R-FCAS requirements methodology

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PowerWater

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Introduction

The Secure System Guidelines[1] (SSG) describes the application of ancillary services for the Northern Territory (NT) power systems, including those used to maintain the frequency as defined by the *Frequency Control Ancillary Services* (FCAS).

Regulating FCAS (R-FCAS) is the service used to balance short-term and minor fluctuations in supply and demand, as well as to follow trends in changes in load over periods of approximately 30 minutes. These fluctuations in the supply-demand balance occur due to both predictable patterns in demand; behind-the-meter (BTM) solar output over the day; and minor deviation in the output of non-regulating generator units.

R-FCAS does not rectify imbalances due to trip of a generator or large load – this is addressed by *Contingency FCAS* (C-FCAS). R-FCAS does not rectify significant imbalances arising from forecast errors of utility-scale solar farms.

R-FCAS requirements for the NT regulated systems are set out in the SSG and have historically been set as the greater of a *Minimum Regional Figure* (5 MW for the DKES) and the *System Load Rate of Change*, which is the (anticipated) change in demand over a 30-minute period. These requirements are implemented by the Power System Controller.

As the NT regulated power systems continue to integrate BTM solar as part of a broader transition toward supply of electricity from renewable energy, the dynamics of system load changes must be addressed by R-FCAS provision. The Power System Controller has recently reviewed and updated the methodology used to calculate R-FCAS requirements, accounting for the impacts of BTM solar.

R-FCAS methodology

The proposed updated methodology sets requirements based on the observations of changes in recent historical system load data over the past year. It is anticipated that the methodology would be re-applied as new data becomes available (on an annualised basis), resulting in dynamic requirements accounting for growth in BTM solar and other changes that impact load patterns.

R-FCAS requirements are determined separately for different times of year and times of day, as well as different day types. For example, the R-FCAS requirements can be expected to be greater during the evening peak than overnight.

The summary approach to determining R-FCAS requirements is as follows:

1. System load data is obtained at five-minute resolution for at least the last 12 months.
2. This data is categorised according to:
    a. The season of year, i.e., wet season or dry season.
    b. The day type, i.e. weekday or dry season.
    c. The interval of time of day, discussed below.
3. For each interval in each category, the change in system demand over 30-minutes is determined, creating a distribution of system demand changes that represents the R-FCAS that would have been

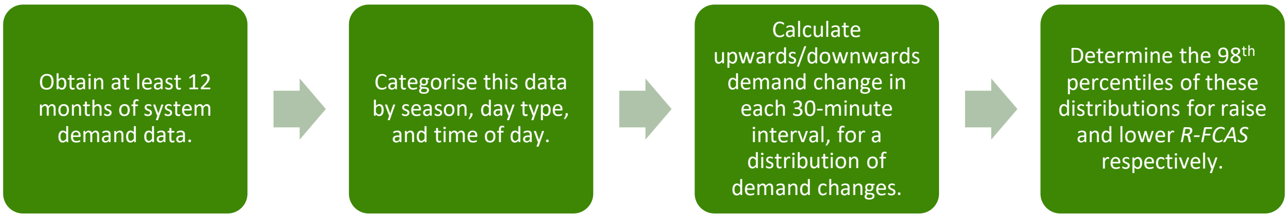
[1] Power and Water Corporation - Secure System guidelines v4.2, 30th April 2020.

required. This is determined separately in both the upwards (raise R-FCAS) and downwards (lower R-FCAS) directions.
4. The raise and lower R-FCAS requirements are then set from a defined percentile of these distributions.

The advantages of this approach are:

- Requirements are set based on actual system operations.
- Requirements are simple to compute.
- Requirements can be re-calculated as new data becomes available, allowing requirements to be varied periodically.
- The use of a percentile provides a mechanism to balance risk and cost.

Figure 1 - R-FCAS determination process



Selection of percentile

For raise R-FCAS the requirement was set to the 98th percentile of the distribution upwards and downwards changes in system load and it was deemed sufficient for application across the Darwin-Katherine Power System based upon sensitivity modelling. It should be noted that selection of a higher percentile means that R-FCAS requirements will be larger and changes in demand can be met with greater confidence, but this also means that the cost of reserving this R-FCAS capacity will be higher.

The selection of percentile was such that the R-FCAS provision is sufficient to cover most anticipated changes in system load, discounting the impact of outliers that would increase requirements. Such probabilistic approaches and limits are compatible to those used in other jurisdictions.[2]

Selection of daily intervals

The intervals used to aggregate requirements across the day are as follows:

- Weekdays:
  - Early morning: 5am – 7:30am;
  - Late morning: 7:30am – 11am;
  - Afternoon: 11am – 6pm;
  - Overnight: 6pm – 5am;
- Weekends:
  - Morning: 5am – 11am;
  - Afternoon: 11am – 6pm;
  - Overnight: 6pm – 5am.

[2] For example, the Flexible Ramp Product in California have been set to the 2.5th percentile (downwards) and 97.5th percentile (upwards). In Texas, regulation requirements have been set to the 98.8th percentile of historical deployments.

These were determined from analysis of daily load patterns (Figure 3) and are intended to be representative of the changing daily load patterns, whilst managing operational complexity for power system controllers.

These intervals may be revised in the future as demand varies, for example, due to further uptake of BTM solar.

Results from 2023-24 data analysis

The proposed method was applied to an initial data set from 15th March 2023 to 7th August 2024, namely, approximately 17 months of demand data. Table 1 presents the calculated requirements for raise and lower R-FCAS for weekdays in the wet and dry season, and Table 2 presents the equivalent for weekends.

Table 1. Weekday R-FCAS requirements.

INTERVAL	TIME	RAISE (DRY)	RAISE (WET)	LOWER (DRY)	LOWER (WET)
Early Morning	5am – 7:30am	15.9 MW	17.6 MW	2.8 MW	2.6 MW
Late Morning	7:30am – 11am	5.8 MW	10.8 MW	11.7 MW	13.0 MW
Afternoon	11am – 6pm	15.6 MW	19.2 MW	7.4 MW	13.2 MW
Overnight	6pm – 5am	4.8 MW	5.1 MW	10.6 MW	11.5 MW

Table 2. Weekend R-FCAS requirements.

INTERVAL	TIME	RAISE (DRY)	RAISE (WET)	LOWER (DRY)	LOWER (WET)
Morning	5am – 11am	6.2 MW	9.6 MW	8.3 MW	10.6 MW
Afternoon	11am – 6pm	15.4 MW	18.2 MW	5.7 MW	12.1 MW
Overnight	6pm – 5am	2.6 MW	2.9 MW	9.2 MW	10.3 MW

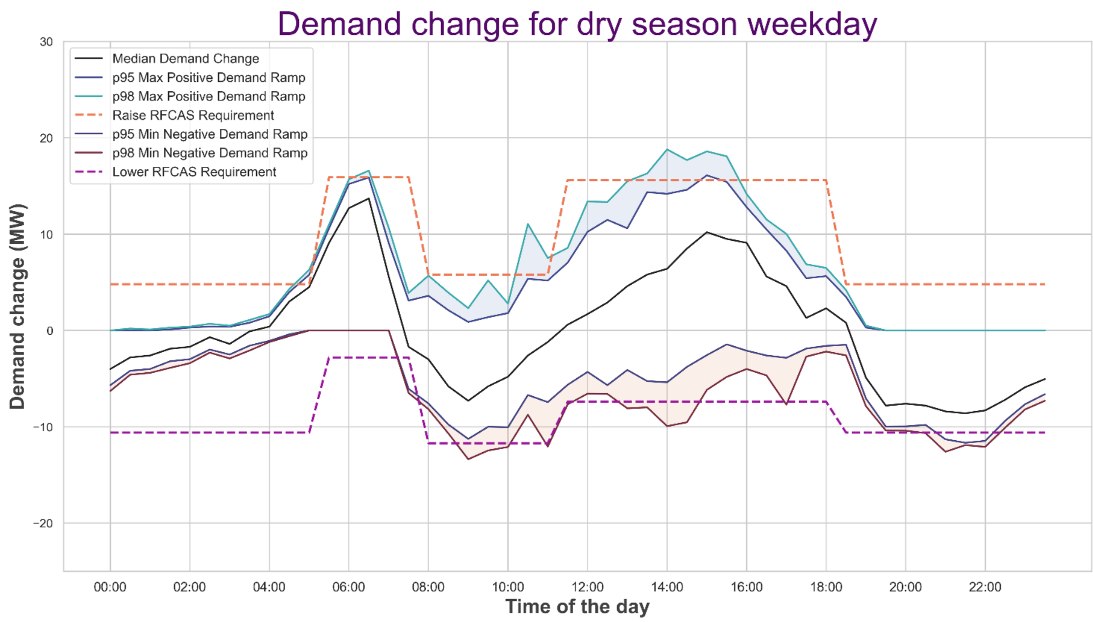
Figure 2 presents weekday half-hourly percentiles – the 98th percentiles of the greatest upwards and downwards demand change in the dry season for illustrative purposes. For context, the 95th percentiles are shown for comparison. The median (50th percentile) demand change is presented, indicating whether demand is normally ramping up, ramping down, or is flat at a particular time of day.[3] A positive value means demand is ramping up, and a negative value means demand is ramping down.

The weekday charts show a distinct period of up-ramps (positive demand changes) into the morning peak, with more sustained up-ramps into the evening peak. Down-ramps are not as large as up-ramps, with the largest median up-ramps being approximately 12 MW, while the largest median down ramps is approximately 8 MW. Compared with the morning peak, the evening peak shows a greater range of

[3] The median is the value for which – at that time of day – half the observed demand change observations are less than that value, and the other half are greater than it.

possible ramping outcomes, relative to the median ramp. Hence, the method produces larger R-FCAS requirements in both the raise and lower directions.

Figure 2. Demand change percentiles and R-FCAS requirements for weekdays in a) the dry season



Application considerations

The following application considerations form part of the proposed methodology:

- The minimum regional requirement of 5 MW for the Darwin -Katherine Power System (DKPS) will continue to apply.
- The MW RFCAS reserve values derived from the proposed methodology are the recommended RFCAS requirements.
- Some intervals may be combined where the requirements in both have similar values, to simplify the control room implementation.
- During real time operations, these requirements may be temporarily superseded if, for example, operational tools and forecasts indicate the potential for challenging situations or large demand changes. These occurrences will be captured for further analysis and factored into future periodic analysis of R-FCAS requirements.
- Requirements will be reviewed using no less than 12 months of historical demand data at a 5-minute resolution. Updates to R-FCAS requirements will be based on the outcomes of this analysis.

Staged implementation

The proposed methodology will be implemented in a staged manner, commencing with the DKPS, where the greatest operational efficiencies and enhancements to power system security are expected.

The transition from the existing spinning reserve policy to the FCAS-based methodology for each Regulated Power System will follow a structured process, involving the development and integration of multiple applications. Consideration must be given to how RFCAS is managed within the control room to support the broader transition from the spinning reserve framework to the implementation of the FCAS methodology.

The implementation process for the proposed R-FCAS methodology for the DKPS includes the following steps:

- Research and development of the methodology, including simulations using historical data.
- Trial application of R-FCAS management shadowing existing spinning reserve limits to determine effectiveness.
- Development of operational systems, tools, and applications to support R-FCAS application.
- Integration of lessons learned from the trial phase into system design, tool functionality, and application decision-making.
- Concurrent consultation on the proposed methodology alongside amendments to the Secure System Guidelines (SSG).
- Operational readiness assessment, followed by refinement and full operational deployment.
- Decommissioning of outdated spinning reserve limits in alignment with the revised SSG.

Despite the progress already made in developing, testing, and trialling the methodology, the transition to real-time operations will be phased to ensure that the security and reliability of the DKPS are not compromised. Upon successful implementation in the DKPS, a similar approach will be applied to the Alice Springs and Tennant Creek power systems, tailored as necessary to suit each system's operational requirements.

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