Managing a Plant Shutdown at 30,000 feet

How to land the perfect shutdown!

Authored by –

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The title of this paper might sound strange even a bit bizarre. However, it is amazing how much in common flying an aircraft from point A to point B has with managing a major plant Shutdown. The most risky parts of a flight are well known to be the take-off and the landing. Pilots undertake extensive pre-flight checks that ensure that the systems and subsystems are working correctly. During the landing the Pilots also ensure that they are following the correct procedures to ensure a safe landing.

Shutdown risks are also at their highest at the start and end. As the Shutdown commences the site needs to be made safe enough for the numerous people who have arrived to start their work. To ensure this happens all of the the Isolation must be in place, the Permits issued and plant made safe. Similar challenges also need to be managed at the end of the Shutdown. These become apparent as the plant is being brought back on line. Risks need to be mitigated as energy sources are reinstated and plant is recommissioned often while people are still finalising their work activities.

During an actual flight the risks are lower. So as long as the plane operates correctly and the pilot avoids mountains and turbulence the flight should be smooth. Similarly with a Shutdown, as long as the work has been planned and scheduled correctly and the right Isolations, Job and Safety Instructions have been provided, the Shutdown should also run smoothly.

Another similarity relates to the people who undertake the Shutdown work. They can be compared to the flight crew. The flight crew is supported by a host of people on the ground. The ground crew have access to systems to help them complete their work. In a similar manner the Shutdown workers are supported by others who work across the organisation. These people also have access to systems such as **Enterprise Resource Planning** (ERP) and **Permit to Work** (PTW).

*"The **People** and **Systems** combine to ensure the **Shutdown** is completed **Safely, On Time** and **Within Budget**".*

Planning & Scheduling Work		**Remove Equipment from Service**	**Undertake Work**	**Managing Isolations & Permits Restore Equipment back into Service**
Planning Work Activities	**Scheduling**	**Risk Assessment**	**Personal Risk Assessments**	**Managing Isolations & Permits**
People		**Permits & Isolations**	**Communication**	**Moving & Test Running Equipment**
Tools & Equipment		**Additional Job Dependent Requirements**	**Housekeeping & Monitoring Safety**	**Removing Isolations & Restoring Power**

A plant Shutdown can be broken down into 4 significant stages.

1. Planning & Scheduling Work
2. Removing the Equipment from Service
3. Undertake Work
4. Managing Isolations & Permits - Restore Equipment back into Service

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Planning and Scheduling Work

Planning

The word “planning” is often confused or interchanged with scheduling. The action of planning relates to the planning of individual activities. Scheduling is the action of placing a number of planned activities into a Program of Work.

The planning activity is the responsibility of the nominated Planning Group. It is essential that the Planner considers all aspects of the work including the safety of the people who will eventually carry out the work. Each work activity should be formally approved by a responsible person before it is placed into a Program of Work.

The most efficient and effective way to create a Work Order for a work activity is via a Standard Template. The Standard Template is a reusable entity that has already passed through a pre-planning process. The amount and accuracy of pre-planning will depend on how specific the template is to the job that is being undertaken. Some refinement may be required after a Work Order has been created from the Standard Template. This is required to more accurately reflect the work to be undertaken.

The Standard Template should include: -

- Description of Activity including Job & Safety Instructions
- Labour Requirements including the number of Resources & the Skills and Competencies required to complete the work
- Material Requirements including Spare Parts & Consumables including Material Safety Data Sheets(if applicable)
- Equipment Requirements including Mobile Plant & Tools

Accurately determining the number, types, skills and competencies of the Labour Resources required to complete the job is an important part of the planning process. This information along with the duration of the activity is required to effectively schedule and assign the activity to the correct resources.

Knowing what consumables are to be used and having access to Material Safety Data Sheets is critical in determining both the Job and Safety Instructions. Accidents including fatalities have occurred when the recommended procedures have not been followed when using some hazardous materials.

Having the correct tools to undertake the activity is also essential. People will sometimes improvise and even make tools in order to complete the job if the correct tools are not available. Using an incorrect or improvised tool can result in accidents.

Equipment

Working out what equipment will be needed during the Shutdown is another important planning activity. In some cases overhead Cranes and lifting Rigs are only used during a Shutdown. So it is essential that they are inspected and in good condition before work commences. It is the Maintenance Team that is responsible for ensuring the equipment is in good condition.

People

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The people involved in Shutdowns can include a mixture of internal Staff and external Contractors. In some Shutdowns the external Contractors outnumber the internal Staff. Contractors normally work for different organisations throughout the year. So they need to be aware of the issues relating to each specific organisation. It is important to know if a Contractor has completed a formal site induction. It is the Safety Teams responsibility to ensure all Contractors have undertaken this activity. The Safety Team are also responsible to ensure everyone has been issued with adequate Personal Protective Equipment.

In order to match and assign the correct people to the Work a register of their Skills and Competencies needs to be developed and maintained. Training Courses then need to be developed to provide people with the required Skills and Competencies. The need to retrain a person should be automatically triggered once their license expires.

Shutdown Scheduling and applying for Permission to Work

As stated earlier, scheduling is the action of placing a number of planned actives into a program of work. The efficient scheduling of shutdown work is necessary to ensure that activities are completed safely within prescribed time limits. Efficient scheduling of a planned Shutdown is important to support the aim to safely return of the facility to service on schedule and within the approved budget.

*"**Planning** determines "**What"** needs to be done and **Scheduling** determines **"When"** it needs to be completed".*

Shutdown scheduling brings together the Work, Equipment and People to form an achievable Program of Work. The Shutdown Scheduler is responsible for this part of the process. They will first determine the Critical Path. The Critical Path is the longest sequence of activities in the schedule which must be completed on time for the Shutdown to finish on the due date and time. Once the Critical Path is known other none critical work can be scheduled to occur concurrently with the critical activities.

The sequence in which activities are scheduled can also dramatically affect Shutdown safety. Issues to be considered include work conflicts, where people are working in the same area or need to have access to the same equipment. The movement of overhead Cranes and mobile plant into and out of an area where people are working also has the potential to cause incidents or accidents.

Once the work activities are scheduled the "Applications for Permission to Work" need to be created. It should be possible to automatically create such a request directly from each Work Order. Automatic requests have the following advantages: -

- They remove a manual step from the process
- Information is shared between the two systems and therefore does not need to be duplicated
- Eliminates human error where someone forgets to create an application
- Provides the Isolation / Permit system with a greater level of detail relating to the work activity
    - Risks are more accurately assessed
    - The decision on what Isolations, Permits and additional Job dependent requirements can be assessed more confidently
    - The Isolation Officer can check to ensure the Safety Instructions on the Work Order are adequate for the work activity
- Creates a direct link between the ERP and Permit To Work Systems

- If Work Orders are rescheduled in the ERP system changes are visible in the Permit to Work system
- Status changes can be made between the ERP and PTW systems as process steps are completed

Once the permission to work has been agreed the work activities can be assigned. Assigning people to the work is the responsibility of the Team Leader. They also need to ensure that the people they assign have the correct skills and competencies to undertake the work.

Removing Equipment from Service

Before the equipment can be removed from service the "Applications for Permission to Work" need to be reviewed. The first consideration that needs to be made is has the planning and scheduling stage provided adequate information. The information has to be sufficient to make a determination on what safeguards need to be put in place to prevent an accident from occurring. If there is insufficient information then the application needs to be returned to the Planner. Once there is sufficient information to process the application then the Isolation Officer can action the request.

Each work activity needs to be the subject of a formal Risk Assessment. A Risk Assessment considers individual Risks and their potential Consequences. This step is required to determine what safeguards and controls need to be put in place or completed to ensure that the work activity will be undertaken safely. Safeguards include: -

- Isolations
- Permits
- Job Dependent Requirements
- Safety and Test Equipment

Grouped and Individual Isolations

Equipment can have multiple energy sources that must be considered when determining the correct Isolation procedure. Electrical, mechanical, gas, radiation, hydraulic and pneumatic are the most common energy sources that need to be neutralised in order to protect workers. Isolations also need to take into consideration potential or stored energy. Potential energy needs to be released or prevented from being released while the work is being undertaken.

Potential energy include -

- Pressure Vessels that need to be at atmospheric pressure prior to entry
- Moving Equipment that needs to be secure before a brake or hold back assembly is removed

Grouped or shared Isolations can isolate whole sections of plant i.e. system or sub-system. This type of Isolation is very efficient and effective as all work in the area can be conducted under the one shared Isolation. Individual Isolations on the other hand cover very specific areas of plant and are often applied based on a single or group of work activities.

In reality, Shutdown Isolation Plans use a combination of Grouped and Individual Isolations. The Isolation Team have the responsibility to determine the way the plant will be isolated as well as how power will be restored both during and at the end of the Shutdown. Just like the Scheduler has the responsibility to determine the Critical Path. The Isolation Officer has to determine how the Isolations are configured. Consideration needs to be given based on the fact that some equipment

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might need to be reenergised and moved during the Shutdown. They also need to factor in test runs and the requirement that some equipment, like a Boiler, may need to be recommissioned before the end of the Shutdown. As the lifting of Isolations potential stops multiple work activities. The Isolation and Permit configuration is critical to ensure the **On Time** target is achieved.

The Isolation Plan needs to be developed based on the requirements of the work. It should be possible to create an Isolation Plan from a register of Isolation Templates. It should also be possible to build a single Isolation Plan from a number of different Isolation Templates.

When placing the Isolations it is essential to know "**What"** to isolate, "**Where"** the Isolation point is located and "**How"** it should be isolated. This requires the Isolation points to be identified, labelled and formally registered in the PTW system. Visual identification can be achieved by using a metal tag or an engraved traffolyte label. However, electronic identification and verification is the most accurate way to ensure the right Isolation point has been located.

*"**Mobilising** the **Isolation Process** can dramatically improve not only the **accuracy** but also **reduce the time** it takes to apply the **Isolation**"*

Permits to Work

Isolations are the highest level of control an Organisation can provide to eliminate equipment related risks. There are other areas where the same level of control cannot be applied. Areas such as, working at heights or in confined spaces requires another or additional type of control mechanism. This comes in the form of Permits. Permits mandate a required procedure to be followed. However, unlike an Isolation which provides a physical barrier, Permits rely on the people to do the right thing and follow the documented procedure.

Job Dependent Requirements

Another area for the Isolation Officer to consider is the Job-dependent requirements. Most of these requirements should have been outlined in the Work Order Job and Safety Instructions. However, additional requirements might be required for example the placing of Safety barriers or erecting a temporary fence. These items need to be in place before work commences.

Safety & Test Equipment

Sometimes safety equipment such as breathing sets, safety harnesses and fire extinguishers are nominated by the Isolation Officer on a Permit. These items need to be regularly checked to see that they are fit for service. It is the responsibility of the Safety Team to ensure that safety equipment is in good condition and ready for use prior to it being issued.

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Undertaking Work

Communications

In-flight communications are an important component in ensuring the safety of the passengers on the flight. A similar approach can be used during a Shutdown. Regular team briefings should take place during the Shutdown. The meetings should focus on how the work is progressing and always include a discussion on the safety aspects of the work. Another really important area of communication is when multiple crews are working on the same work activity. An effective handover from crew to crew can be vital in maintaining a safe environment. One example where this did not happen was during a Ball Mill liner change. The previous crew had removed liner bolts but did not remove the liners. The next crew rotated the Ball Mill and the unrestrained liners fell killing a worker.

Pre-Work Risk Assessments

A Pre-Work Risk Assessment (PRA) should be undertaken by the work party before the work commences. The PRA can identify potential risks that might occur during the execution of the work. PRAs can also be conducted at the start of every day. Additionally a PRA should be undertaken if any team member feels unsafe with the way the activity is progressing.

Housekeeping

During a major plant Shutdown the site transforms from being an operational plant into a construction site. The type of accidents and incidents that can occur can be different to those experienced during normal operation. The majority of construction fatalities fall under what is often referred to as the “Fatal Four”.

1. Falls
2. Struck by Object
3. Electrocutions
4. Caught-in/between

Having an organised workplace is essential to reduce or eliminate shutdown incidents and accidents such as slips, trips and falls. Some organisations apply a 3 ‘S’ principle of **Sort**, **Scrap** and **Store**. Any old parts are immediately scrapped. New parts are stored off site and only brought in when needed. Welding Sets are located in designated areas and have their leads covered to protect them from damage. Items such as lubricants are also placed in designated areas with drip trays to prevent any leakage from spreading into walkways.

Safety Monitoring

Proactive Monitoring

Proactive monitoring includes: -

- Hazard Identification Inspections
- Gas and Atmospheric Checks
- Compliance checks on Isolations, Permits, People and Processes.

Proactive monitoring of the Shutdown site can either be conducted as a random or a controlled exercise. A controlled audit would involve the Isolation Officer selecting a group of interconnecting Isolations and Permits. They would then check compliance. Once the audit has been completed the results should be recorded against the Isolations or Permits they have been checking.

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It is important to monitor the people who are working on the Shutdown. Shutdowns often entail people to work additional hours. It is important that the people have adequate breaks away from the work place. Another consideration should be to ensure a healthy working environment. The workplace should be well ventilated and the temperature controlled to a reasonable level.

Reactive Monitoring

Reactive monitoring covers incident and accident investigation. Hopefully, with all the other safeguards in place, incidents and accidents should be few and far between. However, if an incident has occurred the results and actions coming from the investigation should also be recorded against the Isolation or Permit that was in place at the time.

Managing Isolations & Permits - Restore Equipment back into Service

The Isolations and Permits need to be managed both during and at the time the work activities are completed. During the Shutdown work activities may have to be rescheduled. When work is rescheduled the Isolations and Permits checked to see if they need to be adjusted or extended. The scope of the work may also change or a new work activity be identified. These circumstances also call for a re-evaluation of the safeguards that are currently in place.

From time to time equipment may need to be moved into a new position in order for work to continue. This action requires the work to stop, the area to be cleared and the source of power to be restored. Another situation where power needs to be temporarily restored is during a test run. When the equipment has moved or the test run has been completed the Isolations need to be re-instated for the work activity to continue.

As stated earlier some equipment may need to be placed back into service early. This is often needed to ensure the plant is in a state of operational readiness once the final work activities have been completed.

The Isolation Plan needs to be able to accommodate for the situations where temporary and early restoration of power is required. The Isolation and Permit Plan needs to be flexible. It should to be developed so that such events do not cause widespread disruption and delays to the program of work.

*"Having **Effective** and **Efficient Isolation Plans***
*dramatically **reduces** the time it takes to return*
*the Plant to **Service"***

Continuous Improvement

It is important to continuously improve the overall process. Any issues that have been identified should be reviewed and changes made to the system to ensure they do not reoccur in the future.

A review can result in the improvement of: -

- Work Order Templates
- Risk Assessments Assumptions
- Isolation Templates
- Grouping of Isolations

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- Permits

As stated at the start, a flight crew relies on the support of ground staff and their systems. Similarly people who carry out the Shutdown activities also rely on support staff and their systems. Having an organisational approach to Shutdown Management ensures that the Shutdown will be completed **Safely**, **On Time** and **Within Budget**.

All that is left to be said is "Ladies and Gentlemen please take your seats, fasten your Safety Belts and have a safe and comfortable flight"

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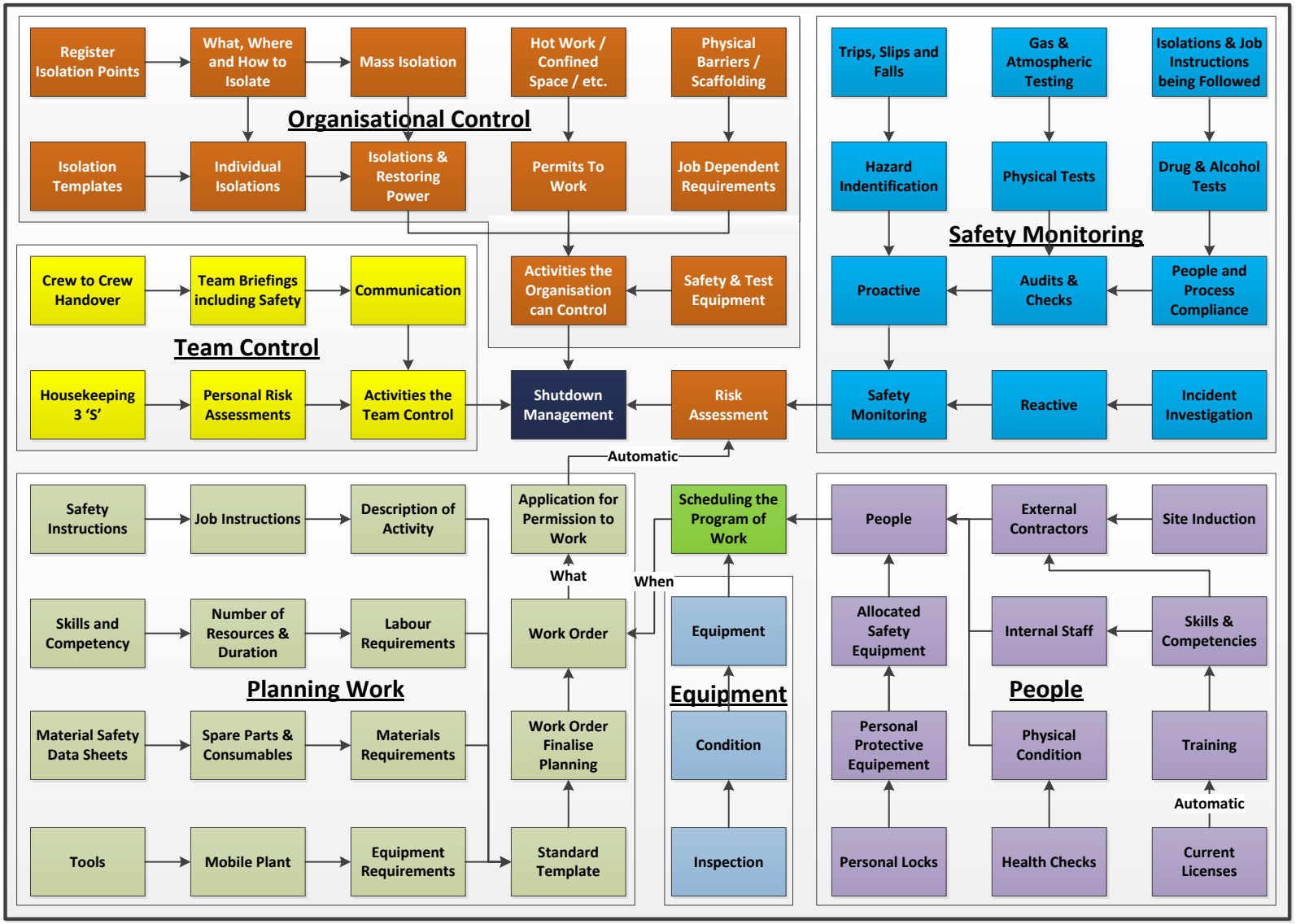
APPENDIX 1 – Shutdown end to end



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About the Author

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Process focussed Mechanical Engineer with over 30 years' experience in mining, utilities and manufacturing industries. Peter has undertaken many roles during his career moving from first line supervision to Maintenance and Plant Management. As a Consultant, Peter has assisted over 60 organisations in 20 countries in how to efficiently and effectively manage their Physical Assets.

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