

Boundary Dam – Generator 53 Repair Recommendation Report



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Attachment 1 to
SCL Boundary Unit 53 Allocations FISC

Executive Summary

As outlined in the following ordinance the determination by Seattle City Light is to use emergency contracting means to rebuild Unit 53 immediately and delay the rebuild of Unit 56 that would otherwise normally be scheduled to start this year.

Unit 53 History

Generator 53 went into operation in 1968 and was last rebuilt in 1983.

On August 17th, 2012, Unit 53 dropped 130MW when water infiltrated the distribution bus and resulted in loss of one section of twelve on Phase A. This unit was returned to service on November 7th, 2012 under restricted operation up to 120MW. A final de-rated capacity was established on November 13th, 2012 at a maximum of 147MW (out of 160MW normal max capacity). Voith assisted SCL in returning this unit to service.

On April 27, 2013 at 8:28am, Unit 53 tripped off-line rejecting 140MW of load. Subsequent investigations revealed that B- and C- phases in slot 254 had gone to ground with at least some damage to the core. While there was no “smoking gun” that might indicate why this happened, it did occur approximately 180 degrees from the last repair making it conceivable that vibration contributed to this failure. In addition, both failures occurred on or near a split-line. The CO2 system also released potentially extinguishing a fire though this is speculation. PPD Electrical Engineering and Voith subject-matter experts determined the following.

Voith’s Draft Comments (Verbatim)

On 5/2/13 Voith arrived on site to access the damage to unit 53 generator at Boundary Dam. During the inspection it was visible what appears in slot 254 that a coil had gone to ground in the core slot. There was signs molten core iron on the face of core, separation of laminations, plus core slag in the back of the frame. Also heated black carbon smoke in the area. Plus on the rotor poles there is a metallic material adhered to them.

The location of this failure is about 18 inches up from the bottom what looks to be in the core split slot which has signs of chevron.

At the time of this inspection there was no clear testing information available. But my understandings on a quick megger check. A phase did not have any issues. B phase was grounded, C had a weak megger. This still needs to be confirmed.

This unit had been rewound what is believed to be in early 1990's. But about 3 months ago Voith was contracted to repair failed winding on A phase. The direction given by SCL consultant was to cut out one full circuit on that phase. There are 12 circuits per phase. So A phase had 11 circuits, B and C still had there 12 circuits.

SCL is asking what options or actions can be taken to get this unit back in service ASAP to get past the spring run-off. From discussion with SCL it is there understanding that this unit will need a rewind and new core in the very near future.



Damage to Unit 53



Unit 53: Rotor pole metallic material



Unit 53: Separation of laminations



Unit 53: Separation of laminations



Unit 53: Note slag from damage to core

Initial Options Considered

Immediately after the release of Voith's report on Unit 53, PPD Engineering and Project Management gathered and discussed the following options:

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Analysis/Engineering Options:

- Don't do anything – unit 53 can not be repaired or the risk is too high to return the unit to service on a de-rated basis. Proceed to Rewind options.
- Pull rotor and perform further investigation – analyze if unit goes back in service at this time. If so:
 1. Place 55 rotor in place temporarily (2 days), remove 53 to analyze (5 days), set back in 53 (1 day) and then complete 55 (1 day).
 2. Wait for completion of 55 (6-7 weeks) and then remove 53 (5 days) for further analysis, leave out on floor (depending upon what the decision on the 56 Rebuild is).
- Determine now that 53 will be repaired on what SCL knows now and put back in service; prepare repair contract/schedule/funds.

If 53 goes back in service:

- Run as per normal but de-rated, CO2 system and relay settings as per normal. Last on/first off.
- Run as per normal but without the CO2 system. If it burns, so what. Look at safety protocol/relays to compensate. Last on/first off.
- Run as per normal but de-rated (either with or w/o CO2). First on/last off.
- Repair and run only in extreme conditions per agreement with PM/SOC (spinning reserves).

Rewind Options:

- Keep Unit 53 out of service and rewind as soon as possible – delay rebuild of Unit 56 until 2014/15.
- Keep Unit 53 out of service and rewind as soon as possible – continue with Unit 56 as scheduled (floor space will be critical). This would mean rewinding two units at the same time.
- Keep Unit 53 out of service and rewind after Unit 56 has been rebuild.
- Perform temporary repairs on 53 and return to service but rewind as soon as possible.
- Perform temporary repairs that will last a year and return to service – rewind after 56 Rebuild is complete.
- Perform temporary repairs that will last 4-5 years and return to service – rewind as scheduled after 56/32/31.

Result of this meeting: PPD determined that with the damage sustained to the core, deep and extensive damage to the insulation and the recent frequency of failure that the

risk was too high to return Unit 53 back into service on a temporary, de-rated basis. The Spring, 2013, run-off would have diminished and the lack of water resources would not justify an immediate repair. While it would be possible to epoxy impacted areas of the core and isolate the impacted sections of the B- and C-phases, in combination with the earlier A-phase damage, the potential for additional winding failures would mean the potential for further releases of CO₂, and the possible impact to personnel, or, as an alternative if this system were de-activated, a fire within the unit or the powerhouse itself.

PPD decided to pursue analysis of the first three options:

- Rewind Unit 53 and delay rebuild of Unit 56
- Rewind Unit 53 and rebuild Unit 56 at the same time
- Rebuild Unit 56 and then rewind 53

Options Research

The ability to rebuild both units at the same time would require the removal of the Unit 53 rotor from the powerhouse as there is only enough floor capacity to hold one rotor at a time. A purpose-built slab would be poured in an area to the north of the main parking lot and a temporary building (an Alaskan-type structure with heating in order to minimize cost) would be constructed for this rebuild. An alternative would be to utilize a majority of the floor space in an existing warehouse after analyzing floor capacity and possibly reinforcing as necessary. It was determined that there is no conceivable ability to remove or restore an intact rotor through the restriction of the powerhouse access tunnel so this option was quickly eliminated. The tunnel opening is 19' wide while the Unit 53 rotor is 27' – ½" without poles attached.

The remaining two options remained viable so it any decision would have to come down to financial and resource impacts to SCL.

Schedule

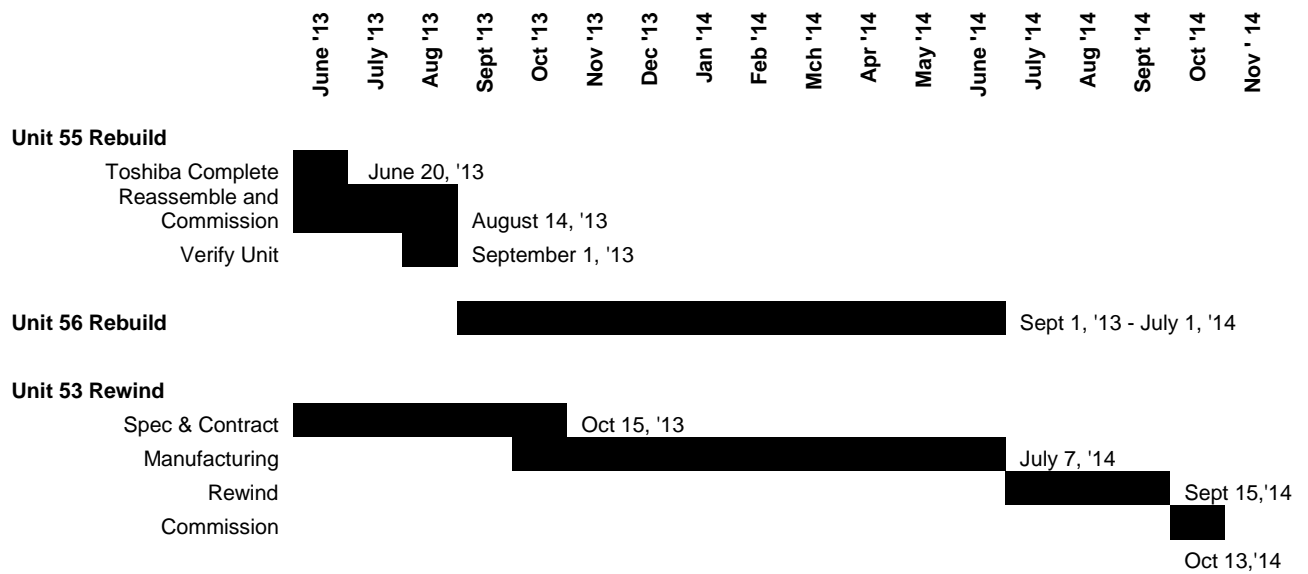
Rebuild Unit 56 and then rewind Unit 53 (Option 1)

Toshiba has not been able to deliver on the Unit 55 rewind schedule as originally planned resulting in a generator turnover date of approximately June 20, 2013. Reassembly of the unit and commissioning will result in a return to production around August 14, 2013. In order to gain some degree of certainty in its' operation, Unit 55 will be run at least two weeks prior to immediate disassembly and the rebuild of Unit 56.

Toshiba is contractually obligated to continue their work on Unit 56, albeit later than originally contracted due to their inability to deliver Unit 55 as scheduled. Toshiba has manufactured some materials, such as the stator frame, though they lag behind where they need to be in most other material. Weir Hydro has already delivered the Unit 56 turbine runner to the site and this is sitting in the SE corner of the powerhouse. Power

Production's 2013 – 2014 existing capital plan and most of its' resources are completely built around the planned continuation of this work and any change would require radical program and resource changes.

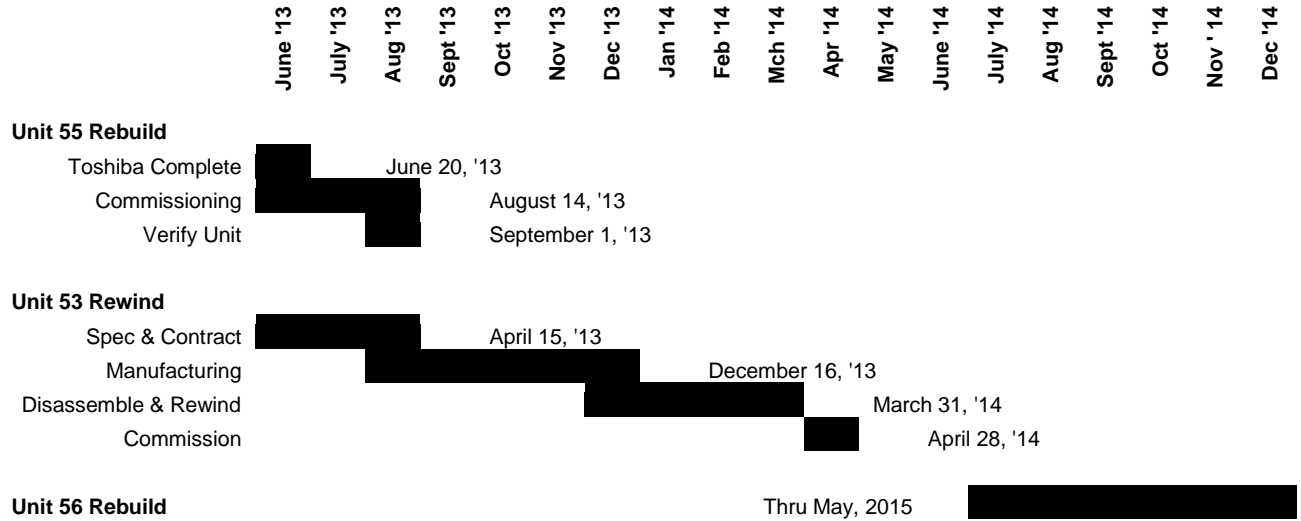
Another advantage of this approach would be the ability for Engineering and Project Management to have more time to develop a full drawing and specification package for Unit 53. There has been considerable analysis of the condition of the other three units that are similar to Unit 53 (Units 51, 52 and 54). These four units were already scheduled per the Strategic Plan for rewinds starting in 2017 and continuing through 2021. If it were determined that these units required rewinds in rapid succession to Unit 53 a developed set of documents would be beneficial. See Option 1 schedule below.



Rewind Unit 53 and then rebuild Unit 56 (Option 2)

PPD would negotiate an emergency contract with potential vendors to rewind Unit 53 based on their abilities to deliver at, or close to, the schedule shown below. The advantage of this approach is that it would return Unit 53 to service possibly in time for the 2014 run-off and certainly much more quickly than any other scenario. Unit 56 would continue to operate as it does now and would only be taken out of service when Unit 53 work is complete. There is risk in this – there is a reason Unit 56 is otherwise scheduled to be rebuild starting this year. However, even if Unit 56 has an issue during this duration SCL would not be at further loss. This scenario will require some negotiation with Toshiba and SCL will approach this with every tool at our disposal, including holding Toshiba in default. It will also result in less formal rewind documents

then might otherwise be utilized. The ability to establish trust and maintain good communication on a minimalistic specification will be key in making this a successful rewind.



Costs and Impacts

Power Marketing analysis, if both units remained out of service from June 1, 2013 through December 1, 2014, is shown below and indicates a potential, combined impact of around \$63M of wholesale loss.

Option 1 would have both units out of power production until Unit 56 returned to service around July 1, 2014 – Unit 53 would remain out until around mid-October, 2014. This would account for the vast majority of these lost funds.

On the other hand, Option 2 would keep Unit 56 in service until around mid-July, 2014 and potentially return Unit 53 by the first of May, 2014 minimizing losses around \$9M. Cost of a rewind under emergency conditions still has to be determined – estimates range from \$14M - \$18M. This is an extremely aggressive schedule. Also, it is undetermined what costs, if any, that SCL will have to absorb by delaying the rebuild of Unit 56.

First of Month	Unit 53 Capacity	Unit 56 Capacity	Spinning Reserve \$/MWH	53 Lost Generation \$	56 Lost Generation \$	Total Lost Generation \$
6/1/13	146	200	5	\$2,302,946	\$3,154,720	\$5,457,666

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7/1/13	146	200	5	\$3,954,661	\$5,417,344	\$9,372,005
8/1/13	146	200	5			
9/1/13	146	200	5			
10/1/13	146	200	5			
11/1/13	146	200	5			
12/1/13	146	200	5			
1/1/14	146	200	5			
2/1/14	146	200	5			
3/1/14	146	200	5			
4/1/14	146	200	5	\$2,507,276	\$3,434,624	\$5,941,900
5/1/14	146	200	5	\$2,340,544	\$3,206,224	\$5,546,768
6/1/14	146	200	5	\$2,079,507	\$2,848,640	\$4,928,147
7/1/14	146	200	5	\$3,619,550	\$4,958,288	\$8,577,838
8/1/14			5			
9/1/14			5			
10/1/14			5			
11/1/14			5			
12/1/14			5			
				\$16,804,483	\$23,019,840	\$39,824,323
Max Potential LLH-HLH Differential price \$ sales lost				\$6,015,840	\$6,015,840	\$6,015,840
Total Potential lost \$ sales due to Boundary Unit outages				\$22,820,323	\$29,035,680	\$45,840,163
Potential max spinning reserves lost due to Unit outages				\$7,463,520	\$10,224,000	\$17,687,520
Overall Total if you include Max spinning reserves unit capacity				\$30,283,843	\$39,259,680	\$63,527,683

Data condensed from e-mail by Ole Kjosnes on May 21, 2013

Further Considerations – Updated Financial Impact

From May 1, 2013 through July 2, 2013, Seattle City Light's Power Marketing division has assembled data indicating that SCL has lost approximately \$5,750,000 in sales in the time that Unit 53 has been unavailable. It is expected that day-to-day losses will moderate as the year progresses due to normal reduction of available water resources but these will pick back up again as SCL moves into winter/spring seasons and associated increases.

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Summary

PPD recommends Option 2, rewind of Unit 53 immediately and deferral of the rebuild of Unit 56 until a start date of late July, 2014, as the best option forward to minimize power production loss and financial impact to SCL.

Under these recommendations, SCL issued an Emergency Declaration on June 6, 2013 for all contracting associated with the rebuild of Unit 53.