



System Operations Division Security Constraints Process Overview

Document Location Map

- 📁 **Level 2 Document User Domain Process**
- 📁 **Outages and Constraints (OC) /Security Assessment**
- 📄 **PR-OC-204 Security Constraints Process Overview**

Document Status: **Approved**

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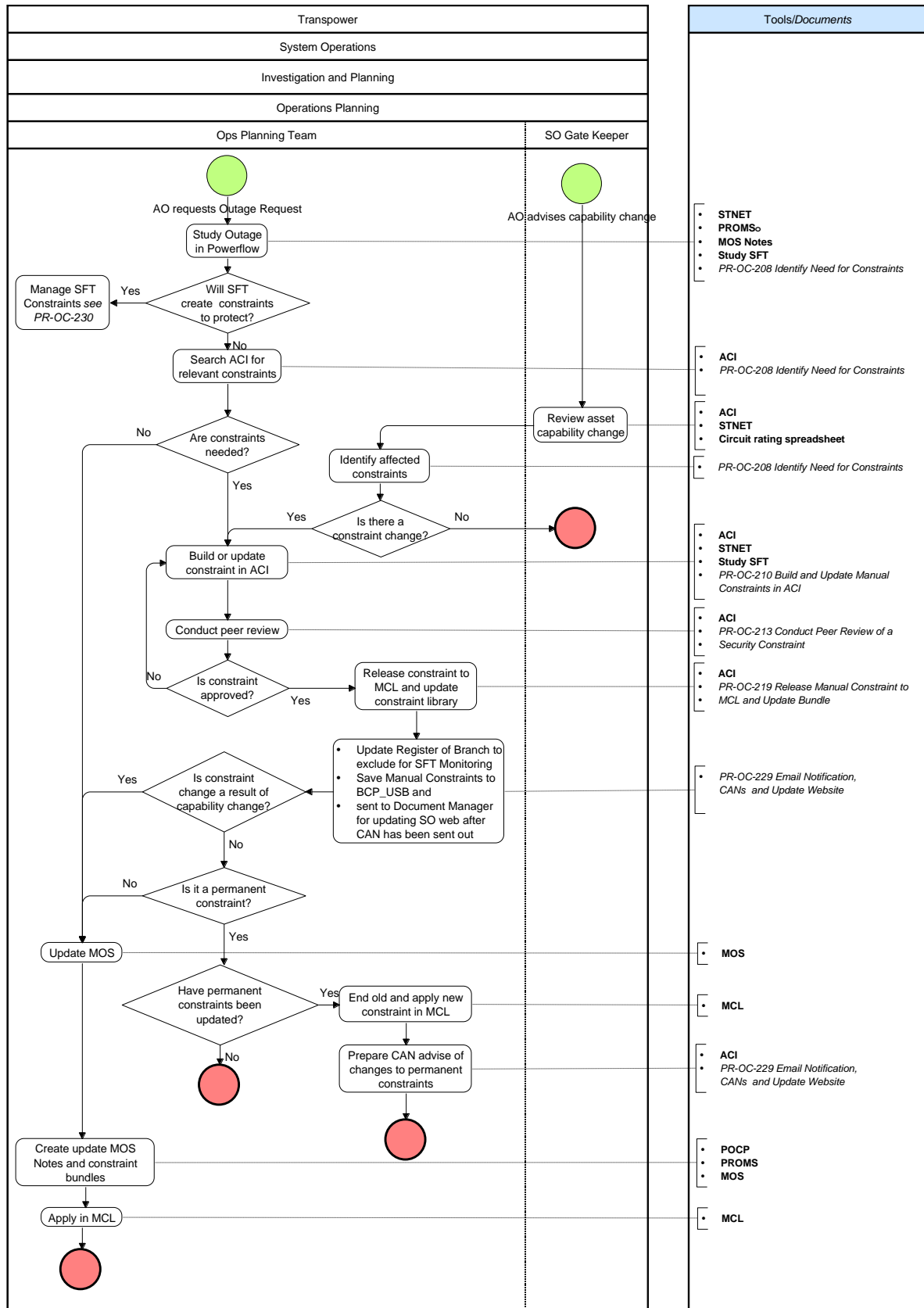
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Revision History

Revision	Date	Change	Section
V01	24/5/10	Supersedes PR-SH-040, reference documentation updated.	
V02	22/10/10	Updated for EGR to Code changes.	
V03	11/2/11	SFT Update update flowchart add 2 points to OPE small amendment update permanent, outage, constraint section insert step 1	1 5 9 10 11
V04	4/7/11	Procedure Summary diagram updated, Role responsibilities for SFT SME added, New Manual Constraints Register added	1 5 7
V05	14/7/11	Removed role responsibilities for SFT SME	1 and 5



1 Procedure Summary Diagram



NOTE – The diagram above shows how the process in the Security Constraints Process Overview; document number PR-OC-204, supports the Outages and Constraints (OC) Macro Process of the DMS.



2 Purpose

Purpose and Objectives This document gives background information about the security constraint development process. It explains the SPD model and constraint types, and gives an overview of considerations around applying constraints.

External Policy/ Rules & Regulations Policy Statement

Related Internal Policies, Processes and Procedures Transpower or DMS Procedures that people must be aware of when they follow this procedure.

PR-EA-001 Grid Assets Seasonal Ratings Changeover.doc

GL-OC-202 Security Constraints Development Methodology.doc

PR-OC-208 Identify Need for Constraints.doc

PR-OC-210 Build & Update Constraints in ACI.doc

PR-OC-213 Conduct Peer Review of Security Constraints.doc

PR-OC-215 Determine Conductor Thermal Characteristics for use in Constraints Development.doc

PR-OC-218 Release Constraint to MCL and Update Bundle.doc

PR-OC-219 Create or Modify Security Constraints & Bundle Names

PR-OC-229 Email Notification CANs Updating Website

UG-OC-205 Security Constraint Development Paper

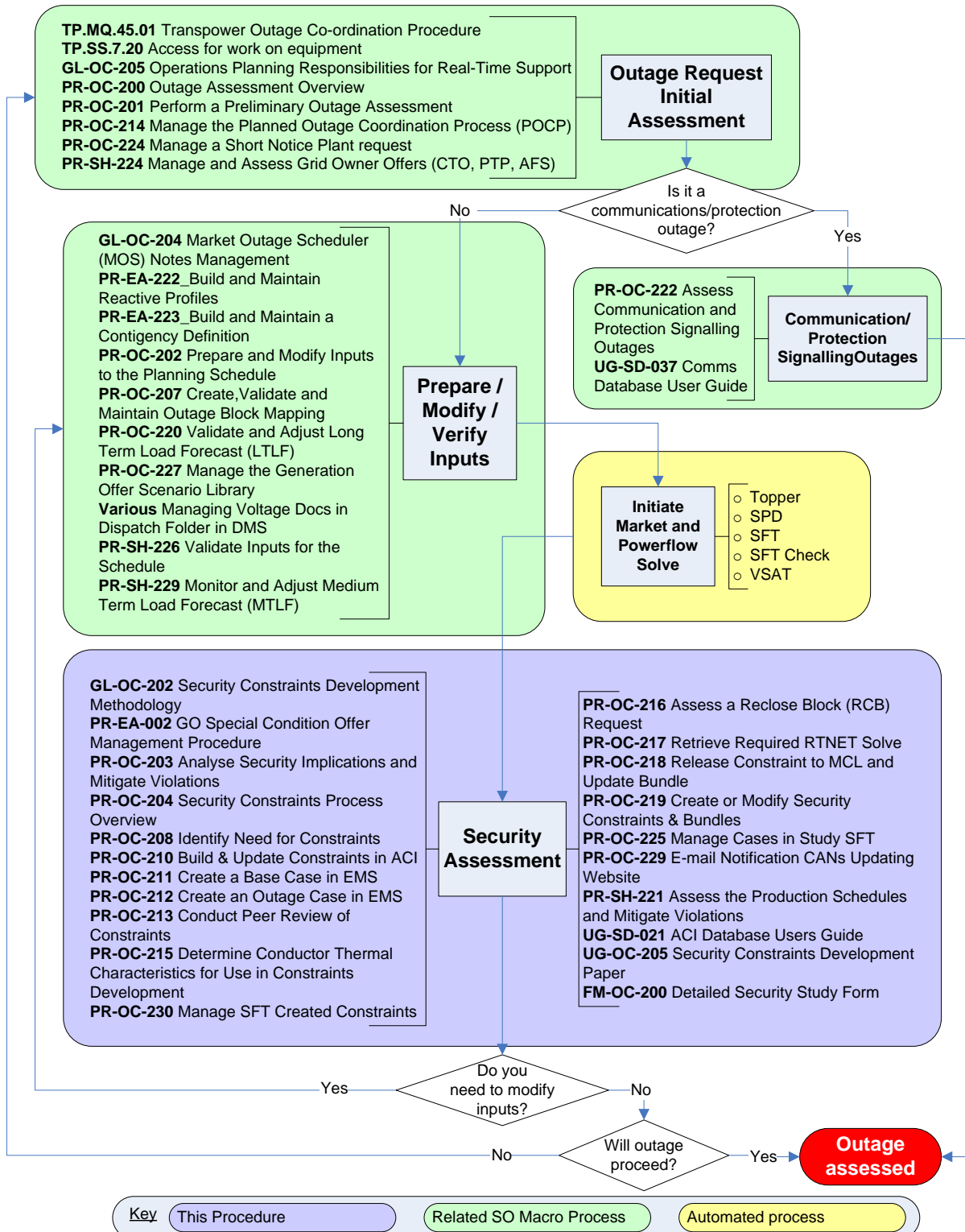
Market System training modules (self-study workbooks):

- Manual Constraint using Constraint Library
- Market Operator Interface (MOI) concepts
- Overrides concepts
- Overrides
- Outage Management Concepts



3 Related Procedure/Processes

Outage Assessment Process Documents



4 Constraint Development – General

Need to maintain security

Contingent events can overload remaining transmission circuits. The overload results in the circuits being removed from service and this, in turn, may overload other remaining circuits. This also results in circuits being removed from service. The removal of circuits may eventually result in cascade failure.

The System Operator needs to maintain reasonable reserve transmission capacity to allow for contingent events and to meet principle performance objectives.

System Operator responsibilities

The System Operator needs to:

- manage equipment loadings to within their ratings as advised by the Asset Owner
- manage voltage at points of service
- maintain sufficient system stability margins, for both pre and post contingent events.

This is achieved by applying transmission security constraints to the scheduling, pricing and dispatch (SPD) model.

Internal Policies and Guidelines

- TP.OG.45.03: Dictionary of operating terms
- TP.GG 01.10: Equipment Rating

Dependencies

- Equipment Ratings Change Notification Process.
- Commissioning Process
- Outage Co-ordination Process.

Summer/Shoulder/Winter changeover

From 10 May to 20 October Winter day ratings apply. During this period, all relevant permanent Winter constraints are to be applied.

From 20 October to 1 December and 15 March to 10 May Shoulder day and winter night ratings apply. During this period, all relevant permanent Shoulder and Winter constraints are to be applied.

From 1 December to 15 March Summer day and winter night ratings apply. During this period, all relevant permanent Summer and Winter constraints are to be applied.

Changeover of these constraints will be applied automatically by the Market systems based on their temperature attributes without the need for manual intervention.

Note: Each permanent constraint is to be evaluated individually as some are only to be applied during certain grid conditions. i.e. There are constraints for the "Hawera_Auto bus splitting scheme" enabled and disabled, hence you would only apply one of these constraints at any one time.

Reference: See the following document on Summer/Winter changeover:

PR-EA-001 Grid Assets Seasonal Ratings Changeover

5 Constraint Development – Responsibilities and Timeframe

Responsibilities

The following table lists the roles involved in the process and describes the responsibilities for each role.

Role	Responsibilities
Operations Planning Engineer (OPE)	<ul style="list-style-type: none"> ▪ Identifying requirements of changes to security constraints through the Equipment Ratings Change Notification process, general power system or outage assessment studies, and the commissioning process. ▪ Developing security constraints within acceptable timeframe. ▪ Ensuring accurate constraints equations. ▪ Updating and managing content of ACI Constraint Database. ▪ Ensuring constraints in the ACI database are reflected correctly in MCL. ▪ Identifying when CANs need to be issued for constraints, and drafting CANs for permanent constraints. ▪ Reviewing the post- real time performance of the constraints and fine-tuning of constraints to ensure they meet their intended objectives. ▪ Validating SFT Constraints in the WDS schedule. ▪ Setting up branches for monitoring in the CSM base model. ▪ Update Register of Branches to Exclude for SFT Monitoring spreadsheet ▪ Notify SO doc administrator to update manual constraints spreadsheet to SO website. ▪ Maintain a copy of the manual constraints spreadsheet in the SO BCP_USB Backup directory.
Operations Planning Team Leader (OPTL)	<ul style="list-style-type: none"> ▪ Ensuring process detailed in this document is followed. ▪ Reviewing and approving security constraint to be entered into the market model (SPD).
Operations Planning Manager	<ul style="list-style-type: none"> ▪ Ensuring the staff follow the process. ▪ Accountable to Transpower management.
Security Co-ordinator	<ul style="list-style-type: none"> ▪ Issuing CANs.



6 Tools

Introduction This topic outlines the systems, tools, and procedures used in the development and management of constraints.

Systems/Tools The tools that may be used in the security constraints development process include but are not limited to the following:

- Power Flow and Contingency Analysis - STNET and STCA in the EMS application (maintained by SO and WEMS)
- Dynamic Stability Analysis – DigSilent or PSS/E
- SCADA information from HabConnect (maintained by WEMS)
- Circuit Rating Spreadsheet (maintained by Operations Planning)
- Asset Capability Information (ACI)
- SPD Drawing (maintained by Market Services)
- ACI Constraint Database (maintained by WEMS)
- MCL Market Constraints Library
- Voltage Stability Assessment Tool (VSAT) (maintained by SO and WEMS)
- Market Outage Scheduler (MOS)
- Simultaneous Feasibility Test (SFT)
- Study SFT
- SFT check
- Market Operator Interface (MOI)



7 Constraint Development – Flags, Outputs and Tasks

Flags

- Unmanageable contingencies in real time operation or in system studies for which there is a generation solution. This may indicate a requirement for security constraints or a need for fine-tuning or modification to existing constraints.
- Infeasibilities in SPD caused by security constraints-This may indicate insufficient generation or inaccurate load forecasting.

Outputs

The required output is an up-to-date constraint, with relevant people being notified.

Tasks

Below is a list of the tasks involved in the Constraint Development Process:

Constraints developed during planning

- Required constraints are identified and developed at planning stages rather than at real time.

Constraints reviewed and updated

- Equipment ratings or system configuration changes are captured and affected constraints are reviewed and updated to reflect these changes prior to new ratings or configuration being implemented.

Purpose of Constraints documented

- The purpose and scenarios that the constraints are designed for are clearly documented and easily accessible.

Database updated

- The ACI and MCL is updated in a consistent and timely manner.

Changes communicated

- Operational staff are well informed of any new constraints and changes to existing constraints in a timely manner.
- The market participants are well informed of any new permanent constraints or changes to existing permanent constraints through the Customer Advice Notice.

Registers Updated

- A register of manual constraints is maintained in the Register of Branches to Exclude for SFT monitoring - Manual Constraints tab.
- A copy of the register is kept on the system operator website.
- The information on the system operator website is reliable and up to date.
- A copy of register is kept in the nipub:\BCP_USB directory.



8 SPD Model

Linear model

The Scheduling Pricing Dispatch (SPD) model is a simplified linear model of the AC power system. The SPD model determines the 'optimised' schedule and dispatch quantities of generation. The dispatched generation quantities affect the utilisation of the transmission system. However, due to the simplified linear model, the modelled utilisation may not reflect the actual utilisation of the physical transmission system.

Limitations of SPD model

The SPD model does not allow for ...	Result
Potential contingent events	It does not attempt to maintain reasonable reserve transmission capacity to allow for contingent events but only for steady state conditions.
Voltage variations and reactive power flows inherent in the AC system	Voltage management and utilisation of the transmission capacity to transmit reactive power have not been considered.
Dynamic system stability margins	It does not ensure sufficient margins are maintained.

The table below shows the limitations of the SPD model.

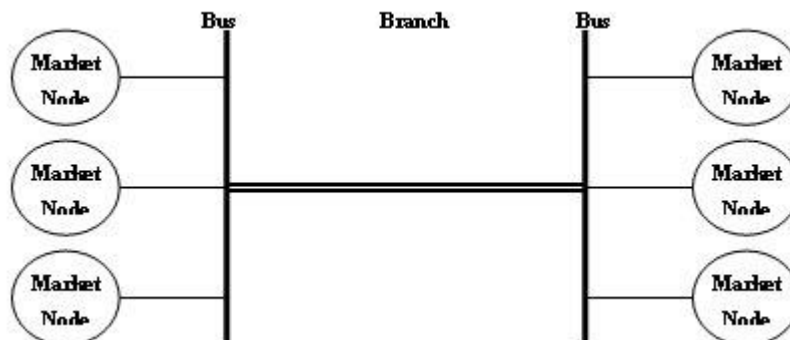
It is necessary to adjust the SPD solution to ensure the dispatched quantities allow the 'Code' requirements to be met.

Needs for adjustment through application of constraints

The System Operator adjusts the SPD solution to ensure sufficient reserve transmission capacity is maintained in the actual transmission system to allow for contingent events. The adjustment is made taking into account the effect of voltage, reactive power flows and any dynamic stability requirements. To adjust the SPD solution, the System Operator applies transmission security constraints in the SPD model.

Elements in transmission system

The transmission system has three major elements. The following diagram shows how they relate to each other.





9 Constraint Types

Three constraint types

The following table lists the three types of security constraints that can be applied to the three major elements of the transmission system.

Type of Constraint	Description
Market Node Constraints	This is applied to set the maximum or minimum offers made by a particular trader (purchaser, generator or both) and trade type (energy or reserves) specific to a market node. It is not necessary to apply this type of constraint to manage security.
Bus Constraints.	This is applied to set the maximum or minimum generation at a bus or group of buses. This effectively allows the System Operator to force generation on or off directly. If this type of constraint is applied the System Operator pays for the constrained on cost.
Branch or Group Constraints	This is applied to set the maximum MW flow on a specific branch or group of branches representing a specific transmission circuit or group of transmission circuits respectively. If the maximum limit is exceeded, the constraint forces generation and creates a different set of marginal prices within the constrained area. If this type of constraint is applied the market pays for the constrained on costs.

Branch and Group constraints

A constraint can be applied to:

- A single element. This is referred to as a Branch Constraint. This can be applied directly through **MCL** or the ACI Constraints Database. These are applicable not only to a single branch but also to a single bus or market node.
- One or more elements. This is referred as a Group Constraint and is directional. This needs to be built in the ACI Constraints Database or automatically created by SFT before it can be applied.



10 Applying Constraints

Applying bus constraints

Most of the time the security can be managed by limiting flows on transmission circuits with branch constraints. However, when a minimum Mvar generation for voltage support is required branch constraints that only specify MW limits may not be sufficient. Therefore, bus constraints may be necessary. The System Operator bears the constrained on cost resulting from bus constraints. Bus constraints are avoided whenever possible.

Note: An example of a bus constraint was constrained on generation at Huntly in June 2000.

Bus versus branch constraints

Branch Constraints inflict costs to the market. Bus Constraints inflict costs to the System Operator. The transmission security constraints need to be designed to allow the SPD solution to approximate to a full power system solution while not unduly restricting the SPD solution from the least cost dispatch.

To achieve this, a branch constraint is used whenever possible. A bus constraint is used only if branch constraints are insufficient to manage security. If a bus constraint is necessary, the Operations Planning Manager must be consulted prior to the application of constraint.

Permanent, outage and temporary constraints

Generally, transmission security constraints can be either SFT or Manual constraints, Manual constraints can be either Permanent or Outage constraints

- **SFT Constraints** are applied on a trading period by trading period basis and are not associated with an outage or set configuration, but rather the forecasted topology for a given trading period. SFT creates constraints in the WDS, SDS, and SDPQ schedules, these constraints must be validated by Operations Planners and Security Coordinators to exclude invalid constraints
- **Manual Constraints**
 - **Permanent constraints** are applied for the 'normal' grid configuration when all transmission capacity is available. These constraints are permanently maintained in SPD.
 - **Outage constraints** are applied only for the period of planned or unplanned transmission outages. The need for an outage security constraint is identified as part of the outage coordination and planning processes either at the scheduling stage or in real time - particularly as a result of an event.
 - **Temporary constraints** can be applied to the normal grid, or for a planned or unplanned outage. They are typically applied as an interim measure until an appropriate permanent or outage constraint is developed and applied in SPD.

Constraining transmission

For both the normal and outage grid configurations Operations Planning manage security for both steady state and the occurrence of a single contingent event. In certain circumstances constraints may be applied to manage double circuit contingencies. Transmission is to be constrained as required to meet system security requirements and generation offer prices are not to influence constraint management.

Market dispatch solution

Security constraints are only applied for market dispatch solution. When there are insufficient market generations in the area, applications of transmission security constraints in the SPD model do not result in the desired dispatch scenarios. Instead, SPD may create infeasibilities in the SPD solve. For these situations other means of security management (such as demand management) may need to be pursued.

Constraint Infeasibility

Constraints should not be applied in situations where generation availability may be limited or restricted. e.g. geothermal generators that usually offer only one tranche of generation offers (e.g. Wairakei).



11 High Level Overview of Security Constraints Process

Diagram

The Diagram on the following page gives a high-level Overview of the Security Constraints Development Process.

Real-time unmanageable contingencies

Rarely, there may be unmanageable contingencies in real-time that trigger the Security Constraints Process. The table below outlines the tasks for such an event.

Task	Description	Tools/Documents
1	Will SFT create a constraint to manage? <ul style="list-style-type: none"> ▪ If yes, advise the Security Coordinator If no , go to task 2.	<ul style="list-style-type: none"> ▪ Refer to PR-OC-230 Manage SFT created constraints
2	Do the required constraints exist in ACI? <ul style="list-style-type: none"> ▪ If yes, advise the Security Coordinator ▪ If no, go to task 3. 	<ul style="list-style-type: none"> ▪ PR-OC-208 Identify Need for Constraints ▪ UG-SD-021 ACI Database Users Guide.
3	Build constraint in ACI.	<ul style="list-style-type: none"> ▪ ACI ▪ STNET ▪ Study SFT ▪ PR-OC-210 Build & Update Constraints in ACI.
4	Conduct peer review.	<ul style="list-style-type: none"> ▪ ACI ▪ PR-OC-213 Conduct Peer Review of Constraints
5	Is the constraint approved? <ul style="list-style-type: none"> ▪ If yes, go to task 6 ▪ If no, repeat tasks 3 and 4 until the constraint is approved. 	
6	Release constraint to MCL and advise the Security Coordinator.	<ul style="list-style-type: none"> ▪ ACI ▪ PR-OC-218 Release Constraint to MCL and Update Bundle.



12 Document Information

12.1 Metadata

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