Mill Creek Generating Station
In-Service Testing Criteria

This document defines various operational parameters of the Mill Creek Generating Station which demonstrate the plant's acceptable capability to provide effective regulation service on NorthWestern Energy's electrical transmission system.

1. Referenced Documents

1.1. Montana Public Service Commission (MPSC)

- NorthWestern Energy , Docket D2008.8.95, Order No. 6943a
  - Service Date: May 20, 2009
  - Application for the Approval to Construct and Operate the Mill Creek Generating Station to Supply Regulation Service

1.2. Western Electricity Coordinating Council (WECC) Standards

- BAL-004-WECC-1
  - Automatic Time Error Correction
- BAL-STD-002-0
  - Operating Reserves
- IRO-STD-006-0
  - Qualified Path Unscheduled Flow Relief
- PRC-STD-001-1
  - Certification of Protective Relay Applications and Settings
- PRC-STD-003-1
  - Protective Relay and Remedial Action Scheme Misoperation
- PRC-STD-005-1
  - Transmission Maintenance
- TOP-STD-007-0
  - Operating Transfer Capability
- VAR-STD-002a-1
  - Automatic Voltage Regulators (AVR)
- VAR-STD-002b-1
  - Power System Stabilizer (PSS)

1.3. Montana Department of Environmental Quality

- Air Quality Permit #4255-00
  - Final Date: January 22, 2009
- Air Quality Operating Permit OP4255-00
  - Draft Issue Date: February 12, 2010

1.4. NorthWestern Energy Purchase Order 301264

  - To: Pratt and Whitney Power Systems Inc.
  - Effective Date: June 24, 2009
  - Equip/Material: Gas Turbine Generators with SCRs
  - Project Title: Mill Creek Generating Station

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- Exhibit 1B Swift Pac 50 (Rev.5)
  - Sheet-1, Notes Applicable to Performance and Emissions Data
  - Assumed Fuel Properties
  - Estimated Performance and Emissions
  - Figure 9337a: Net Power vs. Ambient Temp
  - Figure 9338a: New LHV Heat Rate vs. Ambient Temp
  - Figure 9339a: Net Power vs. Ambient Temp
  - Figure 9340a: Net LHV Heat Rate vs. Ambient Temp
  - Figure 9341a: Net LHV Heat Rate vs. Net Power
  - Figure 9341b: Net LHV Heat Rate vs. Net Power
  - Figure 9242a: Net LHV Heat Rate vs. Net Power
  - Figure 9342b: Net LHV Heat Rate vs. Net Power
  - Figure 9243a: Net LHV Heat Rate vs. Net Power
  - Figure 9344a: Net LHV Heat Rate vs. Net Power
- Exhibit 1B2 Swift Pac 50
  - Sheet-1, Notes Applicable to Performance and Emissions Data
  - Assumed Fuel Properties
  - Estimated Performance and Emissions
- Attachment 1B
  - Substantial Completion, Performance and Quantity Guarantee and Related Damages
- Attachment 1C
  - Factory and Field Tests (v37-0805)
- Attachment 15
  - Plant Controls Design Criteria
- Attachment 16
  - CTG Performance & Control and Scope Design Criteria
- Project Specification PS-V202-01
  - Date: August 18, 2008

1.5. Project Documents

- Zachry Calculation C-A013757-ELDE002
  - Electrical Load List
- McHale Performance Document: PWPS 0808 TP R1

2. System Startup Performance Testing Criteria

The Northwestern Energy (NWE) Mill Creek Generating Station (MCGS) includes three (3) Pratt and Whitney Power Systems (PWPS) Swift Pac units. These units are a combustion turbine-generator set; each set includes two (2) simple cycle combustion turbines that are connected to one (1) Brush generator. The Mill Creek facility includes an assemblage of the following major systems, all of which are integrated to comprise and support each fully functional Swift Pac Generating Unit.

- Twin Simple Cycle Combustion Turbines (3)
- Turbine Generators (3)
- Generator Step-Up (GSU) Transformers (3) + one (1) spare
- Balance of Plant (BOP) Equipment
- Envirokinetics (EKI) Selective Catalytic Reduction (SCR) System (3)
- Demineralized Water Supply System
- Fuel Gas Delivery System
- Fuel Oil Storage and Delivery System
- Ammonia Storage and Delivery System

Each of the above systems must operate efficiently and effectively to not only meet the rated Unit load requirements, at a permitted emissions rate, but also must respond to the regulating requirements of the load and demand on the electrical transmission system. The system requirements include the following performance guarantees, measured at ambient conditions and corrected per industry guidelines.

- Maximum Net Capability of 44.049 MW per Swift Pac Unit **[Point 368, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Natural Gas, 0.9 Power Factor
  - Ambient Temperature of 81.5°F, Water Injected, 21.6% Relative Humidity
  - Power Measured at the Generator Terminals
  - Power De-Rating based on PWPS Figure 9337a
- Maximum Net Capability of 49.629 MW per Swift Pac Unit **[Point 535, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Natural Gas, 0.9 Power Factor
  - Ambient Temperature of 39.5°F, Water Injected, 76.6% Relative Humidity
  - Power Measured at the Generator Terminals
  - Power De-Rating based on PWPS Figure 9337a
- Maximum Net Capability of 42.580 MW per Swift Pac Unit **[Point 455, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Liquid Fuel, 0.9 Power Factor
  - Ambient Temperature of 81.5°F, Water Injected, 21.6% Relative Humidity
  - Power Measured at the Generator Terminals
  - Power De-Rating based on PWPS Figure 9337a
- Net heat rate of 9,994 Btu/kWhr **[Point 368, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Natural Gas, 0.9 Power Factor
  - Ambient Temperature of 81.5°F, Water Injected, 21.6% Relative Humidity
  - Power Measured at the Generator Terminals
  - Heat Rate Variation with Ambient Temperature based on PWPS Figure 9243a
- Net heat rate of 10,291 Btu/kWhr **[Point 455, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Liquid Fuel, 0.9 Power Factor
  - Ambient Temperature of 81.5°F, Water Injected, 21.6% Relative Humidity
  - Power Measured at the Generator Terminals
  - Heat Rate Variation with Ambient Temperature based on PWPS Figure 9243a
- Net heat rate of 9,680 Btu/kWhr **[Point 535, Guaranteed]**
  - 2 Gas Generators, Base Loaded on Liquid Fuel, 0.9 Power Factor
  - Ambient Temperature of 39.5°F, Water Injected, 76.6% Relative Humidity
  - Power Measured at the Generator Terminals
- Part Load Heat Rate of 11,017 Btu/kWhr **[Point 537, Guaranteed]**
  - At 17.00 MW Power Output, 1 Gas Generator on Natural Gas
  - Ambient Temperature of 39.5°F, 0.9 Power Factor
  - 76.6% Relative Humidity, Water Injected
  - Heat Rate Variation with Ambient Temperature based on PWPS Figure 9242a
- Part Load Heat Rate of 11,260 Btu/kWhr **[Point 539, Guaranteed]**
  - At 15.83 MW Power Output, 1 Gas Generator on Natural Gas
  - Ambient Temperature of 39.5°F, 0.9 Power Factor
  - 76.6% Relative Humidity, Water Injected
  - Heat Rate Variation with Ambient Temperature based on PWPS Figure 9242a
- Minimum Net Capability of 3.681 MW per Swift Pac Unit **[Point 424, Demonstrated]**
  - 1 Gas Generator, Base Loaded on Natural Gas, 0.9 Power Factor
  - Ambient Temperature of 39.5°F, Water Injected
  - Power Measured at the Generator Terminals
  - Power De-Rating based on PWPS Figure 9339a
- Generator response rate of 15 MW/min per Gas Generator **[Attachment 1B]**
  - Corresponding to a 30 MW/min Ramp Rate per Swift Pac
  - Ramp Rate Availability based on Unit Idle / Off Condition
  - Information included in PWPS provided Performance Test Procedure
  - Guarantee on Diesel Fuel and Natural Gas
- Cold start time of 10 minutes **[Attachment 16]**

  - Cold Start to Maximum Load
  - Including 5 minute purge time for the SCR
  - Guarantee on Diesel Fuel and Natural Gas
- Second Gas Generator Start in 60 seconds on Natural Gas **[Attachment 16]**
  - 90 second start on liquid fuel

- Testing shall have tolerances based on the following table: **[Attachment 1C]**

Generator output	± 0.93%
Fuel Flow	± 0.42%
Fuel LHV	± 0.90%
Heat Rate	±1.36%
Exhaust Temperature	± 1.0%
Exhaust Gas Flow	± 1.0%

- Automatic Generation Control (AGC) capability

The plant is expected to operate full-time in Automatic Generation Control with control commands from NorthWestern Energy's Systems Operation Control Center (SOCC). The plant MW load demand signal is received by the Plant Control System (PCS) which then calculates and sends hard-wired MW load demand signals to each CTG.

- Regulation and Area Control Error (ACE)

Mill Creek is one of the first power plant installations to be built specifically for electrical transmission grid regulation duty. The design requirements for grid regulation are stringent since they require the plant to continually change load in a short time frame (seconds to minutes). A typical load-following or scheduling-duty plant by comparison requires load changes from tens-of-minutes to a few hours. In addition to MW regulation duty, the plant's MVAR load and AVR set-points will also be adjusted as required to support the grid.

As a transmission balancing authority it is incumbent on NWE to maintain a constant balance between electrical energy supply and demand within its control area. The instantaneous measure of this balance is known as the Area Control Error, which is calculated every 4 seconds. The Control Performance Standards (CPS) are a measure of how well NWE manages its ACE. There are three components to the CPS. For purposes of this document, NWE's main concern is the CPS2 component which is a statistical measure of the ACE's magnitude. A balancing authority's ability to meet the CPS2 standard is a function of the variability of the balancing agency's supply resources and load in conjunction with the amount of regulating resource it has available to follow the net variability. NWE's need to meet the CPS2 standard has required them to develop the Mill Creek Generating Station as a long-term regulating resource.

The CPS2 requirement states that the 10 minute average ACE shall not exceed a quantity known as L_{10} (spoken as "L-sub-10"). The constant L_{10} is unique to each balancing authority and is a function of each balancing authority's relative contribution to the ability of the interconnected grid to maintain line frequency. While this constant is recalculated occasionally, it typically does not change much over time. NWE's L_{10} generally runs from 24 MW to 25 MW with the current L_{10} value being 24.61 MW.

NWE tracks their CPS2 performance by calculating the net ACE over each successive 10 minute period during the month and compares it to their L_{10}. NWE's compliance level must be ≥ 90% to comply with the CPS2 standard. If NWE's 10 minute ACE exceeds their L10 by more than 10% of the 10 minute periods in the month, then they have failed to comply with the CPS2 standard.

NWE currently has several short-term contracts with suppliers for their regulating resources. Mill Creek Generating Station will replace some or all of those contracts. While NWE calculates the ACE every 4

seconds, they will typically not send a signal calling for more or less power on the grid unless the magnitude of the ACE is 5 MW or greater.

3. Specific Equipment In-Service Testing Criteria

The following specific equipment testing requirements fulfill the in-service testing requirements of the Stipulation and Agreement, as well as the Western Electricity Coordinating Council accreditation requirements. Each equipment system as set forth below shall be evaluated for successful completion of in-service testing on an individual basis. The failure of the NorthWestern Energy to meet the requirements as specified for the specific equipment can impact, to an extent to be determined, NorthWestern Energy's ability to include the costs associated with that specific equipment in the NorthWestern Energy's rate recovery regulatory proceeding for the Mill Creek facility.

As a prerequisite to finalizing the in-service testing of the below outlined specific equipment, the following actions shall be completed:

- All major construction work is complete.
- All preoperational testing is complete.
- The associated specific equipment successfully meets the operational guarantees as set forth contractually with the Original Equipment Manufacturer or responsible contractor.

Combustion Turbine Set **[Attachment 1B]**

Each combustion turbine set includes two (2) combustion turbines (including a compressor, combustor and turbine) which operate with a design exhaust flow of 155.6 lbs. /sec. at an exhaust temperature of 938.5°F while combusting natural gas. Each combustion turbine must demonstrate the capability of operating over the design load range on natural gas or diesel fuel. The heat rate of the combustion turbine at full load is 9,994 Btu/kWhr.

Generator **[Attachment 1B]**

The generator will be capable of being fully dispatched at a rate of 30 MW/minute over the design load range of 3.681 MW to 49.629 MW net power output, at a power factor of 0.9, with an ambient temperature of 39.5°F, while combusting natural gas. The normal generator start time to synchronization is less than 5 minutes. The generator will be capable of delivering the design megawatts and megavars within its capability limits.

Balance of Plant Auxiliaries **[Ref. 1.5]**

The Balance of Plant (BOP) auxiliaries including all associated fans, pumps, blowers, digital control system, power distribution equipment and support systems operated in a fully integrated manner at a maximum overall electric load of 5,622 kVA and meet the operational requirement for any or all units at full load and varying through design load ramp rate.

4. Emissions Control System

The Continuous Emissions Monitoring System (CEMS) is typically utilized to monitor the effectiveness of the water injection system and Selective Catalytic Reduction (SCR) system. An independent Relative

Accuracy Test Audit (RATA) should be completed on the CEMS within 180 days of initial startup of the unit.

NOx Removal Equipment **[4255-00 II.A.7]**

Emissions of NOx from each generating unit shall not exceed 11.07 pounds per hour (lb/hr) using natural gas and 10.09 lb/hr based on a 30-day rolling average using ultra low sulfur fuel oil (#2) based on a 30-day rolling average, effective during all periods of operation, including startup and shutdown (ARM 17.8.752).

PM/PM_{10}/$PM_{2.5}$ **[4255-00 II.A.10]**

Emissions of PM/PM_{10}/$PM_{2.5}$ from each generating unit shall not exceed 7.30 lb/hr based on a 30-day rolling average using natural gas and 19.30 lb/hr using ultra low sulfur fuel oil (#2) based on a 30-day rolling average, effective during all periods of operation, including startup and shutdown (ARM 17.8.752).

VOC Emissions **[4255- 00 II.A.9]**

Emissions of VOCs from each generating unit shall not exceed 2.47 lb/hr using natural gas and 18.98 lb/hr based on a 30-day rolling average using ultra low sulfur fuel oil (#2) based on a 30-day rolling average, effective during all periods of operation, including startup and shutdown (ARM 17.8.752).

SO_2 Emissions **[4255-00 II.A.11]**

Emissions of SO2 from each generating unit shall not exceed 0.83 lb/hr based on a 30-day rolling average using natural gas and 0.80 lb/hr using ultra low sulfur fuel oil (#2) based on a 30-day rolling average, effective during all periods of operation, including startup and shutdown (ARM 17.8.752).

Carbon Monoxide Emissions **[4255-00 II.A.8]**

Emissions of CO from each generating unit shall not exceed 10.78 lb/hr using natural gas and 9.83 lb/hr based on a 30-day rolling average using ultra low sulfur fuel oil (#2) based on a 30-day rolling average, effective during all periods of operation, including startup and shutdown (ARM 17.8.752).

Audible Sound Levels **[Attachment 1B]**

During full load operation of the plant while firing on either natural gas or diesel fuel the audible level of 65 dBA at 400 feet should not be exceeded.

5. Commissioning Procedures Plan

A Project Specific Commissioning Plan shall be developed by all Contractors to cover all work to turn over a fully commissioned plant. The procedures shall be complete in all detail and shall be specifically designed for each component, equipment, and system.

The manuals shall include, but not be limited to, the items set forth below:

- An alphabetical listing of all plant systems, providing the names, general system description and a definition of mechanical and electrical system boundaries.
- A description of the Contractor's inspection, testing, and preoperational check out activities including sequential and step-by-step test procedures for the systems defined above.
- A general description of contractual performance, functional, and acceptance tests, which are applicable to plant equipment and systems.

- Documentation showing the completion of the environmental regulatory compliance tests which have been set out in the contract.
- Check lists, punch lists, forms, test formats, and data sheets.
- A master commissioning schedule providing task durations, forecasted turnover dates, and identification of critical path leading through first fire and substantial completion.
- A plant wide lock-out/tag-out (LOTO) procedure for all companies performing work on site.
- Fire protection and detection drawings and settings as necessary per system.
- Turnover documentation that meets provided acceptance criteria for system cleanliness.

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