

# SFT Implementation

## Parallel Operations Final ReportParallel Operations Final Report

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

SYSTEM OPERATOR

*Keeping the energy flowing*

TRANSPOWER



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## 1.1 Parallel Operations Notes

- During the parallel operations phase, weekdays from 17:00 to 19:00 the following was carried out to provide an environment aligned to Production with SFT on:

The SFT test environment used the same following inputs as production at all times:

- Outages (although at times these were not automatically acknowledged / accepted so were not used until manually accepted)
- Load forecast
- Bids / offers

During the parallel operations period the following manual actions were carried out:

- Acknowledging / accepting changes to outages (new ones and time changes of existing ones)
- Applying any discretionary constraints
- Modelling the HVDC including risk subtractor
- Any manual adjustments to the Load Forecast
- Applying any overrides to outages that need to be modelled. Of note, at present, when the KIN splits are put in place and modelled an override needs to be applied to our system that tells contingency analysis that the ARI KIN overload scheme is armed
- Manually ran RTD schedules so that the dispatch in the SFT Test system was exactly the same as in Production (dispatching whenever schedules are dispatched in real time). Manual model changes (changing voltage set points / transformer tap positions etc) that are applied to our schedules
- See Appendix A for the list of every constraint generated by SFT for the entire parallel operations phase. This list includes constraints generated by all SFT schedules so includes:
  - Constraints generated out to WDS timeframe
  - For outages that were subsequently cancelled (so the constraints were never applied in real time)
  - For branches we will not be creating constraints for in the future. Due to the flag and override not being available prior to parallel operations SFT was allowed to generate constraints to protect every branch. In reality there will be a large number of branches that will be flagged to not protect (do not create a SFT constraint for). This will typically be:
    - Supply transformers
    - Tertiary windings of interconnectors
    - Spur feeds with little or no generation
    - Where contingency analysis modelling is inadequate so constraints would be inaccurate
      - Where a runback scheme cannot be accurately modelled and /or where the operation of the scheme would cause a subsequent violation on another branch
      - Where voltage collapse would result in inaccurate post event loads
- See Appendix B for the list of all constraints that were binding in RTD (indicative of what would have occurred in final pricing).
- Appendix C is a list of all the Production system constraints that bound during parallel operations.



## 2 Parallel Operations Observations

- There were no unnecessary SFT constraints generated in scheduling time due to planned outages (where an exclude SFT constraint outage override would have been applied).
- All constraints generated by SFT and applied to RTD were valid.
- There was no RHS adjustments required in real time, whenever a constraint was binding the associated violation was active or near violating.
- At times, constraints were not generated where offers did not reflect intended generation. In some cases a security violation occurred in real time, though the manually applied constraint would not be binding in this situation either.
- **Benefits of SFT:** Based on parallel operations and scenario testing results the following results became apparent:
  - Generators will be able to offer closer to binding constraint limits with reduced margins of error due to the constraints all being created based on the most up to date offers, topology and load forecasts. At present permanent and outage constraints are manually created for a small number of what is expected to be the worst case scenarios (load / generation). It is a manual process and depends on accurately identifying when new / associated outages / changes to system conditions will require creating new constraints or changing existing ones. Given how quickly the situation can change this often doesn't get identified until real time or near real time. Existing constraints then get changed unexpectedly by occasionally large proportions. Alternatively discretion is used in real time, while this doesn't have the pricing impact of a binding constraint, it does impact on generators ability to control fuel supply. Where, for example, Southland changes rapidly from low to high generation pattern SFT immediately identifies where this is an issue for transmission and generation (being constrained) and where associated outages are or are not still feasible.
  - There were a number of SFT constraints generated where it had not been identified previously that there were problems in steady state. These have now become permanent constraints. Again, having these constraints in the schedules allows early management of offers and outages rather than unexpected restrictions, Grid Emergencies and large constraint changes in real time.
  - There were two instances during parallel operations where SFT results were assessed by planning and real time staff due to the speed and accuracy of the constraints generated and the ability to quickly check the impact on security of the outage. Increasing the speed and accuracy of outage planning given the latest information will allow outages to occur that previously would not have been considered due to complexity in planning; this will have the downstream affect of delaying the need for transmission investment. The two examples were:
    - A short notice outage on a significant 220kV circuit (OHW\_WKM1) where the constraint that had been applied did not alleviate security issues. A number of staff and over six hours of planning was required to create additional constraints and check if the outage could proceed when SFT results were immediate. SFT very quickly identifies what constraints will be applied for the given topology (including associated outages that had not been considered when the manual constraint(s) were created) and generation offers.
    - A large generator offer in the Upper North Island was withdrawn the day before a 10 day significant 220kV circuit outage that had been planned with the generator on. Unplanned security issues appeared

to require load agreements that could not be obtained at short notice and / or grid reconfiguration (BOB splits) with the resulting reduction in security. As soon as the new offers were reflected SFT identified the constraints that would now be required and security could be maintained without the system splits or load agreements. Additionally, it only took 10 minutes to run a schedule modelling the generation off for the Monday morning peak and confirmed that the constraints would achieve security during the outage.



### 3 Appendix

#### 3.1 Appendix A – All SFT generated constraints

ARI_BOB1.1	ATI_WKM1.1	ATI_WKM	ARI_LN	ARI_KIN1.1	HAT_WKM1.1	:S	HAMWKM1\$	ARI_LN	HEN_HPI1.1	ALB_HEN3.1	:S	ALB_HEN3	HEN_LN
ARI_BOB1.1	HAT_WKM1.1	\$HAMWKM1	ARI_LN	ARI_KIN1.1	HAT_WKM1.1	HAMWKM1!	ARI_LN	HKK_OTI2.1	ATU_DOB1.1	ATU_DOB1.1	ATU_DOB1	OTI_LN	
ARI_BOB1.1	HAT_WKM1.1	:S	\$HAMWKM1	ARI_LN	ARI_KIN1.1	HAT_WKM1.1	HAMWKM1\$	ARI_LN	INV_NMA.1	NMA_TW11.1	:S	NMA_TW11	INV_LN
ARI_BOB1.1	HAT_WKM1.1	:S	HAMWKM1!	ARI_LN	ARI_KIN2.1	ARI_KIN1.1	\$ARIKIN!	ARI_LN	INV_NMA.1	NMA_TW12.1	:S	NMA_TW12	INV_LN
ARI_BOB1.1	HAT_WKM1.1	:S	HAMWKM1\$	ARI_LN	ARI_KIN2.1	ARI_KIN1.1	ARIKIN!	ARI_LN	KAW_T13	110KV_EDG_OWH.1	EDG_OWH	XF	
ARI_BOB1.1	HAT_WKM1.1	HAMWKM1!	ARI_LN	ARI_KIN2.1	ARI_KIN1.1	ARIKIN!	ARI_LN	KAW_T13	220KV_EDG_OWH.1	EDG_OWH	XF		
ARI_BOB1.1	HAT_WKM1.1	HAMWKM1\$	ARI_LN	ATI_OHK.1	WKM_PPI_WRK.1	:S	WKM_WRK_OHK_LN	KAW_MAT1.1	KAW_MAT2.1	:S	KAW_MAT2	MAT_LN	
ARI_BOB1.1	HAT_WKM2.1	\$OHWWKM1	ARI_LN	ATI_OHK.1	WKM_PPI_WRK.1	WKM_WRK	ATI_LN	KAW_MAT1.1	KAW_MAT2.1	KAW_MAT2	MAT_LN		
ARI_BOB1.1	HAT_WKM2.1	:S	\$OHWWKM1	ARI_LN	ATI_OHK.1	WKM_PPI_WRK.1	WKM_WRK_OHK_LN	KAW_MAT2.1	KAW_MAT1.1	:S	KAW_MAT1	MAT_LN	
ARI_BOB1.1	HAT_WKM2.1	:S	OHWWKM1!	ARI_LN	ATI_WKM.1	WKM_PPI_WRK.1	WKM_WRK	ATI_LN	KAW_MAT2.1	KAW_MAT1.1	KAW_MAT1	MAT_LN	
ARI_BOB1.1	HAT_WKM2.1	:S	OHWWKM1\$	ARI_LN	COB_STK2.2	BAL_HWB.1	BAL_HWB_COB_LN	KAW_OHK.1	WKM_PPI_WRK.1	:S	WKM_WRK	KAW_LN	
ARI_BOB1.1	HAT_WKM2.1	OHWWKM1!	ARI_LN	COB_STK2.2	COB_UTK1.1	MPI_UTK	COB_LN	KIN_TRK1.1	HAT_WKM1.1	\$HAMWKM1	KIN_LN		
ARI_BOB1.1	HAT_WKM2.1	OHWWKM1\$	ARI_LN	COB_STK2.2	MPI_UTK.1	MPI_UTK	COB_LN	KIN_TRK1.1	HAT_WKM1.1	HAMWKM1!	KIN_LN		
ARI_BOB1.1	OTA_WKM1.1	OTA_WKM1	ARI_LN	COL_HOR2.1	ATU_DOB1.1	:S	ATU_DOB1_HOR_LN	KIN_TRK1.1	HAT_WKM1.1	HAMWKM1\$	KIN_LN		
ARI_BOB1.1	OTA_WKM2.1	OTA_WKM2	ARI_LN	COL_HOR2.1	ATU_DOB1.1	ATU_DOB1	HOR_LN	KIN_TRK1.1	HAT_WKM2.1	OHWWKM1!	KIN_LN		
ARI_HAM1.1	ARI_BOB1.1	\$ARIBOBI	HAM_LN	COL_HOR2.1	ATU_IGH1.1	:S	ATUIGHI*HOR_LN	KIN_TRK1.1	HAT_WKM2.1	OHWWKM1\$	KIN_LN		
ARI_HAM1.1	ARI_HAM2.1	\$ARIHAM2	HAM_LN	COL_HOR2.1	ATU_IGH1.1	ATUIGHI*	HOR_LN	KIN_TRK1.1	KIN_TRK2.2	KIN_TRK2	KIN_LN		
ARI_HAM1.1	ARI_HAM2.1	:S	\$ARIHAM2	HAM_LN	COL_HOR3.1	ATU_DOB1.1	:S	ATU_DOB1_HOR_LN	HAT_WKM1.1	\$HAMWKM1	TRK_LN		
ARI_HAM1.1	HAT_WKM1.1	\$HAMWKM1	HAM_LN	COL_HOR3.1	ATU_DOB1.1	ATU_DOB1	HOR_LN	KIN_TRK1.2	HAT_WKM1.1	HAMWKM1!	TRK_LN		
ARI_HAM1.1	HAT_WKM1.1	:S	\$HAMWKM1	HAM_LN	COL_HOR3.1	ATU_IGH1.1	:S	ATUIGHI*HOR_LN	HAT_WKM1.1	HAMWKM1\$	TRK_LN		
ARI_HAM1.1	HAT_WKM1.1	HAMWKM1!	HAM_LN	COL_HOR3.1	ATU_IGH1.1	ATUIGHI*	HOR_LN	KIN_TRK1.2	HAT_WKM2.1	OHWWKM1!	TRK_LN		
ARI_HAM1.1	HAT_WKM1.1	HAMWKM1\$	HAM_LN	CPK_WWD_WIL3.3	MTI_WKM1.1	MTI_WKM1.1	MTI_WWD_LN	KIN_TRK1.2	HAT_WKM2.1	OHWWKM1\$	TRK_LN		
ARI_HAM2.1	ARI_BOB1.1	\$ARIBOBI	HAM_LN	CPK_WWD_WIL3.3	MTI_WKM2.1	MTI_WKM2.1	MTI_WWD_LN	KIN_TRK1.2	KIN_TRK2.2	KIN_TRK2	TRK_LN		
ARI_HAM2.1	ARI_HAM1.1	\$ARIHAM1	HAM_LN	EDG_KAW1.1	ATI_OHK.1	ATI_OHK	KAW_LN	OHK_WRK.1	WKM_PPI_WRK.1	WKM_WRK	WRK_LN		
ARI_HAM2.1	ARI_HAM1.1	:S	\$ARIHAM1	HAM_LN	EDG_KAW1.1	EDG_KAW3.1	EDG_KAW3_KAW_LN	OKE_OWH.1	KAW_OHK.1	KAW_OHK	OKE_LN		
ARI_HAM2.1	HAT_WKM1.1	\$HAMWKM1	HAM_LN	EDG_KAW2.1	ATI_OHK.1	ATI_OHK	KAW_LN	OKE_TMI.1	KMO_TRK2.1	KMO_TRK2	TMI_LN		
ARI_HAM2.1	HAT_WKM1.1	:S	\$HAMWKM1	HAM_LN	EDG_OWH.1	EDG_KAW3.1	EDG_KAW3_EDG_LN	OKE_TRK.1	KAW_OHK.1	KAW_OHK	TRK_LN		
ARI_HAM2.1	HAT_WKM1.1	HAMWKM1!	HAM_LN	EDN_INV.1	GOR_ROX.1	GOR_ROX	INV_LN	OKE_TRK.1	KMO_TRK1.1	KMO_TRK1	TRK_LN		
ARI_HAM2.1	HAT_WKM1.1	HAMWKM1\$	HAM_LN	HAM_KPO1.2	HIN_KPO.1	HIN_KPO	KPO_LN	OKE_TRK.1	KMO_TRK2.1	KMO_TRK2	TRK_LN		
ARI_KIN1.1	ARI_KIN2.1	\$ARIKIN2	ARI_LN	HAM_KPO2.2	HIN_KPO.1	HIN_KPO	KPO_LN	ROX_T10	110KV_BAL_GOR.1	BAL_GOR	XF		
ARI_KIN1.1	ARI_KIN2.1	:S	\$ARIKIN2	ARI_LN	HAT_WKM1.1	HAT_WKM2.1	\$OHWWKM1	WKM_LN	ROX_T10	110KV_GOR_ROX.1	GOR_ROX	XF	
ARI_KIN1.1	ARI_KIN2.1	:S	ARIKIN2!	ARI_LN	HAT_WKM1.1	HAT_WKM2.1	OHWWKM1!	WKM_LN	ROX_T10	110KV_HWB_ROX.1	HWB_ROX	XF	
ARI_KIN1.1	ARI_KIN2.1	:S	ARIKIN2\$	ARI_LN	HAT_WKM1.1	HAT_WKM2.1	OHWWKM1\$	WKM_LN	ROX_T10	110KV_HWB_ROX2.1	HWB_ROX2	XF	
ARI_KIN1.1	ARI_KIN2.1	ARIKIN2!	ARI_LN	HAT_WKM2.1	HAT_WKM1.1	\$HAMWKM1	WKM_LN	STK_T3	110KV_MPI_UTK.1	MPI_UTK	XF		
ARI_KIN1.1	ARI_KIN2.1	ARIKIN2\$	ARI_LN	HAT_WKM2.1	HAT_WKM1.1	HAMWKM1!	WKM_LN	WKM_PPI_WRK.1	ATI_WKM.1	:S	ATI_WKM	WKM_LN	
ARI_KIN1.1	HAT_WKM1.1	:S	HAMWKM1!	ARI_LN	HAT_WKM2.1	HAT_WKM1.1	HAMWKM1\$	WKM_LN	WKM_PPI_WRK.1	OHK_WRK.1	:S	OHK_WRK	WKM_LN

### 3.2 Appendix B - RTD SFT Binding Constraints

Trading Date	Period	Group Branch Name	Formula	Limit (MW)
20/08/2010	34	ARI_HAM1.1_ARI_HAM2.1_ŞARIHAM2_HAM_LN	.447 * ARI_HAM2.1+1.429 * ARI_HAM1.1 <=	84.34
20/08/2010	33	ARI_HAM1.1_ARI_HAM2.1_ŞARIHAM2_HAM_LN	.449 * ARI_HAM2.1+1.4 * ARI_HAM1.1 <=	82.52
31/08/2010	33	KAW_OHK.1_WKM_PPI_WRK.1_Ş_WKM_WRK_KAW_LN	.511 * WKM_PPI_WRK.1+-1 * KAW_OHK.1 <=	301.7
6/09/2010	36	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.734 * GOR_ROX.1+-1 * ROX_T10.T10 <=	48.53
6/09/2010	35	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.735 * GOR_ROX.1+-1 * ROX_T10.T10 <=	48.57
6/09/2010	34	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.74 * GOR_ROX.1+-1 * ROX_T10.T10 <=	57.19
6/09/2010	33	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.739 * GOR_ROX.1+-1 * ROX_T10.T10 <=	57.8
8/09/2010	37	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.594 * GOR_ROX.1+-1 * ROX_T10.T10 <=	47.85
8/09/2010	35	ROX_T10_110KV_GOR_ROX.1_GOR_ROX_XF	-.6 * GOR_ROX.1+-1 * ROX_T10.T10 <=	48.49
20/09/2010	38	KIN_TRK1.2_HAT_WKM1.1_ŞHAMWKM1_TRK_LN	-.072 * HAT_WKM1.1+-1.043 * KIN_TRK1.2 <=	64.49
21/09/2010	37	HAT_WKM1.1_HAT_WKM2.1_OHWWKM1Ş_WKM_LN	-.496 * HAT_WKM2.1+-1.3 * HAT_WKM1.1 <=	665.24
21/09/2010	37	HAT_WKM1.1_HAT_WKM2.1_OHWWKM1!_WKM_LN	-.496 * HAT_WKM2.1+-1.3 * HAT_WKM1.1 <=	665.24
21/09/2010	37	HAT_WKM1.1_HAT_WKM2.1_ŞOHWWKM1_WKM_LN	-.496 * HAT_WKM2.1+-1.3 * HAT_WKM1.1 <=	665.24
30/09/2010	35	KAW_MAT2.1_KAW_MAT1.1_KAW_MAT1_MAT_LN	-1 * KAW_MAT1.1+-1.074 * KAW_MAT2.1 <=	103.42
30/09/2010	35	KAW_MAT1.1_KAW_MAT2.1_KAW_MAT2_MAT_LN	-1 * KAW_MAT2.1+-1.074 * KAW_MAT1.1 <=	103.42
5/10/2010	35	KIN_TRK1.2_KIN_TRK2.2_KIN_TRK2_TRK_LN	-.533 * KIN_TRK2.2+-1.046 * KIN_TRK1.2 <=	67.86
8/10/2010	38	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.969 * HIN_KPO.1+-1.058 * HAM_KPO1.2 <=	78.15
8/10/2010	37	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.968 * HIN_KPO.1+-1.058 * HAM_KPO1.2 <=	78.1
8/10/2010	36	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.973 * HIN_KPO.1+-1.056 * HAM_KPO1.2 <=	77.95
8/10/2010	35	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.969 * HIN_KPO.1+-1.055 * HAM_KPO1.2 <=	78
8/10/2010	34	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.969 * HIN_KPO.1+-1.055 * HAM_KPO1.2 <=	78.01
8/10/2010	33	HAM_KPO1.2_HIN_KPO.1_HIN_KPO_KPO_LN	-.968 * HIN_KPO.1+-1.055 * HAM_KPO1.2 <=	78.01

### 3.3 Appendix C – Binding Production Constraints

Trading Date	Period	Group Branch Name	Formula	Limit (MW)
20/08/2010	33	ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	ARI_HAM2.1*1.42+ARI_HAM1.1*.49<=	87
20/08/2010	34	ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	ARI_HAM2.1*1.42+ARI_HAM1.1*.49<=	87
2/09/2010	35	ARI_HAM_1_and_2_ARI_RUNBACK_ENABLED_W_P_1A	ARI_HAM2.1*1.42+ARI_HAM1.1*.49<=	87
6/09/2010	33	HWB_ROX_2_W_O_z	ROX_T10.T10*-1+GOR_ROX.1*-.74<=	50
6/09/2010	34	HWB_ROX_2_W_O_z	ROX_T10.T10*-1+GOR_ROX.1*-.74<=	50
6/09/2010	35	HWB_ROX_2_W_O_z	ROX_T10.T10*-1+GOR_ROX.1*-.74<=	50
6/09/2010	36	HWB_ROX_2_W_O_z	ROX_T10.T10*-1+GOR_ROX.1*-.74<=	50
8/09/2010	33	ROX_T10_P_1_temp	ROX_T10.T10*-1+GOR_ROX.1*-.6<=	50
8/09/2010	35	ROX_T10_P_1_temp	ROX_T10.T10*-1+GOR_ROX.1*-.6<=	50
8/09/2010	37	ROX_T10_P_1_temp	ROX_T10.T10*-1+GOR_ROX.1*-.6<=	50
20/09/2010	33	INV_MAN_2_W_O_1	INV_NMA.1*-1+NMA_TWI1.1*.6<=	433
20/09/2010	34	INV_MAN_2_W_O_1	INV_NMA.1*-1+NMA_TWI1.1*.6<=	433
20/09/2010	35	INV_MAN_2_W_O_1	INV_NMA.1*-1+NMA_TWI1.1*.6<=	433
20/09/2010	37	INV_MAN_2_W_O_1	INV_NMA.1*-1+NMA_TWI1.1*.6<=	433
20/09/2010	38	INV_MAN_2_W_O_1	INV_NMA.1*-1+NMA_TWI1.1*.6<=	433
5/10/2010	35	KIN_TRK_1_W_P_2A	KIN_TRK1.2*-1.05+KIN_TRK2.2*-.5<=	67
8/10/2010	33	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74
8/10/2010	34	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74
8/10/2010	35	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74
8/10/2010	36	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74
8/10/2010	37	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74
8/10/2010	38	HAM_KPO_2_W_O_1	HAM_KPO1.2*-1.05+HIN_KPO.1*-1<=	74