REACTIVITY MANAGEMENT IN CONTROL ROOM OPERATIONS

"Reactivity Management for Hockey Players"

Tracy Primeau[1], Andrew Dykeman[2]
Bruce Power, Ontario, Canada[1], Point Lepreau, New Brunswick, Canada[2].

Abstract

This paper will cover a review of WANO SOER 2007-1, Reactivity Management (RM) from a Control Room Operations point of view. It will answer the question: what recommendations are possible to implement at the Control Room Operator (CRO), also known as the Certified Control Room Operator and Control Room Shift Supervisor (CRSS) level?

History has indicated that reactivity management events continue to happen in Nuclear Power Plants (NPP's) all over the world. This paper will discuss how the CRO/CRSS as the final barrier can improve this trend.

The paper will be written as a descriptive piece.

The paper will metaphorically examine the role of the Control Room Operations staff in reactivity management control and safety.

1. Introduction

This paper compares the CRO job to being a goalie in any level of hockey. If everything gets by our defenses and strategies around reactivity management there may be an event. At the end of the day much like a goalie making sure the puck doesn't go in we are tasked with ensuring that reactivity management is not adversely affected by bad defense or poor planning. The other players (operations support) are responsible for finding any holes and plugging them before they hit our crease.

2. Pre-Game/Preparation

Crew Supervision is one of the areas where weaknesses in supervision have been key contributors in many events specifically with inexperienced operators.

The shift supervision should direct core reactivity changes and ensure conservative decision making during plant operations and fuel handling. There are a couple of very specific methods that should be reinforced; minimize distractions, clearly define the roles and responsibilities of the crew and ensure there is additional staffing during high activity times.

Tools used include coaching, pre-job briefs and human performance error-reduction methods.

In the hockey world this is what a good coach does; prepares his team before they hit the ice and ensures the rookies get extra coaching when starting out. He defines the roles and responsibilities of his team, tells his captain/goalie what he expects and makes sure that everyone is available for the strongest lines possible during the playoffs.

Our coach in the Main Control Room (MCR) is the CRSS and they are there to ensure the CRO/goalie is prepared for her shift and answers all the questions listed below in a team-like atmosphere.

What does success look like given the maintenance/fuelling for the shift ahead?
Are NOP/ROP responses within acceptable limits?
Are the average zone level, zone pair tilts and individual zones meeting expectations?
Is your head in the game? Are you "fit for duty?"
What is the worse that could happen? What traps can you anticipate?
What are the reactivity management or general goals for the shift/run-up?

3. Practice/Simulator Training

WANO found that weaknesses in **Training** both initial and continuing indicate that operators do not possess the necessary knowledge and skills to safely operate the reactor under all core conditions.

We need to provide operators with good training on reactor physics fundamentals, core characteristics and how reactivity control systems operate to control reactivity during normal and abnormal or emergency conditions.

Once core reactivity is taught to the operators, the actions the CRO can use to properly control the reactor need to be practiced both in initial and continuing training. The trainers are expected to include Operating Experience (OPEX) where relevant, reinforce management expectations and Human Performance (HU) tools and provide "Just In Time" training for infrequent evolutions.

The fundamental skill of hockey is skating and that has to be learned before passing, shooting and checking. Skating is a science much like reactivity management where balance is required and your skills (and in this case your skates) need to be sharp.

Many star hockey players talk about "seeing the ice", the CRO is required to always think about reactivity management in every task they do, always "seeing the core" and how it might be affected.

When on training it is the CRO's job to expect that their scenarios are relevant, accurate, challenging and likely-based on failure rates or industry experience? They must ensure that the simulator scenario guides reinforce conservatively placing the plant in a safe known condition and they should demand that the simulator is modelled correctly to represent the station state of equipment and its present core.

3.1 Experience

Part of the training process is sharing your experiences with others.
Your experience can keep only YOU out of trouble unless you share it.

Once the CRO has experienced reactivity management events, approach to critical (ATC) and forced poison outages, they must share this experience with their peers and with the trainees coming into the role. Simulator scenario guides should be written based on these experiences so all certified staff can see exactly what happened. If that is not possible due to constraints in simulator modelling, then at the very least, face to face rollouts on events should happen between every CRSS and CRO to discuss measures to avoid a similar outcome and to encourage thinking about what barriers could be put in place to avoid affecting reactivity management in the future.

Coaches too will take a bad game and show the team where they went wrong, what barrier was broken to allow that puck into the goal and what the team should be doing to avoid the same thing happening again. If the response chosen was the right one, then that experience should be shared as a best practice with all who can benefit from it.

4. Coaching/Crew Supervision (from the bench)

Crew Supervision is not just required pre-game/shift but also during the course of the action. This is where minimizing distractions becomes so important. Coaching is required to ensure concurrent tasks are not taking place during reactivity manipulations and that oversight is especially important with newly certified staff. The presence of the supervisor alone offers defence in depth as their peer is more likely to stop and consult if there is some one close by to consult with.

On top of that is the need for both the CRSS and the CRO to reinforce expected behaviours in anyone who can impact RM. For example, crew supervision at the start of shift meeting... “When you do this task, I am concerned about this, because of this effect on RM and that is my #1 job for the station/plant.”

This includes not only the CRO but also the field operators, control room support operators, chemistry, RM instrument maintainers and maintenance departments understanding the importance of the equipment they maintain. All of these team players need to know they play a role in control of reactivity in some way or another.

The coach of a good hockey team ensures that everyone involved understands how their role on the team can influence a positive or negative outcome in a game and how their job is not only to produce but also to make sure the goalie doesn't have to deal with that puck anymore than necessary.

4.1 Coaches, Trainers, GM/Oversight and MCR control

Beyond the MCR are other roles that can support Operations in many ways. At Bruce Power we have another layer of oversight in the Shift Manager as well as a Field Supervisor and Maintenance Managers. Above that are the Operations Manager and the VP of the Station. All of these roles should be communicating and clarifying their expectations so that consistency is found across all crews in the handling of any reactivity management issues.

In hockey the coach is supported at ice level by his trainers and assistants and the General Manager, owners or executives are there to support the team and to deal with some of the other business of the organization. The goalie should always be covered by his defence when he is actually handling the puck. This would be similar to the CRSS closing down the MCR to all when the CRO is in the middle of a major evolution.

Overview is key to
- find the gaps in defenses.
- reinforce the fundamentals for understanding the unexpected (i.e. Moderator temperature coefficients).
-communicating effectively to everyone in the operations organization.

All levels must remember that what is important above all else is the safe operation of the reactor and management of reactivity and at the rink, the winning of the game. With these successes, production and profit making will follow.

5. Self-criticism /Self-assessment

Areas for Improvement (AFI's) or Individual Development Plans (IDP's) for each certified individual should be recorded from their training weeks with the expectations that improvements will be tracked. At a higher level each site needs to perform a **self-assessment** of how their reactivity management program is progressing. Even when you are at the top of your game you must continue to self-assess your practices to ensure you stay there.

5.1 Reviewing Tapes/Lessons Learned

Looking at simulator tapes of yourself and your team is similar to players watching themselves in replays. You can see more objectively your strengths and weaknesses when you are removed from the play.

Reviewing events you were not actually involved with is also important. Ask yourself the questions…what CRO actions could have prevented the event? Include this information in Pre-Job Briefs and also in face to face discussions/rollouts with the crew.

In hockey, looking at tapes of different styles of play that are successful and those that are not helps the team and the goalie improve their technique and their consistency in response. Operating Experience (OPEX) is invaluable in both the NPP world and in improving results on the ice.

5.2 Standards of Play/WANO standards

It's easy to compare the WANO standards to the Standards of Play set in Canada by the Hockey Canada Board of Directors. In the year 2007 WANO issued the SOER 2007-1 on Reactivity Management, referred to in this paper, because of a trend they had noticed in RM events. Hockey Canada also emphasized some new standards of play in 2007-2008 to call certain penalties with very strict enforcement and use teamwork to remove from the game "Checking to the Head" and "Checking from Behind."

Although the regulator may be our referee, officiating our method of operations, we don't want to find ourselves with a penalty, we should use the coaching and teamwork we have available to us through WANO P O's and C's and our other peers in the industry. The Candu Owner's Group (COG) is already well invested in this process.

We as the CRO need to ask ourselves when performing, reviewing or developing procedures….What WANO standards are applicable for this RM activity?
What has WANO seen as weaknesses in RM throughout the industry? Have we addressed those in this procedure or action we are about to perform?

Much like the goalie on the team we hold the responsibility of seeing the overall picture on the ice and sharing with the rest of our team where we might have weaknesses and what standards we may be close to crossing.

6. The Theory/Reactor Engineering

Reactor Engineering and Operations and in particular CRO's need to improve their communication between each other. Reactor Engineering (we refer to this as Fuel and Physics in CANDU's), need to be available to assist CRO's during reactivity changes and communication of core operating cycle information. This is especially important before reactor start-ups and simulator modelling of the core is key to understanding how the core will respond.

6.1 On-ice/Reactor Engineering in the MCR

Having Reactor Engineering in the MCR for major evolutions and start-ups is akin to having a trainer available on the bench to help with any unforseen circumstances and to let the coach know if there is any team member that is not up to their normal expectations.

6.2 In the dressing room/Info on Core Provided to Ops.

What affects reactivity? What doesn't affect reactivity? The answers to these questions need to be provided to CRO before they are responsible for the unit. Reactor Engineering needs to determine and provide criticality predictions and reactivity plans to Operations before they start up or shut down a unit especially one with a different core (i.e. fresh vs. equilibrium) In this case Reactor Engineering is more like the team doctor and nutritionist as well as the trainers preparing the CRO before they "hit the ice."

7. The Playoffs/Outages

Like hockey during the playoffs, reactivity management during an outage has many more facets to consider and many more holes to fill. Below are some specific cases that can lead to unexpected reactivity management events.

7.1 The unexpected/Premature Criticality Events

One of the issues that crops up repeatedly is not knowing exactly when the reactor will be critical while following the Approach to Critical (ATC) procedure. Backup systems should indicate no abnormalities before ATC and operation is to be confirmed effective when required. During the playoffs, there are always unexpected outcomes and challenges to be faced much like during an outage.

7.2 Not done often/Train on ATC

ATC's are often poorly modelled in simulators. How to approach an error-free run-up will require a Pre-Job Brief (PJB) as well as Fuel and Physics support. A clear understanding by all of what criticality looks like is imperative to event-free operation. Any evolution that is not performed often needs more training and discussion beforehand whether it is an ATC or game 7 of a series you expected to win in four.

7.3 Power Plays/Working shorthanded

A power play whether in the regular season or during the playoffs requires a different set of skills to master and kill the penalty. The same applies to working shorthanded without the full complement of MCR staff. Both require increased vigilance and a more defensive method of operating/playing.

In the NPP the CRO is trying to avoid a reactivity management event in the same way the goalie is trying to avoid being scored on during the power play. Both require their team to offer extra support, more defence in depth oversight and a higher level of energy.

8. The Right Equipment/Equipment and Work Coordination

Reactivity control equipment deficiencies are sometimes not identified and promptly resolved especially those that affect the control and monitoring of reactivity. Not just the equipment; but the environment needs to be maintained in order to avoid breakdowns that cause reactivity events.

In hockey, the puck and the ice have to be kept at a certain temperature in order to ensure everything will work as expected. Many players use the term fast ice vs. slow ice to explain why the game ended up with an unexpected result.

8.1 Replace or Repair/Prioritize RM related equipment

Work Management needs to establish appropriate priority and coordination of work on systems that affect reactivity control and monitoring. Such equipment must be maintained, replaced and/or repaired in a timely manner.

Hockey players require their gear to be in good repair, skates to be sharpened, the sticks to be the right kind for their role on the team and the one that works best for them. The goalie much like the CRO has the most expensive gear and hopefully the gear that offers the most protection as they are the ones with the pucks flying at their heads.

8.2 Operator Workarounds (OWAs)
OR Dealing with the Injured List/Equipment out of service

The goal should be to eliminate operator workarounds related to reactivity control equipment as soon as practical. In the meantime while living with the OWA, guidance should be provided to operations on specific mitigating actions for each workaround.
Having equipment out of service is one example of an OWA; another could be, as mentioned above, working without a full team.

The goalie may lose or break his stick and be required to rely on his team-mates to back him up until he has it back in his hands. He or she may have some of their defence team off injured or be injured themselves and will need to have different strategies to protect the crease for one game, a few games or an entire series.

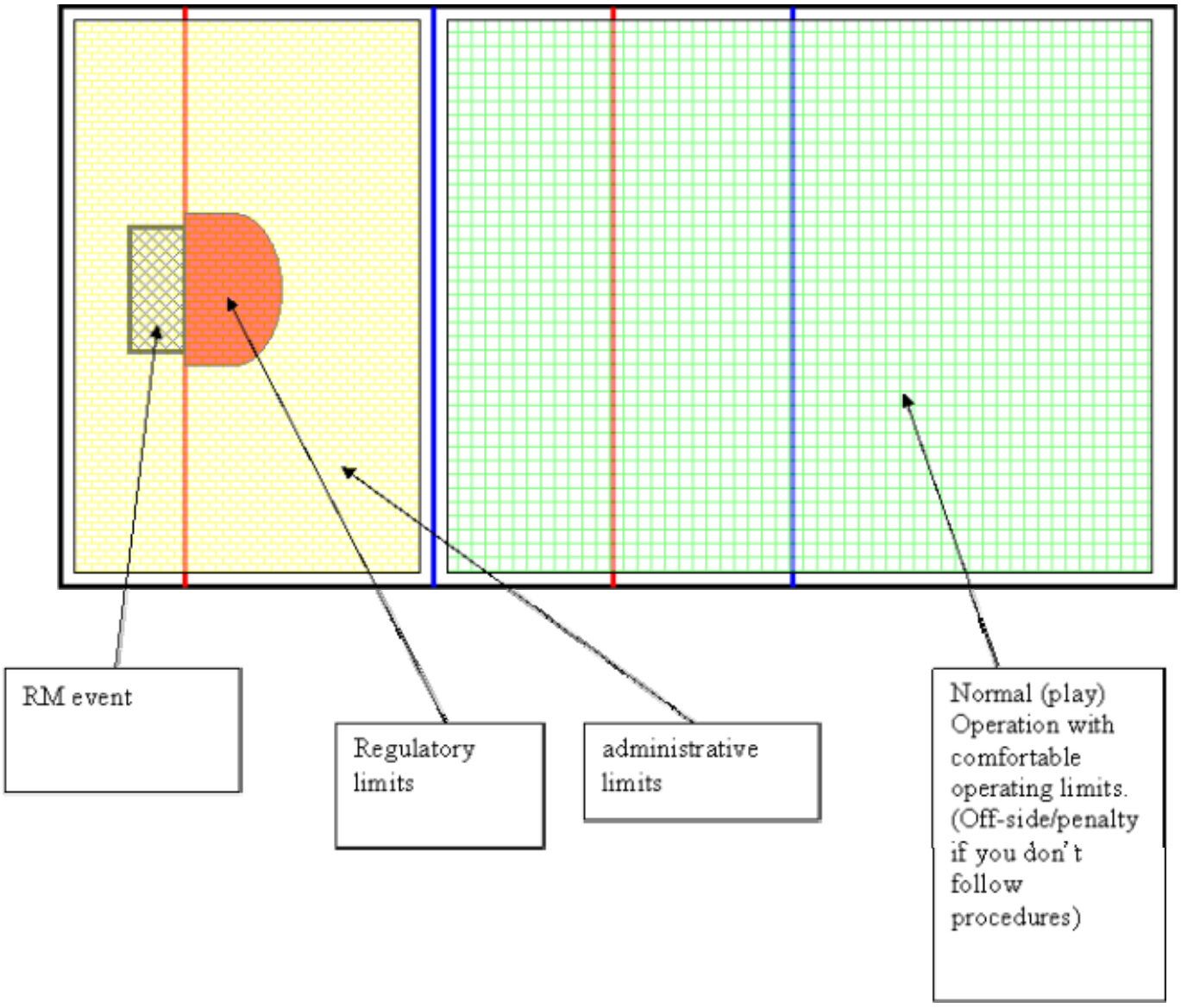
9. Conclusion

The goalie and CRO have much in common. The goalie has the most gear and the biggest responsibility. The CRO has the most training of any operator and is responsible for the safety of the core at all times. The goalie never gets to sit on the bench and let someone else take their spot for a couple of shifts; either does the CRO. Someone else may watch the panel for them but ultimately they are responsible for that unit for that entire twelve hour shift.

The goalie is pelted with flying pucks from every direction and blamed when a few slip past. The CRO is bombarded with questions, work protection, phone calls, Safety System Tests and fuelling and is expected to never let a puck past. We have to get a shut-out every single game.

Jacques Plante put it best…"How would you like a job where, every time you make a mistake, a big red light goes on and 18,000 people boo?"

Sound familiar?



10. Recommendation

Let's make our net smaller, our defensive line larger and get a shut-out every day.

If everyone in the organization understands Reactivity Management and supports the team that gets on the ice, the coach and the goalie, the possibility of getting that shut out everyday will become a reality.

11. References

WANO SOER 2007-1 Reactivity Management.

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