Branch Procedure

ASSET AND NETWORK PLANNING	Document No	:	NFB 0010
	Amendment No	:	3
	Approved By	:	MA&NP
	Approval Date	:	4/2/2016
	Review Date	:	4/2/2019

Supersedes Branch Procedure (Network Regulation) NFB0010 am.2

NFB 0010 NETWORK DEMAND FORECASTING – SUMMER AND WINTER PEAK DEMAND FORECAST PROCESS

1.0 PURPOSE

To document the steps involved in creating the annual Summer and Winter peak demand forecasts and to explain the workings and relationships between the source data, the calculations and output required to produce these forecasts.

The summer and winter seasons are currently defined as being within the following dates:

Winter: 1st May – 31st August	Summer: 1st November – 31st March

The peak demand forecasts provide the basis for updating strategic asset management plans (SAMP). Peak demand growth determines the capital investment required over the forecast period.

Changes in electrical demand by the various classes of customers on the network are forecast and published annually. The forecasting method is based on sound numerical principles and provides maximum MVA, MW and MVAr loads and Power Factor for summer and winter peak periods for the ten year forecast period.

The forecast includes loads on each zone substation, major customer substation, transmission substation, bulk supply point and the company's total network load. The forecasts allow for planned load transfers, spot loads, land releases and re-development areas and also include trends for base and statistical variance growth scenarios. Loads supplied by embedded generation to the network are incorporated in the calculation of maximum demand forecasts.

2.0 SCOPE

This procedure covers the production of the Summer and Winter Peak Demand Forecast report, which estimate peak demand in MVA, MW and MVAr on a temperature corrected basis at the company Total, Bulk Supply Point (BSP), Transmission Substation (TS) and Zone Substation (ZS) levels for the ten year forecast period. The forecasts provide both undiversified and diversified values where metering is available.

Temperature Corrected Maximum Demand (TCMD) is the estimate of the likely load that could be expected to occur if the season's weather corresponded to an average (typical) season – the 50% Probability of Exceedance (PoE) and to an extreme season – the 10% PoE.

3.0 REFERENCES

Internal
Internal Paper – "Representative Weather Stations for Normalisation of Peak Demands within the Integral Energy Area"

External
Handbook HB 5031–2011 Records classification
SAS Programming documentation
PV-Wave 8.0 Users Guide (UsersWAVE80.pdf)

4.0 DEFINITIONS

Base forecast
Represents the forecast before the impact of the expected Spot Loads, Load Transfers and Lot Releases. See also Modified Forecast.

Capacity
The rated continuous load-carrying ability, expressed in megawatts (MW), megavolt-amperes (MVA), or megavolt-amperes reactive (MVAR) of generation, transmission, or other electrical equipment.

Circuit Breaker (CB)
An electrical apparatus that breaks that connection of an electrical circuit.

Coincidence
A measure of the degree to which loads coincide with each other.

Diversified
The load recorded at a point of aggregation. For instance, the load measured at a TS that is supplying several ZSs. See also Undiversified

Diversified (forecast)
Calculated amount determined by multiplying the undiversified demand by a diversification factor. This factor is determined from the historical data.

Diversified (historical)
The direct load measurement at the substation.

Diversity
The tendency for customer's peak demands to occur at different times, resulting in the aggregated load for a particular time being less than the sum of the individual peak loads.

Document control
Employees who work with printed copies of documents must check the Business Management System regularly to monitor version control. Documents are considered "UNCONTROLLED IF PRINTED", as indicated in the footer.

Exports
Electricity (energy and power) being sent out of a network or part of a network (such as an individual transformer).

Load transfers
A reconfiguration of the network to change the path of supply for particular customers within a defined area. The change results in a load decrease for one substation (as it supplies fewer customers) and a corresponding load increase for another substation (as it supplies additional customers). The relevant load transfers are those which are sizable (above 1 MW) and which are undertaken either as a permanent change, or can be expected to be active at the time of peak demand in the future. More load transfers occur at times of peak demand when the network is constrained. Load transfers are generally undertaken to reduce the net load at risk, by transferring load from a substation with high load at risk to another substation with low or no load at risk; that is, one with greater available capacity above peak demand.

Lot releases
New developments (residential and commercial & industrial) which have a defined period of development in which the load can be expected to build over the life of the project.

Major Customer
A customer that is supplied by a dedicated ZS.

Meter data
Highly accurate, revenue class metering of the electrical load at a Substation. Readings are taken as an average over a 15 minute period, and are filtered to remove 'spikes' often associated with sudden or momentary surges in consumption resulting from changes being made to the network's configuration.

Modified forecast
The forecast after the incorporation of historical Spot Loads, Load Transfers and Lot Releases. See also Base Forecast.

Monthly peak demand data
The highest demand recorded at an individual point during the month. Readings generally include MW, MVA and MVAr.

Peak demand forecast
The Summer Demand Forecast, or the Winter Demand Forecast.

Post Model Adjustments (PMA)
Post Model Adjustments are designed and used to capture future changes in demand resulting from government energy efficiency policy or programs which may not be considered fully by econometric energy forecasts.

Probability of Exceedence (PoE)
The likelihood of a value being exceeded in any one season. For instance, a 10% PoE forecast value is estimated to be exceeded by the actual value only once every 10 seasons on average. A 50% PoE value, is likely to be exceeded every second year on average.

Recordkeeping
Making and maintaining complete, accurate and reliable evidence of business transactions in the form of recorded information. (Source: Handbook HB 5031–2011 Records classification).

Review date
The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval. However a review may be mandated at any time where a need is identified due to changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice.

Spot loads
Defined projects which are expected to draw a defined amount of load, on a specified date at a particular point in the network. They are assumed to draw their total expected demand from the day of connection. Spot loads also incorporate expected capacitor installations which have the effect of lowering the MVA required for a given level of MW demand.

Temperature corrected maximum demand (TCMD)
Temperature Corrected Maximum Demand is the expected peak demand normalised by the reference weather conditions. A 10% PoE season is defined as a 1 in 10 year event. A 50% PoE season is defined as a 1 in 2 year event.

Transmission Substation (TS)
TS with a primary voltage of 132kV and secondary voltage of 66kV or 33kV which is part of the company's transmission network and supplies the sub-transmission network.

Undiversified
The direct summation of the individual peak loads of the lower level substations connected to a point of aggregation; for example, summation of the substations' demand supplied from that point assuming their peak demands occur at the same time. See also Diversified.

Zone Substation (ZS)
A ZS with a primary voltage of 132, 66 or 33kV and a secondary voltage of 22 or 11kV which is part of the company's sub-transmission network.

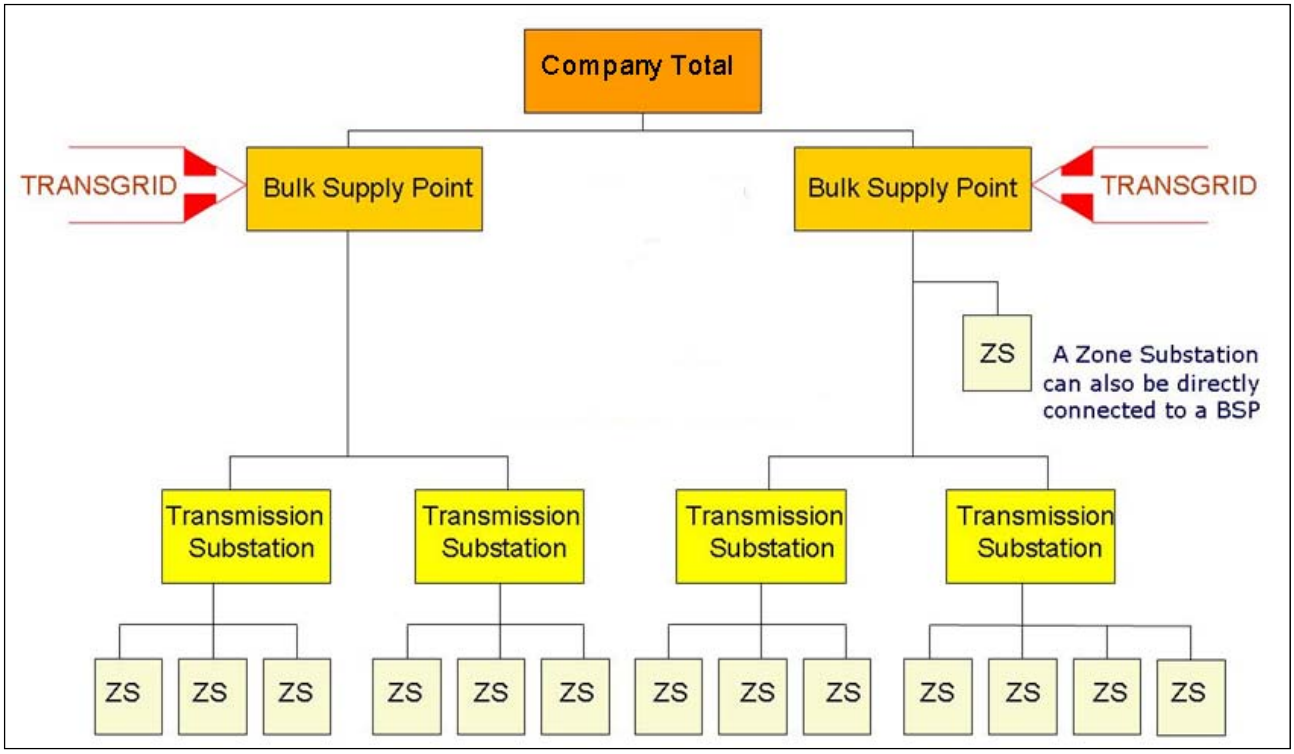
5.0 ACTIONS

5.1 The company's region

The company's electricity supply is taken from the NSW transmission network at either 132,000 or 66,000 volts, and is reduced to 33,000, 22,000 or 11,000 volts through a network of TS and ZS.

Distribution substations further reduce the voltage to levels to supply customers' homes and business. The system is connected together by underground cables and overground conductors.

Peak demand forecasts are created for the company's ZS, TS and HVC's. While not part of the company's network, the company also forecasts the demand drawn from Transgrid's BSP and the company's total aggregated (and diversified) load that is drawn at a system level – referred to as the 'company total'.



5.2 Preparing the forecast

The peak demand forecast uses a bottom up approach that takes into account the effects on demand such as temperature and calendar which includes working days, weekends and holidays. The process begins with a forecast of peak demand at the individual ZS level, then moves upward to TS, BSP and finally to total company network level by aggregating the forecast values progressively.

The summer and winter forecasts are prepared for a ten year forecast period. The forecast process commences approximately two weeks after the season has ended.

The process for creating a forecast is broken up by a series of modules:

- Update the forecast templates;
- Extract NLH data;
- Calculate the TCMD;
- Apply the Planners' input;
- Apply Post Model Adjustments (PMA);
- Check the reasonableness of the forecast; and
- Prepare forecast report.

Because daily maximum demand during winter and summer at some substations may be temperature dependant, a direct comparison is not readily discernible without reference to a standard weather or temperature criterion. Peak demands in each respective season are therefore converted to TCMDs by making an estimate of the demand that would have occurred at standard weather conditions.

Two peak demand scenario forecasts are produced. The first forecast is for typical conditions or an average season with a 50% PoE. The second forecast anticipates either extreme hot or cold conditions. This is the 10% PoE forecast.

The methodology followed in deriving these forecasts are detailed in Branch Workplace Instruction WFB 0001 - Network Demand Forecasting – Summer and Winter Peak Demand Forecast.

5.3 Peak demand forecast process

In the following sections the process of constructing a forecast is outlined.

5.3.1 Update the forecast templates

Capacity Planners provide information regarding changes to the company's block diagram within the network for the current forecast season. This becomes the foundation for executing the bottom up approach. The block diagram provides details on new ZS, network configuration and connectivity changes and estimated timings associated with the changes.

All the templates used to create the forecast are unique to each forecast season. Each forecast is contained in its own unique directory.

5.3.2 Extract NLH data

The process of data extraction requires the use of the Network Load History (NLH) database. NLH may hold up to three types of available measured (meter, SCADA and CB) demand data in the database for each ZS, TS, BSP and major customer. For forecasting purposes, meter data is the superior quality data of the three measured data sources and is used in the forecast where available. NLH also contains Bureau of Meteorology (BOM) data that contains temperature statistics for various weather stations, both inside and outside the company area. Richmond and Nowra temperature data is used in the forecasting process as they best represent the changes in temperature in the company area as a whole[1].

To extract data from the NLH database temperature and ZS files must be edited to reflect the historic season required for extraction.

5.3.3 Calculate the TCMD

Weather correction is applied to the peak demands at all substations levels where there is a strong relationship between demand and temperature. Summer demands at ZSs in the Blue Mountains and demands of all major customers are not subject to any weather normalisation.

The normalisation method is based on a simulation approach. For summer, two reference weather stations are employed for temperature correction of the maximum demand. One weather station at Nowra is used for the South Coast area which covers the Dapto BSP Region and the other weather station at Richmond is used for the remaining the regions. For winter, one weather station at Richmond is used for the whole company network area.

The temperature correction method consists of two steps:

- Develop or update a regression model for estimating the relationship of demand, weather and periodic patterns (calendar effects) of demand, and
- Simulate the demand using multi-years of historical weather data to produce 10% and 50% normalised demand.

[1] Two reference weather stations are sufficient to represent the temperature variations within the company area. (see the internal paper "Representative Weather Stations for Normalisation of Peak Demands within the Integral Energy Area")

The regression model uses the most recent six years of daily maximum demand and temperature to determine the relationship between demand, weather and periodic patterns of demand. Various input parameters are employed for the model. The day of the week variables account for the difference between daily peak by day of the week and workday or non-workday. For summer, a set of holiday variables are included to describe the load reductions or increases associated with holidays. Separate variables are used for the following days: New Year's Day, Australia Day, and Christmas. In addition, a school holiday variable is introduced to capture the reduced loads (increased loads in some south coast ZSs) occurring during the school holiday period in December and January. For winter, Queen's Birthday holiday is treated as a non-workday. Monthly and bimonthly variables capture some of the seasonal demand variations. Year variables describe the changes in base load level for each year. Previous hot or cold day effect variables are included to explain the impacts of the successive hot or cold days on daily peak demand.

From the regression model, daily demands are estimated using 24 years of daily weather data available at the reference weather stations. Annual seasonal maximum demands are derived from the calculated daily demands. The 10% and 50% demand values are computed from the distribution of annual seasonal maximum demands to give the 10% and 50% PoE TCMD values. The TCMD values for the latest year are the starting points of the peak demand forecasts.

5.3.4 Apply the Planners input

The planner's input is used to determine known events and local knowledge which is incorporated into the forecasts. This input is added to form the final 10 year forecast. The input consists of a spreadsheet of information regarding the future activities at each ZS. This includes new developments planned to occur (lot releases), new load increases expected from customer applications (spot loads) and also information regarding the transfer of load from one ZS to another.

A probability factor is applied to the demands of future land releases and spot loads to address uncertainty regarding the rate of development or whether the projects will proceed. Yearly demands for lot releases are projected using an S-curve growth rate for the period between the proposed start and end years. Demands for spot loads are applied at the proposed year.

The Capacity Planners' local knowledge is used to verify load transfers, embedded generation, proposed spot loads and predicted lot release information.

5.3.5 Apply Post Model Adjustments

Post Model Adjustments (PMA) are designed and used to capture future changes in the peak demand which may not be considered fully by econometric energy forecasts. PMA include the demand impacts from different state and national energy policies and programs, such as Minimum Energy Performance Standards (MEPS), NSW Energy Savings Scheme (ESS), change of building codes and NSW Solar Bonus Scheme (SBS).

PMA are applied to each year of the forecast for each ZS based on the ZS residential, commercial, industrial mix and its peak demand for the season as each policy and program targets different customer sectors.

5.3.6 Check the reasonableness of the forecast

A 'checksheet' is produced for each ZS (refer Annexure A in Workplace Instruction WFB 0001) for the Capacity Planner to confirm whether the ZS forecast is reasonable given the organic growth and the additional planning information supplied. TS and BSP's do not have a 'checksheet' but are also checked by Capacity Planners after the ZSs have been checked and finalised.

Before 'checksheets' can be signed off, a manual check is performed to confirm that the planning information has been added correctly. Checking is also conducted at the TS, BSP and total network levels to confirm that values are linked properly within the forecasting spreadsheets.

The spot load and lot release inputs to the demand forecast model are based on the information collected from individual developers, planning authorities and local councils, and from the Capacity Planners. This information is further checked against the latest figures released by ABS (population growth projections, numbers of development approvals and dwelling unit commencements) and other relevant forecasts by public and private agencies.

5.3.7 Prepare forecast report

The forecast report is the final step in the forecasting process and outlines the latest season as well as the forecasted company network total for the 10 year forecast period. Each TS contains a description of the planned changes. The opening paragraphs and the forecast tables for each TS are updated to include the latest information which is provided by Capacity Planners.

Before the forecast report can be commenced, it is important that the Capacity Planning Manager signs off on the project list given by the Capacity Planners. The sign off confirms that no further projects or revised information will be submitted prior to the forecast report being produced. It also certifies that the Capacity Planning section acknowledges that the demand forecast is to be based on the information provided by Capacity Planners

A draft forecast is prepared and is circulated to the Network Demand Manager, Capacity Planning Manager, Manager Asset & Network Planning and the Chief Engineer for review. Approved changes are made to the draft forecast to produce the final forecast for approval which is then signed off and printed. The final report is uploaded to the intranet for use for capacity planners and other stakeholders in the business.

5.3.8 Forecasting assumptions

- Peak demand forecasting considers the historical patterns in the data for forecast model development.

- ZS, TS and BSP forecasts assume that any planned spot loads, load transfers and lot releases will be executed on time with reasonable accuracy.

- TCMD forecasts assume that temperature is the most significant factor in the weather normalisation of peak demand together with other significant calendar variables.

6.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

Type of Record	Storage Location	Retention Period*
Forecast Reports	Intranet	Required as State archives as determined by GA40 section 6.1.
Internal Papers	G:\Forecasting\ZS Forecasts\Documentation\Internal Papers\weatherStation.doc	Required as State archives as determined by GA40 section 6.1.

* The following retention periods are subject to change, eg if the records are required for legal matters or legislative changes. Before disposal, retention periods must be checked and authorised by the Records Manager.

7.0 AUTHORITIES AND RESPONSIBILITIES

Manager Asset & Network Planning has the authority and responsibility for approving this procedure and the Peak Demand Forecast.

Network Demand Manager has the authority and responsibility for:

- the methodology used in the forecasting process;
- timely notification to the Senior Forecasting Analyst of any changes in assumptions or forecasting policy required to be used in the preparation of the forecast;
- reviewing of the Peak Demand forecasts;
- discussions and advice to the Capacity Planning Manager, the Manager Asset & Network Planning and the Chief Engineer concerning the assumptions, accuracy, timeliness and limitations of forecasts produced by the branch;
- the review of all calculations undertaken to produce the Peak Demand Forecast; and
- the presentation of the Peak Demand Forecast to the Manager Asset & Network Planning and the Chief Engineer.

Senior Forecasting Analyst/Forecasting Analyst has the authority and responsibility for updating and editing all files, overseeing that all linkages between files are maintained and producing the peak demand forecast including:

- updating and editing all directories, files, scripts and macros;
- downloading ZS, TS, and BSP readings and other weather parameters from the Unix system;
- overseeing that all linkages between files are maintained (as outlined in this procedure) to produce the Peak Demand Forecast; and
- summer and Winter Forecasts at the ZS, TS, BSP and Total System level as described in this procedure for a 10 year period.

Capacity Planners have the authority and responsibility for providing relevant information to the Senior Forecasting Analyst/Forecasting Analyst and undertaking a reasonableness check of the forecast including:

- updating the company's block diagram of the network;
- providing information regarding the future activities at each ZS. This includes new developments to occur (lot releases), new load increases expected from customer applications (spot loads) and also information regarding the transfer of load from one ZS to another;
- undertaking a reasonableness check of the draft forecast; and

- signing the ‘check sheet’ to reflect that the Planner’s information has been accurately recorded and that the documented forecast is reasonable.

8.0 DOCUMENT CONTROL

Content Coordinator : Network Demand Manager

Distribution Coordinator : Branch Process Coordinator