

Shutdown Planning

- *distinctions and special problems*

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**Shutdown means a planned general outage of the equipment and assets that are an enterprise's major means of production or service delivery for the purpose of essential maintenance and statutory checks. Almost without exception, the main power and other utilities are disconnected for a time.*

Shutdowns entirely disrupt the activities of normal business. In a manufacturing enterprise, production is terminated and, in the FM environment, 'essential' services may be suspended.

In all cases there is high potential for massive customer inconvenience and dissatisfaction. Because of this, a shutdown demands the best management attention.

The challenge

The foremost challenge confronting a maintenance manager when faced with a maintenance shutdown is schedule establishment and control. Many factors conspire to upset best intentions and well laid plans.

Shutdown planning is uniquely challenging. It is considerably more problematic than routine running maintenance and more difficult than capital project planning. Because of the absolute need to keep business disruption to a minimum, shutdown durations are extremely short compared with other 'time bound' projects. The compressed time 'allowed' by management generally demands high manning intensity, which in turn dictates unconventional work patterns - overtime and shift work being the norm rather than the exception. In addition to these manning challenges, material deliveries are almost invariably critical, with *every* item having the potential to cause the shutdown completion date to slip.

The day-to-day difficulties that are the normal lot of hard-pressed maintenance departments are greatly amplified during shutdowns. The effects of any miscalculation are significantly increased at this time. Relationships within the organisation can often be tested to the limit. Heightened interdepartmental friction and internal friction within the maintenance department itself can jeopardise the program, if not contained. Everybody involved or affected by the shutdown activities should be sympathetic to the unique constraints. At shutdown time particularly, individuals must subjugate personal needs and agendas, abandon mindless demarcation and work together in common purpose, focusing on the paramount needs of the enterprise.

There are very few departments in an enterprise that are not affected by a shutdown undertaking. It is highly desirable to develop a list of critical shutdown activities and decisions required for each natural work group or department. Besides liaison with the work requesting departments, the maintenance group should hold shutdown meetings with other departments. The aim is no avoidable surprises for anyone on the day. A good communication process encourages full co-operation and develops team spirit.

The tendency is to assume that the organisational roles and responsibilities appropriate for day-to-day operations are just as applicable for shutdown projects. This is not the case. Organisations are in the main designed to control routine – including those where routine events are chaotic! Even when well-



Figure 1. Shutdown of an air separation plant. Abnormal maintenance of the reversing heat exchanger.

planned, shutdowns are anything but routine. As a result of the emerging unknowns, they are filled with exceptions and emergencies. The shutdown organisation must be structured to meet these special circumstances. Additional work management, inspection and material control resources will almost invariably be needed.

External risks

The greatest threat to the shutdown plan comes from outside the enterprise. Any need that must be satisfied externally is clearly not within the full control of the maintenance manager and therefore poses a special risk. Lack of any of the following at the correct point in time can jeopardise the shutdown plan and so has to be carefully managed:

- Spares, materials and equipment
- Contract labour
- Engineering services
- Hired equipment
- Regulatory and insurance inspectors
- Utility supplies (especially those that will be turned off!)
- Utility company engineering departments
- Agreement for work affecting neighbouring property, shared services, etc

Developing the shutdown program

The prime goal of the shutdown planning process is to produce a detailed, overall time-based plan - not merely a worklist. Because of the compressed time, an almost minute-by-minute schedule of calendarised and time-slotted tasks is the goal to strive for. Even though planned job sequences and timings are likely to change on the day, achieving a detailed schedule will nevertheless pay off. The *process* of producing such a schedule will always ensure the best shutdown outcome, even when arising circumstances force changes.

The worklist

Listing jobs for an upcoming shutdown should begin immediately following the preceding shutdown - simply because many of these future jobs will be based on discoveries made during the equipment internal inspections that have just taken place. Throughout the period between shutdowns, all prospective work should be registered immediately it is recognised. As each job is identified, it should be written up, a work request generated and passed to the nominated shutdown planner for evaluation.

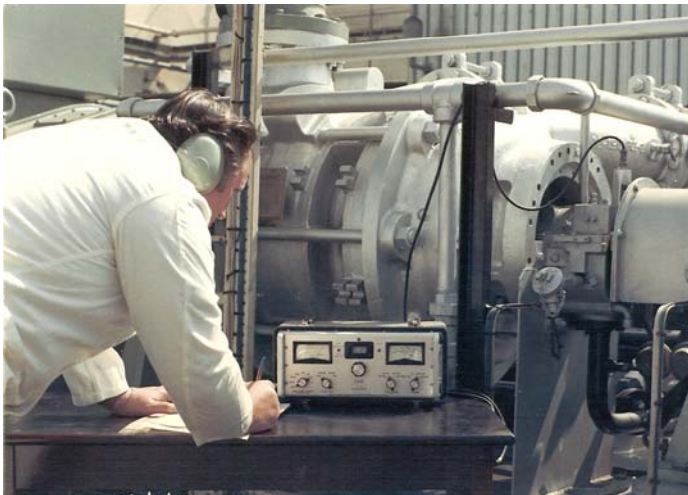


Figure 2. Checking the bearing vibration of a 5000 hp nitrogen turbo-compressor on an air separation plant. It's essential to carry out extensive on-condition checks before bringing critical machines down for maintenance.

To preclude a last minute rush of jobs, a cut-off date for submitting work requests should be set. After this deadline, no further jobs should be admitted to the worklist without the approval of higher management.

The shutdown worklist is dynamic document. It should be regularly reviewed in meetings attended by representatives of all the involved departments. At these meetings, some previously registered jobs may be deleted as no longer necessary, and new jobs added. As the shutdown work cut-off deadline approaches, the minds of job requesters will become more concentrated on what is most important and really needs to be achieved with the finite resources available during the limited period of the shutdown. So expect appreciable

movement of jobs on and off the worklist at this stage. Be flexible with the worklist and only restrict changes after the cut-off date.

Electrical, piping and other tie-ins to existing facilities for new projects and plant additions should never be overlooked when compiling the shutdown worklist. It is always extremely worthwhile making provision for these essential future connections to avoid the need for further costly shutdowns. Even when project needs have not yet been fully defined, best endeavours should be used to make provision for the tie-ins that are known to be needed.

Planning the workscope

Detailed planning of the shutdown should begin well before its start date. The first task of the shutdown-planning group is to decide whether or not the attributes of each proposed job on the worklist make it true shutdown-dependent work. Any job that can be carried out during normal operation at an opportunity outage should be rejected, as it is not shutdown-dependent work.

As a primary aim of the planning is to reduce the length of time that the facility is actually out of operation, the overall shutdown plan should be divided into three distinct stages:

1. Pre-shutdown
2. Shutdown
3. Post-shutdown

An aggressive approach is essential in order to push as many maintenance activities as possible into the pre-shutdown and post-shutdown workscope. This calls for ingenuity and thinking ‘outside of the box’ by all parties concerned. Close co-operation between maintenance, equipment user groups and the safety department is the order of the day. All parties must work in common purpose in order to achieve the minimum outage time.

Pre-shutdown, shutdown and post-shutdown worklists by class of work should be produced for each geographical area of the facility.

Pre-shutdown activities

Some jobs will have activities and preparation tasks that can be initiated before the time of the shutdown. These should be identified, listed and developed as pre-shutdown workscope.

A plant usually shuts down in stages with items of equipment potentially coming available to the maintenance department before the entire facility is shut down. The maintenance department should strive to initiate work on each piece of equipment as it becomes available. Additionally, subject to risk analysis and work permit, it is possible that disassembly of superficial and other parts can begin whilst machines are still operational. Full advantage should be taken of all possibilities to maximise the pre-shutdown scope.

It is not merely prudent but absolutely vital to carry out detailed physical inspection and examination of the facility during the shutdown scoping period to identify any defect condition or difficulty that has been understated or overlooked in the worklist. This includes on-condition monitoring checks of major mechanical items by vibration, oil analysis, process performance checks, etc, and infra-red thermography of electrical panels, electrical components, thermal insulation and refractories. It is essential to carry out extensive on-condition checks before bringing critical entities down for maintenance. During the physical inspection, rusted or defective fasteners or other limiting conditions that could slow down equipment dismantling can also be noted and remedial work provided for in the pre-shutdown workscope.

Post-shutdown activities



Figure 3. Stripping the 40,000 rpm rotor of an air separation plant expansion turbine. When an internal examination of a critical machine is planned, expect to discover a defect that hasn't previously revealed itself and ensure the availability of potentially necessary spares.

Production start-up activities can normally be carried out in parallel with many maintenance completion activities. Like for pre-shutdown, post-shutdown work should be maximised. Jobs with activities that can be finalised after the commencement of start up activities should be developed as post-shutdown workscope.

Shutdown activities

Perhaps a little paradoxically, if there is any doubt as to whether or not an activity could be accomplished as part of the pre-shutdown or post-shutdown scope, it should be automatically placed on the shutdown list. Erring on the side of caution is desirable because it is very important to know the shutdown 'worst case' workload. That is, the largest possible scope of the workload that is to be carried out with operations shutdown. Using this approach, together with a good planning methodology, there can be reasonable assurance that the planned shutdown length will not be exceeded.

Job & task planning

When each job has been agreed and approved as part of the final worklist, it must be analysed in detail. Each job's constituent tasks have to be identified, the best task execution sequence decided and each task's content analysed and estimated for labour time, materials and special needs. This can be carried out with the aid of a project planning computer system, or manually using a job-planning sheet, an example of a Job Planning Sheet is shown in the Appendix. Whichever way, it must be systematic. It is essential that all job influences are identified and careful thought is given to pin-pointing the possible concurrent activities that, when executed at the same time, will allow the elapsed time of the shutdown to be compressed.

A note of caution. If each job's duration can't be estimated with reasonable accuracy, then the critical path can't be reliably identified and, ultimately, the length of the shutdown can't be controlled.

Those individuals that are estimating the time and materials requirements for each job should inspect each job's location, speak to the job requester to test the real needs and, where possible, involve the person who will be in charge of carrying out the job – if its not themselves. They should also study all pertinent reports and technical information. The aim is to collect relevant information from every available source and not take the job request at face value or rely on supposition to specify the actual job execution needs. Even experienced maintenance supervisors and estimators can't always be aware of particular details that may greatly affect the job on the day.

Allowances should be included in time estimates for obtaining permits to work, gathering materials and for the arrival and interaction with supporting staff – for example, inspectors and safety personnel. Jobs requiring special lifts need to be pre-planned in detail. It is easy to overlook the need for special insurance-approved lifting aids and attachments.

Purchased materials and services

Jobs requiring materials with a long delivery period must be identified as early as possible. These types of jobs, generally associated with abnormal maintenance, are dealt with on an exception basis with purchase orders placed expeditiously to assure material deliveries well before the start date of the shutdown. In order to guarantee the availability of quality-compliant items - items that will fit and function as needed - it may be necessary to arrange for work-in-progress and pre-delivery inspection and test of parts and assemblies made to order.

Other purchase orders for material requirements are initiated for both stock and non-stock materials as they are identified during job planning. 'Running stocks' should not be depleted by call-offs for parts and materials guaranteed to be used during the shutdown. By all means increase the maximum stock quantities on hand, but avoid raiding the normal running stock levels unless you have to. Normal maintenance stock should always be kept in reserve to service the running plant and unplanned eventualities.

There will inevitably be uncertainty about the need for some spares. In many cases the final decision will be dependent on disassembly inspections planned for the shutdown. In the case of business-critical equipment, it is best to be conservative and make a prudent prediction of spares needs in consideration of the worst credible scenario. What's the worst condition that can be credibly expected when the kit is opened up? What is the likelihood? Should it be provided for? When an internal examination of a critical machine is planned, expect to discover a defect that hasn't previously revealed itself and ensure

the potentially necessary spares are to hand. When 'worst case' spares are not available from stock, it is prudent to make special arrangements with the supplier whereby he provides the parts that could be needed. He can hold them on reserve as part of his stock, or supply on a 'sale or return' basis – in this case the returns handling charge should be agreed beforehand. Suppliers may not always be able to supply a particular long lead spare. However, the supplier will often know of some organisation that has the spare on stock and he can provide you with contact details. It's then over to you to tap into that organisation's altruism and try to negotiate the spare part's possible availability on whatever terms you can agree to!

Provisional contracts for contract labour and hired equipment should be placed early with suppliers on a 'best guess' basis in order to guarantee their availability at shutdown time. Good contract labour is in short supply so, by making an early reservation, both the quality as well as the needed quantities are better assured.

Completing the shutdown schedule

Scheduling the overall plan involves deciding how long the shutdown will last, including the working shift patterns. Much of this will already be evident at this stage from the previous planning activities, but some revision may well be necessary. The three-stage program will take full account of and dovetail together with the shutdown and start up sequences and activities planned by the user groups.

Starting scheduling activities with less than 90% of the final workscope is generally counterproductive. Working with a poor initial scope definition will result in considerable inefficiencies and wasted time because of continuous, extensive reworking of the schedule documents.

The estimated workhours must be totalled for each resource. Resources include craft labour, services and special resources, for example, crane/lifting gear, high pressure water cleaning, scaffolding, inspection/testing and transport. This can be a tedious manual task, but an effortless one using a computer.

It generally takes more hours to complete a shutdown than the calculated sum of the workhours required for each job under routine conditions. Why? Because overall productivity will be lower than in normal circumstances. This productivity penalty is as a result of the compressed duration of the shutdown, the necessity for overtime and the organisational problems inherent in such an ad-hoc project. The overall manhour estimates and time plans must make allowances for this unknown, yet unavoidable, inefficiency. Of course, ample allowances for meal and other breaks must be included.

After the total workhours needed for each resource have been determined, worker levels and costs can be forecast based on 'what if' values of shutdown length, etc. Different crew sizes can be 'tried', subject to the nature of the job and the labour intensity factor for the relevant areas allow. It is almost inevitable that the manning levels in one or more areas will present the maintenance manager with an organisational problem of nightmare proportions.

The preliminary contracts for additional labour, special services and common use equipment, like scaffolding and cranes, should now be finalised. The specification of common use of scaffolding requires ingenuity to conceive and plan for aggregate needs. However, good access planning will pay off both in reduced scaffolding costs and a shorter schedule.

Finally

Plant and equipment is most vulnerable to inadvertent damage, vandalism and sabotage when internals are opened up. Face this risk squarely. Don't assume that your organisation is immune to such events and make provision for reasonable precautions in the shutdown plan.

Lastly, don't forget the cover for safety, fire, first aid and security.

Good shutdown planning!

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