Maintaining Control Centre Operational Effectiveness and Teamwork During Transitions in Station Capabilities

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Abstract

The one constant in the operation of power generation facilities is the pervasiveness of ongoing change. Ongoing change can be driven by continuing improvement initiatives from commercial and peer competitiveness, safety enhancement, the availability of new capabilities, equipment obsolescence, and regulatory changes. This continuing stream of station changes can result in impacts at all levels of the organization from equipment functionality, location and conventions, to work strategies and practices, and organization responsibilities and priorities.

The introduction of these changes must be managed in a way that minimizes challenges and disruption to continuing station operations and ensures the benefits of specific changes are fully realized. An under-appreciated yet critical aspect is the management of transition periods where station operations are conducted between initial change introduction and complete fulfilment. During such periods, the control centre staff become the primary managers of change introduction and mitigation of challenges imposed by conflicts of partial change implementation.

This paper discusses the Canadian experience with maintaining control room operational effectiveness and teamwork in CANDU control rooms during the introduction of changes in station capabilities.

1. INTRODUCTION

CANDU nuclear utilities are continually striving to improve station performance, control risks, and maintain station operating condition. Experience has shown that to achieve consistent and effective station operation, the day-to-day equipment configuration must be rigourously monitored and controlled. While at the same time, change must be accommodated to realize the opportunities offered by improvements to equipment and operational practices.

The control of station configuration and management of station changes is a key station function. Ongoing continous improvement initiatives, the collective experience and lessons learned of utility peers, and technological advances in equipment provide a rich, continual stream of change intitiatives for consideration by utility management and potential station adoption. Such an environment presents utilities with several unique challenges, for example:

- Assessment - Characterizing and comparing the relative benefits and risks of each proposed improvement initiative.
- Selection - Prioritizing investment allocation and balancing implementation resourcing among several improvement opportunities to realize maximum station benefit.

- Development - Coordinating the successful development of all aspects of each improvement initiative.
- Implementation - Placing the improvement into service with minimum risk and disruption to normal station production.
- Monitoring - Assessing operational performance to confirm benefit expectations.

The challenge of 'Implementation' is the first instance where the introduction of station change has the potential to directly impact on ongoing station operations. Any changes must be managed in a way that minimizes challenges and disruption to continuing station operations. However, in practice the introduction of change is not instantaneous, and may often involve a period of time from initial installation until declaration of in-service that may span days to months. During such transition periods, the control centre staff are additionally burdened with coordinating and managing the work associated with change completion, and development and oversight of operational workarounds necessary to overcome operational limitations created by partial change implementation. Maintaining operational effectiveness and shift team teamwork in such an environment can present additional challenges.

2. BACKGROUND

2.1 Control of Changes

Canadian utilities employ several means to manage station equipment configuration and operating practices so that changes representing improvements are selected, developed, and introduced into service in a controlled and purposeful manner. On a day-to-day basis, the station equipment configuration is maintained within predefined values to support the intended operating state. Operating actions are limited to approved practices and behaviours as defined by procedures and training programs. Supervisory and peer oversight provide assurance that individual operating actions and changes of configuration maintain the station within regulatory limits and optimally aligned with production needs.

Canadian utilities employ a formal Engineering Change Control (ECC) process as the means to manage the selection, prioritization, development and introduction into operations of equipment improvements. The ECC process is conducted within the juristiction of station engineering support departments and is overseen by engineering mangement. The ECC process has five stages with the following activities per stage:

- Stage 1 - Scoping - Assessment of benefits and technical options; estimation of workscope, costs, resource needs and schedule; project review and approval by the station Change Control Board; and project team creation and resourcing.
- Stage 2 - Design - Definition of workplans; specification of requirements; design of equipment and procedures; and preparation of the design documentation package.
- Stage 3 - Build - Procurement of materials; assembly of equipment; development of operations and maintenance training; and testing of assembled equipment.
- Stage 4 - Install - Definition of installation plan; install equipment, train operating and maintenance staff; and update the design package to 'as built' status.

- Stage 5 - Commisison - Definition of commissioning plan; commission equipment and procedures; preparation of operating memo, and conduct 'available for service' meeting.

A similar process is employed to manage the selection, development, and introduction of non-equipment changes (e.g., improvements in procedures, adjustments in operating limits and setpoints, or changes to individual and team responsibilities). For non-equipment changes, the station operations departments and management are involved in overseeing, managing and approving the changes.

2.2 Introducing Changes into Service

Operating personnel may become involved in contributing to the definition or reviewing aspects of proposed changes at any stage of the change introduction process. However, shift operating staff can take on a leadership role in controlling and managing change introduction during Stage 4 or Stage 5 activities.

Activities for Stage 4 - Install and Stage 5 - Commision may be conducted in one of two ways:

- Outage - Regularly scheduled station shutdowns provide an opportunity to introduce changes without complicating normal power production as it allows systems to be taken out of service, equipment replaced, and tested without compromising normal station production. Scheduled outages are held annually, and so offer infrequent opportunities for introducing equipment changes.
- At Power - The introduction of many changes can be accommodated during normal power production. In such cases the change must be managed so as not to jeopardize or risk power production. Equipment changes are scheduled as an activity on the daily workplan and are staged to minimize impact on normal power production activities (e.g., daily on-power fuelling, safety system testing, equipment surveillance rounds).

In practice, the introduction of substantial improvements often involves managing change introduction across both types of station operating states. An outage may be used to shutdown a system for installation of equipment upgrades and to conduct initial functional testing; while at power operation may be required to fully commission and characterize new equipment operation prior to declaration of use for in-service. This creates an extended period of time where the day-to-day status of the equipment undergoing change must be closely monitored, and related work expedited. Further, the long term impact upon station configuration management must be appropriately managed, to ensure that upon completion of Stages 4 and 5 that:

PHYSICAL PLANT = PAPER PLANT (documentation) = ELECTRONIC PLANT (databases)

2.3 Role of Control Centre Staff

The shift crew for each reactor unit is lead by one or more Authorized Nuclear Operators (ANO) who direct and supervise a team of six to seven nuclear operators and a variable number of non-operating trades staff depending on the work to be done. The ANOs for a single reactor unit lead their shift team from the reactor unit controls area within the plant control centre. They are assisted in their duties by a Supervised Control Panel Operator (SCPO) and a Field Supervising Nuclear Operator (SNO), who have work areas within the reactor controls area for each reactor unit. The SCPO assists with supervision of reactor unit operation and conduct of equipment tests, and the SNO assists with specification, direction, oversight, and recording of reactor unit field work by assigned nuclear operators and trades support staff.

The reactor unit ANOs are also assisted by a number of non-reactor unit dedicated shift staff:

- Shift Supervisors - One supervisor is designated the Shift Station Manager (SM) with overall responsibility for station operations and in particular oversight of station activities outside of individual unit operations. A second supervisor is designated the Control Room Shift Supervisor (CRSS) with responsibility for oversight of all control room operating actions in support of individual unit production and safety.
- Field Shift Operating Supervisor (FSOS) - A field supervisor who is responsible for oversight of all field operating actions in support of individual unit production and safety.
- Work Control ANOs - One of more ANOs who are assigned to review and authorize the work to be conducted in the plant for the shift.
- Common Services Panel and Field Operators - Four nuclear operators who supervise and control station common services under the direction of the CRSS.
- Fueling Handling Supervisor and Operators - Seven Fuel Handling staff who conduct reactor unit refuelling operations during weekday day shifts.

When plant changes are being introduced, the ANO and supporting staff for each reactor unit are presented with work additional to their normal reactor operation and maintenance duties. The additional work can include:

- Communication with non-shift staff who comprise the change project team,
- Review of installation status, workplans, and change related procedures,
- Assessment of the operational risks to reactor unit safety and production of the change installation status and proposed work,
- Formulation of operational workarounds, if required,
- Authorization, assignment, pre-job briefing of staff, and oversight of change related work, and
- Update of change related work records.

3. ISSUES, IMPACTS, AND MANAGEMENT

The experience in effecting and managing station changes at the Darlington site has highlighted the importance of the following issues as challenges to maintaining station operational effectiveness and teamwork during change transition periods:

- Maintaining Implementation Teamwork - Station changes are implemented by teams of project and shift staff. Project staff normally work weekdays and have extensive understanding of the change basis and implementation work. Shift staff work a regular rotation schedule and generally have little understanding of change basis or implementation work beyond what is communicated in work permit requests. In essence, ANOs are faced with forming or reforming work teams to continue with change implementation on a shift basis. With such variability in team composition and familiarity with team staff, additional supervisory effort must be applied to reviewing team member roles, work assumptions, and work assignments in pre-job briefings, and work oversight throughout the shift, as well as maintaining continuity from shift to shift.

- Communication of Implementation Status - Implementation status associated with plant changes must be communicated from shift-to-shift, and from shift-to-project team staff. The shift-to-shift communication is via turnover discussions, work records, and reactor unit log entries. Shift-to-project staff communication is primarily limited to work records and reactor unit log entries due to few opportunities for face-to-face discussion as a result of differences in work schedules. The use of the reactor unit Equipment Status log has proven to be effective in support of both shift-to-shift and shift-to-project staff communication. The Equipment Status log is maintained by shift staff, summarizes current equipment departures from reference status, is organized by system categories, and is readable by all staff via the plant communication LAN.

- Understanding Operational Implications of Partial Implementation - During implementation of equipment changes, equipment may have limited capabilities, or be administratively limited in use. These capability and usage restrictions may impact current plant operations or operating actions needed to be undertaken in response to planned or unplanned events. ANOs must develop an understanding of these potential operational implications at the beginning of each shift and convey this understanding to the shift team. Pre-installation reviews of equipment changes by operators with the project design team have proven useful to identify operational vulnerabilities, and identify the need for workarounds for functional compensations or substitution as part of change implementation plans.

- Minimizing Operational Challenges - Implementing equipment change is a routine practice, however the work in support of a specific change is an example of an infrequently performed task. Unfamiliarity with the work environment, poor anticipation of work needs, and having work performed by non-operating staff increases the potential for errors to occur that may impact personnel and plant safety, or production. As additional support for error minimization and occurrence recognition, Darlington has found it useful to encourage change rehearsals in mockups, training of non-shift staff in Event Free Tool (EFT) work behaviours, conduct of pre- and post-work briefings on shift, and provide frequent to continuous field oversight of work in support of changes by senior shift staff.

- Maintaining Momentum of Change Completion Work - For 14 shifts of the week, day staff are only available for 5 shifts and then only for 66% of time. Communication between project champions and shift staff is limited to this period. At the same time, shift staff on day shifts change every few days due to shift rotation. To overcome these discontinuities in staffing and improve communication with some projects, Darlington appoints project shift champions from a pool of ANOs who work permanent day shifts. The designated day staff ANO for a project reviews change implementation progress with the project team on a weekly basis, and serves as the shift staff representative in communicating issues arising from change completion work in a timely manner so that the momentum of change completion work can be sustained.

- Encountering Breakdowns or Discovery Work - The occurrence of equipment breakdowns, unanticipated mismatches in components, or discovery of existing equipment repair needs are just some of the issues that bring planned change implementation to a halt. To provide focus, to overcoming these issues promptly, Darlington employs Fix It Now (FIN) teams who interface with project staff and expedite problem rectification so that change completion work can resume.

- Monitoring Progress and Promoting Completion - Work progress can be measured and reported in a number of manners. Staff at Darlington have found that standardizing and giving emphasis to reporting work status by what aspects are complete rather than underway or started increases the incentive for change implementation teams to expedite work completion.

- Planning Staff Resource Allocation - During reactor unit outages, shift staff resources can be diverted from non-outage units to outage unit needs in order to advance planned work. Consequently, continuing change completion work on non-outage units is subject to delay or disruption. Experience has shown that it is prudent to minimize planning for and dependence on work completion in support of equipment changes on non-outage units in such periods, unless additional shift resources can be made available.

- Staged Multi-unit Installation - In multi-unit stations such as Darlington, reactor unit changes must be replicated across all four units. Due to outage schedules, project team availability and size, and common cause upset risk; changes are introduced one unit at a time. This can result in the four units having different equipment operating configurations over several months that can present an operating complication. The Darlington experience has demonstrated that it is often beneficial to keep change implementation teams together and move teams from unit to unit to benefit from previous unit implementation experience.

- Recognition and Resolution of Conflicts - Conflicts in planned work can occur for a number of reasons. While the environment, work plans, resourcing strive to be controlled to accommodate change completion work, changes in operational priorities, equipment breakdowns, and other evolving needs can lead to conflicts in work priorities. At Darlington, we have found it important to train staff in maintaining awareness of conditions in the broader work environment (i.e., operational focus) and not to be too attentive to individual work needs at the exclusion of all else. Maintaining this broader perspective has shown to be beneficial in recognition of conflicting needs and work team participation in definition and acceptance of solutions.

4. CONTROL CENTRE RESOURCE IMPACTS

The support for station teamwork within and among workgroups through change transitions creates additional and new demands on station resources. Some important resulting station control centre resource impacts include:

- Temporary Workspace - Equipment changes are frequent, and demand assignment of temporary workspace to support planning, review of work, and job briefings. Such workspaces should be adjacent to but separate from the workspaces dedicated to support supervision and monitoring of reactor unit operations. Provision for allocation of such workspace should be a consideration in future control centre planning.

- Communication off-unit - Work in support of implementing equipment changes can require extended communication between control centre staff, field work teams, and project staff. To minimize disruption of normal communications in support of reactor unit operations, extensive communication about change implementation work aspects should be conducted over separate facilities. Dedicated phone and email workstations adjacent to the control area but separate from the workspaces used in support of reactor unit operation should be provided in future control centre planning.

- Temporary Storage - During change implementation, a location for temporary storage of project work packages, schedules, records and supporting materials adjacent to the reactor unit control area is needed. Provision for such storage had not been considered with current plant control centre designs. Both outage and ongoing equipment change management needs provide a sufficient basis for consideration of this addition in future control centre planning.

- Change Status Log - Current administrative logs maintained by shift staff do not completely serve the needs of communicating change implementation status from shift-to-shift or shift-to-project staff. Currently two log

applications, and a change management application are used - a Shift log for chronological entry of work on each shift, an Equipment Status log for recording of departures of equipment from reference states, and an Equipment Status Monitoring (ESMII) system, that automatically tracks each controlled change to the station's 500,000 components. Communicating change completion status requires a log with both current status and chronological recording capabilities. Thought shoud be given to restructuring log implementations so that data is retained in databases and specific log access is structured by database report views. Such an approach would allow use of current log data to be more easily customized for specific operational needs.

5. CONCLUSIONS

This paper has outlined the Canadian experience with maintaining station operational effectiveness and teamwork through transitions in station capabilities. Canadian utilities are continuing to further refine change control and implementation, and teamwork practices based on both local and international peer experience.

6. ACKNOWLEDGMENT

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7. REFERENCES

None.