Basis for the Nuclear / Supply Chain Partnering Agreement

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Executive Summary

This document forms the "design basis" for the cross-functional indicators documented in the Supply Chain / Nuclear partnering agreement. The tables listed in Appendix E document required indicators, suggested targets and oversight forums for review. These cross-functional performance indicators were chosen to ensure both Nuclear and Supply Chain focus on those areas of most benefit to the business through business transformation. Most of these indicators are already fully operational and the rest can be easily generated.

Figure one shows the tiered relationships of indicators generated by Supply Chain.

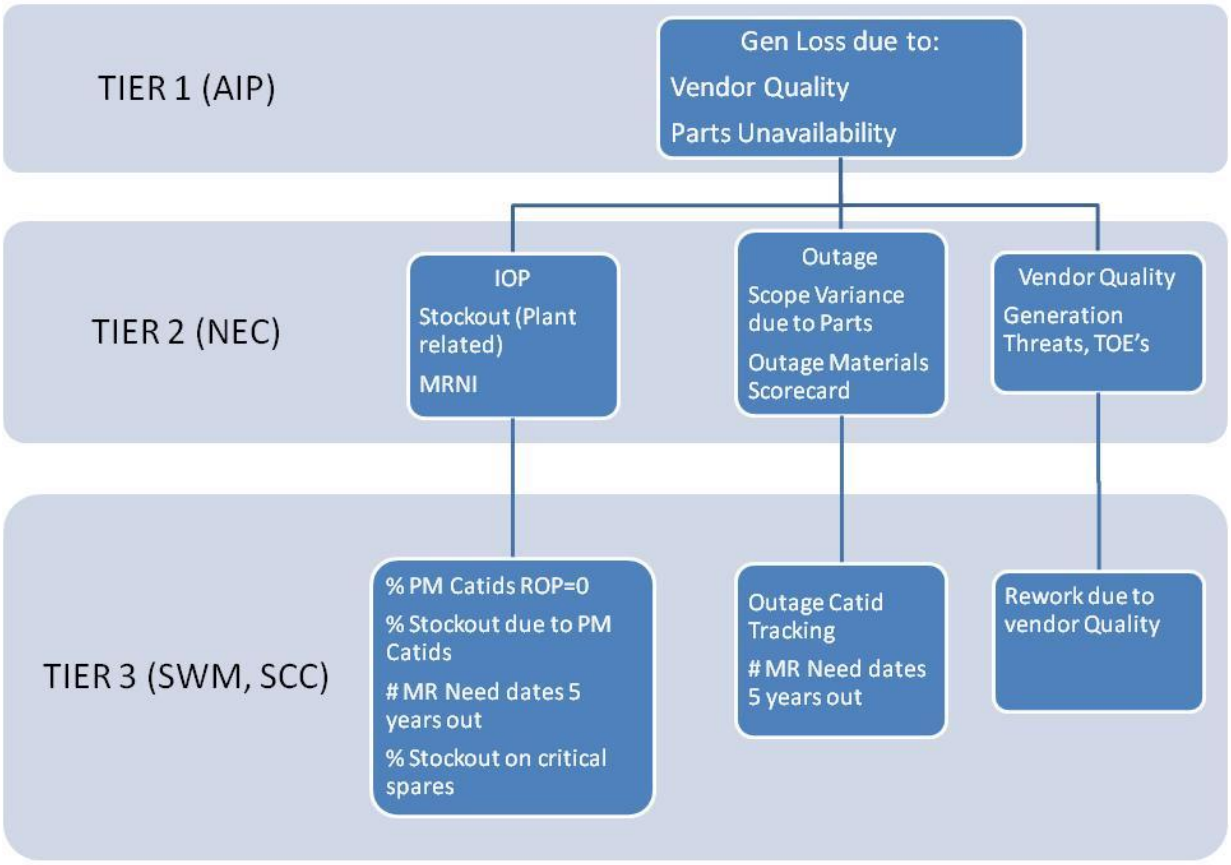


Figure 1 Indicators Generated by Supply Chain

Figure two shows the tiered relationships of indicators generated by Work Management. Only incremental (new) indicators are shown here as the full suite of work management indicators is exhaustive.

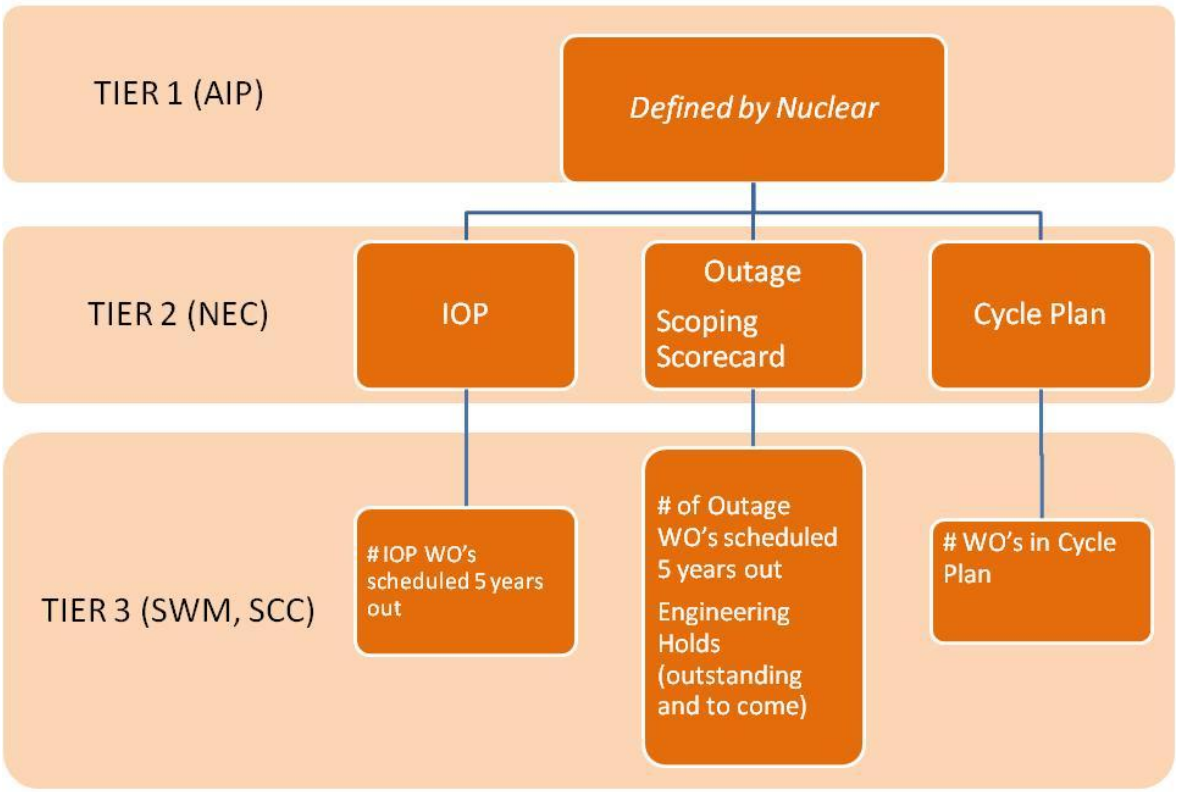


Figure 2 Indicators Generated by Work Management

For the most part, these performance indicators build on work already done in Nuclear Supply Chain and Work Management over the last 18 months, as such represent evolution towards excellence. However, major changes are necessary in the ownership of inventory. Nuclear and Supply Chain will need to partner in a major initiative to transform the warehouse to "a nuclear warehouse". Supply Chain will no longer source commonly available, non plant equipment items. Ownership of the inventory will need to transition to those who order the parts. These actions will be detailed under business transformation initiative BAS-NSC-15. It will be critical to both organizations to ensure this initiative is properly supported, both with resource and leadership.

Background

The purpose of this document is to summarize my learning's in the past 18 months in Nuclear Supply Chain. Like every supply chain organization, the secret to success does not lie solely in supply chain science. The secret to success lies in collaboration with the customer, understanding each others needs and developing solutions that are mutually beneficial to the business. The same can be said for vendor relationships, although innovation should be beneficial to both OPG and the supplier.

The report forms the basis for the Supply Chain / Nuclear service level agreement. It documents the reasons why measures were chosen and provides cautions and OPEX on how these measures have been successful or failed in the past.

As of January 2011, the only two metrics reported by NSC for the equipment reliability cornerstone were inventory accuracy and stock out. While Nuclear would acknowledge that inventory accuracy is important, it is hardly of direct importance to equipment reliability. One would think that stock out would be a reasonable measure of supply chain performance. However, stock out is only measured on material that has a re-order point. Stock out was reported in January of 2011 at 3.1%. It is my belief that stock out was historically reduced by setting ROP/TMAX to zero as opposed to any aggressive strategy to actively manage re-order points. While there are cases where zeroing out ROP/TMAX is appropriate, such as when a catid is obsolete and replaced by another new catid, it is a fact that historically ROP/TMAX was also set to zero inappropriately.

Since January 2011, ROP/TMAX were added back for over 4000 critical spares and many Model Work Orders for predefines. As a result, stock out has risen from 3.1% in January of 2011 to a high of 6.1% in May 2012. As such, stock out is now a better measure of actual supply chain performance, even though the metric definition has not changed.

The main point of this discussion is that siloed metrics can drive siloed behaviours. For Supply Chain to be successful in restocking inventory, it needs to call upon Maintenance and Design to address obsolesce, yet stock out is not a plant metric. With the plant focused on work management and holds, the ROP/TMAX was set to zero in frustration, knowing full well the work management process would eventually address the problem (but only after plant equipment had failed, no parts were available and holds were generated). It is critical that Nuclear and Supply chain agree to a set of metrics for which they both share in the outcome.

In early 2011, new metrics were developed for the Supply Chain report card that better reflected plant objectives. These were percentage of outage scope removal due to parts unavailability, generation loss due to vendor quality and average age of equipment backlogs.

In the period from 2005 to 2010, nuclear supply chain shed 40% of it's staff through efficiency improvement initiatives. This is a considerable achievement, especially when one considers other parts of the business were maintaining or even increasing staff. Customer demands increased in a period where Supply chain capacity would have decreased without the initiatives. Through the

business transformation process in the next few years, Supply chain will once again come under considerable cost pressure. The need for innovation to meet plant needs can not be over emphasized. Most initiatives in the 2005 - 2010 period were internally focused on Supply Chain efficiencies. To achieve the next level of performance, both the customer and Supply chain must change. The good news is that both can become more efficient in the process and the power plant will have access to more parts, not less. But both need to change to achieve this. Both need to focus on cross functional metrics. This paper outlines what needs to change to leverage both organizations into a stronger position, both in efficiency and effectiveness.

Inventory Discussion

Much debate has raged about inventory levels in Nuclear. The discussion that follows demonstrates the radically different viewpoints that in my mind spark the debates. One is the classical Finance / Supply Chain view of inventory, the other is the "plant manager's" view of inventory. It's important to understand these viewpoints because neither is right or wrong, but decision making weighted too heavily with one bias can be destructive to the company bottom line.

Classical Finance / Supply Chain View of Inventory

Most manufacturing companies buy and store raw material, convert the raw material to a finished product, then store and sell the finished product to generate net income. The term "inventory" refers to the combined value of the raw materials and finished goods in storage.

There are three basic reasons for keeping an inventory:

1. Time - The time lags present in the supply chain, from supplier to user at every stage, requires that you maintain certain amounts of inventory to use in this lead time. However, in practice, inventory is to be maintained for consumption during 'variations in lead time'. Lead time itself can be addressed by ordering that many days in advance.
2. Uncertainty - Inventories are maintained as buffers to meet uncertainties in demand, supply and movements of goods.
3. Economies of scale - Ideal condition of "one unit at a time at a place where a user needs it, when he needs it" principle tends to incur lots of costs in terms of logistics. So bulk buying, movement and storing brings in economies of scale, thus inventory.

In summary, inventory is "insurance" to cover uncertainty in supply and demand. Inventory can also protect against repetitive procurements costs.

On the balance sheet, inventory is carried as an asset. The value of a company's assets are always equal to the value of it's liabilities plus its owner's equity. Viewed as an asset by itself, there are two potential problems with inventory:

1. Obsolescence; in that the customer will no longer want the product due to fashion trends or technology changes
2. Spoilage; in that some products have limited shelf life

Either condition will reduce the value of goods sold and have a negative affect on earnings. In financial terms, the inventory value is depreciated. The company loses money because inventory is sold for less than cost, or it can no longer be used or sold. Thus having the "right amount" of inventory is important from a balance sheet perspective.

Inventory takes on a new light when viewed from a cash flow perspective. Cash flow is an important indicator of a company's liquidity and is calculated as;

Cash Flow = Net Income + depreciation - increase in accounts receivable + increase in accounts payable – increase in inventory

A company's liquidity is maximized by selling off more finished inventory (generating net income), running down accounts receivable (collecting debt owed to the company), running up accounts payable (incurring more debt to others) and minimizing inventory. Obviously a sole focus on cash flow and liquidity creates other problems.

Finally, when inventory is looked at through return on investment perspective;

- It consumes capital that could be used for other purposes
- It incurs holding cost in warehouse operations that could be used for other purposes

It's these three viewpoints (balance sheet, cash flow and ROI) that have led many company's to place a great deal of emphasis on minimum inventory values.

The Plant Manager's View of Inventory

Being a former plant manager, I'll be simplistic here;

- I don't pay for inventory (the plant is only "charged" when the part is withdrawn from inventory)
- I am held accountable to production targets
- I can't predict when the plant will fail so every part in the power plant should be in inventory (particularly because I don't pay for it)
- Because every part should be in inventory, there is no need to plan the inventory demand. It can be a totally reactive process such a ROP/TMAX.
- I can use the issue and returns process to help control my budget (not as intended)
- If the plant needs a part, I expect it to be instantly replenished (in a reactive manner) in case the plant breaks again
- I need supply chain to manage our tools through the inventory process
- Everything else I need (non plant parts) should be brought in through nuclear procurement, regardless of criticality

In short, inventory is a supply chain problem and should never be my problem.

The Balanced View Point

In reaching the right balance, it's important to understand the differences and similarities in both viewpoints. The first major difference between electricity generation and the typical manufacturing company cited above is that there is no finished good's inventory. With the minor exception of pumped water storage, electricity can not be practically stored. It is simply not possible to reduce the finished goods inventory as it is already zero.

The raw material inventory cited above applies to fuel procurement and all the same arguments apply. However, the bulk of the inventory (514M$ worth) is neither raw material nor finished goods. It is of course the parts required for maintaining the power plant. Only parts of the arguments for a typical manufacturing facility are applicable. There are fundamental differences that can not be ignored. At the same time, there are similarities that need to be heeded.

The important differences;

- "Obsolescence" in nuclear refers to the inability to get parts, some of which were sourced 50 years ago. Obsolescence in a typical manufacturing operation refers to the customer no longer wanting the product. There is no danger of the power plant not wanting a part for fashion or technology reasons. Typically parts sourced many years earlier and held in inventory are just as good (if not better) than new parts. The difficulties in sourcing products that were built up to fifty years ago are very real and consume much of the plant engineering resource, not just procurement resource.
- Cash flow in a typical company is increased when inventory is converted to finished product and sold. This is not true for the nuclear parts inventory as it is not strictly a component of the value chain. Nor is "Supply Chain" really a supply chain; it's a procurement organization. On the other hand, generation revenues can be stopped if a critical component fails and is not available.
- Contrary to the plant manager position, component failure is predictable. Equipment reliability programs have evolved significantly in the last five years. Criticality assignment, failure and effects modes analysis, system health analysis and trending of repeat component failures, predictive maintenance techniques are all tools that have resulted in much improved system health plans and better preventative maintenance programs.

The important similarities;

- The inventory is still very much insurance. It protects the power plant from excessive down time due to sourcing and vendor lead times. Moreover, procurement when the power plant is on line is typically much cheaper than when it is not.
- The balance to be struck between "just in time" and logistics and procurement costs is still there. In fact, multiple procurement cycles for the same product over the life of the plant typically triggers obsolescence engineering costs multiple times, especially for electronic components that are subject to frequent vendor upgrades and software changes. More inventory avoids these costs.
- The opportunity to waste money on inventory is still present; in particular for parts that are bought and never used .
- Holding costs are no different, in fact geography of the nuclear warehouses results in significant holding costs. Nuclear warehousing requires unique controls such as material trace. This adds significantly to material handling costs. Material requested and not issued also results in very significant material handling costs as the material is de-packaged, picked, staged, returned and re-stocked,

- Some parts do have shelf life and are subject to "spoilage"

Benchmark Information

Nuclear plant inventories have been rising due to AP913 programs calling for inventory of critical spares, but also driven by contingency material ordering and inflation. Benchmarking information is available but one needs to be careful what data is being reported. Most private companies report inventory value based on book value, which includes depreciation. The OPG inventory value of 514M$ is based on average unit price that does not include depreciation. OPG book value is considerable less than this (in the order of 430M$). Also, the OPG inventory value typically does not include capital spares, whereas benchmark information may or may not include capital spares. Capitalization practices vary considerably between utilities. The point here is to be very careful about drawing conclusions about inventory value when comparing to others.

In February of 2011, [redacted] reported (to me personally) their AUP inventory has increased by 150M$ in the last three years. 120M$ worth was due to critical spares, the rest was due to contingency parts and inflation. While OPG inventory value is on the high end, others are approaching OPG per unit values.

Opportunities for OPG

It should be obvious that targeting nuclear parts for inventory reduction purposes should be approached with extreme caution. While it's tempting to conclude that slow moving inventory is no longer of value, our experience is the opposite. In 2011, 60 million dollars worth of slow moving inventory was reviewed by engineering for value added. The review consumed engineering resource over the entire year. In conclusion, 5M$ worth of the 60M$ was agreed to be surplused. Further reviews are possible, but with diminishing returned value. I personally reviewed many of the items Engineering recommended to keep. Included in this subset were things like DCC parts; PDP 1173's for Darlington, which would be very expensive to source, and grappling hardware for the fueling machines, which fortunately has never been used. However, probability is almost certain it will be used during defuel for Refurb.

Figure 3 Darlington Warehouse

Procurement of non plant material

About 60M$ (number to be confirmed) of the inventory kept is products that are readily available in the market place and would be cheaper to source through other means such as procurement cards. Figure 3 shows $63,000 worth of extension cords that were bought for the D1231 outage. 710 extension cords were ordered, 15 were used. In discussion with the Maintenance manager, maintenance will no longer be fabricating extension cords (a good decision). In fact, the plan was to replace all non

CSA approved extension cords with CSA approved material during the outage. While this is still the plan, the timelines have changed resulting in the inventory shown here.

It is important to note that in order to inventory the product in passport, it must be depackaged and individually bar coded with bin location and warehouse location. This consumes warehouse resource with no value added.

Appendix A provides several other examples of warehouse material that is not directly related to plant equipment. Brake fluid, carpenter's glue, armour all, windex, gloves, mops, pails, rakes, kiddy pools, vinegar…. The complete list is exhaustive. These common household items if needed, should be sourced through procurement cards and not moved through the warehouse (where catids are applied, barcodes for source and bin location are applied, equipment is de-packaged into issue quantities, and in some cases, material tracing is applied)

Nuclear and Supply Chain need to work together on an initiative to stop this practice and replace it with a direct order process. There is significant return on investment for the company here with no impact or risk to operations.

Inventory Ownership

Pre business transformation inventory was owned by Nuclear Supply Chain, which in turn reported to the CNO. Post BTS, it will no longer make sense to hold inventory ownership with Supply Chain as there is no direct link with the customer other than at the CEO level. Ultimately, inventory levels can only be controlled by those who order the parts. Inventory ownership needs to be transferred to plant maintenance.

The current financial practice is the requisitioner's budget is only charged when the part is withdrawn from stores. This is fraught with problems:

- orders can be placed and cancelled by a requisitioner without them paying. Sometimes these are significant purchases like the stator cooling core change kit (1.5M$). There is no ownership for this problem.
- inventory is manipulated at year end by either withdrawing or returning equipment to stores to satisfy budget requirements. This adds no value to the bottom line. In fact value is subtracted in wasted warehouse effort.
- the system provides incentive to maximize contingency parts with no accountability for the cost. (I might need it, so I'll order it. If it don't use it, no worries).

This is a bit like getting insurance and only having to pay for it if a claim is made. Your incentive is to maximize coverage with no regard for cost.

The practice needs to change so the requisitioner is charged for the material as soon as the order is placed. This will undo the behaviours mentioned above. The requisitioner would not be charged for withdrawal, nor would there be a credit given for return. This in turn, will provide

incentive to use the existing inventory, even if it is not an exact fit for the plant (IEE, NICR or MOD required)

Approximately 330M$ of the inventory is held by Pickering, which has 7½ years of remaining life. As pointed out earlier, while reviews have been done to confirm most of the slow moving inventory makes sense to keep, this will change as the plant approaches end of life. The best possible outcome for the inventory is to use it. Often this requires engagement of plant design. For example, a 120Vac voltage regulator was just replaced in unit 4. Rather than procure an exact replacement, a Pickering 5-8 voltage regulator was used and "NICR'd into" unit 4. While this is standard practice if forced, the financial changes mentioned above will motivate more of this type of behaviour. This is necessary as the plant ages and remaining inventory needs to be used up.

Other opportunities

There are other opportunities such as smart ordering, improved outage planning, improved cycle planning that are discussed in the balance of this report. All are opportunities to buy the right inventory once, in a proactive manner linked directly to equipment reliability needs.

Inventory Recommendations

- Value of non plant inventory; reduce to zero over a three year period
- Value of plant inventory; hold to benchmark
- Transfer inventory ownership to plant maintenance, and include inventory values in the maintenance score card.

Outage Work Management Discussion

Outage Performance Prior to January 2011

Figure 4 outlines historical performance of how many unique catid's (parts) were unavailable at breaker open for planned outages. While this data has historically been available, there were never any targets set to hold supply chain accountable for a result that mattered… how many parts did the powerplant not get that it needed? On the surface this result would seem to be a purely supply chain accountability, yet there can be many reasons why a part is not available that are well beyond supply chain's internal sphere of influence. Parts availability is truly a cross functional, team sport. This is discussed more in the next section.

While it is tempting to draw conclusions from this data, the indicator as shown is of limited use because the data points may or may not have included scope reduction prior to outage start, nor does the data reflect the size of the outage. For instance, the P951 outage would appear to be the best performance, but over 500 work orders were cut from scope 4 months prior to outage start, and total outage scope only called for 1773 unique catids. By contrast, the P1141 outage called for

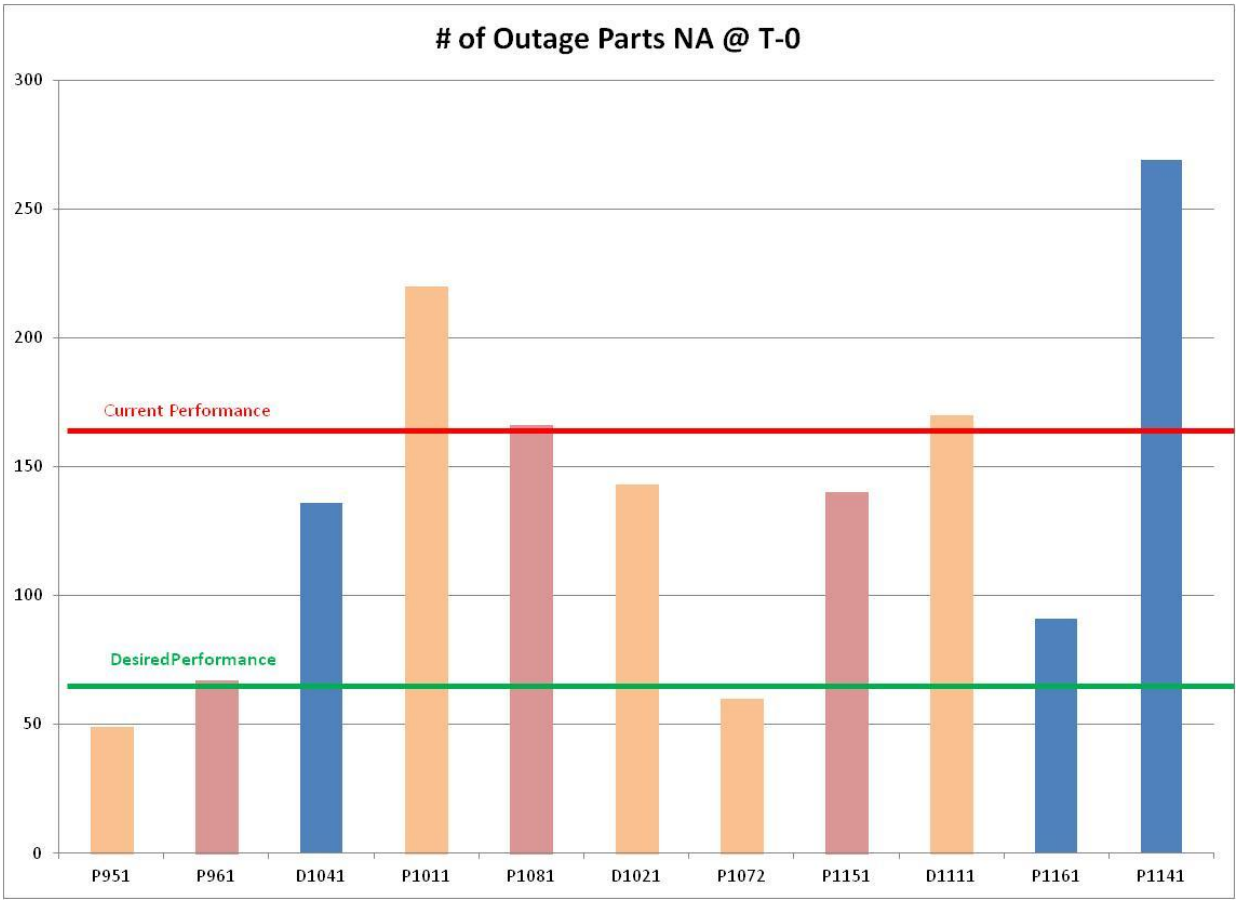


Figure 4 Planned Outage Parts not Available at T-0

over 4500 unique catids and 3500 is a more typical number.

A better indicator of procurement for outages is percentage of scope removed due to parts unavailability. Unfortunately this data is not available prior to P1141. While the stations were tracking scope variance, the sources of the scope variance were not well tracked. In some cases up to 80% of scope variance was not tagged with a reason. However, it is known the scope variance due to parts for P1141 was well over 5%. Industry best performance is less than 0.5% scope removal due to parts unavailability.

Corrective Actions Post January 2011

Performance Trending

Formal trending of outage parts unavailable was implemented by Supply Chain in May of 2011. It was decided to simply track "parts that are not here" as opposed to measures being tracked by outage management at the time. "Parts not here" is simple to understand vs counting task holds. The desire was to have a metric everyone can understand and track what really matters to the power plant.

Trending was established for the P1141 and P1161 outages as shown below.

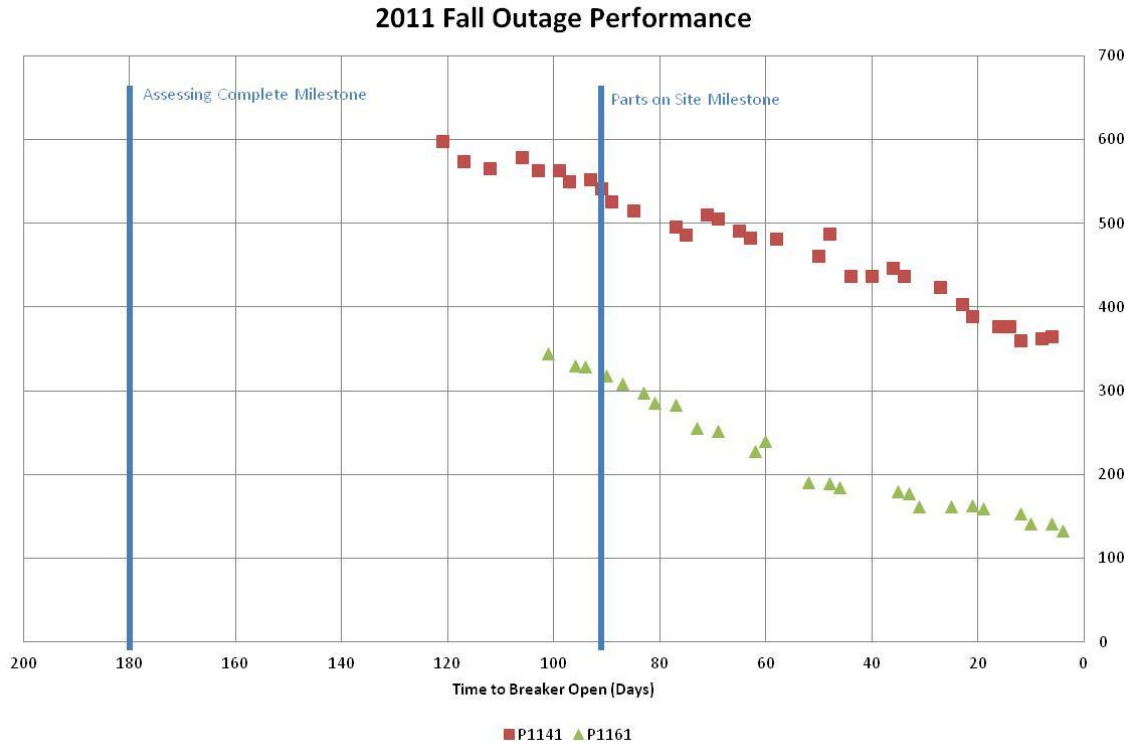


Figure 5 Pickering 2011 Fall Outage Parts Tracking

Self Assessment No11-000525 was conducted on the ~ 100 parts that were not available at breaker open for the P1161 outage. The self assessment found that 60% of the unavailable parts had a delivery date, meaning if they had simply been ordered sooner, the parts would have been available to the outage. This prompted us to examine our governance and compare ourselves to others in when the need for parts is identified. We found that while we compared favourably to others at the phase 1 assessing milestone (13.5 months out), with 60-65% of parts identified, others hit 90% of parts identified by 9 months out where OPG was still only have 60-65% identified.

A new scorecard was developed with the objective of getting senior management attention on the planned outage preparations sooner. At the time, metric report out started on the CNO call 6 months out. For many parts, if the need is not identified by this time it is already too late. The report card is shown below. The scorecard shows progress on parts identified and satisfied vs. targets benchmarked with the industry at 13.5 month, 9 months, 6 months, 3 month and 1 month out. The idea is that as material procurement improves, the scorecard colouring should change from red to green / white as you look towards the bottom right corner.

OPGN
Outage Preparatory Score Card — **June 2012**

ONTARIO POWER GENERATION

Outage #	Milestone #9 (13.5 months) Industry Benchmark = 60%/ 50%		Milestone #tbd (9 months) Industry Benchmark = 85%/ 70%		Milestone #23 (6 months) Industry Benchmark = 90%/ 80%		Milestone #29 (3 months) Industry Benchmark = 94%/ 90%		Milestone #TBD (1 months) Industry Benchmark = 94%/ 92%	
	CATIDs identified	CATIDs satisfied	*CATIDs identified*	CATIDs satisfied	*CATIDs identified*	CATIDs satisfied	*CATIDs identified*	CATIDs satisfied	*CATIDs identified*	CATIDs satisfied
P1161	60%	NA	63%	NA	87%	NA	88%	81%	87%	83%
P1141	56%	NA	67%	NA	85%	NA	94%	81%	99%	89%
P1281	57%	NA	63%	NA	79%	48%	91%	69%	95%	89%
D1231	64%	NA	78%	NA	91%	59%	97%	89%	109%	103%
P1271	66%	NA	77%	61%	83%	71%	99%	90%	100%	93%
P1211	55%	38%	78%	64%	90%	78%	96%	88%		
D1341	73%	NA	86%	57%	87%	69%				
P1351	65%	43%	79%	65%	80%	66%				
D1321	59%	38%								
P1361	71%	53%								
P1341	50%	40%								

Figure 6 OPGN Outage Preparation Scorecard

As stated earlier, parts procurement is truly a team sport. Getting the need identified sooner required the support of Maintenance assessing. The self assessment, the needed behaviour change and the needed performance indicators were discussed at length with Assessing management. MA-0013 was revised to require supply chain sign off on the phase 1 assessing milestone. The results are apparent in the scorecard, although performance on P1211 and D1341 is clearly better than P1271.

The second very important finding of the P1161 self assessment was that for the ~40 parts that had no delivery date, most needed engineering support. The report concluded "an EFIN approach" is required, as opposed to a "holds resolution" approach. The difference is subtle but important. An EFIN approach focuses on whatever needs to be done to get the part in the power plant. A holds resolutions approach simply focuses on getting to the next step in the procurement process. As a result, "the team with no name" was formed at Darlington to help prepare for the D1231 spring outage.

Parts requiring engineering support were greatly improved during the D1231 outage preparations, but the team unfortunately did not start early enough. Only 62 catids had to be removed from D1231 scope. The following wording from the report (June 2012) describes how powerful the EFIN (team with no name) approach was for D1231:

" At time of breaker open March 23, 2012 there were 123 cat id's unavailable.

Material requests were generated as follows:
19 prior to scope freeze March 23, 2011. At the present time 10 of these have now had the demand satisfied, 6 have purchase orders placed including future outage quantities, 2 are in OSD&D and 1 is out for RFQ.

28 after scope freeze but prior to assessing milestone September 23, 2011.
For the items categorized above the biggest churn contributing to unavailability was obsolescence resulting in IEE or NICR's required. The Team with no Name will actively resolve these issues going forward. Unfortunately the team was late starting for D1231 but will show noted improvement for D1341 and D1321. At the present time 8 of these now have parts on the shelf, 2 have Purchase Orders placed, 5 are out for RFQ, 1 remains with Design, 4 are with Procurement Engineering, 2 have had the demand satisfied, 4 are in OSD&D and 1 is at P/R status.

This clearly demonstrates we did not drop the ball and continued the procurement process. [Even though the work was removed from scope - MVT]*"*

The team was also recognized as a strength in the station peer evaluation and WANO has recommended others to benchmark the team for difficult to get parts.

A self assessment was also conducted for the P1281 outage. The following recommendations were made in addition actions already in progress:

1. Diligently, control scope after PO-6 and turn away all "nice to do" work. The likelihood of getting materials for these additions drastically reduces.
2. Implement "real time" assessing.
3. Perform early walk down of material requests that were "recycled" from previous outages.
4. Continue daily monitoring of new material requests (after PO-6) for lessons learned.

Items 1 and 2 are self explanatory, although it is interesting to note that more management attention paid to the procurement process actually helps the outage management process. Identifying the need sooner increases the probability of success and decreases the probability of having to re-plan the work with alternate maintenance strategies because parts are not available. This in turn, increases the pressure to maintain scope control which further helps outage outcome.

One of the traps discovered during P1281 was for parts "with previously satisfied demand". Supply chain was thinking "you have the parts because I issued them to you previously" (typically in a previous outage) but maintenance could no longer locate them. This was being caught during the walkdown period 1 month out which is of course far too late to re-start the procurement process if needed, As a result, for P1271 and P1211, early walkdowns were completed for previously satisfied demand. In some cases, these early walkdowns actually triggered new procurement that would have been lost otherwise. This practice needs to continue.

Supply Chain also implemented daily monitoring of all MR's generated after the assessing freeze milestone. This was fully implemented for P1271, and preliminary data is shown below.

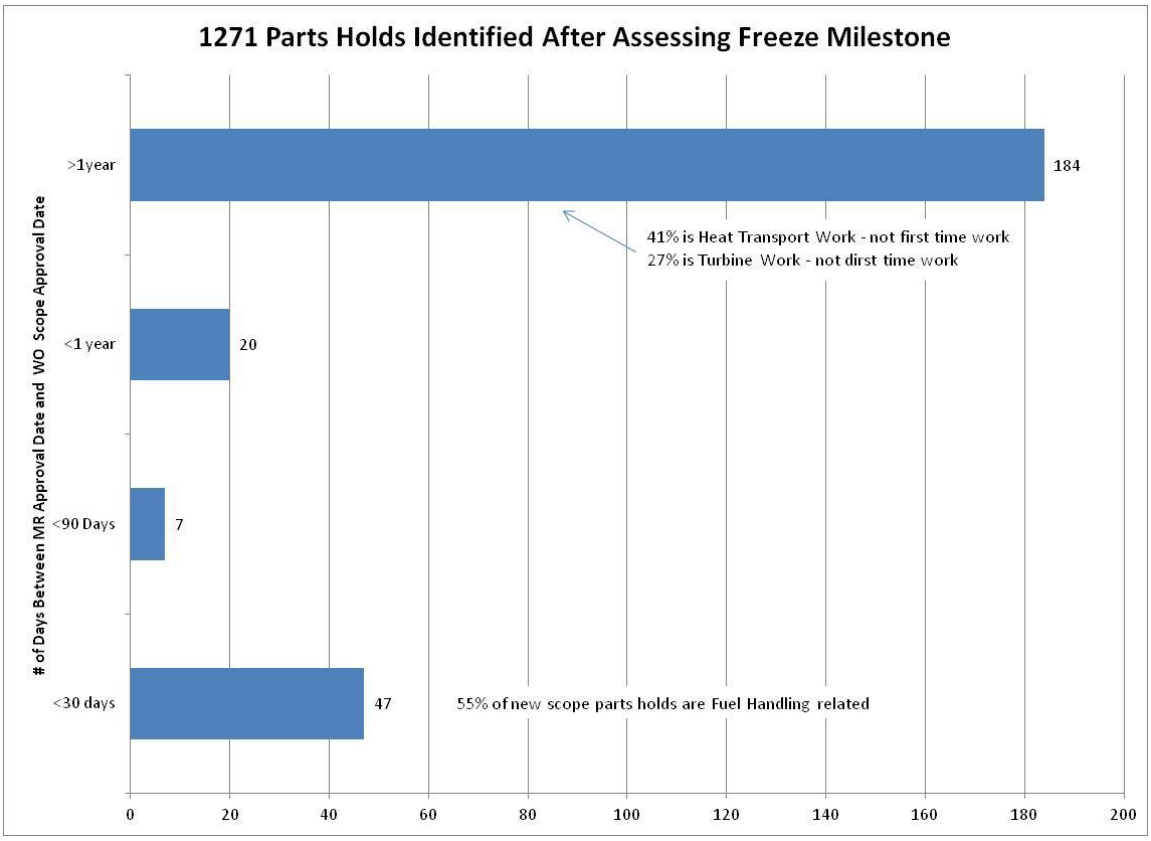


Figure 7 MR's Identified After Assessing Freeze

The graph shows only MR's identified that resulted in parts holds, not all MR's. In other words, these only represent the MR's for which material was not in stock. The surprising thing about this data is that 184 / 258 "late MR's" are generated from work ***orders that were added to scope at least a year prior to the MR being approved***. 41% of this work is heat transport related and all of this work has been performed before in previous outages. 27% is turbine work and again, is not "new" work. The reasons for this are discussed below, but it is definitely a future opportunity.

P1271 is somewhat unique in that a lot of fuel handling work was added late to outage scope. 55% of the MR's approved less than 30days after scope add were fuel handling related (catenaries, snout clamp overhaul and ram change). Since this will now be part of ongoing reliability improvements for the P5-8 units, the opportunity here is to get this work scoped sooner into future outages and allow proper time for procurement. At the time of writing, this scope had not yet been added to the P1351 outage but a commitment has been made to do so by July 18.

The interesting thing about the above data is that the perception has always been "late MR's are due to late scope". The facts do not bear this out. Late MR's more typically are generated from scope that has been approved for at least a year. P1271 data shows 71% of late MR's come from

work orders that were in approved outage scope at least a year earlier, and the number is typically higher than 71%.

P1271 parts procurement (Figure 9) is skewed by the non typical late addition of fuel handling scope. In fact if you compare the 1271 and 1211 (figure 10) parts tracking below, it is obvious the impact the fuel handling scope addition had on the P1271 outage preps (steep rise in the orange and blue lines). It is also obvious that most of the fuel handling parts were in stock as the demand was immediately satisfied (plant manager view!). The only parts not in stock were the catenaries.

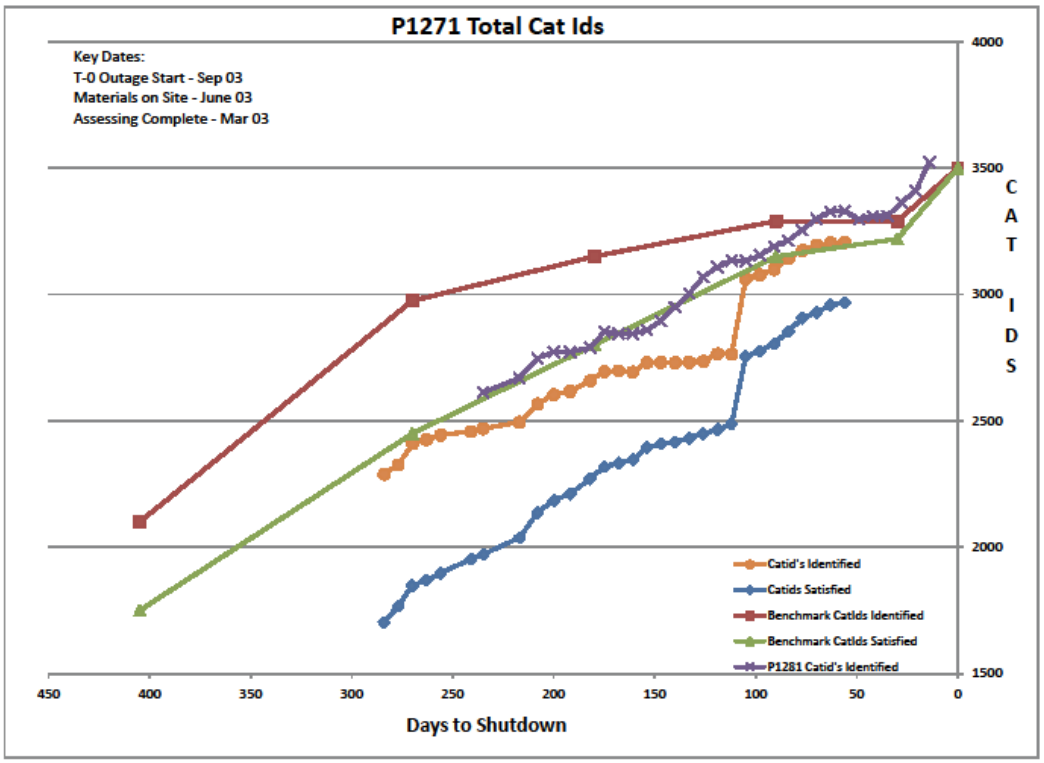


Figure 8 P1271 Outage Parts Tracking

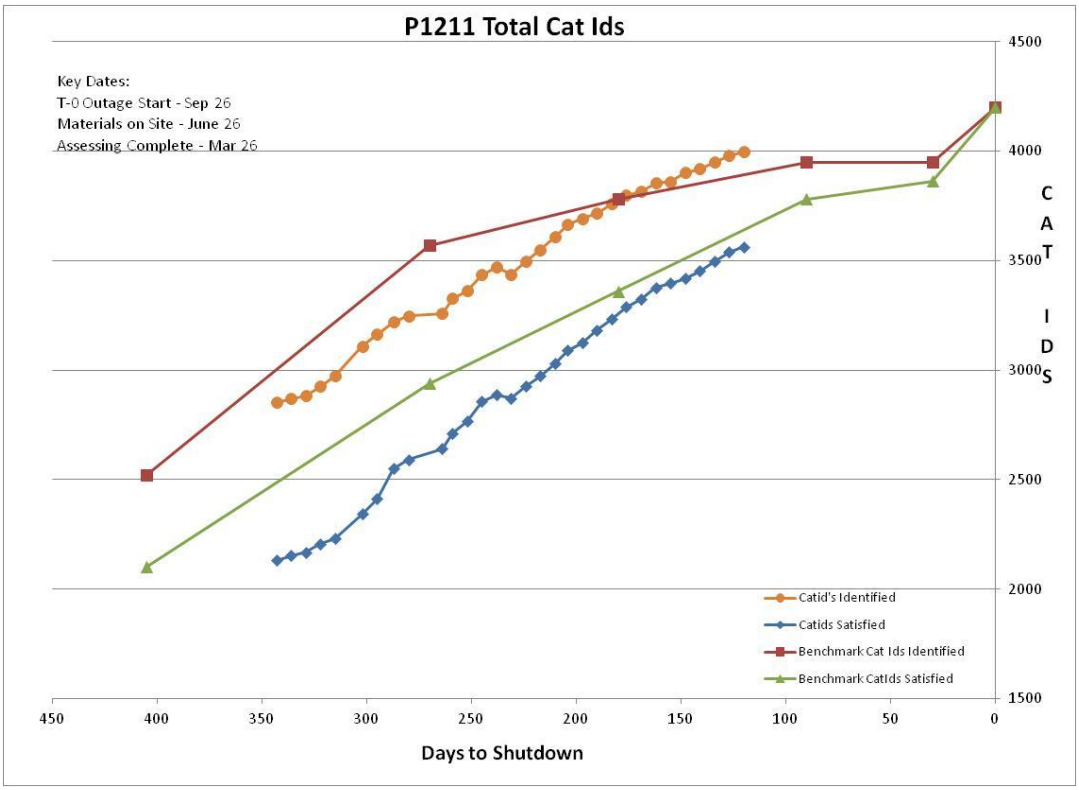


Figure 9 P1211 Outage Parts Tracking

Late MR's attached to WO's that have been in scope since the major scope milestone is typical of all outages however, particularly for heat transport and turbine work. There are two primary reasons;

1. Assessing practice
2. Historical process for obsolete parts

It is beyond the scope of this paper to discuss assessing practice, but many of the issues that result in late MR generation were identified in the WANO TSM conducted at Pickering in May 2012 for Maintenance assessing. Corrective actions identified in this TSM, if properly implemented will improve early identification of parts.

Process for Obsolete Parts

The procurement of parts is driven primarily by plant demand. Prior to 2012, if a Cat ID was on a material request for planned work, the plant work management metrics, tools and processes drove the procurement need. This caused problems when the requested Cat ID was no longer available. Procedures did not allow the replacement Cat ID to be placed on a material request until they were approved on the Bill of Material (BOM) for the equipment. Conversely, a Cat ID could not be approved on the BOM, via IEE or NICR for example, until it was in the procurement process and technical information available. This "circular reference" caused needless delays in the procurement process. "Work-arounds" existed but were not effective.

In 2012, the PGO (Parts Gone Obsolete) was introduced. A hold is now applied to work orders to signify that material needed to complete the work is obsolete or no longer available, and replacement material is required to be procured and approved for installation. The PGO hold is applied on Work Order tasks by Maintenance Planning Assessors when requested by Procurement Engineering. Application of the PGO hold allows the Assessor to change demand from the original Cat ID to the replacement Cat ID even when not approved for installation (i.e. not verified on the BOM). This provides the correct priority (i.e. increased visibility) to Supply Chain for procurement of the replacement Cat ID. It also allows supply chain to proceed at risk with procurement rather than wait for resolution of the engineering holds. The PGO hold can only be removed when the replacement Cat ID has been approved on the BOM for the equipment.

The PGO hold has considerably shortened the procurement process for obsolete parts, yet it is a new process and has not been full tapped for potential. The next steps need to be metrics that show how many PGO holds are expected for each outage and how many have been worked off. The same could actually be said of all engineering holds. At any given time, the current outage metrics only show what holds are outstanding as opposed to tracking actual progress vs. the total expected for the outage. A false sense of security is created in only reporting on what is outstanding vs. what is "to come".

Summary of Outage Corrective Actions

In my mind the outage self assessments initiated by Supply Chain have been effective in identifying opportunities to improve and this practice needs to continue for every future planned outage. Many actions have already been put in place through the self assessments and resultant performance indicators. These need to continue to reap full benefit. A summary is provided below:

- Production of an "outage score card" allowing senior management a snapshot overview of how parts identification and procurement is proceeding vs. benchmark performance, well before outage metrics are aired on the CNO call.
- Production of trends for each outage showing catid identification and procurement vs benchmark performance. These are "aired' on the NCOO call and at station SWM's.
- Introduction of the PGO hold to speed procurement of obsolete parts.
- Dispelling the myth that late MR's come from late scope. Identifying to the station on a daily basis the true source of late MR's and scope addition.
- Introduction of "the team with no name" to take a "EFIN" approach for engineered parts replacement.

Future Outage Opportunities

Figure 10 shows the distribution of approved MR need dates for Pickering over the next 5 years. The green line shows planned outage related MR need. It is apparent, that at any given time,

supply chain can only see outage demand for the next three outage campaigns. The first peak is demand for the 2012 fall outages; the next peak is the 2013 spring outages (1342 and 1351); and the final peak is for the 2013 fall outages (1341 and 1361).

The blue dashed line in 2017 represents approved MR's for work that is not scoped into any outage. More than likely, most of this was work de-scoped from previous outages because it was not possible to procure the parts. It is important to note that Supply Chain does not do anything with demand that is placed in 2017. Supply Chain has no way of knowing whether or not the demand in 2017 is real or not. For example, some of the demand in 2017 is for new solenoid valves for the IPRV's, which require a vacuum building outage to install. Obviously, this is not going to happen. In another case, very important work had to be de-scoped from 1141 ("B" valves for feedwater) due to inability to spec and source suitable replacement valves. When de-scoped from the 1141 outage, Pickering outage management then moved the work orders to approved scope in 1341 in the outage management system (OMS). When supply chain inquired a month later, the MR need dates were all set to 2017 even though the OMS scope date was 2013. Outage management thought their job was done when scope was moved in OMS, but in fact unless a manual update is run, the need date gets moved to 2017 automatically by batch information system update as soon as the de-scope occurs. Without supply chain intervention, the likely outcome would have been a re-scope of the work 12-18 months out, then the whole process would repeat itself. This minor oversight is a major reason why parts have been unavailable for repeat outages in the past.

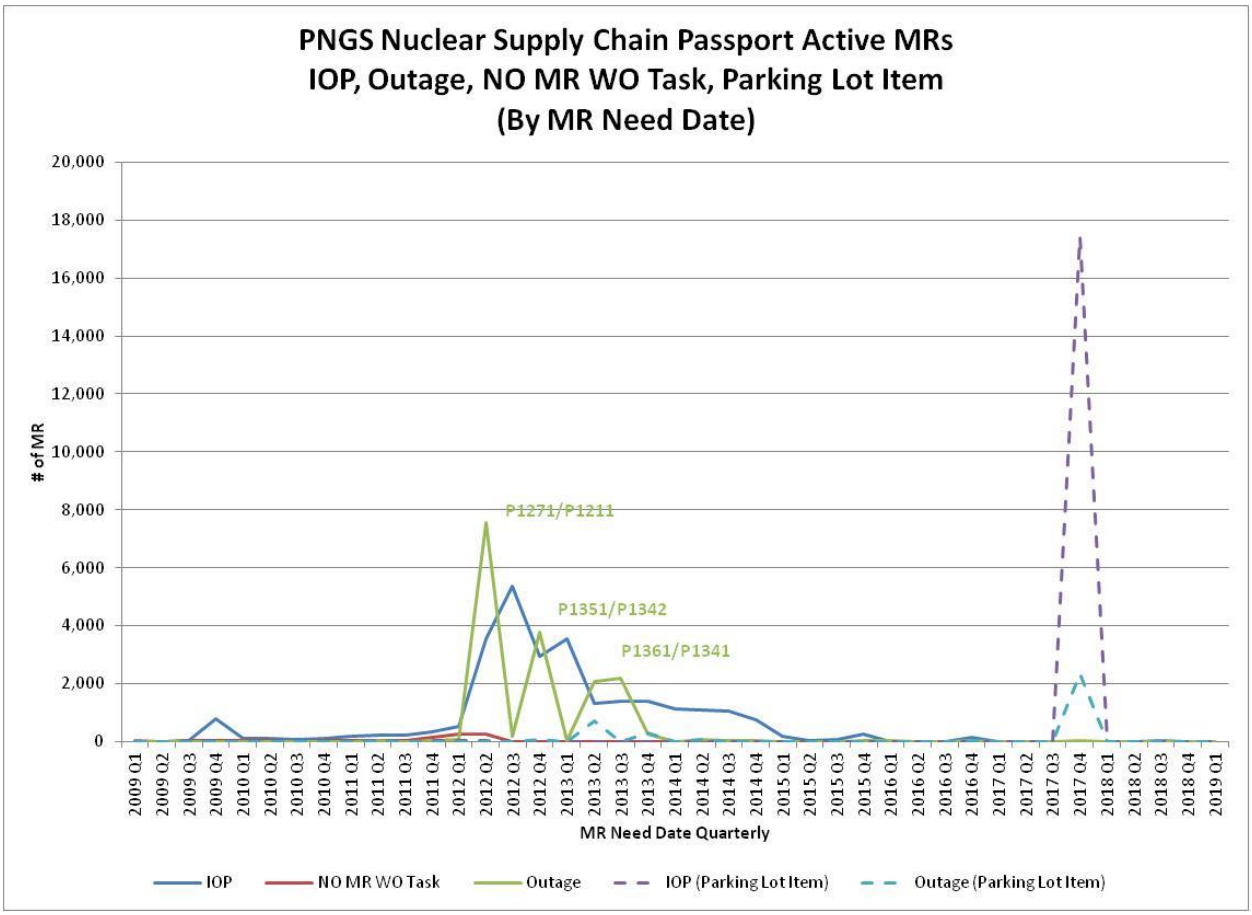


Figure 10 Pickering Future Outage Demand

The reason supply chain can only see demand for three outage campaigns is the manner in which outages are scoped. Figure 11 shows the scoping profile for the P1351 outage. Note that little or no scope is approved prior to the 18 month major scope milestone. A little over 500 WO's were then brought into approved scope.

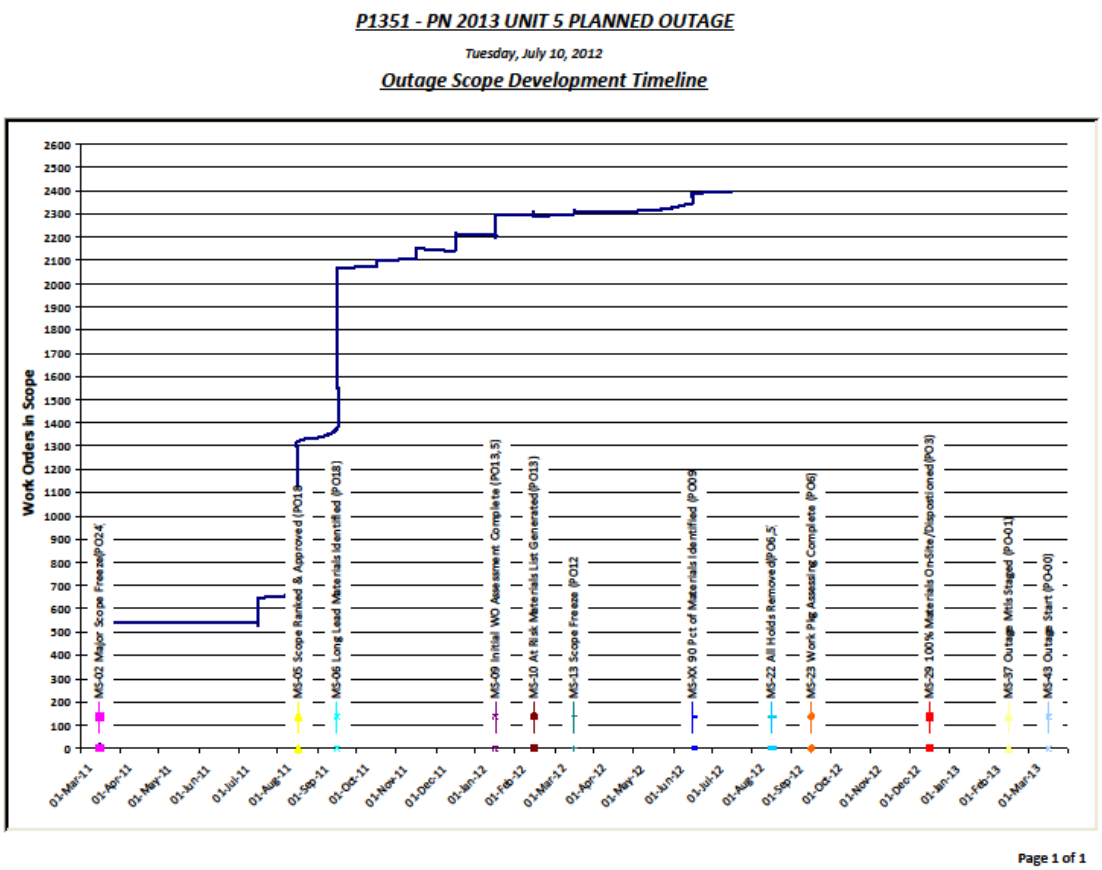


Figure 11 Pickering 1351 Scoping Profile

At the 12 month milestone, approximately 800 more work orders are brought into scope, and then a major scope addition takes place a month after the scope freeze milestone of over 800 work orders. It is interesting to note that this caused supply chain to miss the long lead identification milestone because scope was actually reflective of true outage scope a month after it should have been.

Figure 12 shows the D1231 scoping profile. Again, zero work orders are in approved scope prior to the major freeze millstone (T-18), but in this case 1100 (as opposed to 500) work orders are brought into scope. Just before the scope freeze milestone, another 300 work orders are brought into scope, and after the scope freeze milestone, another 300 work orders are added to scope over about a two month period.

It is important to note that both these charts are taken from passport approved scope, not from OMS. The interesting thing about both charts is the very steep rise in approved scope right before (and sometimes after) a milestone is due. Keep in mind that any MR's associated with non scoped work have a 2017 need date. So to supply chain, need dates change seemingly overnight.

If it's possible to make decisions in a very short time frame about approved scope, it is an indicator that it was known all along these work orders were going to be in approved scope, or at least at some date much earlier than the scoping process.

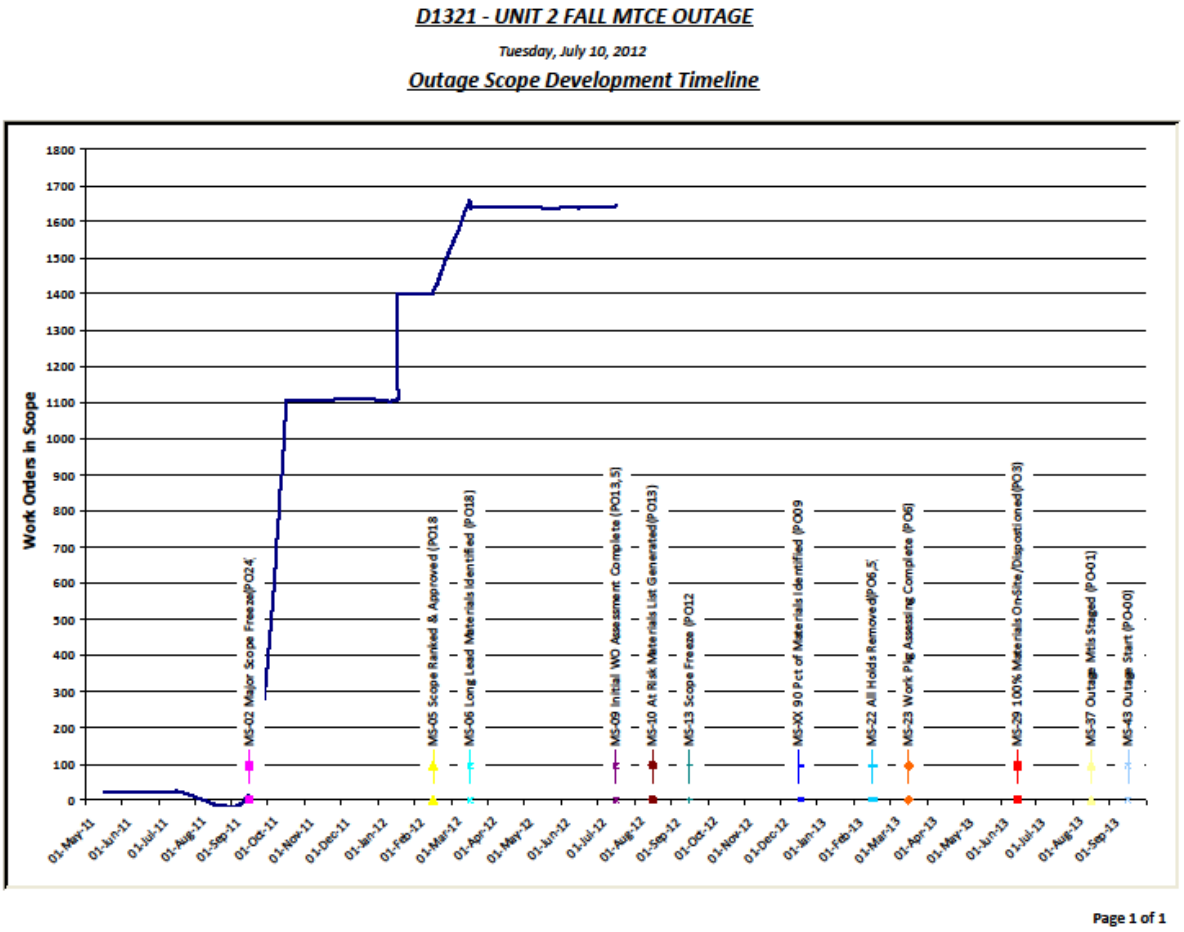


Figure 12 D1321 Scoping Profile

Figure 13 shows the MR need date profile for Darlington. In this case, demand is really only visible for the two 2013 outages. This is because the 2014 outage has not hit the major scope milestone ad the time of writing.

From both a supply chain and a plant perspective, the earlier a decision is made to add approved scope work the better (as long as it's the right scope). This lets assessing start earlier, and gets the procurement process started earlier, but more importantly, it allows support organizations to look through the work "horizontally" and clear multiple holds for the same type of work in different outages.

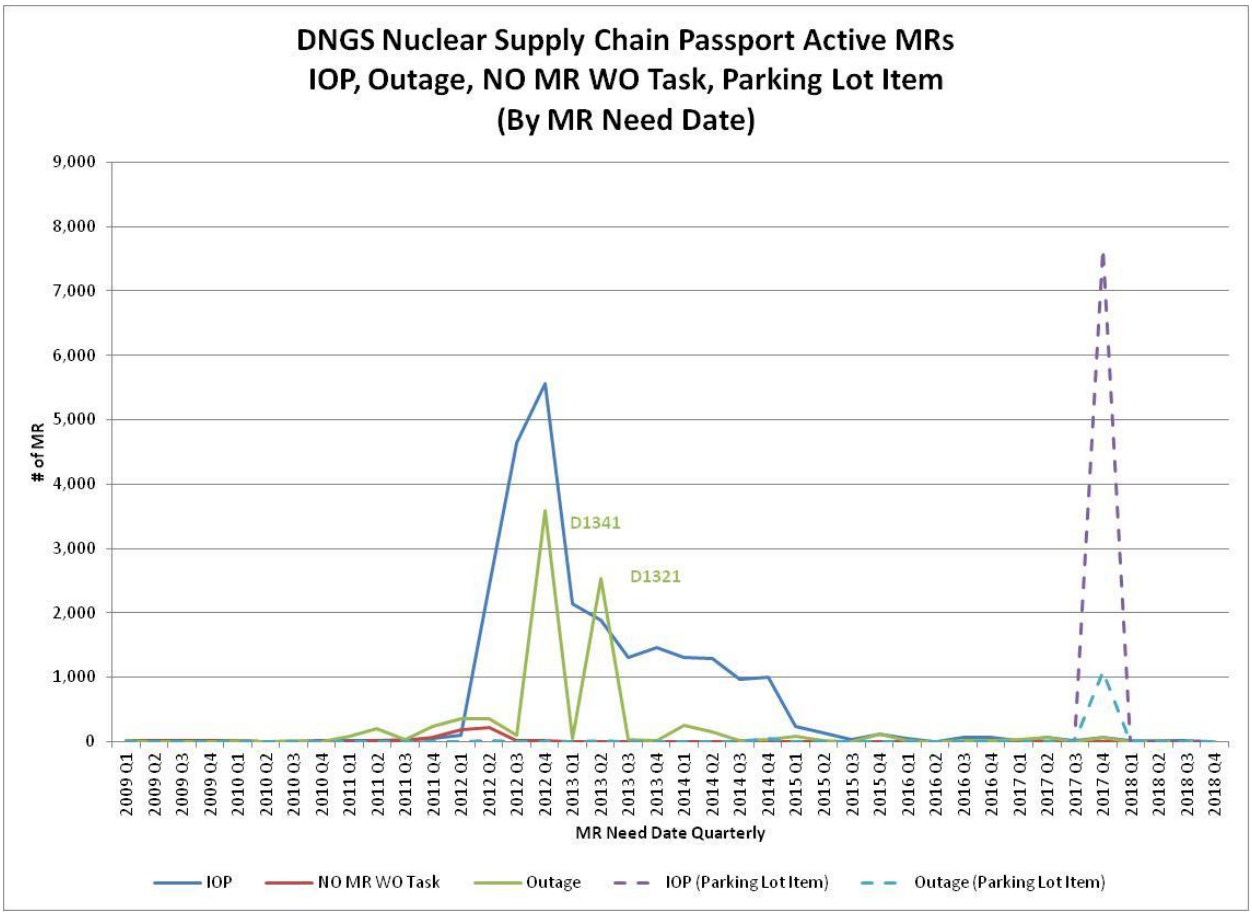


Figure 13 Darlington Future Outage Demand

The whole point of this discussion is that behaviour driven by milestone compliance without performance indicators and target lines drives very "lumpy" behaviour. While one could argue milestones have been met (arguably they have not for some of these data points), the manner in which it is being done is very inefficient for support organizations. If supply chain knew a valve is required for the next five outage campaigns, it could order for all five once and stage delivery with the supplier. As it is, at best supply chain only know about two outage demands, then find out over a period of years the demand is really for five. This in turn can trigger the obsolescence process multiple times, which is inefficient for engineering. The process being describes here, where demand should be know for the next five years because we plan to do the same thing across multiple units, is referred to as "smart ordering". The smart ordering concept has been presented to each site's senior work management meetings. Smart ordering is described in further detail in appendix B.

These charts presented here, or some form there of, need to be part of the outage long term metrics package. **The target should be to have zero demand in 2017.** All of it should be moved to approved ***PASSPORT*** scope for future outages, or be cancelled if the work will not be done.

Outage Recommendations

- Supply Chain to continue with the self assessment process after every planned outage. Even if the report only concludes we just need to finish what we started, this is still of value
- Supply Chain to continue with publication of late MR's (after assessing freeze milestone 6 months out)
- Continue with outage metrics as developed and finish the process to get them embedded in CNO metrics (Ron Hall)
- Continue with "scope removal due to parts" as the tier 3 scorecard metric. Set the target to 10% of the outage scope variance (e.g a 10% outage scope variance would result in no more than 1% scope removal due to parts).
- Develop metrics for PGO holds and integrate into the work management process. (Frank Dias)
- Develop true work off curves for all engineering holds, that not only show what is outstanding, but also what is expected "to come" based on past outage experiences (Frank Dias)
- Develop a suite of metrics that allow senior management to exercise oversight on the outage scoping process. Success would look like work orders are added to approved scope as soon as the plant has made the decision to do the work, typically at plant health committee. As such, important equipment reliability work is slowly fed into approved outage scope, as opposed to being force fed right before a milestone is due.
- Included in the above should be the MR need date profiles shown here, with a target of having zero demand placed in the hold bin five years out (2017 at the time of writing). Note that proper management of approved scope would show decreasing, but visible demand for the next 5 years of outage campaigns.

Online Work Management Discussion

Overview

The online work management process is primarily driven by predefines. Corrective and deficient work are added to the schedule each week to support backlog reduction, but the schedule is primarily built around pre-defined maintenance. There are really two problems to manage from a procurement perspective;

- Ensure that all pre-defines have parts, typically through an ROP/TMAX process. Pre-define execution is typically non-optional for criticality (crit) 1 and 2 work. While crit 3 work can be deferred, the option should only be exercised infrequently. If crit 3 work is deferred too long, the problem can become a crit 1/2 problem as redundancy is lost.
- Ensure parts are available for important equipment reliability work (typically corrective and deficient work orders). Lead times to support parts for this work can be the same as required for outage because typically obsolescence is involved.

Its important to understand the distinction because the management processes supporting each need to be different. Each requires separate metrics and oversight to run efficiently. Part of the problem with IOP is that it has been assumed that each problem can be managed the same using the T-process. This has proved very ineffective.

A self assessment of on line work was conducted by supply chain in March of 2012 (NO11-000551. The report concluded;

1. Apply ROP/TMAX to applicable parts required for the PM and critical equipment work orders
2. Improve the inventory management system and process to improve the material availability for parts required by PM and critical equipment work orders
3. Identify long lead materials by increasing the use of Cycle Planning (Coding and assessing). Very limited use is made of the cycle plan. See figure 14.
4. Right size the scope (meaning that T-26 to T-9 scope is overloaded with more work than maintenance can do. This is being done thinking many holds will clear and make more work ready. See the report for more detail)

What follows is a discussion on “stock out” which is the best strategy to manage repetitive work like pre-defines, and a discussion on the cycle plan, which is the best strategy to manage sourcing of long lead material as is typically required for plant reliability work.

Stock-out

As described in the background for this report, stockout is a metric that has been improperly used in the past. The definition of stockout is;

CatIDs with ROP > 0 and Status not in 'NOPRUCH' or 'OBSOLETE' and Quantity On Hand (QOH)

The metric can be easily manipulated by setting ROP to zero, so stockout, without the right oversight can be a very misleading metric. Appendix C of this report shows stockout trends in 2008. Stockout reduced from 10% to less than 5% in a period of 3 months. Considering the population of catids with a defined ROP limit hovers just over the 100,000 mark, it is very difficult to imagine how this performance was achieved through actual procurement.

A comprehensive self assessment was conducted by supply chain in February 2012. Major conclusions for the SA were;

- The definition was made more restrictive, to include cases safety stock levels were established without ROP
- Enhance the use of Master Product Agreements and related Blanket Purchase Orders
- Return quarantined and staged materials currently not available for end use to the stock
- Finish identified Critical Spares identification (Darlington & Pickering)
- Increased management focus on Replenishment through metrics
- Staff Training Implementation
- Sustained Materials clean up through the batch program updates

These actions were undertaken to bring a renewed focus to stockout and reduce the stockout percentage from a high of 6.7% to a yearend end target of 4%. These actions will in turn help better support the IOP schedule.

However, these actions alone are insufficient to secure success. A "snap shot" self assessment conducted by supply chain in May 2012 concluded that while the overall stock metric is a reasonable measure of supply chain performance, more stratification is required to truly reflect support needed for the work management processes.

The snap shot self assessment analyzed the 6% stockout at the time on a population of 107,757 catids. The assessment concluded that;

> *" although greater than 57% or quantity 61,801 replenishment material Cat ID's are not associated to plant equipment, the overall stock out level of this material is relatively low at 3.57% and as a result is in fact helping to bring the overall stock out metric down. Conversely of the 43% or quantity of 45,956 remaining replenishment materials that are associated to plant equipment has a higher stock out percentage currently at 9.16%."*

Further stratification is required of the stockout measure in order to track what is really meaningful to work management and the power plants. These are defined in the recommendations section below.

One might conclude that the 57% of catids with no link to BOMs are not important to plant operations. It's true that many of these catids will be for material described in the inventory section of this report and appendix A. They are typically easy to procure. However, included in this group of catids are items like boron, gadolinium, discrete electronic components and other sub components not practical to link to a BOM. To draw the conclusion these are unimportant to plant operations would be incorrect. For this reason alone, the focus in 2012 remains on all items affecting stockout. However, as stockout is reduced over the year, the focus will need to shift to the stratified measures identified in the recommendation section.

Focus on these revised stockout measure will have considerable benefit to the IOP program, however there is an important shift in priority that must be recognized for this to work. Today, engineering accepts it's priority for holds removal from the work management process. When a stockout occurs on a part associated with a crit 1 pre-define, only a parts hold is generated. If the part can no longer be procured due to obsolescence, engineering holds will not be generated until a predefine WO is due and scheduled in the T process. By this time it can be too late to be successful at procuring a replacement. Waiting for holds for a crit 1/2 predefine makes no sense, but reality today is this is how engineering gets direction to work. To be successful in achieving low stockout on plant material, Engineering and supply chain will need to work side by side. Supply chain must identify the stockout need early and engineering needs to support both stockout and work management holds.

Cycle Plan

As mentioned in the overview, the current T process is by and large the only method used to secure long lead parts for on line work. The ineffectiveness of this process in procuring obsolete parts was well documented in the "procurement breakthrough strategy" report (see self assessment NO10-000425). The report documented that in some cases, obsolete parts procurement was cycled in and out of T weeks for up to ten years. Securing an obsolete part requires a focused effort on many players account and can take months of effort. The report recognized that teamwork needed to be 'created' and called for formation of an "EFIN" team. By and large, EFIN has been very successful but their focus has been rightly limited to very high profile items. EFIN members will tell you that success depends on all team members contributing and once the process is started, it must continue until resolution. Placing the procurement process on hold for 13 weeks and coming back to it simply does not work.

In the two years since the report was written, other measures have helped drive improved obsolescence procurement. The PGO hold mentioned in the outage section of this report helps support IOP as well. The "team with no name" for outages has adopted the EFIN concept for outage procurement. Arguably, the whole process works much better for outages because there is focus on the same scope for at least a one year period. And in some cases, the team with no name can focus on one part for multiple outages, further increasing efficiency. No such parallel concept exists for IOP today however.

Major evidence of the problem is provided by the MR need date profile, previously discussed in the outage section and repeated here in Figure 14.

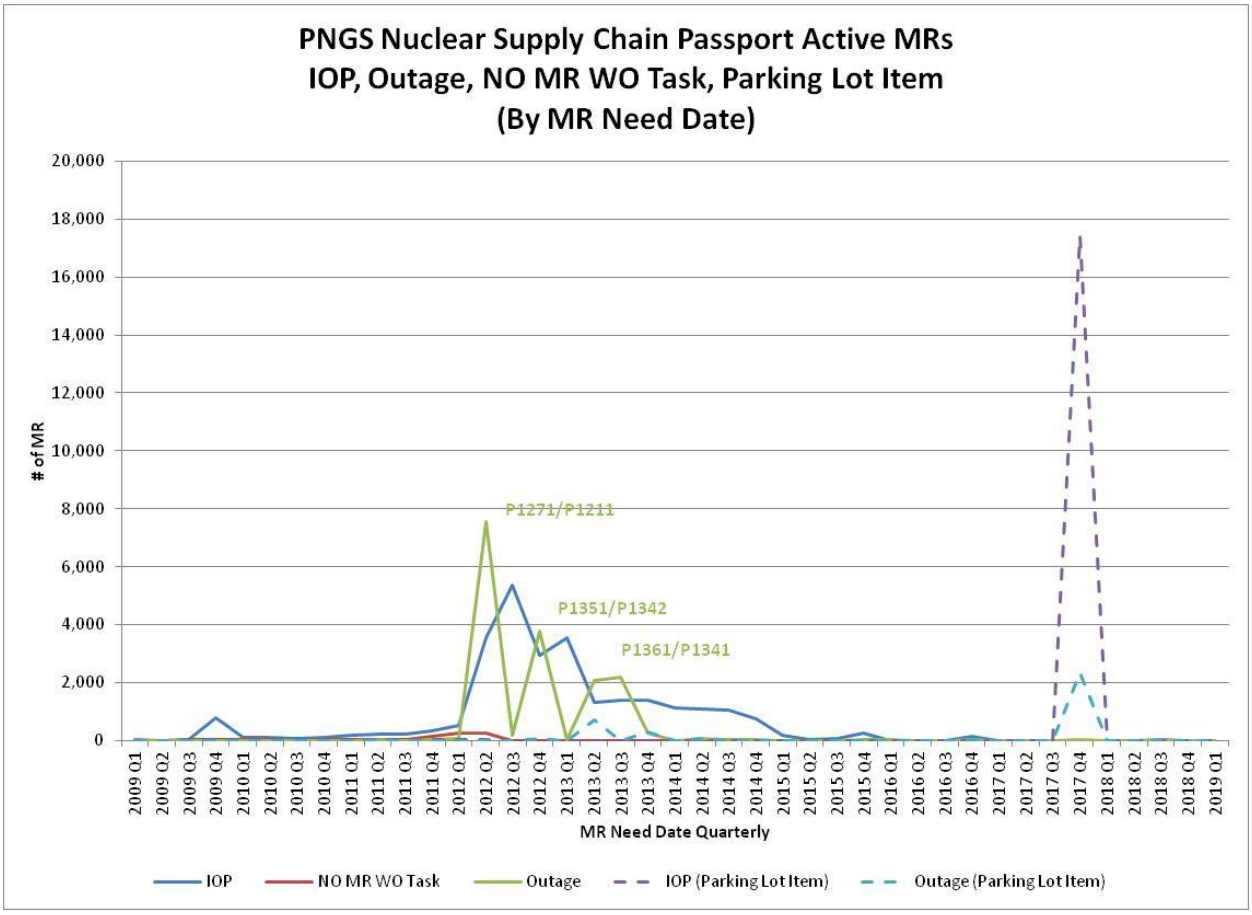


Figure 14 MR Need Date Profile

The solid blue line reflects the Pickering need date for parts driven through the IOP process. The dashed purple line represents the demand that has been "dumped" in 2017. The total parts demand for which supply chain has no direction, is roughly equivalent to the current known demand for the next six planned outages.

Figure 15 shows the historical MR usage rates for IOP and outage at Pickering. Note that IOP averages no more than 3500 MR lines per quarter (the vacuum building outage period is clearly an exception). In figure 14, IOP is calling for about 5500 MR lines in the third quarter, this when two planned outages are scheduled. These trends surprize people because schedules are supposed to be loaded to 125% of maintenance resource availability, so one would think this should not happen. However, remember this is a parts view and a not a maintenance hours view. When one strips out of the predefine work that consumes resource but no parts, the resultant profile looks significantly different and magnified.

Figure 16 shows the number of work orders that are actually loaded into the cycle plan. By work week, there are no more than 17 and on average, about 4 work orders per week. This is almost an insignificant number.

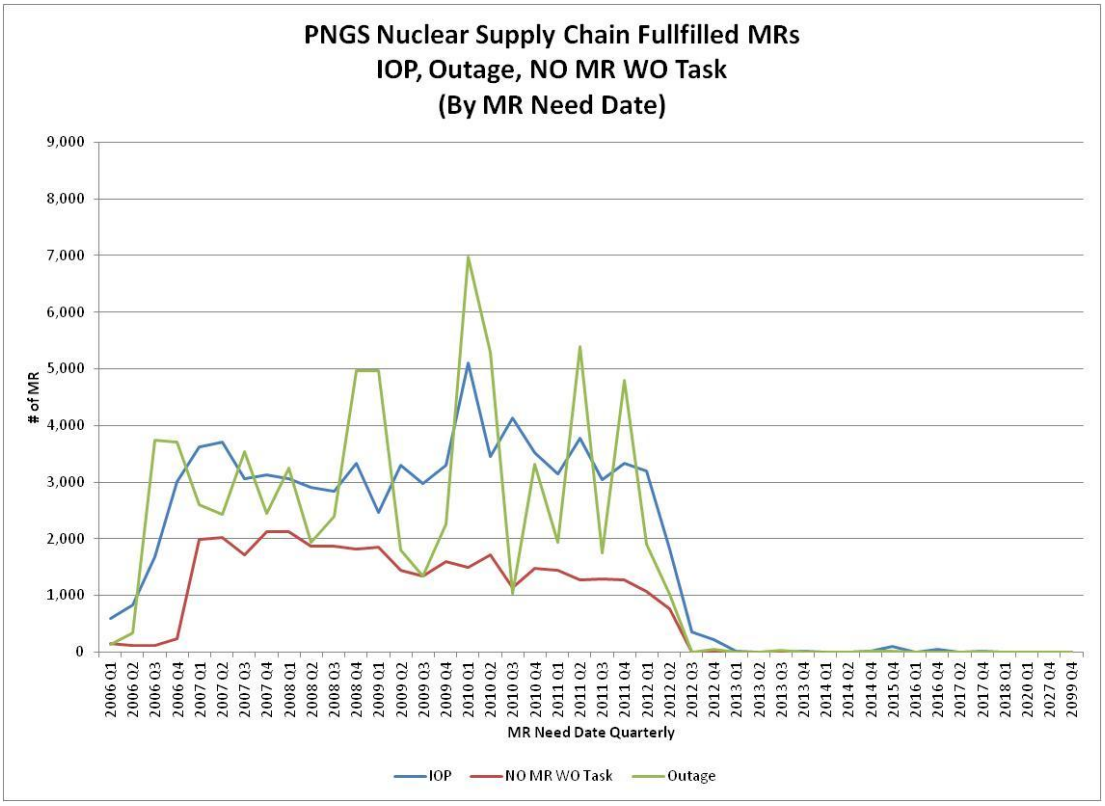


Figure 15 Historical MR Usage at Pickering

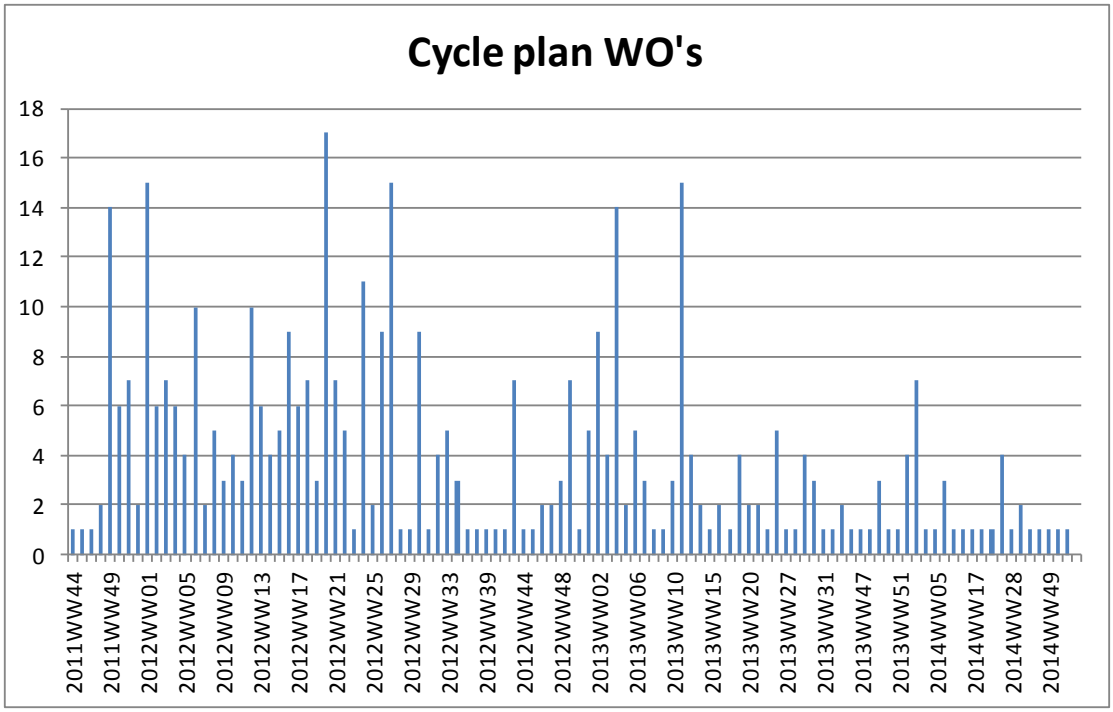


Figure 16 Cycle Plan Work Order Loading at Pickering

What should be happening is all work should either be in outage, IOP, or cycle plan. As pointed out in the Maintenance planning TSM, this would be consistent with the US nuclear approach. There should not be a "dumping ground". There is no way supply chain can do supply planning when so much work is not scheduled. Similar to outage, these metrics need to be visible by station management, with work off curves in place to reduce the 2017 demand to zero, have all work either in IOP, outage or cycle plan and the proper metrics and accountability system (modelled off of outage) for the cycle plan. Both plant and supply chain would be more successful at getting the work ready to execute.

On Line Recommendations

Develop sub tier metrics for stockout that show:

- How much of the stockout is linked to material associated with a BOM
- How many catids linked to pre-defines have an ROP of zero
- How much of the stockout is related to predefined demand
- How much of the stockout is related to critical spares

Each should be trended with target rates set and agreed to by nuclear.

Develop metrics for cycle plan performance

- Similar to outage, cycle plan work should be treated as one scope of work and managed like a project
- No MR need dates should be in 2017. All work should be "placed" with a valid need date.

Final Work Management Discussion

Much of the supporting facts shown in this report are a roll up of detail which is readily available, but perhaps historically not presented in a format that is easily understood. My belief is the metrics proposed are easily understood by both parties. That said, the author realizes that there are many metrics discussed here and there is danger of losing focus on what really matters at the Tier 1, AIP level.

The primary objective of all the controls proposed here is that Supply Chain should never find itself on outage critical path for procurement of material that should have been readily available. Multiple repeat events concerning procurement of Born and Gadolinium have come way too close to holding up outage progress in the past, not withstanding the nuclear safety impact. For this reason, I am proposing an AIP scorecard measure be added, that is "generation lost due to material procurement". To the best of my knowledge, this number has always been zero. Detailed targets should be worked out through the AIP scorecard process, but my suggestion is as follows:

Threshold: >85,700 MW-hrs (One week of a Pickering Unit)

Target: 0 (historical performance)

Maximum: Target + all outage milestones met (meaning procurement is well in front of need)

Vendor Quality

Program Description

In February of 2011, [redacted] was benchmarked for number of reasons, one of which was vendor quality. [redacted] had the following to offer;

- They initially tried taking poor performing vendors to claims court. All this did was scare away their vendor base and cause well performing vendors to needlessly question terms and conditions
- They built a large test facility for parts, which definitely helped plant performance but really didn't solve the root cause for vendor quality. At the time, they had spent over 200M$ on the test facility
- They developed metrics that clearly showed the impact vendor performance was having on plant performance
- They started a series of escalated meetings with poorer performing vendors, using the above metrics to explain how their operation affect's [redacted] What they are looking for is whether or not the vendor is willing to work with them in solving quality issues. If yes, they work towards resolution. If no, they remove the vendor from the ASL and may pursue claims court.

Their recommendation to OPG was to implement the last two bullets. Since that time supply chain have established tier 1,2,3 and 4 metrics for vendor quality. The top tier measure is vendor quality issues that actually affect forced loss. The relationship between the various tiers is shown below.

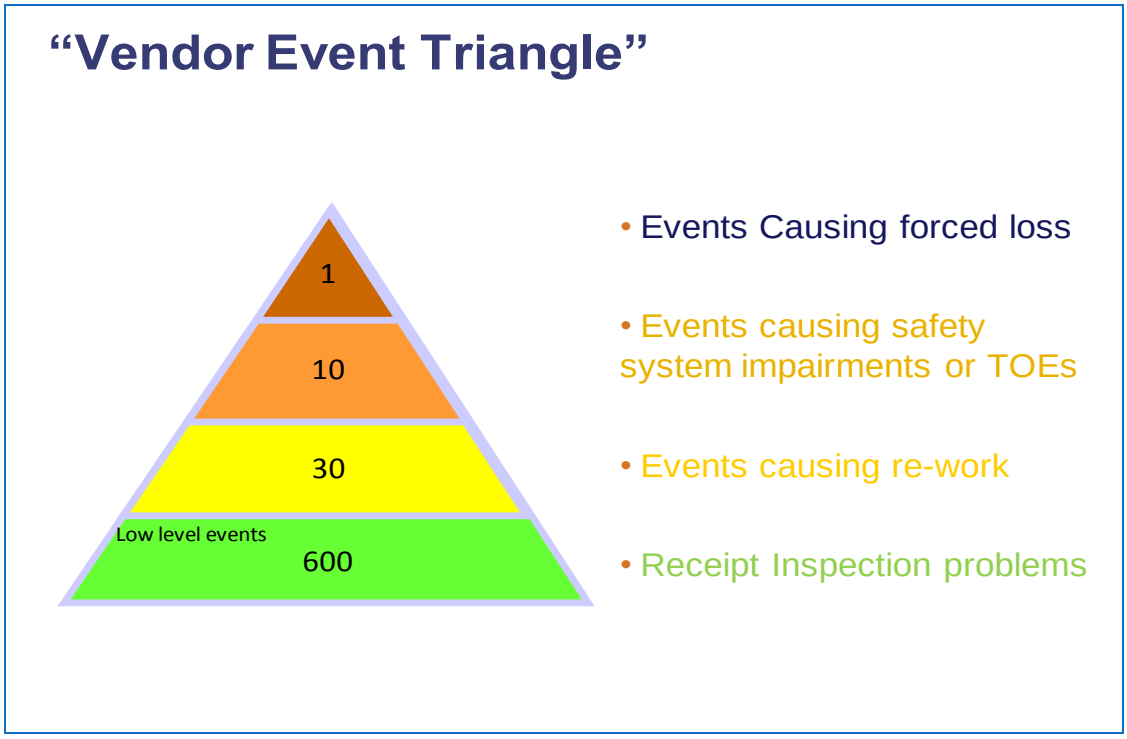


Figure 17 Vendor Quality Triangle

Supply chain retroactively went back and traced all the higher level vendor quality events for 2010, then started to process recommended by [redacted] to meet with each of the vendors causing forced loss. What we have learned right away is that the "triangle" relationship truly does exist. That is, vendors causing forced loss also have the highest OSDD (over, short, damaged or discrepant).

Since 2010, the following events have occurred at the tier 1 level

- DN FH Ram bearing failure (2010, GE)
- D3 Current Transformer (2010, ABB)
- P1 Governor bush (2010, Siemens)
- P4 Governor Locking Pins(2010, Siemens)
- P5 NOP amplifiers (2011, Sartrex)
- P6 Trip plunger O rings (2012, Siemens)
- P4 pressurizing pumps (2012, ETI)

Since program inception, vendor quality issues have cost OPG over 95M$ in lost generation revenue. The program has been very effective at changing supplier behaviours as evidenced by lack of repeat events and decreasing event frequency and severity. Siemens have had multiple events (not related) so the jury is still out on their commitment to improve. However, up until

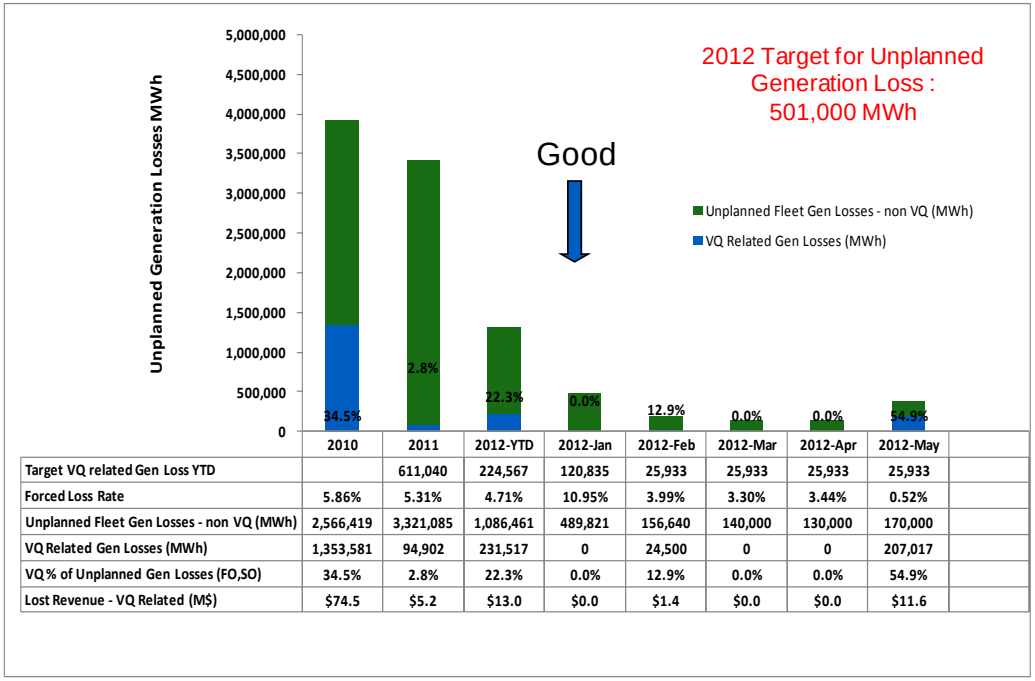
this point the program has been mainly reactive. There is a train of thought that more source surveillance and vendor audits would assist in being more pro-active, but I think evidence would suggest otherwise. One thing that is clear is using this [redacted] approach results in clear and apparent management changes in the vendors of interest. As stated earlier, vendors with breakthrough events have many other issues as evidenced by the event triangle. For example, one vendor who had one breakthrough event also had a greater than 40% receipt inspection rejection ratio. This would suggest the underlying problems are deep routed and require fundamental change. Source surveillance and vendor audits do not typically generate the deep routed change that is necessary to correct fundamental quality problems. This program accomplishes that objective.

The program comes at a small cost to OPG. Three quality engineers are assigned on a full time basis to this program. It is tempting, given the dramatic results achieved to date to assign more people and grow the program. No doubt there would be cost benefit to OPG, but this will not change the mainly reactive nature of the program.

What follows in figures 18 through 20 is the tier 1, 2 and 3 performance indicators from the program. The “Self Assessment Findings” section provides additional insight as to what is fundamentally happening in the vendor community and provides suggestions on what can be done in a more proactive manner.

Performance Indicators

OPGN Fleet Generation Loss Performance – Vendor Quality Related May 2012



	2010	2011	2012-YTD	2012-Jan	2012-Feb	2012-Mar	2012-Apr	2012-May
Target VQ related Gen Loss YTD		611,040	224,567	120,835	25,933	25,933	25,933	25,933
Forced Loss Rate	5.86%	5.31%	4.71%	10.95%	3.99%	3.30%	3.44%	0.52%
Unplanned Fleet Gen Losses - non VQ (MWh)	2,566,419	3,321,085	1,086,461	489,821	156,640	140,000	130,000	170,000
VQ Related Gen Losses (MWh)	1,353,581	94,902	231,517	0	24,500	0	0	207,017
VQ % of Unplanned Gen Losses (FO,SO)	34.5%	2.8%	22.3%	0.0%	12.9%	0.0%	0.0%	54.9%
Lost Revenue - VQ Related (M$)	$74.5	$5.2	$13.0	$0.0	$1.4	$0.0	$0.0	$11.6

Methodology:
Data captured on this slide is taken from the Nuclear Generation Report issued by Nuclear Finance Operational Performance Reporting (Unexpected Generation Loss codes FO, FEPO, SO, FD, RFD).

Definition: "Vendor Quality Related"
Each Unexpected Generation Loss issue is reviewed to determine if supplier material quality issues contributed to the loss. Material availability issues will be included when supplier quality is a factor. The data reported in this graph may be revised as SCR CAPs are finalized with detailed causal information.

Unplanned Outage & Derate Losses due to Vendor Quality:

2012:
Pickering:
Heat Transport Pressurizing Pump Motors P4 – loss in May of 207,017 MWh ($11.6 Million) with continued loss in June. Vendor is Elettra Technology, SCR P-2012-04524. Bravo investigation in progress.

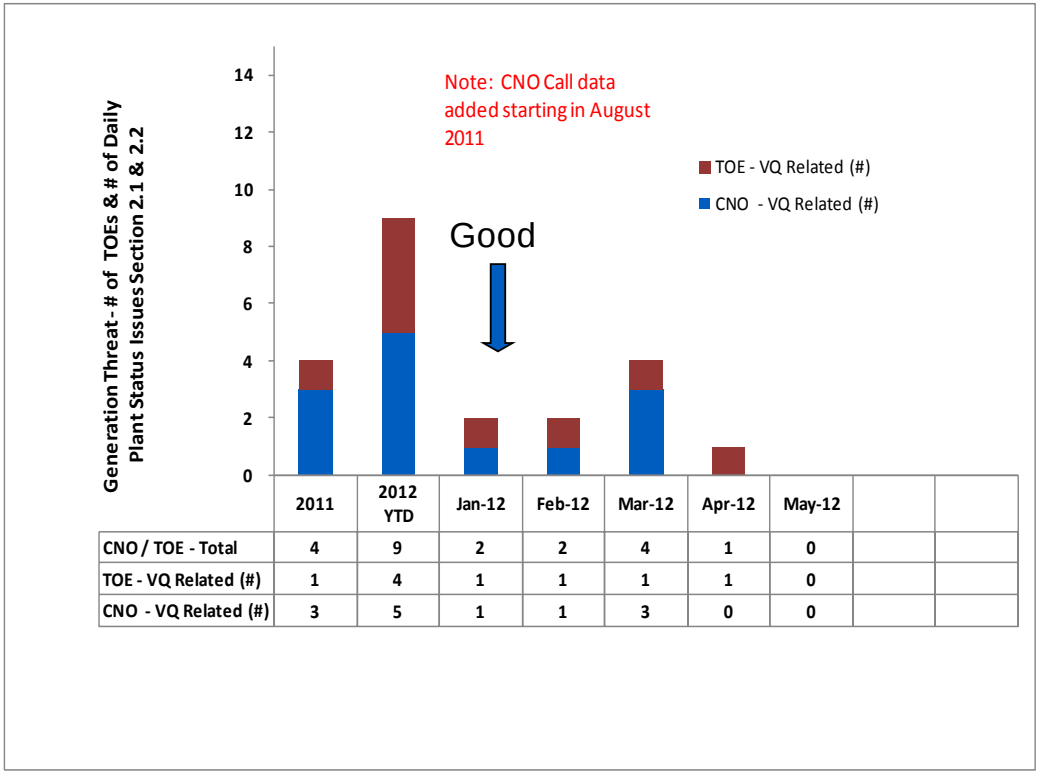
VQ related forced loss (P1261of 24,500 MWh ($1.4 million) due to incorrect Siemens O-Ring Material (SCR P-2012-01882).

2011:
Pickering A:
•Extended Fuel Machine Repairs (AECL / RN Tooling) P-2011- 01207 (P-2010-23944, P-2010-25745)
Pickering A: Outage
•Unit 4 -41100-MV12 Steam Leak on the Turbine system (expansion joint issue P-2011-11179)
Pickering B: Outage
•SDS2 ROP Amplifier availability (Sartrex) P-2011-01123 (P-2009-16253)
Darlington:
•CCW Pump Separator (Flowserve) SCR -D-2011-00498
•Temperature Detector PS failure (Test Force Systems)

2010:
Pickering A:
• Governor Valve Oscillations – wrong bushing , P-2010-19059; Dowel Pins Fail result in valve failing Open P-2010-27248 (Siemens)
• Unit 4 P1043 return to service issues (Black & McDonald)
Pickering B:
• DCC Software - programming issue (L3 MAPPS) P-2010-24789
Darlington:
• Power Supply failure AA Logic Module (AECL/Sartrex/AAK) D-2010-05332
• Fuelling Machine Bearing s (GE Hitachi / Barden) D-2010-12041
• Current Transformer reversed polarity (ABB Brampton) D-2010-13954

Figure 18 Generation Loss due to Vendor Quality

OPGN Generation Threat Performance (CNO Call & TOE) – Vendor Quality Related May 2012



	2011	2012 YTD	Jan-12	Feb-12	Mar-12	Apr-12	May-12		
CNO / TOE - Total	4	9	2	2	4	1	0		
TOE - VQ Related (#)	1	4	1	1	1	1	0		
CNO - VQ Related (#)	3	5	1	1	3	0	0		

Generation Threat / Technical Operability due to Vendor Quality:

2012:

Pickering:

P-TOE-54600-SG3-BY1 initiated for SG battery Failure, Extent of Condition

Significant event: P1261 Incorrect Material O ring supplied by OEM (P-2012-01882)

TOE initiated for unsuccessful qualification type test for SDS1 Sartrex I/C Amplifier (P-2012-01555)

Significant/Reportable event: 012 Standby Generator Impairment Declared (P-2012-01648 ; C-CAN Power)

Unit 4 HTS, pressurizing pump motor failure (SCR P-2012-04524). Vendor: Elettra Technologies.

Darlington:

D-TOE-63488-00002 ; Poor reliability of the annulus gas flow indicating transmitter 63488-FIT50.

NK38-TOE-68000-0002 SDS fuses confirmed to be poor vendor Quality (Bussman)

D-2012-02730 : Defective Fuel Bundles. (GE-Hitachi).

D-2012-03414: LZC pump impairment (Rollce-Royce).

2011:

Pickering :

High Temperature Transmitter – Cat ID 662912-1 Sartrex **no spares** to replace original Fisher Cat ID (223455-1).

Darlington:

•Current Transformer – Unapproved sub-supplier (ABB Brampton / Piedmont B & I) D-2011-01102

•LZC 4P3 – Power Frame oil seals overheating (D-2011-08448) Cat ID 579730-3 Rolls-Royce Civil Nuclear / Hayward Gordon. 4P3 unavailable.

•Unit 3 Logic Module Power Supply – (D-2011-09487) Cat ID 685035-1 Versatile Ins (Amidyne Group). Repeat Issue. TMOD NK38-CORR-63700-0403340 (ECR 19872), Alpha investigation complete. Root Cause is not VQ related.

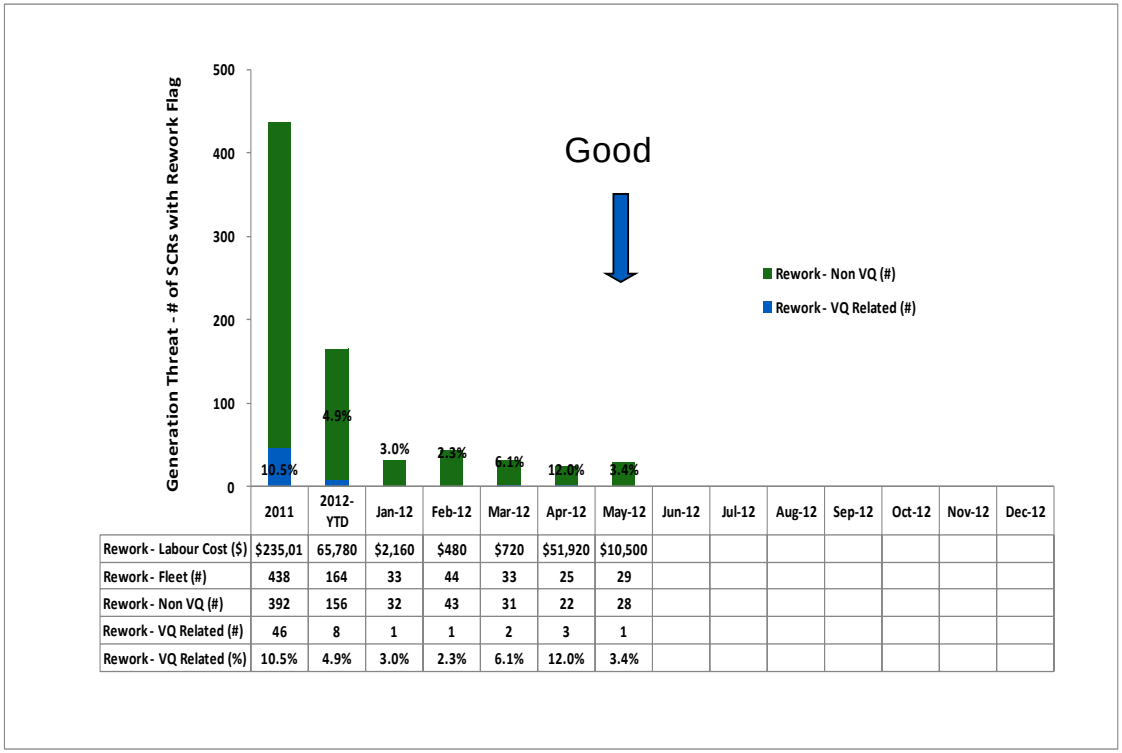
TOE Methodology:
Data captured on this slide is taken from the Darlington, Pickering and Nuclear Support SCR Databases (TOE Flag = "Y").

CNO Call Methodology:
Data captured on this slide is taken from the Daily Plant Status Teleconference (CNO Call) Ref. N-FORM-10497
Section 2.1: Significant / Reportable Events
Section 2.2: Significant Equipment or Special Safety System Impairments, Generation Threats and Associated Contingencies.

Definition: "Vendor Quality Related"
Each SCR is reviewed to determine if supplier quality issues contributed to the requirement for a TOE or CNO Call section 2.1 or 2.2 entry. The data reported in this graph may be revised as SCR CAPs are finalized with more detailed causal information.

Figure 19 Generation Threats, TOEs due to Vendor Quality

OPGN Generation Threat Performance (Rework) – Vendor Quality Related May 2012



	2011	2012-YTD	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Rework - Labour Cost ($)	$235,01	65,780	$2,160	$480	$720	$51,920	$10,500							
Rework - Fleet (#)	438	164	33	44	33	25	29							
Rework - Non VQ (#)	392	156	32	43	31	22	28							
Rework - VQ Related (#)	46	8	1	1	2	3	1							
Rework - VQ Related (%)	10.5%	4.9%	3.0%	2.3%	6.1%	12.0%	3.4%							

Methodology:
Data captured on this slide is taken from the Darlington, Pickering and Nuclear Support SCR Databases (Rework Flag = "Y"). Rework costs are derived from the associated work orders.

Definition: "Vendor Quality Related"
Each SCR with the Rework Flag marked as "Y" is reviewed to determine if supplier quality issues contributed to the requirement for Rework. The data reported in this graph may be revised as SCR CAPs are finalized with more detailed causal information.

Rework performed due to Vendor Quality: (*Italics =To be confirmed)*

2012:

Pickering:

•P056 Trash Screen failure during commissioning P-2012-05912. NCAR issued to PSI Canada.

•Main Volume Vacuum Pump float valve failures P-2012-00192 (CO) and P-2011-16075 (C3) for repeat failures on valve's roll pins

•NCAR 001477-11-05 issued to Dresser Rand.

2011:

Pickering A:

•Marotta Valves (F/H SCR-P-2011-22149) Update Feb.'12
•Motor winding - P-2011-00095 D4 (TRC/Twin City Fan) –
•Block Machining LPSW Strainer -P-2011-02272 D4 (Weir)
•Press. Gauge failure – P-2011-03284 D4 (Conval / Ashcroft)
•O-Ring kit wrong – P-2011-03848 D4 (Flowserve)
•Heater temp switch – P-2011-04187 D4 (Munters QL-4)
•U4 GC Sample Pump failed pump motor – P-2011-04750 D4 (Air Dimensions – QL4)

Pickering B:

•RV Passing - P-2011-00287 – C3 (Farris Eng)
•NV dimensional fit - P-2011-01970 D4 (Velan)
•Shear key failure - P-2011-02136 D4 (RP Adams – QL-4)
•Oil Seal Dimension – P-2011-03235 D4 (Flowserve Repair)
•D2O Collection Pump Failure – P-2011-07477 C3
•Rolled gasket – Moderator flange leak – P-2011-07520
•Alarm Unit transorber failure – P-2011-10637/8/9/11015 CO P-2011-08339; P-2011-11431 (Sartrex).
•Actuator displacement – P-2011-10685 D4 (Rotork)

Darlington:

•PRV Passing - D-2011-00618 D4(Crane Supply / Mueller)
•Air Lock limit switch dead band - D-2011-00907 D4 (Rexel / Honeywell).
•Valve packing wrong – D-2011-01910 D4 (Argopack)
•D1111 Liss Rework – D-2011-05383 C3 (Lakeside PC) –
•D1111 SV defective – D-2011-04560 D4 (Asco Valve)
•D1111 Actuator Issues – D-2011-04539 C3 (Dresser Avon) – NCAR issued to Dresser Avon
•Rectifier failure – D-2011-06729 – D4 (Sartrex CGD)
•Valve seized – D-2011-06358 D4 (Copes Vulcan)
•RV leak rate – D-2011-06746 C3 (TRC / FC Kingston)

Figure 20 Re-Work due to Vendor Quality

Self Assessment Findings

A self assessment was conducted in Q2 2012 of all vendor quality events listed in the performance indicators above. The findings are as follows;

- Many non-breakthrough events are prevented from becoming breakthrough because of OPG bench testing. Examples are LZCS valves, F/H parts dimensional checks, numerous issues with Darlington LISS NV's, and Marrota valves (F/H).
- Almost every event, breakthrough or not seems related to sub supplier control, including both OEM (Siemens O rings, ABB current transformer, F/H Ram bearings, busman fuses) and manufacturer of record situations (Marrota valves, LZCS power frames).
- There are a lot of events associated with motor replacement. The obvious one is the Pickering unit 4 pressurizing pump motors(PPM) (brg failure and premature brg wear), but Pickering 5-8 PPM's have had oil frothing issues, and Pickering 5-8 moderator motors had junction boxes 180 degrees out causing cabling re-work during the outage. This prompted supply chain to investigate motor OPEX from before the vendor quality program inception. The following was uncovered:
    - Darlington 2nd Stage reheat. Both motors failed 4-5 hours in service
    - Darlington main boiler feed pump motor repair. Motor was sent back out for repair and multiple issues were found to be overlooked during original repair.
    - Darlington Circulating Water Screen wash Motor (2-71110-SCM2) - tripped on overload (Ainsworth)
    - Pickering Shutdown Cooling Pump Motor - Fit (ETI)
    - Pickering Repetitive Fan Motor failures (034-73150-FM511) (TRC / Twin City Fan)
    - Pickering End Shield Cooling Pump Motor - Thermal Event (Ainsworth)
    - Pickering Primary Heat Transport MCP Motor - Poor rewind (Schultz)
    - Pickering Shutdown Cooling Pump Motor - Anti-rotation Clutch broken (ETI)
    - Pickering U7 GC Pump Motor Failure - windings shorted to ground (Kinectrics CGD Air Dimensions)
    - Several repeat problem with Pickering 5-8 CCW pump motors See P-2009-27223, P-2008-25093, P-2008-24847

It is of interest to note that WANO has issued OPEX on large motor replacement that includes the following recommendations (not an exclusive list):

> *"Appropriate specifications and oversight are provided to vendors, services shops, or onsite facilities, when having a large motor repaired, refurbished, or overhauled/rewound. Specifications should include an insulation system design that meets present day criteria (turn-to-turn protection, volts per mil rating, coil connection techniques, etc.) and in-process testing during the winding process to ensure problems are identified prior to the motor leaving the facility."*
>
> *"Appropriate reviews and observations are performed to ensure that supplemental and station personnel execute appropriate workmanship when performing*

> *maintenance on large motors, particularly when rewinding motors, making electrical connections, and reassembling lubrication oil and cooling systems (e.g., connections and welds).”*

These recommendations require all motor replacement to be channeled through a “center of excellence” that can decide on the appropriate risk based controls and implement them with the right degree of oversight. This ‘center of excellence” approach needs to exist both in supply chain and engineering.

The findings surrounding bench testing can be addressed using a similar approach. Most of the bench testing issues are related to valves. A center of excellence also need to be created for valves, and bench testing needs to be moved to the factory, again with the right degree of oversight. This has an added benefit of eliminating maintenance work at site.

Finally, in the past 10 years, the North American supplier base has been eroded by overseas pricing competition, particularly for labour intensive operations. This is why almost all events concern relationships with sub-suppliers or manufacturer of record. A reactive approach to controlling sub supplier quality across 530 primary suppliers simply isn’t going to work. OPG needs to further reduce the approved supplier list and enter partnering agreements with fewer vendors where profit and loss are tied to plant performance. This will provide the incentive for vendors to manage quality in a proactive manner. To illustrate this point further, consider the new relationship OPG has with it’s ES/MSA vendors; 300M$ worth of spend leveraged between two vendors, each with profit and loss tied to performance. By contrast, OPG has about 300M$ in parts spend each year, spread across 530 vendors who are only accountable for parts and labour. Those who are successful with managing quality overseas (Apple computer comes to mind) have entering partnering agreements with very few vendors and strong oversight is exercised by the parent company.

The effort required to move to strategically sourced parts is very significant. It took a team of people 18 months to negotiate the ES/MSA agreement. It is not realistic to expect all parts can be strategically sourced in the next three years. Our OPEX however would suggest a concentrated focus on motors and valves would bring immediate benefit to the company and would warrant the necessary investment in time and resource for both nuclear and supply chain.

Vendor Quality Recommendations

Continue with current performance metrics for vendor quality. While the current program is somewhat reactive, it has still been highly effective for OPG in turning around what is an industry problem.

A more proactive approach will require reduction in the number of suppliers, and incentive based performance contracts. This is the subject of a separate white paper on strategic sourcing.

Move towards a “center of excellence” approach in both Engineering and Supply Chain for major plant equipment. Based on current performance, chose motors and valves as the first target areas. Motors and valves should also be our first target for improved strategic sourcing arrangements.

Personal Comments

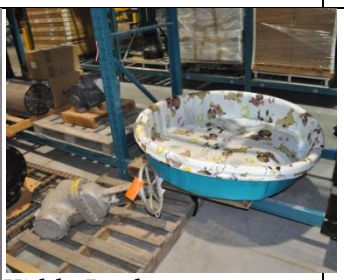
I have found most people in supply chain are not afraid of hard work and accountability. The management team in particular has a strong desire to improve and learn. They are legitimately concerned however of being held accountable to requirements their customer does not feel to be important, or worse yet, counter to what they are trying to achieve.

In my time in Supply Chain, I have come to appreciate that purely supply chain driven objectives, while not wrong, can often drive incorrect behaviours. I have also learned that exactly the same can be said of purely plant driven objectives. I hope this paper will help management understand that change is required on both sides of the fence. Once more, the measures recommended here will force change on both sides. When the two are aligned, great things happen, and perhaps most importantly, staff engagement is high. I have personally witnessed this in team with no name meetings, valve procurement for 3K3 with EFIN, even just speaking with our representative in the OCC during outages. These people know that what they are doing matters and they know they are making a difference in part, because leadership is there to tell them. This in turn, drives performance levels well beyond compliance.

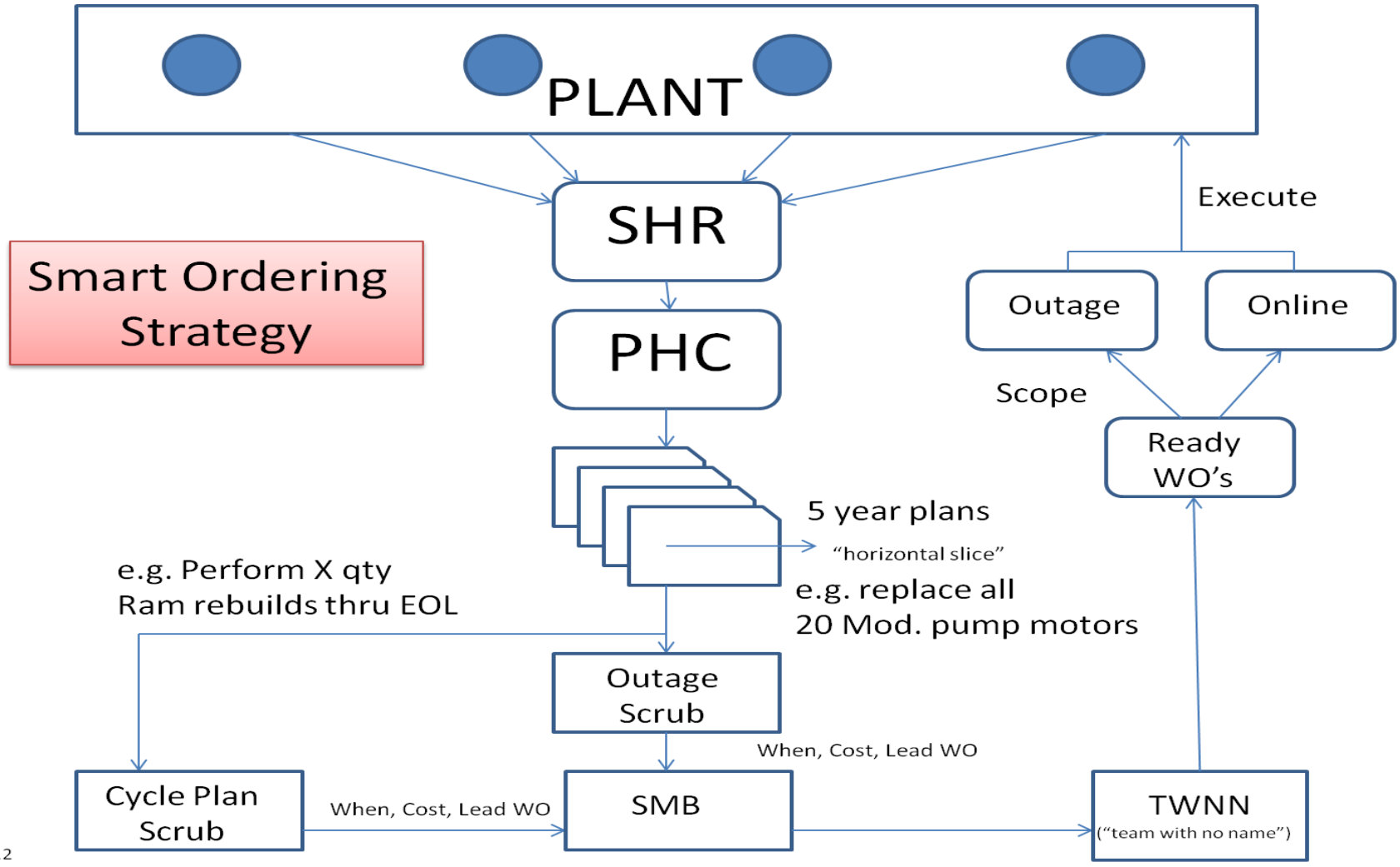
I can not over emphasize the importance of being in the field and talking to the shop floor about the issues they face. And helping the shop floor understand what the big picture looks like. Pretty much all the ideas presented here are not new, but good ideas go no where without leadership.

One final comment I think to be the most important of all. Over 100 people a year in North America die in warehouse related accidents. There have been 3 fatalities alone in the Toronto area in the last 2 years. Every single one is avoidable by following simple rules. For example, a driver was crushed between his trailer and a warehouse because he failed to chock the tires. Following very simple rules may be easy, but breaking the same rules can just as easily result in behaviour re-enforcement when nothing bad happens. The job gets done faster and so the “short cut” gets re-enforced. This is referred to as “normalization of deviance” and its human nature. When we discussed our two medically treated accidents in January with our staff, they 100% concurred they were victims of normalization of deviance. We committed to spend more time with them and they committed to follow the rules. Since that time I have witnessed a transformation in the warehouses. Housekeeping is vastly improved, area ownership is apparent, great ideas have been implemented in hazardous material control; the list is exhaustive. While we are not where we need to be, the improvement is noticeable. The whole point here is if employee behaviours are ignored, the safety behaviours will return to the pre January level or worse. Continuous management presence, observation and coaching is required from all level of management to avoid this. A warehouse fatality, as demonstrated by the driver who was crushed, can happen all too easily.

Appendix A – Non Plant Warehouse Material

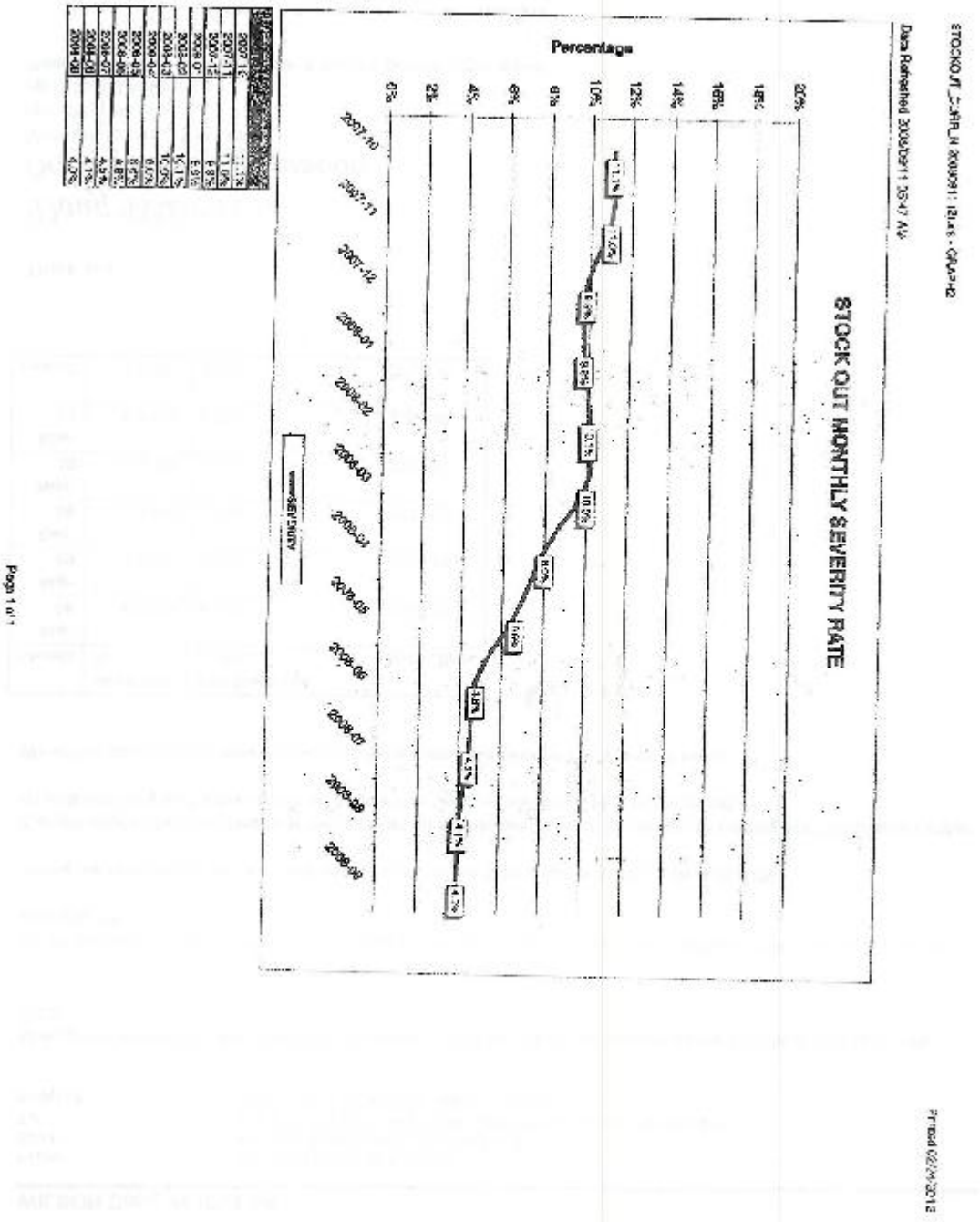
 Brake Fluid	 Carpenter's Glue	 Brake Cleaner	 Grout (with expiry date)
 Bottled Water	 Vinegar	 Kiddy Pool	

Appendix B – Smart Ordering Process Overview



May 2012

Appendix C – Historical Stockout Performance



Appendix D – Current Business Plan Targets

Report Card Metrics - Annual T	2012	2013	2014	Improvement over 2011	Related Benchmarking Indicator(s)
Safety					
All Injury Rate (#/200 k hours worked)	0.92	0.92	0.92		Best Quartile = 0.88
Accident Severity Rate (days/200k hours worke	2.04	2.04	2.04		BQ = 1.26 (2.04 based on CEA group 1 Utilities)
Category A, B, C Spills (#)	0	0	0		
Category D Spills (#)	2	2	2		2 is based on historical actuals (none in 2011)
Reliability					
Stock Out Materials (%)	4.0	3.0	2.0	-67%	Best Quartile = 1.0; 2011 YTD actual 5.6.
Inventory Accuracy (%)	99.5	99.5	99.5	0%	Best Quartile = 99
Average Age of WO IOP Backlog (CC/CN and D	Corrective: DN=186; PN=387 Deficient: DN=268; PN=412	Corrective: DN=138; PN=282 Deficient: DN=237; PN=349	Corrective: DN=81; PN=176 Deficient: DN=206; PN=317	50% - 90%	Best Quartile = CC/CN (81) DC/DN (206)
Outage Scope Variance	DN = 25 PN = 30	DN = 23 PN = 27	DN = 20 PN = 25		Best Quartile = 13
Scope Removal due to Unavailable Parts	3.5	2.0	0.5	-90%	Benchmark = 0.5; 2011 YTD actual is 5.
Unplanned Generation Lost due to Vendor Qual	501000	339500	251700	-82%	New Indicator; based on [redacted] model
Value for Money [1]					
OM&A - Base and Outage (M$)	72.5	73.2	73.9		As per approved guidelines dated Aug 26/11
Inventory Value (Gross at Pickering & Darlingto	514.0	514.0	514.0		Based on 2011 target of $514k with no change until 2015 (Pickering EOL inventory strategy)
Total Process Cost (¢kWh)	0.145	0.152	0.148		Based on Aug 31/11 gen/outage plan revision
Human Performance					
Corrective Action Program (CAP) - Effectivenes	88	89	90		
Corrective Action Program (CAP) - Quality of Le	88	89	90		
Corrective Action Program (CAP) - Timeliness o	90	90	90		
Repeat Stock Out Events on Critical Items (#)	5.0	3.0	1.0		New Indicator

*DER - Design Electrical Rating

1. **Note: Regular Staff headcount targets have been set, but are excluded from table due to lack of benchmark data.**

Appendix E – Recommended Performance Indicators and Targets

Outage Indicators		Accountability			Year			Oversight Forum
Indicator	Existing / New	Generation	Primary	Secondary	2013	2014	2015	
Outage Scope Removal due to parts	Existing	Outage	Supply Chain	Maintenance, Engineering, Outage	10% of OPGN outage scope variance target			NEC
Outage Materials Score card	Existing	Supply Chain	Supply Chain	NA	As defined on the existing scorecard			NEC, CNOO
Outage Catid Tracking	Existing	Current: Supply Chain Future: Outage	Supply Chain	Maintenance, Engineering	As defined by existing target lines			SWM, NCOO, SC daily call
Outage Scoping Score Card	New	Outage	Outage	NA	TBD: Objective is to smooth scope approval and identify approved need sooner			SWM, NCOO
Outage Engineering Metrics	New	Outage	Engineering	NA	TBD: Objective is to track Actual vs outstanding. (not just outstanding)			SWM
MR Need Date profiles	New	Supply Chain	Outage	Supply Chain	<3,000 outage MR's with 2018 need date*	<1,500 outage MR's with 2019 need date*	Zero outage MR's with 2020 need date*	NEC

- Unless in approved outage scope.

Online Indicators		Accountability			Year			Oversight Forum
Indicator	Existing / New	Generation	Primary	Secondary	2013	2014	2015	
Stockout	Existing	Supply Chain	Supply Chain	Engineering	3%	2%	1%	NEC, SCC
MRNI	Existing	Supply Chain	Maintenance	Work Management	PN 40% DN 25%	PN 30% DN 20%	PN 20% DN 20%	NEC, SWM
% of PM Catids with no ROP	New	Supply Chain	Supply Chain	NA	TBD	TBD	<1%	SWM, SCC
% Stockout on Plant Equipment	New	Supply Chain	Supply Chain	NA	<6%	<3%	<1%	SWM, SCC
% of Stockout linked to PM's	New	Supply Chain	Supply Chain	NA	<10% (.3% total)	<10% (.2% total)	<10% (.1% total)	SWM, SCC
% of Stockout related to critical spares	New	Supply Chain	Supply Chain	Engineering	TBD	TBD	TBD	SWM, SCC
MR Need Date profiles	New	Supply Chain	Work Management	NA	<17,000 IOP MR's with 2018 need date	< 8,000 IOP MR's with 2019 need date	Zero IOP MR's with 2020 need date	NEC, SCC, SWM
% of WO's not in outage, online or cycle plan	New	Work Management	Work Management	NA	TBD	TBD	Zero	SWM

Vendor Quality Indicators		Accountability			Year			Oversight Forum
Indicator	Existing / New	Generation	Primary	Secondary	2013	2014	2015	
MW-Hrs lost due to VQ	Existing	Supply Chain	Supply Chain	Engineering	339500 (18.7M$)	251700 (13.8M$)	163900 (9.0 M$)	NEC, SCC
TOE / Gen Threats due to VQ	Existing	Supply Chain	Supply Chain	Engineering	TBD after baseline 2012 performance established			NEC, SCC
Rework due to VQ	Existing	Supply Chain	Supply Chain	Engineering	No Specific Target – declining trend			SCC

Inventory Indicators		Accountability			Year			Oversight Forum
Indicator	Existing / New	Generation	Primary	Secondary	2013	2014	2015	
Total Inventory	Existing	Supply Chain	Maintenance	NA	494	474	454	NEC, SCC
Non Plant Inventory	New	Supply Chain	Supply Chain	Maintenance	40	20	0	NEC, SCC