Effective Procedural Operations

Best Practices and Tools for Optimized Procedure Management and Execution

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Abstract

Are the most critical procedures at your refinery being effectively managed, applied and executed? Do you know the real costs of procedure execution problems? Are your procedures being consistently executed based on operational best practices?

Over the past ten years, refineries have focused on improving operations through process control improvements. This has included such areas as applying model based control and process optimization techniques. These areas continue to provide tremendous benefits, but additional focus is being placed on other operational aspects including procedure effectiveness in the management of abnormal situations and process state changes to further increase profitability as well as providing safer and more effective operations.

Commonly executed procedures have a major impact on operations and include startups, shutdowns, emergency procedures, bringing equipment to intermediate safe operational states, equipment changeovers and others.

Variation in procedure executions and deviation from procedural best practices can be costly. Examples of tangible costs include:

- Increased the time required for decoking operations due to improper furnace startup/shutdown sequences
- Incorrect procedure execution at peak loading resulting in safety incidents or compliance issues
- Skipped procedure actions resulting in equipment damage and loss of production
- Reduced operational efficiency due to operator overload at critical processing periods
- Transition to a shutdown state when the proper execution of a best practices based procedure could have resulted in less down time, safer operations and a faster transition to full production
- Increased the time required to startup or shutdown a process unit

These risks and their associated costs can be avoided or reduced through the use of effective procedural operations. Effective procedural operations can provide an easy to implement path to reduced risk and bottom line dollar benefits.

This paper explores the Best Practices and State-of-Art tools used by world class organizations to discover, plan and improve procedural operations.
**Times Have Changed**

Industrial manufacturers are executing procedures differently than they did 20 years ago. With years of technology investment, distributed control systems, historians and advanced controls have enabled efficient process operations when operating at a fixed operating point (e.g. common feedstock or common product slate).

**Best Practices and Tools for Optimized Procedure Management and Execution**

This paper discusses the why, where and what of one of the latest and most significant in process control strategies we now have available.

You may ask “why are we seeing a change in how we execute operating procedures. As an Industry have we not been utilizing procedures since processes were created?"

The fact of the matter is, while most refiners have had procedural systems since the initial start-up of production, the impact of human factors on profitability, and the value of consistent procedural execution are only now becoming conventional wisdom for the industry. In fact we still find many refiners whose procedures in operation differ significantly from those procedures they have documented.

From years of studies and direction from the Abnormal Situation Management (ASM) Consortium (ASMC), we now have guidelines/practices and experience to setup and utilize Procedural Operations to derive real plant benefits. There is no longer any reason not to drive toward best practices procedural execution.

With the increasing acceptance of the benefits available from better procedural operations, a demand has come from refinery operators for solutions which can enable EFFECTIVE procedural execution. Here is where the process control industry must respond with solutions that can drive true and measurable bottom line benefit. It truly is the tools; techniques and planning that make Procedural Operations Effective.

Over the years our sites have invested in Distributed Control Systems (DCS), historians, advanced controls and any number of other technologies designed to enabled efficient operation of processes when operating at a fixed operating point (e.g. common feedstock, common product slate).

As those technologies mature, companies are demanding new sources of benefit from control suppliers. Suppliers must respond to challenges like increasing operating flexibility to allow faster response to market opportunities. This requires the ability to flawlessly move from one operating mode to another as fast as possible.

Other challenges include:

The drive to lower or eliminate further costs by reducing the costs of abnormal situations.

The reduction of the impact of incorrect execution of procedures (because they couldn’t be found, were out of date, were not suitable, were not detailed enough, incorrect data). Elimination of non-value added work by the operators in executing procedures so that they can focus on processing cost and efficiency.
And, the loss of knowledgeable staff due to retirement or moving on to other responsibilities. The needed retention of knowledge can be achieved by encoding know-how about procedures into a system.

Also,

- Sites that are wishing to improve transitions between operating modes or feed-stocks in response to market demand.

- Sites where procedures are frequently not followed correctly, resulting in losses in production, off-spec material.

- Sites that are looking to reduce operator workload in non-value added areas, to consolidate the work-force, thereby, allowing operators to have more time to focus on cost control and profit maximization.

An Effective Procedural Operations Implementation will help make changes consistently and do it as well as the best operator.

**What is Procedural Operations**


- **Operating Procedures**: Operating procedures are a set of explicit guidelines and instructions that, when followed by the operational personnel, will minimize deviations from design or operating intent.

- **Design or Operating Intent**: Design or operating intent refers to “how the plant is to be run” as specified by operating targets and limits (Sutton, 1997). Typically operational targets are explicitly defined in the operating instructions and the control system settings, operating limits may be explicitly or implicitly specified depending on plant practices.

Therefore, within the confines of this paper procedural operations is the result of automating, semi-automating or guiding the operator with real-time control intelligence as being part-of the control system itself. That is, an integrated part of the standard operations tools and process control system. And, a properly implemented system is one that is designed and executes effectively.

We will examine an actual application later within this paper.
What are the Value and Benefits

What is the value and benefit areas of an Effective Procedural Operations Implementation?

Effective Procedural Operations (in this context) was created to provide for the following needs:

- **Shutdown/Startup** – seldom executed therefore subject to error or inconsistencies
- **Grade Change** – Normal production change (grades, rates, equipment, etc.)
- **Abnormal Condition resulting in SafePark** – Bringing the plant to a safe holding point that may be resumed by Operations, or subsequently to Shutdown the plant.
- **Cyclic Planned Activities** – Activities repeated based upon well defined criteria, normal operations (regeneration, pump changeover, decoking, etc.)

The value may be described from at least three perspectives:

- **Safety** – In one site study of Incident failures, 8% of all root causes were of Procedure related incidents. Not only costing an additional $12.8 million over 5 years but also caused personnel to be at higher risk. We can only think what value to place on life. Safety experts have long argued that the majority of accidents are caused by human error.
- **Efficiency** – During a site study it was identified that improvements in one procedure reduced execution time by four hours multiplied over corporate sites might see a benefit of over $6 million. We’ll see more later-on.
- **Reliability** – Performing procedures in the same validated way that the most experienced Operators do and based on operational best practices, automated as much as possible and with the ability to measure and correct deficiencies is a good path to improvement.

Value/ Benefits Summary

A proper implementation of Procedural Operations (we call that Effective Procedural Operations) saves time by reducing the time to execute operating procedures (special procedures like shutdown/startup, transition, etc.).

Time is related to product scrap, product degradation and the cascade effect through the plant.

As in an example of a crude switch. When a crude switch is optimized by using Effective Procedural Operations there can be a 30% decrease in downtime/slowdown through the first two units. This downtime/slowdown is rippled through the rest of the units like a Coker unit. Reducing downtime/slowdown is where the largest benefit in money may be found and could amount to millions from just a few procedures.

Further benefit is gained by answering the need to collect and preserve the site expert knowledge of the operators by moving that knowledge into a traceable and improvable system. Most plants are facing retirements of their older knowledge base. This is especially significant as these same older operators who are nearing retirement hold the “real” procedures for running the plant in their heads. Refineries need a solution to capture this knowledge before it walks through the plant gate for the final time. And, procedures that only get executed once a year or two.

Next is the safety aspect. By executing the procedure the correct way and validated way (the way the best operator would do it) the same every time, we significantly reduce the risk of human induced incidents. Further, if something does go wrong a SafePark can be initiated quickly with automation (if possible). Some operators call this smoothness.
Finally, the reliability of the process and equipment is improved because less errors and better methods are used. Like, equipment damage, decreased lifespan of equipment, or materials and possible compliance issues.

An Example of implemented Effective Procedural Operations.

We will see how a manual procedure is converted to be an Effective semi-automated procedure and the value and benefits obtained.

In the above example, a Stripper procedure has been encoded into the process control system. This is the example we will use to get an idea of a Procedural Operations implementation. Notice in the graphic that a link labeled “Shutdown Procedure”, upper left hand corner, has been programmed into the procedure to view the Manual Procedure that was used to create this Semi-automated version. Also, right above the button is another button labeled “SHUTDOWN” that is used switch to the semi-automated procedure screen.
Manual Procedure

In this example, pressing the “Shutdown Procedure” link allows the viewing of the Manual Procedure. This may or may not be beneficial to you but is here to describe what is possible.
Automated Procedure

After pressing the “SHUTDOWN” button, we are switched to this view. Please note that this example is one possibility to a solution and that these screens are reusable components that can be leveraged as defined by operators and/or templates of display components that can be reused based upon the operator specific user interface requirements.

Following the example, the automated procedure has been started. The blue check box indicates a completed step and a green check box is currently executing.

Notice that three steps have executed automatically, and is now prompting the operator to enter the evacuation target Time. This is an example of automated and assisted manual steps.

Also, note the entry prompt in the lower left corner, and the warning/information text in the lower right box.

After the last operator interaction step, the system is now instructing the operator to execute a manual field operation. In this case the field operator is informed to execute this portion of the procedure via a phone call, radio or a portable field unit like the IntelaTrac tool. At completion of the manual execution in the field the step is confirmed by checking the box “Confirm”.

Note: As an example of why converting a manual procedure to semi-automated is important would be the manual procedure was out of date…had not been updated in two years…there had been equipment changes and it turns out the operators never followed the procedure because it always made for a difficult shutdown. Or the operators were having problems managing the conditions where they were monitoring two units and both had problems…needed to be offloaded by the system.
After confirmation the procedure executes automatically to the next manual step input to confirm the evacuation pump is running. Note that there are a number of step that can be executed automatically, but require the Console Operator to manually confirm the actions taken and the desired results achieved.

The entire execution of the stripper procedure is executed automatically, semi-automatic and or assisted prompts with checks and measures that have been tested and verified prior to use.

Execution can be a blend of pure automatic actions (no console operator intervention), semi-automatic where console operator intervention is needed, and entirely manual field operator tasks.

Also, the metrics of execution can be saved, analyzed and reported. Changes to the procedures can now be measured to verify improvement. Measuring the criteria of the procedure execution can lead to classification of procedures such as the “Golden Procedure”.

An entire Management of Change (MOC) process can be created to effectively manage special procedures, that is, procedures that are dynamic (changing as the plant and Operation work practices change), yet you want to accomplish this under a well defined MOC process – including revision control and tracking.

As an example of why this is important is if a unit is shutdown once every two years…a critical parameter may be pressure…can the operator compare the pressure profile of an executing procedure with a prior execution so they know if it is proceeding normally? Can the procedure be easily compared to identify areas of optimization, improvements or potential training issues?
Integration into the Process Control System is the key to greater benefits.

<table>
<thead>
<tr>
<th>Value Calculator – PVC Stripper Example</th>
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<tbody>
<tr>
<td><strong>Total Annual Savings</strong></td>
</tr>
<tr>
<td><strong>Entry</strong></td>
</tr>
<tr>
<td>What is your annual production of PVC? ( million # )</td>
</tr>
<tr>
<td>How many operating days do you have per year?</td>
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<tr>
<td>What is your average operating profit ( ¢/# )</td>
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<tr>
<td>How much lost production do you have annually for all reasons? ( million # )</td>
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<tr>
<td>How much lost production is due to stripper outages? ( per cent )</td>
</tr>
<tr>
<td>How many planned and unplanned stripper outages do you have annually?</td>
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<tr>
<td>How many hours would a stripper shutdown last without automated procedures?</td>
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<tr>
<td>Percent of Time Reduction with Automated Procedures</td>
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<tr>
<td>Number of hours to execute with Procedural Operations</td>
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**Sample of a Value calculator for the previous Semi-Automated procedure**

From the sample value calculator above. Yellow boxes are for input, based upon plant operations. Note the “percent of time savings” box. This is the percent of reduction of execution by automating this procedure. Normal reduction time is in the range of 5 to 30 percent. But, in this case we saw a reduction of 80% execution time. This is calculated to be a bottom line adder of $12,100 for the one procedure executed over 30 Stripper Shutdown Outages.

There are literally hundreds of these kinds of examples on process sites.
Value Impact

Another form of value from a proper implementation of Procedural Operations is shown above showing interesting data acquired from a site study conducted by the ASM Consortium.

In this study dollar loss are spread over a 5 year period, and show that 8% of all Incidents are procedure related at a cost of $2.6 million per year.

The above chart shows by priority the cost relationship to causes. Note that the number one issue called PIO or Potential Improvement opportunities are the largest share of losses.

Potential Improvement Opportunities (PIO) are those that the root cause is that there was not enough detail or ambiguity in the details of performing the step or procedure.

These are the Low Hanging Fruit so to speak. These PIO become visible during the work of implementing a Proper Effective Procedural Operations Analysis.

This pre-work is very important and should not be conducted or put-off. We will discuss this work later on.

PIO can be as simple as a procedure saying “turn the valve”, instead of "open the valve to 50% flow rate", or “With the Valve ensure a 50% flow rate”.

This is very important, because the implementation of Procedural Operations forces you to think through the details, especially as it relates to control systems interactions. And, interactions is the silver bullet of the implementation.
Total interaction or integration with the control system, right down to where the rubber meets the road, in the control logic. The process of thinking through the details is where the pre-work comes in. Even if it's just another set of eyes (experience) looking over your work.

**How to Start**

If you are aware of the problems and solutions the fix is downhill.

**Awareness, Planning, Implementation and Maintainability**

The first priority is that site management has to be fully aware of the process gaps, solution capabilities, benefits and competitive challenges.

An Effective Procedural Operations Solution is what provides the vehicle to measure and close the gap between where you think you are and actually knowing the effectiveness of executing non-routine procedures like shutdown/startups and transitions.

Some sites have implemented make-shift systems to control a Procedural but more-often failed because of necessary control upgrades, complex coding, personnel turn-over and continuing maintenance of the system. Key items of success is not only the Operational interaction effectiveness of the solution, but just as important is the supportability of the solution to continue and derive values over the entire life.

Know exactly were your site measures up to where you want to be, and take the edge from your competition.

**Effective Procedural Operations Tasks – Pre-Work**

Before jumping into coding automatic procedures, be sure you know where you are going, what your priorities are, how you are getting there and the correct metrics to show success. Please understand, this is not a trivial point, failures in implementation are often traced to poor scoping and the lack of good planning.

Steps to proper implementation:

- Scoping Workshop
- Project Support
- Procedure Evaluation and Design
- Best Practice benchmarking
- Automated Procedure Value analyses
- Procedure Workflow
- Simulation and verification
- Continuation Lifecycle support
The Scoping Workshop is the first task to perform

The result will be a plan including scheduled tasks of what must be completed and a process on how to find the dollar value from converting manual procedures to semi-automated procedures. These scheduled activities will prepare and execute what is needed to implement an Effective Procedural Operations project.

Activities may range from prioritizing procedures, what is it that makes an effective system, gathering information to verify procedure needs, what current economic data does the site have, setting up a system to track economic benefits, what tools are necessary to be effective, workflow, risk assessment criteria, change management, system installation, testing and verification.

Project support is the work of setting up the applications and manual conversion planning to semi-automated procedures within the control system. This work is accomplished via programming the Control Module using the Control System tool set.

Planning the verification and testing process of the procedure execution. A simulation technique can be improvised where proper Process Simulation Systems are absent. At least to the exit of the control signals form the controller. Some sort of simulation is necessary prior to on-line connection. Planning should be a multiple stage of testing/qualification – from the upfront logic verification, to the execution against normal and abnormal simulated variables, to the “step thru” of the procedure along with the Operator allowing for participation and verification of each control action done. During this stage is where you can step thru the procedure and all auto actions must either be done and/or confirmed by the Operator.

What is needed to be effective?

Site problem awareness, does everyone fully understand what Procedural Operations can deliver? Some sites believe that having manual procedures are enough, but are they?

Recent ASMC sponsored studies indicate sites that believe their manual procedures are sufficient still may have unknown problems.

Ask yourself, are procedure related incidents recorded and tracked properly? Is there a measurable improvement system for critical procedures? How are golden procedures measured and compared to non-golden procedures? Can a small change be measured for reliability and efficiency? Are these procedures executed the same across shifts and personnel? How does a known decrease in execution time reflect on production dollars?

The point is how do we provide continuous improvement opportunities if we can not measure the key areas of contention or bottleneck of the problem.

Where do we start and where are we going?

Awareness is the beginning point. What is Procedural Operations and does my site need it? Who should be involved? What kind of Procedures are we talking about? What do we need to make an educated decision? What are the economics of an Effective Procedural Operations? What are the priorities? How do other companies start? What are the goals of being Effective?
Effective Procedural Operations - WhitePaper

Answers to the above questions are the objective of the Scoping Workshop. The Scoping Workshop will collect the necessary data to make the next-step decisions and plans. From awareness of what Effective Procedural Operations is, to what safety, reliability and cost savings could the site expect?

**Then what?**

During the Scoping Workshop a plan and schedule of activities is generated based on Site needs and wants. Site needs and wants will be translated to activities. The planned activities will prepare and execute what is needed to implement an effective procedural operations project.

Activities may range from prioritizing procedures, what is it that makes an effective system, gathering information to verify procedure needs, what current economic data does the site have, setting up a system to track economic system, what tools are necessary to be effective, workflow, risk assessment criteria, change management, system installation, testing and verification.

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Flowchart of Scoping Workshop

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Onsite work with site management, operators and engineers.

The workshop defines & documents the site’s Process Procedure needs, allowing a next step proposal with time-line schedules to be created detailing work to be accomplished.

**Deliverables:**

- Solution demo, Management Awareness and pre-planning.
- Area interviews to determine all possible procedure candidates and gaps in procedure needs.
- Possible Value of converted manual to semi-automatic procedures (Value Calculators)
- Prioritized list of procedure candidates.
- Next step planning and project scheduling.
Best Practice Assessment to ASM guidelines

There are 39 Best Practice Guidelines.

The Best Practice Assessment is designed to compare your current procedures and practices to ASM Procedural Practices, a findings report is generated and reviewed with operations management.

The findings of the Assessment are used to discover and fix gaps within department procedures.

The very important point that I would like to impress here is that of documenting the difference (focus/methodology) between "manual procedures" versus the more sophisticated functionality related with the "semi-auto or auto" procedures. This is part of the classification in that it shows that you can get more value from one semi-auto procedure automation (due to timing, impact of incorrect action, and other consequences of incorrect action) versus many manual procedures.

**Best practice Guideline 1.1**

*Provide specific procedures to cover start-up, shutdown, normal, abnormal, and emergency modes of operation.*

Sample Impact questions:

1. Have you been trained and/or have familiarity with U.S. Federal OSHA Process Safety Management (PSM) regulations [Standard 29 CFR 1910.119 (f)] on operating procedures?
2. Are there accurate and up-to-date written operating procedures for distinct operating modes including startup (initial, from turnaround, from emergency shutdown), normal operations, temporary operations, and shutdown (planned and emergency) available?
3. Are there operating procedures that support abnormal situations?
4. While OSHA PSM regulations do NOT explicitly require procedures to cover abnormal situations. However, do existing operation procedures include operating limits provided with consequences of deviations and steps required to correct or avoid deviation?
5. Do the operating procedures supporting abnormal situations address the prevention and response to the most critical process deviations?
6. Have you been trained on these procedures?
Value Assessment

Personnel interview, data assessment from incident reviews and assessment findings. Percent of procedure caused incidents compared to total – total cost of incidents and cost of procedure failures. Also, how is training applied and the risk of failures reduced by training?

Documenting the bottom line value and cost Metrics of your startup, shutdown and other manually based procedures will highlight areas for improvement. Improving procedure effectiveness by finding and fixing errors, inconsistencies and efficiency will not only save money by reducing incidents but more importantly may save personal injury.

Concluding Comment

We should not make the mistake of ignoring what we do not know. We should discover where we are and plan to improve or at least correct the situation.

From “stop, fix, go” to “planned smooth transition” in the safest, most reliable and efficient method…. 