

1 Q. In reference to PR-PUB-NLH-037, please provide justification for the \$49,000 spent
2 on overtime costs for overhauling Holyrood breaker B1L37.

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5 A. In its response, Hydro assumes that the question is referring to B1L17. For overall
6 justification of the overhaul of Holyrood B1L17, please refer to the report
7 “UNFORESEEN ITEM: Holyrood B1L17 230 kV Breaker Overhaul” report submitted to
8 the Board on May 5, 2014 and attached as PR-PUB-NLH-064 Attachment 1.

9

10 It was important to proceed with the overhaul of Holyrood breaker B1L17
11 immediately to restore power system integrity.

12

13 Power system integrity and vulnerability was impacted with only one of the two
14 Holyrood Unit 1 breakers available. With a failure of the second unit breaker, Unit 1
15 would be unavailable to supply power to the grid. Similarly, with only one of the
16 two Holyrood breakers for transmission line TL217 available, a failure of the second
17 line breaker would result in TL217 being removed from service.¹ Without this
18 breaker, the system on the Avalon Peninsula was vulnerable to equipment outages
19 and significant customer impact.

20

21 In order to minimize the time for this exposure it was prudent to complete the
22 overhaul as safely and quickly as possible by having terminal station workers work
23 extended hours requiring overtime payments.

¹ The failed state of Holyrood breaker B1L17 resulted in an opened 230 kV diameter and only one connection to the power system for Holyrood Thermal Generating Station Unit 1 and for transmission line TL217.

**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

**UNFORESEEN ITEM:
Holyrood B1L17
230 kV Breaker Overhaul**

Newfoundland and Labrador Hydro

May 5, 2014



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1 INTRODUCTION

1.1 Background

On January 5, 2014, during the process of synchronizing Unit 1 at the Holyrood Thermal Generating Station (HTGS), an imbalance of current and a suppression of 230 kV bus voltage occurred. This caused relay protection systems to operate and resulted in trips to the 230 kV transmission lines TL242, TL217 and TL218, HTGS Units 1 and 2 and widespread customer outages on the Avalon Peninsula (Appendix A provides a system map showing the location of the HTGS). It was determined that this event resulted because a phase on the Unit 1 air blast circuit breaker, B1L17, was 'stuck closed' during the closure of the 230 kV unit disconnect switch B1T1. The closure of the unit disconnect switch is one of the final steps prior to synchronizing the unit to the grid.

Restoration of power on the Avalon Peninsula commenced immediately following the event. However, the availability of HTGS Unit 1 was delayed until the source of the problem was found. When it was determined that the issue with breaker B1L17 was the cause of the incident, the breaker was isolated and the HTGS Unit 1 was brought on-line to supply power through the second unit breaker, B1B11 (refer to Appendix B for the Holyrood Terminal Station single line diagram).

Even though HTGS Unit 1 was returned to service, power system reliability was impacted with only one of the two unit breakers available. With a failure of the second unit breaker B1B11 or associated equipment, Unit 1 would be unavailable to supply power to the grid. In addition, with a failure of the line breaker B12L17 or associated equipment, there would be no connection for transmission line TL217 into the Holyrood Terminal Station (HRD TS). Therefore, it was important to immediately undertake efforts to return the breaker to service and the Allowance for Unforeseen Items account was utilized.

The breaker was restored to service on April 6, 2014. The total project cost was \$360,000.

1.2 Details on Failure of HRD B1L17

The Holyrood Terminal Station is located on the Avalon Peninsula, and contains a 230 kV ring bus¹ that connects 230 kV transmission lines TL217, TL218, and TL242 to terminal station equipment such as power transformers, breakers, current transformers, potential transformers, and insulators. In addition, the terminal station provides the high voltage connection for all three generating units at the HTGS which supply power to the Island Interconnected System.

During the attempt to synchronize HTGS Unit 1 on January 5, an imbalance of current and a suppression of 230 kV bus voltage occurred. This caused relay protection systems to operate and resulted in trips to the 230 kV transmission lines TL242, TL217 and TL218, HTGS Units 2 and 3 and widespread customer outages on the Avalon Peninsula. It was later determined that this event resulted because one of the three phases on the unit air blast circuit breaker, B1L17, was ‘stuck closed’ during the closure of the 230 kV unit disconnect switch B1T1.²

After the system was restored following this event, B1L17 was isolated, allowing HTGS Unit 1 to be put on-line via the other unit breaker, B1B11. However, this resulted in only one path for Unit 1 and for transmission line TL217 to connect to the grid, resulting in reduced reliability.

Following an inspection by Hydro personnel, it was determined that the failed breaker would require an overhaul before it could be returned to service.

¹ 230 kV Ring Bus is an arrangement of 230 kV breakers so that the failure of any one circuit breaker does not interrupt power to other circuits, and so that parts of the terminal station may be de-energized for maintenance and repairs.

² The closure of the unit disconnect switch is one of the final steps prior to synchronizing the unit to the grid.

2 PROJECT

2.1 Project Description

The project required an overhaul of the 230 kV DLF Asea Brown Boveri (ABB) air blast circuit breaker.³ The overhaul was undertaken immediately upon completion of the investigation of the breaker components.

The project was carried out by Hydro personnel with supervision from ABB. The work included the removal and replacement of the existing breaker heads, columns, control blocks, and control valves. Once the parts were replaced, the breaker was subjected to testing to ensure that it operated correctly. Once the testing was completed, the breaker was released to Hydro's Energy Control Center and put back into service. (See Appendix C for a picture of this breaker).

2.2 Project Schedule

The following are the major milestones associated with the overhaul of breaker B1L17 at the HRD TS:

January 5, 2014	Breaker failed in service
January 5-February 14, 2014	Breaker overhaul completed
April 6, 2014	Breaker returned to service

While the breaker overhaul was completed in February, testing was required in order for the breaker to be returned to service. To perform the testing, an outage was required at HTGS Unit 1. This outage did not take place until the first week in April due to continuing

³ DLF ABB Breaker – A common type of air blast circuit breaker that requires compressed air to operate the mechanisms and extinguish the internal arc during breaker operation.

high customer demand requirements. The breaker was put back in service on April 6, 2014.⁴

2.3 Project Cost

The cost of the overhaul of breaker B1L17 at the HRD TS is summarized in Table 1.

Table 1: Project Final Cost

Category	Cost (\$ 000)
Labour	36.9
Overtime	49.0
Materials	165.9
Consultants	108.2
Total	\$360.0

⁴ For the period following completion of the overhaul, the breaker was available to be returned to service in an expedient manner, if required.

3 JUSTIFICATION

Following the events of January 4th and 5th, 2014, during which the power system experienced a number of equipment failures such as the failure of the Sunnyside Terminal Station (SSD TS) transformer T1 (resulting from a fault and fire), Western Avalon transformer T5, and 230 kV breakers B1L03 and B1L17 at SSD TS and HRD TS, respectively, it was important to proceed with the overhaul of HRD B1L17 immediately to restore power system integrity.

Even though HTGS Unit 1 was returned to service, power system reliability was impacted with only one of the two unit breakers available. With a failure of the second unit breaker, Unit 1 would be unavailable to supply power to the grid and transmission line TL217 would also be removed from service.⁵ The system on the Avalon Peninsula was now vulnerable to another event which could result in additional equipment outages and significant customer impact. Therefore, it was important to immediately undertake efforts to return the breaker to service and the allowance for unforeseen was utilized to overhaul HRD breaker B1L17.

⁵ The failed state of HRD B1L17 resulted in an opened 230 kV ring bus and only one connection to the power system for HGTS Unit 1 and for transmission line TL217.

4 CONCLUSION

On January 5, 2014, the 230 kV air blast circuit breaker HRD B1L17 failed, causing a system disturbance resulting in trips to transmission lines TL217, TL218 and TL242, a trip of two units at the HTGS, and widespread customer outages on the Avalon Peninsula. With this failure and the potential of an extended outage to the breaker, the integrity of the power system was compromised, in particular with respect to Holyrood generation supply and the transmission system to the Avalon Peninsula. Without delay, the 230 kV breaker was overhauled and readied to be put back in service.

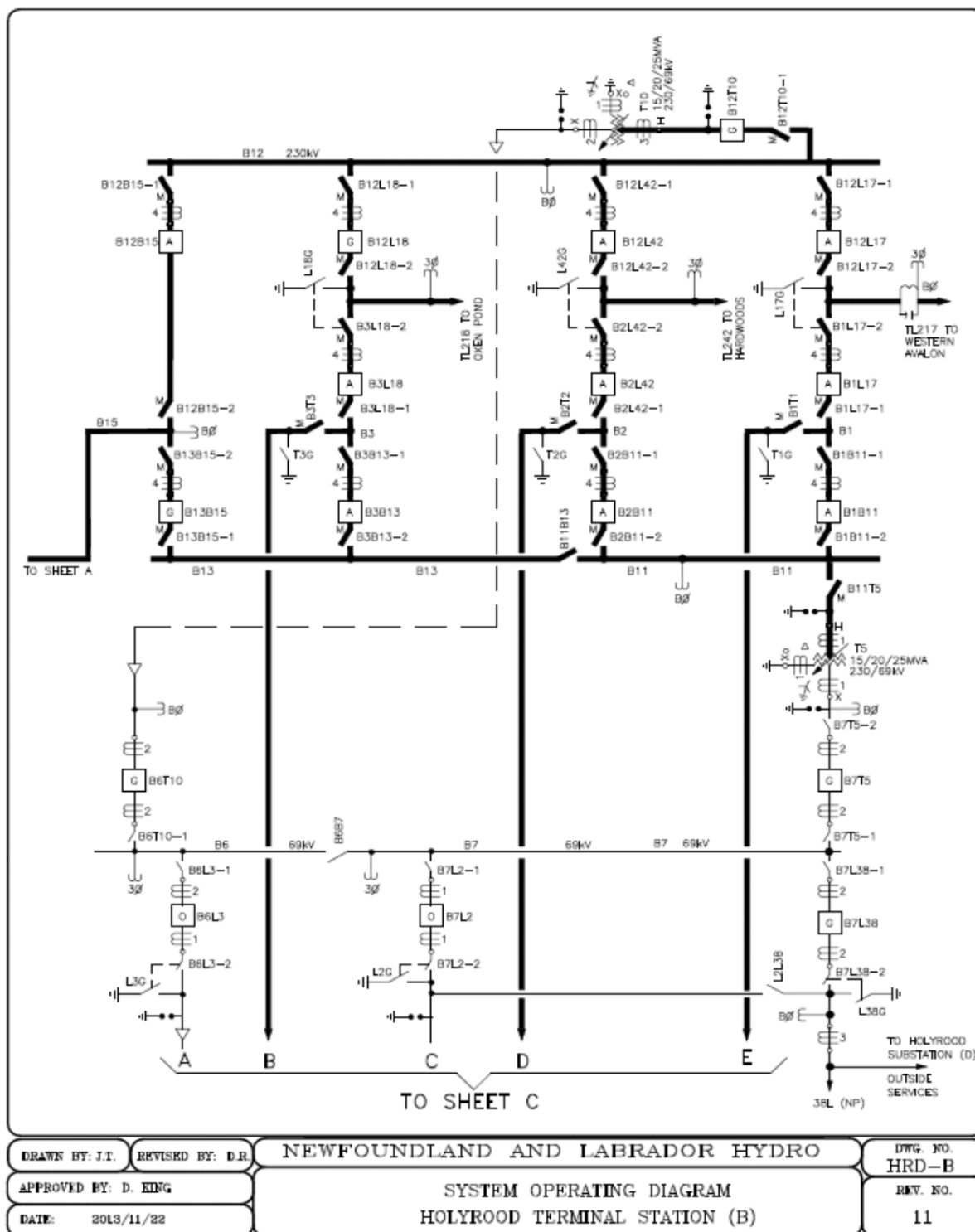
The 230 kV breaker overhaul is considered capital by nature and, as it was urgent and unforeseen, resulted in the use of the 2014 Allowance for Unforeseen Items. The total cost for the overhaul was \$360,000.

APPENDIX A

System Map



APPENDIX B
Holyrood Terminal Station Single Line Diagram



APPENDIX C

Picture(s)



Figure 1: 230 kV Air Blast Circuit Breaker in the HRD TS - DLF Asea Brown Broveri (ABB)