

SFT Implementation

Customer Scenario Testing ReportCustomer Scenario Testing Report

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8/11/2010



*Keeping the lights on
24 hours a day, 7 days a week*

SYSTEM OPERATOR

Keeping the energy flowing

TRANSPOWER



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1 Introduction

1.1 SFT Constraints during Abnormal Situations

In order to run the requested historical scenarios with SFT on the following was carried out to create a schedule as accurate as possible:

The inputs from the actual final pricing case for the particular day were applied:

- Outages
- MV90 metering data for area loads
- Bids and offers
- Load forecast from actual SDPQ (Dispatch) schedule that spanned the study time

All permanent and outage manual constraints were invalidated

The schedules were then run with SFT on

1.2 SFT Scenario Results

For each scenario in this report a summary has been created containing the following:

- All the SFT constraints that were created
Note Have not listed all the manual constraints that were applied with SFT off
- All the constraints that were binding with SFT On and with SFT Off
- A sample of nodal prices (pertinent to the scenario) with SFT On and with SFT Off

Each SFT On case has been published to WITS UAT. Constraint outputs for the particular schedules can be viewed there.

Only Dispatch prices within the last three months can be viewed in WITS so Excel workbooks have been created containing the raw data from each case with all the Constraint and PNode (nodal prices) Outputs. The data has been provided for SFT On and for SFT Off so the results can be compared with identical inputs.

For all of the scenarios, some being extreme, SFT always solved.

No SFT constraints were generated that would not be required, though for Scenario 7 while the results with SFT on have been shown here, this is only to demonstrate that SFT continued to AC solve and create valid constraints even during this extreme situation. In reality for this event where constraints could never be satisfied (N-8) SFT would be turned off. At least until it was identified where security could be restored. Monitoring (SFT creating constraints) would then be turned off where security could not be restored and SFT would be turned back on. Any initial infeasibilities / high spring washer pricing which may have been occurred before SFT was turned off would be dealt with as per the current resolution process.

Binding HVDC constraints have not been included in results summary.

2 Scenarios

2.1 Scenario 1: Reduced transmission capacity between Waitaki and Southland

Due to outages, similar to CYD CML TWZ outage TP 12-23 on 19 August 2009
WITS UAT schedule: SDS 26/10/2010 09:29:50 TP12-23

2.1.1 Investigation

Sequence of events

18-Aug-2009

13:39 Short notice outage required 06:00-10:00_19/08 CYD CML TWZ 1.

19-Aug-2009

06:31-06:39 CYD_TWZ2 component violation

06:41 Frequency keeper changed due to issues with maintaining security

08:22 CTO Submitted for CYD CML TWZ 1, CML T5, CML FKN 1, FKN T2 Return time was 10:00 now 11:00.

2.1.2 Results

SFT On

All SFT generated constraints:

LIV_NSY.1__CYD_TWZ2.1__S__CYD_TWZ2__NSY__LN
LIV_NSY.1__CYD_TWZ2.1__CYD_TWZ2__NSY__LN
NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN
NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN

Binding Constraints:

TP	Constraint	Limit	Price	Constraint Build
13	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.67	8.93	-948 * CYD_TWZ2.1 + -1 * NSY_ROX.1
14	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	268.01	12.9	-949 * CYD_TWZ2.1 + -1 * NSY_ROX.1
15	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.96	18.07	-93 * CYD_TWZ2.1 + -1 * NSY_ROX.1
16	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.9	19.15	-923 * CYD_TWZ2.1 + -1 * NSY_ROX.1
17	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.9	10.3	-917 * CYD_TWZ2.1 + -1 * NSY_ROX.1
18	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.94	8.25	-92 * CYD_TWZ2.1 + -1 * NSY_ROX.1
19	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	256.45	1.49	-916 * CYD_TWZ2.1 + -1 * NSY_ROX.1
20	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.94	13.63	-914 * CYD_TWZ2.1 + -1 * NSY_ROX.1
21	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	267.97	14.58	-918 * CYD_TWZ2.1 + -1 * NSY_ROX.1
22	NSY_ROX.1__CYD_TWZ2.1__S__CYD_TWZ2__ROX__LN	256.45	17	-916 * CYD_TWZ2.1 + -1 * NSY_ROX.1

Sample of nodal prices:

TP		12	13	14	15	16	17	18	19	20	21	22	23
Energy Price	ROX2201	8.94	0.02	0.02	0.02	0.02	9.99	9.99	16.01	0.02	0.02	0.02	10
	TWZ2201	9.01	9.03	13.04	18.01	18.88	20.38	18.48	18.01	13.44	14.41	16.81	10.23

SFT OffBinding Constraints:

TP	Constraint	Limit	Price	Constraint Build
13	CYD_TWZ_1_W_O_1_z	267	8.72	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
14	CYD_TWZ_1_W_O_1_z	267	12.61	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
15	CYD_TWZ_1_W_O_1_z	267	17.44	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
16	CYD_TWZ_1_W_O_1_z	267	19.61	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
17	CYD_TWZ_1_W_O_1_z	267	20.07	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
18	CYD_TWZ_1_W_O_1_z	267	8.36	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
19	CYD_TWZ_1_W_O_1_z	267	1.42	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
20	CYD_TWZ_1_W_O_1_z	267	13.17	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
21	CYD_TWZ_1_W_O_1_z	267	16.28	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=
22	CYD_TWZ_1_W_O_1_z	267	16.3	-1 * NSY_ROX.1 + -.99 * CYD_TWZ2.1 <=

Sample of nodal prices:

TP		12	13	14	15	16	17	18	19	20	21	22	23
Energy Price	ROX2201	8.94	0.02	0.02	0.02	0.02	0.02	9.99	16.01	0.02	0.02	0.02	10
	TWZ2201	9.01	9.04	13.05	18.01	20.11	20.59	18.84	18.01	13.58	16.78	16.84	10.23

2.1.3 Observations

Scheduled prices are indicative of those that occurred in final pricing.

The management of security violations in these situations remains unchanged; the RHS of the constraint will be amended in real time if / as needed.

2.2 Scenario 2: Multiple generation unit tripping

Similar to 23 September 2009

WITS UAT schedule: Dispatch (SDPQ) 29/10/2010 14:51:56 TP19-25

2.2.1 Investigation

Sequence of events

09:08 Multiple generating units tripped NI 49.23Hz, SI 49.58Hz.

09:14 GEN Grid emergency 09:24-11:00. Request load reduction of 5% from all NI participants, additional generation.

09:24 LOAD Advised RCC and RCN that the load has now stabilised, and they don't need any further parties to reduce load.

09:31 LOAD Advised connected parties that they can now restore all load.

09:34 MW Additional 70MW of generation will be available at 10:00

16:49 GEN 17:00-21:00 declared due to insufficient generation in the North Island.

2.2.2 Results

SFT On

No violations were present as a result of the loss of generation / shortfall.

No SFT Constraints were generated.

Sample of nodal prices:

TP		19	20	21	22	23	24	25
Energy Price	BEN2201	22.1	40.18	40.12	40.07	26.45	29.37	12.57
	HAY2201	28.82	54.87	46.55	44.75	29.55	32.79	14.06

SFT Off

No binding constraints.

Sample of nodal prices:

TP		19	20	21	22	23	24	25
Energy Price	BEN2201	22.1	40.18	40.12	40.07	26.45	29.37	12.57
	HAY2201	28.82	54.87	46.55	44.75	29.55	32.79	14.06

2.2.3 Observations

There was no impact during the shortfall of generation event whether SFT was on or off. With no scheduled security issues there were no SFT constraints generated. As expected there was no change in prices.

2.3 Scenario 3: Shortage of generation capacity in the North Island

North Island Reserves set to zero

Similar to 5 October

WITS UAT schedule: Dispatch (SDPQ) 28/10/2010 12:24:05 TP34-41

2.3.1 Investigation

Sequence of events

09:25	GEN	Grid Emergency declared for insufficient generation offers in the NI from 09:25 to 12:00
11:17	GEN	Revised, now 09:25 to 14:00
13:41	GEN	Revised, now 09:25 to 20:00
18:00	CE RAFS AFs	in the North Island set to zero at 18:00 due to inability to maintain NI frequency keeping reserves
18:38	IL EVENT	Generation tripping causes interruptible load event
19:48	GEN	Revised, now 09:25 to 23:00
20:27	RAFS	North Island RAfs restored

2.3.2 Results

SFT On

All SFT generated constraints:

KAW_MAT1.1__KAW_MAT2.1__KAW_MAT2__MAT__LN
KAW_MAT2.1__KAW_MAT1.1__KAW_MAT1__MAT__LN
KAW__T13__220KV__EDG_OWH.1__EDG_OWH__XF
MST_UHT1.2__MST_UHT2.2__S__MST_UHT2__UHT__LN
MST_UHT1.2__MST_UHT2.2__MST_UHT2__UHT__LN
MST_UHT2.2__MST_UHT1.2__S__MST_UHT1__UHT__LN
MST_UHT2.2__MST_UHT1.2__MST_UHT1__UHT__LN
KAW__T13__110KV__EDG_OWH.1__EDG_OWH__XF

No binding SFT constraints.

Sample of nodal prices:

TP		34	35	36	37	38	39	40	41
Energy Price	HAY2201	8.72	4.75	272.69	985.82	46.06	46.02	43.17	37.11



SFT Off

No binding constraints.

Sample of nodal prices:

TP		34	35	36	37	38	39	40	41
Energy Price	HAY2201	8.72	4.75	272.69	985.82	46.06	46.02	43.17	37.11

2.3.3 Observations

Again, there was no impact during this shortfall of generation event whether SFT was on or off. There were no binding constraints so as expected there was no change in prices.

2.4 Scenario 4: Shortage of generation capacity in the North Island

North Island reserves set to zero

Similar to 14 October 2009

WITS UAT schedule: Dispatch (SDPQ) 28/10/2010 10:02:43 TP35-41

2.4.1 Investigation

Sequence of events

17:21 GEN Declared for North Island from 17:21 to 22:00
 17:49 GEN North Island CE RAFs zeroed
 19:45 GEN North Island RAFs restored

2.4.2 Results

SFT On

All SFT generated constraints:

KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
WGN_WVY1.1__HWA_SFD1.1__S__HWA_SFD1__WGN__LN
WGN_WVY1.1__HWA_SFD1.1__HWA_SFD1__WGN__LN

No binding constraints.

SFT equivalent of constraints that bound with SFT Off:

TP	Constraint	Limit	% Binding	Constraint Build
35	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN	66.67	92.4	-0.75 * HAM_WKM.1 + -1.042 * KIN_TRK1.2
35	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	66.76	87.2	-0.512 * KIN_TRK2.2 + -1.042 * KIN_TRK1.2
36	KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN	66.51	89.8	-0.75 * HAM_WKM.1 + -1.04 * KIN_TRK1.2

Sample of nodal prices:

TP		35	36	37	38	39	40	41
Energy Price	HAY2201	871.07	1044.69	49.76	41.12	24.94	47.69	52.95

SFT Off

Binding constraints:

SFT equivalent of constraints that bound with SFT Off:

TP	Constraint	Limit	Price	Constraint Build
35	ARI_HAM_W_P_1A	62	285.6	1.04 * ARI_HAM1.1 + -0.07 * HAM_WKM.1 <=
39	COB_MOT_2_W_O	26	16.73	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=
40	COB_MOT_2_W_O	26	35.97	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=
41	COB_MOT_2_W_O	26	41.18	-1.016 * STK_UTK1.2 + -1 * MPI_UTK.1 <=



Sample of nodal prices:

TP		35	36	37	38	39	40	41
Energy Price	HAY2201	861.22	1044.69	49.76	41.12	25.03	47.77	53

2.4.3 Observations

The manually applied constraint that bound in SFT Off was not created to protect what was the worst violation on the day, post event load on KIN TRK 1 for a HAM WKM contingency. SFT created a constraint to manage this event, but was not scheduling it to bind. The overall North Island price in this shortfall of generation event would be unchanged by SFT.



2.5 Scenario 5: HVDC Pole 2 outage

Ascertain what happens when the North Island and South Island markets are separated

Similar to TP 16-18 on 12 November 2009 when the average price separation was \$870.00

WITS UAT schedule: Dispatch (SDPQ) 28/10/2010 13:06:51 TP15-19

2.5.1 Investigation

Planned outages

HVDC Bipole outage planned 05:30_11/11/09 – 20:00_15/11/09

Actual outage 05:30_11/11/09 – 17:00_15/11/09.

2.5.2 Results

SFT On

All SFT generated constraints:

COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN
ROX__T10__110KV__GOR_ROX.1__GOR_ROX__XF
NSY_ROX.1__CYD_TWZ1.1__CYD_TWZ1__ROX__LN
NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN
EDG_OWH.1__EDG_KAW3.1__EDG_KAW3__EDG__LN

No binding constraints.

Sample of nodal prices:

TP		15	16	17	18	19
Energy Price	BEN2201	145.07	140.42	145.43	145.43	145.1
	HAY2201	1000.04	1054.14	1004.37	985.3	452.39

SFT Off

No binding constraints.

Sample of nodal prices:

TP		15	16	17	18	19
Energy Price	BEN2201	145.07	140.42	145.43	145.43	145.1
	HAY2201	1000.04	1054.14	1004.37	985.3	452.39

2.5.3 Observations

There were no binding constraints so as expected there was no change in prices.

2.6 Scenario 6: NSY ROX line is in constraint

With no outages occurring to test how this constraint behaves with SFT

Similar to TP 23-26 on 5 January 2010

WITS UAT schedule: Dispatch (SDPQ) 28/10/2010 13:59:31 TP23-26

2.6.1 Results

SFT On

All SFT generated constraints:

NSY_ROX.1__CYD_TWZ1.1__CYD_TWZ1__ROX__LN
NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN
LIV_NSY.1__CYD_TWZ1.1__CYD_TWZ1__NSY__LN
LIV_NSY.1__CYD_TWZ2.1__CYD_TWZ2__NSY__LN

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
25	NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN	275.13	35.66	-352 * CYD_TWZ2.1 + -1.307 * NSY_ROX.1
26	NSY_ROX.1__CYD_TWZ2.1__CYD_TWZ2__ROX__LN	275.32	34.37	-352 * CYD_TWZ2.1 + -1.308 * NSY_ROX.1

Sample of nodal prices:

TP		23	24	25	26
Energy Price	ROX2201	28.56	28.53	10.11	10
	TWZ2201	30.04	30.01	29.71	28.92

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
25	NSY_ROX_1_S_P_z	270	35.47	-34 * CYD_TWZ1.1 + -1.33 * NSY_ROX.1 <=
26	NSY_ROX_1_S_P_z	270	37.25	-34 * CYD_TWZ1.1 + -1.33 * NSY_ROX.1 <=

Sample of nodal prices:

TP		23	24	25	26
Energy Price	ROX2201	28.56	28.53	10.11	8.44
	TWZ2201	30.04	30.01	29.7	28.91



2.7 Scenario 7: Major transmission trippings causing loss of power to Auckland

TP 31 25 January 2010

WITS UAT schedule: Dispatch (SDPQ) 3/11/2010 09:49:59 TP29-36

2.7.1 Investigation

25-Jan-2010

Planned outages

HLY OHW 1 07:30-18:00

OTC generation on extended outage

Sequence of events

- 14:17 OHW WKM tripped
- 14:19 RTCA Multiple violations due to OHW WKM tripping, investigating options for system splits, generation discretion and outage recall.
- 14:45 HAM WKM tripped
- 14:50 ARI HAM 1 & 2 trip, ARI end only (runback operation).
- 14:55 ARI BOB tripped
- 15:12 GEN: Grid Emergency declared for Zone 1 North of HLY including GLN from 15:12 until 19:00 (scheduled return of HAM WKM). Due to OHW WKM, HAM WKM, ARI HAM 1 & 2, ARI BOB trippings and likelihood of further event, OTA WKM 1 load is at capability and Z1/GZ1 voltage stability limits are being exceeded). Connected parties to reduce load by 10% and maintain. Current Z1 load approx 1550MW.
- 15:49 CTO: Submitted for HLY-OHW 1 End time was 18:00 now 16:00
Circuit Recalled
- 15:52 HLY OHW 1 restored
- 16:20 GEN: In consultation with Operations Manager and due to likelihood of another event a further 10% load reduction requested in Zone 1 North of HLY, including GLN. Zone 1 load currently approx 1470MW.
- 17:08 Instruction: Under previously issued GEN and to manage risk of HAM OHW tripping (lightning now in Waikato area) remove AR from HAM 492, Open BOB 222 and 282. Have modelled BOB 222/282 open as overrides applied to HAM WKM outage.
- 19:53 OHW WKM 1 and HAM WKM 1 restored
- 19:55 ARI BOB 1 restored
- 19:56 ARI HAM 1 & 2 restored
- 19:57 PTP: Restore OTA-BOB splits @ BOB & Restore HAM 492 A/R
- 20:00 GEN: Ended & All shed load to be restored.



2.7.2 Results

SFT On

All SFT generated constraints:

ARI_HAM1.1__ARI_HAM2.1__ARIHAM2\$__HAM__LN
ARI_HAM1.1__HAM_WKM.1__S__HAMWKM1\$__HAM__LN
ARI_HAM1.1__HAM_WKM.1__HAMWKM1\$__HAM__LN
ARI_HAM2.1__ARI_HAM1.1__ARIHAM1\$__HAM__LN
ARI_HAM2.1__HAM_WKM.1__S__HAMWKM1\$__HAM__LN
ARI_HAM2.1__HAM_WKM.1__HAMWKM1\$__HAM__LN
COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN
KIN_TRK1.1__HAM_WKM.1__HAMWKM1\$__KIN__LN
KIN_TRK1.2__HAM_WKM.1__HAMWKM1\$__TRK__LN
ARI_KIN1.1__ARI_KIN2.1__S__ARI_KIN2__ARI__LN
ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN
ARI_KIN2.1__ARI_KIN1.1__ARI_KIN1__ARI__LN
BOB_OTA1.2__BOB_OTA2.2__BOB_OTA2__OTA__LN
HLY_OHW2.1__HLY_OTA2.1__S__HLY_OTA2__HLY__LN
HLY_OHW2.1__HLY_OTA2.1__HLY_OTA2__HLY__LN
OTA_WKM1.1__HLY_OHW2.1__HLY_OHW2__WKM__LN
OTA_WKM1.1__HLY_SFD.1__HLY_SFD__WKM__LN
OTA_WKM1.1__HLY_TWH1.1__HLY_TWH1__WKM__LN
OTA_WKM1.1__OTA_WKM2.1__S__OTA_WKM2__WKM__LN
OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN
OTA_WKM1.1__SFD_TMN1.1__SFD_TMN1__WKM__LN
OTA_WKM1.1__TMN_TWH1.1__TMN_TWH1__WKM__LN
OTA_WKM2.1__HLY_OHW2.1__HLY_OHW2__WKM__LN
OTA_WKM2.1__HLY_SFD.1__HLY_SFD__WKM__LN
OTA_WKM2.1__HLY_TWH1.1__HLY_TWH1__WKM__LN
OTA_WKM2.1__OTA_WKM1.1__S__OTA_WKM1__WKM__LN
OTA_WKM2.1__OTA_WKM1.1__OTA_WKM1__WKM__LN
OTA_WKM2.1__SFD_TMN1.1__SFD_TMN1__WKM__LN
OTA_WKM2.1__TMN_TWH1.1__TMN_TWH1__WKM__LN
ARI_KIN2.1__ARI_KIN1.1__S__ARI_KIN1__ARI__LN
KIN_TRK1.1__KIN_TRK2.1__KIN_TRK2__KIN__LN
KIN_TRK1.2__KIN_TRK2.1__KIN_TRK2__TRK__LN
BOB_HAM1.1__BOB_HAM2.1__BOB_HAM2__HAM__LN
BOB_HAM2.1__BOB_HAM1.1__BOB_HAM1__HAM__LN

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
29	ARI_HAM1.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.62	0	-.093 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
29	ARI_HAM2.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.62	2555.58	-.093 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
29	KIN_TRK1.2__HAM_WKM.1__HAMWKM1\$__TRK__LN	54.22	1731.86	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
30	ARI_HAM1.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.78	1141.4	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
30	ARI_HAM2.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.78	0	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
30	KIN_TRK1.2__HAM_WKM.1__HAMWKM1\$__TRK__LN	54.29	684.04	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
31	ARI_HAM1.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.59	0	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM1.1
31	ARI_HAM2.1__HAM_WKM.1__HAMWKM1\$__HAM__LN	45.59	3320.78	-.094 * HAM_WKM.1 + 1.032 * ARI_HAM2.1
31	KIN_TRK1.2__HAM_WKM.1__HAMWKM1\$__TRK__LN	54.13	2250.3	-.11 * HAM_WKM.1 + -1.035 * KIN_TRK1.2
32	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	60.32	33025.16	.912 * ARI_KIN2.1 + 1.062 * ARI_KIN1.1
32	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	397.41	596120	-.649 * OTA_WKM2.1 + -1.317 * OTA_WKM1.1
33	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	57.91	32748.83	.916 * ARI_KIN2.1 + 1.056 * ARI_KIN1.1
33	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.81	559910	-.65 * OTA_WKM2.1 + -1.288 * OTA_WKM1.1
34	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.18	32921.81	.906 * ARI_KIN2.1 + 1.056 * ARI_KIN1.1
34	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	394.2	560680	-.646 * OTA_WKM2.1 + -1.29 * OTA_WKM1.1
35	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.78	32822.95	.915 * ARI_KIN2.1 + 1.057 * ARI_KIN1.1
35	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.68	561080	-.647 * OTA_WKM2.1 + -1.287 * OTA_WKM1.1
36	ARI_KIN1.1__ARI_KIN2.1__ARI_KIN2__ARI__LN	58.77	33280.16	.926 * ARI_KIN2.1 + 1.057 * ARI_KIN1.1
36	OTA_WKM1.1__OTA_WKM2.1__OTA_WKM2__WKM__LN	393.81	560190	-.645 * OTA_WKM2.1 + -1.288 * OTA_WKM1.1

Sample of nodal prices:

TP		29	30	31	32	33	34	35	36
Energy Price	ARI1101	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
	HAY2201	236.24	121.39	306.38	156461.2	154608.6	154609.9	155014.9	158390.8
	OTA0221	481.87	230.26	625.61	494180.8	490672.6	490672.6	489931.5	489083.8
	TRK2201	-14.57	18.82	-19.02	4330.82	4327.37	4327.09	4334.08	4401.22

SFT Turned Off

Results when SFT turned off as would occur in this situation:

No SFT constraints generated.

No binding constraints.

Sample of nodal prices:

TP		29	30	31	32	33	34	35	36
Energy Price	ARI1101	84.64	84.66	87.03	100.29	81.38	89.51	93.32	97.5
	HAY2201	78.32	77.96	80.11	104.98	83.98	93.22	101.24	102.16
	OTA0221	91.24	91.03	93.44	124.55	99.56	110.37	119.92	120.83
	TRK2201	82.56	82.37	84.64	103.76	83.62	92.54	100.61	101.2



SFT Off**Binding constraints:**

TP	Constraint	Limit	Price	Constraint Build
31	OHW_WKM_1_S_O_1A	54	745.95	-1.04 * KIN_TRK1.2 + -.11 * HAM_WKM.1 <=

Sample of nodal prices:

TP		29	30	31	32	33	34	35	36
Energy Price	ARI1101	84.64	84.66	262.97	100.29	81.38	89.51	93.32	97.5
	HAY2201	78.32	77.96	109.88	104.98	83.98	93.22	101.24	102.16
	OTA0221	90.68	90.48	159.86	123.79	98.96	109.7	119.19	120.09
	TRK2201	82.56	82.37	50.57	103.76	83.62	92.54	100.61	101.2

2.7.3 Observations

While the results with SFT on have been shown here, this is only to demonstrate that SFT continued to AC solve and create valid constraints even during this extreme situation. In reality for this event where constraints could never be satisfied (N-8) SFT would be turned off. At least until it was identified where security could be restored. Monitoring (SFT creating constraints) would then be turned off where security could not be restored and SFT would be turned back on.

2.8 Scenario 8: South Island West Coast split

Ascertain how SFT manages the associated constraints

Similar to TP 23-26 on 1 February 2010 when the West Coast split caused high Upper South Island prices

WITS UAT schedule: Dispatch (SDPQ) 29/10/2010 10:48:22 TP23-26

2.8.1 Investigation

01-Feb-2010

Planned outages

08:00_18/01-16:00_12/02 GYM_C1C2C3: 5 Mvar restriction required on GYM caps due to GYM T1 outage for Electronet maintenance

07:30_01/02-18:00_02/02 Daily APS OTI 1

Sequence of events

07:24 PTP: APS OTI 1 & COL OTI 2

08:27 HKK CAPS: ENS report of fire in HKK CAP room

08:31 CTO: Submitted for HKK CAPs out from now until 18:00 due to fire in CAP room

08:57 HKK N-1: Post contingent volts at HKK at 1 stage indicating 59.27 (minimum is 59.4). Looking at options, raising voltages, finding out how long HKK caps will be unavailable, may declare Grid Emergency and remove HKK OTI, checking recall time on APS OTI/COL OTI 2.

10:00 HKK CAPS: Fire/failure caused by reactor coils. Westpower are going to bypass them. Caps should be available at 13:00. 1.5MW Water heating load control available if required.

12:06 DOB T1/T2/T12: Tripped. LOS DOB 6.9MW, GYM 7.2MW, KUM 8MW, HKK 11.5MW, OTI 0.6MW (total 34.2MW)

12:16 AFS: DOB T1/T2/T12

12:17 GEN: Grid Emergency declared DOB, GYM, KUM, HKK, OTI 12:17-13:00 due to number of switching instructions required to restore.

12:18 PTP: Open DOB 112, restore DOB T12

12:21 PTP: Restore DOB T1 - DOB load restored

12:26 PTP: Open KUM 232 & 242, close DOB 112

12:28 GYM 82: (DOB GYM) tripped.

12:38 PTP: Open GYM 102, close 82 - GYM load restored.

12:42 PTP: Open KUM 222, close GYM 102, close KUM 222 - KUM load restored

12:46 PTP: Open HKK 282, close KUM 232

12:47 HKK 262: (HKK KUM) tripped

12:51 PTP: Close KUM 242 - OTI load restored.

12:56 PTP: Close HKK 262 - HKK load restored

12:57 PTP: Close HKK 282, restore DOB T2

12:57 GEN: Grid Emergency DOB, GYM, KUM, HKK, OTI ends.

2.8.2 Results

SFT On

SFT generated constraints:

EDN_INV.1__GOR_ROX.1__GOR_ROX__INV__LN
ROX__T10__220KV__EDN_INV.1__EDN_INV__XF

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
26	ROX__T10__220KV__EDN_INV.1__EDN_INV__XF	50.87	2.03	-1.087 * EDN_INV.1 + 1 * ROX_T10.T10

Sample of nodal prices:

TP		23	24	25	26
Energy Price	HKK0661	62.81	64.05	64.05	60.86
	ISL2201	48.83	48.88	48.88	46.42
	STK2201	50.12	50.17	50.17	47.67

SFT Off

No binding constraints.

Sample of nodal prices:

TP		23	24	25	26
Energy Price	HKK0661	62.81	64.05	64.05	60.99
	ISL2201	48.83	48.88	48.88	46.51
	STK2201	50.12	50.17	50.17	47.77

2.8.3 Observations

There were no additional constraints generated due to the trippings.

The tripped equipment was never offered out by the Grid Owner so was not modelled out of service. SFT depends on equipment being modelled out of the market.

DOB T1, T2 and T12 tripped but was made available for service ten minutes later. This would be typical in a wide spread event, only the equipment that could not be returned to service would be offered out and subsequently modelled.

With no binding constraints in either schedule affecting the upper South Island prices are similar whether SFT is on or off.

2.9 Scenario 9: Spring washer pricing at OTA

Similar to TP 16-21 on 2 February with emphasis on final price outcomes

WITS UAT schedule: Dispatch (SDPQ) 29/10/2010 10:16:52 TP16-21

2.9.1 Results

SFT On

All SFT generated constraints:

COB_STK2.2__COB_UTK1.1__COBUTK1*__COB__LN
ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN
ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN
ARI_HAM2.1__HAM_WKM.1__HAM_WKM__HAM__LN
COL_HOR2.1__COL_HOR3.1__COL_HOR3__COL__LN
COL_HOR3.1__COL_HOR2.1__COL_HOR2__COL__LN
KIN_TRK1.1__HAM_WKM.1__HAM_WKM__KIN__LN
KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
SFD__T10__220KV__CST_NPL2.1__CST_NPL2__XF

No binding SFT constraints.

SFT equivalent of constraints that bound with SFT Off:

TP	Constraint	Limit	% Binding	Constraint Build
17	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.73	91.5	.475 * ARI_HAM2.1 + 1.04 * ARI_HAM1.1
17	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.73	91.5	.475 * ARI_HAM1.1 + 1.04 * ARI_HAM2.1
18	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.72	93	.474 * ARI_HAM2.1 + 1.041 * ARI_HAM1.1
18	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.72	93	.474 * ARI_HAM1.1 + 1.041 * ARI_HAM2.1
19	ARI_HAM1.1__ARI_HAM2.1__ARI_HAM2__HAM__LN	50.76	92.7	.476 * ARI_HAM2.1 + 1.041 * ARI_HAM1.1
19	ARI_HAM2.1__ARI_HAM1.1__ARI_HAM1__HAM__LN	50.76	92.7	.476 * ARI_HAM1.1 + 1.041 * ARI_HAM2.1

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
17	ARI_HAM_1_and_2__ARI_RUNBACK_DISABLED_S_P_1	45	3.42	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=
18	ARI_HAM_1_and_2__ARI_RUNBACK_DISABLED_S_P_1	45	50.84	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=
19	ARI_HAM_1_and_2__ARI_RUNBACK_DISABLED_S_P_1	45	50.89	1.05 * ARI_HAM2.1 + .48 * ARI_HAM1.1 <=

2.9.2 Observations

SFT constraints while generated did not bind as there was no scheduled security violation, though the constraints were generated. The constraint that bound with SFT off was not to protect the worst security issue which was for post event load on KIN TRK 2 in the event of HAM WKM contingency.

2.10 Scenario 10: Spring washer pricing at TRK

Similar to TP 26-29 on 3 February 2010 with emphasis on final price outcomes
WITS UAT schedule: Dispatch (SDPQ) 29/10/2010 13:15:13 TP26-29

2.10.1 Results

SFT On

All SFT generated constraints:

BOB_HAM1.1__BOB_HAM2.1__BOB_HAM2__HAM__LN
BOB_HAM1.1__OHW_OTA1.1__OHW_OTA1__HAM__LN
BOB_HAM1.1__OHW_OTA2.1__OHW_OTA2__HAM__LN
BOB_HAM2.1__BOB_HAM1.1__BOB_HAM1__HAM__LN
BOB_HAM2.1__OHW_OTA1.1__OHW_OTA1__HAM__LN
BOB_HAM2.1__OHW_OTA2.1__OHW_OTA2__HAM__LN
KIN_TRK1.2__HAM_WKM.1__HAM_WKM__TRK__LN
KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN
COB_STK2.2__COB_UTK1.1__COB_UTK1__COB__LN
COB_STK2.2__MPI_UTK.1__MPI_UTK__COB__LN
COL_HOR2.1__COL_HOR3.1__COL_HOR3__COL__LN
COL_HOR3.1__COL_HOR2.1__COL_HOR2__COL__LN
KIN_TRK1.1__HAM_WKM.1__HAM_WKM__KIN__LN
KIN_TRK1.1__KIN_TRK2.2__KIN_TRK2__KIN__LN
KIN_TRK1.2__OHW_WKM1.1__OHW_WKM1__TRK__LN
KIN_TRK1.2__OTA_WKM1.1__OTA_WKM1__TRK__LN
KIN_TRK1.2__OTA_WKM2.1__OTA_WKM2__TRK__LN

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
27	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	54.35	1119.77	-.537 * KIN_TRK2.2 + -1.047 * KIN_TRK1.2
28	KIN_TRK1.2__KIN_TRK2.2__KIN_TRK2__TRK__LN	54.18	1107.74	-.538 * KIN_TRK2.2 + -1.047 * KIN_TRK1.2

Sample of nodal prices:

TP		26	27	28	29
Energy Price	ARI1101	71.68	441.33	433.39	84.7
	HAY2201	68.72	104.9	100.61	80.97
	KIN1101	72.37	633.75	623.75	85.51
	OTA2201	78.21	161.78	156.46	92.4
	TRK2201	70.69	19.16	15.58	83.52

SFT Off

Binding constraints:

TP	Constraint	Limit	Price	Constraint Build
28	KIN_TRK_1_S_P_1A	57	353.88	-.07 * HAM_WKM.1 + -1.04 * KIN_TRK1.2 <=

Sample of nodal prices:

TP		26	27	28	29
Energy Price	ARI1101	71.68	93.04	164.38	84.7
	HAY2201	68.72	88.65	84.63	80.97
	KIN1101	72.37	95.43	205.33	85.51
	OTA2201	78.21	100.92	110.4	92.4
	TRK2201	70.69	91.63	66.63	83.52

2.10.2 Observations

On the day the manually applied constraint was relaxed from 54MW to 57MW and discretion was used to manage security. SFT will not change this process, if binding constraint(s) are causing undesirable effects the constraint may be relaxed, though the constraints are valid. Once the SFT constraint was relaxed resulting prices would have been similar.