearly defined IOW implementation plan? | ☐ | ☐ |
| Have all stakeholders agreed upon the strategy for outlining IOW documentation and updates? | ☐ | ☐ |
| Do all stakeholders know how to handle suggested monitoring instrumentation/controls and/or sampling points? | ☐ | ☐ |
| Has the frequency of subsequent IOW reviews been identified? | ☐ | ☐ |
| Has the process ownership been established? | ☐ | ☐ |
| Is it clear how to communicate IOW exceedances and to whom? | ☐ | ☐ |
| Is there a required follow-up plan (e.g., modify inspection plans or investigate exceedances)? | ☐ | ☐ |

> **VAST KNOWLEDGE AND EXPERIENCE.** HELPFUL ATTITUDE. EASY TO DEAL WITH. WE PLAN TO CONTINUE CARRYING OUT CCD ASSESSMENTS ON THE REST OF OUR PLANT.
>
> *CCD Assessment, June 2023*

# Developing Consistent CCDs **Across a Facility**

## Corrosion Control Documents (CCDs) Program Requirements Checklist

A CCD summarizes a unit's process description and its corrosion systems or loops. A comprehensive CCD can include more than 75 damage mechanisms that range from localized to general and from stress corrosion cracking to mechanical embrittlement. Maintaining CCDs can prevent unexpected leaks or deterioration of equipment and materials during a shutdown.

Use this checklist to develop a consistent set of CCDs that can be used as a basis for IOW determination.

### BEST PRACTICE:

To support mechanical integrity best practices, CCDs should be updated every five years*, or after every major turnaround.

** Concurrently with unit's process hazard analysis (PHA)*

## Does Your Written IOW Procedure Include These Elements?

| | Y | N |
|---|---|---|
| Materials of construction | ☐ | ☐ |
| Equipment design (U-1) | ☐ | ☐ |
| Piping specifications | ☐ | ☐ |
| Process description | ☐ | ☐ |
| Process operating data including pressure, temperature, water samples, and process samples | ☐ | ☐ |
| Material & heat balance | ☐ | ☐ |
| Types of contaminants, such as $H_2S$, ammonia, chlorides, etc. | ☐ | ☐ |
| Process flow diagrams (PFDs) | ☐ | ☐ |
| Inspection summaries and histories | ☐ | ☐ |
| Risk-based inspection (RBI) data | ☐ | ☐ |
| Operational history, including management of change, failure analysis, root cause analysis, etc. | ☐ | ☐ |

# Identify a **Problem Solving Team**

The best approach to improve overall efficiency and reduce lost opportunity costs is to create a problem-solving team. This multidisciplinary team should include experienced engineers with expertise in damage mechanisms, fitness-for-service (FFS), ASME and API equipment and piping design, welding and materials, repair plans, plant operations, and TAR execution. A properly staffed TAR problem-solving team will resolve equipment inspection discoveries quickly and efficiently, thereby minimizing lost opportunity costs and reducing the number of unnecessary repairs.

If your plant is lacking some of the above skill sets, Equity is available to supplement your plant personnel and help your team with TAR planning, operations, and execution. Equity brings our extensive industry experience to each project. We were the lead author for several industry standards, including Damage Mechanisms (API 571), Fitness-for-Service (API 579-1/ASME-FFS-1), and Equipment Design (ASME Section VIII Division 2). Our team also actively participates on several codes and standards committees, including API 579 and various API equipment standards, ASME B31.3, ASME Section VIII Divisions 1 and 2, NACE, etc.

A properly staffed problem-solving team can help reduce the resolution time for new discovery and in turn minimize the potential for a possible TAR extension and the associated millions per day in lost opportunity costs.

→ READ MORE

"Industry Insights: Turnarounds: Executing a Problem-Solving Team"

This article focuses on the advantages of a problem-solving team to resolve equipment inspection discovery and efficiently minimize lost opportunity costs.

## BEST PRACTICE:

It is often cheaper to **"reserve"** the problem-solving team resources in advance rather than trying to source emergency assistance when the damage is identified.

### EQUITY'S TECHNICAL STRENGTH

**1400+**
COMBINED YEARS OF EXPERIENCE

**20**
AVERAGE YEARS OF EXPERIENCE

"

THE TEAM WAS GREAT TO WORK WITH, **I HAVE NO COMPLAINTS.** THEY WERE VERY SUPPORTIVE AND THEY ALWAYS GET WHAT I NEED.

*Refinery Rebuild & Start-up Problem-Solving Team, January 2023*

# Turnaround **Execution**

Measuring the success of a TAR is determined by completing inspections of all equipment within the planned scope and carrying out all necessary FFS assessments and repairs during the scheduled outage window. To achieve this, a plant needs to have a dedicated and experienced problem-solving team available who can contribute to the TAR's success. This team plays a critical role in identifying and qualifying unanticipated damage, guiding inspection efforts, and providing immediate recommendations for weld repairs and post-weld heat treatment (PWHT) procedures. Their expertise and assistance are invaluable in maintaining the integrity and efficiency of the entire TAR process. On-site or virtual TAR support from experienced subject matter experts is intended to improve communication, control project costs, and reduce schedule delays while maximizing safety and long-term equipment reliability.

- Engineering Triage
- Determine/Manage NDE Scope
- Perform FFS Assessments
- Develop Repair/Mitigation Strategy
- Post-Shutdown Planning

## BEST PRACTICE:

During a TAR, the problem-solving team should **meet daily** to log new discoveries, discuss resolution plans, and provide status reports on previously found issues.

# Turnaround Execution

| Services | Description | Benefit |
|---|---|---|
| **Engineering Triage** | On-site support engineer works with site inspection and engineering staff to:<br>• Review inspection findings and triage all run, repair, or replace decisions<br>• Liaise for large or more complex FFS assessments<br>• Guide inspection efforts related to any FFS evaluations<br>• Assess PWHT layouts<br>• Develop NDE scope for FFS assessments | • Improve response time on inspection findings<br>• Decrease time to arrive at a decision<br>• Improve reliability<br>• Save time and money |
| **Perform FFS Assessments** | • Perform on-site Level 1 or Level 2 FFS assessments<br>• Liaise the more complex Level 3 assessments to the main office<br>• Run the spectrum from simple $T_{mins}$ to complex cracking and creep evaluations | • Perform FFS assessments quickly and effectively<br>• Facilitate run/repair/replace decisions<br>• Improve reliability – saves time and money |
| **Develop Repair & Mitigation Strategies** | Engineer will assess all repair recommendations to:<br>• Develop repair plans for the mechanical contractor, including sketches, calculations, welding parameters, etc.<br>• Employ FFS methods to optimize repair scope – e.g., large-corroded areas<br>• Reduce weld buildup area via FFS LTA assessments | • Provide ability to tie in with FFS repair plans to ensure that repairs are optimized for the desired future operation cycle<br>• Save time and money<br>• Improve reliability |

# Post-Turnaround **Planning**

Once a TAR is successfully completed, the execution should be reviewed for lessons learned and to identify potential improvements for future TARs. “Choke points” or considerable delays that arose should be reviewed to understand why they occurred and determine how these can be prevented in future TARs. You will increase the effectiveness of future TARs by summarizing the findings and reviewing recommendations and follow-up actions.

## BEST PRACTICE:

The post-TAR review is critical, as it is estimated that approximately **80%** of the scope for the next TAR can be identified upon the completion of the TAR.

| Turnaround Stages | Description | Benefit |
|---|---|---|
| **Post-Turnaround Debrief & Planning** | Turnaround team reviews TAR and collaborates to:<br>• Summarize findings and follow-up actions (e.g., replacement, analysis, future inspection)<br>• Update and evergreen risk-based inspection (RBI) plan for future intervals<br>• Modify damage review documents (CCDs, MOEs) | • Provides access to expert debrief of shutdown findings<br>• Develops evergreen RBI plans<br>• Increases turnaround effectiveness |

# How Ready Are You for Your **Upcoming Turnaround?**

| | Y | N |
|---|---|---|
| Are you inspecting the right equipment, units, or components? | ☐ | ☐ |
| Is your inspection plan prioritized to find the highest risk items at the beginning of the TAR? | ☐ | ☐ |
| Have you conducted a proactive FFS assessment? | ☐ | ☐ |
| Have you identified the problem-solving team to support the TAR? | ☐ | ☐ |
| Do you have the right NDE services mobilized for the plan? | ☐ | ☐ |
| Are you ready to guide inspectors on exactly what damage to look for? | ☐ | ☐ |
| Do you have solutions planned for expected damage? | ☐ | ☐ |
| Do you have the personnel available to make quick decisions? | ☐ | ☐ |

## Choose Equity for Your Next Turnaround

The three key steps provided will help plants overcome challenges, reduce delays and cost overruns, and improve overall TAR performance. Equity has the engineering expertise and turnaround knowledge to support refineries, petrochemical plants, and other industrial processing facilities. By leveraging our expertise, plants can enhance their TAR processes to achieve greater operational efficiency and profitability.

Equity's Mechanical & Structural Engineering team is internationally recognized as leaders in aging infrastructure services and support. As pioneers of FFS technologies and lead investigators on many international standards, we leverage our design and in-service expertise to ensure assets are safe to operate even with the presence of damage or defects.

We offer remote and on-site engineering support during plant outages. Our pre-coordinated TAR support enables our clients to expedite decisions during time-critical projects. When employing Equity for shutdown support, you will benefit from the experience and expertise of the on-site engineer, plus you will have unlimited access to numerous Equity subject matter experts (SMEs).


**CONTACT OUR TEAM**

Sales@E2G.com

+1.216.283.9519

**VISIT**

www.E2G.com