British Columbia Transmission CORPORATION™

Alcan to BCTC Transfer Limit Update
(Maximum Kemano Output: 880 MW)

REPORT NO. SPA 2007 – 45

29-MAY-2007

System Planning and Performance Assessment

Disclaimer

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EXECUTIVE SUMMARY

The Alcan to BCTC transfer limits have been updated based on the new KMO maximum output of 880 MW while taking the new KIT separation relays into account. The highlights are summarized below.

a) Under system normal condition with 6 KIT capacitors in service or 5 capacitors in service but at low KIT load, the benefit of increased Kemano output capability of 880 MW is realized in the new Alcan to BCH transfer limits. KMO generation shedding has been applied to reduce swings and improve system performance for 2L101 faults.

b) The Alcan to BCH transfer limits for both system normal and one KMO-KIT line outage condition have been restored to the levels prior to the reduction of KMO inertia.

Alcan to BCTC Transfer Limit Update
(Maximum Kemano Output: 880 MW)
TABLE OF CONTENTS

1. INTRODUCTION

Recently there have been some equipment and operation changes in Alcan. The maximum Kemano output is increased to 880 MW from 850 MW. In addition, two new relays have been installed at Kitimat (KIT) to separate Alcan from BCTC system (referred to as KIT separation scheme below) upon detecting certain contingencies in this area. Accordingly Alcan has requested BCTC to review and update the Alcan to BCTC transfer limits for system normal condition with all equipment in service and also the scenario of one of the Kemano to Kitimat lines out of service to account for the effect of above changes.

Operation planning studies have been conducted as requested and the results are stated in this report. Sensitivity studies to account for the effect of number of Kemano generators on line and the number of shunt capacitors at Kitmat on line are included.

2. STUDY ASSUMPTIONS

The studies are conducted based on the following assumptions.

a) The KIT separation scheme***** is in service.
b) The power generated by Eurocan IPP supplies Eurocan load only.
c) The settings of the existing out-of-step relays at MIN remain unchanged.
d) The maximum load at KIT is assumed to be 630 MW.
e) The maximum load at MIN is assumed to be 100 MW.
f) KMO generation shedding is available for loss of 2L101.

****** *KIT separation scheme contains two relays at KIT to detect multi-phase faults. One relay looks toward Alcan system and the other toward the BCTC system. If either relay detects any multi-phase fault, the KIT to MIN (2L103) line will be tripped immediately. In addition, detection of any fault including single line to ground or multiphase faults on the KMO-KIT line the relay will also trip open 2L103.*

3. ALCAN TO BCTC TRANSFER LIMITS

The transfer limits are constrained by equipment thermal limits, maximum operating voltages, KMO generator var capability, and transient stability and voltage stability concerns. Various pre-outage and post outage power flows, transient stability and voltage stability studies have been conducted to assess the transfer limits. Results indicate that Alcan to BCTC transfer limit varies with load at **KIT** (L_{KIT}) and **MIN** (L_{MIN}) and are summarized with the following equation for both scenarios:

Alcan to BCTC transfer limit $\mathbf{P_T}$ **(P_2L103)** is the minimum of:

- 380 MW, or
- 2L103 thermal limit (ambient temperature dependent), or
- $(A + B \times L_{MIN})$

Where

- A, B are to be computed using KIT load (L_{KIT}) based on data in Table - 2.
- L_{MIN} is load at MIN.

These loads are defined as below:
L_{KIT} = -87KIT-88KIT- 2L103KIT
L_{MIN} = -2L103MIN - 2L99MIN

Where:

- 87KIT = MW flow on 87L at KIT toward KMO
- 88KIT = MW flow on 88L at KIT toward KMO
- 2L103KIT = MW flow on 2L103 at KIT toward MIN
- 2L103MIN = MW flow on 2L103 at MIN toward KIT
- 2L99MIN = MW flow on 2L99 at MIN toward Skeena

L_{MIN} is the net of power into MIN on 2L103 and power going out from MIN on 2L99

- L_{MIN} is assumed to vary between 0 to 100 MW.
  However the equations can be applied for MIN load greater than 100 MW.

L_{KIT} is the net of power into KIT on 87L and 88L and power going out from KIT on 2L103

- L_{KIT} is assumed to vary between 300 to 630 MW
  If L_{KIT} < 300 MW, it is acceptable to set LKIT = 300 MW
  If L_{KIT} > 630 MW, the results are not applicable. A separate study needs to be conducted to determine the limits.

The actual values of transfer limits for both system normal and one KMO-KIT line OOS are listed in Table - 1.
Appendix A shows the limits in graphical form for system normal.
Appendix B shows the limits in graphical form for one KMO to KIT line out of service.

Kemano generation shedding for loss of 2L101 is required during high transfers. Detailed requirements are specified in Table-3.

Table-1 Transfer limits from Alcan to BCTC

System Condition	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units On Line	Kitimat Load (MW)	Kitimat to Minette Transfer Limit (MW)
System Normal	6	8	$300 < L_{KIT} \leq 480$	380 MW
			$480 < L_{KIT} \leq 536$	324 MW ~ 380 MW
			$536 < L_{KIT} \leq 580$	280 MW ~ 324 MW
			$580 < L_{KIT} \leq 630$	230 MW ~ 280 MW
	5	8	$300 < L_{KIT} \leq 480$	380 MW
			$480 < L_{KIT} \leq 536$	324 MW ~ 380 MW
			$536 < L_{KIT} \leq 580$	250 MW ~ 324 MW
			$580 < L_{KIT} \leq 630$	160 MW ~ 260 MW
	6	7	$300 < L_{KIT} \leq 400$	360 MW ~ 380 MW
			$400 < L_{KIT} \leq 450$	330 MW ~ 380 MW
			$450 < L_{KIT} \leq 536$	244 MW ~ 380 MW
			$536 < L_{KIT} \leq 580$	200 MW ~ 244 MW
			$580 < L_{KIT} \leq 630$	120 MW ~ 200 MW
	5	7	$300 < L_{KIT} \leq 400$	380 MW
			$400 < L_{KIT} \leq 450$	330 MW ~ 380 MW
			$450 < L_{KIT} \leq 536$	244 MW ~ 330 MW
			$536 < L_{KIT} \leq 580$	140 MW ~ 244 MW
			$580 < L_{KIT} \leq 630$	40 MW ~ 190 MW
	6	6	$300 < L_{KIT} \leq 480$	190 MW ~ 370 MW
			$480 < L_{KIT} \leq 536$	134 MW ~ 190 MW
			$536 < L_{KIT} \leq 580$	70 MW ~ 134 MW
			$580 < L_{KIT} \leq 630$	0 MW ~ 90 MW
	5	6	$300 < L_{KIT} \leq 480$	190 MW ~ 370 MW
			$480 < L_{KIT} \leq 536$	134 MW ~ 190 MW
			$536 < L_{KIT} \leq 580$	0 MW ~ 134 MW

(To be continued on next page)

Table-1 Transfer limits from Alcan to BCTC (continued)

System Condition	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units On Line	Kitimat Load (MW)	Kitimat to Minette Transfer Limit (MW)
One of Kemano – Kitimat Lines O.O.S.	6	8	$300 < L_{KIT} \leq 450$	265 MW ~ 310 MW
			$450 < L_{KIT} \leq 530$	175 MW ~ 265 MW
			$530 < L_{KIT} \leq 560$	150 MW ~ 175 MW
			$560 < L_{KIT} \leq 612$	15 MW ~ 150 MW
	5 (note 1)	8	$300 < L_{KIT} \leq 450$	265 MW ~ 310 MW
			$450 < L_{KIT} \leq 505$	195 MW ~ 265 MW
			$505 < L_{KIT} \leq 530$	120 MW ~ 195 MW
			$530 < L_{KIT} \leq 560$	30 MW ~ 160 MW
	6	7	$300 < L_{KIT} \leq 450$	240 MW ~ 290 MW
			$450 < L_{KIT} \leq 530$	150 MW ~ 240 MW
			$530 < L_{KIT} \leq 560$	80 MW ~ 150 MW
	5 (note 1)	7	$300 < L_{KIT} \leq 450$	240 MW ~ 290 MW
			$450 < L_{KIT} \leq 480$	205 MW ~ 240 MW
			$480 < L_{KIT} \leq 505$	150 MW ~ 205 MW
			$505 < L_{KIT} \leq 530$	105 MW ~ 170 MW
			$530 < L_{KIT} \leq 550$	60 MW ~ 130 MW
			$550 < L_{KIT} \leq 560$	10 MW ~ 80 MW
	6	6	$300 < L_{KIT} \leq 380$	230 MW ~ 260 MW
			$380 < L_{KIT} \leq 450$	150 MW ~ 230 MW
			$450 < L_{KIT} \leq 505$	90 MW ~ 150 MW
			$505 < L_{KIT} \leq 530$	30 MW ~ 130 MW
			$530 < L_{KIT} \leq 550$	0 MW ~ 90 MW
	5 (note 1)	6	$300 < L_{KIT} \leq 380$	230 MW ~ 260 MW
			$380 < L_{KIT} \leq 450$	150 MW ~ 230 MW
			$450 < L_{KIT} \leq 480$	90 MW ~ 150 MW
			$480 < L_{KIT} \leq 505$	10 MW ~ 130 MW

Note:

1. The limits are based on the large capacitor bank (KIT #8 55.2 MVAR) out of service. However if the outage capacitor is a smaller unit and the KIT #8 capacitor (55.2 MVAR) remains energized, then the transfer limit can be increased by 30 MW, provided that the computed limit is less than or equal to 120 MW.

Table-2 Calculation formula for A and B of $P_T = A + B \times L_{MIN}$

System Condition	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units On Line	Kitimat Load (MW)	Calculation Formulas for A and B	
System Normal	6	8	$300 < L_{KIT} \leq 480$	$A = 380$	$B = 0.0$
			$480 < L_{KIT} \leq 536$	$A = 380 - 1.0 \times (L_{KIT} - 480)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 324 - 1.0 \times (L_{KIT} - 536)$	$B = 0.0$
			$580 < L_{KIT} \leq 630$	$A = 280 - 1.0 \times (L_{KIT} - 580)$	$B = 0.0$
	5	8	$300 < L_{KIT} \leq 480$	$A = 380$	$B = 0.0$
			$480 < L_{KIT} \leq 536$	$A = 380 - 1.0 \times (L_{KIT} - 480)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 324 - 1.68 \times (L_{KIT} - 536)$	$B = 0.0 + 0.2 \times (A - 324)/74$
			$580 < L_{KIT} \leq 630$	$A = 260 - 1.0 \times (L_{KIT} - 580)$	$B = -0.2 + 0.1 \times (A - 250)/50$
	6	7	$300 < L_{KIT} \leq 360$	$A = 380$	$B = 0.0$
			$360 < L_{KIT} \leq 400$	$A = 380 - 0.5 \times (L_{KIT} - 360)$	$B = 0.3$
			$400 < L_{KIT} \leq 450$	$A = 360 - 0.6 \times (L_{KIT} - 400)$	$B = 0.3 + 0.3 \times (A-360)/30$
			$450 < L_{KIT} \leq 536$	$A = 330 - 1.0 \times (L_{KIT} - 450)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 244 - 1.0 \times (L_{KIT} - 536)$	$B = 0.0$
			$580 < L_{KIT} \leq 630$	$A = 200 - 1.0 \times (L_{KIT} - 580)$	$B = 0.0 + 0.3 \times (A - 200)/50$
	5	7	$300 < L_{KIT} \leq 400$	$A = 380$	$B = 0.0$
			$400 < L_{KIT} \leq 450$	$A = 380 - 1.0 \times (L_{KIT} - 400)$	$B = 0.0$
			$450 < L_{KIT} \leq 536$	$A = 330 - 1.0 \times (L_{KIT} - 450)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 244 - 1.23 \times (L_{KIT} - 536)$	$B = 0.0 + 0.5 \times (A - 244)/54$
			$580 < L_{KIT} \leq 630$	$A = 190 - 1.4 \times (L_{KIT} - 580)$	$B = -0.5 + 0.3 \times (A - 190)/70$
	6	6	$300 < L_{KIT} \leq 480$	$A = 370 - 1.0 \times (L_{KIT} - 300)$	$B = 0.0$
			$480 < L_{KIT} \leq 536$	$A = 190 - 1.0 \times (L_{KIT} - 480)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 134 - 1.0 \times (L_{KIT} - 536)$	$B = 0.0 + 0.2 \times (A - 134)/44$
			$580 < L_{KIT} \leq 630$	$A = 90 - 1.0 \times (L_{KIT} - 580)$	$B = -0.2 + 0.7 \times (A - 90)/50$
	5	6	$300 < L_{KIT} \leq 480$	$A = 370 - 1.0 \times (L_{KIT} - 300)$	$B = 0.0$
			$480 < L_{KIT} \leq 536$	$A = 190 - 1.0 \times (L_{KIT} - 480)$	$B = 0.0$
			$536 < L_{KIT} \leq 580$	$A = 134 - 1.46 \times (L_{KIT} - 536)$	$B = 0.0 + 1.0 \times (A - 134)/64$

(To be continued on next page)

Table-2 Calculation Formulas for A and B of $P_T = A + B \times L_{MIN}$ (continued)

System Condition	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units On Line	Kitimat Load (MW)	Calculation Formulas for A and B	
One of Kemano – Kitimat Lines O.O.S.	6	8	$300 < L_{KIT} \leq 450$	$A = 285 - 0.31 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 530$	$A = 265 - 1.13 \times (L_{KIT} - 447)$	$B = 0.0$
			$530 < L_{KIT} \leq 560$	$A = 175 - 0.71 \times (L_{KIT} - 527)$	$B = 0.0$
			$560 < L_{KIT} \leq 630$	$A = 150 - 1.4 \times (L_{KIT} - 562)$	$B = 0.65 \times (A - 150) / 70$
	5 (note 1)	8	$300 < L_{KIT} \leq 450$	$A = 285 - 0.31 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 505$	$A = 265 - 1.19 \times (L_{KIT} - 447)$	$B = 0.0$
			$505 < L_{KIT} \leq 530$	$A = 195 - 1.67 \times (L_{KIT} - 506)$	$B = 0.4 \times (A - 195) / 35$
			$530 < L_{KIT} \leq 630$	$A = 160 - 2.71 \times (L_{KIT} - 527)$	$B = -0.4 - 0.05 \times (A - 160) / 95$
	6	7	$300 < L_{KIT} \leq 450$	$A = 260 - 0.31 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 530$	$A = 240 - 1.13 \times (L_{KIT} - 447)$	$B = 0.0$
			$530 < L_{KIT} \leq 630$	$A = 150 - 1.14 \times (L_{KIT} - 527)$	$B = 0.3 \times (A - 150) / 40$
	5 (note 1)	7	$300 < L_{KIT} \leq 450$	$A = 260 - 0.31 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 480$	$A = 240 - 1.13 \times (L_{KIT} - 447)$	$B = 0.0$
			$480 < L_{KIT} \leq 505$	$A = 205 - 1.21 \times (L_{KIT} - 477)$	$B = 0.2 \times (A - 205) / 35$
			$505 < L_{KIT} \leq 530$	$A = 175 - 2.14 \times (L_{KIT} - 506)$	$B = -0.05 + 0.2 \times (A - 175) / 45$
			$530 < L_{KIT} \leq 550$	$A = 130 - 2.0 \times (L_{KIT} - 527)$	$B = -0.25 - 0.05 \times (A - 130) / 50$
			$550 < L_{KIT} \leq 630$	$A = 80 - 4.0 \times (L_{KIT} - 552)$	$B = -0.2 + 0.1 \times (A - 80) / 40$
	6	6	$300 < L_{KIT} \leq 380$	$A = 260 - 0.32 \times (L_{KIT} - 287)$	$B = 0.0$
			$380 < L_{KIT} \leq 450$	$A = 230 - 1.23 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 505$	$A = 150 - 0.34 \times (L_{KIT} - 447)$	$B = 0.4 \times (A - 150) / 20$
			$505 < L_{KIT} \leq 530$	$A = 130 - 1.91 \times (L_{KIT} - 506)$	$B = -0.4 + 0.2 \times (A - 130) / 40$
			$530 < L_{KIT} \leq 630$	$A = 90 - 1.2 \times (LKIT - 527)$	$B = -0.6$
	5 (note 1)	6	$300 < L_{KIT} \leq 380$	$A = 260 - 0.32 \times (L_{KIT} - 287)$	$B = 0.0$
			$380 < L_{KIT} \leq 450$	$A = 230 - 1.23 \times (L_{KIT} - 382)$	$B = 0.0$
			$450 < L_{KIT} \leq 480$	$A = 150 - 0.67 \times (L_{KIT} - 447)$	$B = 0.4 \times (A - 150) / 20$
			$480 < L_{KIT} \leq 630$	$A = 130 - 2.07 \times (L_{KIT} - 477)$	$B = -0.4 + 0.2 \times (A - 130) / 60$

Note:

1. The limits are based on the large capacitor bank (KIT #8 55.2 MVAR) out of service. However if the outage capacitor is a smaller unit and the KIT #8 capacitor (55.2 MVAR) remains energized, then the transfer limit can be increased by 30 MW, provided that the computed limit is less than or equal to 120 MW.

Table-3 KMO Generation Shedding Requirement on Loss of 2L101

System Condition	P_2L103 (MW)	Generation Shedding Requirement
System Normal	P_2L103 ≤ 150	No generation shedding
	150 < P_2L103 ≤ 250	Shed one KMO units of 100-114 MW
	250 < P_2L103 ≤ 350	Shed two KMO units of 200 - 224 MW
	350 < P_2L103	Shed three KMO units of 330 - 342 MW
One of Kemano – Kitimat Lines O.O.S.	P_2L103 ≤ 150	No generation shedding
	150 < P_2L103 ≤ 200	Shed one KMO unit of 100-114 MW
	200 < P_2L103	Shed two KMO units of 180 - 200 MW

4. CONCLUSIONS

The Alcan to BCTC transfer limits have been updated based on the new KMO maximum output of 880 MW while taking the new KIT separation relays into account. The highlights are summarized below.

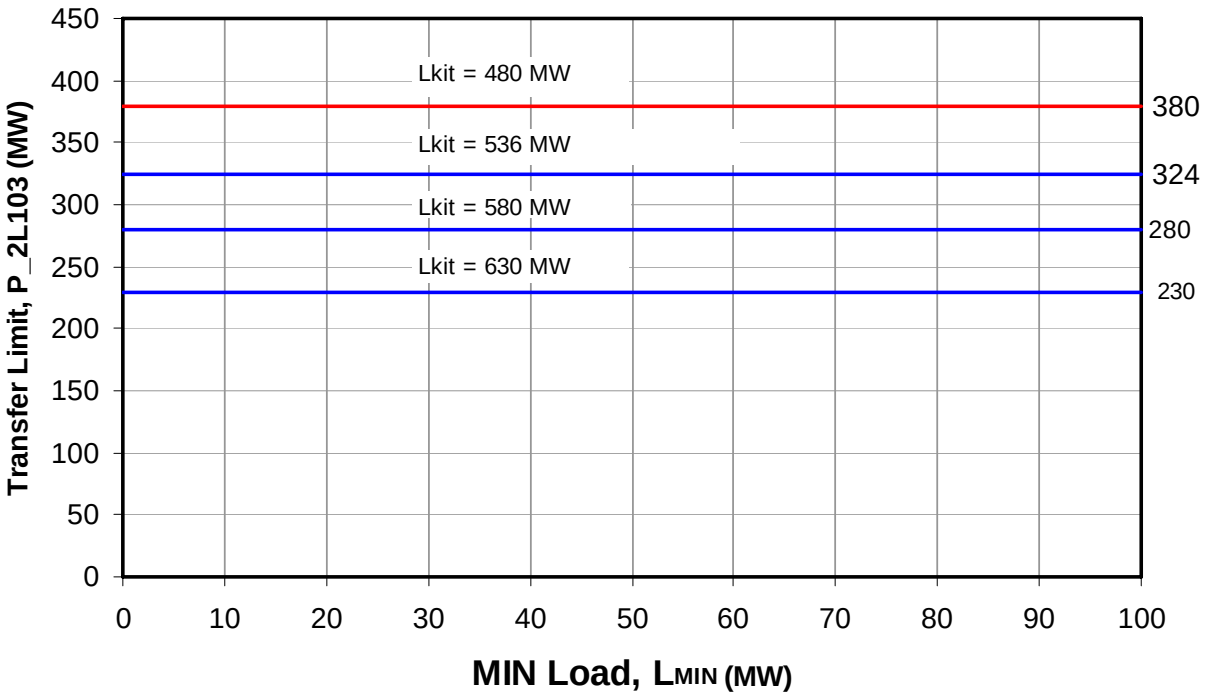
a) Under system normal condition with 6 KIT capacitors in service or 5 capacitors in service but at low KIT load, the benefit of increased Kemano output capability of 880 MW is realized in the new Alcan to BCH transfer limits. KMO generation shedding has been applied to reduce swings and improve system performance for 2L101 faults.

b) The Alcan to BCH transfer limits for both system normal and one KMO-KIT line outage condition have been restored to the levels prior to the reduction of KMO inertia.

5. Appendix A – TRANSFER LIMIT NOMOGRAMS FOR SYSTEM NORMAL

APPENDIX A-1

Alcan to BCTC Transfer limit
All circuits in service
Based on 8 KMO units and 6 capacitor banks at KIT in service

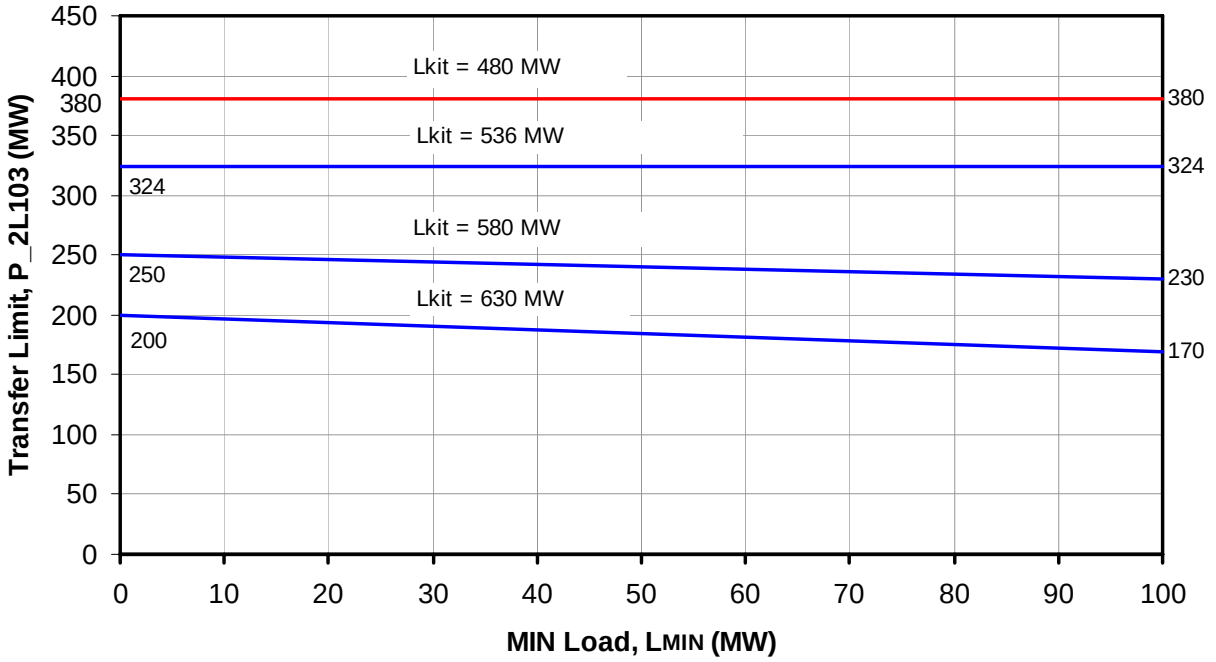


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX A-2

Alcan to BCTC Transfer limit
All circuits in service
Based on 8 KMO units and 5 capacitor banks at KIT in service

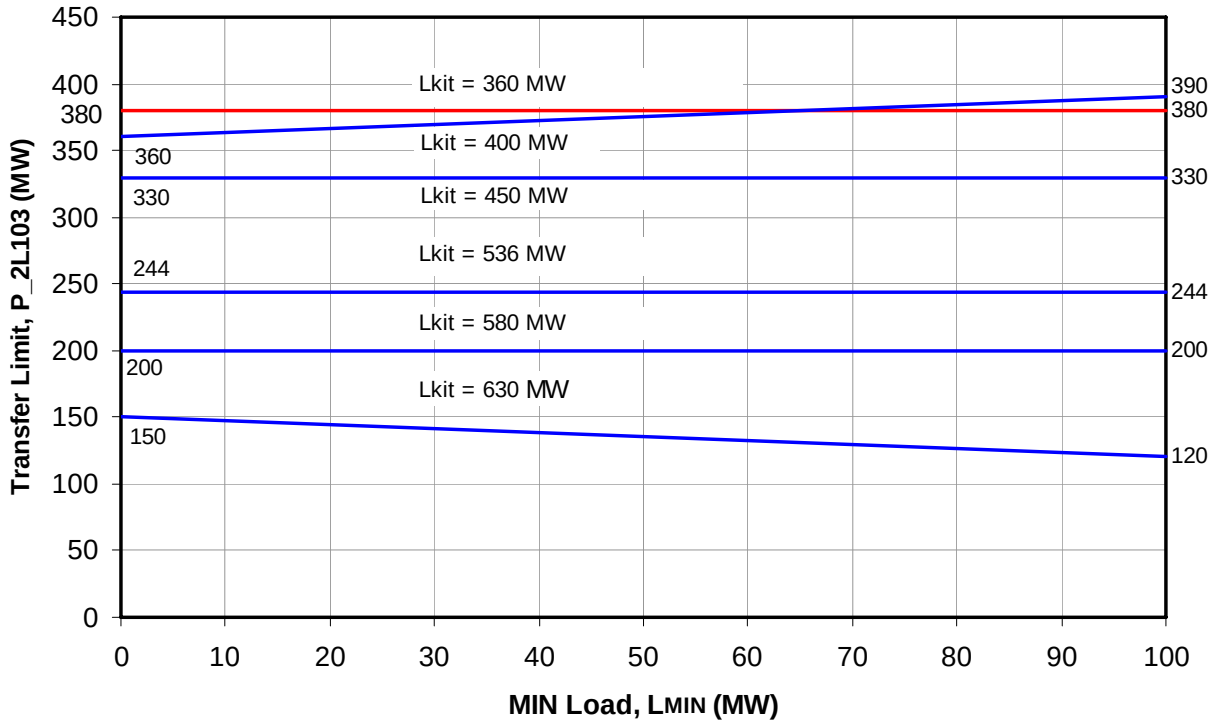


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX A-3

Alcan to BCTC Transfer limit
All circuits in service
Based on 7 KMO units and 6 capacitor banks at KIT in service

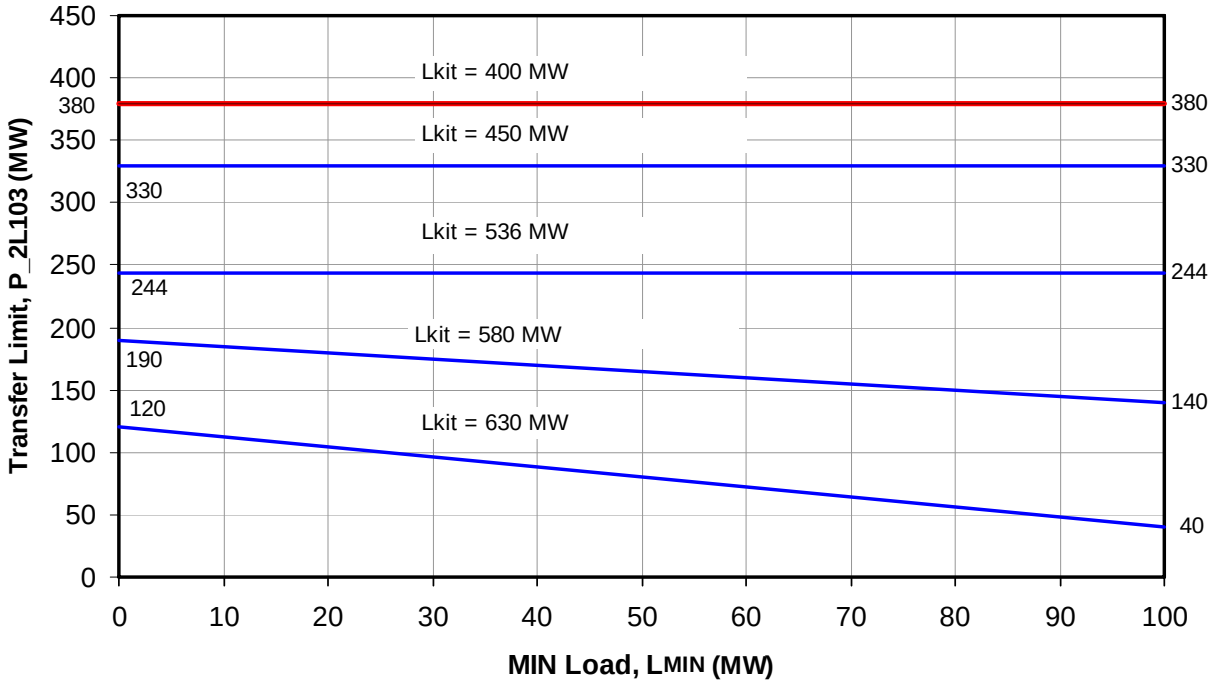


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX A-4

Alcan to BCTC Transfer limit
All circuits in service
Based on 7 KMO units and 5 capacitor banks at KIT in service

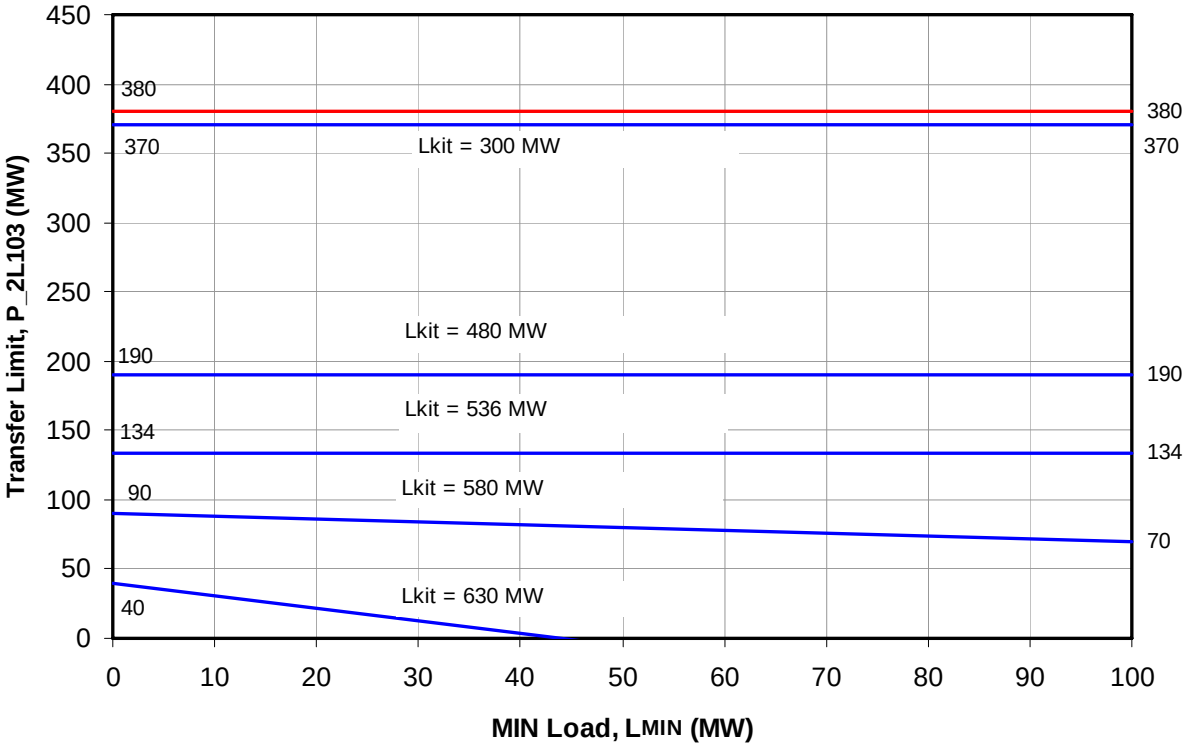


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX A-5

Alcan to BCTC Transfer limit
All circuits in service
Based on 6 KMO units and 6 capacitor banks at KIT in service

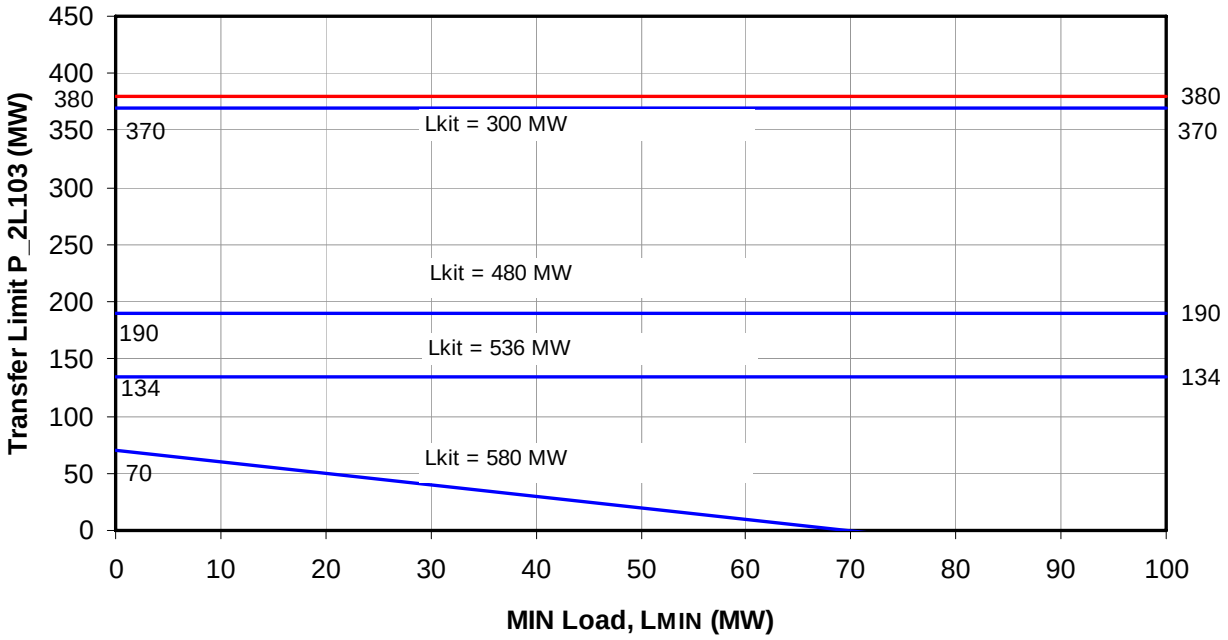


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX A-6

Alcan to BCTC Transfer limit
All circuits in service
Based on 6 KMO units and 5 capacitor banks at KIT in service



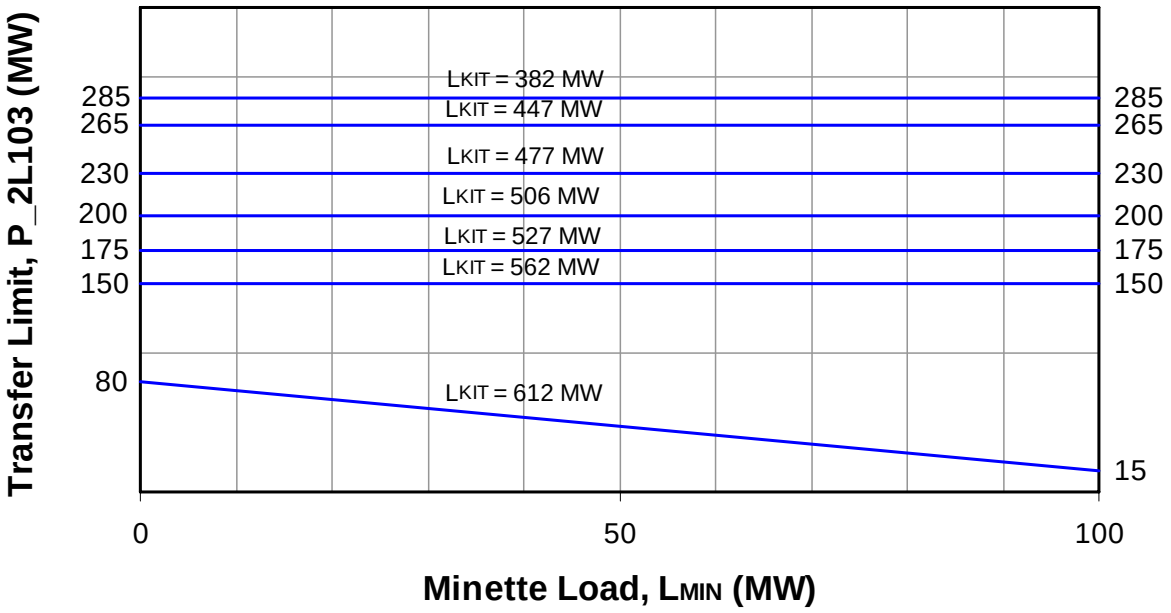
Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

6. Appendix B – TRANSFER LIMIT NOMOGRAMS WITH ONE OF KMO - KIT LINES O.O.S.

APPENDIX B-1

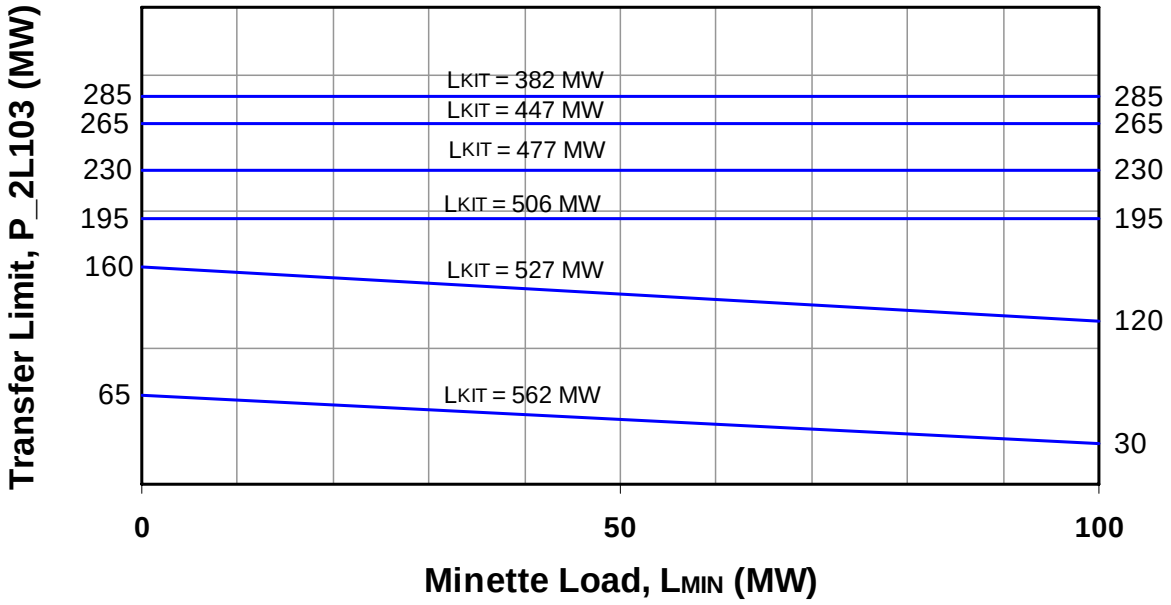
Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 8 KMO units and 6 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX B-2

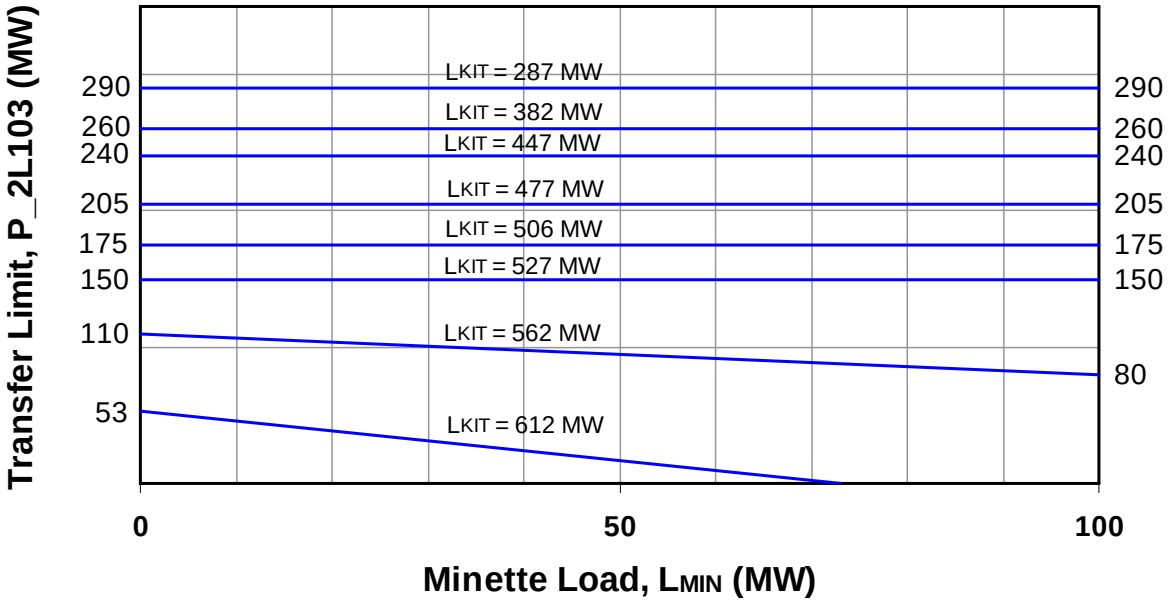
Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 8 KMO units and 5 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX B-3

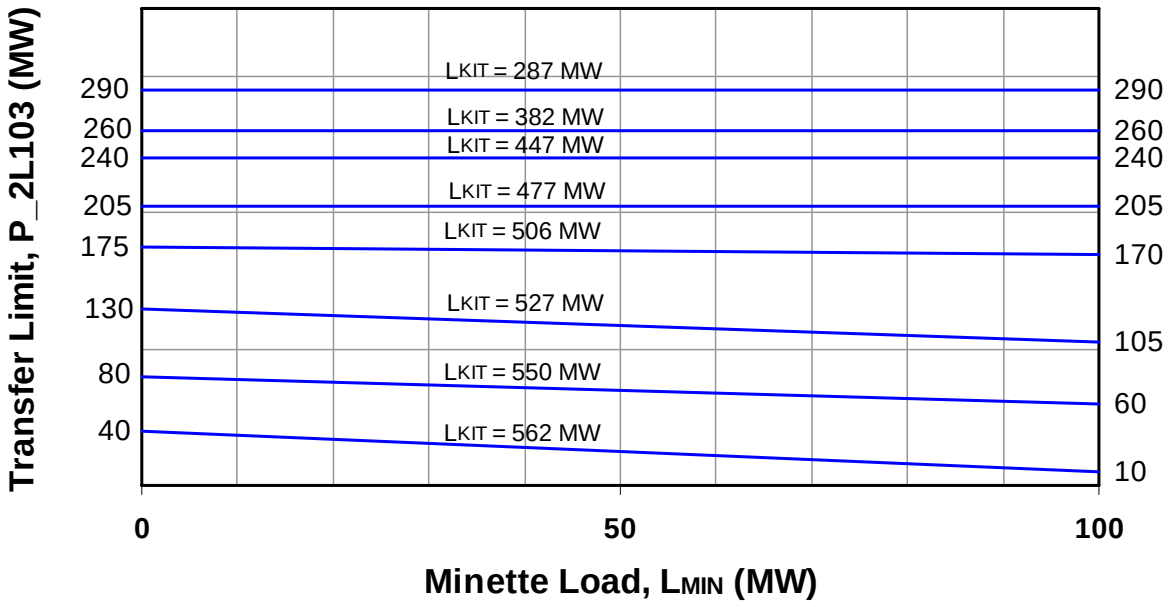
Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 7 KMO units and 6 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX B-4

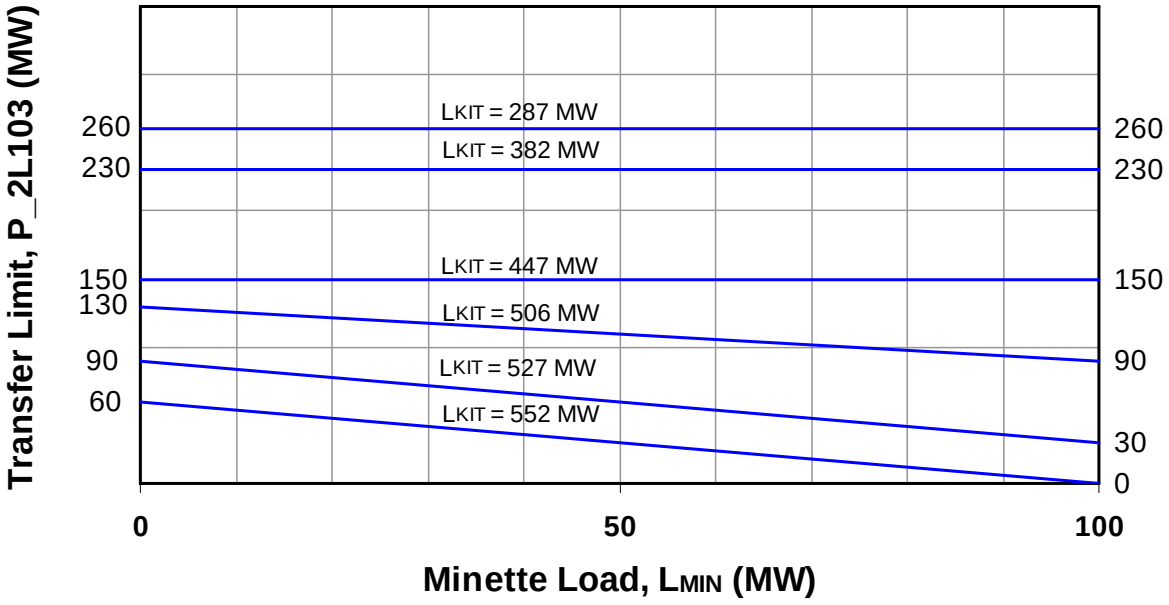
Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 7 KMO units and 5 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX B-5

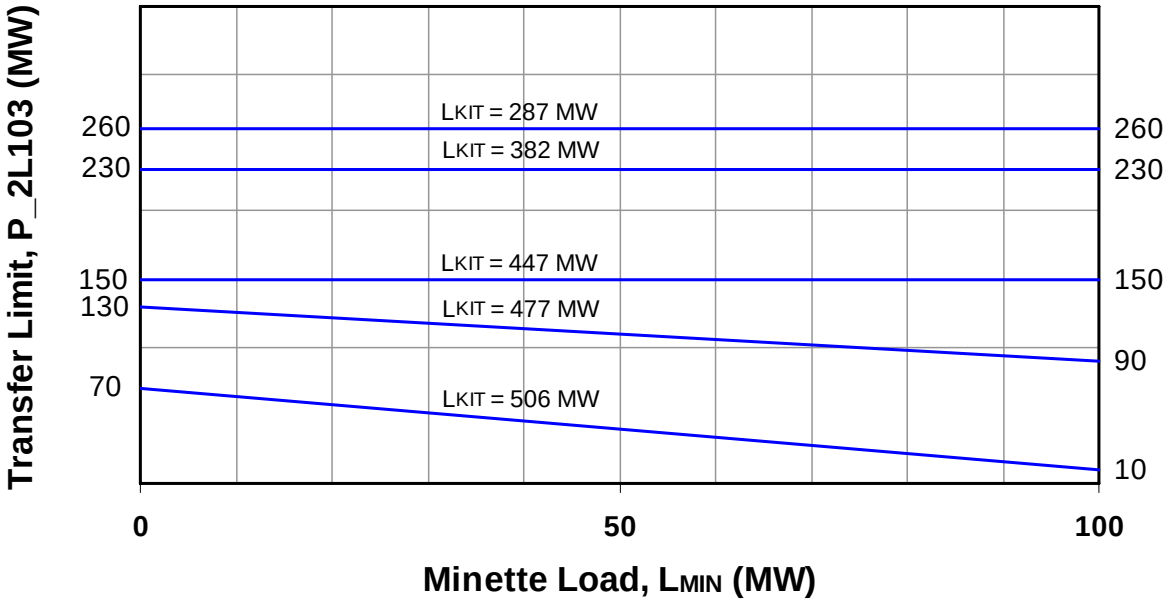
Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 6 KMO units and 6 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

APPENDIX B-6

Alcan to BCTC Transfer limit
One of KMO-KIT lines O.O.S.
Based on 6 KMO units and 5 capacitor banks at KIT in service



Limited by acceptable transient performance or KMO reactive power reserves

