

# OPERATIONAL READINESS WITHOUT DELAY



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## What is Operational Readiness?

A quick Internet search for “Operational Readiness” (OR) will uncover a range of industry examples including many from the military and specifically from NASA where “Mission Operations Readiness” or MOR was a primary focus leading up to each shuttle launch, particularly after the Challenger disaster.

As major capital projects in the oil and gas and chemical industries have become increasingly larger and more complex, operational readiness has also become a key focus of program directors and megaproject managers worldwide. The biggest challenge for these projects is to bring them online, on-schedule and within budget despite shifting resource availability, supply chain uncertainties and a broader lack of operational readiness that inevitably delays startup. Larger project size and investment also mean that any delay has a correspondingly larger financial impact on the owners and supply chain providers.

Because project delays cascade from inception to completion, accelerating operational readiness early in the project is a proven approach to help avoid delays during commissioning and startup. Such delays are often caused by, or increased by, improper or insufficient mechanical completion, inadequate operator training and poor procedures.

This paper explores the workforce development challenges to achieving operational readiness and focuses on key opportunities to accelerate that goal by developing key **workforce performance tools** (procedures and training) early in the project lifecycle. Effective and timely training and accurate procedures have been shown to affect the project from early stage commissioning through final acceptance testing and full production. These tools are also a primary line of defense to prevent incidents and near misses – *more than half of which occur during plant startup, shutdown and other nonroutine operations.*

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Developing **key workforce performance tools**, like procedures and training, early in the project lifecycle can help accelerate operational readiness.

### Megaprojects present Mega-challenges

Large capital projects and megaprojects directly impact the bottom-line of an organization during construction and for many years after the plant is on-line and making product. Despite the enormous cost of capital projects, an Ernst & Young Study of 365 global oil and gas megaprojects found that **64% faced cost overruns** and **73% experienced schedule delays**.<sup>1</sup>

These cost and schedule overruns delay unit startups further adding to the overall project costs. Accenture Research found that startup delays resulted in approximately **\$700,000 of lost cash flow per day** for a new North American ethylene cracker in 2011.<sup>4</sup>

The new reality for capital expansion projects is:

- 1. Increasingly larger scales and technical complexity
- 2. Uncertain regulatory requirements
- 3. Challenging geographic locations – resource skill base, supply chain risks, political instability
- 4. Constant workforce fluidity – staff changes
- 5. Urgent market pressures to produce

For a megaproject manager, this new reality creates the necessity to plan and deliver earlier in the project life-cycle than perhaps ever before. From design, construction and supply chain management to regulatory compliance and resourcing, the project focus must be on readiness for commissioning, startup and operation.

As shown in **Figure 1**, no segment of the industry is exempt from schedule and cost overruns and therefore the benefits of an operational readiness focus apply equally to refineries and ethylene crackers, deep-water oil and gas platforms, pipelines and LNG facilities.

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*Source: <sup>1</sup>Ernst & Young Study*

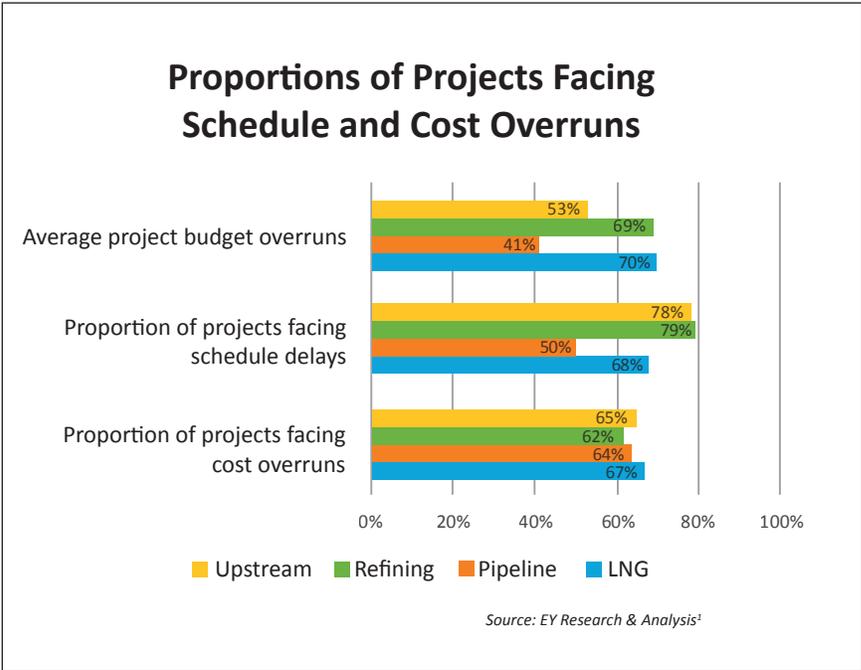


Figure 1

## Reduce delays through Operational Readiness

Schedule and cost overruns can be attributed to a range of complex variables related to failure to integrate engineering, construction and operations effectively leading to an ultimate lack of operational readiness. Recent Deloitte case studies found that up to **30% of the potential value of a major program can be destroyed as a result of operational readiness failure.**<sup>2</sup> Many of these failures result directly from the complex interplay between technology, infrastructure, people and process.

Often, the 'people' side of achieving operational readiness presents the greatest challenge. How can these challenges be overcome? **Accelerating operational readiness is one way.**

When startup occurs without issues, full production is achieved more quickly and overall cost-to-deliver is reduced. Focusing early attention and tracking key performance indicators (KPIs) on issues that drive operational readiness may be one of the most powerful tools in the project management toolkit. Any incremental investment in operational readiness resources or tools is far outweighed by reduced schedule and cost delays. Operational readiness improves the transitions from engineering to construction to producing asset. As mentioned earlier, these benefits grow as the projects become increasingly larger.

## Adopt Operational Readiness best practices

Creating an operational readiness focus for major capital projects and accelerating operational readiness are best practices of high performing organizations. To achieve these, high performing organizations:

- Plan early for startup and operations - consider production issues earlier in design phases, involve operations stakeholders in the design phases
- Verify and establish consistency and appropriateness of operations and maintenance procedures in advance of delivery
- Develop procedures during construction to ensure accurate reflection of as-built information
- Involve operations in determining skills required to startup and operate the facility
- Prepare training programs during construction phases
- Begin operator training in parallel with final construction phases

# 30%

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Source: <sup>2</sup>Deloitte Case Studies

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Figure 2 illustrates the recommended timing to begin working on key human performance factors like procedures and training.

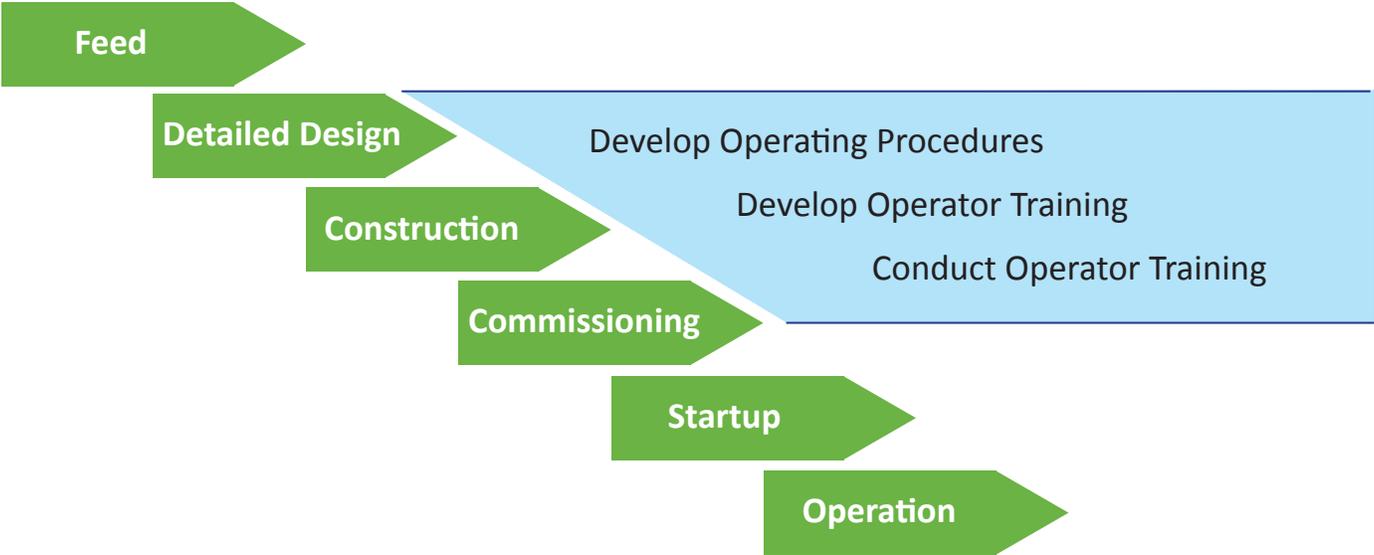


Figure 2

Focus on Workforce Development early

Gains from reduced delays related to design, procurement and contracting can be lost quickly if human performance factors impede timely and safe commissioning and startup of the new processes. During these phases, the accuracy of information and the competency of the operations workforce executing the tasks are paramount.

Since being prepared to operate requires accurate and relevant information, receiving inconsistent sets of procedures from equipment suppliers, EPCs and subcontractors can create even further delays. Each of these suppliers has their own approach to developing system information and procedures that may not align with the owner’s operations culture. In addition, the system information is often based on a ‘standard design’ that does not accurately reflect the site-specific design. For these reasons, it is important to establish requirements for content and format early in the process and engage professionals in training manual and operating procedures development to ensure that your operations workforce receives exactly what they require and can use from day one.

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*...engage professionals in procedure and training manual development to ensure that your operations team receives exactly what they require...*

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Ensuring the accuracy of drawings, technical information and procedures should come naturally to most major project teams. However, aligning and integrating that information into a front-end strategy that will train and assure the competency of operations and maintenance personnel is a project often assigned to resources who may have more availability than experience. Since training can include a wide range of topics from safe work practices and permitting, to mandated regulatory topics to equipment-specific vendor training and simulation, it is vital that the training team be well-versed in regulatory requirements, technical terminology, operational concepts, technical disciplines and job roles. These are necessary, in addition to a practical understanding of instructional design, gap assessment, competency assurance and the integration of procedures into pre-startup training programs.

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## Evolving Regulatory Environment

Just as preparing the operations workforce for commissioning and startup is an important driver for effective and accurate training and procedures, so are the various regulatory requirements that can risk being overlooked with a focus on “first oil” or “startup.” Regulations like BSEE’s Safety & Environmental Management Systems (SEMS) for upstream, DOT Operator Qualification (OQ) for midstream, OSHA Process Safety Management (PSM) for downstream, among others, all require that the workforce be trained and competent and have accurate procedures to ensure personal and process safety. Any non-compliance with these regulations present major hurdles to on-time and safe startup and operation.

In fact, an Accenture survey of major capital projects in the utility industry<sup>6</sup> found that **54% of respondents felt that regulatory compliance was the greatest challenge** and the primary cause of schedule and cost overruns for major projects. This challenge is further complicated in an evolving and uncertain political and regulatory environment. Inevitably, prior requirements will be replaced with new requirements, and mid-stream oil and gas projects will need to adapt and adjust their training or procedures to accommodate the new mandates.

### Critical Human Performance Issues...

- Complete and accurate drawings
- Complete and accurate procedures
- Procedures compatible with operations culture
- Training based on as-built conditions
- On-time training of operations personnel

While the primary intent of these regulations is accident prevention, compliance will also support smoother and faster startups with minimal trips or upsets. The tools developed to ensure that workers can safely and effectively perform their jobs are the same tools that will increase operational readiness and reduce time to production.

## Changing Workforce Demographics

For any major project, assessing and hiring experienced and qualified resources has always been a challenge. Today's workforce is more dynamic than at nearly any time in the last 50 years. The aging workers are approaching, and often choosing, retirement just as new workers enter, often with little operations experience or technical training. This "brain drain" has been discussed and debated for many years, but the effects are becoming more apparent in all segments of the industry. While many of the older, experienced workers have re-entered the workforce to run major projects, there is little chance they will remain once the assets are operational. This means their knowledge must be captured in training and procedures, and transferred to the younger operations crews.

This dynamic also impacts the way in which technical information should be delivered. Increasingly, training and technical instructions are presented in smaller chunks and are delivered in "YouTube-like" videos or simulation scenarios that resemble video games. Blended learning techniques apply a range of learning styles using mixed media that might include a short on-line video segment followed by an interactive simulation and culminating in a hands-on exercise using a process simulator.

New learning methods and performance support technologies will continue to impact the way in which information is delivered during all phases of a capital project. From web-based training modules for policies and mandated topics to self-study manuals, hands-on sessions and process simulations, as well as operating and maintenance procedures to support operational readiness in a major project will often require an extended performance solutions team with broad training expertise.

Today's workforce is more dynamic now than at nearly any time in the last

**50 years.**

## Prepare and provide training that delivers

Training program manuals, facilitator guides, exercises and evaluations should reflect the process and equipment accurately and should apply sound instructional best practices. It is vital that training development isn't just an adjunct assignment for a project or design engineer. For training to deliver results, it should be developed by qualified training professionals working in conjunction with the operations and equipment experts. Training that applies blended learning methods including self-paced, web-based, walkdowns and simulations will reach the broadest audience and will deliver the best results in terms of comprehension, competency and confidence.

Since new projects will require a combination of equipment vendor and site-specific training content, it is vital that the training developers understand how to best integrate various sources into a logical and fit-for-purpose learning experience. The foundation of most programs will lie in the system training manuals that document critical information including the purpose, equipment, operating sequences, parameters, hazards and consequences of deviation for each major system. This information, whether electronic or printed, will provide a resource for a range of training to support process operations and maintenance.

Effective training development requires access to all technical drawings including process flow diagrams (PFDs) and piping and instrumentation drawings (P&IDs), in addition to the process and equipment descriptions and manuals provided by the various vendors and EPCs. This includes major components, process skids and major system packages. Sometimes, the EPC may consolidate much of this information into a single repository that is delivered as part of the design and construction package. It is vital to incorporate accurate and complete operating procedures into the training since these procedures provide a framework for training on the sequence for process startup, monitoring, troubleshooting and shutdown.

Training and operating procedures development can occur in sequence or in parallel depending on project schedules, resource availability and budgeting, but it is important to integrate these efforts to ensure accuracy, continuity of information, ease of management of change, and ultimately the logical comprehension and competency of process operators. Training for process systems should follow a logical sequence that progresses from a process overview to detailed equipment descriptions

### Choose a Procedures and Training Provider Who Has:

- In-Depth Procedure Experience
- Solid Operations Experience
- An Instructional Systems Design (ISD) Training Philosophy
- A Proven Track Record in the Industry
- Field-Proven Formats

to specific actions and precautions. The following is a typical outline of essential operations training topics for new or existing processes:

**Process Description**

- Purpose of system and major products
- Process overview
- Inputs and outputs
- Key processes (reaction, compression, etc.)
- Process chemistry (hazards, materials)

**Major Equipment**

- Component types and function
- Key operating considerations

**Startup Sequences (Procedures)**

- Initial, normal/routine, startup following maintenance
- Special procedures\*\*
- Initial conditions
- Utilities and support systems
- Key valve alignment
- Precautions

**Operating Parameters (Procedures)**

- Monitoring critical variables
- Operating limits/alarms
- Consequences of deviation

**Shutdown Sequences (Procedures)**

- Normal/planned shutdown
- Emergency shutdown

**Process Troubleshooting**

- Alarm management
- Major equipment

General

Specific

*\*\*For initial commissioning and startup training, there will be additional “special” procedures to be addressed including flushing, nitrogen purging and pressure testing.*

The training content outlined above can be developed and delivered in a variety of formats and methods. The foundation will most often be in the form of the system training manual mentioned earlier (sometimes called the operating manual) and should include all the information in the outline. From that basis, specific self-study guides, computer-based modules, plant walkdowns and even dynamic simulations can be developed to facilitate delivery depending on project needs and budgets.

Timing for training, especially pre-commissioning training is often driven by the availability of operations personnel who are also focused on mechanical completion and acceptance testing. If possible, training should be delivered in shorter sessions or modules rather than a non-stop marathon. This “chunking” of the training not only permits time for the operators to complete other critical assignments but also provides the opportunity to reinforce training with hands-on experience during commissioning and startup activities. While this approach extends the “training” bar on the project schedule, it will pay dividends in a better prepared workforce and smoother startups.

In the end, true operational readiness requires that individuals who will startup and operate the process have the knowledge and skills to safely and effectively bring the plant online. Training based on the foundation outlined here will satisfy the operational readiness requirement but will also help ensure safe startup performance and compliance with applicable regulations for hazardous accident prevention.

## Develop accurate and effective Operating Procedures

The need for effective operating procedures has been confirmed in countless studies related to major accident causes. In fact, an average of **36.2% of incidents resulted from inadequately written procedures** in a study covering more than 50 years of data<sup>7</sup>. During that same period, operator error was the cause in an average of 26.2% of the events.

Operating procedures are a pillar of all major regulations for the process industries, from OSHA 1910.119, Process Safety Management, BSEE’s Safety & Environmental Management Systems (SEMS), the Center for Chemical Process Safety’s (CCPS) Risk-Based Process Safety to the Department of Transportation’s Pipeline & Hazardous Material Safety Administration (PHMSA) rules for pipeline operations<sup>8/9</sup>.

### Chunking

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*Source: <sup>7</sup>Analysis of Past Incidents in the Process Industries*

Because over half of all incidents and near misses occur during nonroutine operations like startup and shutdowns, effective procedures are even more mission-critical for new projects.

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**Effective procedures provide key information the operator needs, including the:**

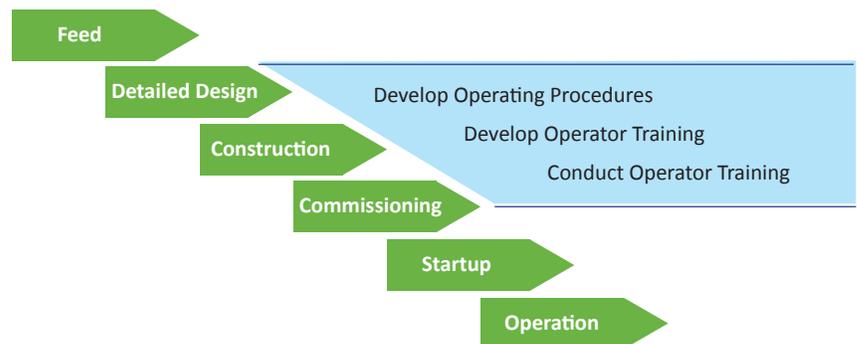
- Steps required for a given operation and the sequence of step performance
- Equipment identification and valve line-ups
- Hazards associated with the operation and required personal protective equipment (PPE)
- Warnings and cautions associated with specific steps
- Control limits, operating parameters, expected ranges and consequences of deviation
- Diagrams and drawings to enhance interpretation
- Checklists to confirm that steps are performed and documented
- Troubleshooting charts

**Procedures should be written to cover all phases of process operations including:**

- Commissioning
- Startup
- Shutdown
- Normal Operations
- Temporary Operations
- Abnormal Operations
- Emergency Operations
- Emergency Shutdown

So, is there a “best time” to begin to write the operating procedures for a new process? The answer depends on several factors and the availability of Issued For Construction drawings.

**Figure 3** shows an accepted best practice for this timing.



**Figure 3**

While accurate drawings and final design decisions are critical for procedure development, there are still many advantages to beginning them even before “final” drawings are issued.

Both commissioning and standard operating procedures can be written in parallel with final mechanical completion and acceptance testing activities since there is access to equipment not yet in-service that may not be possible during operation. This allows procedure developers and subject matter experts to walk down systems and verify equipment locations, piping runs and other critical information on the drawings.

It is important that the procedures are developed according to industry best practices to ensure that they not just meet regulatory requirements, but provide clear, concise instructions for safely performing operational tasks. Therefore, the format, content and style of the procedures should be determined in consultation with experts in the field.

The procedure developer should also bring an in-depth understanding of the technical process that the procedures address. This combination can save extensive rework to correct technical errors, omissions or issues with formatting and wording of the procedural steps. Any of these errors will impact the availability or usability of the final procedures and impact other downstream aspects of the project including commissioning and ultimately plant startup.

When determining the best approach, and partner, for developing operating procedures for a major project, follow similar guidelines to those given for choosing a training development provider – extensive procedure expertise and references combined with solid operations experience and industry-proven formats that can be tailored to the specific project requirements.

Choosing the right resource to develop the procedures and beginning early in the overall project, will deliver dividends during plant startup by accelerating the time to overall operational readiness.

### Good Operating Procedures should be...

- Compliant with and adhere to regulatory guidelines
- Consistent with industry best practices
- Uniform in design and format
- Concise and suited to the task
- Compatible with procedure/document management systems
- Comprehensive in hazards and precautions

## Summary ... On-Time Startup and Operation

Operational readiness drives on-time project delivery. At each phase of a major project, it is imperative to keep the end in mind and consider the operational impact of key decisions. Today's increasingly complex projects demand even greater diligence and the assurance that resources are prepared and integrated to deliver. Preparing and supporting the operations workforce with accurate procedures and well-developed training programs are critical steps to accomplishing this goal.

Developing these critical tools early in the process after detailed design allows them to include information and images that may only be accessed during construction, mechanical completion and acceptance testing. Training sessions conducted during these stages provide a unique opportunity for operations personnel to see inside equipment, piping and vessels that will be inaccessible after startup. That knowledge will add insight to decisions they make during startup and later during operation.

Developing operations training and procedures earlier can also help mitigate the inevitable delays in the project caused by resource availability, equipment issues and other unforeseen events. Follow the recommendations outlined here and accelerate your project's operational readiness to deliver on-time startup and production.



### Operational Readiness Best Practices...

- Consider **production** throughout design phases
- Involve **operations** early in project
- Actively assess, manage and close **gaps**
- Ensure accuracy and develop **procedures** during construction
- Develop operator **training** during construction
- Train operators in **parallel** with final construction activities
- Use **simulation** training to expose operators to realistic scenarios
- Complete **safety-critical** training first

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## About the Authors

**TDS [tdshou.com]** - TDS provides workforce learning and development solutions and has served the oil and gas industry since 1993. TDS collaborates with companies in the oil and gas, pipeline, petrochemical and refining industry to improve workforce performance and bring out the best in their most valuable asset – their people. Expertise in the industry, as well as in adult learning and competency management, provides TDS a keen understanding of your business, and our flexibility allows us to deliver customized solutions quickly and efficiently. **+1 800.480.1128**

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