MHD Substation

161 kV Interconnection

Facilities Study

March 25, 2004

Electric Transmission Planning
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Executive Summary

NorthWestern Energy ("NWE") has completed a Facilities Study for interconnection of 50 MW of the Interconnection Customer Project at the MHD Substation Interconnection Point located in Silver Bow County, MT. The Facilities Study considers the facilities required to physically and electrically interconnect the generator high side bus with NWE’s electric transmission system in accordance with the conclusions of the System Impact Study and in accordance with Good Utility Practice. The study considers the proposed generation project in conjunction with all the Generation Interconnect projects prior to the Interconnection Customer’s Project in the NWE queue.

The System Impact Study found that the Interconnection Customer Project can be connected to the 161 kV bus at the MHD Substation interconnection point described in the study prepared for Interconnection Customer by NWE on May 7, 2003.

This report provides a summary of Facilities Study results. NWE is responsible for maintaining acceptable system reliability, and we must be certain that any degradation of system reliability as a result of connecting the Interconnection Customer Project is within the tolerances of NWE and regional performance criteria.

The Facilities Study is intended to provide the preliminary design layout, transmission system upgrade and construction routing information, major equipment specifications, and clear delineation of responsibility for facilities installation; an estimate of the cost to install the Transmission Provider Interconnection Facilities and Interconnection System Upgrades; and an estimate of the schedule to complete the installation of the Transmission Provider Interconnection Facilities and Interconnection System Upgrades.

Any deviation from the generator design or interconnection specifications provided to us may cause the results of this analysis to become inaccurate. If any Generation Interconnect project drops from the queue prior to the Interconnection Customer Project going on-line it may cause the results of this analysis to become inaccurate. If this occurs additional studies may be required.

This Facilities Study does not constitute a request for transmission service. This study examines the physical interconnection of the Interconnection Customer generator to the electrical system and does not imply that Interconnection Customer will receive any transmission required to deliver the generation output to the load. Interconnection Customer must follow the procedures described in the transmission tariff available on NWE’s OASIS site (www.nwoasis.org) to
request and/or reserve transmission service. Interconnection Customer is responsible for ensuring all WECC criteria, policy, and guidelines are satisfied.
Interconnection Data

The basic proposed generator and interconnection information used in these studies includes:

- **Project Name** – MHD Substation Interconnection Project
- **Size** (Rating) – 50MW
- **Generator Type** – (8) 6100 kW (5890 kW Net to system) reciprocating natural gas engine sets.
- **Fuel** – Natural Gas
- **Location** – MHD Substation (Silver Bow County, MT)
- **Proposed Commercial Operation Date** – December 1, 2004
- **Facilities** – Connection to the 161 kV transmission line at the MHD Substation
- **Power Factor** – .80
- **Transformer** – (1) 45/60/75 MVA 161/13.8 kV transformer; Impedance – 10% on 45 MVA base
Interconnection Substation Facilities

The MHD Substation One Line drawing and MHD Substation Physical Layout are shown in Appendix A. The existing 161 kV bus will be tapped to the north of the existing MHD Ground Switch. The Ground Switch is to be replaced with a 161 kV circuit Switcher. An air break switch, 161 kV power circuit breaker and metering equipment will be installed within the MHD Substation. The Point of Interconnection will be where the NWE 161 kV bus to the MHD switch meets the jumpers to the 161 kV bus for the air break switch installed on the line side of Interconnection Customer's 161kV power circuit breaker. The MHD Substation is owned by MERDI and an arrangement will need to be made by Interconnection Customer with MERDI for the installation of the interconnection facilities within the MHD Substation.

- **Instrument Transformers – Owned by NWE**
  - There will be 3 CT’s.
  - There will be 3 PT’s.
  - The instrument transformers must meet the requirements set forth in the Scoping Document for Revenue Metering.
  - The instrument transformers will be tested at NorthWestern Energy’s shop prior to installation or as an alternative, can be tested on site. The onsite testing is more expensive than testing the equipment in the shop.
  - Interconnection Customer will purchase and install the instrument transformers. Ownership will be transferred to NWE upon completion of the Interconnection.

Interconnection Customer is to build, own and operate the generator step-up substation, the 161 kV line from the plant to the deadend tower at the MHD Substation and all relaying and communications associated with the operation and protection of the 161 kV line. NWE may comment on areas that appear to be incorrect, or deficient, but will not assume responsibility for the correctness of protection pertaining to Interconnection Customer’s system.

The Facilities owned by Interconnection Customer must meet all applicable national, state, and local construction and safety codes.
Interconnection Relaying Facilities

- **Line Relaying**
  - **Primary Relaying**
    - The line relaying shall consist of a three-terminal SEL 311L line differential relay scheme and a three terminal POTT scheme between the South Butte Substation, the Interconnection Customer terminal at the MHD Substation and the ASIMI Substation. NWE will install and own the 161 kV line relay package at the MHD Substation.
  - **Backup Relaying**
    - The backup line relaying shall consist of step-distance relaying utilizing the phase elements and the ground time over current elements of the SEL 311L and SEL321 relays.
  - **Reclosing Philosophy**
    - Reclosing will not be allowed for three phase faults or trips caused by thermal overloading.
  - **Synch Check**
    - Not required on the 161 kV breaker at the MHD Substation.
  - **Polarizing Source**
    - 161 kV potentials will be required on the 161 kV bus at the MHD Substation. If metering potential transformers are used they shall be wire-wound with dual secondary windings.
  - **Communications**
    - Redundant communications channels will be required between the South Butte Substation, MHD Substation and ASIMI Substation for line differential and transfer trip relaying.
    - The existing F/O cable will serve as one of the communication channels, it will need to be extended into the MHD substation.
• The second communications channel will be a newly established radio channel between the South Butte Substation, the MHD Substation, and the ASIMI Substation.

• **Substation Relaying**
  
  o Interconnection Customer will provide primary and backup relaying for the section of line between the Interconnection Customer generation facility and the Interconnection Customer terminal at the MHD Substation.

  ▪ NWE will review this protection package to verify that it coordinates with NWE’s 161 kV line relaying.

  o Breaker Failure

  ▪ At the MHD substation the main line protection package will include a 161 kV breaker failure scheme that will transfer-trip the remote end line breakers should the Interconnection Customer 161 kV terminal breaker fail. This will be done redundantly over SEL Mirrored Bits utilizing both communications channels.

  ▪ Additionally there will be provisions to trip and block close of the Interconnection Customer 161 kV terminal breaker should it receive a breaker-fail transfer-trip signal from either the South Butte Substation or the ASIMI Substation.

  o Supervisory Controlled ABSWs

  ▪ The #1 and #3 ABSW at the MHD Substation shall be supervised via the SCADA RTU.

• **Generation Relaying**

  o NWE will review the generation protection package to be installed by Interconnection Customer to verify that it contains the following protection devices:

  ▪ Phase/Ground Overcurrent

  ▪ Over/Under Frequency

  ▪ Over/Under Voltage
- **Phase Sequence/Under Voltage**

- **Special Protection Schemes**
  - Remedial Action Schemes (Stability)
    - None required.
  - Overload Management Schemes (Thermal)
    - None required.

- **Supervisory Control and Data Acquisition**
  - **RTU**
    - There will be a Tetragenics Series 332 SCADA RTU installed by NWE at the MHD Substation.
  - **Device Control/Indication**
    - The RTU will provide the ability to open, and close ABSW #1 and ABSW #3 at the MHD Substation.
    - It will also report switch status for the ABSW’s, the 161 kV PCB and for the MHD transformer bank circuit switcher.
  - **Analog Quantities**
    - A, B and C phase currents, megawatts, megavars, kilovolts are to be reported on the 161 kV line breaker.
    - Substation kilovolts, frequency and battery voltage are to be reported.
    - These quantities will be those reported by the SEL relays and/or the power quality monitoring device.
  - **Alarms**
    - The appropriate alarms shall be provided for the 161 kV breaker, primary and backup line relaying, 161 kV potential and communications.
• Interconnection Customer will provide access and wiring to the equipment alarms in their 161 kV PCB.

**Tie Point RTU**

- NWE will install and program a Tetragenics Series 332 Tie-Point RTU at the MHD Substation.
- The Tie-Point RTU will provide the following quantities (also stated in the metering section):
  - Generator Analog Quantities
  - Kwh to NorthWestern Energy
  - Kwh from NorthWestern Energy
  - Instantaneous megawatts
  - Instantaneous megavars
  - KwT to NorthWestern Energy
  - A,B,C Phase Voltages
  - A,B,C Phase Amps

**Control House**

- NWE will require space in the MHD Substation control house to accommodate a 76” wide x 24” deep x 86” high footprint. This footprint will be such that the equipment to be added will meet NESC working space rules.
- HVAC Requirements
  - HVAC will have adequate capacity to maintain a control house temperature between 80° F and 60°F.
- Relaying Modifications/Additions
  - South Butte Substation
- The existing line panel will be modified to accommodate the new relaying.
- One of the existing SEL321’s will be used in the POTT scheme, the other will replaced by a SEL 311L line differential relay.

- **MHD Substation**
  - NWE will install a line protection relay package consisting of one SEL 311L Line Differential relay and one SEL321-1 for the protection of the 161 kV main line.
  - Interconnection Customer will install a Line relay package for the protection of the 161 kV generator line. This relay package will be specified by Interconnection Customer.

- **ASIMI Substation**
  - The existing line panel will be modified to accommodate the new relaying.
  - One of the existing SEL321’s will be used in the POTT scheme, the other will replaced by a SEL 311L line differential relay.

- **Relay Protective Zone Diagram**
  - See drawing in Appendix A.

- **Miscellaneous**
  - The line differential relaying on the 161 kV line will require auxiliary CT’s in the 161 kV currents of the MHD transformer.
  - NWE will require two sets of CT’s from Interconnection Customer’s 161 kV PCB on the Generator side of the breaker.
    - These CT’s to be 1200:5 ratio, Class C800. Interconnection Customer will provide access and wiring to these CT’s.
  - Coordination of Relay Settings Process
- NWE will work with Interconnection Customer or its consultant to coordinate the settings and requirements for the 161 kV line protection, breaker failure and generator backup relaying.

- Power Quality Monitor

- A SEL 734 meter will be installed by NWE at the MHD Substation to monitor 161 kV potential and phase currents associated with service to Interconnection Customer.
Interconnection Metering Facilities

- **Meter Form, Voltage, & Class:**
  
  - This project will require one Form 9S, 120 Volt, billing revenue class watthour meter.

- **Meter Type/Manufacturer:**
  
  - Siemens type 2510 Maxsys multi-function meter or equivalent.

- **Meter Communication Requirements:**
  
  - **Telemetered Data:**
    
    - Data from the meter to the control house will be transmitted between two short haul modems using RS232.
    
      - NWE will install fiber optic cable.
      
      - Interconnection Customer is to install two 2 inch Schedule 40 PVC conduits from the control house to the metering enclosure with a pulling tape installed inside the conduits.
      
      - Two short haul Modems per meter or a fiber link per meter will be required.
      
      - Short haul modems will be supplied by NWE.
      
    - Data transmission from the short haul modem (located inside the meter enclosure) to all downstream points will be determined by the metering/relay departments of NWE.
    
    - The RS232 port on the meter is strictly for internal NWE use.
    
    - MODBUS protocol will be used for data transmission on the RS232 port of the revenue meter.
    
    - Metered metrics extracted from the revenue meter are limited to:
      
      - Delivered & Received MWH, Instantaneous ± MW, Instantaneous ± Mvar, Instantaneous Phase “A” Volts &
Amps, Instantaneous Phase “B” Volts & Amps and Instantaneous Phase “C” Volts & Amps.

- Depending upon timing issues the instantaneous amps might not be included in the telemetered data.

- Modem Data:
  - Revenue meter will be equipped with internal dial-up phone modems.
    - NWE will install appropriate phone communication conductors between the control house and the meter.
    - A dial-up modem and a MSU (modem sharing unit) may be required at the control house and will be installed by NWE if required.

- Special Programming Requirements:
  - Bi-directional metering will be required at the billing metering point.
  - Transformer loss compensation will not be required.

- Auxiliary Power Requirements (Meter Only):
  - DC auxiliary power will be required on the revenue meter.
    - If DC is not available, then AC may be used in conjunction with a backup UPS.
      - The UPS will be installed inside the meter enclosure.

- Meter Location – Physical:
  - Distance from the CT’s
- As close to the revenue meter as possible. In the event that the total secondary circuit length exceeds fifty feet per phase, greater than # 10 AWG copper will have to be used. Actual size will be dependant upon the circuit length.

  - Distance from the PT’s

    - Same requirements as for the CT’s.

  - Enclosure requirements:

    - The standard NWE’s meter enclosure will be used at the meter site.

  - Mounting Structure:

    - If the instrument transformers and meter are located inside a NWE sub-station then NWE will provide a structure that meets the above requirements on which the meter enclosure will be mounted.

    - If the instrument transformers and meter are located on property owned by Interconnection Customer then the Interconnection Customer will provide a structure that meets the above requirements on which the meter enclosure will be mounted.

- **Meter Location – Electrical:**

  - The metering point will be at the MHD Substation on the line side of the 161 kV Power Circuit Breaker.

- **Meter Connectivity:**

  - Cabling requirements for instrument transformers:

    - Current Transformers:

      - Four # 10 AWG or larger, copper conductors.

      - Actual size dependant upon overall circuit length.
• Voltage Transformers (PT’s):
  • Four #10 AWG or larger, copper conductors.
    o Actual size dependant upon overall circuit length.
• Auxiliary DC Power: (Auxiliary power for the revenue meters).
  • Two #12 AWG or larger copper conductors.
• Heater and AC Power to the meter enclosure:
  • One three-wire 240-volt circuit of at least #10 AWG or greater, copper conductors.
  o Cabling requirements for Telemetered data, modem, KYZ, EOI & other
• Phone Modem:
  • Two #24 AWG or larger, twisted pairs - one pair to be designated as “spare”
    o Standard Cat 5 cabling works well.
• Short haul modem requirements:
  • Four #24 AWG or larger, twisted pairs - two pairs to be designated as “spares”
    o Standard Cat 5 cabling works well.
• Optional pulse output cabling for KYZ, EOI or other: IF REQUIRED
  • Sixteen #18 AWG or greater stranded copper conductors - eight to be designated as “spares”. Conductors must have a minimum insulation rating of at least 120 Vac.

• Meter Testing:
  o The revenue meter will be fully tested prior to installation and will be re-certified for accuracy on an annual basis. Interconnection Customer will be responsible for all costs associated with the annual re-certification. A typical re-certification meter test, at 2002 levels, would cost approximately $235.00
• **Instrument Transformer Requirements:**

  o Voltage Transformers (PT’s)

    ▪ Manufacturer & Type:
      
      • Unspecified at this time.
      
    ▪ The metering VT’s/PT’s should be of sufficient ratio to supply 120 VAC to the potential metering circuits inside the watthour meter.
      
    ▪ A secondary winding dedicated to revenue metering only.
      
    ▪ Accuracy class to be at least 0.3 %
      
      • If 0.15% transformers are available they should be used.
      
    ▪ The “Burden” rating should be ZZ with a thermal rating of at least 2 kVA.
      
    ▪ The BIL to be determined by substation design.

  o Current Transformers (CT’s)

    ▪ Manufacturer & type
      
      • Unspecified at this time.
      
    ▪ Current ratio:
      
      • To be of sufficient ratio to supply at least 5 amps of secondary current to the metering elements when the generator is operating at its normal capacity.
      
    ▪ Accuracy class to be at least 0.3 % thru a Burden of 1.8 Ω.
      
    • During periods of reverse flow, when the plant is receiving power from the grid, the current passing through the current transformers will be minimal. It is therefore imperative that the most accurate instrument transformers are employed. If 0.15% transformers are available they should be used.
If 0.15% instruments are found they may be de-rated to a Burden of 0.9 Ω but should have a rating of at least 0.3% accuracy @ 5% rated current.

- The BIL to be determined by substation design.

Instrument Transformer Testing:

- All instrument transformers will be fully tested at our metershop prior to installation.
  
  - If preferred, NWE can test the instrument transformers "On Site" using NWE’s “Mobile Metering Lab” (MML). The cost for the MML per hour is $360.00 and does not include labor or other equipment. This testing normally requires a four-man crew and a bucket truck. If the instruments transformers are not connected and sitting on the ground then testing may only require a two man crew and a ladder.

- All instrument transformers will be tested "On Site" at six-year intervals. Interconnection Customer will be responsible for all costs associated with these tests.
  
  - Depending upon the amount of disconnection and reconnection, a typical re-certification instrument transformer test, at 2002 levels, would cost approximately $3,550.00 to $5,100.00.


- It may be prudent to design and install operational bypasses on all instrument transformers.
  
  - “On-Site” instrument transformer testing using NorthWestern’s MML will be required at six year intervals. Prior to testing, all instrument transformers must be isolated and disconnected from the circuit with the appropriate clearances taken. If circuit bypasses are not installed, shutdowns may be required that could result in lost revenue. The average “shut down” is approximately six hours.
    
    - If the instrument transformers are to be located inside NWE’s substation, the
design and construction of the circuit bypasses would be the responsibility of NWE but all costs would be born by Interconnection Customer.

• **Metering Costs: Estimate of the cost to install metering:**
  
  o Metering installation from the secondary taps on the instrument transformers, to the output of the short haul modem located inside the control house; the estimated metering cost is $10,250.00. This would include the meter, enclosure, modems, cable/wire and labor to install.

  ▪ This estimate does not include the cost of the instrument transformers or their installation.

  ▪ This estimate does not include installation of underground conduits and other related hardware for the control, secondary, heating, and auxiliary circuits.

• **Metering Installation Time Table:**

  o Order and receipt of the revenue meter:

    ▪ Allow sixteen weeks from the time NWE places the meter order with the factory to its arrival at NWE’s metershop.

    • Allow two weeks from the arrival of the revenue meter at NWE’s meter shop to the completion of all necessary meter testing.

  o Metering enclosure:

    ▪ Allow seventeen weeks for the construction of the metering enclosure. This time is necessary to order and receive all the necessary components of the enclosure. Actual construction can be done in two working days.

  o Modems, MSU and miscellaneous metering communication equipment:

    ▪ Allow eight weeks from order date to their receipt.

  o Site preparation:
The installation of the instrument transformers, and all conduits for control cables and secondary circuits must be installed prior to the installation of the meter enclosure and meter.

All control cables, fiber (optional), heating circuits, auxiliary circuits, and secondary circuits must be properly installed prior to the installation of the meter enclosure and meter.

- Actual meter installation:

  - After the site preparation has been completed allow four working days for meter installation.

    - Installation includes mounting and wiring the metering enclosure.
    - Connecting and testing all control, communication, heating, auxiliary and secondary circuits.
    - Programming and commissioning the revenue meter, instrument transformers and associated secondary wiring.

- **Ownership & Responsibilities:**

  - Interconnection Customer will be responsible for the purchase and delivery of the instrument transformers to the metershop for testing. NWE will be responsible for the instrument transformer transportation to the metering site.

    - Interconnection Customer will be responsible for the installation of the Instrument transformers.
    - Nothing other than the billing meter will be connected to the secondary windings dedicated to the revenue metering.

  - Ownership of the instrument transformers will be transferred to NorthWestern Energy upon the Commercial Energizing of the Interconnection Customer Power plant.

    - NWE will provide maintenance and testing of all instrument transformers.
• All maintenance and testing to be paid for by Interconnection Customer

  o NorthWestern Energy will own, operate, and maintain all metering hardware from the Primary terminals of the instrument transformers.
    - The cost of the metering hardware and its installation, including but not limited to the meters, instrument transformers, enclosures, communication devices, and wiring will be the responsibility of Interconnection Customer.
Interconnection Communications Facilities

- NorthWestern Energy Telecommunications Department (NWE Telecom) will provide a Supervisory Control and Data Acquisition (SCADA) channel between the MHD Substation and the NorthWestern Energy System Operation Control Center (SOCC) in Butte.

- NWE Telecom may provide, if requested by Interconnection Customer, a SCADA channel for Tie Point RTU quantities from the MHD substation to NorthWestern Energy SOCC.
  - An agreement to carry telemetry circuit(s) would be required

- Tele-protective relay (relaying) channels will be provided to support relaying schemes for:
  - Relay scheme between South Butte Substation and MHD Substation,
  - Relay scheme between South Butte Substation and ASIMI Substation, and
  - Relay scheme between MHD Substation and ASIMI Substation.

- NWE Telecom will provide a telephone circuit for the substation control house phone at MHD Substation.

- NWE Telecom will provide a telephone circuit for dial-up relay device configuration at MHD Substation

- NWE Telecom will install new infrastructure to provide SCADA, telephone, and relaying channels including:
  - New microwave path between MHD Substation and Northwestern Energy’s (NWE) Beef Trail communications site,
  - New microwave path between ASIMI Substation and NWE’s Beef Trail communications site,
  - New microwave path between South Butte Substation and NWE’s Beef Trail communications site, and
  - New fiber optic cable installed between the existing MHD splice can and the MHD substation control house.

- Communications equipment required to establish microwave paths:
• South Butte Substation requirements include
  ▪ Microwave equipment,
  ▪ Antenna,
  ▪ Telecommunications tower,
  ▪ Channel Bank with Tele-protection channels for relaying,
  ▪ Space within the substation that will accommodate a 19" x 90" equipment rack for communications equipment,
  ▪ Site Communications Monitor System (CMS) RTU, and
  ▪ 48 or 125VD battery capacity will be required to meet DC loading of new telecommunications equipment.

• ASIMI Substation requirements include:
  ▪ Microwave equipment,
  ▪ Antenna,
  ▪ Telecommunications tower,
  ▪ Channel Bank with Tele-protection channels for relaying,
  ▪ Space within the substation that will accommodate a 19" x 90" equipment rack for communications equipment,
  ▪ Site Communications Monitor System (CMS) RTU, and
  ▪ 48 or 125VD battery capacity will be required to meet DC loading of new telecommunications equipment.

• MHD Substation requirements include:
  ▪ Microwave equipment,
  ▪ Antenna,
  ▪ Telecommunications tower,
  ▪ Channel Bank with Tele-protection channels for relaying,
- Space within the substation that will accommodate a 19” x 90” equipment rack for communications equipment,
- Site Communications Monitor System (CMS) RTU, and
- 48 or 125VD battery capacity will be required to meet DC loading of new telecommunications equipment.

- **Beef Trail Telecommunications Site requirements include:**
  - Microwave equipment,
  - Antennas,
  - Space within the site that will accommodate two 19” x 90” equipment racks for communications equipment, and
  - 48 or 125VD battery capacity will be required to meet DC loading of new telecommunications equipment.

  - Communications Equipment required to establish fiber optic cable paths:
    - **South Butte Substation requirements include:**
      - Additional circuit cards for the existing RFL multiplex shelf, and
      - Additional fiber termination supplies.
    - **ASIMI Substation requirements include:**
      - Additional circuit cards for the existing RFL multiplex shelf, and
      - Additional fiber termination supplies.
    - **MHD Substation requirements include:**
      - RFL multiplex shelf and associated circuit cards to provide relaying and telephone circuits,
      - Fiber termination shelf and associated termination supplies,
      - Fiber optic cable to connect the control house to the MHD Sub splice can, and
      - Fiber optic cable to connect the MHD Sub splice can to the existing MHD splice can.
    - **SOCC**
• Additional circuit cards and an RFL multiplex expansion shelf.
  o All materials and labor will be provided by NWE Telecommunications Department
**NorthWestern Energy Cost Summary**

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<th>Cost</th>
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<tr>
<td>NWE Relaying</td>
<td>$162,550</td>
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<tr>
<td>NWE Metering</td>
<td>$10,250</td>
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<td>NWE Communications</td>
<td>$250,021</td>
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<tr>
<td>NWE SOCC EMS Interface</td>
<td>$15,000</td>
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| TOTAL                         | $437,821 |
## Appendix Listing

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Butte MHD Substation One Line Diagram
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