



Local Area Transmission Plan – Final

NorthWestern Energy's Electric Transmission
Two Year Local Area Planning Cycle
January 1, 2012 to December 31, 2013

T&D Engineering - Planning and Capacity West Department

Photo: Industrial Park, Butte, MT – K Bauer

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Executive Summary

This report is NorthWestern Energy's third biennial local transmission plan for Montana developed under FERC Order 890 Attachment K provisions. NorthWestern Energy's (NWMT) methodology, process and criteria are used to evaluate the electric transmission system, ensuring that system reliability is maintained into the future. NWMT's followed the business practice, methodology, criteria and process outlined in its FERC Order 890 Attachment K filing.¹

Reliability, by definition, examines the adequacy and security of the electric transmission system. Consistent application of the methodology, criteria, and process for all Balancing Authority Area (BAA)² customers' (i.e., retail, network and point-to-point) information is ensured through the openness and transparency of NWMT's process. All customers are treated on an equal and comparable basis as NWMT's transmission system planning process is designed to be transparent, open and understandable. NWMT's methodology is intended to define operating conditions that fail to meet reliability criteria and then identify solutions (e.g., transmission and non-transmission³) that solve the problem.

NorthWestern Energy has performed a multi-seasonal, multi-year study that was designed to examine its system's reliability under normal operating conditions, and all single and credible multiple outage conditions. Previous biennial transmission plan study work has created a benchmark for future biennial studies to be compared against. This comparison provides knowledge on how the system is changing over time. Given the results, NWMT has designed mitigation plans that resolve the identified problems, starting with the most critical.

To ensure that the NWMT's Local Transmission Planning process was open and transparent throughout the entire process, a Transmission Advisory Committee (TRANSAC) was formed in 2007. TRANSAC is an advisory stakeholder committee that meets regularly with NWMT to provide input and comments during the planning stages of NWMT's Local Transmission Plan. Please see Attachment A – TRANSAC Charter for an outline of TRANSAC's purpose and Attachment B – Transmission Advisory Committee (TRANSAC) for an outline of TRANSAC's involvement with the development of this plan.

¹ All Attachment K related documents can be found on NWMT's OASIS website by clicking on the "Attachment K Business Practice Links" document under the Transmission Planning – Attachment K folder. The shortcut to this document is [Attachment K Business Practice Links](#). There are two documents that outline how NWMT conducts its transmission planning process. The first document is in section 'Q' of the links document and is called the "Business Practice ETP Methodology, Criteria and Process (Effective 9-25-12)". This document addresses the FERC Order 890 transparency principle. The second document is in section 'P' of the links document and is called the "Attachment K Business Practice 10-20-09 (Effective 10-28-09)". This document addresses the nine FERC Order 890 principles.

² NERC defines a Balancing Authority Area as: "The collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains resource balance within this area."

NERC further defines Balancing Authority as: "The responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a Balance Authority Area, and supports Interconnection frequency in real time."

³ Demand-side resource, generation, interruptible load, etc.

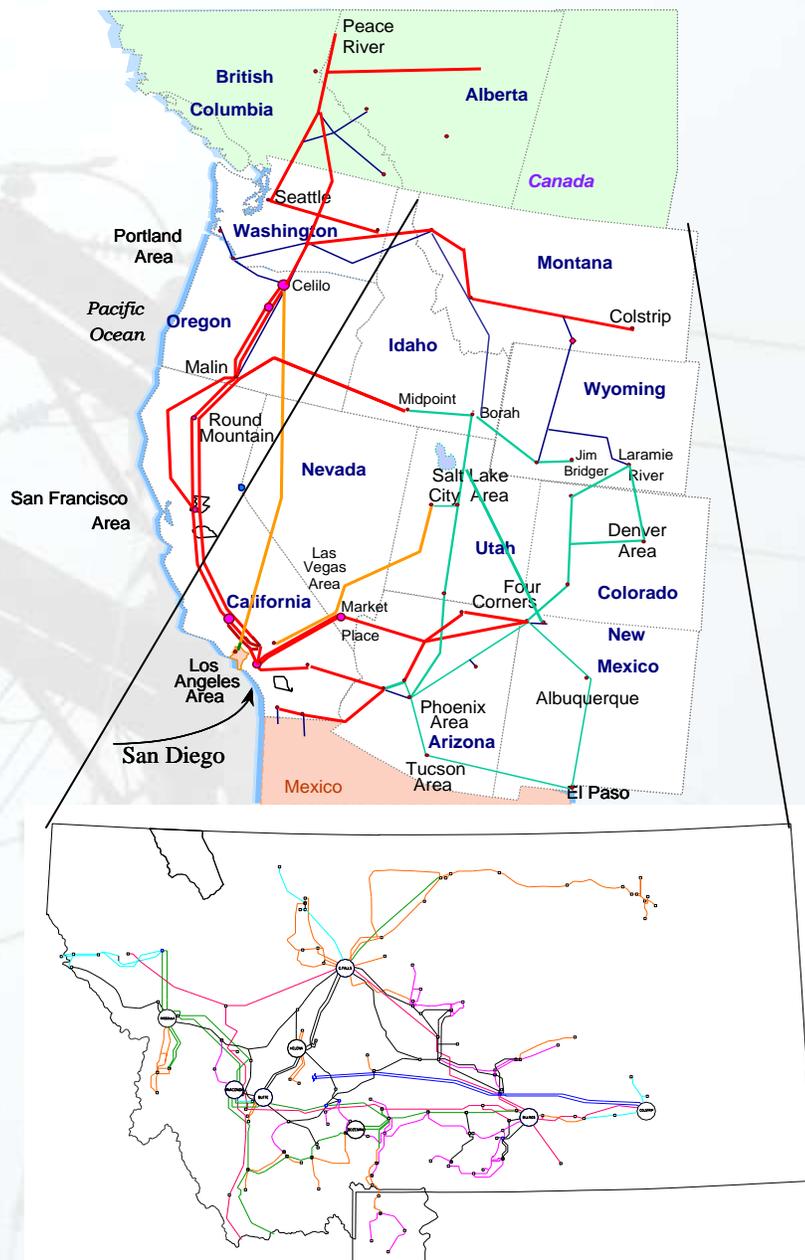
This document walks through NWMT's efforts to develop the Local Transmission Plan that addresses reliability by examining the adequacy and security of the electric transmission system while following NWMT's business practices, methodology, criteria and process. The findings of NWMT's efforts include the following:

- ❑ No major problems with the higher voltage bulk electric system (e.g., 230 kV and above) were observed under all operating conditions and scenarios with the exception of one creditable double contingency after the shutdown of a large (150+ MW) thermal generation plant.
- ❑ On the underlying system in the near term, no thermal problems occurred under normal operating conditions. Minor low voltage problems were observed in the Columbus/Absarokee area under normal peak load operating conditions.
- ❑ Without planned mitigation, a limited number of outages may cause additional voltage and thermal problems on lower voltage systems. Heavy summer conditions continued to govern in most areas.
- ❑ Thermal problems observed are both line and transformer capacity related, which can be mitigated through upgrades or operational means. As loads grow, transformers tend to reach capacity limits before line segments.
- ❑ As load grows, substation-related outages are becoming more critical without mitigation.
- ❑ No outages resulted in uncontrolled cascading.
- ❑ No transient stability problems were observed.
- ❑ With load growth over time and without mitigation, thermal loads and related problems grow and voltages decline.
- ❑ Mitigation completed since the end of the last planning cycle has fixed, lessened impacts, or deferred previously identified problems.
- ❑ Proposed generation interconnection projects present the greatest uncertainty in future planning scenarios. However, these interconnection projects will carry with them appropriate mitigation either through the interconnection process or the transmission service process to ensure that the existing transmission system performance is not negatively impacted.

NWMT Transmission System Overview

NWMT's local transmission system provides regulated electric transmission services to approximately 300,000 electric customers. NWMT's electric transmission system consists of approximately 7,000 miles of transmission lines and associated terminal facilities. NWMT is registered with the North American Electric Reliability Corporation (NERC) as a Balancing Authority, Planning Authority⁴ and Transmission Planner⁵.

Effective January 1, 2009, 222 megawatts of electricity from the jointly owned Colstrip 4 coal-fired unit in southeastern Montana were rate based. The 150 MW Dave Gates Generation Station, wholly owned by NWMT, began serving Montana electric customers January 1, 2011. This facility provides regulating reserves, which means that it



⁴ NERC defines a Planning Authority as: "The responsible entity that coordinates and integrates transmission facility and service plans, resource plans, and protection systems."

⁵ NERC defines a Transmission Planner as: "The entity that develops a long-term (generally one year and beyond) plan for the reliability (adequacy) of the interconnected bulk electric transmission systems within its portion of the Planning Authority Area."

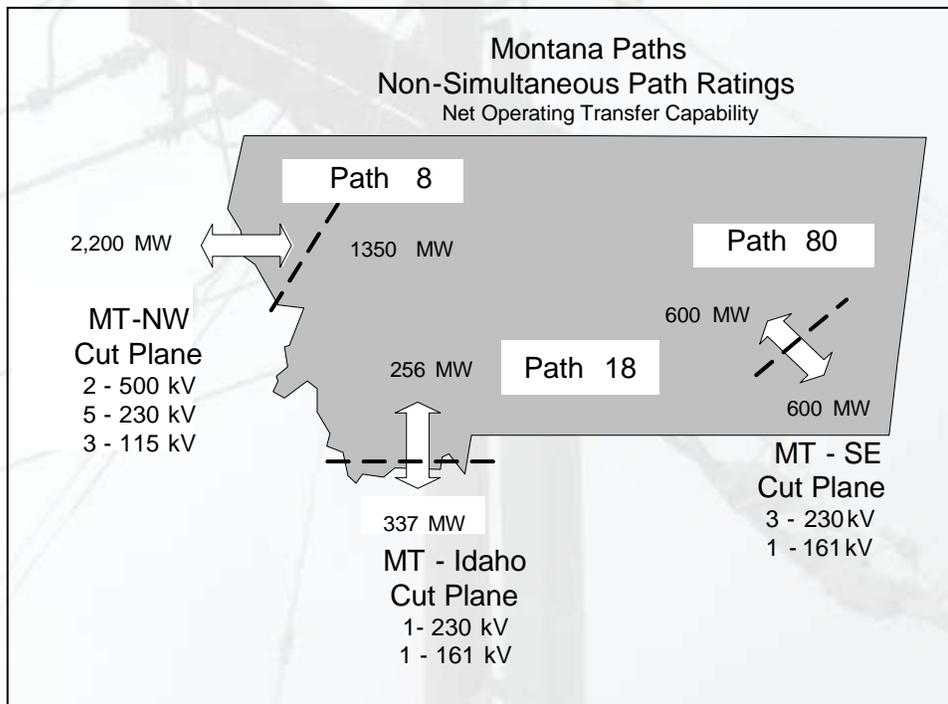
provides the reserve capacity necessary to maintain transmission system reliability by balancing on a moment by moment basis as customer demand and available resources fluctuate. Finally, on December 1, 2012, NWMT's Spion Kop Wind facility commenced commercial operation, adding 40 MW of renewable generation resources to our supply portfolio.

The transmission system, with voltage levels ranging from 50,000 to 500,000 volts, serves an area of 97,540 square miles, which is equivalent to two-thirds of Montana. The 500 kV transmission system is primarily used to move power from Colstrip in eastern Montana to the Northwest. NWMT's lower voltage transmission system is used primarily to serve local load, but also contributes to the flows on the tie lines connected to neighboring utilities.

NWMT's transmission system has interconnections to five major transmission systems⁶ located in the Western Electricity Coordinating Council (WECC) area and one Direct Current (DC) interconnection to a system that connects with the Mid-Continent Area Power Pool (MAPP) region.

Figure 1: Montana Paths displays the external paths with the associated non-simultaneous path ratings. Not illustrated is new Path 83, the Montana - Alberta tie line (MATL) from Great Falls to Alberta, which commenced commercial operation on September 18, 2013 with a path rating of 300 MW.

Figure 1: Montana Paths



⁶ Idaho Power Company, Avista Corporation, Bonneville Power Administration, Western Area Power Administration and PacifiCorp.

Figure 2: NWM's Bulk Electric Transmission System displays the 100 kV and above bulk electric transmission system. The color coding of lines is as follows:

- Red: 230 kV
- Green: 161 kV
- Blue: 115 kV
- Yellow/Black: 100 kV

Figure 2: NWM's Bulk Electric Transmission System



Meeting FERC Order 890 requirements

The Federal Energy Regulatory Commission (FERC) issued its Order No. 890 on February 16, 2007 (Order). The Order provided amendments to the regulations and the pro forma Open Access Transmission Tariff (OATT) adopted in Orders 888 and 889. The Order became effective May 14, 2007. The Order requires a more inclusive transmission planning process incorporating the following nine principles: (1) Coordination, (2) Openness, (3) Transparency, (4) Information Exchange, (5) Comparability, (6) Dispute Resolution, (7) Interconnection wide Participation, (8) Economic Congestion Studies, and (9) Cost Allocation for New Projects⁷. The documents that outline NorthWestern Energy's efforts to support FERC Order No. 890, including business practices, are listed in a single document and posted on the NWMT OASIS website: [Attachment K Business Practice Links](#).

NorthWestern Energy's Attachment K was approved by FERC on April 8, 2010. NorthWestern Energy met FERC Order 890 requirements by following its Attachment K Business Practice⁷ and through the publication of this Local Transmission Plan. NWMT met the requirements for the nine principles as follows:

- Coordination and Openness are met through 1) a public process to allow two-way communication with stakeholders and interested parties throughout NWMT's transmission planning process; and 2) coordination of NWMT's plan with the Northern Tier Transmission Group (NTTG) throughout their regional planning process; and 3) coordination of NWMT's plan with the Western Electricity Coordinating Council's (WECC) interconnection wide planning organizations. (See the *Public Input* section of this Local Transmission Plan.)
- Transparency is met through the disclosure of NWMT's basic methodology, criteria, process and data used to develop its local transmission plan⁸ along with its mechanism to request input through the public process (TRANSAC meetings). (See the *Public Input* section of this Local Transmission Plan.)
- Information Exchange is met through data requests to NWMT's Load Serving Entities (LSE) and/or customers (e.g., network and point-to-point)⁹ and once data is combined NorthWestern Energy submits to WECC the annual WECC Loads and Resources data request and the WECC Power Supply Assessment data request.
- Comparability is met through the combination of the forecast load and generation information received from the customers with NWMT's transmission line and equipment

⁷ The document that addresses the nine FERC Order 890 principles is posted on NWMT's OASIS website: [Attachment K Business Practice 10-20-09](#).

⁸ Please refer to the following document, which is posted on NWMT's OASIS website: our [NWMT's Business Practic ETP Methodology, Criteria and Process \(Effective 9-25-12\)](#).

⁹ NorthWestern Energy's data gathering efforts from its Load Serving Entities (LSE) are posted on the [NWMT OASIS](#) website under the "Transmission Planning" folder. Under the "Transmission Planning" folder there will be annual Customer Loads & Resources Data Request Information folders from 2007 forward.

data and including that data, as appropriate in the database used in the reliability assessment.

- Dispute Resolution is met through NWMT's dispute resolution process and by following the WECC dispute process for regional and interconnection wide planning disputes.¹⁰
- Regional and Interconnection wide Participation is met by NWMT's active membership in the Northern Tier Transmission Group (NTTG), and the WECC Transmission Expansion Policy and Planning Committee (WECC TEPPC). Also, this local transmission plan is shared with interconnected transmission systems, regional and interconnection wide entities as required or requested.
- Economic Congestion Studies are met through the Economic Congestion Study Process. Three economic congestion study requests were received in 2012 and three study requests were received in 2013. (See the *Economic Congestion Study Cycles* section of this document.)
- Cost Allocation for New Projects is met by following NWMT's Open Access Transmission Tariff (OATT) business practice "Local Cost Allocation Methodology Outside of OATT"¹¹.

¹⁰ NorthWestern Energy's Dispute Resolution is described in its [Attachment K](#) and NWMT's [OATT](#), posted on NWMT's OASIS website. [WECC's Dispute Resolution Procedures](#) - Appendix C (last modified 10/14/2009) is posted on the WECC website and available to those who can log in. Login credentials are provided only to employees of WECC member organizations.

¹¹ The document called "[Local Cost Allocation Methodology Outside of OATT](#)" is posted on NWMT's OASIS.

Future Requirements - FERC Order 1000

FERC Order 1000, issued July 21, 2011, amended the transmission planning and cost allocation requirements established in Order 890 to ensure that Commission-jurisdictional services are provided at just and reasonable rates on a basis that is not unduly discriminatory or preferential. With respect to transmission planning, this Final Rule: (1) requires that each public utility transmission provider participate in a regional transmission planning process that produces a regional transmission plan; (2) requires that each public utility transmission provider amend its OATT to describe procedures that provide for the consideration of transmission needs driven by public policy requirements in the local and regional transmission planning processes; (3) removes from Commission-approved tariffs and agreements a federal right of first refusal for certain new transmission facilities; and (4) improves coordination between neighboring transmission planning regions for new interregional transmission facilities. Also, this Final Rule requires that each public utility transmission provider must participate in a regional transmission planning process that has: (1) a regional cost allocation method for the cost of new transmission facilities selected in a regional transmission plan for purposes of cost allocation; and (2) an interregional cost allocation method for the cost of certain new transmission facilities that are located in two or more neighboring transmission planning regions and are jointly evaluated by the regions in the interregional transmission coordination procedures required by this Final Rule. Each cost allocation method must satisfy six cost allocation principles.

FERC Order 1000 included two compliance filing dates – the first, October 2012, was to respond to the regional planning and cost allocation portion of the Order and the second, July 2013, was to respond to the coordination of interregional planning and cost allocation portion of the Order. NWMT and the other FERC jurisdictional transmission providers that are members of the Northern Tier Transmission Group (“NTTG”) region met both of these filing deadlines. In May 2013 FERC accepted, subject to a further compliance filing, NWMT’s and other NTTG members’ October 2012 regional planning and cost allocation compliance filing and established September 14, 2013 as the due date for the response to this Order. NWMT, and the other transmission providers, also met this date. Also in May 2013, NWMT made its interregional compliance filing two months before its due date in July 2013, and FERC has not responded to this Order at this time.

In response to the September 14th Compliance Filing, FERC approved the filing so NTTG could start the implementation of FERC Order 1000, but the approval is subject to FERC’s final Order after their full review of the September Filing. The planning requirements portion of FERC Order 1000 provides opportunity for stakeholders to propose input on public policy requirements and its associated transmission needs on the local level and to submit projects that are regional in nature to the region¹².

¹² Since NWMT is a member of Northern Tier Transmission Group (“NTTG”), stakeholders should submit their requests directly to NTTG at info@nttg.biz.

Public Input

Local

TRANSAC

The concept of a Transmission Advisory Committee (TRANSAC) was formulated at an open public meeting held May 3, 2007 to present and review the development of a strawman, NorthWestern Energy's initial proposed response to FERC Order 890. This effort developed into NWMT's "OASIS Attachment K Business Practice" and addresses openness, transparency and ways for the public to provide input¹³. The purpose of TRANSAC is to provide an open transparent forum whereby electric transmission stakeholders can comment and provide advice to NorthWestern Energy during its electric transmission planning process. TRANSAC membership is open to anyone and is established through self-nomination. Standards Of Conduct (SOC) and Critical Energy Infrastructure Information (CEII) are followed, and discussion at these meetings is limited to NWMT electric transmission planning issues. TRANSAC is not a decision-making body, and does not make decisions as a group; it provides comment and advice only. Please see Attachment A – TRANSAC Charter for an outline of membership, process, member responsibilities, contacts and confidentiality. For the 2012-2013 Local Area Planning Cycle, NWMT held a minimum of four TRANSAC meetings per year.

Following the release of the 2010-2011 Local Area Transmission Plan in November 2011, efforts were made to contact each of the 62 individual stakeholders to verify contact information and their wish to continue as stakeholders in our process. The result of this effort was to begin the 2012/2013 planning cycle with 49 TRANSAC members. As of December 13, 2013 there are 60 individuals on the stakeholders distribution list that is comprised of representatives from such organizations as Avista Corporation; Bonneville Power Administration; Central Montana Electric Power Cooperative; Columbia Grid; Duke Energy; Exergy Development Group; Gaelectric Power; Grasslands Renewable Energy, LLC; Great Northern Properties; Idaho Power Company; Independent Consultants; Large Customer Group (LCG); Missoula Electric Cooperative; Montana Consumer Council; Montana Department of Commerce; MT Department of Environmental Quality (DEQ); Montana Public Service Commission (MPSC); Naturener (USA & Canada); NorthWestern Energy; Oversight Resources, LLC; PPL EnergyPlus, LLC; Puget Sound Energy; Ravalli Electric Co-operative; Renewable Northwest Project; Sagebrush Energy, LLC; Southern Montana Electric G&T Cooperative; SWCA Environmental Consultants; and Western Area Power Administration (WAPA). Notices of meeting related postings on the OASIS website and meeting related material are sent to the stakeholder distribution list on a regular basis. All individuals are invited to attend or join in the TRANSAC meetings, and NorthWestern Energy solicits their input throughout the planning process.

The development of the Electric Transmission System Plan is discussed with TRANSAC members through a series of meetings and conference calls that were announced and posted on NWMT's OASIS

¹³ See Principle 2 – Openness and Principle 3 – Transparency of the "[Attachment K Business Practice 10-20-09](#)" posted on NWMT's OASIS.

website¹⁴. Four meetings and one conference call were held in 2012, and five meetings and one conference call were held in 2013. The postings on the OASIS website include the meeting announcements, agendas, meeting materials and meeting summaries. For a summary of meeting dates and topics discussed, please see Attachment B – Transmission Advisory Committee (TRANSAC).

Public Meetings

As a result of the public meetings held in Helena and Butte in November 2011 during the 2010/2011 local area planning cycle, NWMT was asked to provide an additional presentation to 20 Economic students from the University of Montana Western on December 19, 2011. During the 2012/2013 local area planning cycle NWMT also provided a presentation to the Electricity Technical Advisory Committee (ETAC) in Helena on Feb 27, 2013.

NWMT chose to conduct two public meetings during the 2012/2013 local area planning cycle. One meeting was held at the Great Falls Division Office on October 8, 2013 and the other meeting was held at the Bozeman Division Office on October 10, 2013. These two locations were chosen because they had not been visited before in the course of previous local area planning cycles, and both areas had new transmission line construction projects in progress. Announcements for the meetings were posted on the OASIS at least 30 days prior to the meeting dates, with newspaper announcements printed in both cities. The meeting notice was also posted on NorthWestern Energy's intranet and internet websites.

There were 7 participants at the Great Falls meeting held October 8, 2013 including several NWMT employees, a Senate District representative, a Helena Chamber representative and a supplier. There were 8 participants at the Bozeman meeting held October 10, 2013 including an NWMT employees, and representatives from BPA, WAPA and Power Engineers. The question and answer portion of the meetings centered around customer growth, upgrades, mitigation, resource mix and the purchase of hydro plants from PPL.

Regional Planning

In the regional context, NWMT is an active member of the NTTG and uses the NTTG process for regional planning and cost allocation, regional coordination with adjacent regional planning entities. NTTG develops a biennial Regional Transmission Plan and responds to requests for Economic Congestion Studies pursuant to FERC Order 890. NWMT participates in the interconnection-wide planning activities of the WECC Planning Committee and the WECC TEPPC.

NWMT's Attachment K, the NTTG Planning Agreement and the NTTG Planning Charter govern the relationship between NWMT local transmission planning and the NTTG's regional transmission planning activities. These documents are listed in the Attachment K Business Practice Links Document, available on NWMT's OASIS website¹⁵. The FERC 890 principle obligations, which are met by NTTG includes, but

¹⁴ Once at the [NWMT OASIS](#) website, scroll down until you see 'Transmission Planning – TRANSAC' folders on the left hand side of the screen. There are folders for 2012 and 2013. The 'Transmission Planning – TRANSAC – Archive' folder has folders for 2007, 2008, 2009, 2010 and 2011.

¹⁵ See Section 1-A for Attachment K, and Section 2-D for NTTG Charters and Agreements of the [Attachment K Business Practice Links](#) Document.

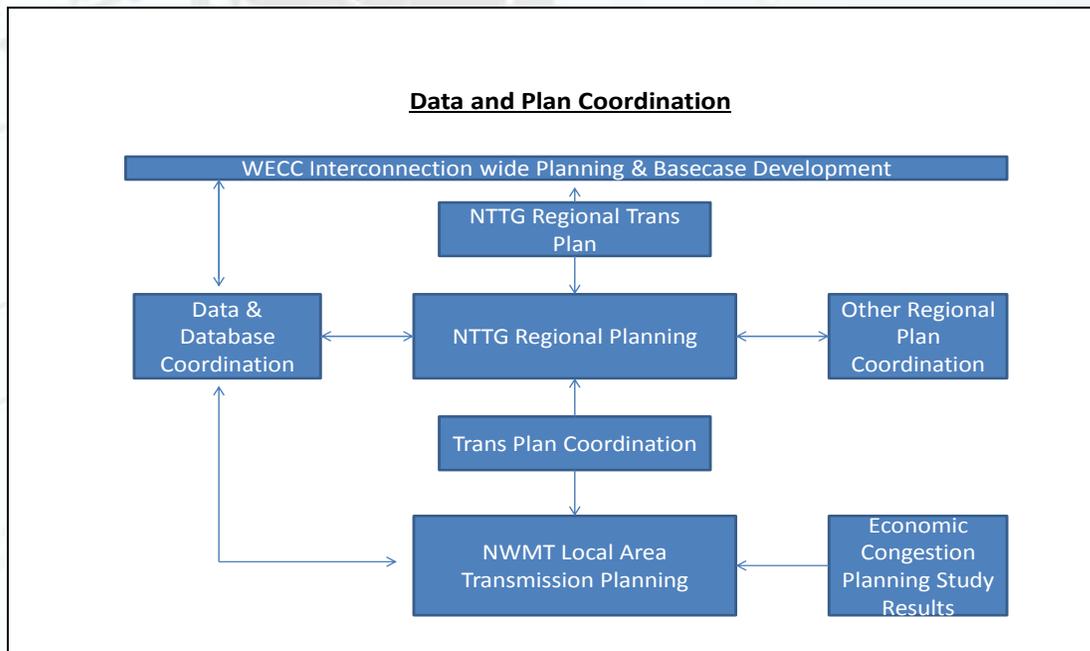
are not limited to, an open forum to coordinate transmission plans of its members with those of other regional transmission groups within the Region. NTTG also has a cost allocation committee that determines cost allocations for qualifying system additions where agreement on cost allocation has not been reached.

NWMT actively participates in NTTG’s biennial planning process by providing data and technical expertise and planning staff to develop NTTG’s regional transmission plan. The NTTG regional transmission plan is shared with neighboring regional entities (e.g., Columbia Grid, WestConnect and CAISO). Also, the NTTG’s biennial regional transmission plan is shared with stakeholders, other regional planning entities, WECC and state and federal regulators.

NWMT keeps TRANSAC Stakeholders informed of regional and interconnection wide activities through NWMT’s Local Area Process. This is done by posting NTTG Stakeholder meeting notices on NWMT’s OASIS, providing email notices to the Stakeholders, and by providing regional and interconnection wide updates at TRANSAC meetings.

An example of the data and plan coordination for this process is shown in Figure 3: Local and Regional Planning. As the figure shows, data and plan information is coordinated between the local planning process, the NTTG regional planning process and the WECC interconnection wide planning process¹⁶.

Figure 3: Local and Regional Planning



¹⁶ See Section 2-M Transmission Planning Guidance Document of the [Attachment K Business Practice Links](#) Document.

Interconnection wide Planning

WECC Annual Study Program

In addition to NWMT's own local transmission planning study and NTTG planning activities, NWMT participates in the Western Electricity Coordinating Council ("WECC") Annual Study Program and the WECC TEPPC transmission planning effort. NWMT provides its local transmission plan, data and assumptions to WECC committees¹⁷ that are responsible for building databases. WECC committees use these data for database development, load and resource assessments, operating studies and planning studies.

The **Bulk System Planning Study** originates through the WECC System Review Work Group (SRWG) annual planning program. The WECC study follows the same process as the System Operating Limit (SOL) studies, except the season can range from two to ten years in the future and may include proposed new facilities. The goal of the planning study is to examine the reliability of the future transmission system under prescribed seasonal loads, generation patterns, and various outage conditions and to identify appropriate upgrades and/or new facilities to maintain bulk system reliability into the future.

Customers can be directly involved in NWMT's local planning through participation in NWMT's TRANSAC. NWMT keeps TRANSAC Stakeholders informed of regional and interconnection wide activities through NWMT's Local Transmission Planning Process. This is done by posting NTTG Stakeholder meeting notices on NWMT's OASIS, providing email notices to the Stakeholders, and by providing regional and interconnection wide updates at TRANSAC meetings. Customers can also be involved in NTTG regional planning and be involved in WECC interconnection wide planning, but will not have a vote unless they are members of those organizations.

NWMT participates in interconnection wide transmission reliability and economic congestion studies as appropriate to ensure data and assumptions are coordinated. The footprint of the study and how NWMT is affected by the request guide NWMT's participation in the study.

Distribution of the Local Area Transmission Plan

Part of the biennial process is to make available the results of each two-year cycle. Distribution of each biennial Local Area Transmission Plan includes, but is not limited to the following:

- Posted on NWMT OASIS website
- TRANSAC Stakeholders, which includes surrounding utilities
- Regional and Interconnection Wide entities
- Posted on NWMT in-house website, iConnect

¹⁷ For example: WECC System Review Work Group (SRWG) and WECC Load and Resources (LRS) Subcommittee.

Economic Congestion Study Cycles

Input for NWMT’s Economic Congestion Study cycle happens throughout a 12-month cycle as shown in Table 1 – NWMT Economic Congestion Study¹⁸.

Pursuant to FERC Order 890, stakeholders may request an Economic Congestion Study. The purpose of FERC Order 890 Economic Congestion Studies is to ensure that customers may request studies that evaluate potential upgrades or other investments that could reduce congestion or integrate new resources (e.g., wind developers) and loads on an aggregated or interconnection wide basis, not to assign cost responsibility for those investments or otherwise determine whether they should be implemented. This is different than a proposed new generation interconnect study, which is conducted to evaluate interconnecting a new Generating Facility. Likewise, separate studies are conducted to consider the effects of increasing the capacity or changing the operating characteristics of an existing Generating Facility that is interconnected with the Transmission Provider’s Transmission System.

A request for an Economic Congestion Study may be confined to NWMT’s Balancing Authority Area (BAA), in which case NWMT would complete the study using the methodology, criteria and process described within this Local Area Transmission Plan. A request for an Economic Congestion Study may be included as a scenario in NWMT’s local transmission planning cycle if it is received in a time frame that would allow this inclusion. Requests received outside of the two-month timing cycle shown in Table 1 – NWMT Economic Congestion Study, may be considered in the Economic Congestion study cycle the following year.

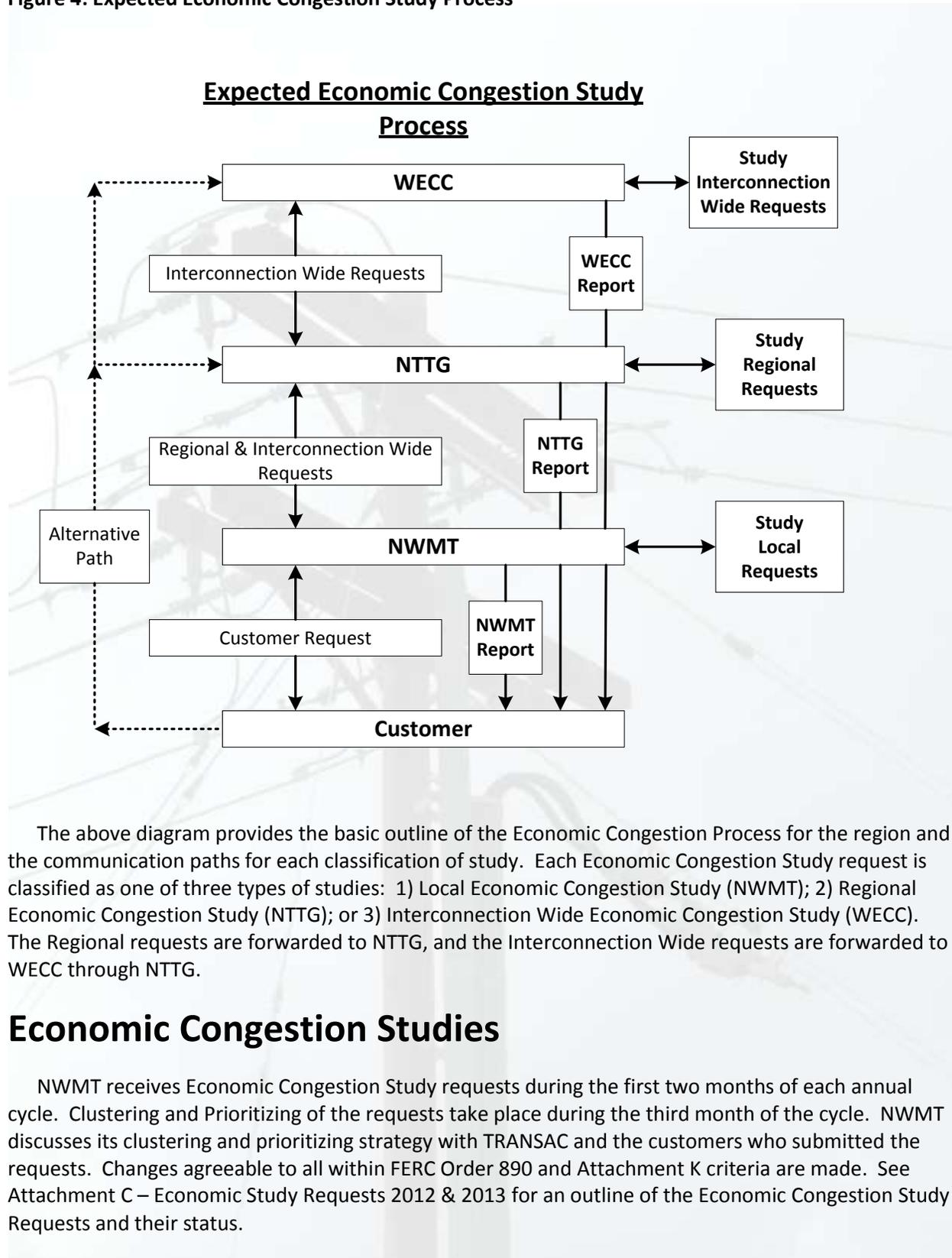
If NWMT receives a request for an Economic Congestion Study that expands beyond NWMT’s BAA, then the request will be classified as a regional or interconnection wide study request and NWMT will forward the request to Northern Tier Transmission Group (NTTG) or to WECC TEPPC. NWMT will coordinate and participate in their Economic Congestion Study as required.

Table 1 – NWMT Economic Congestion Study

Month*	Activity
1	Receive Requests
2	
3	Cluster & Prioritize
4	Study
5	
6	
7	
8	
9	
10	
11	Report
12	Results Meeting
* NWMT uses reasonable efforts to meet these time frames.	

¹⁸ For a full discussion on Economic Studies, please see Principle 8 – Economic Planning Studies of the [Attachment K Business Practice 10-20-09](#).

Figure 4: Expected Economic Congestion Study Process



2012 Economic Congestion Study Cycle

NWMT received three Economic Congestion Study requests by the end of February 2012: one request from Gaelectric and two from NorthWestern Energy. All three requests were deemed valid studies, reviewed with TRANSAC at a March 7th phone conference and classified as Regional (NTTG) studies. The three study requests were sent to, and reviewed by NTTG, and classified as valid regional studies. The studies were conducted in the second quarter of 2012, completed the third quarter of 2012, and reported in the fourth quarter of 2012¹⁹. There were no Local Economic Congestion Study requests received in 2012. See Attachment C – Economic Study Requests 2012 & 2013 for a description of the three Economic Congestion Study requests.

2013 Economic Congestion Study Cycle

NWMT received three Economic Congestion Study requests during the first two months of the 2013 cycle. The three requests received were: one from Gaelectric and two from PPL Energy Plus. A TRANSAC phone conference was held on March 7, 2013 to review and classify the requests. All three study requests were designated as valid local area requests. NWMT agreed to conduct the Gaelectric study and to cluster the two PPL Energy Plus study requests such that the south-to-north aspects of the requests become the second local Economic Congestion Study that NWMT would conduct. The north-to-south aspects of the requests were to be handled through an uncertainty scenario in the local area planning cycle, but after meeting with PPL and discussing study details, NWMT determined that this request was very similar to a transmission service type study, and beyond the scope of the local area planning process. A High Wind with Imports from north of Great Falls uncertainty scenario was developed and studied instead, and is reported in the Uncertainty Scenarios section of this document.

There were no regional or interregional Economic Congestion Study requests received in 2013. See Attachment C – Economic Study Requests 2012 & 2013 for a description of the three 2013 Economic Congestion Study requests. The two Local Economic Congestion Studies, completed by NWMT in 2013, are posted on NWMT's OASIS website²⁰.

¹⁹ The 2012 NTTG Approved Economic Study Report is posted on the Northern Tier Transmission Group (NTTG) website at http://nttg.biz/site/index.php?option=com_docman&task=cat_view&gid=417&Itemid=31.

²⁰ The Economic Congestion Study Reports for 2013 will be posted on NWMT OASIS website upon completion. <http://www.oasis.oati.com/NWMT/index.html>.

Planning Methodology

NorthWestern Energy’s Planning Methodology, Criteria and Process are outlined in NWMT’s [Business Practice ETP Methodology, Criteria and Process](#) dated September 18, 2012.

The remainder of this section summarizes the highlights from this business practice. Also, for all of NWMT's Business Practices and Attachment K related documents, please refer to footnote #1 on page 5.

NWMT Local Transmission Planning Methodology

NWMT’s methodology includes the four major steps shown in Table 2 – Planning Methodology. These steps are 1) Goal and Scenario Definition, 2) Technical Study, 3) Decision, and 4) Reporting. NWMT used scenario planning and not probabilistic planning for developing the electric transmission system plan. Local transmission planning may be confined to a specific geographic area, such as the Bozeman area, or it may be broadened to examine a specific transmission line or lines that extend over a large geographic area, such as NWMT’s BAA. The transmission lines used in a local transmission planning study may range in size from 50 kV to 500 kV and may be networked or radial.

1. Goal & Scenarios
2. Technical Study
3. Decision
4. Reporting

Local transmission planning methodology involves forecasting customer demand, identifying area reliability problems, evaluating possible mitigation options and selecting a solution that solves the area’s transmission needs. Transmission planning evaluates the transmission system reliability up to 15 years in the future. The planning effort considers transmission and non-transmission alternatives to resolve the reliability problem for a specified area. NWMT’s methodology is flexible and is intended to develop a plan that:

- ❑ Responds to customers’ needs;
- ❑ Is low cost (e.g., Total Present Value Revenue requirement, Rate Impact, etc.);
- ❑ Considers non-transmission and transmission alternatives;
- ❑ Assesses future uncertainty and risk;
- ❑ Promotes NWMT’s commitment to protecting the environment;
- ❑ Includes input from the public and other interested parties;
- ❑ Provides adequate return to investors;
- ❑ Complements corporate goals and commitments;
- ❑ Meets applicable NERC and WECC Standards and requirements;
- ❑ Meets the Montana Public Service Commission expectations;
- ❑ Meets Regional and Interconnection Wide planning requirements;

- ❑ Addresses customer and stakeholder concerns in an open, fair, and non-discriminatory manner.
- ❑ Satisfies the requirements of applicable FERC and MPSC Orders; and
- ❑ Conforms to applicable state and national laws and regulations.

NWMT worked with its Transmission Advisory Committee (TRANSAC) to establish the goal and to provide input throughout the entire Local Transmission System Planning Process. See Attachment A – TRANSAC Charter, and Attachment B – Transmission Advisory Committee (TRANSAC) Meetings.

Reliability Criteria

Electric transmission reliability is concerned with the adequacy and security of the electric transmission system. Adequacy addresses whether or not there is enough transmission, and security is the ability of the transmission system to withstand contingencies (i.e., the loss of single or multiple transmission elements).

- ❑ NWMT Internal Reliability Criteria is a set of technical transmission reliability measures that have been established for the safe and reliable operation of NWMT's transmission system.
- ❑ The FERC approved Standards (consisting of those implemented by NERC and WECC) and WECC Standards set minimum performance standards for voltage excursions and voltage recovery after a credible outage event on the transmission system. Credible outages are those more likely or plausible, and required to be considered by the governing standards.

NWMT uses these criteria in evaluating a change or addition to its electric transmission equipment and/or a change or addition to load or generation. NWMT uses these reliability criteria as needed to fully evaluate the impacts to its electrical system of proposed lines, generation or loads. NWMT augments these criteria with other standards such as, but not limited to, the American National Standards Institute (ANSI) and Institute of Electrical and Electronics Engineers (IEEE) standards.

NWMT planning ensures that any change that either directly or indirectly affects its transmission system will not reduce the reliability to existing customers to unacceptable levels. The NWMT electric transmission system must remain dependable at all times so that it may provide reliable high quality service to customers.

NWMT Internal Reliability Criteria

NWMT Internal Reliability Criteria are used for reliability performance evaluation of the electric transmission system. Steady state implies the condition on the transmission system before an outage or after an outage and after switching occurs, regulators adjust, reactors or capacitors switch, and the electrical system has settled down (typically three minutes or more). This latter condition is also called post-fault reliability requirements.

NWMT's criteria include a collection of ANSI standards as well as past and current practices, that when applied with experienced engineering judgment, lead to a reliable and economical electric transmission system. These criteria support the NERC/WECC Standards and WECC Reliability Criteria that disallow a blackout, voltage collapse, or cascading outages unless the initiating disturbance and

corresponding impacts are confined to either a local network or a radial system. An individual project or customer load may require an enhanced reliability requirement.

NWMT plans for a transmission system that provides acceptable voltage levels during system normal conditions and outage conditions. Areas of the NWMT system that are served by radial transmission service are excluded from single contingency evaluation, due to economic considerations.

Steady State and Post Fault Voltage Criteria for 230 kV and Below

The steady state voltage criteria listed in the tables below are based on the assumption that all switching has taken place, all generators and transformer Load Tap Changers (LTCs) have regulated voltages to set values, and capacitors or reactors are switched. The basis for the percent voltages is the designed operating voltage.

As shown in Table 3 – Maximum Upper Voltage Criterion, the recommended upper voltage limit for a load-serving bus is 105% unless equipment rating dictates a different limit. NWMT follows the limit as outlined in the ANSI standards (i.e., ANSI C84.1). It is possible that a load-serving bus voltage may exceed the table value if conditions allow a higher voltage without harm to NWMT or customer equipment.

Table 3 – Maximum Upper Voltage Criterion	
At Unregulated Load-Serving Bus	
	Upper Operating Limit
Voltages	105%

The allowable minimum percent voltage for any load-serving bus that is within a network configuration is shown in Table 4 – Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus. It is possible that a load-serving bus voltage may fall below the table value if conditions allow a lower voltage without harm to NWMT or customer equipment. This table considers FERC/NERC and WECC criteria as applied to the bulk electric system busses (100 kV and above). This table is also applied on lower voltage transmission busses that are not part of the bulk electric system (50 kV and 69 kV).

The minimum allowable percent voltage for a load serving bus that is on a radial transmission system for an event on the radial line must only meet the existing system performance (N-0) shown in Table 4 – Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus. Any unacceptable voltage performance must be mitigated in accordance with the criteria described below. The use of a Special Protection Scheme (SPS)²¹ is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use a SPS. The values in Table 4 – Minimum Allowable Percent Voltage at NWMT Unregulated Load-Serving Bus assume that all other methods to control voltage have been explored (such as capacitors, reactors, and line switching, etc.).

²¹ Also known as Special Protection System (SPS)

Nominal Voltage	Existing System (N-0)	First Contingency (N-1)	Second Contingency (N-2)
230 kV and 161 kV	95%	95%	93%
115 kV and 100 kV	95%	93%	90%
69 kV and 50 kV	93%	93%	90%

Note:

1. Percent voltage is measured from the nominal voltage.
2. 50 kV and 69 kV and radial 100 kV segments are not bulk electric system elements.

Steady State Voltage Criteria for 500 kV

The allowable operating voltage range for the 500 kV transmission system is 100% to 110% of nominal, or 500 to 550 kV. This range is different from other voltage levels because equipment used on the 500 kV system is nominally rated at 525 kV +/-5%.

Thermal Ratings

Transmission conductor continuous rating is based on 25°C (77°F) ambient air at 1.4 mph (2 ft/sec), 50°C conductor temperature rise, and 75°C (167°F) maximum operating temperature unless conditions dictate otherwise (e.g., some conductors and lines may be specifically designed for higher operating temperatures). This rating is entered as Rate A in the powerflow base cases. Unacceptable conductor loading can be mitigated by system improvements or, in some cases, an Overload Mitigation Scheme (OMS) that changes system conditions to mitigate the overload. The use of an OMS is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use an OMS.

Transformer rating is based on the following:

- For standard service conditions (24-hour average ambient air temperature of 30°C or 86°F, or less), the continuous rating is 100% of the highest operational nameplate rating. This rating is entered as Rate A in the powerflow base case.
- For winter service conditions (24-hour ambient air temperature less than 0°C, or 32°F,) loading to 125% of the standard service condition rating may be allowed.

Unacceptable transformer loading can be mitigated by transformer replacement, system improvements or, in some cases, an OMS that changes system conditions to mitigate the overload. The use of an OMS is evaluated on a case-by-case basis, with no assurance that NWMT will accept or use an OMS.

General Minimum Equipment Specifications

The general minimum specifications for North Western Energy Transmission and Substation equipment are listed in Table 5 – T&S Equipment: General Minimum Specifications. This table also summarizes the MVA or capacity, voltage, current, equipment Basic Impulse Level (BIL), Maximum Continuous Over Voltage (MCOV) for lightning arresters, and interrupt ratings of equipment as applicable and associated grounding requirements.

Table 5 – T&S Equipment: General Minimum Specifications

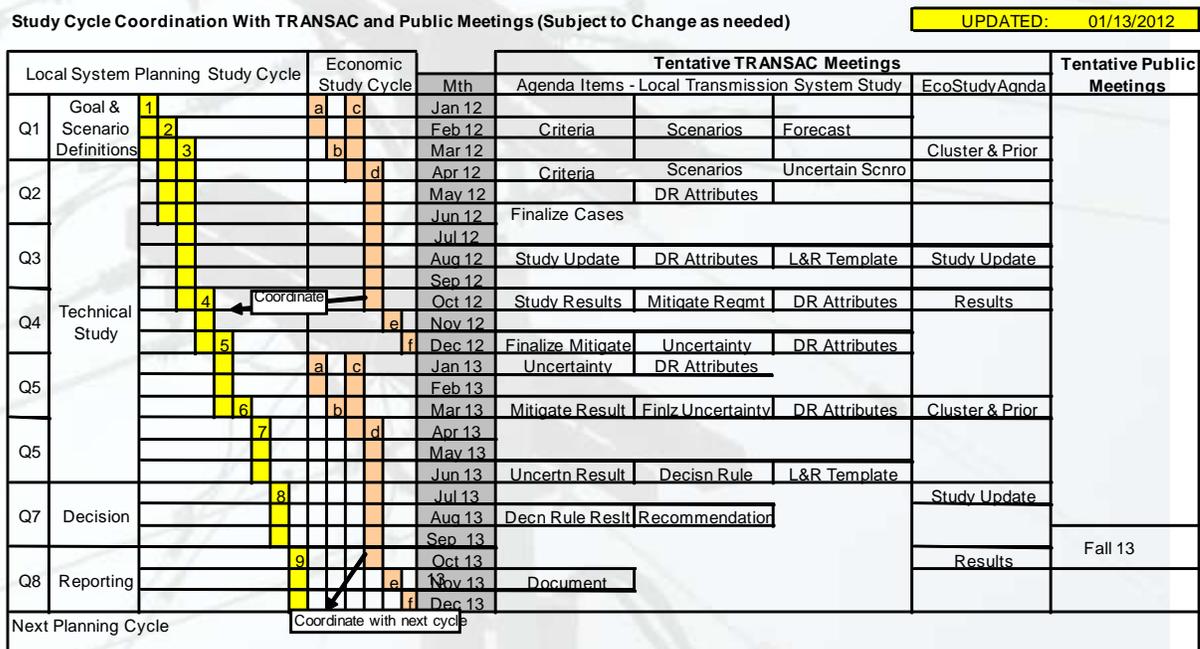
Transmission and Substation Equipment: General Minimum Specifications						
	Nominal System voltages - kV					
	230 kV	161 kV	115 kV	100 kV	69 kV	50 kV
MVA and Current Ratings *(1)	As Req'd	As Req'd	As Req'd	As Req'd	As Req'd	As Req'd
Equipment BIL (kV) *(2)	900	750	550	550	350	350
Maximum Design Voltage (kV) *(3)	242	169	121	121	72.5	72.5
Breaker Interrupt Current (kA)	40	40	40	40	40	40
Breaker and Switch Continuous Current (A) *(4)	1200	1200	1200	1200	1200	1200
Arrester Duty Rating/MCOV (kV) *(5)	172/140	120/98	90/70	90/70	54/42	39/31.5
Substation Insulator Class	TR-304	TR-291	TR-286	TR-286	TR-216	TR-214
Transmission Line BIL, wood (kV) *(6)	1105	780	610	525	440	355
Transmission Line BIL steel (kV) *(7)	1265	945	695	610	525	440
Notes:						
(1) Project and equipment specific as required to avoid thermal overloads						
(2) 1050 kV BIL is also used on some 230 kV equipment						
(3) At least 5% over nominal						
(4) 2000 amp equipment is used in some applications						
(5) For effectively grounded systems						
(6) Insulator support hardware ungrounded						
(7) Insulator support hardware grounded						

Voltage criteria for 500 kV, General Minimum Equipment specifications, Transmission Equipment Rating and Loading, Special Protection Scheme (SPS) and Overload Mitigation Scheme (OMS) Application, Voltage Ride Through, Harmonics, and Subsynchronous Resonance, are outlined in [NWMT's Business Practice ETP Methodology, Criteria and Process \(Effective 9-25-12\)](#), which is posted on NWMT's OASIS website.

Process to implement Methodology

Figure 5: Study Cycle Coordination outlines the process to implement and coordinate the Local Transmission Planning Study Cycle, the Economic Study Cycle and TRANSAC involvement. The Local Transmission Planning Study Cycle is conducted over a two-year period (8 Quarters outlined on the far left). The yellow highlighted numbers (1 through 9) coordinate to the “Notes” area at the bottom and explain the basic activities covered during the quarters and months (grey column toward the middle). The tan highlighted letters (a through f) explain the basic activities for the Economic Study Cycle. The remainder of the Figure outlines an example of TRANSAC and Public Meetings.

Figure 5: Study Cycle Coordination



NOTES For Flow Chart

Local System Plan

- 1 Develop Goal and Scenario Definition
- 2 Build Base Cases
- 3 Conduct Technical studies for the existing system
- 4 Build mitigation change cases
- 5 Conduct study with mitigation
- 6 Develop uncertainty cases
- 7 Conduct uncertainty analysis
- 8 Decision Rule Analysis
- 9 Reporting

Economic Study Request

- a Receive requests
- b Cluster and prioritize requests
- c RFP for consulting services
- d Conduct technical study
- e Write report
- f Results meeting with sponsor

Previous Plan Results Update

Previous Local Transmission study cycles resulted in a matrix that listed the Highest Priority System Problems. This section outlines the current status of past events that are still active from previous local area plans. The solutions were included in the 2012 State of the System Study and rolled into the current 2012-2013 Local Transmission Plan study cycle. Information on the following items that now rank part of

the top 15 in this 2012-2013 Local Area Plan can be found in the 'Prioritizing Critical Problems' section of this document.

- Great Falls 100 kV System N-0 (Ranked #1 in 2010-2011 Plan): Completed in 2011. Tap changes were made on the 230/100 kV transformers at the Great Falls 230 kV Switchyard. Area generator GSU upgraded allowing for lower generator set-points.
- Missoula 100 kV System N-0 (Ranked #2 in 2010-2011 Plan): Completed in 2011. Tap changes were made on area 161/100 kV transformers in the Missoula and Hamilton areas.
- Rainbow - GF Northeast 100 kV line (Ranked #4 in 2010-2011 Plan): Reconductor of the Great Falls 230 kV Switchyard to Montana Refinery 100 kV line to high temperature conductor. Completed in 2012.
- Missoula-Hamilton Heights 161 kV Lines N-1 (Ranked #5 in 2012-2011 Plan): Mitigation completed in 2011 for the Missoula 100 kV System N-0 problem, also mitigated this problem.
- Missoula #4 161 kV Bus Outage (Ranked #11 in 2010-2011 Plan): Bus sectionalizing power circuit breaker was added to the Missoula #4 bus in 2011.
- Billings Steam Plant 230 kV bus Outage (Ranked #9 in 2010-2011 Plan): Partially mitigated in 2012 with the addition of two new power circuit breakers. Balance of mitigation planned for 2018 includes new 230/100 kV auto substation. Now ranked #4 in 2012-2013 Plan.
- Mill Creek 161 kV Bus Outage (Ranked #3 in 2010-2011): Preliminary work was completed in 2012 with construction of a new 230/161 kV tie in the Butte area as a prerequisite to accommodate the extended outage for construction of an entirely new bus adjacent to the existing facility. Mill Creek rebuild scheduled for 2014. Now ranked #15 in 2012-2013 Plan. South Butte 230/161 kV tie mitigated severe outage.
- Ennis–Lone Mountain 69 kV or Ennis Auto 161 kV Bus (Ranked #7 in 2010-2011 Plan): Ongoing. Conversion of the existing Bozeman Jackrabbit – Meadow Village 69 kV line to 161 kV is currently being constructed and is scheduled for completion in 2015. Now ranked #2 in the 2012-2013 Plan.
- Columbus Area 50 and 100 kV System (N-1) (Ranked #6 in 2010-2011 Plan): A new 100 kV line from the Columbus area to the Chrome Junction area along with a new 100/50 kV LTC Auto-transformer in the Chrome Junction area are under consideration. Siting work is underway and mitigation tentatively scheduled for completed in 2017. Now ranked #1 in 2012-2013 Plan.
- Missoula #4 – Hamilton Heights 161 kV Lines (N-2) (Ranked #10 in 2010-2011 Plan): Conversion of one of the existing Missoula #4 to Hamilton Heights 69 kV line to 161 kV is staged over a number of years with initial stages tentatively scheduled for 2016, completion in 2022 or later. Now ranked #3 in the 2012-2013 Plan.
- East Gallatin 161 & 50 kV Bus Outages (Ranked #13 in 2010-2011 Plan): Rebuild of the 161 kV bus is tentatively scheduled for 2018. Now ranked #5 in 2012-2013 Plan.
- Missoula Rattlesnake kV Bus Outage (Ranked #8 2010-2011 Plan): A sectionalizing bus breaker is scheduled for installation in 2015. Now ranked #6 in 2012-2013 Plan.
- Rainbow Switchyard 69kV Bus (Ranked #15 in 2010-2011 Plan): Mitigation part of an ultimate plan to move Rainbow Switchyard to Crooked Falls. Majority of the 69 kV bus is scheduled for 2014 and 2015 with completion scheduled for 2019. Now ranked #10 in 2012-2013 Plan.
- Columbus-Rapelje-Alkali Creek 161 kV Line (Ranked #16 in 2010-2011 Plan): Part of an ultimate plan scheduled for completion in 2017. A new 230/100 kV tie will replace the existing 161/100 kV tie at Columbus Rapelje scheduled for 2015. Now ranked #12 in the 2012-2013 Plan.

- Clyde Park 161/50 kV Transformer and Bus Outage (Ranked #14 in 2010-2011 Plan): Preliminary mitigation plan has been developed, tentatively scheduled for 2017. Now ranked #13 in 2012-2013 Plan.
- Great Falls-Canyon Ferry-East Helena 100 kV lines (N-2) (Ranked #12 in 2010-2011 Plan): A temporary OMS mitigation scheme has been implemented. Hard mitigation tentatively scheduled in 2017. This problem is not ranked in the top 15 of the 2012-2013 Plan.

Goal

The goal for NorthWestern Energy's local transmission system plan was reviewed by all participants in the January 26, 2012 TRANSAC meeting. The goal is to develop a 15-year local transmission system plan that will:

- Use modeling scenarios defining current and different future load and resource conditions under normal and outage conditions
- Evaluate and prioritize problems found, and use a decision rule to identify the best plans for mitigation
- Consider transmission and non-transmission alternatives to mitigate system reliability problems
- Be coordinated with regional and interconnection wide entities
- Be coordinated with TRANSAC
- Have the study results presented to stakeholders for comment, and to NWMT management for approval and inclusion in the 15-year business plan
- Report management's decision to TRANSAC

Planning Scenarios

Scenarios are developed based on the goal of the local transmission system plan and to examine different load and dispatch patterns in the future to identify conditions that stress the transmission system in planning models and simulations. Through simulations potential problems in system adequacy or security are revealed under normal or abnormal system conditions. Scenarios are determined per the goals of the transmission plan and look at a 15-year planning study period: current year, five years, ten years and fifteen years into the future. NWMT uses scenario planning and not probabilistic planning for developing the local area transmission plan. NWMT may, however, use probabilistic assessment methods within a defined scenario to evaluate uncertainty.

Base case scenarios are used to examine the transmission system under a variety of future assumptions for a specific period of time. The scenario assumptions may include, but are not limited to, the following:

- Load Forecast (e.g., study year)
- Load Condition to Study (e.g., season, peak load or light load, etc.)

- ❑ Generation Available (e.g., generation additions/changes). Proposed generation projects are considered on a case-by-case basis, and may be included depending on project status and progress (LGIA, TSR, designation, etc.).
- ❑ Generation Dispatch Conditions (e.g., how is the generation operated). Based on historical operation, transmission service agreements, etc.
- ❑ Transmission System Elements Available (e.g., transmission element additions/changes)
- ❑ Transmission System Configuration (e.g., what elements are out-of-service)

The following “base” scenarios have been found to produce maximum stress on the local or bulk transmission system, and are used for planning purposes:

- ❑ Heavy Load Scenarios: Two typical heavy load scenarios tend to stress the local area transmission system.
 - “Heavy Winter”, maximum load conditions (heating with high power factor), maximum thermal generation, median hydro generation, moderate exports.
 - “Heavy Summer”, maximum load conditions (irrigation and cooling, lower power factor), high thermal generation, high hydro generation, and moderate exports. Heavy Summer conditions tend to govern in local area planning scenarios today.
- ❑ Light Load Scenarios: Two typical light load scenarios tend to stress the bulk or export system
 - “Light Spring”, light load conditions (little heat or cooling, no irrigation), moderate thermal generation, maximum hydro generation, heavy exports.
 - “Light Autumn”, light load conditions, high thermal generation, low to median hydro generation, and moderate exports. Light autumn conditions typically govern in bulk system planning today.

As a result, 16 base cases were used: four seasons (heavy summer, heavy winter, light autumn and light spring) for the present and future over a 15-year planning horizon (2012, 2017, 2022 and 2027). All cases were based on a 1/10 load forecast (modeled load has a 1 in 10 or 10% chance of being exceeded in actual conditions).

Historical load and system performance weigh heavily in scenario development, along with certain assumptions about the future. Scenario assumptions can include: load forecasts (growth), load condition (peak, light), generation (as available and how dispatched), transmission (additions, upgrades, and status, in-service or out).

Additional scenarios can be developed to consider other conditions that may stress the system such as: various combinations of path loadings, time of day variations in load and path loadings, and the effects of new paths, generation, or load.

A “sensitivity analysis” or study of uncertainty scenarios helps establish risks, costs, or other potential impacts of the uncertain future. Uncertainty Scenarios are developed with the knowledge that the future and the assumptions made in scenarios are uncertain. For example, the effects of higher or lower

load forecasts can be considered, as well as differences in generation dispatch, or the effects of proposed new generation or load.

Scenarios are examined in present and future cases for system adequacy and security under normal and outage conditions. Adequacy refers to the capacity of the system for future needs, while Security examines the ability of the system to maintain service through system disturbances or outages. The system must be designed and operated to meet reliability criteria and requirements for voltage levels, thermal capacity, and dynamic stability as established by FERC, NERC, WECC, regional and local requirements under normal and outage conditions. Other criteria such as Volt-amperes reactive (VAR) margins may be examined as well. Normal operating conditions that are studied include all system elements in their normally in-service operating state (referred to as an N-0 condition). Outage conditions that are studied include the loss or fault of one (N-1) or more (N-2, etc.) system elements (line, transformer, bus).

When models and simulations reveal system inadequacies under these study conditions, mitigation scenarios are developed to examine the effects and costs of various solutions to problems. Solutions could include, but are not limited to, new construction (transmission lines, substations), generation (new or dispatch changes), system reconfiguration, or other solutions (Demand-Side Management (DSM), imports/exports, etc).

The base scenarios used for the current year, outlined in Table 6 – Study Scenarios, were used to develop the 5-, 10-, and 15-year scenarios, along with the load forecast.

Table 6 – Study Scenarios

Study Scenarios

BASE SCENARIOS

Scenario Name/Year	Load Conditions		Generation			External Paths			Comments
	Demand	P F	Hydro Gen	Thermal Gen	Wind	MT-NW Path 8	MT-ID Path 18	MT-SE Path 80	
Heavy Summer	Max	0.92	Median to High	High	0 to Max	Moderate Export	Heavy Export	Moderate Export	Max local area stress expected. Heavy irrigation load and cooling load, lower power factor.
Heavy Winter	Max	0.98	Low to Median	Max	0 to Max	Moderate Export	Moderate Export	Moderate Export	Local area stress expected, worst condition in some areas (Big Sky). Heavy heating load with high power factor.
Light Spring	Min	0.95	Max	Moderate	0 to Max	Heavy-Max Export	Low-Moderate Import	Low-Moderate Import	Heavy bulk system stress expected.
Light Autumn	Min	0.95	Low to Median	High	0 to Max	Heavy-Max Export	Low-Moderate Import	Low-Moderate Import	Heaviest bulk system stress expected.

Study Criteria

- System Normal and Outage conditions were modeled and studied for adequacy and system security.
- Segment or element thermal loads >85% were noted under these conditions; loads above 100% were noted as overloads (transformers were allowed up to 125% load in winter).
 - Overloaded segments were “tripped” per standard relaying practice (100% thermal on lines, 125% minimum thermal on transformers) to check for “cascading” outages except as noted below per new NERC requirements;
 - 230 kV lines are not tripped below 150% thermal per requirements of NERC PRC-023.
 - May apply to path lines or other system lines and elements deemed critical.
- Voltages outside of NWMT planning criteria were noted (93% and 95% low voltage limit depending on line voltage; 105% high voltage limit).
 - Load-serving bus voltages may fall above or below the tabled value if conditions allow a higher/lower voltage without harm to NWMT or customer equipment.
 - Certain equipment ratings may dictate different limits.
- Existing OMS or SPS schemes were considered.

Technical Study

Technical Study is the second step in local transmission planning. It examines the reliability of NWMT’s electric transmission system that moves power around NWMT’s BAA and between the bulk electric transmission system and the distribution system. NWMT used a sophisticated computer model (i.e., PSS/E) to simulate generator output, electrical flows through the transmission lines and transformers, electrical equipment action, customer loads and export (or import) path flows. The purpose of the technical study is to quantify transmission system performance by measuring the bus voltage, equipment loading, reactive power requirement, system frequency, and other electrical parameters.

NWMT did not conduct studies for every possible load and resource dispatch combination for the 8,760 hours of the year. Instead, only the load and resource dispatch patterns that stressed the transmission system were evaluated. The reliability of the local transmission system was evaluated with all transmission lines in-service or with a variety of elements out-of-service. For each computer simulation run, the transmission system voltage, equipment loading, and other parameters were measured and compared to specific reliability criteria²². If the reliability criteria were not met, then appropriate mitigation (transmission and non-transmission) was modeled in the base case database and the computer model simulation was run again. This process continued until the reliability criteria were met. The mitigation measures could include enhancements to the transmission system, generation development, demand resource development or other alternatives.

²² Federal Energy Regulatory Commission, NERC, WECC or NWMT reliability criteria.

A database was developed that included technical data for generation, transmission lines, electrical system equipment and customer load levels and geographic distribution. NWMT presented its forecast data for transmission to TRANSAC. The basic methodologies for developing this forecast data are described below.

- **Transmission:** NWMT used the existing transmission infrastructure as the starting point. This data was reviewed, and any updates to the existing transmission data were included in the base case. Future additions to the transmission system may or may not have been included. If a new transmission project was under construction, then it was included in the base case. Future new transmission additions not under construction were not included in the initial base case unless a prior planning study had accepted the project and NWMT agreed to include it after discussing it with TRANSAC. For example, the proposed Columbus Rapelje-Chrome Junction 100 kV line was included in the five-year and later base cases. Other future new transmission additions were considered as one of the mitigation options when transmission system reliability problems arose during the study.

New interconnection wide transmission projects that affect NWMT's transmission were included if the project received WECC Phase 3 approval and NWMT agreed to include it after discussing it with TRANSAC. For this Local Area Plan, the MATL line was included in the **2017** and later base cases. MSTI and the proposed 500kV and AMPS line upgrades were not included.

- **Generation:** NWMT used the existing generation infrastructure as a starting point. This generation data was reviewed, and any updates or changes were included in the base case. Future generation additions, including generation from NWMT's generation interconnect and transmission service request queue, was considered on a case-by-case basis, but generally was included if a signed interconnection and transmission service agreement existed. Since NWMT's Balancing Area currently has significantly more generation installed than load, proposed new generation additions may significantly change the transmission system configuration because of the mitigation requirements (i.e., transmission fixes) to connect and move power across NWMT's transmission. The Local Transmission Plan planning process cannot ignore this. NWMT studies each generation addition individually.
- **Demand Resources:** NWMT obtains demand response resource forecasts directly from the Load Serving Entities (LSEs) and customers within the BAA. DSM was included in the Load Forecast.

Using this database information, NWMT developed the base cases used to model the transmission system. NWMT's base cases also included the data for the entire WECC region. The time frame that the base case data represents is for a very specific condition that may occur over the course of the year. Thus, defining the conditions for a base case involves defining the generation, transmission configuration and customer load levels that are the focus of the study. Transmission planning's purpose is to ensure transmission system reliability under all operating conditions, which means that the studies need focus only on the conditions that may stress the system. The following two examples describe stressed system conditions:

Example 1: Montana load at peak load conditions, such as the summer peak day, and high generation stress the local area transmission system serving the local area load.

Example 2: Montana load at light load conditions, such as the middle of the night, with high generation levels and high export levels that stress the high voltage transmission system.

The technical analyses use different engineering studies to evaluate the system performance. These studies are designed to use different engineering perspectives to ensure system reliability is maintained. These methods may include, but are not limited to, the following:

- Steady-State Powerflow Analyses
- Post-Transient Steady-State Powerflow Analyses (or Steady-State Post Fault Analyses)
- Transient Stability Analyses (or Dynamic Analyses)
- Fault Duty Analyses
- Reactive Margin Analyses

A study of the transmission system under static conditions is a steady state powerflow study, and a study over time²³ is called a transient stability study. The steady state powerflow analysis is a static evaluation of a local area transmission system that examines the transmission system under normal operating conditions with all lines in-service and with single and credible multiple transmission lines or elements out-of-service (i.e., N-1, N-2, etc. conditions). Note that the “-1” in N-1 represents the number of transmission elements that are out-of-service. A transient stability study (i.e., a dynamic simulation study) evaluates the transmission system performance on a progressive time dependent basis. These studies evaluate credible outage events to determine if the transmission system will recover to acceptable steady-state operation after the outage. The studies include an assortment of outage events that are intended to provide a thorough test of the reliability of the transmission system. After a powerflow simulation is completed, a search of the simulation results for unacceptable thermal overload and voltage excursion is made. Unacceptable transmission system performance must be corrected by including transmission and non-transmission (e.g., demand-side resource, generation, etc.) fixes into a second simulation. Additional mitigation or fixes are included in the simulation until a valid solution is found. A valid solution is one that meets the reliability criteria described previously. Economic and system performance information for this scenario is identified and retained for comparative analysis between scenarios during the decision step.

Each scenario study must evaluate the effectiveness of existing Special Protection Schemes (SPS) within NWMT BAA. A SPS is used to maintain system reliability for voltage performance problems. Existing SPS include NWMT's Acceleration Trend Relay (ATR) device to trip generation at Colstrip for major events, the Bonneville Power Administration's SPS to directly trip the Miles City DC tie for certain

²³ The PSS/E model automatically completes a transient stability study by running the computer model repeatedly over time and recording how the generation and transmission elements change over time as the result of an outage. A sequence of results is produced that depict how the generation and transmission system equipment responds to this outage condition. The time step must be very small to accurately capture transmission system changes because generation and load are matched instantaneously. For example, a dynamic study runs a simulation of the system, with progressive “real” time adjustments, every ¼ cycle or 0.00417 seconds. Thus to make a 5 second study, the program must be run 1,200 times.

500 kV events west of Garrison and a SPS to trip the Hardin generation for certain 500 kV events. The Colstrip generation employs generator tripping for critical outage events on the 500 kV electric transmission system. The generator-tripping scheme is a computer-based relay called the ATR. This device monitors the generator speed and acceleration (real time), and digitally analyzes these quantities to determine when an unstable event is in progress. If an unstable event is in progress, the device determines the amount of generator tripping that is required to protect the electric transmission system from instability and unacceptable low-voltage swings caused by the event. The ATR then proceeds to trip the necessary number of generating units at Colstrip before the event causes instability problems to occur. To model the ATR in the study NWMT uses special internally developed NWMT software in conjunction with the PSS/E model.

In addition, as new generation is added to the existing generation sources, NWMT must fully evaluate the impacts to the existing SPS operation and whether or not the new generation must be on a SPS or if other forms of mitigation are required. NWMT may also consider an Overload Mitigation Scheme (OMS) to control thermal overloading. See the Criteria section of this Local Area Transmission Plan for a more detailed discussion of the SPS and OMS use.

These studies and analysis of the changes in system scrutinize: steady-state and transient voltage levels after the loss of a single line or other system element (e.g., transformer, generator, etc.) and multiple lines, or other system elements; changes in the line and equipment thermal loading conditions; changes in Volt-Ampere reactive (VAR) requirements (voltage support); and unacceptable frequency excursions. All relevant reliability criteria are applied in these evaluations.

NWMT also conducts fault duty studies and reactive margin studies as needed. A fault duty study is a study of electrical current interrupting devices (e.g., breakers) to ensure the device can open under maximum fault conditions. When a fault or short circuit occurs on a power line, the protective relay equipment detects the increased current (i.e., fault current) flowing in the line and signals the line's circuit breakers to open. When the circuit breakers open, they must be capable of interrupting the full fault current. The worst-case fault current is commonly referred to as the "fault-duty". A reactive margin study is a study to ensure that the transmission system has sufficient VAR resources to maintain adequate voltage levels.

Developing the Load Forecast

NWMT developed its peak load forecasts, conservation and demand-response data ("load forecast data") from two sources. First, pursuant to FERC MOD-016, which became effective in June 2007, NWMT obtained load forecasts from Load Serving Entities (LSE) within the Balancing Authority Area (BAA). NWMT obtained load forecast data from Network Customers and Point-to-Point Customers pursuant to NWMT's tariff and FERC Order 890, respectively. NWMT asked that these load forecasts be adjusted for any MW savings from customers' conservation programs. These peak load forecasts were summed, assuming they were time coincident, to calculate the BAA load forecast. NWMT's second source was a regression-based peak load forecast model that NWMT has maintained over the years. In this regression-based model the loads within NWMT's BAA are metered and tracked so that loads are well-defined. If the LSE and NWMT load forecast results are significantly different, NWMT attempts to reconcile these differences. If NWMT cannot reconcile these differences, NWMT chooses which forecast to use in the study.

NWMT obtained load forecast data for ten years of monthly data and annual data extending through a fifteen-year planning horizon.

NWMT used a peak load forecast that is based on a 50% probability of being exceeded (i.e., 1-in-2 assumption). The forecast may be adjusted up to a 1-in-10 or 1-in-20 (i.e., 10% and 5% probability, respectively) to capture heavy peak load conditions. For studies within the BAA, 70% of a 1-in-2 peak load forecast will be used for light load (spring and autumn) and 100% of a 1-in-10 peak load forecast will be used for heavy load (summer and winter).

The NWMT BAA area peak load forecast is adjusted to reflect demand response resource reductions, conservation reductions and other appropriate peak load modifying sources. Once a BAA load forecast was developed, this forecast was disaggregated to the load buses in NWMT's BAA. There are two types of load buses: 1) a load bus where the load does not change over time (e.g., a single, large industrial load bus); and 2) a load bus where the load changes over time (e.g., residential load). NWMT used its knowledge of load characteristics along with regression analysis to extrapolate the individual load bus data in time. The load bus forecasts were summed and compared to the BAA load forecast. If the two forecasts do not match, NWMT adjusts the changing load bus forecasts until the two forecasts are the same.

In developing the Load Forecast a number of variables are used:

- ❑ Dependent
 - Load
- ❑ Independent
 - Population
 - Large Industrial Load
 - Winter Heating Degree Day
 - Summer Maximum Temperature
 - Month Energy

Potential changes to the Load Forecast include linear regression coefficients and independent variables. Historical data trends can be used in linear regression model development to forecast energy and peak load. Independent variable data dating back to 1990 is also used. NWMT data includes all loads within its BAA and counts each of the following only once:

- ❑ Load Serving Entities
- ❑ Point-to-point Customers
- ❑ Network Customers

The estimated models are then used to forecast annual energy load and seasonal peak loads by forecasting independent variables into the future. Historical forecasts are based on expected or average conditions (i.e. 1-in-2). NWMT uses monthly loads shaped to results of regression-based forecasts to develop the non-peak load months and the monthly energy load forecasts. Future forecasts use expected or average conditions (i.e. 1-in-2) and also a 1-in-10 or 1-in-20 peak load.

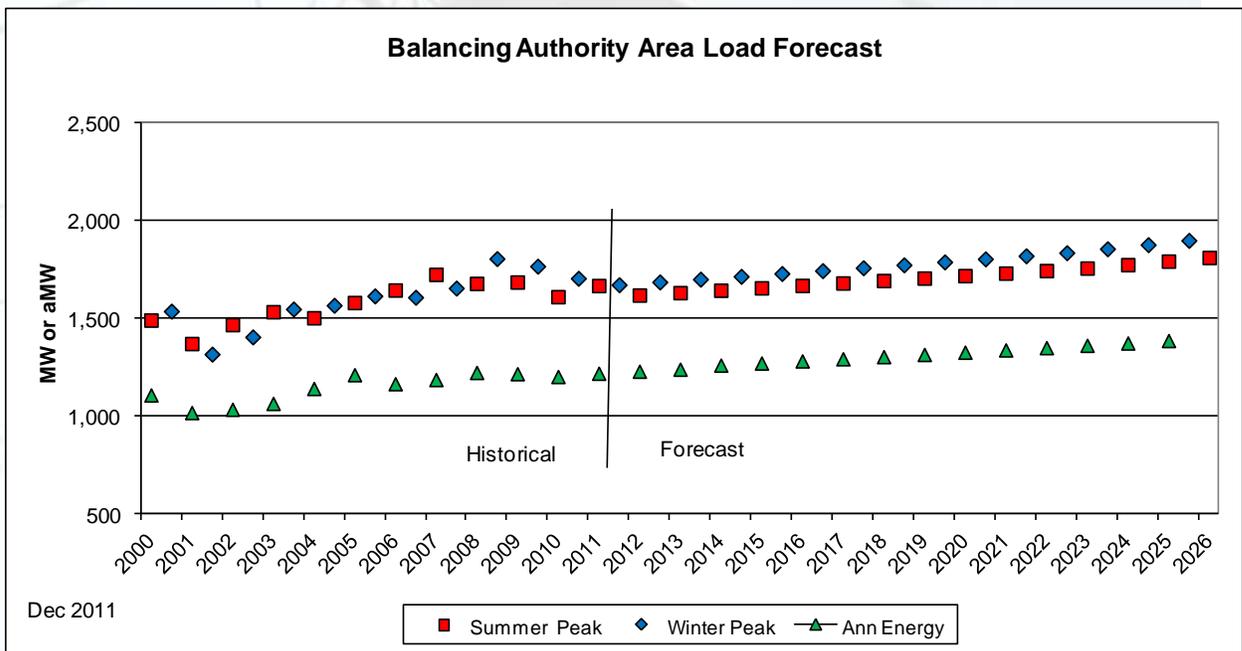
To forecast uncertainties, NWMT uses various techniques for forecasting independent variables. Varying one or more of these independent variables develops different forecasts:

- ❑ Historical Temperature: Average of six weather stations in NWMT’s BAA. The heating degree days and maximum temperature forecasts are set equal to the historical average (represents 1-in-2).
- ❑ Population Forecast: Population is forecast based on the U.S. Census forecast for Montana. Forecast growth of 0.91%, approximately equal to the 1990-2010 historical average growth of 1.06%.
- ❑ Large Industrial Load: The large industrial load forecast is based on historical data from 1990-2010, yielding a forecast growth rate of 1.24%.
- ❑ DSM Forecast: The Demand Side Management forecast is developed by NWMT’s Energy Supply group and is subtracted from the regression-based energy and peak load forecast results.

Load Forecast

The load forecast presented herein is the Fall 2011 forecast with the energy supply Demand Side Management (DSM) targets applied. The graphic below displays the BAA load forecast assuming normal temperature. The winter peak is forecast slightly higher than the summer peak.

Figure 6: Balancing Authority Area Load Forecast



The following table, Table 7 – Balancing Authority Area Load Forecast with DSM, presents the data displayed in the above graphic.

Table 7 – Balancing Authority Area Load Forecast with DSM

		Balancing Authority Area Load Forecast - w/DSM					
		Peak MW			Annual Energy		
		Winter		Summer	avg MW		
Actual	00-01	1536	2000	1490	2000	1107	
	01-02	1316	2001	1370	2001	1017	
	02-03	1404	2002	1467	2002	1034	
	03-04	1547	2003	1533	2003	1064	
	04-05	1566	2004	1502	2004	1140	
	05-06	1614	2005	1580	2005	1211	
	06-07	1607	2006	1644	2006	1165	
	07-08	1654	2007	1724	2007	1186	
	08-09	1805	2008	1678	2008	1222	
	09-10	1766	2009	1685	2009	1216	
	10-11	1704	2010	1610	2010	1201	
Forecast	11-12	1671	2011	1667	2011	1218	
	12-13	1685	2012	1618	2012	1228	
	13-14	1700	2013	1631	2013	1239	
	14-15	1714	2014	1643	2014	1249	
	15-16	1729	2015	1655	2015	1260	
	16-17	1743	2016	1668	2016	1270	
	17-18	1758	2017	1680	2017	1281	
	18-19	1773	2018	1693	2018	1292	
	19-20	1788	2019	1705	2019	1303	
	20-21	1804	2020	1718	2020	1314	
	21-22	1819	2021	1731	2021	1326	
	22-23	1835	2022	1744	2022	1337	
	23-24	1855	2023	1757	2023	1349	
	24-25	1876	2024	1774	2024	1361	
	25-26	1898	2025	1792	2025	1373	
				2026	1810	2026	1385
		BAAGR	0.9%		0.8%		0.9%
	Per Yr	16.2		13.7		11.2	

The estimated peak load sensitivity used in the summer and winter peak models is shown in Table 8 – Estimated Peak Load Temperature Sensitivity.

Table 8 – Estimated Peak Load Temperature Sensitivity

Season	MW Change per Degree	Forecast Average System Temperature
Winter	3.4	-4 degrees
Summer	7.3	97 degrees

The monthly peak load forecast is displayed in Table 9 – Peak Load Forecast. A monthly shape factor was developed and applied to the winter and summer peak load forecasts to develop the non-peak month peak forecast. This information was supplied to WECC and other entities.

Table 9 – Peak Load Forecast

Balancing Authority Area Peak MW - w/DSM												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
											1553	1682
2012	1671	1530	1434	1320	1307	1480	1618	1538	1371	1341	1493	1617
2013	1685	1543	1446	1331	1318	1491	1631	1550	1381	1352	1506	1631
2014	1700	1556	1458	1342	1329	1502	1643	1561	1392	1364	1519	1645
2015	1714	1569	1470	1354	1340	1513	1655	1573	1402	1375	1532	1659
2016	1729	1583	1483	1365	1352	1525	1668	1585	1413	1387	1545	1673
2017	1743	1596	1495	1377	1363	1536	1680	1597	1423	1399	1558	1687
2018	1758	1610	1508	1388	1375	1548	1693	1609	1434	1411	1571	1701
2019	1773	1623	1521	1400	1386	1559	1705	1620	1444	1423	1584	1716
2020	1788	1637	1534	1412	1398	1571	1718	1632	1455	1435	1598	1730
2021	1804	1651	1547	1424	1410	1582	1731	1645	1466	1447	1612	1745
2022	1819	1665	1561	1437	1423	1594	1744	1657	1477	1460	1626	1760
2023	1835	1680	1574	1449	1435	1606	1757	1669	1488	1473	1640	1776
2024	1855	1698	1591	1465	1451	1622	1774	1686	1503	1489	1658	1795
2025	1876	1718	1610	1482	1467	1638	1792	1703	1518	1506	1677	1816
2026	1898	1738	1628	1499	1484	1655	1810	1721	1534	1523		

In developing the base cases described in “State of the System Study” section, NWMT used a ‘System Load’, as opposed to the Balancing Authority Area load referred to in the above tables and graphs. The System Load is calculated by starting with the Balancing Authority Area load and adding or subtracting specific load components such as foreign-embedded (e.g., rural electric cooperatives) loads and auxiliary plant loads, which are then reacquired through the base case building process via user entry into the planning software.

The System Load level assumptions (for summer) used include:

- Historical: 1-in-2 (2012 = 1467 MW)
- Proposed: 1-in-10 (2012 = 1499 MW)
- Scenario: 1-in-20 (2012 = 1507 MW)
- Scenario: 1-in-50 (2012 = 1517 MW)

The basic methodologies for developing this forecast data include Transmission, Generation and Demand Response Resources. Each of these three is described below²⁴:

- ❑ Transmission: NWMT used the existing transmission infrastructure as a starting point. The data was reviewed and updates to the existing transmission data were included in the base case. If a new transmission project were under construction, then it was included in the base case. Future new transmission additions not under construction were not included in the initial base case unless a prior planning study has accepted the project and NWMT agreed to include it after discussing it with TRANSAC. These projects may be included in some of the base and/or uncertainty scenarios and not others. Other future new transmission additions were considered as one of the mitigation options if transmission system reliability problems arose during the study.
- ❑ Generation: NWMT used the existing generation infrastructure as a starting point. The generation data was reviewed and any updates or changes were included in the base case.
- ❑ Demand Response Resources: The DSM forecast was developed by NWMT's Energy Supply group and was subtracted from the regression-based energy and peak load forecast results.

State of the System Study

As stated in the Planning Scenarios section above, NWMT developed 16 base cases: four seasons (heavy summer, heavy winter, light autumn and light spring) by four time frames (2012, 2017, 2022 and 2027). The state of the system studies were used to help determine system needs through the 15-year planning horizon, to ascertain compliance with NERC TPL reliability standards, with emphases on the bulk electric system (100 kV and above) and to reveal critical outages, weak links, operational constraints, and future planning and budget requirements. The state of the system study comprises system normal and outage runs on all seasons of the 2012 base cases to determine the present 'state of the system' as it exists today. The existing system configuration in 2012 and a 1-in-10 load forecast were used for all cases. No proposed (future) generation, mitigation or planned system upgrades were included in the 2012 case.

Contingencies were used to facilitate simulation runs of the same system conditions through each base case. The outages used include lines, transformers, buses and plants (generation). The contingencies studied included:

- ❑ System normal (N-0)
- ❑ Single segment or element outage (N-1)
- ❑ Selected credible double segment or element outage (N-2)

²⁴ For further detail, please refer to "Business Practice OASIS Methodology, Criteria and Process – FERC Order 890 Transparency Principle" found on the [NWMT OASIS](#) website in the "Business Practices, Criteria and Forecast" folder under the "Transmission Planning" folder.

- ❑ Selected extreme contingencies

System Normal and Outage conditions were modeled and studied for adequacy and security. Segment or element thermal loads greater than 85% were noted and loads above 100% were noted as overloads (transformers were allowed up to 125% load in winter). Overloaded segments were “tripped” per standard relaying practice (100% thermal on lines, 125% minimum thermal on transformers) to check for “cascading” outages except as noted below per new NERC requirements:

- 230 kV lines are not tripped below 150% thermal per requirements of NERC PRC-023.
- This requirement may apply to path lines or other system lines and elements deemed critical.

Voltages outside of NWMT planning criteria were noted (93% and 95% low voltage limit depending on line voltage and 105% high voltage limit). Load-serving bus voltages may fall above or below the table value if conditions allow a higher/lower voltage without harm to NWMT or customer equipment. Certain equipment ratings may dictate different limits. Existing OMS or SPS schemes were considered.

State of the System Summary of Findings 2012 Cases

Heavy summer conditions govern for voltage and thermal conditions on most normal and outage scenarios. Heavy winter conditions governed in some areas ; few problems were observed under light load conditions.

No major problems with the higher voltage bulk electric system were observed. Almost all higher voltage bulk system segments and elements met criteria under all operating conditions and scenarios (500, 230 and 161 kV). Most problems are observed on lower voltage system segments or elements (50, 69, and 100 kV), such as older, smaller conductor or transformers, or auto transformer ties to lower voltage systems.

Minor voltage problems remain in some areas under outage conditions with some minor problems becoming worse. Low voltage problems include:

- Dillon – Sheridan 69 kV system
- Lewistown Area 50 kV system
- Columbus – Stillwater Area 100 & 50 kV system
- Big Timber Area 50 kV system
- Bitterroot Area 69 kV system

Thermal Issues results of 2012 Cases:

- ❑ No system elements illustrate thermal overload under **system normal** conditions.
- ❑ Several system elements can become thermally overloaded under **N-1** conditions during **heavy loading**:
 - Loss of Clyde Park 161/50 kV auto bank overloads Melville-Big Timber 50 kV line and Big Timber Auto.
 - Loss of the Ennis-Lone Mountain 69 kV line overloads Jack Rabbit 50/69 auto bank. Mitigation is in progress.

- Loss of 100 kV facilities in the Columbus area may cause additional element overloads, low voltages, and cascading outages in the 50 kV system in the Columbus and Stillwater areas. Mitigation is in progress.
- Loss of portions of Billings Steam Plant 230 kV bus may cause minor overloads on the Broadview-Alkali Creek 230 kV line or the Rimrock 161 kV phase shifter in the Billings area. These overloads can be easily mitigated with phase shifter adjustment.
- A loss of the East Gallatin 161 kV bus puts Bozeman at risk and could result in significant loss of the Bozeman 50 kV system due to another transformer overload and resulting cascades.
- Loss of the Burke A or B 115 kV lines overloads the remaining Burke line west of Montana due to clearance issues. Avista reconnected their segments of the line and finished in the Fall 2012.
- Several system elements can become heavily loaded under N-1 conditions:
 - Loss of Dillon-Ennis 161 kV line heavily loads the Dillon-Salmon 161/69 kV auto banks.
 - Loss of Hardin Auto heavily loads the Hardin-Colstrip 115 kV line due to a current limited device.
 - Several outages heavily load the Hardin-Crossover 230 kV line due to a current limited device.
- Several substations have two auto transformers operated in parallel (in-service, side-by-side). In some cases, loss of one bank causes the sister unit to overload.
 - Loss of one of the Dillon-Salmon 161/69 kV auto banks causes the other auto bank to overload.
 - Loss of Assiniboine 161/69 kV auto bank or Rainbow 100/69 kV auto bank heavily loads its sister unit under heavy loading conditions.

In many of these cases, problems had been discovered previously and mitigation plans are already in process.

Voltage Issues for 2012 Cases:

- Under **normal operating conditions**, minor high voltage problems are observed in the Billings, Bridger, and Red Lodge area 50 kV systems under light spring loading and for light loading conditions in the Bozeman-Livingston area 50 kV system. Tap changes may correct the problem.
- No voltage problems are present on the BES for normal operating conditions.
- Low Voltage is produced under N-1 conditions during heavy loading in the following events:

- Loss of the Columbus-Rapelje – Alkali Creek 161 kV line produces low voltage in the Columbus-Chrome area 100 & 50 kV systems under heavy summer conditions. Mitigation is planned.
- Loss of the Lower Duck – Columbus-Rapelje 161 kV line produces low voltage in the Big Timber area 50 kV system during Heavy Summer conditions.
- Loss of Dillon-Ennis 161 kV line produces low voltage in the Dillon-Sheridan area 69 kV system during Heavy Summer conditions.
- Loss of other auto banks around the system may produce low voltage problems. High voltage ties to low voltage systems are more critical today.
 - Loss of Sheridan 161/69 kV auto transformer results in low voltage in the Dillon area 69 kV auto transformer Results in low voltage in the Dillon area 69 kV system.
 - Loss of Glengarry 100/50 kV auto transformer results in low voltage in the Lewistown area 50 kV system. A spare transformer is on-site.
 - Loss of Clyde Park 161/50 kV auto transformer or a bus fault, results in widespread low voltage across the Livingston 50 kV system under Heavy Summer or Heavy Winter conditions. A spare transformer is on-site.
 - Mill Creek 161 kV bus outage presents low voltage, overloads and widespread outage risks to the Butte/Helena/Bozeman areas. Prerequisite mitigation completed in 2012 fixed overloads, and limited low voltage, balance of mitigation is scheduled for 2014.
- No low voltage problems are present for Light Autumn or Light Spring conditions.
 - Some problems noted above may not have been ranked among the critical system problems.

2012 N-2 (Category C) Outage Results

- Loss of portions of Billings Steam Plant 230 kV bus may cause minor overloads on the Broadview-Alkali Creek 23 kV line or the Rimrock 161 kV phase shifter in the Billings area. These overloads can be easily mitigated with phase shifter adjustment.
- Loss of the East Gallatin 161 kV bus puts Bozeman at risk and could result in significant loss of the Bozeman 50 kV system due to another transformer overload, and resulting cascading overloads.
- Loss of the Mill Creek 100 kV bus could overload the Anaconda and Drummond 100/50 kV autobanks. Mitigation already planned by converting the Anaconda-Drummond 50 kV line to 100 kV will mitigate this problem.
- The Colstrip – Sarpy Auto 115 kV line can overload for certain double contingency outages. The line rating is now limited by in-line wave traps; planned communication upgrades mitigate the problem.

- ❑ The Hardin – Crossover 230 kV line can overload for certain double contingency outages. This line was derated due to ratings on WAPA-owned current transformer 's (CT's) at Crossover; CT taps have been changed removing this derate.
- ❑ Loss of the Ennis 161 kV bus can create voltage and thermal problems in the Big Sky area. Mitigation is underway.
- ❑ Loss of the Missoula 4 – Hamilton Heights 161 kV transmission lines (common corridor) could cause segments of the Missoula 4 – Hamilton 69 kV A and B lines to overload. Mitigation is planned.
- ❑ Loss of the Highwood – Judith Gap South 230 kV line in conjunction with the Rainbow – Stanford 100 kV line may result in low voltage in the Stanford area 69 kV system.
- ❑ Loss of the Harlowton or Glengarry 100 kV buses results in low voltage on the local 50 kV systems.
- ❑ Loss of the Canyon Ferry 100 kV lines from Great Falls to Helena may overload the Holter – Helena Valley 100 kV line. Voltages in the Helena area approach minimums. A temporary OMS is in place until hard mitigation can fix this problem.

Thermal Issues 2017 – 2027 Cases

- ❑ **No thermal overloads** were observed under **normal** system conditions.
- ❑ Shutdown of Corette generating plant planned in 2015 would accelerate the need for additional system upgrades in the Billings area. Several contingencies in the Billings area heavily load the Billings Steam Plant 230/100 kV autobanks, with overloads appearing in the ten year planning horizon. Another 230/100 kV autobank tie in the area is being considered.
- ❑ The Baseline – Meridian 100 kV line may overload under contingency conditions within the five year planning horizon. This is the remaining “weak” link in the Billings Area 100 kV system.
- ❑ The Three Rivers 161/100 kV auto bank could overload for loss of the Three Rivers – Jackrabbit 161 kV line or other Category C contingencies within the ten year planning horizon. The overloads observed are due to heavy reactive flow through the transformer. LTC setting adjustments could limit the reactive powerflow for the contingencies.
- ❑ Several outages may overload the Trident Auto 100/50 kV transformer within the five year planning horizon. Mitigation plans are already under consideration.
- ❑ Loss of the Mill Creek - South Butte 230 kV line in conjunction with either Mill Creek – ASIMI 161 kV lines may overload the remaining Mill Creek – ASIMI 161 kV line due to a current limited device within the five year planning horizon. Mitigation plans for another system problem will mitigate this as well.
- ❑ Loss of the Rattlesnake 100 kV bus may overload the Missoula #1 – Reserve St 100 kV line and heavily load the Reserve St and Missoula #4 161/100 kV auto banks within the 5 year planning horizon. Mitigation is planned.

Voltage Issues 2017 - 2027 Cases

- ❑ Under normal system conditions, minor voltage problems were observed on certain area 50 and 69 kV systems, easily mitigated with tap changes or capacitors. No problems observed on BES elements.
- ❑ Loss of the Painted Robe – Roundup 100 kV line, Broadview – Roundup 100 kV line or Broadview 100 kV bus may result in minor low voltage problems on the Roundup 50 and 69 kV systems within the five year planning horizon.
- ❑ Loss of the Highwood – Judith Gap South 230 kV line may result in minor low voltage problems in the Lewistown area 50 kV system.
- ❑ Loss of a Missoula 4 – Hamilton Heights 161 kV line may result in minor low voltage problems on the Hamilton area 69 kV A line within the fifteen year planning horizon. Mitigation is planned.
- ❑ Loss of the Shorey Road – Columbus Rapelje 230 kV line may result in minor low voltage problems in the Columbus area within the fifteen year planning horizon. Mitigation is planned.
- ❑ Loss of the Garrison 230 kV bus may result in widespread marginal to low voltages in Butte, Helena, and Bozeman areas in the ten to fifteen year planning horizon. This situation has improved from previous study plans with loss of large industrial load in the Missoula area.
- ❑ Loss of the Laurel – Bridger 100 kV A and B lines results in low voltage in the Bridger area within the five year planning horizon.
- ❑ Loss of the Judith Gap 100 kV bus may result in low voltages in the Benchland area 100 kV system within the five year planning horizon.

Prioritizing Critical Problems

Upon completion of the state of the system studies, study work continued to examine system performance and to determine system needs through the 15-year planning horizon, revealing critical outages, weak links, and operational constraints. Emphasis was placed on the bulk electric system (100 kV and above) to ascertain compliance with NERC TPL reliability standards. Future planning, mitigation, and budgetary requirements were determined.

State of the system studies revealed a number of potential system problems, but did not prioritize these problems. With input from TRANSAC, NWMT developed a process for prioritizing system problems based on the consequences and likelihood of an event and the associated problem. Consequences of the problem or event included consideration of criteria violations (stability, thermal, and voltage problems) as well as the amount of load affected (or numbers of customers) and served to quantify the severity of a problem (see Table 10 – Consequences Rating Factors). Likelihood of the event or problem considered under what conditions the problem occurred (or how often the system was at risk): normal system conditions with all system elements in-service (very likely) or outage conditions with one or more system elements unavailable (much less likely), load conditions (what % of time could the problem occur...peak load, light load), seasonal conditions (summer, winter), and other

conditions to help quantify the risk such as exposure to the risk (a long transmission line as compared to a single transformer or short segment of bus). See Table 11 - Likelihood Factors. Each of these criteria was assigned a factor which was used to help rank the severity or probability of the event or problem. The equations and ranking factors used to quantify consequences and likelihood are illustrated below.

$$\text{Consequences Factor} = (\text{Stability} + \text{Thermal} + \text{Voltage Problems Factors}) \times \text{Peak Load Affected}$$

Table 10 – Consequences Rating Factors

Consequences Rating Factors			
Stability and Thermal Problems		Voltage Problems	
Extreme – Interconnection wide Impacts, Widespread Outages	10	Outage	10
Severe – Division Wide Impacts, multiple outages	5	Very Low < 80%	5
Moderate – Localized Impacts, single outages	2	Low < FERC 715	2
Minor – Small Impacts, no outages	1	High	2
None – No problems observed	0	None	0

An example calculation of a problem or event consequences factor is given as follows: The Steam Plant 230 kV bus outage can cause system problems under heavier summer loading conditions. This outage does not create any stability problems (no impact – rating factor 0), but was judged a severe thermal problem (division-wide impacts – rating factor 5). Under this outage condition other equipment in the area may overload and trip as well, creating a wide spread voltage problem (i.e. an outage condition – rating factor 10) affecting up to 400 MW of connected load (considered proportional to numbers of customers affected). The consequences factor for this event was then calculated per the equation and rating factors above: Consequences Factor = (0 + 5 + 10) x 400 = 6000. This factor has no units, but was used to rank and compare the consequences of this problem or event to other system problems or events. It was entered in the appropriate column in Table 12 – Highest Priority System Matrix.

$$\text{Risk Factor} = \text{System Cond. Factor} \times \text{Seasonal Cond. Factor} \times \text{Other Cond. Factor}$$

Factors used in this determination are as follows:

Table 11 - Likelihood Factors

Likelihood Factors					
System Condition		Seasonal Condition		Other Conditions	
Normal	.09995	S Peak	0.125	Normal – Occurs at N-0 Cond.	1.0
Outage 1	0.0005	W Peak	0.125	Major – Long line > 30 miles	1.0
Outage 2	0.00005	SW Peak	0.25	Moderate – Medium Line	0.5
		Light	0.25	Minor – Short Line < 3 miles	0.1
		Average	0.75	Sub – Substation Equipment	0.033
		All	1		

An example calculation of the likelihood or risk factor for the Steam Plant 230 kV bus outage problem follows: The consequences of this event occur under N-1 or Outage 1 **system conditions** (rating factor 0.0005, much less likely than normal conditions) during heavier summer loading **seasonal condition** (rating factor 0.125 to represent a longer time period of exposure). “Sub” **other conditions** apply (exposure limited to substation equipment only, rating factor 0.033). The likelihood or risk factor for this event was then calculated per the equation and rating factors above: Risk Factor = 0.0005 x 0.125 x 0.033 = 0.000002 overall. This factor has no units, but was used to rank and compare the likelihood of this problem or event to other system problems or events. It was entered in the appropriate column in Table 12 – Highest Priority System Matrix.

Finally, an overall risk or “expected consequences” was developed for each problem based on the product of the consequences of the event times the likelihood of the event, or simply stated “Severity” times “Probability”. For the Steam Plant example, the consequences factor of 6000 was multiplied by 0.00002 to yield an overall risk factor of 0.0125. The largest products of this analysis were given the highest priority for mitigation.

Table 12 – Highest Priority System Matrix illustrates the top fifteen highest ranking system problems revealed in the study work.

Table 12 – Highest Priority System Matrix

Highest Priority Electric Transmission System Problems/Decision Matrix															
System Element/Event	WECC Category (A,B,C,D)	Year Problem Starts	Consequences of Event					Likelihood					Expected Conseqs CF x RF	Expected Conseqs Rank	Mitigation Plan
			Stability Problems	Thermal Problems /Load Loss	Voltage Problems	Peak Load Affected (MW)	Conseqs Factor	System Condition	Seasonal Condition	Other Exposure Condition	Risk Factor				
Columbus Area 50 and 100 kV System (N-1)	B, C	Present	None	Moderate	Outage	19	228	Outage1	Average	Major / Sub	0.000400	0.0911	1	Yes	
Ennis-Lone Mt. 69 kV or Ennis Auto 161 kV Bus	B, C	Present	None	Minor	Outage	33	363	Outage1	Wpeak	Major / Sub	0.000065	0.0234	2	Yes	
Missoula 4-Hamilton Heights 161 kV Lines (N-2)	C	Present	None	Moderate /Severe	Outage	82	1148	Outage2	SWPeak	Major	0.000013	0.0144	3	Yes	
Blgs Steam Plant 230 kV Bus Outage	C	2015	None	Severe	Outage	400	6000	Outage1	SPEak	Sub	0.000002	0.0125	4	Yes	
E. Gallatin 161 kV & 50 kV Bus Outages	C	Present	None	Severe	Outage	96	1440	Outage1	SWPeak	Sub	0.000008	0.0120	5	Yes	
Rattlesnake 100 kV Bus	C	2017	None	Severe	Outage	190	2850	Outage1	SWPeak	Sub	0.000004	0.0119	6	Yes	
E. Helena 100/69 kV Autobank and Bus Fault	B, C	2017	None	Moderate	Outage	64	768	Outage1	SWPeak	Sub	0.000008	0.0064	7	Yes	
Broadview - Billings Area 230 kV Double	C	Present - 2015	None	Minor	Low	198	792	Outage2	SPEak	Major	0.000006	0.0050	8	Yes	
Laurel Auto-Bridger Auto 100 kV A + B lines	C	Present	None	Moderate	Outage	39	468	Outage2	SWPeak	Major	0.000009	0.0044	9	Yes	
Rainbow 69 kV Bus	C	Present	None	Minor	Outage	19	209	Outage1	All	Sub	0.000017	0.0035	10	Yes	
Dillon-Salmon 161/69 kV Autobanks and Bus Faults	B, C	Present	None	Moderate	Outage	34	408	Outage1	SWPeak	Sub	0.000008	0.0034	11	Yes	
Columbus-Rapelje - Alkali Ck 161 kV Line	B	Present	None	None	Low	24	48	Outage1	SWPeak	Moderate	0.000063	0.0030	12	Yes	
Clyde Park 161/50 kV Autobank and Bus Fault	B, C	Present	None	Moderate	Outage	30	360	Outage1	SWPeak	Sub	0.000008	0.0030	13	Yes	
kV or Big Timer 161/50 kV Auto	B	Present	None	None	Low	11	22	Outage1	SWPeak	Major	0.000125	0.0028	14	Yes	
Mill Creek 161 kV Bus Outage	C	Present - 2015	None	Minor	Low	120	480	Outage1	SWPeak	Sub	0.000004	0.0020	15	Yes	

The problem with the highest expected consequences, Great Falls City 100 kV System under N-1 (loss of a single element) conditions, is listed first in the number 1 rank position, and was considered the most serious problem found in this study effort. Subsequent problems listed after, ranked 2, 3, 4, and so on were deemed to be less critical.

The remainder of this section briefly describes and outlines the 15 ranked problems listed above, and the remaining five problems identified and fixed in the 2010-2011 Study Plan that are not already included in the above 15. Each item is listed by rank, effected area and includes mitigation considered and recommendations.

Rank #1: Columbus – Absarokee – Stillwater Area

100 kV and 50 kV Systems

Status: Identified in the 2008-2009 Study Plan – Partially Fixed in 2011, with budgeted years and final mitigation tentatively scheduled to be complete in 2016

- Problem Statement:

- Low voltage can occur on the Columbus Area 100 kV and 50 kV systems under normal (N-0) peak conditions. This was fixed in 2011.
- Loss of the following transmission elements (N-1 conditions) results in very low voltages and loss of load in the Columbus – Absarokee – Stillwater Area under peak load conditions.
 - Columbus Rapelje – Columbus Auto 100 kV line
 - Columbus Auto – Absarokee – Chrome Junction 100 kV line
 - Columbus Rapelje 161/100 kV autotransformer
 - Chrome Junction 100/50 kV autotransformer
- The consequences associated with this problem are moderate.
 - Voltage is approaching minimum levels under normal conditions, and is low under outage conditions.
 - Partial load shedding of a large mine customer due to equipment protection occurs.
 - Load in the Columbus area is at risk due to further equipment overloads and possible tripping of equipment.
- The probability of this event is very likely.
 - Under normal heavy summer loading conditions, voltage is at or near minimum levels.
 - Multiple long line exposures makes line more susceptible to faults, but overload problems may only occur under peak load conditions.
- The overall risk associated with this problem is moderate.
- Mitigation Considered
 - Build a new 100 kV line from Columbus Rapelje to Chrome Junction and add an additional 100/50 kV autotransformer at Chrome Junction.
 - Build a new 161 kV line from Columbus Rapelje to Chrome Junction and add a 161/50 kV autotransformer at Chrome Junction. This solution did not add any additional benefit over the new 100 kV line.
 - Build a new 161 kV line from Big Timber to the Nye area and add a 161/50 kV autotransformer at a new substation. This solution did not add any additional benefit over the new 100 kV line and would require further mitigation for any load growth in the area.
 - Upgrading the 50 kV system from Billings to the Columbus Area to 100 kV. This solution corrected the low voltages under normal peak load conditions and some,

but not all of the outage related problems. In conjunction with this upgrade, NWMT also considered converting the 50 kV system from Bridger through Red Lodge to Chrome Junction to 100 kV as well. This combination of mitigation corrected all existing system problems in the area but provided very little capacity for additional load growth in the area and would require the expensive conversion of multiple 50 kV substations along these lines to 100 kV.

- Add additional static and dynamic VAR support (i.e. capacitor, dynamic var device (DVAR), static var compensator (SVC), etc.). This solution only corrects the low voltages under normal peak conditions, but caused other segment overloads under outage conditions
- Add a nearby gas-fired standby generation facility. This solution still requires the building of a new transmission line (gas or electric) and would require full-time operation. This is a high-cost solution. It was also determined that sufficient fuel resources were not available on a full time basis.

□ Recommendations

- Upgrade the existing capacitor bank at Chrome Junction from 4.0 MVAR to 8.0 MVAR to correct current low voltage problems under normal peak conditions. This was completed in 2011.
- A new 100 kV line from Columbus area to the Chrome Junction area along with a new 100/50 kV LTC Auto-transformer in the Chrome Junction area provides a viable long-term solution to all the outages effecting the Columbus-Absarokee-Stillwater area.
 - This solution works well with the new 230/100 kV autotransformer suggested to assist in the loss of the 161 kV line between Columbus and Billings discussed later.

□ Uncertainty issues

- Loss of significant load in the area would defer mitigation.

Rank #2: Bozeman Area

Ennis – Big Sky 69 kV System

Status: Identified in the 2008-2009 Study Plan – Siting work began in 2008; efforts are ongoing, target completion of this project is 2014

□ Problem Statement

- Loss of the 69 kV source from Ennis to Big Sky overloads the remaining source to Big Sky from Bozeman under winter peak conditions.
- The consequences associated with this outage are moderate.
 - Over 30 MW of peak load are threatened in the Big Sky area.

- The probability of this event is very likely.
 - The Ennis 69 kV line has significant exposure to weather and fire in heavily forested mountainous terrain.
- The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Study work on this problem began prior to the local area planning process. 69 kV and 100 kV upgrades were considered, but found to be ineffective or short-term solutions. Alternate sources (new lines, standby generation, etc) were not found to be practical or economical.
- Recommendations
 - Conversion of the existing Bozeman Jackrabbit – Meadow Village 69 kV line to 161 kV was shown to provide a viable, cost effective long-term solution. Siting work and construction has begun on this project, with line completion tentatively scheduled for 2014.

Rank #3: Missoula/Hamilton Area

Missoula – Hamilton Heights 161 kV (N-2)

Status: Identified in the 2008-2009 Study Plan - Preliminary mitigation developed; initial mitigation tentatively scheduled for 2015, with project completion anticipated in 2022

- Problem Statement
 - Loss of both 161 kV lines from the Missoula Area to the Hamilton Area leads to the tripping of other lines due to overload under peak load conditions.
 - The consequences associated with this outage are moderate.
 - Several lines in the Bitterroot Valley trip due to overloads.
 - A peak load of over 80 MW in the Bitterroot Valley is lost.
 - The probability of this event is not very likely.
 - In order for this event to occur both lines must be out-of-service at the same time.
 - Both lines share the same 40-mile corridor however, which constitutes a credible N-2 outage.
 - The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Converting the Bitterroot Valley 69 kV system to 100 kV.

- Does not provide a long-term solution.
- Various new 161 kV sources from the East and South.
- Various new 161 kV sources from the North.
 - Includes a new 161/69 kV 100 MVA auto-substation near Stevensville.
- Converting a portion of the Bitterroot Valley 69 kV system to 161 kV.
- A new standby generating station in the Hamilton Area.
- Recommendations
 - A new 161 kV source from the Missoula area to the new 161/69 kV 100 MVA auto-substation provides the most long-term, viable, and cost-effective solution.
 - This solution also includes converting portions of the Bitterroot Valley 69 kV system to 161 kV.
 - This solution is a 15-year staged solution.
 - A 69 kV line to be replaced by a new 161 kV line from the Missoula Area to the new 161/69 kV 100 MVA auto substation in the Stevensville Area.
 - A 69 kV line to be replaced by a new 161 kV line that continues from the new substation into the Hamilton Area.
 - Capacitor banks to be added at different locations in the Bitterroot Valley to assist with voltage support during the staging.

Rank #4: Billings Area

Steam Plant Switchyard 230 kV Bus

Status: Identified in the 2008-2009 Study Plan – Phase 1 solution completed in 2011; Phase 2 tentatively scheduled for 2015

- Problem Statement
 - The Billings Steam Plant Switchyard 230 kV bus was economically designed and constructed using an air-break ring bus many years ago. A fault on this bus or nearby equipment connected would cause an outage of all lines and equipment connected to the bus. With the growth in load to today's levels, such a fault under heavy load conditions could lead to additional system equipment overloads and a widespread outage in the Billings area.
 - The consequences associated with this outage are severe.
 - Load loss could approach 400 MW under heavy load conditions, affecting load in the Billings area and extending west towards Big Timber.

- The probability of this event is unlikely.
 - Bus exposure is limited and equipment is regularly inspected and maintained.
 - The problem occurs only under summer peak load conditions.
- The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Reconfiguration of the system and upgrades to overloading system equipment was considered, but found not to be economical or viable.
- Recommendations
 - Selected replacement of certain ring bus air-break switches with power circuit breakers will provide an economic and viable solution, reducing the number of system elements lost for a bus fault, and preventing associated equipment overloads.
 - The original phase 2 mitigation was found not to be viable due to physical constraints within the substation.
 - Construct a new 230/100 kV tie within the Billings area. A new 100 kV line will also be constructed to accommodate both Transmission and Distribution needs.

Rank #5: Bozeman Area

East Gallatin Substation 161 & 50 kV Bus

Status: Mitigation is preliminary; mitigation tentatively scheduled for 2015

- Problem Statement
 - A bus fault or equipment failure will cause the complete loss of the 161 kV or 50 kV bus at the East Gallatin Substation in the Bozeman area. This bus is a straight bus without power circuit breakers to sectionalize and minimize the outages. Multiple lines and transformers would be lost in either outage, which could lead to other equipment overloads and outages under peak load conditions.
 - This problem was first noticed prior to the local area planning process, but was deferred by correcting more critical problems in the Bozeman area (upgrading Jackrabbit Auto).
 - The consequences associated with this outage are severe.
 - Multiple overloads in the Bozeman/Belgrade area occur.
 - Roughly 100 MW of peak load in the Bozeman/Belgrade area are threatened.
 - The probability of this bus outage is minor.

- Bus exposure is limited, and equipment is regularly inspected and maintained.
- The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Rebuild the 161 kV bus at East Gallatin by adding power circuit breakers to the bus to limit the number of transmission elements lost during a bus fault. By limiting the number of lost transmission elements, equipment overloads are prevented.
 - Moving the distribution load off of the 50 kV bus at East Gallatin to the 161 kV bus.
 - This solution also provides future expansion of the Bozeman area transmission system to accommodate the rapid growth expected to continue.
- Recommendations
 - Rebuild the 161 kV bus by converting into a breaker ring bus or breaker-and-a-half bus. In addition to accommodate addition growth in the Bozeman area, move the distribution load to the 161 kV bus and add a new 161 kV line terminal to the design.
 - Minimize loss of 50 kV elements by adding a sectionalizing breaker in the 50 kV bus. Pending, 2018

Rank #6: Missoula Area

Rattlesnake Substation 100 kV Bus

Status: Preliminary mitigation developed and scheduled for 2015

- Problem Statement
 - A bus fault or equipment failure causes the loss of the 100 kV bus at the Rattlesnake Substation in the Missoula area. This bus is a straight bus without power circuit breakers to sectionalize and minimize the outages. Multiple lines, transformers, and capacitor banks would be lost in the outage, which could lead to other equipment overloads and outages under peak load conditions.
 - The consequences associated with this outage are severe.
 - Multiple overloads occur in the Missoula area.
 - Roughly 200 MW of peak load in the Missoula and Hamilton areas are threatened.
 - The probability of this bus outage is minor.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.

- The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Reconductor thermal limited 100 kV lines along with upgrading several 161/100 kV autotransformers in the Missoula area. This solution would prevent tripping of overloaded equipment but is a high-cost solution.
 - Add a power circuit breaker to the bus to limit the number of transmission elements lost during a bus fault. By limiting the number of lost transmission elements, equipment overloads are prevented.
- Recommendations
 - Replace a sectionalizing air-break switch with a power circuit breaker in the Rattlesnake 100 kV bus. Tentatively scheduled for 2015.

Rank #7: Helena Area

East Helena Switchyard 100/69 kV Autobank or 100 kV bus Fault

Status: New in 2012-2013 Plan; Mitigation is preliminary

- Problem Statement
 - Loss of bus or transformer results in loss of Helena 69 kV system. Relayed spare is on-site
 - The consequences associated with this outage are moderate.
 - Helena area 69 kV system has grown such that the relayed on-site spare is no longer sufficient to serve peak load.
 - Close to 65 MW of peak load in the Helena area is threatened.
 - The probability of this bus outage is minor.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.
 - The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Upgrade the in-service spare at East Helena Switchyard
 - This solution only addresses one issue, the bus fault will not be addressed with this mitigation.
 - Create a new 100/69 kV tie substation in the Helena Area
 - This solution creates a second 100/69 kV source to the Helena 69 kV system.

□ Recommendations

- Build a new 100/69 kV auto substation independent of East Helena in the middle of a new proposed 100 kV line into East Helena.
 - The new 100 kV line being proposed is to address distribution growth and reliability concerns.
 - Adding a second independent 100 kV source to the 69 kV system, will further improve reliability to the Helena sub-transmission system.

Rank #8: Billings Area

Broadview – Billings Area 230 kV credible N-2

Status: New in the 2012-2013 Plan; Mitigation is preliminary.

□ Problem Statement

- Loss of both 230 kV lines from Broadview into Billings, cuts the main source of power into the City of Billings and surrounding area.
- The consequences associated with this outage are minor to moderate.
 - Low voltage in parts of Billings Division now.
 - This is directly related to the weak Columbus – Absarokee – Stillwater area currently ranked #1.
 - The planned shutdown of Corette in 2015 would remove another major source of power into the City of Billings, worsening the problem exposing Billings to voltage instability.
 - Roughly 200 MW of peak load in the Billings area is threatened after the shutdown of Corette.
- The probability of this event is not very likely.
 - In order for this event to occur both lines must be out-of-service at the same time.
 - Both lines share the same 18 ½ mile corridor however, which constitutes a credible N-2 outage.
- The overall risk associated with this outage is moderate.

□ Mitigation Considered

- Build a new generation facility within the Billings area or directly west of Billings.
- Build a new 230 kV source from Broadview into Billings with a diverse route of the current route of the two lines from Broadview.

- Recommendations

- Build a new 230 kV source from Broadview Switchyard into Shorey Rd Substation.
 - Provides additional benefits to the 230 kV system west of Billings.

Rank #9: Billings Area

Laurel Auto - Bridger Auto 100 kV, A + B lines (N-2)

Status: Identified in previous plans, but not ranked; Mitigation is preliminary.

- Problem Statement

- Loss of both 100 kV lines from Laurel Auto to Bridger Auto, removes both BES sources into the Bridger area, resulting in low voltage and/or voltage instability.
- Problem has worsened due to growth in the Absarokee-Stillwater area, however mitigation planned for problems identified in the Absarokee-Stillwater area ranked #1 addresses this growth.
- The consequences associated with this outage are moderate.
 - Almost 40 MW of peak load is threatened including a large mine customer.
- The probability of this bus outage is not likely.
 - In order for this event to occur both lines must be out-of-service at the same time.
 - Both lines share the same 26 1/2 mile corridor however, which constitutes a credible N-2 outage.
- The overall risk associated with this outage is minor.

- Mitigation Considered

- Adding voltage support to the Bridger area.
 - With this being a viable, effective, and minimal cost solution, no other mitigation was considered.

- Recommendations

- Add 10 MVAR of capacitors to the Bridger and Red Lodge areas.

Rank #10: Great Falls Area

Rainbow Switchyard 69 kV Bus

Status: Identified in the 1010-2011 Plan, mitigation scheduled to begin 2014 and completed in 2019.

□ Problem Statement

- A bus fault or equipment failure causes the loss of the 69 kV bus at the Rainbow Switchyard in the Great Falls area. This bus is a straight bus without power circuit breakers to sectionalize and minimize the outages. Multiple lines and transformers would be lost in the outage.
- The consequences associated with this outage are minor.
 - 16 MW of peak rural load in the Great Falls area is threatened.
- The probability of this bus outage is moderate.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.
 - The seasonal exposure is all seasonal conditions. This includes spring, summer, fall and winter, both heavy and light loading.
- The overall risk associated with this outage is minor.

□ Mitigation Considered

- Rebuild the 69 kV bus at the new Crooked Falls Switchyard.
 - This solution also eliminates the environmental risks of transformer failure at the Rainbow Switchyard.

□ Recommendations

- Rebuild the 69 kV bus at the new Crooked Falls Switchyard with a design that limits the number of lost transmission elements.
 - The 69 kV bus design at Crooked Falls provides a sectionalizing breaker along with a transfer bus to improve reliability.
 - West bus construction is scheduled for 2014.
 - East bus construction is scheduled for 2015.
 - The ultimate design of the 69 kV bus also includes two redundant transfers further enhancing reliability of the 69 kV bus.
 - West bank construction is scheduled for 2014.

- East bank construction is scheduled in 2019.

Rank #11: Butte Area

Dillon – Salmon 161/69 kV Auto transformers and Bus Faults

Status: New in the 2012-2013 Plan, mitigation is scheduled for 2014, completion in 2015.

□ Problem Statement

- There are two Dillon-Salmon 161/69 kV transformer banks rated at 18.75 MVA each. During peak conditions these banks are heavily loaded now. Loss of one bank will result in the overload of the other.
- A bus fault or equipment failure will cause the loss of the 161 and 69 kV buses at the Dillon-Salmon substation. Both buses are a straight bus without power circuit breakers to sectionalize and minimize the outages. Multiple lines, transformers and capacitor banks would be lost in the outage.
- The consequences associated with this outage are moderate.
 - Overloads occur on a second 161/69 kV source to the area.
 - Roughly 35 MW of rural and local load in the Dillon Area is threatened.
- The probability of this bus outage is minor.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.
 - A spare single-phase autotransformer is on-site for transformer failure.
- The overall risk associated with this outage is moderate.

□ Mitigation Considered

- Upgrading both transformer banks at Dillon-Salmon and rebuild the 161 kV bus.
- Upgrading a nearby 161/69 kV substation and reconductoring approximately 40 miles of weak 69 kV line.
 - This solution is a high-cost solution and will take many years to complete.

□ Recommendations

- Upgrade both autotransformers at Dillon-Salmon to 30/40/50 MVA, and add sectionalizing power circuit breakers in the 161 kV bus to limit exposure for equipment failure.
 - Bus work and replacement of one transformer bank is scheduled for 2014.
 - Replacement of the second transformer bank is scheduled for 2015.

Rank #12: Billings Area

Columbus Rapelje – Alkali Creek 161 kV line

Status: Identified in previous plans, not ranked in 2011-2012 plan. Upgrades made to the Chrome Junction capacitor bank in 2011 deferred problem. Mitigation is scheduled for 2014 and 2015.

□ Problem Statement

- Loss of the Columbus-Rapelje to Alkali Creek 161 kV line, severs the strong east source to the Columbus-Absarokee-Stillwater Area. As growth continues to the west the 161 kV line becomes heavily loaded impacting these areas.
- Upgrading the Chrome Junction capacitor bank from 4 MVAR to 8 MVAR deferred problem a couple of years.
- The consequences associated with this outage are moderate.
 - Partial load shedding of a large mine customer due to equipment protection occurs.
 - Load in the Columbus area is at risk to exposure of low voltage.
- The probability of this outage is moderate.
 - Over 30 miles of transmission line exposure in a high wind, inclement weather area.
 - Seasonal exposure is limited to peak conditions.
- The overall risk associated with this outage is moderate.

□ Mitigation Considered

- Building a parallel 161 kV line from Columbus-Rapelje to Alkali Creek.
 - This solution is a high-cost solution and will take many years to complete with risks of citing concerns and route diversity to prevent a credible N-2 condition.
- Tie the 230 kV system to the 161 kV system at Columbus-Rapelje.
 - With current generation projects with signed LGIAs in the area, this solution can cause additional system problems resulting in further mitigation.
- Tie the 230 kV system to the 100 kV system at Columbus-Rapelje and disconnect the 161 to 100 kV tie at Columbus-Rapelje.
 - This solution moves the Columbus Area 100 kV system from a weakening 161 kV system to a strong 230 kV system.

□ Recommendations

- Route the 230 kV line from Shorey Road to Wilsall into Columbus-Rapelje.
- Tie the 230 kV bus to the 100 kV bus with redundant 230/100 kV 60/80/100 MVA transformers.
- Remove the 161/100 kV transformer.
- This mitigation recommendation compliments and improves the Columbus Area 100 kV system (N-0) problems identified in previous plans and the Columbus-Absarokee-Stillwater 100 kV system (N-1) problem currently ranked #1.

Rank #13: Livingston Area

Clyde Park Substation

Status: Identified in the 2008-2009 Study Plan – Mitigation is preliminary; mitigation tentatively scheduled for 2017

□ Problem Statement:

- A bus fault on the Clyde Park 161 kV bus or 50 kV bus along with failure of a single-phase 161/50 kV autotransformer at Clyde Park can cause reactive overloads on the 161/50 kV autotransformer at Big Timber Auto and the 50 kV line from Big Timber Auto to Melville.
- The consequences associated with this problem are moderate.
 - 30 MW of load in the Livingston and Big Timber areas are at risk due to equipment overloads and low voltage.
- The probability of this event is not likely.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.
 - A spare single-phase autotransformer is on-site for transformer failure.
- The overall risk associated with this problem is moderate.

□ Mitigation Considered

- Rebuild the 161 kV bus at Clyde Park and add an additional 161/50 kV autotransformer. This solution provides the best reliability to the Livingston and Big Timber areas, however due to physical limitations, it is not possible.
- Build a new 161/50 kV switchyard west of Livingston where existing 161 kV and 50 kV lines cross. This solution is viable, but additional mitigation is still required.

- Rebuild and reroute one of two 50 kV lines from Clyde Park into the Livingston area to 161 kV. This solution is a high cost solution and requires additional work at two substations.
- The following system upgrades can be made:
 - Add capacitors in the Livingston area.
 - Upgrade the overloaded transformer and transmission line at Big Timber Auto.
 - Add relaying to provide an additional source into the Livingston area.
- Recommendations
 - In the near-term time frame, add 18 MVAR of voltage support in the Livingston and Big Timber areas and reconductor the 50 kV line from Big Timber Auto to Melville.
 - In the five to ten year time frame, add relaying to the normally-open power circuit breaker at Livingston Westside, and upgrade the Big Timber Autotransformer to 30/40/50 MVA.
 - In the 10+ year time frame, explore and recommend more permanent but costly solutions (i.e. new 161 kV source, substations, etc.).
 - Provides solution for loss of Duck Creek – Big Timber Auto – Columbus Rapelje 161 kV line, ranked #14.

Rank #14: Bozeman Area

Duck Creek –Big Timber Auto - Columbus Rapelje 161 kV line

Status: Identified in previous plans, but not ranked. Mitigation is preliminary; mitigation tentatively scheduled for 2017.

- Problem Statement
 - Loss of the Duck Creek – Big Timber Auto – Columbus–Rapelje 161 kV line opens the Big Timber 161/50 kV autotransformer. The Big Timber and Livingston loads have grown such that serving Big Timber from Clyde Park is no longer sufficient during peak loading.
 - The consequences associated with this outage are minor.
 - 11 MW of peak load experiences low voltage during loss of this line.
 - The probability of this outage is moderate.
 - Over 40 miles of transmission line exposure in a high wind, inclement weather area.
 - Seasonal exposure is limited to peak conditions.

- The overall risk associated with this outage is moderate.
- Mitigation Considered
 - Adding sectionalizing power circuit breakers at Big Timber in the line.
- Recommendations
 - The mitigation identified in the previously ranked Clyde Park Substation mitigates this problem with the addition of sectionalizing power circuit breakers at Big Timber.

Rank #15: Butte/Anaconda Area

Mill Creek Substation 161 kV Bus

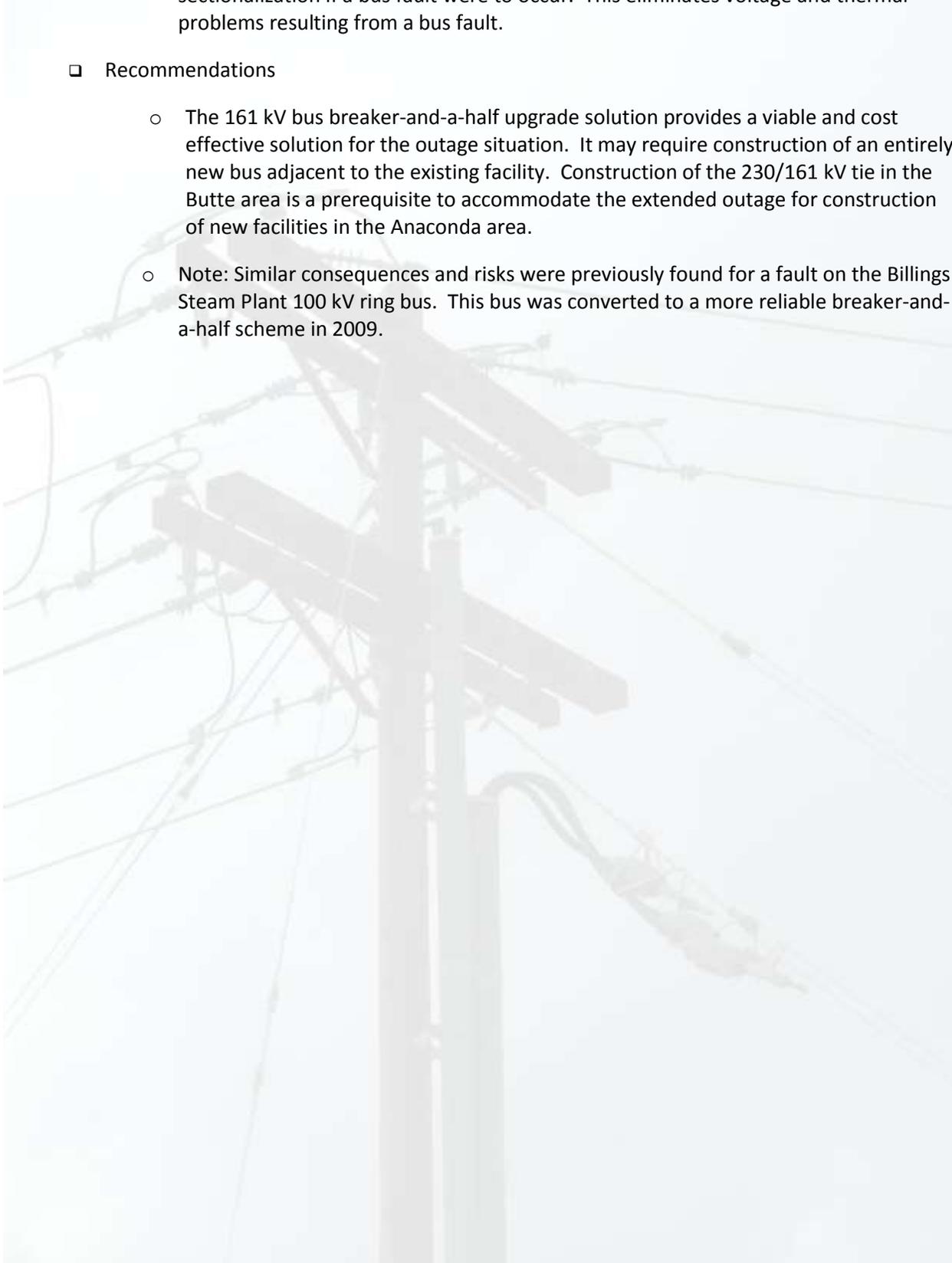
Status: Mitigation for this problem was partially completed in 2012 with the addition of the South Butte 230/161 kV tie. Full mitigation now planned for completion in 2014.

- Problem Statement
 - A bus fault or equipment failure causes the loss of the 161 kV bus at the Mill Creek Substation in the Anaconda area. This bus is an air break ring bus without power circuit breakers to sectionalize and minimize the outages. Several lines and transformers would be lost in the outage, which could lead to other equipment overloads and outages under peak load conditions.
 - The addition of the South Butte 230/161 kV tie has reduced the exposure of this outage to a large industrial customer in the area.
 - The consequences associated with this outage are severe.
 - Nearly 120 MW of peak load in the Butte, Anaconda, Helena and Bozeman areas are threatened.
 - The probability of this bus outage is minor.
 - Bus exposure is limited, and equipment is regularly inspected and maintained.
 - The overall risk associated with this outage is moderate.
- Mitigation Considered
 - A new 230/161 kV tie in the Butte area alleviates overloads and voltage problems associated with this outage, but the solution is short term.
 - Opening a major transmission line to the south does not sufficiently alleviate overloads to provide a viable solution.
 - 161 kV bus breaker-and-a-half upgrade. The configuration at the 161 kV bus in question would be upgraded to a “breaker-and-a-half scheme” to enable automatic

sectionalization if a bus fault were to occur. This eliminates voltage and thermal problems resulting from a bus fault.

□ Recommendations

- The 161 kV bus breaker-and-a-half upgrade solution provides a viable and cost effective solution for the outage situation. It may require construction of an entirely new bus adjacent to the existing facility. Construction of the 230/161 kV tie in the Butte area is a prerequisite to accommodate the extended outage for construction of new facilities in the Anaconda area.
- Note: Similar consequences and risks were previously found for a fault on the Billings Steam Plant 100 kV ring bus. This bus was converted to a more reliable breaker-and-a-half scheme in 2009.



Decision

Decision Rule

An objective of the local transmission planning study was to evaluate the range of potential transmission and non-transmission (e.g., demand side management, generation, conservation, demand response, etc.) solutions within the technical study and then use the results from the base studies and the uncertainty studies to make an informed decision. The decision rule, developed for each transmission solution, can include quantifiable results (e.g., cost) and non-quantifiable information (e.g., written discussion of an issue). NWMT's decision rule may include, but is not limited to, the following information:

- Total present value of utility costs
- System performance statistics to measure customer impacts
- Environmental assessment and/or costs
- Reliability metrics
- Uncertainty and Risk assessment results
- Non-quantifiable assessment
- Provide consistent, documented process

The primary purpose of the decision rule is to provide descriptive information (e.g., costs, risks, etc.) about the system and mitigation needed to resolve the problems in a consistent and documented process. This information can be ordered or weighted so that stakeholders can understand the differences between the scenarios and provide input to NWMT. NWMT management can then use this information and input to make an informed decision for future transmission investment to serve future network load and point-to-point requests. Once approved, the mitigation is prioritized into NWMT's 15-year business plan.

With input from TRANSAC, the following matrix was developed for considering different mitigation alternatives. TRANSAC members suggested keeping the process simple. For practical solutions meeting the reliability, environmental, risk, and other assessment criteria, cost and longevity of the solution became the primary drivers for selecting a mitigation option. Consequences and risk factors from the priority matrix are input into this form, along with cost, expected solution duration, and other comments and discussion as necessary. See Table 13 – Decision Rule Matrix.

Table 13 – Decision Rule Matrix

Decision Rule Matrix

Problem:	Identify the Problem or event			
Mitigation:	Briefly describe the mitigation proposed			
	Units	Raw Data	Rank Factor	Comment
Consequences of Event	MW Affected	Load	Note 1	Describe load lost, voltage or thermal problems, etc
Risk of Event	None	Describe problem conditions	Note 2	Describe under what conditions the problem occurs: normal, outage, load level, seasons affected, etc
Overall Risk	None	Conseq X Risk =	Result	
Cost	TPV Rev Req	\$ Cost	--	List major cost components
Solution Duration	Years	Years	--	Cost/Duration = \$/year
Discussion	Any other notes or comments on problem or proposed mitigation.			

Note 1: Calculate and enter consequences factor per details on priority matrix

Note 2: Calculate and enter risk factor per details on priority matrix

Uncertainty

Operating experience and historical voltage and path flow records continue to help reduce uncertainty and build confidence in the study results. Ongoing operational, path rating, and outage studies demonstrated this as well.

Uncertainty issues primarily affect the timing of mitigation required. Variations in the load forecast would simply demonstrate that mitigation is required sooner or later than predicted in the base study work. Extreme loading scenarios would demonstrate a need for mitigation sooner than expected as well. Loss of major loads in some areas may defer the need for mitigation in those areas. This was demonstrated with the loss of significant load in the Missoula area in the previous planning cycle.

Because of the significant amount of existing generation compared to native load in the study area, variations in generation levels did not have significant or adverse impacts on system reliability. Heavy snow and extreme runoff in 2011 demonstrated the system could perform normally with heavy hydro generation and reduced thermal generation. NWMT also considered several new variations in load and generation during this planning cycle, including an Extreme Winter case, a Low Thermal with Heavy Import Case, a High Wind system wide scenario, and High Generation with Imports from the area north of Great Falls in an uncertainty scenario. Each scenario and findings are described in more detail below.

- In the Extreme Winter scenario, 2017 extreme heavy winter loads were assumed (1:50 forecast) with rivers and reservoirs assumed frozen and little hydro generation available, and very small amounts of wind generation. Thermal plants were dispatched at full capacity. Study results showed that the higher voltage bulk electric system at 230 and 161 kV is more heavily loaded to supply the underlying system, particularly the 100 kV system, as well as auto bank ties to the 100 kV system. Loss of a 161/100 kV auto bank in the Butte area would overload a sister unit, and 100 kV lines in the central Montana area could overload for loss of some higher voltage bulk system elements.
- The Low Thermal/Heavy Import scenario was produced using a 2017 standard heavy summer base case, but all local area thermal plants were switched off-line, and wind generation was very light. Hydro plants were dispatched at typical seasonal levels, and Path 8 (from the west) was set for heavy imports into this area. Again, loss of a 161/100 kV auto bank in the Butte area would overload a sister unit. Loss of a major bus in the Billings area could lead to additional over loads on Billings area ties to the 100 kV system.
- The High Wind System Wide case was created using 2017 heavy summer and light autumn load profiles, with existing wind generation dispatched at full capacity, and other generation dispatched at typical seasonal levels same as the original base cases. These cases illustrated very little problems...no new thermal issues, and only minor high voltage problems under outage conditions in an isolated area in central Montana.
- Finally, NWMT considered a High Generation NOGF (North of Great Falls) scenario using a 2017 light spring load profile. Great Falls and NOGF area wind and hydro generation was dispatched at maximum capacity, with 300 MW importing from a new 230 kV line from the north into the Great Falls area. Remaining wind generation was dispatched at moderate levels, decreasing with distance from the study area. Other import/export paths were held to transfer levels close to the original study case. Results of this study showed that 100 kV facilities in the Butte area could overload under such conditions; furthermore loss of 230 kV lines emanating from the Great Falls area could cause 100 kV facilities in the Helena and central Montana areas to overload.

Overall, the results of these more detailed uncertainty scenarios do illustrate a robust system in most of the local area, with few new potential problems found. The benefits of widely dispersed generation are apparent, but potential weaknesses in the lower voltage bulk electric system, especially 100 kV, are noted under some system conditions in some areas of the system, typically on the older, lower capacity lines and other equipment. Because of the uncertain nature of these scenarios, results of these analysis are not primary drivers for system mitigation, but such results may influence mitigation options under consideration for other system problems. In some cases, interconnection or transmission service studies may reveal and drive the need for this mitigation as well.

Uncertainty did play another role in some mitigation options, especially when new line construction was required. Siting issues and budgetary constraints could significantly impact the timing and implementation of such mitigation alternatives. In such cases, other alternatives or interim measures were actively sought.

Finally, proposed generation or load interconnection projects can create another element of uncertainty in the local area planning process. Interconnection and transmission service studies are showing significant congestion on lines and paths in the Great Falls area, central Montana, and between

the Bozeman and Billings areas. Though each proposal or request is individually studied and required to “stand on its own”, it is important to be sure that local area planning needs and recommendations are compatible with the needs and recommendations of these studies, where possible, and vice versa. For example, with a new generator in-service, certain local area mitigation anticipated may no longer be required, or may no longer be effective. Whether or not a proposed interconnection becomes a reality is a significant uncertainty issue as well. The close coordination and continual study of both the local area and each proposed interconnection will help to alleviate these concerns.

Other Scenarios

Reactive Resource Assessment and Planning (VAr Assessment)

As part of the 2011 – 2012 local area planning effort , NWMT conducted studies to analyze the reactive power demand on local generation, as well as the reactive margin available on the system. Reactive power, also referred to as Volt Amperes reactive ("VAr") is necessary for system voltage support and stability. At present, under system normal conditions, most generators were found to be operating within their rated reactive power limits. Some small hydro electric and wind facilities may be driven to maximum reactive power limits while attempting to maintain set-point voltages in the model however. Historical data does not entirely support this finding, but it could be expected where small generation has a limited ability to successfully control the voltage during seasonal variations in load and voltage on some portions of the system that are less well regulated. In all normal operating scenarios, existing VAr resources were adequate for maintaining voltages within set-point or planning criteria.

Longer-term studies suggest similar results, as do outage-related studies. Smaller generating units with limited reactive power capabilities would tend to reach reactive power limits in attempts to maintain adequate system voltage under outage conditions. In many cases, these problems were revealed in the course of NWMT's routine study efforts, and mitigation is planned to alleviate these conditions. These studies also suggest a need for additional VAr resources in the Helena area in the longer term planning horizon as the margin to maintain voltage criteria decreases. With planned or anticipated upgrades and capacitor control setting changes in other areas, VAr margins elsewhere were deemed sufficient.

Transformer Contingency Planning

During the previous planning cycle, NWMT performed a rigorous analysis of the impact or loss of each substation autotransformer on the NWMT system. All seasonal conditions were considered in determining the impact of the loss of each unit, each outage was ranked “critical” or “non-critical” based on severity or consequences, mitigating measures were noted if applicable, and the availability and locations of spare transformers were noted. All information gathered was shared and distributed to operating and maintenance personnel.

All combinations of voltage ratios and capacity ratings were tallied to compare against the availability of system spares as well. As a result, two used transformers now in stores will be refurbished and made

available as system spares, and one new 100/50 kV unit that can serve multiple locations has been acquired.

NWMT is currently reviewing and updating this analysis and expects to have results and findings completed by year-end 2013.

Recommendation Summary

Table 14 – Recommendation Summary summarizes the major recommendations from the 15 ranked problems, by area, that have resulted from this 2010-2011 Local Area Planning cycle.

Table 14 – Recommendation Summary

Bozeman Area	<p>Rebuild the East Gallatin 161 kV bus by converting into a breaker ring bus or breaker-and-a-half bus. Move the distribution load to the 161 kV bus and add a new 161 kV line terminal to the design.</p> <p>Conversion of the Jackrabbit – Meadow Village 69 kV line to 161 kV. Siting work is in progress, with construction tentatively scheduled for completion in 2014.</p>
Missoula/Hamilton Area	<p>Replace a sectionalizing air-break switch with a power circuit breaker in the Rattlesnake 100 kV bus.</p> <p>A 69 kV line will be replaced by a new 161 kV line from the Missoula Area to a new 161/69 kV 100 MVA auto substation in the Stevensville Area.</p> <p>A 69 kV line will be replaced by a new 161 kV line that will continue from the new substation into the Hamilton Area.</p> <p>Capacitor banks will be added at different locations in the Bitterroot Valley to assist with voltage support during the staging.</p>
Butte-Anaconda Area	<p>Upgrade the Mill Creek Switchyard 161 kV bus to a breaker-and-a-half scheme.</p> <p>Rebuilt the Dillon-Salmon 161 kV bus and upgrade the capacity of the two 161/69 kV autotransformers.</p>
Great Falls Area	<p>Rebuild the Rainbow 69 kV bus at the new Crooked Falls Switchyard to include two 100/69 kV auto transformers.</p>
Columbus – Absarokee – Stillwater Area	<p>Tie the 230 kV system to the 100 kV system at Columbus Rapelje with two new 230/100 kV autotransformers.</p> <p>Construct a new 100 kV line from the Columbus area to the Chrome Junction area along with a new 100/50 kV LTC auto-transformer in the</p>

	Chrome Junction area. Scheduled for 2016.
Billings Area	<p>Add a new 230/100 kV tie at Wicks Lane. Construct a new 100 kV line to support both transmission and distribution needs.</p> <p>Build a new 230 kV line from Broadview to Shorey Rd.</p> <p>Add 10 MVAR of voltage support in the Bridger and Red Lodge areas.</p>
Helena Area	Build a new 100 kV line in Helena to support distribution needs and build a new 100/69 kV auto substation in this line.
Livingston Area	<p>Add 18 MVAR of voltage support in the Livingston and Big Timer areas.</p> <p>Reconductor the 50 kV line from Big Timber Auto to Melville. Scheduled for 2013.</p> <p>Upgrade the Big Timber Autotransformer to 50 MVA.</p>

This concludes NorthWestern Energy’s third multi-seasonal, multi-year study designed to examine our system’s reliability under normal and outage conditions. This study work is the benchmark for future biennial studies to be compared against. This comparison will provide knowledge on how the system is changing over time. Given the results, NWMT has designed mitigation plans that resolve the identified problems, starting with the most critical.

Charter
NorthWestern Energy
Transmission Advisory Committee

July 19, 2007

I. Purpose

The purpose of the NorthWestern Energy (NWMT) Transmission Advisory Committee (TRANSAC) is to provide an open transparent forum whereby electric transmission stakeholders can comment and provide advice to NWMT during the early stages of its electric transmission planning. More specifically, TRANSAC will be the vehicle to:

- A. Provide a forum for open and transparent communications among Montana transmission providers, transmission-providing neighbors, State authorities, customers, and other stakeholders;
- B. Provide an opportunity for stakeholder input on NWMT's response to FERC's Order 890 nine planning principles that will be filed as Attachment K to NWMT's Open Access Transmission Tariff;
- C. Discuss all aspects of NWMT transmission planning activities including, but not limited to, methodology, study inputs and study results;
- D. Provide a forum for NWMT to understand better the specific electric transmission interests of key stakeholders.

II. TRANSAC Membership

- A. TRANSAC membership will be open to anyone.
- B. Members shall be subject to the following conditions:
 - 1. Agree to the Committee's purpose and ground rules as described in this Charter; and
 - 2. Provide advice to NWMT as individual professionals; the advice they provide does not bind the agencies or organizations that the members serve.
- C. Membership will be established through self-nomination. If the TRANSAC membership is either too small or too large, NWMT will work with the committee to determine whether adjusting the size is appropriate and, if so, what mechanism should be used to accomplish the

adjustment.

III. Decisions

- A. TRANSAC is not a decision making body, and it will not make decisions as a group.
- B. Discussion will be limited to NWMT electric transmission planning issues and no other issues.

IV. Process

- A. TRANSAC meetings are open to the public to the maximum extent allowed without violating Standards of Conduct information and Critical Energy Infrastructure Information.
- B. TRANSAC will establish its meeting schedule as needed and will announce its meetings on NWMT's OASIS no less than 10 days prior to the meeting
- C. NWMT will retain a facilitator to manage TRANSAC meetings and carry out the following duties:
 - 1. Draft an agenda for each meeting, which shall be included in all meeting notices.
 - 2. Prepare a summary of all TRANSAC meetings for posting on NWMT's OATIS.
 - 3. Conduct TRANSAC meetings to support a coordinated process that allows all members have an opportunity to speak to all agenda topics in an open and transparent forum.
- D. TRANSAC and NWMT will establish a schedule for Open Public Meetings. Notice of the public meetings will be provided no less than 30 days prior to the meeting using the following methods:
 - 1. Via email, or mail if email is not available, to members.
 - 2. Via local media, i.e. radio, newspaper, etc., as appropriate.
 - 3. Via postings on NWMT's OASIS prior to the meeting.

V. Member Responsibilities

- A. Each member agrees to attend (by phone or in person) and participate in TRANSAC meetings regularly.
- B. Each member agrees to listen carefully and respectfully to other members and to avoid interrupting other members.
- C. Each member agrees to respect the decision of any member to withdraw at any time for any

reason.

VI. Press and Public Contacts

- A. TRANSAC members agree not to discuss their committee activities or information obtained through the committee with the press.
- B. In discussing TRANSAC activities in public forums, members agree to discuss only their ideas, concerns, or positions regarding committee activities and information and not to characterize those of other members.

VII. Confidentiality

- A. TRANSAC members acknowledge that certain information may be protected as confidential information because of Standards Of Conduct (SOC) concerns (e.g., market sensitive data) or because it is classified as Critical Energy Infrastructure Information (CEII).
- B. Information not subject to SOC or CEII concerns will be posted on NWMT's OASIS.
- C. Some (to be determined on a case by case basis) confidential information may be available to members through NWMT OASIS only if access rights have been provided by NWMT and a Confidentiality Agreement has been signed.

Attachment B – Transmission Advisory Committee (TRANSAC) Meetings

The following table outlines the meetings that have occurred in the formation of this 2012-2013 transmission plan. Besides the topics listed, each meeting acknowledged the Standards of Conduct and Anti-Trust Policy, reviewed the agenda, reviewed the summary of the previous meeting, discussed interconnection wide and regional activities, and established a date for the next meeting.

TRANSAC Meeting Schedule and Topics for the 2012-2013 Local Area Transmission Planning Cycle		
Meeting #	Date	Topics Discussed
1	01/26/2012	Interconnection wide, Regional and Bulk Electric System update including FERC Order 1000 activity, Local Area 1 st Quarter of new 2-yr cycle including proposed goal, economic study requests and action item listing.
2	03/07/2012	Conference call to review and classify Economic Study Requests.
3	04/19/2012	Interconnection wide, Regional and bulk electric system updates, FERC Order 1000 related business including Public Policy inclusion into the Local Area Plan, review suggested changes to the ETP Method Criteria and Process Business Practice, Process for Modifying Planning Documents, review the Load forecast for the 2012/2013 cycle and action item listing.
4	06/21/2012	Interconnection wide, Regional and bulk electric system updates, Economic Study update, FERC Order 1000 related business including suggested changes to Attachment K, Attachment K Business Practice and the Method, Criteria and Process Business Practice, Local Area Study base cases, and Load Forecast Correction for DSM and action item listing.
5	09/27/12	Interconnection wide, Regional and bulk electric system updates, Economic Study update, FERC Order 1000 and related documents pertaining to Public Policy, Local Area Study including base case status, state of the system criteria, study, summary results and findings for the 2012 cases for N-0 and N-1 conditions. Also announced the updated, accepted, signed and posted Process for Modifying Planning documents and the Method, Criteria and Process Business Practice.
6	01/24/13	Interconnection wide, Regional and bulk electric system updates, Economic Study update, Interregional filing for FERC Order 1000, Local Area study including state of the system findings, Analysis of 2017, 2022 and 2027 cases.

7	3/7/13	Conference Call to review and classify Economic Study Requests.
8	5/21/13	Interconnection wide, Regional and bulk electric system updates (including Economy Study and FERC Order 1000 updates), Local Area State of the system updates, Proposed Public Meetings, Local Area Economic Studies Update, Prioritizing problems using the Decision Rule, Mitigation Studies and Planning Uncertainty Scenarios.
9	7/26/13	Interconnection wide, Regional and bulk electric system updates (FERC Order 1000 Interregional filing and Biennial Plan Update), Local area economic study update, mitigation plan update and planning uncertainty scenarios update.
10	10/24/13	Interconnection wide, Regional and bulk electric system updates, update on Local Economic Studies, Public meeting review and Draft Two-Year Local Area Transmission Plan Document.
11	12/17/13	Conference call to review Interconnection wide, Regional and bulk electric system updates, Final Draft of the Two-Year Local Area Transmission Plan (posted location on OASIS), Local Economic Studies status and to review stakeholder submittal dates for Quarter 1 of the 2014-2015 Local Area Planning cycle.

Attachment C – Economic Study Requests 2012 & 2013

2012

NorthWestern Energy received three Economic Study Requests during the submittal timeframe. NorthWestern Energy did not request NTTG to conduct stand-alone economic studies on the two NWMT requests (items #2 and #3 below). Rather, NorthWestern Energy requested that the two projects be available to NTTG to cluster with the Gaelectric economic study request (item #1 below) as needed.

The requests were reviewed and discussed at the March 7, 2012 TRANSAC Meeting with updates on the progress were reported to TRANSAC throughout 2012. The requests were deemed valid and sent on to NTTG 3/8/12. NTTG accepted the requests as sub-regional. The studies were conducted in the second quarter of 2012 and completed the third quarter of 2012 and reported in the fourth quarter of 2012²⁵. The following outlines the study requests:

1. Gaelectric North America: Transmission to Northern California: To review the best means of building a transmission line within the NTTG footprint from the Great Falls, Montana area (Point of Receipt) to the Malin Substation (Point of Delivery), to carry approximately 1500 MW of renewable wind energy to the California Market by year end 2018.
2. NWMT#1: MSTI. MSTI is a proposed 500 kV line, approximately 420 miles, extending from Townsend, MT to Midpoint, ID. It is series compensated and power flow is controlled using a Phase Shifting Transformer (PST). NorthWestern Energy suggests that it be coupled with a project such as SWIP to move MSTI's 1500 MW out of NTTG's footprint. In addition to MSTI, NorthWestern Energy proposes a cluster study with the Montana-Northwest 500 kV upgrade. This upgrade consists of reconfiguring the series capacitors in the Colstrip Transmission System and Bonneville Transmission System to 70% series compensation. Additionally, the cluster study should consider at least 2300 MW (800 MW on the 500 kV upgrade, 1500 MW on MSTI) of new wind generation in Montana.
3. NWMT#2: NWMT 500 KV Upgrade: The owners of the Colstrip Transmission System and BPA are considering increasing the capability of the existing twin 500 kV transmission lines that may start as far east as Broadview, Montana and end as far west as the Mid C area of Washington/Oregon. Installation of series capacitors (up to 70%) and appropriate voltage control and expanding the ampacity of existing buses on the 500 kV line may increase the transfer capability up to 500-800 MW. In addition to the 500 kV line may increase the transfer capability up to 500-800 MW. In addition to the 500 kV upgrade, NorthWestern Energy also proposes a cluster study with the MSTI project and at least 2300 MW of new wind generation in Montana (1500 MW on MSTI, 800 MW on the 500 kV upgrade).

²⁵ The 2012 NTTG Approved Economic Study Report is posted on the Northern Tier Transmission Group (NTTG) website at http://nttg.biz/site/index.php?option=com_docman&task=cat_view&gid=417&Itemid=31.

2013

NorthWestern Energy received three Economic Study Requests during the submittal timeframe. A phone conference was held March 7, 2013 with the Transmission Advisory Committee (TRANSAC) to discuss and determine whether the requests were valid or invalid and to classify them as local, regional or inter-regional. The studies were conducted during 2013 and the status of their progress was reported at the various TRANSAC meetings throughout the year²⁶.

The following outlines the three requests:

Gaelectric

The Economic Congestion Study request from Gaelectric was received on February 27, 2013. The request was for a South of Great Falls Congestion Study with the POR at Great Falls, MT and the POD at Garrison Substation. The request is to study the most economic development of the transmission system to relieve the congestion south of Great Falls and deliver the power to BPA at Garrison, assuming the generation was to be developed in the following increments:

- 300 MW of new wind generation coming on line in 2019
- Additional 150 MW of wind generation and 150 MW of combined cycle gas coming on in 2022
- Additional 300 MW of wind coming on in 2025
- Additional 150 MW of wind and 150MW of combined cycle gas coming on in 2028
- Additional 300 MW of wind coming on in 20131

The total added generation in the Gaelectric Economic Congestion Study is 1500 MW. The requested assumptions for the study included:

- The 230 kV line to be built from Jawbone Substation to Broadview to satisfy the Gaelectric Transmission Service Requests is in service.
- The MATL 230 kV line from Lethbridge to Great Falls is in service.
- NorthWestern Energy currently has requests for 230 MW of transmission service requested by PowerX from the MATL termination at the Great Falls 230 kV Switchyard to BPAT. Assume these requests have contracts to purchase part of the 300 MW of new wind generation coming on line in 2019.
- The 150 MW of combined cycle gas plant generation coming on in 2022 is the remainder of the Southern Montana gas generation plant being built.
- The Colstrip 500 kV system upgrades have been completed by NorthWestern Energy
- The Colstrip 500 kV upgrades have been completed by BPA.
- The Gaelectric Jawbone Project is in service at 460 MW
- The Gaelectric Lone Tree Project is in service at 80 MW
- The transmission service upgrades requested for the Lone Tree Project are in service.

²⁶The Economic Congestion Study Reports for 2013 will be posted on NWMT OASIS website upon completion. <http://www.oasis.oati.com/NWMT/index.html>

The March 7, 2013 TRANSAC Conference Call reviewed this request and deemed it a valid local area economic congestion study. NWMT agreed to conduct the Gaelectric Economic Congestion Study.

PPL MT – South of Great Falls – Minimum

The first Economic Congestion Study request from PPL MT was received February 28, 2013 and consists of a 230 kV line connecting Great Falls to Helena to Townsend to Three Rivers. The project could potentially use the existing 100kV line right of way. The POR is the Great Falls 230 kV Switchyard and the POD is the Three Rivers Switchyard. The request asked for existing interconnected generation and generation with signed interconnection agreements.

PPL MT – South of Great Falls – Robust

The second Economic Congestion Study request from PPL MT was received February 28, 2013 and consists of a triangle of 230 kV lines connecting Great Falls to Anaconda, Great Falls to Billings, and Broadview-Billings to Anaconda. The Great Falls to Anaconda and Great Falls to Billings sections could potentially use existing 100 kV line right of way. If necessary, the existing Billings to Anaconda 230 kV line section could potentially be converted to a double circuit line. The POR is the Great Falls 230 kV Switchyard and POD is the Anaconda Mill Creek 230 kV Switchyard and Broadview Switchyard. The request asked for existing interconnected generation and generation with signed interconnection agreements.

Clustering the PPL Requests

The results of the March 7, 2013 TRANSAC Conference call deemed the two PPL MT requests as valid local area economic congestion study requests. NWMT clustered the two PPL requests for the south-to-north portion of the requests and did an Economic Congestion Study. The north-to-south portion of the requests has been studied multiple times in the past. In reviewing the PPL request for the north-to-south portion of the request, NWMT found that the request was more of a TSR study and therefore not appropriate in the local area venue.