Pilbara ISOCo
Independent System Operator

NWIS REDUCED ORDER POWER SYSTEM MODEL USER GUIDE

VERSION: 2.1

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Abbreviation	Definition
NWIS	North West Interconnected System
HP	Horizon Power
APA	APA Group
RIO	Rio Tinto
FCESS	Frequency Control Essential Service
SRESS	Spinning Reserve Essential Service

1. Model Overview

1.1 Introduction

1.1.1 ISOCo manages two PowerFactory models of the North West Interconnected System (NWIS) – the *NWIS Full Model* and the *NWIS Reduced Model*. This User Guide relates to the *NWIS Reduced Model*[1].

1.1.2 The model is developed in DIgSILENT PowerFactory Ver.22. This model user guide document refers to the PowerFactory model NWIS_2024v1_Releasable_Model.pfd.

1.1.3 This document is prepared to provide information to assist users performing system studies. It is assumed that users have sufficient software knowledge and experience to undertake the modelling required to conduct these studies and as such this document does not include any information related to using the software.

The NWIS model has been prepared by integrating three network models provided by the Network Service Providers (NSPs) operating in the NWIS, these are:

- Rio Tinto (RT)
- Horizon Power (HP)
- APA Group (APA)

1.1.4 The sections below provide information on the model structure, Limitations and system setup considerations for performing system studies.

1.2 Model Functionalities

The model is suitable for performing the below system studies:

- Steady State Studies

1.2.1 The model supports Balanced and Unbalanced Load Flow calculations. When conducting studies with unbalanced load flow, it should be noted that not all network elements are accurately modelled to support unbalanced simulations. For example, transmission lines are simulated using equivalent line parameters without transpositions being included.

- Fault Level Studies

1.2.2 Balanced and unbalanced fault level calculations can be completed using the model. The model supports IEC or Complete methods for fault level calculation.

- RMS Dynamic Studies

1.2.3 The model can be used for undertaking balanced RMS studies. It is recommended to use a time step of 2 msec or less for these studies. While the model supports unbalanced RMS studies, the validity of results for unbalanced studies has not been assessed in the current version of the model.

1.2.4 Performance of the model for the more advanced system studies listed below has not yet been assessed. Pilbara ISOCo is in the process of testing and improving model functionalities so that these studies may be supported in future releases.

- Electromagnetic Transient (EMT) Studies

1.2.5 Performing System studies using EMT simulation has not thus far been considered necessary in the NWIS. This is chiefly due to high fault levels in the network as a result of the number of online conventional power stations. However, as NSPs are quickly moving to decarbonise their networks, replacement of conventional power stations with renewable generating systems is expected. This will result in a reduction of fault levels and potentially drive a need for EMT simulations. It is expected that a validated EMT model will be required for new network elements, and a mechanism for releasing a PowerFactory model suitable for performing EMT studies is being investigated.

1.2.6 It should be noted that EMT simulations supporting local studies such as line/transformer energization, shunt capacitor/reactor bank switching, Insulation coordination, etc., are able to be undertaken using the current model. However, the element models within the boundary of the study will need to be modified to ensure they are suitable for the study.

- Eigenvalue Modal analyses

1.2.7 While it is possible to undertake modal analysis on the NWIS model, validity of the results has not been verified.

1.2.8 ISOCo expects that Modal analyses will become more relevant to the NWIS in the near future as the proportion of renewable generating systems increases and as potential interactions between the plant controllers.

- Power Quality and Harmonic Analysis

1.2.9 The current model does not include harmonic sources and therefore is not suitable for power quality assessment. In addition, the reduced model is not considered to be accurate for a system wide frequency sweep and providing polygons for harmonic analysis.

1.2.10 ISOCo is considering a process for providing system polygons to the applicants for the purpose of harmonic assessments, if required.

2. Model Structure

2.1 Overall Structure

2.1.1 The model consists of three grids presented in different colours in the overall NWIS Diagram, as shown in Figure 1.

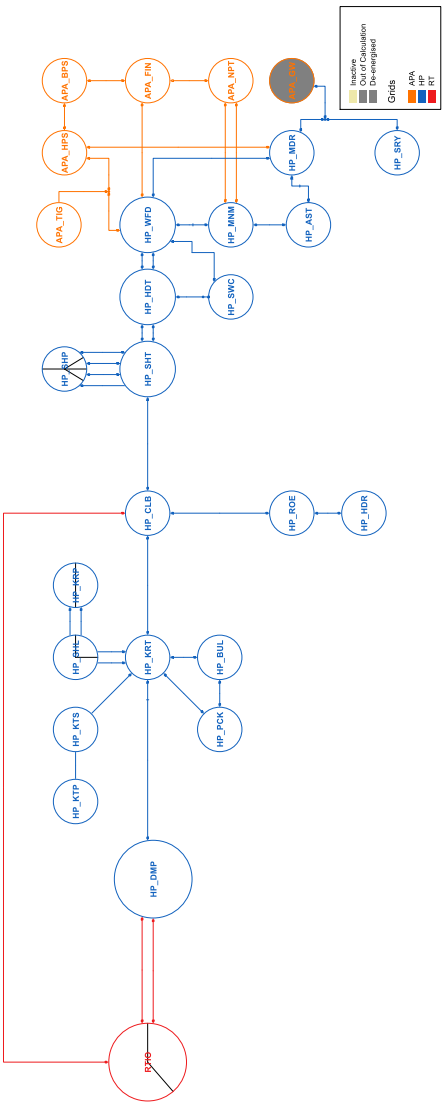


Figure 1 NWIS Reduced Model Overview

2.1.2 The elements of each NSP's network are included in a separate Grid with all element types included in a separate library as shown in Figure 2.

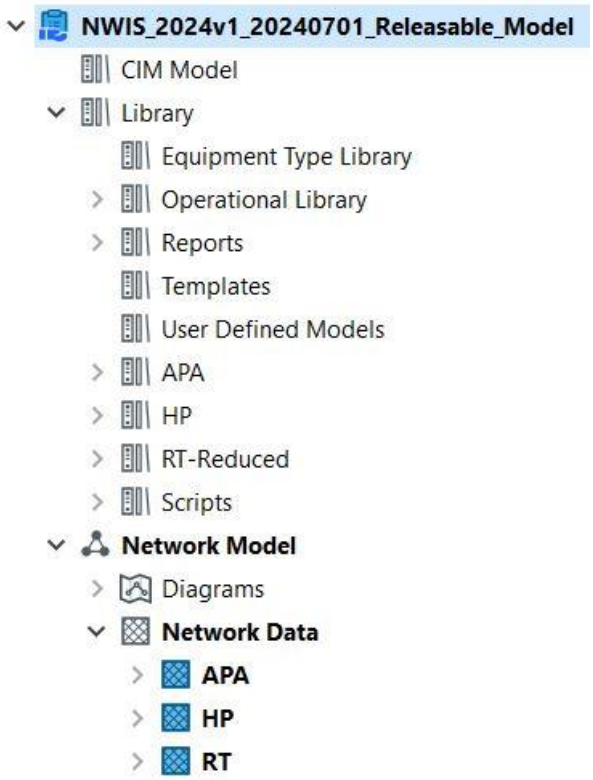


Figure 2 Model structure

2.2 Study Cases

2.2.1 The model includes three network operating conditions representing the network maximum demand with and without *Woodside Pluto Connection* variation and network minimum demand, as shown below:

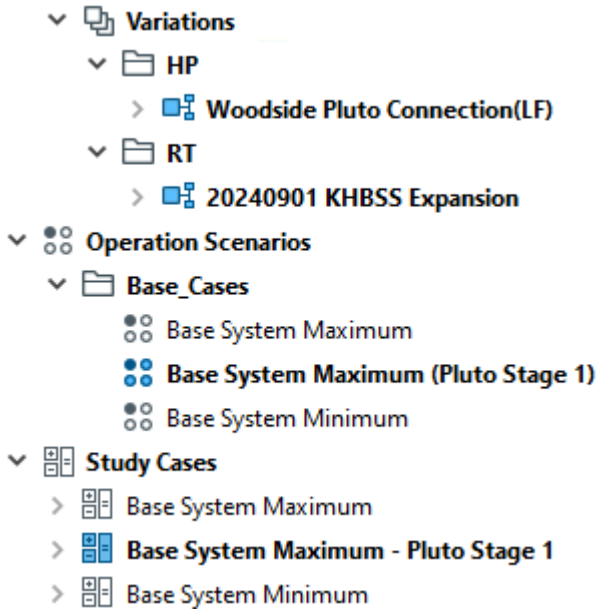


Figure 3 Study Cases

2.2.2 These scenarios are based on the minimum and maximum loads in each grid. The system configuration is adjusted to represent a normal system operating arrangement. It is expected that the user will create project specific *Study Cases* and *Operation Scenarios*.

2.2.3 The model includes two variations incorporating the *Woodside Pluto Connection* in the HP Grid and the *20240901 KHBSS Expansion* in the RT Grid. It is recommended that the user create a new variation when undertaking a study, capturing all modifications to the network. No changes to the base case network configuration are expected as a result of a project specific system study. It is important to follow this practice if submission of the model to ISOCo is required as part of an *Access Application Package*.

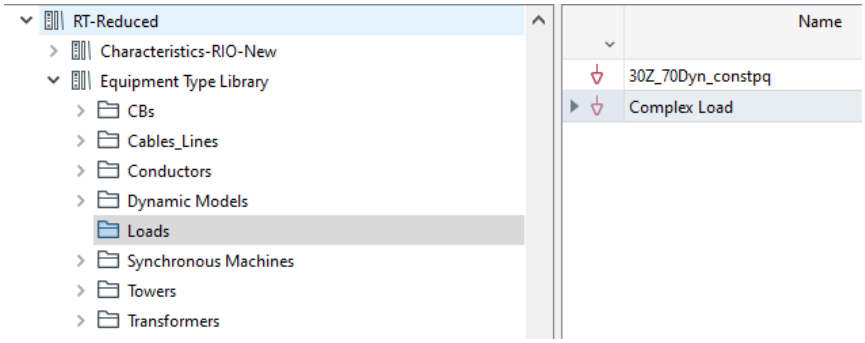
3. Model Set-up for Studies

3.1 Rio Tinto Network

3.1.1 The releasable NWIS model includes a simplified model of the Rio Tinto network. The performance of this model is validated against a detailed model of the same network and is confirmed to have an acceptable accuracy. However, this approach has the limitation of only providing a snapshot of the system operating condition. Hence, the load/generation dispatch within this network should not be directly modified by the user.

3.1.2 For better representation of the load performance under RMS studies, the Complex load type should be used for the loads listed below. To perform a short-circuit study considering motor contributions, 'no type' should be used for these loads.

- CLB Load
- DMP Load
- Inland Equiv JND Load
- Inland Equiv PBD Load
- Inland Equiv WA Load
- PAN Load



3.1.3 When performing system studies using the reduced model, a user must be aware that contingencies of real equipment can only be defined for network elements in the Coastal area using this model. At a high level, the following contingencies are valid for studying disturbances in the Coastal area:

- Fault and/or disconnection of branches (lines and transformers) in the Coastal area (CLBS, YMPS, DMP, MLS),
- Fault and/or disconnection of generators in YMPS and CLPS.
- Load rejection

3.1.4 To represent different load and generation dispatch, RTIO has provided a number of study scenarios which can be selected through a trigger, as shown in Figure 4.

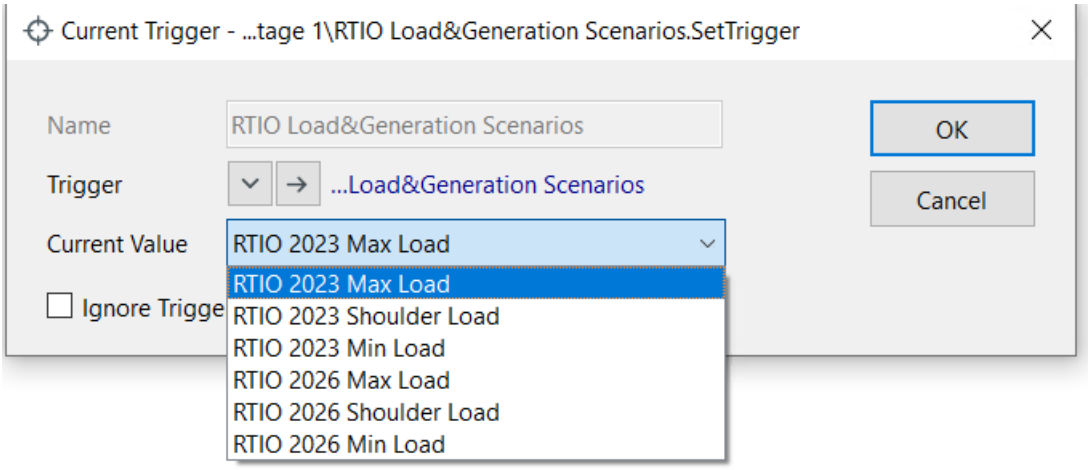


Figure 4 Adjusting the Load and Generation Scenario in the RTIO network

3.1.5 Rio Tinto provides Frequency Control Essential System Service (FCESS) and Spinning Reserve Essential System Service (SRESS) to the NWIS in accordance with the *Pilbara Network Rules*. The generation dispatch in all scenarios allows sufficient headroom to fulfil this requirement.

3.1.6 The RTIO system is connected to the HP system through three 33kV interconnectors, two from Dampier and one from Cape Lambert. The net transfer on these interconnectors should be kept near zero in the initial system setup.

3.1.7 Transfer limits on the 33kV interconnections are as follows:

- Cape Lambert 33kV interconnection to Horizon Power: 36MW @ 0.9 power factor
- Dampier 33kV interconnection to Horizon Power (per line): 25MW @ 0.9 power factor

Therefore, it is recommended to monitor loading on this line and include a trip function if the above limits are reached following a network contingency event.

3.2 Horizon Power Network

3.2.1 The Horizon Power network has two sections, East and West Pilbara, and has interconnectors with the RTIO and APA networks. A 191km 220kV line connects the East and West Pilbara.

3.2.2 The substation loads and generation dispatch in the study cases are based on HP Minimum and Maximum load. For project specific model setup, loading of the substations and generation dispatch can be adjusted. Any adjustments should be made in accordance with Horizon Power's guidance.

3.2.3 The HP network also includes shunt capacitor and reactor banks at HDT and CLB which can be adjusted to minimise reactive power transfer on the interconnectors.

3.2.4 Stage 1 Woodside Pluto project is included as a variation. The Pluto model does not include the dynamic components of the generating units and does not represent the dynamic behaviour of the plant in RMS studies.

3.3 APA Group Network

3.3.1 APA Group's network supplies their customers through a 66kV transmission system. Details of the BHP subsystem is not included in the NWIS model to maintain confidentiality. Considering that load substations are included; this simplification is considered acceptable for the purpose of NWIS wide area system studies.

3.3.2 The substation loads and generation dispatch in the study cases are based upon on 5th and 95th percentile of historical load. For project specific model setup, loading of the substations and generation dispatch can be adjusted. Such adjustments should be made in accordance with APA's guidance.

4. Model Tests

4.1.1 For each released version of the *NWIS Reduced Model* a series of dynamic tests are run to:

- Check the model can be utilised for system studies detailed in this document.
- Identify any (broad) issues in the NWIS as a result of new elements.

4.1.2 Pilbara ISOCo maintains a register of any issues identified though the above process. Users can contact Pilbara ISOCo regarding access to this register.