

Operator Workaround Guideline

How to Manage the Risk of Implementing Operator Workarounds

2018 TECHNICAL REPORT

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How to Manage the Risk of Implementing Operator Workarounds

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ABSTRACT

Operator workarounds are defined as operator action(s) taken to compensate for a degraded or nonconforming condition in design or operation of plant equipment. Operator workarounds are used when overall system function can still be provided by an operator action until the degraded or nonconforming equipment/component is repaired.

All operator workarounds introduce additional risks into the operation of the generating unit. Before an operator workaround is implemented, a process to evaluate and address any risks to personnel safety, environmental compliance, equipment damage, or unit reliability should be followed.

The research described in this report was conducted by receiving input from several member companies and power plants on processes and best practices for managing the risk of implementing operator workarounds. A literature search across various industries was conducted to determine best practices for planning, implementing, communicating, and tracking operator workarounds. Findings from the research include the following:

- All plants should use an operator workaround process and assign a process owner.
- A logical, problem-solving approach must be used to identify risks associated with operator workarounds before these workarounds are implemented. Good communication, documentation, and tracking techniques must be used while operator workarounds are active in order to manage the risks.
- Failure to properly execute an operator workaround risk management process can result and has resulted in serious equipment failures, accidents, and injuries.
- Operator workarounds are indicators that something has malfunctioned in a system or piece of equipment. These failures are opportunities to investigate and make improvements to processes to prevent future failures.
- Operator workarounds often introduce unplanned work load on operators, adding to the operator's burden, which can impact the ability of the operator to adequately supervise plant equipment and processes and to respond to emergency conditions.

This guideline provides a method to establish an operator workaround process and program. A flowchart is provided, and examples that can be used as training aids are described.

Keywords

Operator burden
Operator workaround
Temporary alteration
Temporary modification

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KEY RESEARCH QUESTION

Operator workarounds are defined as operator action(s) taken to compensate for a degraded or nonconforming condition in design or operation of plant equipment. All operator workarounds introduce risk to the continued safe, reliable operation of generating units. This risk must be managed through a process. This report describes how to establish and manage an operator workaround risk management process.

RESEARCH OVERVIEW

The research was conducted by receiving input from several member companies and power plants on processes and best practices for managing the risk of implementing operator workarounds. A literature search across various industries was conducted to determine best practices for planning, implementing, communicating, and tracking operator workarounds.

KEY FINDINGS

- Failure to properly execute an operator workaround management process can result and has resulted in serious equipment failures, accidents, and injuries.
- Operator workarounds are indicators that something has malfunctioned in a system or piece of equipment. These failures are opportunities to investigate and make improvements to processes in order to prevent future failures.
- Operator workarounds often introduce unplanned work load on operators, adding to the operator's burden, which can impact the ability of the operator to adequately supervise plant equipment and processes and to respond to emergency conditions.

WHY THIS MATTERS

Without a process in place to deal with operator workarounds, abnormal conditions that can be left in place long enough become the new normal, operator mental and physical burden is increased, and risk management for the abnormal condition is not performed.

HOW TO APPLY RESULTS

A detailed process flowchart, which can serve as the basis for a good operator workaround risk management process, is provided. Best practices are shown for planning, implementing, documenting and tracking, and communicating the status of operator workarounds.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- Operator workarounds are frequently discussed at the Plant Manager Forums and at the Annual Operations Conference
- EPRI Program 69, Maintenance Management and Technology, also interfaces with operator workarounds.

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PROGRAM: Operations Management and Technology, P108

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1

INTRODUCTION AND DEFINITIONS

Operator workarounds (OWAs) are necessary because of deficiencies in equipment or systems. When a plant component or piece of equipment fails to work as designed, the operator immediately takes on the role of a problem solver. Operators are tasked to keep systems operating for the plant, so they immediately think of other methods to accomplish the function of the degraded or failed component. These other methods are OWAs.

The definition of an *operator workaround* is: operator action(s) taken to compensate for a degraded or nonconforming condition in design or operation of plant equipment. Examples of OWAs include the following:

- Monitoring and draining a tank at a prescribed level due to failure in the automatic drain system
- Monitoring and filling a tank at a prescribed level due to failure in the automatic fill system
- Turning equipment on/off due to failure in automatic controls (sump pumps, for example)
- Opening and throttling a manual bypass valve around an automatic control valve due to failure or degraded performance
- Manually opening or closing valves based upon specific conditions such as a runback, equipment trip, turbine trip, and boiler trip

Some companies use the term temporary alteration/change to describe an OWA. These are **not** the same thing and should be handled with separate processes. The key difference between these two items are that temporary alterations/changes often do not require an operator to perform them. These actions may be performed by Instrumentation and Controls technicians, electricians, or other plant personnel. A *temporary alteration/change* is an alteration or adjustment for a defined time frame to any component, variable, or property within an existing system (except those within clearly defined boundaries or responsibilities), including the following:

- Electrical jumpers
- Lifted leads
- Pulled circuit boards
- Disabled annunciators/alarms
- Mechanical jumpers/bypasses
- Temporary set-point changes
- Installed or removed block flanges
- Temporary fire protection system changes

- Disabled relief or safety valves
- Installed or removed filters or strainers
- Plugged floor drains
- Temporary pumps
- Temporary cooling
- Temporary heating
- Temporary compressors
- Temporary pipe supports

In either case, any deficiency must be dealt with. Ideally, all OWAs and temporary alterations/changes are well documented and communicated, and permanent fixes well planned and implemented as soon as possible.

Risk Management

OWAs introduce risks by deviating from the design and possible safeguards in a process or system. Precautions must be taken to keep track of the risks that OWAs introduce. Therefore, the equipment deficiency, any proposed OWA, and risks being introduced must be well understood. All necessary technical evaluations must be performed before implementing the OWA.

The Nuclear Regulatory Commission (NRC) requires careful evaluation of workarounds because: “Operator workarounds can impact human performance during event response, due to increasing complexity of tasks and more limiting time to perform required actions.”

The solution to successfully implementing workarounds is to identify the risks being introduced and make plans to manage these risks. The goal is to safely keep a system running.

OWAs must be evaluated with the appropriate level of expertise before being implemented. It is often necessary to involve maintenance or engineering personnel to gain a thorough understanding of how the design basis of a system will be affected by making the alteration or implementing the OWA.

Communication

Effectively tracking the open active workarounds is critical to managing risk. Several techniques for tracking and communicating are discussed in this report.

Operator Burden

Operator burden is defined as the work performed by an operator during normal plant operation. OWAs can create or add additional operator burden by causing an operator to respond to undesirable conditions/impediments typically controlled by fully operable components or systems. This approach can create additional risks for plant operations when this operator burden is added to an operator during his/her response to abnormal operating conditions or emergencies.

Key Points

Throughout this guide, key information is summarized in “Key Points.” Key Points are bold lettered boxes that succinctly restate information covered in detail in the surrounding text, making the key point easier to locate. In this report, Key Points are also used to provide additional information and highlight noteworthy utility good practices.

The information included in these Key Points was selected by EPRI personnel and the consultants and utility personnel who prepared and reviewed this guide.

The Key Points in this report are organized according to two categories: technical and safety. Each category has an identifying icon, as shown below, to draw attention to it when quickly reviewing the guide.



Key Technical Point

Targets information that will lead to improved equipment reliability.



Key Safety Point

Identifies information that will lead to improved worker and industrial safety.

2

EXAMPLES OF OPERATOR WORKAROUNDS

Several OWA examples were discussed or witnessed during visits and interviews with member companies (see Figures 2-1 through 2-4). Others listed are from previous experience of the investigators. These examples of OWAs include the following:

- Operation of bypass valves to increase the range for an automatic regulator valve that has completely opened
- Manual operation of a bypass drain valve because the motor-operated valve (MOV) has failed
- Tying the turbine-turning gear engagement handle down to keep the turbine from tripping off turning gear
- Bad oil leak requiring frequent changing of absorption pads or emptying of catch basins or barrels and refilling oil reservoirs
- Sump pump controls out of service requiring operators to manually energize the sump pump on some required frequency to prevent overflow
- Broken air damper drive requiring manual adjustment of dampers
- More frequent cleaning of intake screens or racks due to several factors (leaves, trash from high water, and shad kills during hot weather) can be high operator burden
- Any automatic control loop being operated in manual mode
- Manually opening a fire protection valve if an alarm is received due to failure of the automatic operation
- Roping off access to areas of plant due to leaks and scald/burn hazard, requiring different routes or suspending a section of operator rounds
- Operating an air preheater drive on the backup air motor, requiring more frequent checks and tasks, including draining water trap and adding oil to oiler



Figure 2-1
Operator manually draining water from lube oil tank once every shift

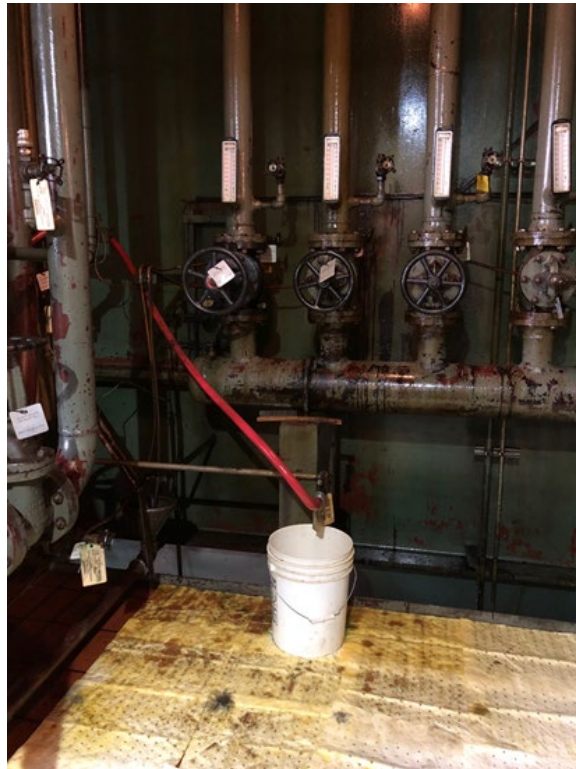


Figure 2-2
Operator capturing and emptying an oil leak

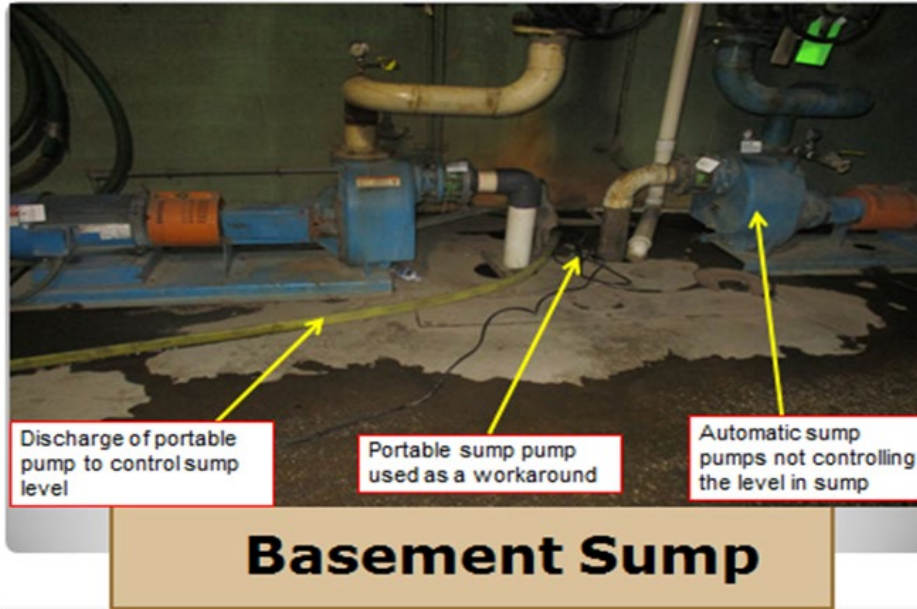


Figure 2-3
Using portable sump pump as workaround for failed sump pump



Figure 2-4
Sewage pump controls in manual mode due to loss of level controller

3

PAST ACCIDENTS WITH OPERATOR WORKAROUNDS AS CAUSAL FACTOR

Operator workarounds have resulted in many accidents. The following are some examples:

- Exxon-Valdex oil tanker grounded and spilled 10.8 million gallons (40.9 million liters) of crude oil, impacting 11,000 square miles (28,490 km²) of ocean and 1,300 miles (2,092 km) of coastline. The ship was outside of approved traffic lanes. This practice had been going on for about 10 years. Accident cost is estimated at \$3.5 billion.
- Locally isolating leaking control valves that supply cooling water to boiler doors when plant shut down. On subsequent startup, these valves remained isolated causing the failure of the boiler doors and resulting plant shutdown with lost revenue until repaired.
- An explosion occurred aboard Apollo 13 as it traveled between the earth and moon. A dented oxygen canister did not drain properly. Instead of replacing the canister, time pressure led to a workaround being devised to use the internal heaters, a solution that seemed to work. The canister later exploded, nearly dooming the ship and crew.
- An explosion and fire at a PVC manufacturing plant killed five people and seriously burned two others. The plant was destroyed and an adjacent warehouse burned. The incident began when an operator over-rode an interlock to get a faulty tank drain valve to open.
- Operators could not get a MOV to completely isolate flow. A “cheater” bar was attached to the MOV gearbox handwheel to apply additional closing torque to the valve operator. This was a common practice throughout the power generation industry. The force exceeded the strength of the gearbox internals causing the gearbox to rupture which sent gears, casing fragments, and other metal pieces out killing the operations personnel.

4

PROCEDURE FOR CONTROLLING RISKS OF OPERATOR WORKAROUNDS

Introduction

The following are several steps to safely and successfully use an OWA:

1. Identify and communicate the problem.
2. Discuss possible solutions with appropriate supervision.
3. Assess risks and hazards, engaging appropriate personnel.
4. Select a solution and gain approval.
5. Implement the operator workaround.
6. Document and track.
7. Communicate.
8. Restore equipment.

A more detailed flowchart of the steps, which also integrate the appropriate parts of the management of change (MOC) process, corrective action process (CAP), work control process, and risk management process are shown in Section 5. Examples using the flowchart are discussed in Section 6.

Purpose and Scope

The purpose for taking time to carefully plan an OWA before simply “trying” things is to manage the risk introduced by the OWA. Remember that an OWA is needed in the first place because something did not work like it was designed. Possible outcomes of implementing an OWA must be considered and contingency plans made. Ask a lot of “What if?” questions to ensure that the possible outcomes of implementing the OWA are understood.



Key Technical Point

The purpose for taking time to carefully plan an operator workaround before simply “trying” things is to manage the risk introduced by the operator workaround.

1. Identify and communicate the problem.

The first step is to clearly identify the problem to be solved before possible solutions are designed. If the problem is not clearly stated, people are often tempted to implement solutions to treat one of the symptoms or results of the actual problem, which could be ineffective or narrow the possible solutions. The problem is communicated to others to ensure that an actual problem exists and not a misunderstanding by the person originally discovering the problem.

2. Discuss possible solutions with appropriate supervision.

Good troubleshooting and problem solving techniques should be used. See EPRI Report 3002008520, “Troubleshooting and Diagnostics for the Power Plant Operator: A Systematic Approach to Troubleshooting,” for examples and techniques for troubleshooting and effective problem solving. The guideline provides a good review of the proper use of human performance improvement tools, including the following:

- Self-checking
- Three-way communication
- **Stopping** when unsure or unsafe
- Questioning attitude

3. Assess risks and hazards, engaging appropriate personnel.

Evaluate what could go wrong and effects on other processes, including active lock out and tag outs, while performing the OWA. Always ensure that there are barriers in place to prevent personal injury. If the workaround cannot be performed safely, another option will have to be considered.



Key Safety Point

If the workaround cannot be performed safely, another option will have to be considered.

Several OWAs that were once routinely performed are no longer acceptable due to the industry’s better understanding and management of safe work practices. An example is removal of boiler clinkers with the unit online. Another example is using a pipe wrench, or cheater, to place additional closing torque on an MOV gearbox handwheel. Another old practice was using some nonconducting material, like a wooden broomstick, to hold a contactor in place, not allowing it to trip out, to force a motor or other electric device to continue operating.

Also consider the effect that the OWA may have on the ability of operators to perform their normal shift functions as well as implement emergency procedures if necessary.

Involve appropriate personnel (on-site and off-site) as necessary, to fully understand the risks and hazards associated with the OWA. Review drawings, logics, process diagrams, procedures, and so on as needed to fully grasp the implications of the OWA.

4. Select a solution and gain approval.

Once a solution is selected, obtain proper levels of approval from the control room operator (CRO), shift supervisor (SS), or operations manager.

Communicate plans and the risk of impact on unit output with the generation scheduling authority as necessary before implementing. Market conditions may have changed such that it is a good time to shut a unit down for repairs rather than implement an OWA. Conversely, grid conditions may have become more critical, raising the consequences of a load reduction or unit trip. In this case, the operations manager and possibly plant manager should become involved and sign off on the actions to be taken.

5. Implement the operator workaround.

Carry out the tasks to implement the OWA. If the OWA does not temporarily solve the problem, return to Step 1 to ensure that the problem is identified.

6. Document and track.

It is very important to properly document the OWA so that subsequent operating shifts are aware of the unusual setup and the risks involved with having active OWAs.



Key Technical Point

It is very important to properly document the operator workaround so that subsequent operating shifts are aware of the unusual setup and the risks involved with having active operator workarounds.

In some instances, OWAs must be immediately deactivated, or other steps taken, in the case of a sudden load reduction or unit trip, to prevent the risk of personnel injuries or to prevent additional damage to equipment. For example, if it is necessary to valve in vacuum pumps across operating units to help a unit having air in-leakage or back-pressure problems, the sudden trip of one of the units may cause the other unit to lose vacuum and trip as well. Operators would have to remember to immediately isolate the remaining unit from the tripped unit, that is, deactivate the OWA.

The documentation must be detailed enough to identify other safety hazards, environmental risks, and any changes necessary when plant conditions change. Procedures that had to be temporarily modified must be noted. Several tools used to track active workarounds include the following:

- A dedicated screen in the unit e-logs
- Manual logs
- Whiteboards
- Tags and log (caution or information)
- Equipment out-of-service logs

Once the OWA is documented, initiate a corrective maintenance (CM) work order in the computerized maintenance management system (CMMS). Certain CMMSs, such as SAP, have a special tag for OWAs. Ensure the work order is tagged as necessary for scheduling during a short-notice outage (SNO).

If the OWA requires a change in an operating procedure, a note should be made in the procedure clearly showing the modification. Usually a standing order is issued to ensure that all shift personnel read about the change and sign off for understanding.

The plant should have a person assigned as the OWA process owner. Duties include a weekly review of all open OWAs and reassessment of the risk load and operator burden associated with the OWAs. This person often also serves as the operations work maintenance gatekeeper.

7. Communicate.

The following are routine plant forums that are used to communicate the existence and status of active OWAs:

- **Shift turnover:** The first and most important communication takes place during the shift turnover meeting. Several EPRI reports address how to effectively perform log keeping and shift turnover. See Appendix D for a list of titles and report numbers. As part of turnover, the oncoming shift must review the OWA log to be aware of the active OWAs on each unit for their watch station. Equipment owners and technical support staff should either read shift turnover reports or be notified by email when an OWA has been implemented on the equipment or system that they are responsible for monitoring.
- **Plan-of-the-day (POD) meetings:** The operations work management gatekeeper reviews new CMs work orders written over the past day as a result of OWAs and decides whether to break the current day ahead maintenance schedule to immediately correct the equipment deficiency.
- **Weekly maintenance scheduling meetings:** Again, the operations gatekeeper helps the team to prioritize and schedule CMs to address OWAs, as appropriate, based on availability and access to equipment and severity of risks. The work listed on the SNO list should also be reviewed to ensure that CMs have been properly planned and spare parts are available or on order.
- **Outage planning meetings:** The OWA list should also be reviewed during longer term outage planning meetings to ensure that scope to make repairs to remove the OWAs is included.

8. Restore equipment.

Once the repairs to the equipment have been performed, operations personnel must restore the equipment alignment to normal and test to be sure that the problem has been solved. A best practice is to include the OWA restoration as part of the work package completion.

If an operating procedure was modified to support the OWA, the procedure must be restored. Be sure to issue a standing order to have everyone read and sign off on the change for understanding.

In some cases, the OWA had been active for so long, such as when a major outage was required to make repairs, that the operators are not aware the OWA has been removed or the equipment operation has changed. Several operators may have been hired and qualified to the modified procedures since the OWA was initiated. It may be necessary to retrain operators when equipment is restored and the procedure reverts back to original.



Key Technical Point

If an operating procedure was modified to support the operator workaround, the procedure must be restored. Be sure to issue a standing order to have everyone read and sign off on the change for understanding.



Key Technical Point

It may be necessary to retrain operators when equipment is restored and the procedure reverts back to original.

5

OPERATOR WORKAROUNDS FLOWCHART

Figures 5-1 and 5-2 are process sheets in which steps are numbered and referenced throughout the examples in Section 6.

Operator Workarounds Flowchart

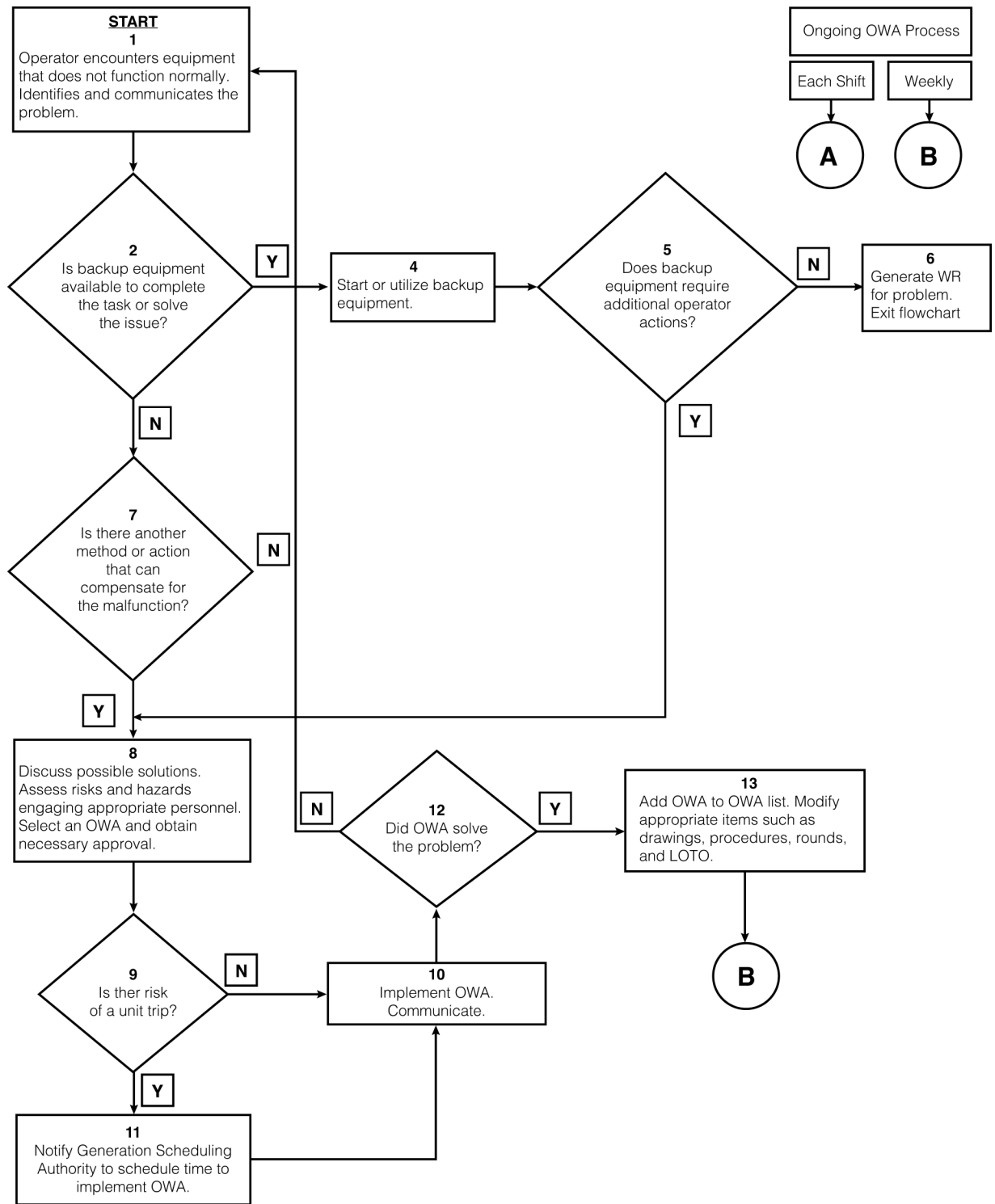


Figure 5-1
Process flowchart 1

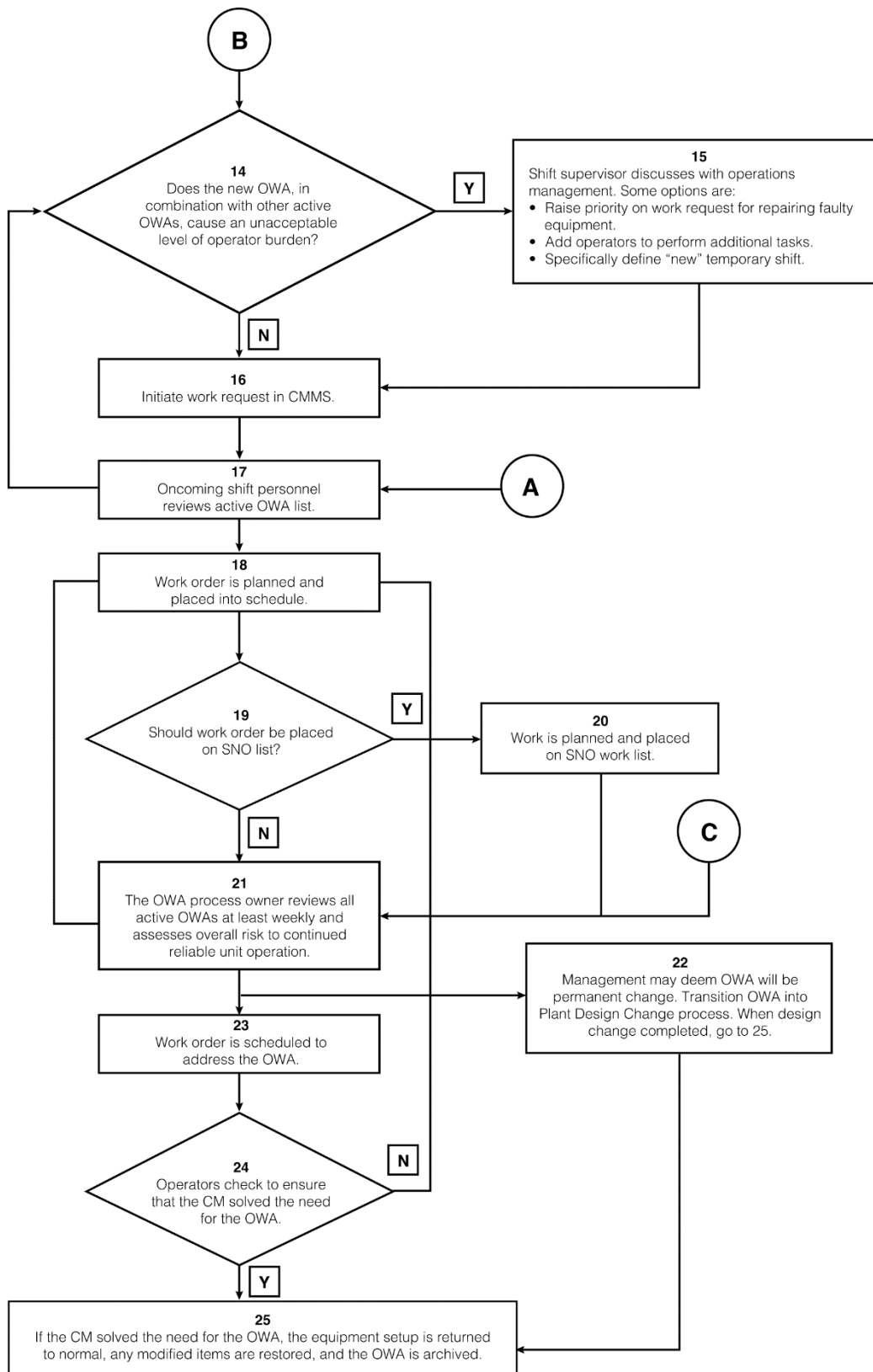


Figure 5-2
Process flowchart 2

6

OPERATOR WORKAROUND EXAMPLES USING FLOWCHART

Please refer to the process sheets from Section 5. Process steps are numbered and referenced throughout the examples.

Example 1: High Turbine Lube Oil Temperature

Scenario: During normal full-load operations, the CRO receives a high turbine lube oil temperature alarm and asks the auxiliary operator (AO) to investigate. The CRO also notes that the cooling water regulator to the lube oil coolers is at 100% demand.

1. **Process Block 1:** Operator encounters equipment that does not function normally. Identifies and communicates the problem. CRO receives a high turbine lube oil temperature alarm and asks the AO to investigate. The CRO also notes that the cooling water regulator to the lube oil coolers is at 100% demand. There may be several causes of the problem, but it is important to state the actual problem before going down different paths or treating symptoms.
2. **Process Block 2:** Is backup equipment available to complete the task or solve the issue? The AO observes that the B lube oil cooler is in service and the A cooler is out of service. The AO checks plant status log and finds that the A lube oil cooler is clean and available. The AO notifies the CRO of findings. The CRO informs the AO that the procedure for swapping turbine lube oil coolers requires the unit to be offline. Since the spare equipment is not available, Process Block 2 is answered NO.
3. **Process Block 7:** Is there another method or action that can compensate for the malfunction? The CRO and the AO determine that other methods are available to lower turbine oil temperature. Process Block 7 is answered YES.
4. **Process Block 8:** Discuss possible solutions. Assess risks and hazards engaging appropriate personnel. Select an OWA & obtain necessary approval. AO and CRO discuss the following possible options to lowering the lube oil temperature:
 - Lower inlet cooling water temperature.
 - Increase cooling water flow through the B lube oil cooler.
 - Reduce unit load.

The operations team determines the following:

- It is not possible to lower inlet water temperature.
- Increase cooling water flow through the B lube oil cooler. A manual bypass valve exists around the cooling water regulator valve. A viable option.
- Reduce unit load. A viable option but since system demand is currently full load and not desiring a forced de-rate, team determines that this is option 2.

SS agrees and approves using the manual bypass around the cooling water regulator valve.

5. **Process Block 9:** Is there risk of a unit trip? Since the risk is minimal, Process Block 9 is answered NO.
6. **Process Block 10:** Implement OWA. Utilizing human performance tools and in communication with the CRO, the AO opens the manual bypass around the cooling water regulator until the CRO acknowledges that the temperature has returned to normal and the high-temperature alarm has cleared. The AO, CRO, and SS all note this OWA in their respective narrative logs for use during shift turnover.
7. **Process Block 12:** Did OWA solve the problem? Since turbine lube oil temperature has returned to normal and the high-temperature alarm has cleared, Process Block 12 is answered YES.
8. **Process Block 13:** Add OWA to OWA list. Modify appropriate items such as drawings, procedures, rounds, and LOTOs. After operations team discussion, the following items are performed. AO adds note to AO status board of configuration change along with instructions to check turbine lube oil temperature for any load changes, at least once every 2 hours, and to manually close the bypass on a plant trip. CRO adds note to control room (CR) status board of configuration change along with instructions to check turbine lube oil temperature for any load changes, at least once every 2 hours, and to instruct AO to manually close the bypass on a plant trip. AO, CRO, and SS make narrative log entries of OWA for communicating at shift turnover. SS also generates an operations preventive maintenance (PM) task to place A turbine lube oil cooler in service when the unit is offline.
9. **Process Block 14:** Does this new OWA, in combination with other active OWAs, cause an unacceptable level of operator burden? Although the CRO will have to monitor turbine lube oil temperatures more carefully and the AO may have to adjust the bypass valve with changing load, the SS determines that there is not an unacceptable level of burden. Process Block 14 is answered NO.
10. **Process Block 16:** Initiate work request in CMMS. Tag as OWA. A work request is initiated to have the B lube oil cooler cleaned when the unit is offline. The plant may use special tags to identify OWAs in the field. If so, a tag could be hung on the bypass valve chain or handwheel.
11. **Process Block 17:** Oncoming shift personnel reviews active OWA list. The OWA is communicated during shift turnover.
12. **Process Block 18:** Work order is planned and placed into schedule. The operations work management gatekeeper reviews the new WR to provide input for priority and scheduling.

13. **Process Blocks 19–20:** Should work order be placed on SNO list? Since the cooler cannot be isolated and cleaned online, it will not be emergent work but should be placed on the SNO work list.
14. **Process Block 21:** The OWA process owner reviews all active OWAs at least weekly and assesses overall risk to continued reliable unit operation. Priorities may be changed and work scheduled sooner as appropriate.
15. **Process Blocks 23–25:** Once the work order is performed to address the OWA (Process Block 23), the operators check to ensure that the CM solved the need for the OWA (Process Block 24). If not, the work order is revisited. If the CM solved the need for the OWA (Process Block 25), the equipment setup is returned to normal, any modified items are restored, and the OWA is archived. In the case of very long-standing OWAs that required a major outage to correct, it may be necessary to retrain operators on the new normal method of operating the equipment.
16. **Process Block 21:** The OWA process owner reviews all active OWAs at least weekly and assesses overall risk to continued reliable unit operation. Priorities may be changed and work scheduled sooner as appropriate.

This may appear to be a simple OWA, but following the process steps ensures the following:

- Risk is identified.
- Contingency plans are identified.
- Good communication takes place.
- Overall risk is minimized.

Suppose, in this example, after a few days, the turbine lube oil temperature again alarms as high. Since the regulator valve is already being bypassed, the choice may be made to swap the coolers. Since this was identified in the past as a risky evolution, extra planning and care, such as running through a table-top exercise of the sequence of steps in the procedure, would be necessary to manage the risk. Also, the generation scheduling authority would be consulted (Process Block 11) and informed of the risk so that consequences of an inadvertent unit trip could be evaluated. Perhaps a load reduction until a later time would be a more palatable solution. In any case, use of the process will drive out the best management of the risks.

As a separate best practice, the equipment owner or engineer should study options to prevent recurrence of the originating problem. These options could include the following:

- Engineering and installing a new automatic control valve with more flow range. Newer valve designs have the ability to control cooling water at low flow during startup all the way through high flows during hot ambient conditions.
- Depending on the unit's mission profile, the oil coolers could be cleaned more often during maintenance outages or during reserve time.
- The swapping procedure and training could be evaluated to minimize or eliminate the risk of activating a trip while swapping online. Isolation valves could then be tested for possible online cleaning of the out-of-service cooler.

By following this process, it is possible to prevent OWAs from becoming accepted as “normal,” that is, from being institutionalized.

Example 2: Air Preheater Drive Electric Motor Fails During Unit Startup

Scenario: The plant received a request to start up a coal-fired unit that was in reserve shutdown. During the startup of the fans and air preheaters, the CRO received an alarm for a tripped air preheater. AOs found that the air preheater stopped and asked the CRO to restart. The motor immediately tripped back out. It was believed that the motor was either locked up or had failed electrically.

1. **Process Block 1:** Operator encounters equipment that does not function normally. Identifies and communicates the problem. The problem is defined as air preheater drive motor failed.
2. **Process Block 2:** Is backup equipment available to complete the task or solve the issue? An emergency air motor is available on the other shaft of the reduction gear. Process Block 2 is answered YES.
3. **Process Block 4:** Start or utilize backup equipment. Additional discussions are held among the staff about the long-term reliability of the backup air motor and whether the air motor drive was designed to start and run an air preheater indefinitely or to shut down a unit in a controlled manner upon failure of the electric drive. The more experienced personnel remember running on air motor drives for several weeks in the past, as long as the oiler is kept full and the moisture trap is kept drained. The decision is made to proceed with the startup on the backup air motor. SS instructs the AO to ensure that the air motor oiler is full and start the preheater rotation via the air motor. The unit startup proceeds. Actions are logged by each watch station participant, including SS, to prepare for shift turnover.
4. **Process Block 5:** Does backup equipment require additional operator actions? The AO will have to verify that air motor drive oiler is kept full and the moisture trap is kept drained while air motor is in service. Process Block 5 is answered YES.
5. **Process Block 8:** Discuss possible solutions. Assess risks and hazards engaging appropriate personnel. Select an OWA & obtain necessary approval. AO and SS discuss the following:
 - How often to perform air motor drive oiler checks per shift
 - How often to perform air motor drive moisture trap checks per shiftSS agrees and approves adding both of these items to the AO normal operator rounds that are performed twice per shift while air motor is in service.
6. **Process Block 9:** Is there risk of a unit trip? Process Block 9 is answered NO.
7. **Process Block 10:** Implement OWA. AO, CRO, and SS all note this OWA in their respective narrative logs for use during shift turnover.
8. **Process Block 12:** Did OWA solve the problem? Since air preheater is rotating with no alarms, Process Block 12 is answered YES.
9. **Process Block 13:** Add OWA to OWA list. Modify appropriate items such as drawings, procedures, rounds, and LOTOs). After operations team discussion, the following items are performed. AO adds note to AO status board of configuration change along with instructions

to check air motor drive oiler full and moisture trap drained during the normal operator rounds (twice per shift) while air motor is in service. CRO adds note to CR status board of configuration change along with instructions to check air motor drive oiler full and moisture trap drained during the normal operator rounds (twice per shift) while air motor is in service. AO, CRO, and SS make narrative log entries of OWA for communicating at shift turnover.

10. **Process Block 14:** Does this new OWA, in combination with other active OWAs, cause an unacceptable level of operator burden? Any other active OWAs also must be taken into account. An unacceptable level of operator burden is one in which the AOs are so consumed with OWA tasks that they are unable to complete normal rounds or would be hindered in responding to emergency situations. Although the AO will have two additional items added to AO operator rounds, the SS decides that the additional checks on the air motor are manageable. Process Block 14 is answered NO.
11. **Process Block 16:** Initiate work request in CMMS. Tag as OWA. A work request is initiated to have the normal air preheater drive motor repaired/replaced. The plant may use special tags to identify OWAs in the field. If so, a tag could be hung on the air motor drive oiler and moisture trap.
12. **Process Block 17:** Oncoming shift personnel reviews active OWA list. The OWA is communicated during shift turnover.
13. **Process Block 18:** Work order is planned and placed into schedule. The operations work management gatekeeper reviews the new WR to provide input for priority and scheduling.
14. **Process Blocks 19-20:** Should work order be placed on SNO list? The electric motor should be checked and repaired/replaced at the next unit shutdown. Process Block 19 is answered YES. The WR is placed on the SNO list.
15. **Process Block 21:** The OWA process owner reviews all active OWAs at least weekly and assesses overall risk to continued reliable unit operation. Priorities may be changed and work scheduled sooner as appropriate.
16. **Process Blocks 23-25:** Once the work order is performed to address the OWA (Process Block 23), the operators check to ensure that the CM solved the need for the OWA (Process Block 24). Once it is confirmed the electric drive is again functional, the OWA log is completed and if any temporary changes were made to rounds procedures, for example, these will be restored and communicated (Process Block 25).

Again, as a separate best practice, the equipment owner or engineer should study options to prevent future failures. For example, if the motor failed because it was improperly lubricated and was packed with grease causing overheating or shorting, then additional training on proper bearing lubrication practices may be necessary. Conversely, if bearings failed and locked up or allowed the rotor to impact and fail the windings due to inadequate lubrication, either training could be revisited or PM schedules adjusted.

7

RISK MANAGEMENT AND CORRECTIVE ACTION PROCESS

All OWAs introduce a level of risk to the safe, reliable, efficient operation of a generating unit. This risk must be understood and managed. As discussed in the introduction, the presence of an OWA is an indicator that something in a system did not work as designed.



Key Safety Point

All operator workarounds introduce a level of risk to the safe, reliable, efficient operation of a generating unit by deviating from the design and possible safeguards in a process or system. This risk must be understood and managed.

Before an OWA is implemented, the plant must be certain that personnel and equipment safety are not compromised.



Key Safety Point

Before an operator workaround is implemented, the plant must be certain that personnel and equipment safety are not compromised.

For example, OWAs that affect key plant protection systems such as fire protection, purge systems, and so on should be avoided. Secondly, the ability of operators to respond to emergency conditions may be affected. Mitigation plans must be made as necessary to ensure that the operators can successfully implement emergency procedures. One example would be blocking off a platform or walkway due to a leak. If a key valve or other piece of equipment that has had access blocked has to be operated, for example, in the case of a unit trip, then another way to access the equipment must be provided. A key to dealing with risk is to develop a formal process for planning and communicating.



Key Technical Point

A key to dealing with risk is to develop a formal process for planning and communicating.

The issue must be vetted with supervision and technical experts as necessary. A mitigation plan must be designed before implementing the OWA.

A WR must always be initiated so plans for repairs can be made. The repairs must be scheduled in an appropriate time frame to remove the risk.

The composite risk level of all active OWAs on the units and plant must be understood. It may be that two or three OWAs taken individually are not of high risk, but if additional failures “line up” in the wrong sequence, a major accident that could result in injuries and/or major equipment damage may occur. Many investigations of accidents or major equipment failures point to several holes in the layers of protection that were introduced by workarounds and temporary alterations lining up that allowed the event to initiate.



Key Safety Point

If additional failures “line up” in the wrong sequence, a major accident that could result in injuries and/or major equipment damage may occur.

Some companies track risk using a simple risk matrix and enter issues by degree of consequence versus likelihood of occurrence. This gives a quick visual reminder of outstanding issues awaiting resolution. A common risk matrix is shown in Figure 7-1.

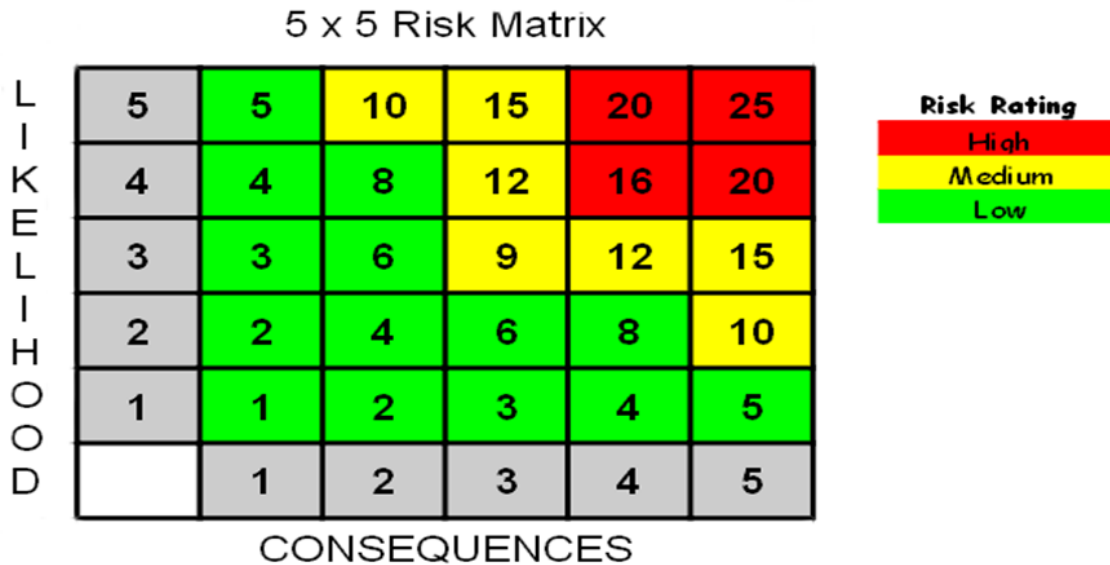


Figure 7-1
Standard risk matrix

Corrective Actions

The nature of OWAs is that they are a temporary solution to a front-line problem. The trouble is that they work and allow systems with problems to continue operating, thereby masking the underlying system weaknesses. At times, OWAs are so successful that they become accepted as a permanent solution. Rather than conducting a thorough hazard analysis and investigation of the root causes of the OWA, over time, the OWA becomes the new normal and is simply accepted. New users of a system or procedure may not even be aware that the process was once accomplished in another manner before it became necessary to implement the OWA.

OWAs must not simply be temporary solutions to problems, but follow-up should be performed. The OWA should be used as an opportunity to make a work process improvement to permanently solve a problem or issue. If the deficiency is large enough or recurs too often, the company's corrective action program (CAP) should be used to follow up. An apparent or root cause investigation should be performed to find causes and propose corrective actions to permanently eliminate the system or process weakness. These process improvements are exactly the intention of a good CAP. The following basic CAP steps should be implemented:

- Capture the shortcomings.
- Investigate the causes.
- Implement permanent solutions to prevent recurrence.



Key Technical Point

The operator workaround should be used as an opportunity to make a work process improvement to permanently solve a problem or issue.

Management of Change and Plant Configuration Management

Another important aspect of managing risk from the abnormal setups caused by OWAs is to integrate MOC and plant configuration processes with the OWA procedure. This has been discussed by keeping good logs, preferably e-logs, on active OWAs. Also, temporary changes to operating procedures must be made. The procedures must then be restored when the OWA is removed.

8

EVALUATING OPERATOR BURDEN AND TRACKING AND AUDITING OPEN OPERATOR WORKAROUNDS

Operator Burden Assessment

Operator burden is defined as the work performed by an operator during normal plant operation. OWAs can create/add additional operator burden by causing an operator to respond to undesirable conditions/impediments typically controlled by fully operable components or systems. This can create additional risks for plant operations when this operator burden is added to an operator during his/her response to abnormal operating conditions or emergencies. The problems with additional operator burden are the following:

- Operators may not have adequate time to complete the normal equipment inspection rounds, reducing the use of human senses in the field for early detection of problems.
- Operators may not be available to respond to developing emergency conditions quickly.
- Operator may not remember the OWA during a high-stress condition.

The SS is responsible for assessing when additional operator burden is introducing too much risk to the ability of the operating shift to adequately monitor and control equipment. Operations management must be notified by the supervisor when the burden is too high.

The OWA process owner should also assess operator burden when doing the weekly review of open OWAs and provide input and voice concerns.

Auditing Operator Workaround Process

Managing open OWAs is really risk management since all OWAs introduce new risk to the safe, reliable operation of the unit. Best practices for managing active OWAs include the following:

- Review of new OWAs or changes in active OWAs during each shift turnover meeting.
- Review of all active OWAs from the log at the beginning of the shift by each watch station operator.
- Conduct a weekly review by the process owner. Overall operator burden, overall risk load, and the ability of operators to respond and execute emergency procedures are among the considerations during the review.
- Review as part of weekly scheduling meetings to determine if work scheduling priorities should change.

- Review of those on the SNO list if a forced outage, short maintenance outage, or reserve shutdown occurs.
- Review as part of longer term outage planning meetings.

Many plant's CMMS systems will display all open work orders associated with open OWAs. These reports help with the review process. There are times when stations, especially nuclear stations, determine that the risk from open OWAs has become unacceptable and schedule maintenance outages to repair equipment and reduce the risks.

Reviews are also necessary because procedures may not always identify all potentially hazardous scenarios. Reviews also ensure that protective systems are not compromised from performing as designed. An example would be isolating deluge systems or CO₂ blanketing systems that keep tripping falsely. Reviews ensure that OWAs do not become "institutionalized" and eventually accepted as normal operation.

9

GAP ANALYSIS AND HOW TO IMPLEMENT GUIDELINE

If a company has no formal OWA procedure, this guideline may be used to establish one. Simply utilizing Section 4 steps and the flowchart in Section 5 should serve as a good start for an adequate program. The examples in Section 6 serve as good, quick training templates.

If there is no formal log of active OWAs, one must be established. If an electronic logging function is not available, a manual log book kept at each unit's control board or in the operating SSs' office is a good start. Sample forms are shown in Appendix F.

The next step is to document all open OWAs. A thorough plant survey may be required. Also ask operators to verify and describe (ideally, with photos) any known, active OWAs. There are probably OWAs, such as the turbine oil cooler cooling water regulator bypass valve operation used in the example in Chapter 6, that have become accepted as "normal" and have been institutionalized. These will be more difficult to recognize. A review of the CMMS backlog may identify OWAs awaiting corrective maintenance.

Once the initial list is established, operations technical staff should review all OWAs and discuss the level of risk involved with each workarround.

Ensure that CM work orders have been written to make all repairs as necessary, and propose the priority for the repairs based on the risk load. Ensure that OWA CM that can be accomplished in a short outage are listed on the SNO list and scheduled in the event of an unplanned outage or reserve shutdown time.

Communicate all active OWAs with each shift during a shift turnover meeting and establish expectations for documentation and communication of all subsequent OWA opportunities. It may be necessary to provide a training session on overtime or during training weeks for plants that utilize a fifth shift.

Over time, as operators see that equipment issues are prioritized and repairs scheduled and made, documentation of new OWAs will improve and the process will continue to mature. The plant's MOC and corrective action programs do not necessarily have to be mature for the OWA process to work, but appropriate CM priorities and scheduling must be accomplished.

If no formal documented program exists for temporary alterations, a program should be established. Either electronic or manual logs must be kept for all lifted leads, forced points, installed jumpers, and suppressed alarms. These logs should be available to and maintained by the CROs and SSs.

10

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A

SUMMARY OF KEY POINTS

Key Technical Points



Key Technical Point

Targets information that will lead to improved equipment reliability.

Page	Key Point
4-1	The purpose for taking time to carefully plan an operator workaround before simply “trying” things is to manage the risk introduced by the operator workaround.
4-2	It is very important to properly document the operator workaround so that subsequent operating shifts are aware of the unusual setup and the risks involved with having active operator workarounds.
4-3	If an operating procedure was modified to support the operator workaround, the procedure must be restored. Be sure to issue a standing order to have everyone read and sign off on the change for understanding.
4-3	It may be necessary to retrain operators when equipment is restored and the procedure reverts back to original.
7-1	A key to dealing with risk is to develop a formal process for planning and communicating.
7-11	The operator workaround should be used as an opportunity to make a work process improvement to permanently solve a problem or issue.

Key Safety Points



Key Safety Point

Identifies information that will lead to improved worker and industrial safety.

Page	Key Point
4-2	If the operator workaround cannot be performed safely, another option will have to be considered.
7-1	All operator workarounds introduce a level of risk to the safe, reliable, efficient operation of a generating unit by deviating from the design and possible safeguards in a process or system. This risk must be understood and managed.
7-1	Before an operator workaround is implemented, the plant must be certain that personnel and equipment safety are not compromised.
7-11	If additional failures “line up” in the wrong sequence, a major accident that could result in injuries and/or major equipment damage may occur.

B

BEST PRACTICES AND CAUTIONS FROM MEMBER COMPANY INTERVIEWS

Procedure

Have a published procedure for operator workarounds (OWAs). If the company does not have a procedure, the use of Sections 4 and 5 of this guideline will serve as an excellent start. Use the steps in Section 9 to establish a program.

Process Owner

Establish an OWA process owner, even for smaller staffs. This person is often also the “gatekeeper” for corrective maintenance (CM) and emergent work orders and ensures the malfunctioning equipment which caused the need for OWAs is fixed in a timely manner. The OWA process owner should review the active list weekly and reassess risk of injuries or unit reliability from active workarounds. The level of operator burden caused by the composite number of active OWAs should be discussed with the Shift Leaders, especially if the OWAs are causing operators to fail to complete rounds.

Review

Review the OWA list weekly. Watch for OWAs that can become “institutionalized,” especially if repairs must wait for a major outage.

Track

Use a tracking tool. Several companies use the module in the Power Vision plant status management software, PlantView, for example. At a minimum, use a manual logbook kept at the unit control board or shift supervisors’ office. A log or books should also be kept for all temporary alterations as well.

Multiskilled Technicians

Some combined-cycle gas turbine (CCGT) plants qualify the maintenance technicians as control room operators (CROs) and rotate duties. The multiskilled workforce is more creative and tends to understand and manage risks better when considering OWAs.

Work Control

Good management of the work control process is important to ensure that CM gets scheduled to manage risk. In addition, PM compliance has an effect on keeping equipment performing well and avoiding the need for OWAs.

Reinforce

Reward innovation and creativity while balancing prudent risk taking. An environment of effective problem solving is desired.

Communication

Plant status control is challenging when equipment is not set up in a normal manner. Excellent communication is essential when active OWAs are present in the plant.

Operating Procedures

Ensure that operating procedures are temporarily modified as necessary to account for active OWAs. Communicate the changes through standing orders or “must read” packages and have operators sign off for understanding. Resend notices when equipment has been repaired and procedures have been returned to normal.

Alarm Management

Having alarm management in excellent condition lowers the risk of missing important alarms that may indicate impending plant upsets caused by OWAs.

Risk Management

Track overall risk from OWAs on a plant or unit risk grid. Some plants use a module in their plant status management software, such as Plantview, to track the risk.

Tagging

Some plants use special tags for OWAs.

Corrective Maintenance

Always initiate a CM work order in the plant computerized maintenance management system as soon as the OWA is implemented.

Measure

Some plants have metrics for OWAs. These may include the total number for each unit or the age of OWAs. In some cases, any OWAs older than 30 days require additional justification to management.

Audit

Occasional plant walkdowns or audits help to ensure that all OWAs are well documented and tagged with appropriate cautions and warnings.

C

SOFTWARE AVAILABLE FOR TRACKING OPERATOR WORKAROUNDS

The following software applications are available for tracking operator workarounds (normally used for overall plant log keeping):

- Capu Tech: <https://www.capuware.com>
- eLogger: <https://www.elogger.com>
- Emerson: <http://www2.emersonprocess.com/en-US/brands/syncade/solutions/electronic-logbooks/Pages/Electronic-Logbooks.aspx>
- eSOMS: <https://new.abb.com/enterprise-software/asset-optimization-management/esoms>
- Honeywell: <https://www.honeywellprocess.com/en-US/explore/products/advanced-applications/dynamo/dynamo-operations-management/Pages/operations-logbook.aspx>
- Infotechnics: <http://www.infotechnics.com/products/opralog-operations-logbook-software/>
- LogBook: <https://trylogbook.com>
- Matrikon: www.matrikonopc.com
- PlantView: <http://www.power-vision.com>
- Shiftconnector: <https://www.eschbach.com/en/solutions/shiftconnector/overview.php>
- Siemens: https://www.energy.siemens.com/us/pool/hq/automation/automation-control-pg/sppa-m3000/plant-management/M3PM11_FS_ShiftLog_e_V10.pdf
- Yokogama: <https://www.yokogawa.com/us/solutions/products-platforms/solution-based-software/operator-effectiveness/electronic-logbook-elogbook/>

Figure C-1 is an example of an e-log page for operator workarounds.

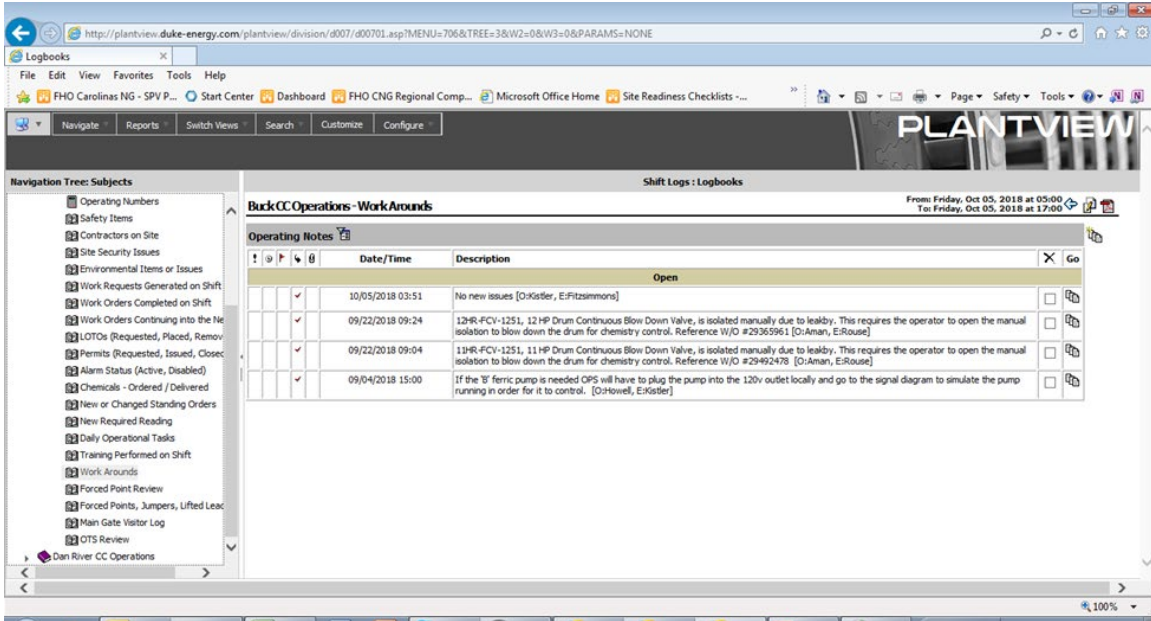


Figure C-1
Example of an e-log page for operator workarounds

D

REFERENCE TO EPRI DOCUMENTS RELATED TO OPERATOR WORKAROUNDS

Conduct of Operations and Maintenance for Hydroelectric Facilities. EPRI, Palo Alto, CA: 2016. 3002007908.

Conduct of Operations for Control Room Personnel. EPRI, Palo Alto, CA: 2013. 3002001133 (OWAs are mentioned in this report).

Corrective Action Program. EPRI, Palo Alto, CA: 2017. 3002011178.

Fossil Power Plant Conduct of Operations Guideline: An Overview of Key Operating Practices. EPRI, Palo Alto, CA: 2016. 3002005512.

Operations Assessment Guideline. EPRI, Palo Alto, CA: 2005. 1008250.

Operations Risk Management. EPRI, Palo Alto, CA: 2016. 3002008523.

Shift Turnover and Log Keeping for Fossil Generating Stations. EPRI, Palo Alto, CA: 2010. 1019807 (update to be published in December 2018).

Troubleshooting and Diagnostics for the Power Plant Operator: A Systematic Approach to Troubleshooting. EPRI, Palo Alto, CA: 2016. 3002008520.

E

REFERENCE OPERATOR WORKAROUND PROCEDURES FROM MEMBER COMPANIES

Sample Procedure 1

Purpose

The purpose of this procedure is to provide guidance in identifying, tracking, and developing corrective action for eliminating operator workarounds (OWAs). This procedure shall be adhered to for the purpose of correcting known plant deficiencies in a sound and timely manner.

Definitions

An *operator workaround* is the action taken to mitigate an equipment, control, or program deficiency that provides an obstacle to reliable plant operation by requiring operations personnel to take corrective actions to comply with procedures, design requirements, or permits. These actions compromise the normal operation of the plant and elevate the risk level.

Operator in charge is the individual in charge of all plant operations during the assigned shift. He/she acts as the company authority when the upper management is not on site.

Responsibilities

The operations manager is responsible for ensuring that the requirements of this procedure are implemented.

Operations management shall establish and communicate alternative actions for correcting equipment deficiencies that significantly affect plant operations.

The operations manager is responsible for the following:

- Prioritizing and categorizing equipment deficiencies to support timely resolution
- Considering the effect that the deficiency has on operation's ability to respond to equipment transients and emergencies
- Evaluating all equipment deficiencies on an ongoing basis to a degree that ensures that the overall combined or cumulative effect on interrelated plant systems is known
- Selecting alternative actions to correct or compensate for equipment deficiencies while optimizing plant production capability and the operator's ability to respond to transients and emergencies

- Assigning sponsors to develop and implement action plans to correct OWAs
- Discussing the OWA backlog at the plan of the day (POD) and work week coordination meetings

The operator in charge is responsible for identifying and tracking OWAs and discussing their backlog at station POD meetings each Monday.

Precautions and Limitations

None

Prerequisites

None

Procedures

General Description

An OWA is an equipment or program deficiency that provides an obstacle to reliable plant operation by requiring operations personnel to take corrective actions to comply with procedures, design requirements, or permits. OWAs have the potential to complicate both normal and emergency plant operations or increase operator burden in responding to operational needs. Examples of an OWA include the following:

- A controller operated in manual that has been designed to operate in automatic. Consideration should be given to the frequency of use and length of time the equipment has been degraded.
- A deficiency that requires operators to perform a number of contingency actions at increased personnel safety risks, or operation of equipment that unnecessarily requires prolonged stays in adverse environmental conditions.
- A deficiency that requires additional time-consuming operator actions to be performed during both normal and emergency plant operations.

Tracking and Correcting Operator Workaround

Operating personnel are expected to identify and track OWAs using Attachment 9.2, Operator Workaround Log Sheet. Notifications/work orders shall be generated for the deficiency stating it is an OWA. A log of OWA related notifications will be kept in the senior operating supervisor's office. Attachment 9.1 provides an example of an OWA description log.

OWAs will be tracked and prioritized in the SAP work management module. The acronym OWA should precede the specific equipment on the title line and identified as an OWA in the written details of the equipment deficiency.

The operator in charge will track and prioritize OWAs with other corrective work orders that directly impact operations.

Where necessary, sponsors will be assigned to develop action plans to eliminate the OWA in a timely manner.

The risk to both station personnel and plant operation created by the OWA should be detailed in the written description of the equipment or process deficiency.

The status of the OWA backlog shall be discussed at the station POD meeting each Monday and at the management review meeting.

The station should have no OWAs older than one year that are not planned to be resolved at the next planned outage.

Documentation

None

References

None

Attachments

Operator Workaround Description Log (see Appendix F)

Operator Workaround Log Book (see Appendix F)

F

SAMPLE FORMS

Sample 1: Operator Workaround Description Log

Equipment Deficiency (State reason for workaround):	
System (Describe the workaround):	
Criticality (Safety, environmental, generation risk, other):	
Date Identified:	Estimated Date of Resolution:
Responsible Discipline or Sponsor:	
Corrective Action Required:	
Craft Needed for Repairs (Include notification and work order number):	
Notification #:	
Work Order #:	

Sample 2: Operator Workaround Log Book

Date:	Time:	Unit:	Shift #:
Define Problem:			
System(s) Affected:			
Risk Type (safety, environmental, unit reliability, equipment damage):			
List Solution Chosen (Describe operator workaround):			
Approved by:	Implemented by:		
Special Cautions or Considerations:			
CMMS Work Order #:			
Expected Duration:			

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QUESTIONNAIRE USED FOR PLANT INTERVIEWS

1. What are your definitions of “operator workarounds (OWAs)” and “operator burden”?
2. How is an OWA different from a temporary alteration or change?
3. Do you have a policy or procedure for OWAs?
4. If so, may we review the policy and/or procedure?
5. How does your risk management plan and/or policy address OWAs?
6. Who can initiate an OWA?
7. Are there approval levels required before an OWA is implemented?
8. How do you track open OWAs (for example, e-logs, Plantview)?
9. Do you track the total operator burden due to OWAs?
10. Do you have a metric for open WPAs?
11. If so, what is acceptable, and what is the upper limit?
12. Is it ever necessary to call in extra staff on overtime to manage active OWAs?
13. How are operator procedures adjusted to account for OWAs?
14. How is the lock out, tag out process adjusted to account for OPAs?
15. Are new operators trained to operator procedures or to actual OWA requirements in place?
16. Do you enter OWAs into the corrective action program tool?
17. What are the incentives for an operator to perform a workaround (trying to determine risk versus reward culture)?
18. Do you perform plant walkdowns to discover and audit open OWAs?
19. What is the size of your maintenance backlog?
20. How are both emergent work and the backlog work orders prioritized and selected for the schedule?
21. What is your average unit equivalent forced outage rate?



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