



# SIA Report

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Kapuskasing TS: Retermination of  
circuits S3S & S4S from Smoky  
Falls GS on to circuit H9K

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1.0

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*Date: 4th February 2008*

## ***HYDRO ONE NETWORKS Inc.: KAPUSKASING TS***

### ***Retermination of the 110kV circuits S3S & S4S from Smoky Falls GS on to the 115kV circuit H9K***

#### ***1. Summary***

This Report summarises the results of the assessment of the new facilities that Hydro One is proposing to install at Kapuskasing TS in response to Tembec Enterprises' decision to remove all of the 110kV facilities at the Spruce Falls mill. The removal of these 110kV facilities will eliminate the only connection available to accommodate the output from Smoky Falls GS.

Hydro One's proposal consists of both an Interim and a Final Arrangement. The Interim Arrangement is designed to provide a direct connection between the Smoky Falls circuits S3S & S4S and circuit H9K without using any of those 110kV facilities at the Spruce Falls mill that are to be removed from service.

The Final Arrangement involves installing a new 115kV breaker at the point of connection of the S3S & S4S circuit-combination on to circuit H9K.

Implementing the Interim Arrangement would therefore allow a connection to be maintained to Smoky Falls GS for its station service supply while also allowing it to continue to operate. However, without a breaker installed at the point of connection of the S3S & S4S circuit-combination on the circuit H9K, the Interim Arrangement would have the potential to adversely affect the reliability of the local system due primarily to the increased exposure resulting from the connection of approximately 80km of additional line to circuit H9K.

Once the new 115kV breaker is installed as part of the Final Arrangement and the S3S & S4S circuit-combination can be separately protected, the exposure of the existing circuits to possible supply interruptions will revert back to their present levels. The Final Arrangement would therefore not be expected to have a materially adverse effect on the IESO-controlled grid.

The direct incorporation of Smoky Falls GS into circuit H9K has also been shown to result in increased flows on circuit H9K. Any potential overloading of this circuit could be addressed by constraining-off some of the generation capacity associated with the local 115kV system. If the new 115kV breaker at Kapuskasing TS were to be installed in circuit H9K rather than in the connection to the voltage regulator, this would then allow circuit H9K to be opened temporarily, thereby providing a further response to potential overloads of this circuit.

While it is recognised that the Interim Arrangement has the potential to adversely affect the reliability of the IESO-controlled grid, it is considered that appropriate mitigating measures remain available to manage the situation should there be a noticeable deterioration in the reliability to those customers connected to circuit H9K during the limited period until the new 115kV breaker can be installed.

Since appropriate measures are considered to be available to mitigate the potential adverse impact that the Interim Arrangement could have on the reliability of the IESO-controlled grid until the new breaker can be installed at Kapuskasing TS, it is therefore recommended that a Notification of Conditional Approval to Connect be issued for this project.

#### ***2. Existing Connection Arrangement***

Smoky Falls GS, located on the lower section of the Mattagami River, is incorporated via a 110kV double-circuit line, approximately 80km in length, into the 110kV busbar at the Spruce Falls Pulp & Paper mill in Kapuskasing. Each circuit of this line, which is owned by Hydro One, is connected to the 110kV busbar at the mill via a 110kV breaker.

A Hydro One owned single-circuit 110kV line, which is connected via the 9A1 in-line breaker to the two circuits to Smoky Falls GS, is also available for providing an emergency supply to the Spruce Falls mill from the Hydro One 115kV system. To accommodate the disparity between the operating voltage of the Spruce Falls 110kV system and that of the Hydro One 115kV system, the 110/115kV voltage regulator VR2 has been installed in the termination of this single-circuit line on to circuit H9K. This connection is normally operated open.

The existing connection arrangement is shown in Diagram 1.

The 110kV breakers 1-115-J, 2-115-J & 9A1, together with the other 110kV facilities at the Spruce Falls mill are all owned by Tembec Enterprises.

### **3. Tembec Decision**

Tembec Enterprises has recently notified Hydro One of their decision to remove all of their 110kV facilities at the mill, on or before 1<sup>st</sup> February 2008. This will eliminate the only connection available to accommodate the output from Smoky Falls GS.

### **4. Hydro One Proposal: Interim**

To maintain a connection to Smoky Falls GS and to avoid restricting its operation, Hydro One is proposing to interconnect the circuit associated with the 9A1 breaker to the two circuits, S3S & S4S from Smoky Falls at a location in Kapuskasing where the circuits are immediately adjacent on the western bank of the Kapuskasing River.

The proposed arrangement is shown in Diagram 2.

This arrangement will provide a direct connection between Smoky Falls GS and circuit H9K without involving any of the existing Tembec facilities.

It is also proposed to include a new MSO (mid-span opener) in each of the Smoky Falls circuits to allow the individual circuits to be isolated and removed from service, as necessary. A further MSO is to be installed in the circuit associated with the 9A1 breaker. This is to be located on the Tembec side of the new interconnection that is to be installed between the three 110kV circuits.

The existing relay protection is to be modified to recognise the addition of the Smoky Falls circuits to H9K. Revised settings have been established and these are to be implemented to coincide with the work in the interim stage.

### **5. Hydro One Proposal: Final**

Diagram 3 shows the proposed final arrangement of the modified connection of Smoky Falls GS on to circuit H9K.

This will involve installing a new in-line 115kV breaker either in the connection to the voltage regulator VR2 or in circuit H9K. This would allow the S3S & S4S circuit-combination to be separately protected so that any faults involving circuits S3S and/or S4S, or the VR2 voltage regulator, could be cleared without removing circuit H9K from service.

The present schedule for installing the new 115kV breaker is the late-summer/early-fall of 2008.

### **6. Assessment**

#### **6.1 Interim Arrangement**

With no circuit breaker in the connection of the S3S & S4S circuit-combination on to circuit H9K, the Interim Arrangement will have the potential to adversely affect the reliability of customers connected to circuit H9K as a result of the increase in the exposure of circuit H9K to possible supply interruptions in response to contingencies involving the circuits S3S & S4S or the voltage regulator VR2.

Furthermore, the required increase in the reach of the existing protection on circuit H9K at Hunta SS so that it can recognise the addition of the S3S & S4S circuit-combination and the VR2 voltage regulator is also expected to result in over-tripping due to the relay protection responding to faults on circuit F1E.

While the proposed Interim Arrangement will have the potential to adversely affect the reliability of the local system, it is expected that this arrangement will exist for only a limited period until the new 115kV breaker can be installed by the late-summer/early fall of this year. It is therefore proposed that the Interim Arrangement should be approved subject to close monitoring. Should the new connection result in a noticeable increase in the number of supply interruptions then the situation would be reviewed to determine appropriate measures that could be implemented to reduce the frequency of the interruptions. This could involve instigating a safe-posture mode, similar to the one proposed to Tembec Enterprises for the present termination arrangement of Smoky Falls GS, whenever storms are in the area. .

Diagram 4 shows the results of a load flow study with Smoky Falls GS connected directly to circuit H9K via the VR2 voltage regulator at Kapuskasing TS. For this study, it was assumed that the TMP (thermo-mechanical pulping) facilities at the mill were not in operation.

This shows that, depending on the ambient conditions (temperature & wind-speed), the projected flows on circuit H9K could exceed its thermal ratings, which have been summarised in the following Table.

<b>115kV Line Ratings: North-East</b>			<i>Ratings at 30°C Ambient: 4km/hr wind: MVA rating at 121kV</i>				
<i>Circuit</i>	<i>Conductor (Limiting Section)</i>	<i>Sag Temp</i>	<i>Continuous at 93°C or Sag Temperature, if lower</i>		<i>Long-Term 'Emergency' at 127°C or Sag Temperature, if lower</i>		
<b>H9K: Hunta SS to Kapuskasing TS</b>							
Kapuskasing TS to O'Brien Jct	795kcmil 26/7	110°C	850A	178MVA	980A	205MVA	
O'Brien Jct to Structure 585	336.4kcmil 26/7	150°C	490A	103MVA	630A	132MVA	
Structure 585 to Carmichael Jct	211.6kcmil 6/1	71°C	280A	59MVA	280A	59MVA	
Carmichael Jct to Fauquier Jct		144°C	370A	78MVA	460A	96MVA	
Fauquier Jct to Malette Jct		88°C	350A	73MVA	350A	73MVA	
Malette Jct to Structure 127		150°C	370A	78MVA	460A	96MVA	
Str 127 to Hunta Jct		D/C Line Paralleled	66°C	260A	54MVA	260A	54MVA
Str 127 to Str 116			68°C	270A	57MVA	270A	57MVA
Str 116 to Hunta Jct			68°C	270A	57MVA	270A	57MVA
Hunta Jct to Hunta SS	795kcmil 26/7	150°C	850A	178MVA	1090A	228MVA	

It should also be noted that there may be more onerous conditions to those represented in the load flow and therefore the extent of any possible overloading could be greater.

Should an overload condition occur then it would be necessary to either restrict the output of the local generating facilities or to introduce a normally-open point into circuit H9K. Opening circuit H9K would have the effect of forcing the output from Smoky Falls GS, together with any surplus output (over the local loads) from the generating facilities associated with the 115kV circuit F1E between Kapuskasing TS and Hearst TS, directly into the 230kV system via the T7 auto-transformer at Spruce Falls TS.

While the opening of circuit H9K would be the preferred option, the absence of any load-breaking switching devices in circuit H9K, other than at the Hunta terminal, would make this very difficult to achieve. All of the existing switches in this circuit require the flow through them to be close to zero before they can be operated safely.

Consequently, during the interim period it is expected that it may be necessary to restrict the operation of some of the generating facilities associated with the local 115kV system to respect the prevailing thermal ratings of circuit H9K.

### *Island Operation*

For the existing arrangement, with Smoky Falls incorporated via the 110kV busbar at the Spruce Falls mill, a contingency involving either circuit L20D or circuit L21S while circuit H9K is being operated open at Hunta SS, would result in an island being formed. The present approach is to reject the principal generating facilities in the island to effectively ensure that it collapses. This would result in the generating facilities at Smoky Falls GS being islanded on to the Spruce Falls system and continuing to supply the load at the mill.

Following the retermination of the Smoky Falls circuits on to circuit H9K, a contingency involving either of the 230kV circuits L20D or L21S, or the T7 auto-transformer at Spruce Falls TS while circuit H9K is being operated open at Hunta SS would similarly result in an island being formed. Rejecting only those generating facilities that are part of the existing North-East SPS may not be sufficient to collapse the island since the output of Smoky Falls GS may be adequate to supply the load in the island. If the island were to be sustained then it could experience extreme voltages that could be outside the normal tolerances of the equipment.

To ensure satisfactory post-contingency performance, facilities will therefore be required to allow automatic tripping of the Smoky Falls units (or its connection) in response to each of the various contingency conditions that could result in the formation of an island.

Since these facilities cannot be made available for the Interim Arrangement, it is expected that it will be necessary to temporarily constrain-off the generation at Smoky Falls during those periods whenever circuit H9K is being operated open between Kapuskasing TS and Hunta SS.

Furthermore, in the event that a decision should be forthcoming on the proposed expansion of the Mattagami River plants then it would be preferable to continue to temporarily constrain-off the generation at Smoky Falls rather than to install the facilities required to initiate generation rejection since they would become redundant once Smoky Falls GS is redeveloped.

## **6.2 Final Arrangement**

With the installation of a circuit breaker either in the VR2 or the H9K connection at Kapuskasing TS, it would then be possible for the S3S & S4S circuit-combination to be separately protected. This would reduce the risk of over-tripping associated with any increase in the reach of the protection at Hunta SS on circuit H9K. Any faults involving the S3S & S4S circuit-combination would then be isolated via the new breaker (together with breaker L1L9 if the new breaker were to be installed in H9K) at Kapuskasing TS.

Since the installation of the new breaker would have no effect on the possible overloading of circuit H9K, there would still be a need to either constrain-off some of the generation capacity or to temporarily open circuit H9K.

*For this reason there is a definite preference for the new breaker to be located in circuit H9K since it would provide a suitable location at which to introduce a normally-open point in circuit H9K.*

Should it not be possible to install the new circuit breaker in circuit H9K at Kapuskasing TS, then consideration should be given to replacing one of the existing in-line disconnect switches or MSOs in circuit H9K with a load-break switch (circuit-switcher). This would allow routine opening of circuit H9K to be performed more easily and quickly whenever overloading is expected. For this particular purpose, the MSO 42H9K-MSO2 at Fauquier TS would appear to be an ideal candidate for replacement.

## 7. *'Ultimate' Arrangement*

Should Smoky Falls GS be redeveloped as part of the proposed expansion of the Mattagami River plants, then there would no longer be a requirement for circuits S3S & S4S and the associated voltage regulator. If the new breaker were to be located in circuit H9K then the freed-up position would be available for reterminating the connection from the T7 auto-transformer at Spruce Falls TS. This would allow the auto-transformer to remain in-service for contingencies involving either circuit F1E or H9K. With the existing arrangement, a contingency involving circuit F1E would result in the automatic disconnection of the T7 auto-transformer.

Diagram 5 shows the proposed 'ultimate' arrangement with the connection of the T7 auto-transformer revised.

## 8. *Additional Requirements for the Final Arrangement*

Apart from the installation of a second 115kV breaker at Kapuskasing TS together with new protective relaying for the S3S & S4S circuit-combination, the following facilities will also be required:

- i. The installation of approximately 20MVAR of shunt capacitors in the Kapuskasing area.

In the SIA Report for the proposed expansion of the Mattagami River plants, it was shown that the removal of the Smoky Falls GS injection into the mill would be expected to result in unacceptable voltages whenever circuit L21S was not in-service. Under this condition, all of the load at Kapuskasing TS and at the mill would be supplied from the TCPL-Kapuskasing generating facility and from the 115kV system via the T7 auto-transformer at Spruce Falls TS. The situation would be even more onerous if the TCPL-Kapuskasing facility were also to be unavailable, since the entire load at Kapuskasing TS and at the mill would then have to be supplied from the 115kV system.

Analysis showed that approximately 20MVAR of additional shunt capacitance would need to be installed in the Kapuskasing area to compensate for the increased reactive power losses and to maintain acceptable post-contingency voltages.

It was also recommended that the North-East SPS should be modified to allow locking of the tap-changers on the T7 auto-transformer at Spruce Falls TS and the T5 auto-transformer at the Spruce Falls mill, in response to contingencies involving either circuit L21S or circuit L20D. This was intended to avoid further depression of the 230kV voltage on circuit K38S.

With an increased post-contingency transfer through auto-transformer T7 from the 115kV system, the voltage on the 115kV system would decline. If the tap-changer on the T7 auto-transformer were to be on automatic control, it would operate to try and maintain the 115kV voltage. The subsequent decline in the 230kV voltage would then affect the voltage on the 110kV system at the mill, and the tap-changer on the T5 auto-transformer would respond. This would further depress the 230kV voltage, leading to eventual voltage collapse.

- ii. The modification of the North-East SPS

In the event that it should be decided to defer the proposed expansion of the Mattagami River plants so that Smoky Falls GS would continue to be connected to circuit H9K, then the North-East SPS should be modified to provide additional selections that would allow the Smoky Falls generating units to be rejected in response to contingencies involving the following circuits:

- L20D Pinard TS to Little Long SS
- L21S Little Long SS to Kapuskasing TS
- T7 Auto-transformer at Spruce Falls TS

Although the selections listed above are required primarily to address concerns regarding the operation of Smoky Falls GS in an island, once a G/R signal becomes available to the Smoky Falls station it would be beneficial to allow Smoky Falls to be select in response to the following contingency conditions that could result in overloading:

- H6T Hunta SS to Timmins TS
- H7T Hunta SS to Timmins TS
- D501P Porcupine TS to Pinard TS
- P502X Porcupine TS to Hanmer TS

## 9. Conclusions

Reterminating the two circuits from Smoky Falls GS on to circuit H9K via the voltage regulator VR2 at Kapuskasing TS has been shown to result in increased flows on circuit H9K. Depending on the prevailing ambient conditions, overloading of circuit H9K could therefore occur and, in the absence of a suitable switching device to allow circuit H9K to be readily opened, some of the generating facilities associated with the local 115kV facilities would need to be constrained-off.

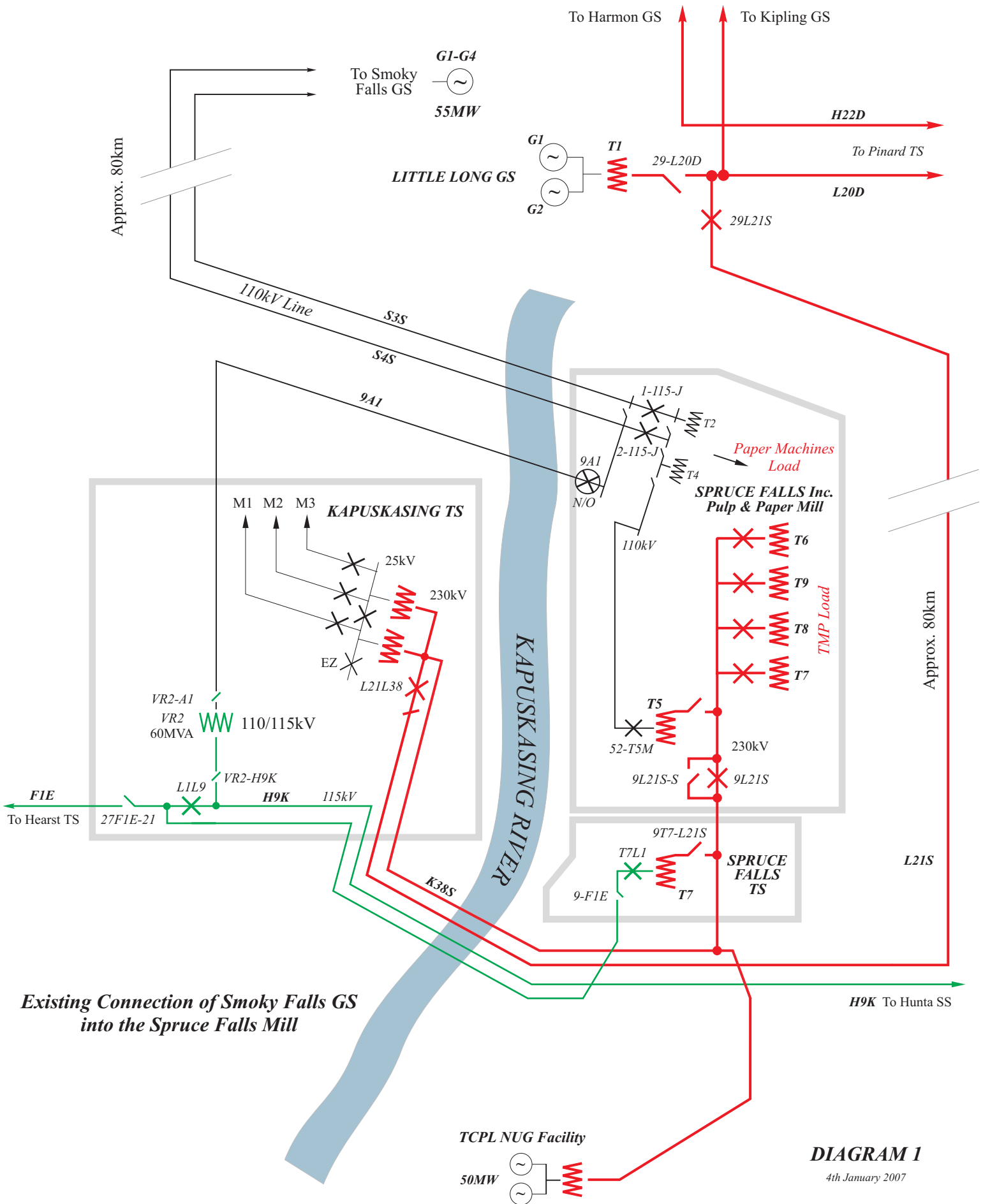
This situation is expected to continue until the Final Arrangement of this Project can be implemented by the late-summer/early-fall of 2008 when a new 115kV breaker is to be installed at Kapuskasing TS to allow the S3S & S4S circuit-combination to be separately protected. However, the requirement to constrain-off generation capacity to respect the rating of H9K will only be avoided if the new breaker were to be installed in circuit H9K rather than in the VR2 connection. If the new breaker were to be installed in the VR2 connection, then in order to avoid overloading circuit H9K, an additional load breaking device would need to be installed at a convenient location in circuit H9K to allow this circuit to be opened whenever the flows are expected to exceed its thermal rating.

Even with a new 115kV breaker installed in circuit H9K to facilitate its opening, the requirement for this connection between Kapuskasing TS and Hunta SS to be opened periodically whenever overloading could occur, is expected to have an adverse affect on system reliability. Under contingency conditions involving the 500kV circuit D501P between Porcupine TS and Pinard TS, circuit H9K would form part of the remaining synchronous connection between Porcupine TS and the 230kV system associated with the Mattagami & Abitibi Rivers. Should circuit H9K be open when a D501P contingency occurs, then the remaining system west and north of the normally-open point at Kapuskasing TS would collapse. For this reason it is expected that during high-risk periods when storms are threatening the 500kV system north of Sudbury that generation would still be constrained-off rather than opening circuit H9K to address possible overloading of this circuit.

This Assessment has also concluded that with Smoky Falls GS connected to circuit H9K, shunt capacitor banks with a rating of approximately 20MVAR would be required in the Kapuskasing area to provide reactive support during outage conditions involving the 230kV circuits L21S. With circuit L21S out-of-service, the loads at Kapuskasing TS and at the Spruce Falls mill would then be supplied from the 115kV system via the T7 auto-transformer at Spruce Falls TS. Without additional reactive support, unacceptable voltages would be expected to occur, particularly if the TCPL-Kapuskasing generating facility were also to be unavailable.

In addition, proposed changes to the North-East SPS have been identified that would allow the tap-changers on the T5 & T7 auto-transformers at the Spruce Falls mill and at Spruce Falls TS, respectively, to be locked post-contingency.

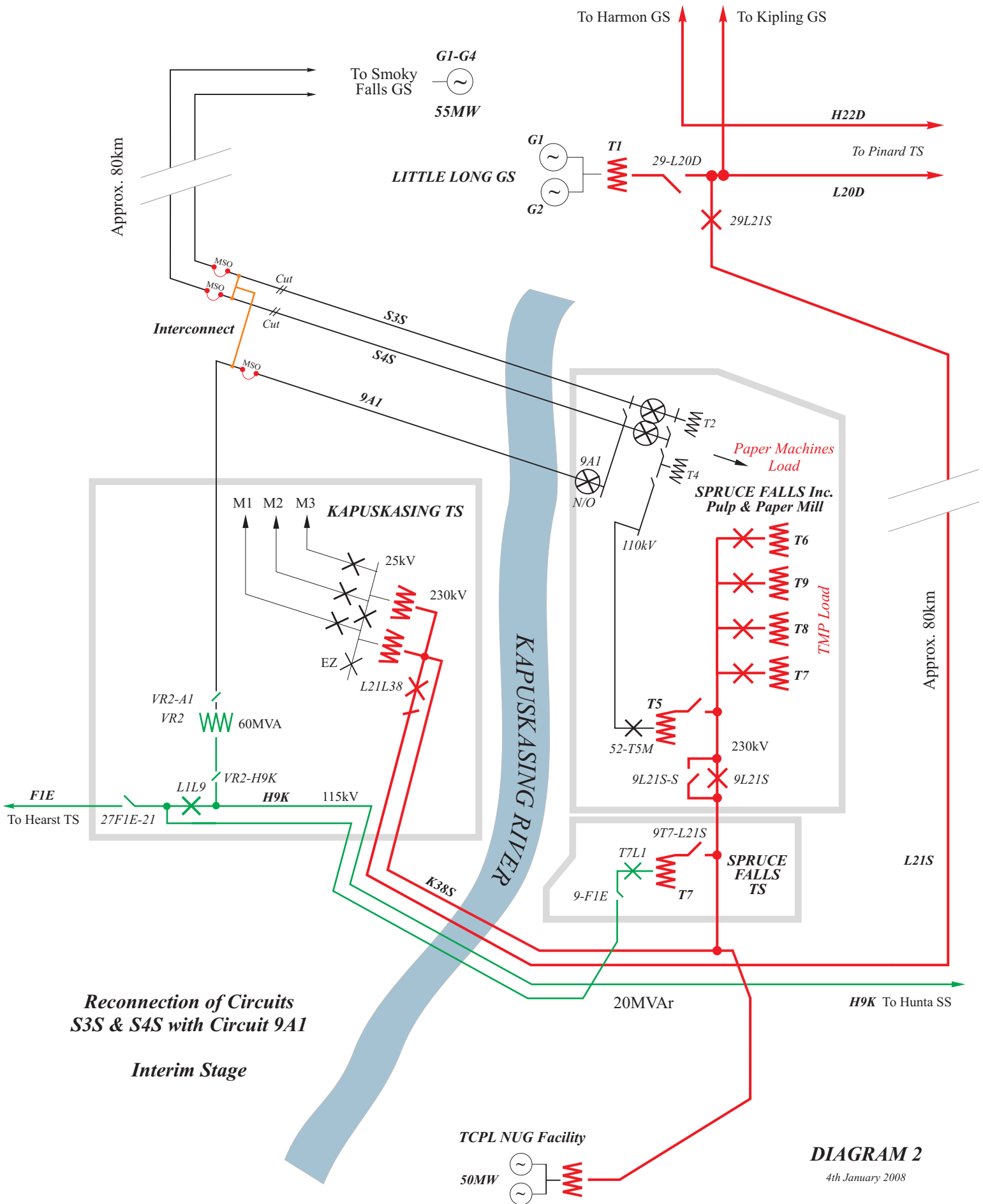
It has also been recommended that, to address concerns regarding the operation of Smoky Falls GS in a subsequent island, facilities be included in the North-East SPS to initiate rejection of the generating units at Smoky Falls GS in response to specific contingencies whenever circuit H9K is being operated open at Hunta SS. However, since these G/R facilities would become redundant should Smoky Falls GS be redeveloped, they should only be installed if a decision is made to defer the proposed expansion of the Mattagami River plants.



**DIAGRAM 1**

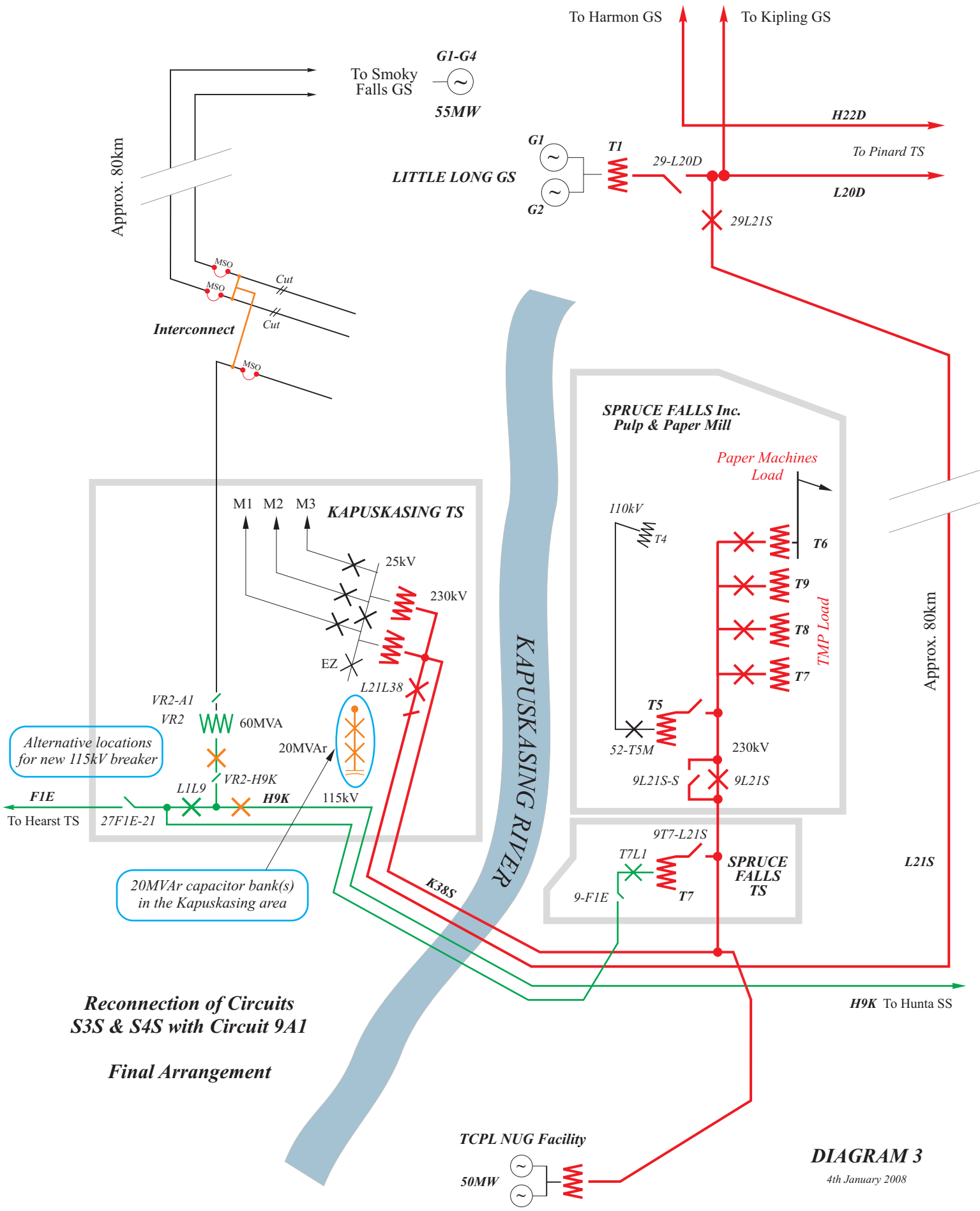
4th January 2007

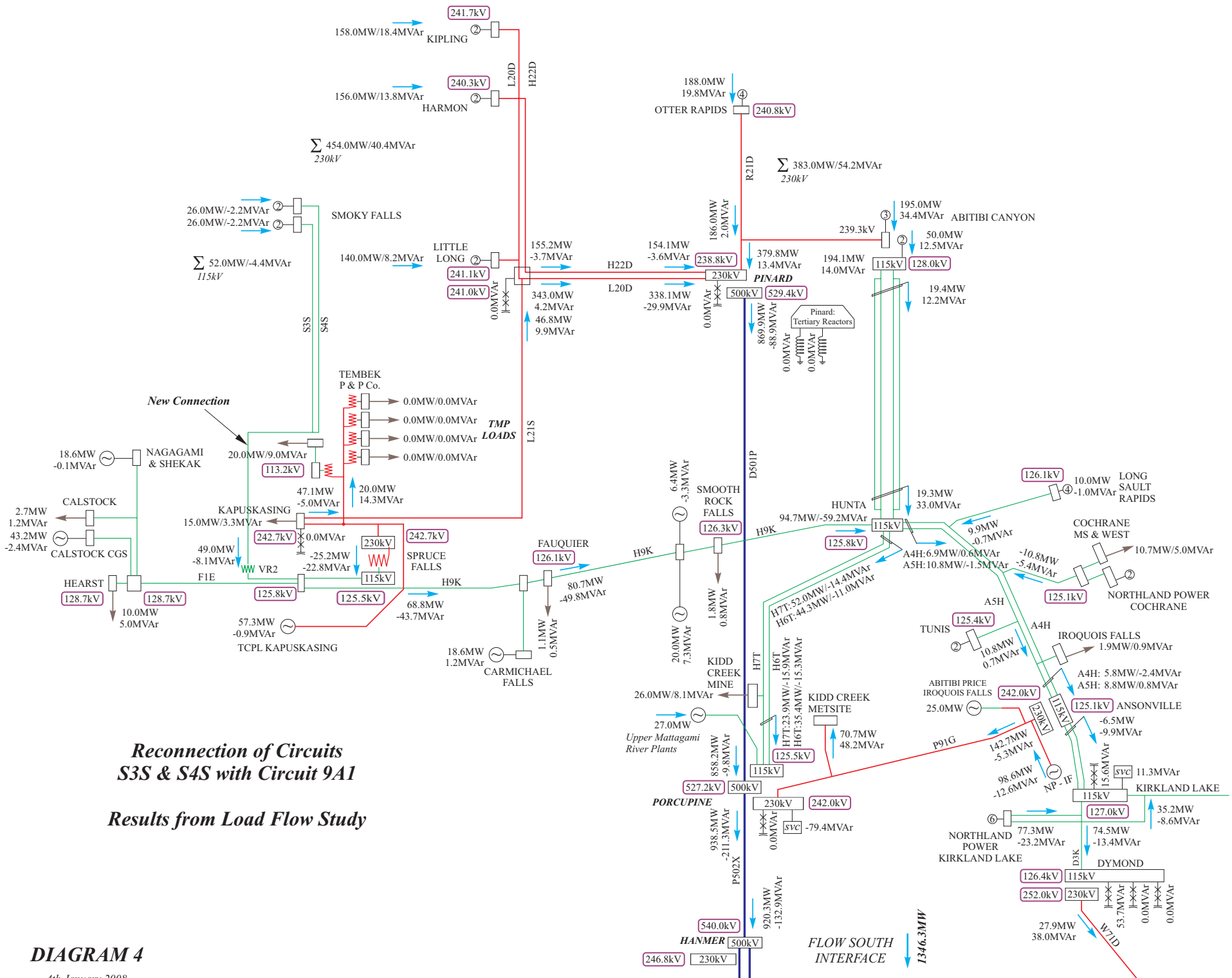




**DIAGRAM 2**

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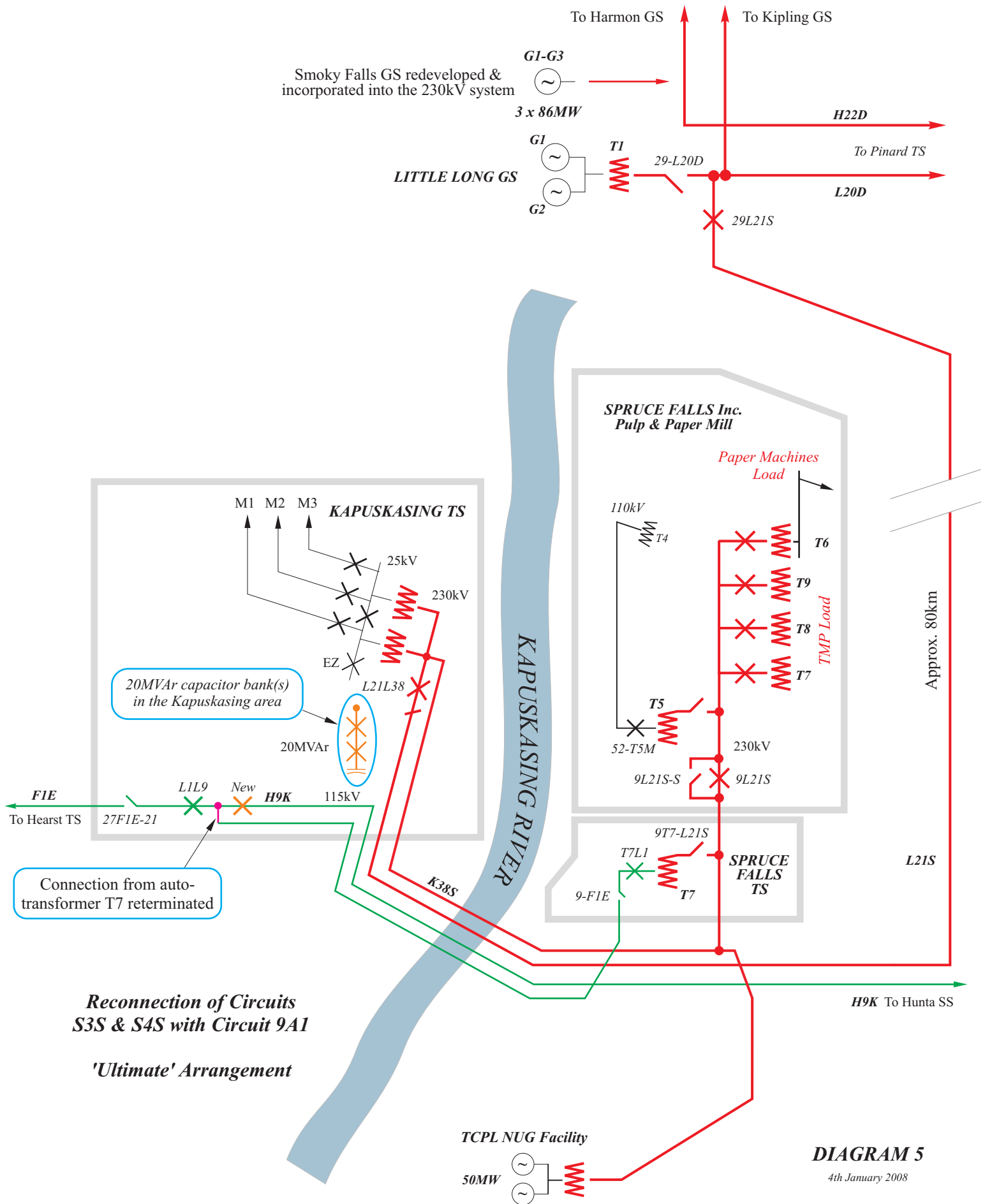


**Reconnection of Circuits  
S3S & S4S with Circuit 9A1**

**Results from Load Flow Study**

**DIAGRAM 4**

4th January 2008



**DIAGRAM 5**

4th January 2008