ATTACHMENT C

Methodology to Assess Available Transfer Capability

1.0 Purpose

This document describes the methodology used in the calculation of Available Transfer Capability.

2.0 Scope

TVA has chosen to use the Flowgate Methodology for calculating Available Transfer Capability (ATC) and Available Flowgate Capability (AFC) for each ATC Path for the time horizons of next hour to 13 months (Short Term Horizon). For time periods greater than 13 months (Long Term Horizon), TVA will conduct a full N-1 load flow analysis on the request. The rest of this document pertains to the calculations of ATC for the Short Term Horizon.

3.0 Definitions

3.2.1 Available Flowgate Capacity (AFC)

A measure of the flow capability remaining on a Flowgate for further commercial activity over and above already committed uses.

3.2.2 Available Transfer Capability (ATC)

A measure of the transfer capability remaining in the physical transmission network for further commercial activity over and above already committed uses.

3.2.3 ATC Path

Any combination of Point of Receipt and Point of Delivery for which ATC is calculated, as well as any Posted Path.

3.2.4 Capacity Benefit Margin (CBM)

The amount of firm transmission transfer capability preserved by TVA for Load-Serving Entities (LSEs), whose loads are located on TVA's system, to enable access by the LSEs to generation from interconnected systems to meet generation reliability requirements. Preservation of CBM for an LSE allows that entity to reduce its installed generation capacity below that which may otherwise have been necessary without interconnections to meet its generation reliability requirements. The transmission transfer capability preserved as CMB is intended to be used by the LSE only in times of emergency generation deficiencies.

3.2.5 Contract Path

An agreed upon electrical path for the continuous flow of electrical power between the parties of an Interchange Transaction. This is usually defined as the sum of the tie line ratings or limiting series elements between the two entities.

3.2.6 Existing Transmission Commitments (ETC)

Committed uses of TVA's transmission system considered when determining AFC.

3.2.7 Flowgate

A mathematical construct, comprised of one or more monitored transmission facilities and optionally one or more contingency facilities, used to analyze the impact of power flows upon the Bulk Electric System.

3.2.8 Independent Power Producer (IPP)

Any entity that owns or operates an electricity generating facility that is not included in an electric utility's rate base. This term includes, but is not limited to, co-generators and small power producers and all other nonutility electricity producers, such as exempt wholesale generators, who sell electricity.

3.2.9 Operating Procedure

A document that identifies specific steps or tasks that should be taken by one or more specific operating positions to achieve specific operating goals. The steps in an Operating Procedure should be followed in the order in which they are presented, and should be performed by the positions identified.

3.2.10 Outage Transfer Distribution Factor (OTDF)

The percentage of a power transfer that flows through the monitored element of a Flowgate for a particular transfer when the contingency element of the Flowgate is out of service.

3.2.11 Power Transfer Distribution Factor (PTDF)

The percentage of power transfer that flows through a Flowgate for a particular transfer when there are no contingencies.

3.2.12 Point of Receipt (POR)

A location that the Transmission Service Provider specifies on its transmission system where an Interchange Transaction enters or a Generator delivers its output.

3.2.13 Point of Delivery (POD)

A location that the Transmission Service Provider specifies on its transmission system where an Interchange Transaction leaves or a LSE receives its energy.

3.2.14 TVA Reliability Coordination Area

The collection of generation, transmission, and load that operate within the boundaries of the Balancing Authority Areas for which TVA provides Reliability Coordination services.

3.2.15 Transfer Distribution Factor (TDF)

TDF is a general term, which may refer to either PTDF or OTDF. The TDF is the percentage of power transferred from source to sink that flows through a Flowgate.

3.2.16 Transmission Reliability Margin (TRM)

The amount of transmission transfer capability necessary to provide reasonable assurance that the interconnected transmission network will be secure. TRM accounts for the inherent uncertainty in system conditions and the need for operating flexibility to ensure reliable system operation as conditions change.

3.2.17 Transmission Service

Services provided to the transmission customer by TVA to move energy from a Point of Receipt to a Point of Delivery.

3.2.18 Transmission Service Provider (TSP)

The entity, such as TVA, that administers the Transmission Service Guidelines or transmission tariff and provides Transmission Service to customers under applicable transmission service agreements.

4.0 Overview

The Flowgate Methodology is based on the assumption that certain elements on the transmission system will begin to reach their limits before the other elements on the system. Therefore by monitoring the more sensitive areas on the transmission systems, transfer capability calculations can be simplified in regard to the number of contingencies and monitored elements examined during each study. This allows for a greater number of studies to be conducted with less simplified input assumptions. The result is more accurate studies that focus on how the power would actually flow if the Transmission Service Requests were to be approved.

5.0 Flowgates

5.1 Flowgate Attributes

A Flowgate is a selected power transmission element or group of elements that act as a proxy for the power transmission system capability and represent potential thermal, voltage, stability and/or contractual system limits to power transfer. There are two types of Flowgates:

OTDF Flowgate: Composed of usually two power transmission elements in which the loss of one (contingency element) significantly increases the loading on the other transmission element (monitored element).

PTDF Flowgate: Composed of one or more power transmission elements in which the total pre-contingency flow over the Flowgate cannot exceed a predetermined limit.

Once limiting elements have been identified as potential transfer constraints, they can be grouped with their related contingencies and identified as unique Flowgates. The rating of the Flowgate is called the Total Flowgate Capacity (TFC) of the Flowgate and is monitored and used for evaluation of all viable transfers for commerce. The TFC values used in the AFC process are consistent with those used for planning purposes.

5.2 Flowgate Identification

Flowgates are chosen to be included in the transfer capability calculation process using the following methods.

1. The Flowgate is requested to be added to the transfer capability calculation process by the Reliability Coordinator, Transmission Operator, or Transmission Owner of the area for which transfer capability is being calculated.
2. A transmission element is identified as a System Operating Limit (SOL) with a limiting value that is lower than the thermal rating or a transmission element is identified as an Interconnection Reliability Operating Limit (IROL).
3. The TSP is notified of a non-thermal SOL or any IROL in a neighboring BA.
4. The Flowgate has been identified as a Reciprocally Coordinated Flowgate by passing the coordinated Flowgate test in the Congestion Management Process (CMP).

5.3 Total Flowgate Capability

The TFC of each Flowgate is equal to the SOL or IROL of that Flowgate if the SOL or IROL is based on a thermal limit. For a voltage or stability limit the TFC is equal to the flow limit that will respect the SOL or IROL.

There are four different TFCs for each Flowgate, (one used for each season). The TFC used in the ATC calculation must match the seasonal capacity being calculated.

In instances where there is a difference in derived limits, such as a tie line, the most limiting parameter is used as TFC.

TFCs will be updated at least once per calendar year. If notified of a change in the facility rating by the Transmission Owner that would affect the TFC of a Flowgate used in the AFC process, the TFC will be updated within seven calendar days of the notification.

6.0 Available Transfer Capability (ATC) Calculations

6.1 Firm Available Flowgate Capability (AFC) Calculations

In accordance with NERC's MOD-030-02 reliability standard, the following equation is used when calculating Firm AFC for a Flowgate for a specified period:

$AFC_F = TFC - ETC_{Fi} - CBM_i - TRM_i + Postbacks_{Fi} + Counterflows_{Fi}$

Where:

AFC_F is the firm Available Flowgate Capability for the Flowgate for that period

TFC is the Total Flowgate Capability of the Flowgate

ETC_{Fi} is the sum of the impacts of existing firm Transmission commitments for the Flowgate during that period

CBM_i is the impact of the Capacity Benefit Margin on the Flowgate during that period

TRM_i is the impact of the Transmission Reliability Margin on the Flowgate during that period

$Postbacks_{Fi}$ are changes to firm AFC due to a change in the use of Transmission Service for that period

$Counterflows_{Fi}$ are adjustments to firm AFC due to power flows in the opposite direction of the Flowgate

6.2 Non-Firm Available Flowgate Capability (AFC) Calculations

In accordance with NERC's MOD-030-02 reliability standard, the following equation is used in calculating Non-Firm AFC:

$$AFC_{NF} = TFC - ETC_{Fi} - ETC_{NFi} - CBM_{Si} - TRM_{Ui} + Postbacks_{NFi} + Counterflows_{NFi}$$

Where:

AFC_{NF} is the non-firm Available Flowgate Capability for the Flowgate for that period

TFC is the Total Flowgate Capability of the Flowgate

ETC_{Fi} is the sum of the impacts of existing firm Transmission commitments for the Flowgate during that period.

ETC_{NFi} is the sum of the impacts of existing non-firm Transmission commitments for the Flowgate during that period

CBM_{Si} is the impact of any Capacity Benefit Margin schedules on the Flowgate during that period

TRM_{Ui} is the impact of the unreleased Transmission Reliability Margin on the Flowgate during that period

$Postbacks_{NFi}$ are changes to firm AFC due to a change in the use of Transmission Service for that period

$Counterflows_{NFi}$ are adjustments to firm AFC due to power flows in the opposite direction of the Flowgate

TVA uses an intermediate step when calculating AFC called AFC initial (AFC_{Init}). This step does not mathematically change the equations, only the order in which they are calculated. This allows for the exchange of AFC_{Init} values with other AFC calculators that share the task of calculating transfer capability for E.ON and AECI and also allows the use of two engines in the process, the TARA AMB engine and the PAAC engine. The current process calculates AFCs the following way:

$$TFC - ETC_{GentoLoad} = AFC_{Init}$$

$$\text{Transmission Impacts} = ETC_{Reservations} + CBM - Postbacks - Counterflow$$

$$AFC_{Init} - \text{Transmission Impacts} - TRM = AFC_{Final}$$

To prove the equations are the same, substitution can be used and the equations can be written as:

AFC_{Final} = AFCinit - Transmission Impacts - TRM

AFC_{Final} = TFC - $ETC_{GentoLoad}$ - $ETC_{Reservations}$ - CBM + Postbacks + Counterflow

AFC_{Final} = TFC - ($ETC_{GentoLoad}$ + $ETC_{Reservations}$) - CBM + Postbacks + Counterflow

AFC_{Final} = TFC - ETC - CBM - TRM + Postbacks + Counterflows

6.3 Existing Transmission Commitments (ETC)

All of the calculated forward flow impact is considered in the AFC calculations as ETC. There is no cut-off used for forward flow impacts. Partial path reservations are included in the calculation of ETC.

6.3.1 ETC_{Fi}

ETC_{Fi} contains two major components, $ETC_{Reservations}$ and $ETC_{GentoLoad}$

$ETC_{GentoLoad}$ is calculated using the following:

1. The impacts of generation to load for the TSP's area. These values are calculated from:
    a. Load forecast for the time period being calculated, and
    b. Unit commitment and generation block dispatch, including all Designated Network Resources.
2. The impact of generation to load for other TSP areas covered by an executed coordination agreement or where the impact is deemed significant. These values are calculated from:
    a. Load forecast for the time period being calculated, and
    b. Unit commitment and block generation dispatch.
3. The impact of generation to load for all other TSP areas. These values are calculated from the seasonal peak load forecast included in the MMWG or NTSG models.

$ETC_{Reservations}$ is calculated using the following:

1. The impact of Network Integration Transmission Service (NITS) for the areas of the TSP and any other TSP covered by an executed coordination agreement.
2. The impact of confirmed Point-to-Point (PTP) Transmission Service expected to be scheduled for the areas of the TSP and any TSP covered by an executed coordination agreement.
3. The impact of any grandfathered obligations expected to be scheduled or expected to flow for the areas of the TSP and any TSP covered by an executed coordination agreement.

6.3.2 ETC_{NFi}

ETC_{NFi} is calculated using the following:

1. The impact of all confirmed non-firm Point-to-Point (PTP) Transmission Service expected to be scheduled for the areas of the TSP and any TSP covered by an executed coordination agreement.

2. The impact of any grandfathered non-firm obligations expected to be scheduled or expected to flow for the areas of the TSP and any TSP covered by an executed coordination agreement.
3. The impact of non-firm NITS (secondary service) for the areas of the TSP and any TSP covered by an executed coordination agreement.

6.4 Counterflow Impact

When applying transmission reservation impacts in the opposite direction of flow on a Flowgate in the AFC calculations, the following counterflow assumptions are used:

Reservation Type	Counterflow Impact Used
Firm Reservations for Firm Calculations	30%
Firm Reservations for Non-Firm Calculations	50%
Non-Firm Reservations for Non-Firm Calculations	50%

These counterflow assumptions are based on operator experience and reasonable engineering judgment.

6.5 Transmission Service Request Rollover Impact

Transmission Service Requests (TSRs) that have met the requirements for rolling over service, and have been determined to have a likelihood of rolling over, are considered at impact in the $ETC_{Reservation}$ calculations for the time periods when the rollover would occur.

6.6 AFC Calculation Frequency

New transmission models are created and AFC_{Init} values are calculated on the following frequencies:

Horizon	Calculation Frequency
Hourly, Hours 1-48	Every hour
Hourly, Hours 48-192	Four times per day
Daily, Days 1-35	Four times per day
Monthly, Months 1-18	Once per day

AFC_{Final} values are calculated every 15 minutes.

6.7 Converting AFCs to ATC

When converting Flowgate AFCs to ATCs on an ATC Path, the following algorithm is used:

$ATC = \text{Minimum of } (AFC_{Flowgate\ n} / TDF_{Flowgate\ n})$

The TDF used in the calculation must be greater than the cut-off. The current cut-off used for calculating transfer capability is 3% for OTDF Flowgates and 5% for PTDF Flowgates. An impact of less than the cut-off is considered no impact when calculating ATC.

The posted ATC is the minimum of the calculated ATC and the Contract Path minus the reservations sold across that path.

6.8 Simultaneous Path Interactions

The Flowgate Methodology allows for ATCs to be calculated on transmissions paths that consider the interaction of reservations requested or granted on other ATC paths. TVA accounts for these simultaneous path interactions in its transfer capability calculations.

6.9 ATC Calculations Intervals and Posting Intervals

ATC values are calculated and posted to OASIS on the following intervals:

ATC Value	Calculation Period	Calculation Frequency
Hourly	Next 192 hours	Every 15 minutes
Daily	Next 35 days	Every 15 minutes
Monthly	Next 18 months	Every 15 minutes

6.10 Total Transfer Capability (TTC)

TVA considers Total Transfer Capability (TTC) the maximum amount of power that is allowed to reliably flow across an interface before transmission impacts such at $ETC_{Reservations}$, TRM, CBM, postbacks and counterflows are considered. TTC is therefore normally the Contract Path amount for the interface. On the interfaces that have very large Contract Paths, such that the Contract Path is above the amount the system could reliability transfer, the TTC is set to a more appropriate transfer limit based on reasoned engineering analysis.

7.0 Source and Sink Definitions

7.1 Source Definitions

If the TSR or approved Transmission Service is sourced in an area, then the sources used in evaluating the TSR or the impacts of approved Transmission Service are obtained from the POR field in the TSR.

If the TSR or approved Transmission Service is sourced in an IPP within TVA's area, then the sources used in evaluating the TSR or the impacts of approved Transmission Service are obtained from the Source field of the TSR.

If the TSR or approved Transmission Service is sourced in an IPP outside TVA's area, the sources used in evaluating the TSR or the impacts of the approved Transmission Service are obtained from either the Source field or the POR field of the TSR.

7.2 Sink Definitions

If the TSR or approved Transmission Service is sunk in an area, then the sinks used in evaluating the TSR or the impacts of the approved Transmission Service are obtained from the POD field in the TSR.

If the TSR or approved Transmission Service is sunk in an IPP within TVA's area, then the sinks used in evaluating the TSR or the impacts of approved Transmission Service are obtained from the Sink field of the TSR.

If the TSR or approved Transmission Service is sunk in an IPP outside TVA's area, the sinks used in evaluating the TSR or the impacts of the approved Transmission Service are obtained from either the Sink field or the POD field of the TSR.

7.3 Model Mapping

When the POR field is used as the source, it is mapped to the online generators within the area, such that all online generation is dispatched based on distributions factors calculated as:
(PMax - PGen) / Total Gen.

When the POD field is used as the sink, it is mapped to the online generators within the area, such that all online generation is dispatched based on distribution factors calculated as:
(PGen - PMin) / Total Gen.

When the source field is used as the source, it is mapped to all the units of the generator.

When the sink field is used as the sink, it is mapped to all of the bus loads that make up the requested sink.

8.0 Load Flow Model Development

The Automated Model Builder (AMB) generates transmission models that simulate anticipated system conditions for the different horizons needed to adequately calculate transmission service capability. These models are derived from the NERC MMWG models, the SERC LTSG models and the SERC NTSG models. The starting models are chosen based on the most recently updated case available.

The transmission models contain the system topology and generation data for the Eastern Interconnection. The generation Facility Ratings, i.e. generation maximum and minimum output levels, are also included in the transmission models.

The AMB modifies the starting cases to reflect anticipated system conditions such as load forecasts, transmission and generation outages or derates, and (in some horizons) approved tags. TVA uses the NERC SDX and the NERC Tag Dump as the basis for this information. The conforming loads within the TSP area, including interruptible loads, will be scaled based on the projected load forecast for that area. Interruptible loads are included since they are considered in the transmission planning process.

Generators that are identified as Designated Network Resources in the TSP's area are modeled in the basecase and are dispatched based on block generation. In some horizons, when the data is available, a direct dispatch based on projected individual generation dispatches is used.

The following assumptions are used, based on reservation class and time period:

Model Horizon	Assumptions
Monthly Firm and Non-Firm Months 1-18	Load will be scaled to the peak for the given month. All outages based on a representative day (3rd Wednesday) will be included.
Daily Firm and Non-Firm Day 1-35	Load will be scaled to the peak for the given day. All outages for the given day will be included.
Hourly Non-Firm Hours 49-192	Load will be scaled to the hourly value supplied to SDX. All outages for the given hour from SDX will be included.

Hourly Non-Firm Reservation Horizon Hours ~30-48	Load will be scaled to the hourly value supplied to SDX. All outages for the given hour from SDX will be included.
Hourly Non-Firm Scheduling Horizon* Hours 1-~30	Load will be scaled to the hourly value supplied to SDX. All outages for the given hour from SDX will be included. Approved tags from the NERC Tag Dump files will be filtered to remove double-counting and modeled in the cases.

**The length of the scheduling horizon changes based on the time of the calculations.*

Outages that are in effect for part of the day are assumed to last the whole day when considering a daily outage in the AMB. Outages that are in effect for part of a month are only considered if they occur on the representative day of the month. This representative day is the third Wednesday of the month being built. Outages from other TSPs that cannot be mapped to the transmission model are not built into the cases by the AMB and are not considered in the AFC/ATC calculations.

Some TSPs external to TVA's area footprint will be modeled with expected outages and load forecasts, depending on the availability of data and the relevance of the external TSP to transfer capability calculations. Block generation dispatch for external TSPs will also be used, as availability allows.

9.0 Congestion Management Process and Allocation

The CMP facilitates better coordination between the non-market and the market entities. A large part of this process involves honoring the available allocation called ASTFC (Available Share of Total Flowgate Capability) on certain Flowgates.

The amount of allocation on a Flowgate is based on the TFC of that Flowgate. The allocation is then split up between the reciprocal entities on that Flowgate, based on its historical impact on the Flowgate.

Each entity can grant Transmission Service, as long as they have sufficient ASTFC on that Flowgate. If they do not have sufficient ASTFC, they can either borrow or transfer it in order to grant the Transmission Service. If no ASTFC is available from any entity, then the service must be denied.

10.0 Coordination with other TSPs

The following data is coordinated with TSPs that are parties to a coordination agreement:

Data	Shared With	Interval
AFC Overrides	Other TSPs whose Flowgates pass the coordination test	Every hour
Transmission Reservations	Signed a coordination agreement	Every hour
Available Share of Total Flowgate Capability (ASTFC)	CMP members	Every hour
AAL File (allocation borrowing)	CMP members	Once a day
Allocation Overrides (BMS files)	CMP members	Once a day

The following data is coordinated through SDX and is available to anyone having access to SDX.

1. Load forecast,

2. Transmission outages, and
3. Generation outages/derates.

The AFC override values are used for external Flowgates when they are provided. If no AFC override value is provided, then the calculated AFC value is used for the external Flowgates. For other input data, if a file is not received, the last file received will be used when possible.

Flowgates that are owned by external entities that have been added to the Flowgate process through the Flowgate identification methodology will be honored in the AFC process for all TSR evaluations, except under the following circumstances:

1. The Flowgate's OTDF or PTDF is below the coordinated distribution factor cut-off.
2. The Flowgate owner is included as the source, sink, POR, or POD of the TSR. This exception is included with the understanding that the Flowgate owner will have the opportunity to evaluate and approve the TSR on its own system.

11.0 Transmission Service Request (TSR) Evaluation

TSRs are evaluated on the same interval that ATC is calculated, every 15 minutes. These requests are evaluated, respecting queue order, based on their impact on all Flowgates in the AFC process, such that the impact is greater than the cutoff of 3% for OTDF Flowgates and 5% for PTDF Flowgates. The requests are also checked against the amount of allocation available on the impacted Flowgates according to the CMP.

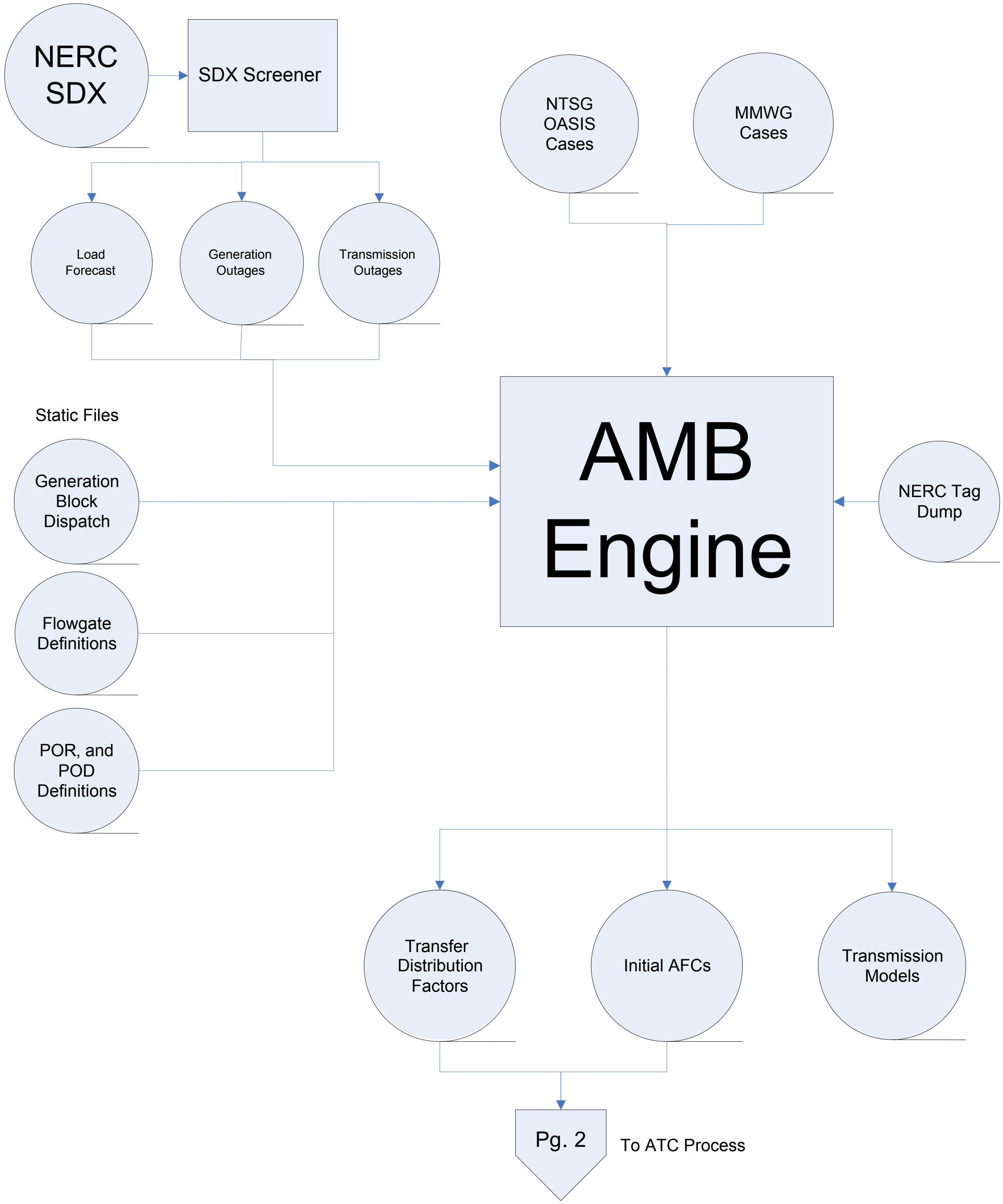
In order for a TSR to be granted it must pass the three following checks:

1. Is there enough AFC available on the affected Flowgate?
2. Is there sufficient ASTFC, including the borrowing of ASTFC, on the Reciprocal Coordinated Flowgates?
3. Is there enough capacity available on the Contract Path to grant the request?

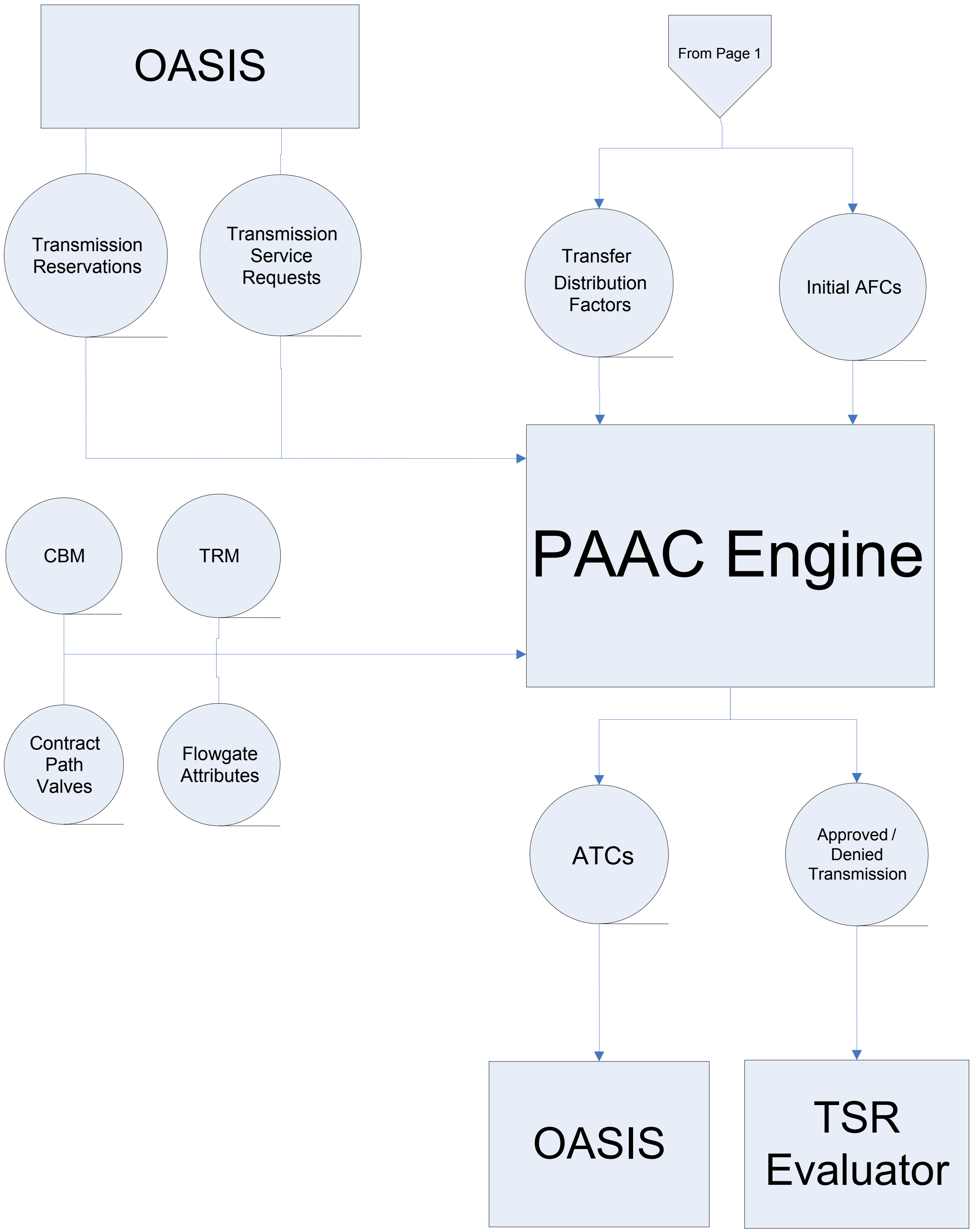
If the request fails one of the three checks, it is then evaluated for bumping opportunities. If bumping is not available, the request is marked failed and the TSR is denied.

12.0 Process Flow Diagrams

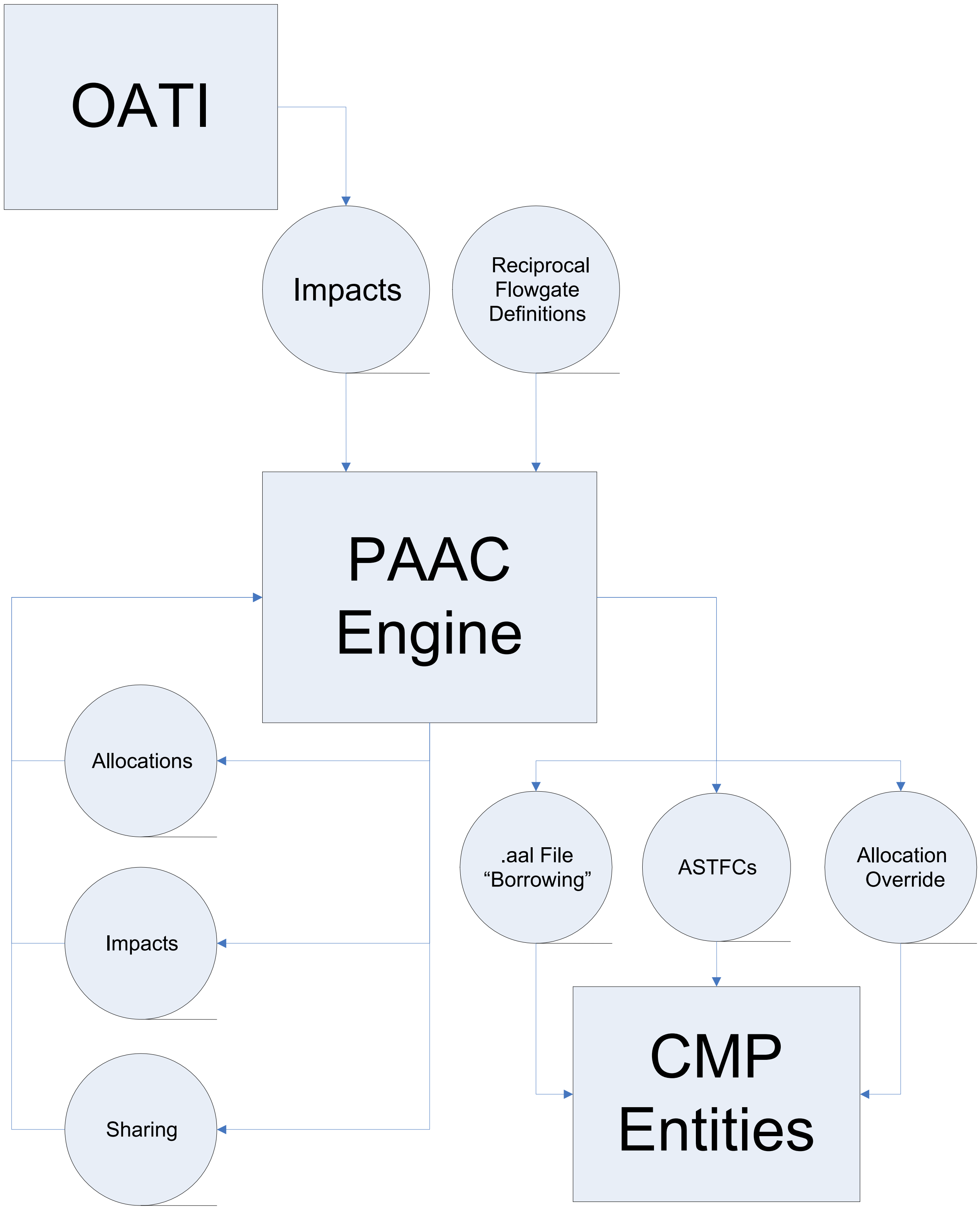
Model Building & AFC_{Init} Creation Process



ATC Process


OASIS
From Page 1
Transmission Reservations
Transmission Service Requests
Transfer Distribution Factors
Initial AFCs
CBM
TRM
PAAC Engine
Contract Path Valves
Flowgate Attributes
ATCs
Approved / Denied Transmission
OASIS
TSR Evaluator

Congestion Management Process



13.0 Transmission Reliability Margin (TRM)

The inherent uncertainty in the assumed system conditions used to compute ATC can result in unreliable transmission system operations. To ensure reliability under a broad range of system conditions, a portion of the computed ATC will be set aside. This capability, known as Transmission Reliability Margin (TRM), will provide the operating flexibility required to ensure reliable operations and will minimize the need to curtail Transmission Service.

13.1 TRM Methodology

Because the impact of power transfers on a transmission network is not limited to the reserved path, TVA does not define TRM by transmission paths. Instead, TRM is applied against the facility ratings of network components and is measured as a percentage or MW reduction of those ratings. This allows the application of TRM on every Flowgate or monitored element, instead of only being applied to the limiting elements of transfer paths. Network facility derating allows for more consistent application of TRM across different transmission paths.

The TRM will account for the following components of transmission system uncertainty:

1. Aggregate load forecast error,
2. Load distribution error,
3. Forecast uncertainty in transmission system topology,
4. Allowances for parallel path (loop flow) impacts,
5. Allowances for simultaneous path interactions,
6. Variations in generation dispatch,
7. Variations in facility loadings due to balancing of generation within a Balancing Authority area, and
8. Short-term system operator response (Operating Reserve actions not exceeding a 59-minute window).

An assessment of the impacts that these components have on the transmission system was made in order to determine the amount of TRM that is sufficient to maintain reliable system operations.

13.1.1 Aggregate Load Forecast

The inability to precisely predict a future load level and the subsequent loadings experienced on transmission system elements requires a reasonable quantity of transfer capability to remain uncommitted in the form of TRM.

The effect the load forecast error has on transmission capacity is determined using PTI MUST. An increase in load is simulated and the change in capability on lines preloaded to 50% or greater is measured.

The load forecast error can be separated into time horizons. The further the horizon from the present day, the more error in the load forecast. The current calculated load forecast errors are the following:

Short Term Daily: 2% error

Monthly: 5.7% error

Therefore, the effect of the aggregate load forecast error on transmission line loading is the following:

Time Period	Percent Effect on Capability
Same day and real-time	2% error => 1% Effect
Day-ahead and pre-schedule	2% error => 1% Effect
Beyond day-ahead and pre-schedule to 18 months	5.7% error => 3% Effect

13.1.2 Load Distribution Error

The distribution of load can vary the loading on the transmission system facilities. This is closely related to the load forecast error. Since the load distribution error is closely correlated to the load forecast error, any uncertainty that would occur because of load distribution error would already be accounted for by the load forecast error component.

13.1.3 Forecast Uncertainty in Transmission System Topology

A reasonable allowance for the impact of facility outages that may occur day-to-day should be accounted for in TRM. Although TVA accounts for outages in the short-term horizon, all transmission configurations cannot be analyzed. Therefore, a certain amount of uncertainty will exist because of variances in system topology. An average effect of transmission outages on line capabilities was determined using a PTI MUST study. In the study, each transmission line was outaged as a single contingency. If the post contingency loading was greater than 80% and the Line Outage Distribution Factor (LODF) for that contingency was greater than zero, then the effect the contingency had on that transmission line was used in the calculation. For example, if a contingency caused the loading on the Bull Run Volunteer 500-kV Transmission Line to go from 82% to 93%, then that effect was taken into account to compute the average, because the post contingency loading was greater than 80% and the LODF was not zero. An average effect on transmission line capability was calculated from the studied contingencies. Based on the study, the average is 2.8%.

Based on the study, a 3% uncertainty factor would sufficiently account for the forecast uncertainty in transmission system topology.

13.1.4 Allowances for Parallel Path (Loop Flow) Impacts

All network elements are subject to parallel path (loop) flows. These parallel path flows are the result of Transmission Service transactions that are not explicitly scheduled on the transmission system. Since these transfers are not scheduled on TVA's system, TVA cannot account for the impact of these third-party transactions. A reasonable quantity of uncommitted transmission capacity such as TRM will ensure that the reliability of the Interconnection is preserved when loop flows occur.

A study of loop flows on TVA's transmission system revealed that on average TVA historically experiences loop flows of approximately 850 MW. In order to determine the effect these loop flows have on transmission line loading, North-to-South and West-to-East transfers were modeled across TVA.

This study determined that the average change in line capability due to loop flows across TVA is 1.5%.

13.1.5 Allowances for Simultaneous Path Interactions

In the short-term horizon, TVA uses the AFC process in which transactions are accounted for using a flow-based method. Each impact from a prior request is subtracted from the TFC on each affected Flowgate. Because of this, there is no need to account for simultaneous path interactions during the short-term planning horizon. Therefore, TVA does not include any amount of uncertainty for the simultaneous path interactions in its TRM calculations in the short-term horizon.

13.1.6 Variations in Generation Dispatch

The impact of variations in generation dispatch on transmission line capability depends mostly on the proximity of the lines to the generators being dispatched. A transmission line in close proximity to a generator may have very small loading when the generator is not being dispatched and a large loading when it is being dispatched. Therefore, the net change in transmission line capacity is large. But in the context of transfer capabilities, it is only necessary to determine the effect of variations in generation dispatch on lines that could be limiting elements to the transfer. Accounting for the change in transmission line capacity for lines that are pre-loaded to 50% (excluding Generator Step-Up transformers) will determine the effect of variations in generation dispatch on lines that are more likely limits to the transfer. This will also help exclude lines that are close to offline generation in the case. The inclusion of these lines would exaggerate the results because of the large changes in line loading when the offline generation is dispatched.

For this study, two different dispatches were created. One is a “normal spring” case and the other is a “drought condition” spring case with low hydro generation. The study determined that the average change in transmission capability for the lines pre-loaded above 50% for two significantly different dispatches on the TVA transmission system is 3.0%.

13.1.7 Variations in Facility Loadings Due to Balancing of Generation within a Balancing Authority Area

System load is a dynamic quantity. Generation increases and decreases in response to these load variations. The variation in generation and load levels can inject uncertainty in the transmission network. TVA’s TRM methodology takes into account errors in generation dispatch and load forecasting. Because TVA includes these errors in the TRM calculation, any uncertainty caused by loadings due to the balancing of generation and load are already captured.

13.1.8 Short-Term System Operator Response (Operating Reserve Actions Not Exceeding a 59-Minute Window)

In compliance with NERC Standard EOP-001-0, TVA has bilateral agreements in place with neighboring utilities for short-term energy emergency assistance. Under these agreements, either party may declare an energy emergency. When this occurs, the other party shall provide emergency assistance to the extent possible without jeopardizing its own power system stability or power supply obligations. An energy emergency, as described in these agreements, is a temporary condition in which an LSE is unable or in imminent danger of not being able to meet its firm load commitments.

In order to maintain transmission capability to meet these emergency energy obligations, a study is done to determine the maximum effect of a generator unit outage on TVA’s transmission system. This type of study is known as a generation in-rush study.

Studies show that the average effect of generation inrush on TVA-owned Flowgates is 2%.

13.2 TRM Usage

Current TRM	Percent Capacity Effect
Same day and real-time	
Aggregate load forecast error impact	1.0
Forecast uncertainty in topology	3.0
Loop flow impact	1.5
Variations in Generation Dispatch	3.0
Operator Response	2.0
TRM Needed	**3%**
Day-ahead and pre-schedule	
Aggregate load forecast error impact	1.0
Forecast uncertainty in topology	3.0
Loop flow impact	1.5
Variations in Generation Dispatch	3.0
Operator Response	2.0
TRM Needed	**3%**
Beyond day-ahead and pre-schedule to 18 months	
Aggregate load forecast error impact	3.0
Forecast uncertainty in topology	3.0
Loop flow impact	1.5
Variations in Generation Dispatch	3.0
Operator Response	2.0
TRM Needed	**3%**

Each TVA-owned Flowgate in the AFC process will have TRM applied to it, based on the largest component of uncertainty during that time horizon for the Flowgate. The above uncertainties are used as the defaults for all applicable Flowgates. For example, in same day and real-time, 3% is the largest TRM requirement from the TRM components of uncertainty; therefore, 3% is used for that horizon. If it becomes known for a specific Flowgate that a certain component of uncertainty has become greater for a specific time period, the TRM for that Flowgate can be reevaluated and applied to the Flowgate. For example, if the loop flow impact on a certain Flowgate becomes much larger than previously expected for a certain Flowgate, the TRM on that Flowgate can be changed to reflect the new uncertainty component expectation.

13.2.1 Converting the TRM Set Aside on a Flowgate to an Amount Set Aside on a Path

TRM is presently applied against the facility ratings of network components and is measured as a percentage or MW reduction of those ratings. In order to post the amount of TRM on specific paths, the margin must be converted to a path number. This is done using the following equation:

$$TRM_{Path} = \frac{TRM_{Flowgate}}{TDF_{Path}}$$

13.2.2 Availability of TRM to the Market on a Non-Firm Basis

TVA does not make TRM available on a non-firm basis, due to the uncertainty still present in the non-firm transfer capability calculations.

14.0 Capacity Benefit Margin (CBM)

CBM is established to ensure that TVA retains enough transmission capacity to allow sufficient power to be imported to replace any generation resources that may not be available as planned to serve the native load of the system. CBM allows Load Serving Entities (LSEs) to reduce their installed generating capacity below that which may otherwise have been necessary, without interconnections, to meet generation reliability requirements. The transmission capability preserved as CBM is intended to be used by LSEs only in times of emergency generation deficiencies. When not being used, TVA makes transmission capability, preserved for CBM, available on a non-firm basis to all transmission customers.

14.1 Methodology for Calculating CBM

Current methodology for calculating CBM is based on aligning the CBM requirement with the Operating Reserve requirements.

CBM = Largest controlled unit interconnected to TVA transmission + Regulating Reserves + Spinning Reserves

Component	MW
Largest Interconnected Unit: Cumberland Fossil Unit	1340 MW
Regulating Reserves Requirement	150 MW
Spinning Reserves Requirement	340 MW
Total	1830 MW

TVA's current CBM is 1900 MW (rounded).

During previous extreme weather situations, many of the adjoining areas have had little surplus generating capacity to sell into TVA. Accessibility to generation in adjoining areas may also be limited by transmission constraints.

Total CBM is prorated to all of TVA's interfaces according to historical knowledge of generation purchases, interface Contract Path limits, and volatility of incremental transfer capability.

TVA updates the CBM values every year and the values are reviewed prior to every peak season or as required by conditions on the transmission system. CBM values may be adjusted on an as-needed basis.

14.2 Interface Reservations

The Balancing Authority makes annual determinations regarding interface reservations needed to support the calculated CBM requirement.

Interface Reservations (current):

Company	MW
AECI	50
AEP	500
AMRN	250
BREC	50
CPLW	50
DUK	50
EES	300
EKPC	50
LGEE	200
SOCO	400
Total	**1900**

14.3 CBM Usage

During the conditions indicated below, CBM can be used to import power by TVA for its native load and network customers and LSEs within the TVA Balancing Authority area. During conditions when resources are projected to be insufficient (herein called a “Generation Shortage”) to serve TVA’s native load and network customers, CBM may be used to import power on a firm basis to ensure the continued reliability of service.

The use of CBM is allowed when the following steps have been taken or the following conditions exist:

- All non-firm sales have been terminated.
- Direct-Control Load Management has been implemented.
- Customer interruptible demands have been interrupted.
- A Generation Shortage has been declared by the TVA Balancing Authority or an LSE.
- TVA or the LSE's TSP is also experiencing transmission constraints, relative to imports of energy on its transmission system.
- There is insufficient posted firm ATC on the interface over which power may be obtained to address the Generation Shortage.

14.4 CBM Usage Process

To use CBM (provided the above noted conditions are met):

A. The LSE experiencing a Generation Shortage shall notify the TVA Balancing Authority System Operator that it has declared a Generation Shortage and that there is insufficient posted firm ATC on the interface over which power may be obtained to address the Generation Shortage.
B. The TVA Balancing Authority System Operator shall notify the TVA Reliability Coordinator System Operator that the LSE has declared a Generation Shortage and request implementation of an Energy Emergency Alert (Level 1, 2, or 3 as appropriate). The TVA Balancing Authority System Operator shall notify the TVA Transmission & Interchange Services Operator that there is insufficient posted firm ATC on the interface over which power may be obtained to address the Generation Shortage.

C. The TVA Transmission & Interchange Services Operator will ensure that the CBM is made available and will make any curtailment necessary of non-firm schedules to provide the ATC on the CBM path.
D. The Purchasing/Selling Entity shall submit a Transmission Schedule using the appropriate transaction number for reserved CBM.
E. The TVA Transmission & Interchange Services Operator shall approve the request.

When not being used, TVA makes CBM available on a non-firm basis to all transmission customers using the standard ATC posting for non-firm. If CBM is needed for existing native load, those non-firm reservations on the specific path will be subject to curtailment following existing procedures.