



Manual No. 032

Business Practices Manual

Merchant HVDC Connection Procedures



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Revision History

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1. Introduction

This introduction to the Midcontinent Independent System Operator, Inc. (MISO) *Business Practices Manual (BPM) for Merchant HVDC Connection Procedures* includes basic information about this BPM and other MISO BPMs. The first section (Section 1.1) of this Introduction provides information about the MISO BPMs. The second section (Section 1.2) is an introduction to this BPM. The third section (Section 1.3) identifies other documents which can be used by the reader as references when reading this BPM.

1.1 Purpose of the MISO Business Practices Manuals

The BPMs developed by MISO provide background information, guidelines, business rules, and processes established by MISO for the operation and administration of the MISO markets, provisions of transmission reliability services, and compliance with the MISO settlements, billing, and accounting requirements. All of MISO's BPMs are available for reference and download through MISO's public website.

1.2 Purpose of this Business Practices Manual

This *BPM for Merchant HVDC Connection Procedures* contains the business practices of MISO in implementing Attachment GGG of its Open Access Transmission, Energy and Operating Reserves Markets Tariff (Tariff). These practices are not intended to supplement the Tariff, and to the extent that there is a conflict between the Tariff and these practices, the Tariff controls.

1.3 References

Other reference information related to this BPM includes:

- MISO Open Access Transmission Tariff (Tariff)
 - Attachment X (Generator Interconnection Procedures)
 - Attachment FF (Transmission Expansion Planning Protocol)
 - Attachment GGG (Merchant HVDC Transmission Connection Procedures)
 - Appendix 1 – Connection Request for a Merchant HVDC Transmission Line
 - Appendix 2 – Transmission Connection Agreement
- Agreement of the Transmission Facilities Owners to Organize the Midcontinent Independent System Operator, Inc., a Delaware Non-Stock Corporation (MISO Agreement)
- BPM-013 Module B Transmission Service.
- BPM-015 Generation Interconnection

- BPM-020 Transmission Planning
- NERC Reliability Standards applicable to transmission planning

2. MHVDC Transmission Connection Process Summary

2.1 Scope and Applicability

MISO's Merchant HVDC Transmission Connection Procedures (MHCP) apply when one of the following is proposed by a customer:

- Connection of a new Merchant HVDC (MHVDC) Transmission Line at a new Point of Connection on the Transmission System
- Additional capacity requested for an existing MHVDC Transmission Line at an existing Point of Connection
- A substantive modification to the operating characteristics of an existing MHVDC Transmission Line

These MHCP do not apply to any of the following:

- Any existing or new facilities included in the MISO Transmission System
- Any Interconnection Facilities as defined in MISO's Generator Interconnection Procedure (Attachment X) and included in an executed Generator Interconnection Agreement
- Any transmission facilities that are included in the rate base of a public utility on which a regulated return is earned

All MHVDC projects must proceed through the Attachment GGG process for MISO to evaluate the project's physical interconnection to the MISO Transmission System. At the completion of MISO's MHCP, MHVDC Transmission Connection Service is provided to physically interconnect an MHVDC Transmission Line to the MISO Transmission System.

Completion of MISO's MHCP does not result in the granting of Transmission Service per Module B or Interconnection Service per Attachment X. Such services may be pursued through the applicable MISO Tariff rules and procedures.

2.2 Process Overview and Diagram

Figure 1 below summarizes the main steps of MISO's MHCP. The process begins with the submission of an MHVDC Transmission Connection Request and ends upon filing with FERC of an MHVDC Transmission Connection Agreement.

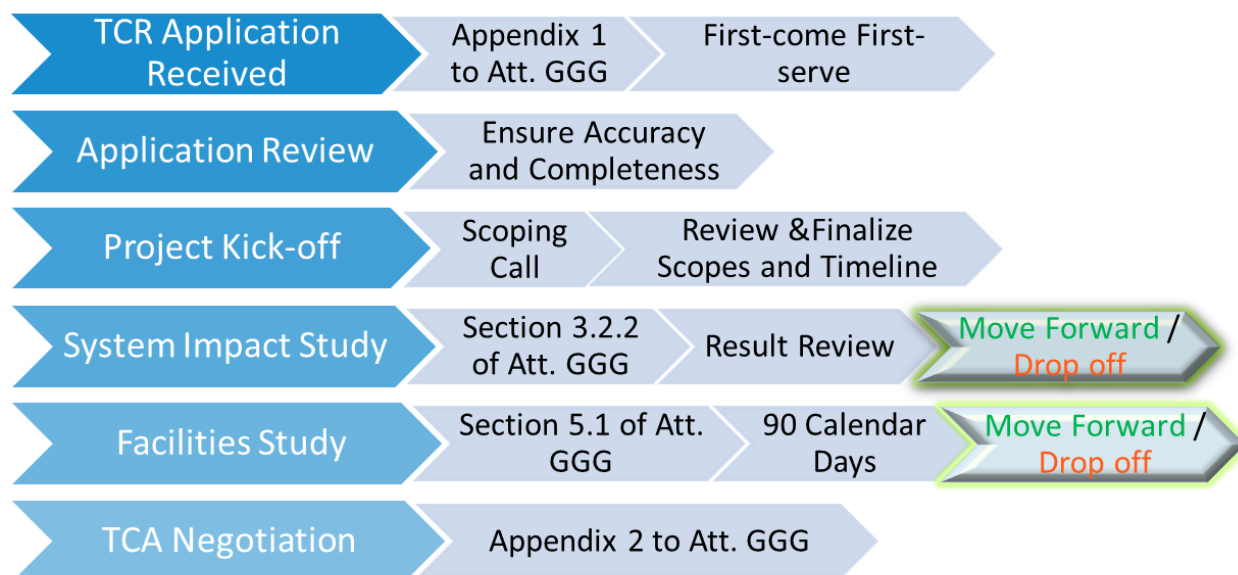
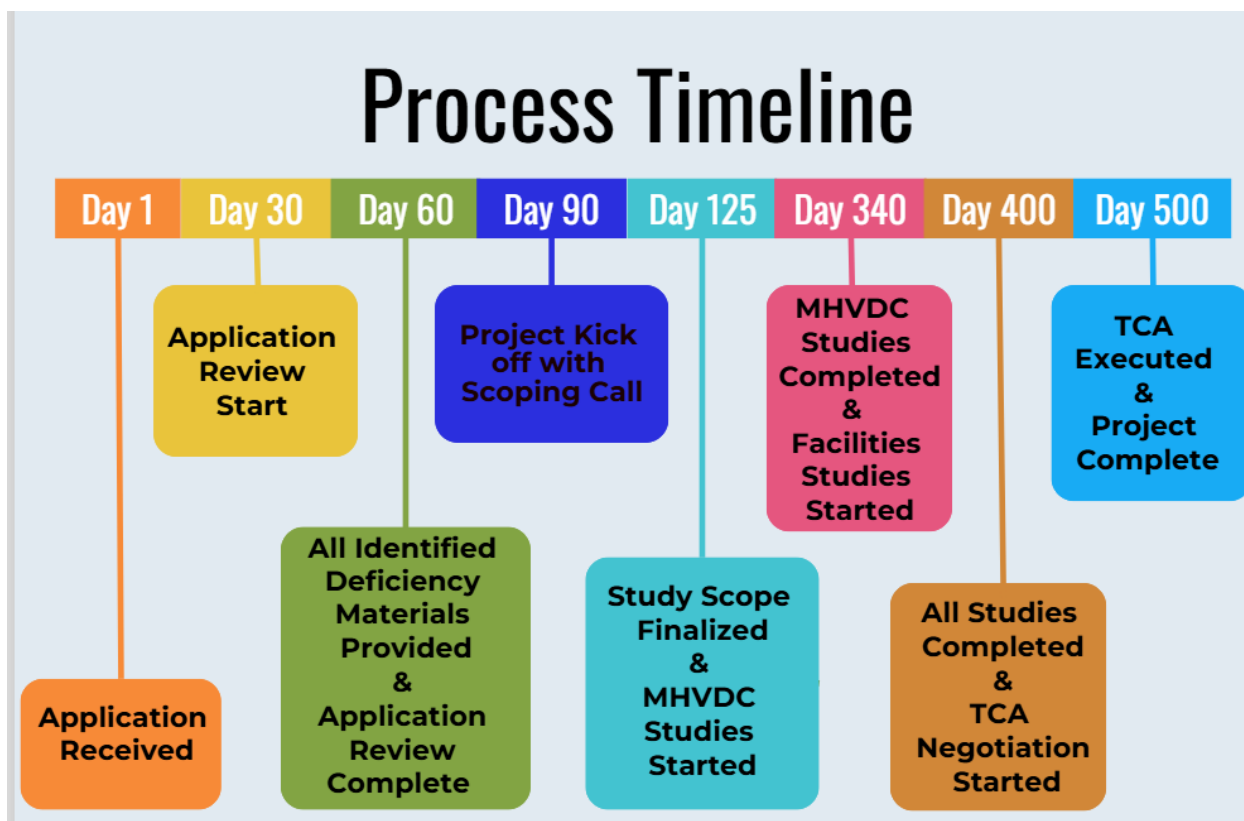


Figure 1 – High-level summary of MISO's MHCP

2.3 Process Timeline

MISO's MHCP may take 18-24 months depending on size of the MHVDC project queue and the complexity of the project. A sample timeline with major milestones is shown below. The number of days shown in the following timeline is calculated in Business Days.



3. Requesting a Transmission Connection

3.1 MHVDC Transmission Connection Request & Deposit Submittal

MHVDC Connection Customers begin the process to request Merchant HVDC Transmission Connection Service by submitting a MHVDC Transmission Connection Request for a Merchant HVDC Transmission Line (Appendix 1 of Attachment GGG) and a corresponding monetary deposit. MISO applies the deposit towards the cost of the required MHVDC Connection Studies. The MHVDC Transmission Connection Request requires the following information:

- Physical Location of the entire MHVDC Transmission Line
 - External or internal to MISO
 - MHVDC Transmission Line name and closest substation common names
 - Voltages and Ratings
 - EMS Bus Name, with Bus Numbers
- Point of Connection to the MISO Transmission System
 - Internal to MISO
 - MHVDC Transmission Line name and closest substation common names
 - Voltages and Ratings
 - EMS Bus Name, with Bus Numbers
- Request Type: Injection to MISO

- Maximum MW/MVAR capabilities and other necessary technical data, including up to date one-line diagram(s)
- Expected Commercial Operation Date (COD)
- Expected In Service Date (ISD)
- Connection Customer's contact information
- An MHVDC Connection Studies Agreement (Attachment B to Appendix 1)

The initial study deposit required per request is \$100,000. An additional study deposit will be requested if a funding deficit is encountered during the studies. MISO will return any unused deposit balance within thirty (30) Calendar Days after the execution of the applicable Transmission Connection Agreement (TCA).

3.1.1 MHVDC Injection Rights

In addition to requesting MHVDC Transmission Connection Service, applicants may request that MISO evaluate the request for Injection Rights on the Transmission System pursuant to Generator Interconnection Procedures as described in BPM-015 Generator Interconnection and Attachment X of the Tariff. Requests for Injection Rights are requests for Interconnection Service from a queue priority perspective and are subject to all Definitive Planning Phase (DPP) requirements including milestones and study deposits.

When submitting interconnection requests associated with an MHVDC Transmission Line into MISO's generator interconnection queue to obtain Injection Rights, information between the two should align. Please note the following for the interconnection request(s):

- Select 'Injection Rights' as the Connection Type
- Select 'High Voltage DC' as Fuel Type
- Select intention to convert to E-NRIS after MHCP completion
- In Service Date (ISD) and Commercial Operation Date (COD) should match the MHVDC TCR ISD and COD, respectively
- POI should match the MHVDC Point of Connection
- Project Name should reference the MHVDC Transmission Project
 - The Project Name should be clear and reasonable to distinguish from previous projects
 - If the current project is a newer phase on a previous MHVDC project already in the MISO MHVDC queue, this project can be named as "XXX Phase y", where "XXX" is the previous project, and "y" is the current phase number.
- MW amount of requested generation interconnection service should be equal or less than MW capability submitted with the output of MHVDC TCR
- Attachment A of the Interconnection Request should reflect the MHVDC converter station specifications, and should match the MHVDC TCR

MHVDC Injection Rights do not grant Interconnection Service or Transmission Service to the MHVDC Connection Customer. MHVDC Injection Rights must be converted to External Network Resource Interconnection Service (E-NRIS) under Attachment X before those rights may be used to offer energy or capacity into the MISO markets. This conversion must occur within three (3)

years from the Commercial Operation Date for the MHVDC Transmission Line as set forth in the TCA. Any amount of Injection Rights that are not converted to E-NRIS within this three-year period will be terminated.

3.1.2 MHVDC Energy Withdrawal Transactions

Withdrawal transactions via MHVDC Transmission Lines are product-specific and are not evaluated under Attachment GGG. A MHVDC Connection Customer may submit separate requests for energy withdrawals from the Transmission System pursuant to the procedures for obtaining Transmission Service as described in BPM-013 and Module B of the Tariff. MHVDC Connection Customers may request either Short-term or Long-term Point-to-Point service. This is described further in Section 4.2.3 below.

When submitting transmission service requests associated with an MHVDC Transmission Line into MISO's Transmission Service queue, information between the two should align.

3.2 MHVDC Application Review Phase

3.2.1 Acknowledgment

MISO will acknowledge receipt of a MHVDC Transmission Connection Request within five (5) Business Days by responding to the MHVDC Connection Customer via email and/or other electronic means and providing a copy of the received MHVDC Transmission Connection Request.

3.2.2 Deficiencies

If any deficiencies are identified, the MHVDC Connection Customer must submit necessary information and/or corrections no later than ten (10) Business Days after the notice was received. Should the MHVDC Connection Customer fail to cure the deficiency, MISO will issue a withdrawal notice in accordance with Section 3.5 of Attachment GGG.

3.2.3 Validation

The MHVDC Transmission Connection Request is considered valid only once all items in Section 3.2.1 of Attachment GGG have been received. This includes:

- i. A completed MHVDC Transmission Connection Request (Appendix 1 of Att. GGG)
- ii. An executed MHVDC Connection Studies Agreement (Attachment B to Appendix 1 of Att. GGG)
- iii. A definitive Point of Connection
- iv. An up to date one-line diagram showing the MHVDC Transmission Line and associated electrical equipment with appropriate ratings and impedance information
- v. An initial study deposit in the amount of \$100,000

When the MHVDC Transmission Connection Request is validated, MISO will provide a copy of the countersigned MHVDC Connection Studies Agreement within five (5) business days.

Valid MHVDC Transmission Connection Requests are processed serially in a first-come, first-served approach. MISO maintains a list of all valid and active MHVDC Transmission Connection Requests on its public website but will not disclose the MHVDC Connection Customer until a Transmission Connection Agreement is filed with FERC.

3.2.4 Application Withdrawal

At any point prior to completion of the MHCP, the MHVDC Connection Customer may submit a written notice of withdrawal to MISO and the study group members of the project. The notice must be delivered via certified mail or an equivalent secure method to ensure receipt and documentation, including secured email to the designated MISO mailbox or submission through the MISO Dynamics/CRM Application Portal (where available). Receipt will be acknowledged by MISO upon validation of the withdrawal request.

If the customer fails to adhere to all requirements of the MHCP, MISO may deem the request withdrawn and provide written notice to the customer with an explanation of the reasons for such deemed withdrawal.

Any associated generator interconnection requests for Injection Rights (DPP projects seeking E-NRIS under Attachment X) may also be withdrawn.

Upon receipt of withdrawal notice, MISO will:

- Cease all active MHVDC studies related to the project
- Release any queued position and cancel the application
- Refund any remaining deposits, minus costs incurred up to the date of withdrawal. The refund will occur once all applicable billing has been processed.

Once withdrawal is confirmed, the request is deemed cancelled. Any attempt to re-initiate the same project will require the submission of a completely new MHVDC Transmission Connection Request, with a new queue position and associated requirements per Section 3.1.

3.3 MHVDC Application Modifications

3.3.1 Determining When a New Request Is Required

MISO will assess whether proposed modifications constitute a substantial modification under the planning criteria. If a modification substantially impacts system studies, changes the power flow impacts, or alters the planning assumptions used in stakeholder-reviewed models, then the requestor may be required to:

Submit a new MHVDC Transmission Connection Request. MISO encourages MHVDC developers to engage early and to proactively work with MISO when considering modifications. All proposed changes must be documented and submitted formally to ensure traceability, stakeholder visibility, and system reliability.

3.4 Ad Hoc Information Sessions

The MHVDC Connection Customer may request an ad hoc information session with MISO and likely affected Transmission Owners and/or neighboring entities given the following circumstances:

- i. MHVDC Connection Customer has identified a path/location for a potential project.
- ii. MHVDC Connection Customer wants to get a better understanding of the available Points of Connection (POC) and any known issues on the local Transmission System.

To request an ad hoc information session, the MHVDC Connection Customer should submit a request to MISO's Help Center using the form in Appendix A of this BPM. The request should include a tentative agenda for the meeting and specific questions. MISO will validate the request and determine which Transmission Owners (TOs) and/or neighboring entities to invite for the meeting. Within ten (10) Business Days of receiving the request, MISO will send an email notification to the Customer with earliest available dates/times for the meeting, which will be scheduled within forty-five (45) Calendar Days of receiving the request, unless another date is agreed upon by MISO and the MHVDC Connection Customer.

4. MHVDC Project Kick-off and Engineering Studies

4.1 Scoping Meeting

Within ten (10) Business days after receipt of a valid MHVDC Transmission Connection Request, MISO will send a summary of the request to the applicable study group to establish a date agreeable to all parties for a scoping meeting. The applicable study group may include the MHVDC customer, any affected MISO Transmission Owners and neighboring system operators, and is described in more detail in section 4.1.1 below.

The purpose of the scoping meeting is to discuss alternative connection options, exchange and analyze information, and confirm the Point of Connection is feasible. MISO, the Transmission Owner(s), and the MHVDC Connection Customer will bring to the meeting such data including, but not limited to:

- Facility loadings
- Instability issues
- Short circuit issues
- Voltage issues including voltage and frequency ride-through capabilities for the MHVDC Transmission Line
- Power quality issues including voltage flicker, harmonics
- General reliability issues
- One-line diagrams and/or layout of applicable substations

The MHVDC Connection Customer may modify its Point of Connection up to five (5) Business Days after the date of the scoping meeting to submit to MISO its modified Point of Connection.

While the detailed scope is tailored case-by-case, the collaboration typically covers, at a minimum:

- Study scope & assumptions: defined transfers/use cases (injection/withdrawal), seasonal loading, dispatch assumptions, contingency sets (including seams contingencies), and criteria.
- Modeling & data exchange: power flow, short-circuit, dynamic/EMT model needs, parameter ranges, and version control/updates.
- Analytical workplan: steady-state thermal/voltage checks, short-circuit duty, stability/EMT screening where applicable, power-quality (harmonics/flicker) screening, and Affected System coordination steps.
- Schedule & deliverables: study milestones, status checkpoints, draft/final report timing, and decision points for mitigation/operating guides.
- Change management: how material changes will be handled (e.g., restudy triggers, additional AFS participants).

4.1.1 Study Group and Affected System (AFS) Partners

MISO will identify an initial set of Affected System (AFS) partners prior to the study scope meeting based on available topology, dispatch, and modeling information. MISO reserves the right to add or remove AFS partners at any time prior to execution of the Transmission Connection Agreement (TCA) if evolving study results, model updates, project modifications, or external requests indicate material impacts outside the host Transmission Owner's footprint.

The Study Group for MHVDC connection studies shall include, but not be limited to:

- MISO Engineers and MISO MHVDC Project Manager
- Representatives from the MHVDC Developer (Connection Customer)
- Impacted MISO Transmission Owner(s)
- MISO's Affected System (AFS) Study Partners (neighboring BAs or ISO/RTOs)

These parties will collaboratively define the study scope, schedules, modelling assumptions, and data requirements for the MHVDC connection studies.

To promote comprehensive analysis and reliability, MISO reserves the right to expand the Study Group by including additional AFS partners, such as:

- Transmission Owners or system operators whose networks may experience flows or stability impacts from the MHVDC project
- Neighboring ISO/RTO representatives if the proposed configuration affects cross-border transfers
- Other Planning Coordinators whose systems may be impacted by contingency or power flow changes due to the MHVDC project
- External reliability entities or subject-matter experts (e.g., damping control specialists, dynamic stability analysts) as required

MISO may add AFS partners if any of the following emerge during the study, such as:

- New or worsened thermal/voltage/stability constraints on external facilities under N-1/N-1-1 or defined contingencies
- Short-circuit duty impacts on external buses or breakers
- Evidence of converter/IBR interactions (e.g., CDS/SSO/harmonics) affecting neighboring systems
- Topological changes, updated ratings, or dispatch/resource changes that alter transfer paths
- Regulatory or neighboring Planning Coordinator/TO requests indicating potential impact

When AFS participation changes, MISO will notify the Study Group, describe the rationale, identify any additional data needs, and update timelines as appropriate. MISO will endeavor to minimize schedule impacts while maintaining study completeness and compliance.

AFS scope, assumptions, data exchange, and milestones will be established case-by-case with the Study Group. The above criteria are guidance, not limits, and do not preclude MISO from taking additional steps necessary to ensure reliability and accuracy.

4.2 Engineering Studies

MISO will prepare a study scope document within twenty-five (25) Business Days of the scoping meeting and circulate to all members of the Study Group for review and comment. The study scope document should include the types of studies to be performed, the models to be used, and estimated study schedule. Each member of the group will have ten (10) Business Days to provide feedback to MISO.

4.2.1 Studies for MHVDC Transmission Connection Service

4.2.1.1 Study Types

The engineering reliability studies for MHVDC Transmission Connection Service may consist of any or all of the following:

- Steady State Analysis
 - Thermal Overload Analysis
 - Voltage Violation Analysis
- Dynamic Analysis
 - Root Mean Square (RMS) Stability Study
 - Electromagnetic Transient (EMT) Dynamic Study
 - Multi-infeed Interactions Screening (MISCR)
 - Converter-driven stability (CDS) Screening
 - Harmonic Performance Study
 - Sub Synchronous Oscillation (SSO) Screening
 - Temporary Over Voltage (TOV) Study
 - DC Fault Performance Study
- Other Planning Studies
 - Short Circuit Analysis
 - PV Curve (Nose Curve) Analysis

- Gen Delta P (ΔP) Analysis
 - Short Circuit Ratio Study
- Affected System (AFS) Analysis
- Transmission Owner (TO) Local Planning Criteria Analysis
- Additional studies necessary for the specific project scenario

These studies may identify Necessary Upgrades to allow the proposed MHVDC Transmission Line to reliably interconnect at the Point of Connection, and address issues associated with the Connection Facilities.

The study report will include any of the following issues that were observed because of the interconnection:

- **Thermal Overloads** – Identification of transmission elements (lines or transformers) that exceed thermal limits under normal or contingency conditions due to the injection or withdrawal profile of the HVDC project.
- **Voltage Violations** – Deviations outside acceptable voltage operating ranges at nearby buses, particularly during contingency scenarios (N-1), as influenced by MHVDC control modes and terminal location.
- **Transient or Dynamic Stability Concerns** – Instances where the MHVDC system interaction may lead to system instability, voltage recovery issues, or oscillatory behavior – especially relevant for large-scale injections or imports.
- **Short-Circuit Duty Increases** – Identification of buses where fault current levels exceed equipment ratings, protection coordination limits, or breaker interrupting capabilities because of the interconnection.
- **Temporary Overvoltage (TOV) Risks** – Detection of conditions that might produce sustained overvoltage levels due to DC-side faults or contingencies, particularly during loss of converter terminals.
- **Sub-Synchronous Resonance (SSR) or Sub-Synchronous Oscillation (SSO) Risks** – Screening-level flags raised if the HVDC terminal interacts with nearby series-compensated lines or turbine-generator systems.
- **Harmonic Distortion** – Evaluation of harmonics introduced by power electronic interfaces, particularly at the converter stations, and whether they exceed IEEE 519 or IEC 61000-3-6 thresholds.
- **Unintended Power Flow Reversals or Loop Flows** – For interregional HVDC projects, reports may include analysis of inadvertent loop flows, directional transfer congestion, or market efficiency impacts.
- **Necessary Upgrades** – Identification of specific upgrades required to mitigate the above impacts. For more detailed information about Necessary Upgrades, please refer to section 5.1.1.

4.2.1.2 References for the Study Types

The following is a list for the current available references for the studies regarding MISO MHVDC projects mentioned in the section above. The list includes corresponding NERC, CIGRE, IEEE, EPRI, and IEC standards and guidelines.

This list will be updated as newer or updated versions of the applicable standards or guidelines are available.

- **NERC Standard PRC-024-2** - “Generator Frequency and Voltage Protective Relay Settings”
- **NERC Standard PRC-029-1** – “Frequency and Voltage Ride-Through Requirements for Inverter-Based Generating Resources”
- **CIGRE TB 604** - “Benchmarking of Control Strategies for HVDC Grids”
- **CIGRE TB 671** - “Technical Requirements and Specifications of State-of-the-Art HVDC Switching Equipment”
- **CIGRE TB 832**- “Guide for electromagnetic transient studies involving VSC converters”
- **CIGRE TB 850** - “Review of Dynamic Performance of HVDC Systems”
- **CIGRE TB 909** - “Guidelines for Subsynchronous Oscillation Studies in Power Electronics Dominated Power Systems”
- **CIGRE TB 934** - “Interaction between nearby VSCHVDC converters, FACTS devices, HV power electronic devices and conventional AC equipment”
- **EPRI** - “HVDC Transmission Studies and Tools” series reports
- **EPRI** - “Integration of Large Inverter-Based Resources”
- **IEEE Std 2800** - “Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems”
- **IEEE 519: 2014** - Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- **IEC 61000-3-6: 2012** – Electromagnetic Compatibility (EMC): Limits – Assessment of Emission Limits for the Connection of Distorting Installations

4.2.1.3 Study Schedule

The following is an example study schedule, covering a period of approximately 9 months.

Please note the study schedule provided herein is intended solely as a general reference and does not constitute a binding timeline. The actual duration and sequence of study phases for each MHVDC Transmission Connection Request determined on a case-by-case basis, accounting for system conditions, study complexity, data availability, coordination needs with affected systems, and other factors.

MISO reserves the right to modify the study schedule at any point during the process based on evolving study results, stakeholder input, or unforeseen constraints. Any updates to the study schedule will be communicated in a timely manner to impacted parties and Ad-Hoc study group.

Milestone	Completion Milestone (Business Days)
Study Scope Finalized, Contract development completed, and Studies kickoff	Day 1
Model Development – Steady State, RMS Stability	Day 31
Steady State Analysis	Day 56
EMT Model Development	Day 72
RMS Stability Study	Day 77
Short Circuit Analysis	Day 92
SSO Screening Study	Day 132
EMT Dynamic Study	Day 157
Converter Driven Stability Screening	Day 162
Additional Studies (PV Analysis, Gen Delta P Analysis, Short Circuit Ratio Study)	Day 167
AFS Analysis and Results	Day 177
Draft Report	Day 192
Draft Report Review	Day 202
Final Report	Day 207

4.2.1.4 Bench Case Development & Model Building

The foundation of credible and actionable reliability analysis for MHVDC Transmission Lines lies in the careful construction of benchmark power flow cases (“bench cases”) and accurate model integration.

A. Selection of Appropriate Base Cases

- Starting Point: MISO will utilize the latest approved MISO MTEP Cases that align with the proposed MHVDC in-service date (typically 5 to 10 years out).
- System Topology: Ensure the model reflects the most up-to-date transmission topology, generator availability, and topology changes planned in the applicable time frame, including but not limited to include the topology changes for the existing TCA identified upgrades, approved LRTP tranche, etc.
- Coordination: For interregional MHVDC projects, coordinate with neighboring entities (e.g., SPP, PJM, ERCOT, TVA, AECI, etc.) to ensure a representative boundary model is used.

B. Incorporation of HVDC Project Data

For the MHVDC converter model, with detailed steady-state representation of MHVDC terminals using standard PSSE or equivalent modeling practices. This includes:

- Converter control modes (constant power, constant voltage, etc.)
- Operating limits (MW/MVAR, voltage control ranges)
- Reactive power capabilities
- Interconnection Points: Clearly represent both injection and withdrawal terminals with bus-level specificity and connectivity to the AC grid.
- Outage Modeling: Ensure contingencies include outage of HVDC terminals and impact assessments.

C. Load Flow Benchmarking

Builds a benchmark or reference case without the MHVDC project to capture baseline conditions.

- Study Case: include the MHVDC model
- Validation Metrics: Ensure bus voltages remain within acceptable thresholds (typically 0.95–1.05 pu) and branch loadings < 100% of continuous rating, unless overloads are part of a planned upgrade or mitigation strategy.

D. Model Submission and Review

Format Compliance: Submit models in the format required by MISO (e.g., *.raw, *.dyr, *.sav files), with full documentation.

- Model Validation: Include supporting spreadsheets or summaries showing validation checks (e.g., Q-V curves, MW balance, voltage profile summaries), and to ensure a representative boundary model is used.

E. Study Conditions and Sensitivities

Models multiple system stress conditions, such as:

- High renewable output scenarios
- High load and low load periods

- Planned outages or N-1 events
- Market Dispatch Variability: Incorporate different dispatch scenarios reflecting regional and interregional diversity to test the HVDC asset's behavior under varied system conditions.

F. Reporting and Documentation

Bench vs. Study Comparison: document all changes in system behavior attributable to the MHVDC project, including:

- Voltage profile shifts
- Thermal loading changes
- Upgrade Identification: If new constraints appear (e.g., overloaded lines or voltage violations), propose mitigations and identify whether upgrades fall under "Necessary Upgrades," "Interconnection Facilities," or other Tariff-defined categories

4.2.2 Injection Rights Studies

Requests for Injection Rights follow MISO's Generator Interconnection Procedures and are subject to both ERIS-level and NRIS-level evaluations per Attachment X and BPM-015 Generation Interconnection.

ERIS-level evaluation assumes full output of the proposed MHVDC Transmission Line and includes:

- Steady state (thermal and voltage)
- Short circuit / fault duty
- Stability

For NRIS-level evaluation, the study will assure the MHVDC Transmission Line output meets generation deliverability criteria given the study methodology described in Appendix C of BPM-015 Generation Interconnection.

These studies may identify additional Network Upgrades to allow the proposed MHVDC Transmission Line to connect reliably to the Transmission System and utilize its Injection Rights.

Interconnection requests associated with MHVDC Injection Rights are subject to all rules and procedures regarding MISO's neighboring entities. Network Upgrades may be required on Affected Systems and identified during the Generator Interconnection (DPP) process.

4.2.3 Transmission Service to Withdraw Energy

Requests for energy withdrawals should follow Module B of MISO's Tariff for obtaining Transmission Service. MHVDC Transmission Lines withdrawing energy do not qualify as Network Load and therefore may not utilize Network Integration Transmission Service (NITS) for such withdrawals.

See BPM-013 for more information on how to request transmission service and the processing of such requests. BPM-020 for Transmission Planning contains more information about Long-term

Transmission Service Requests and the associated system impact study, which may result in additional Network Upgrades.

4.3 MHVDC Facilities Study

The MHVDC Facilities Study identifies time and cost estimates to construct the required Connection Facilities, including any Necessary Upgrades. MISO will use reasonable efforts to complete the Facilities Study within ninety (90) Calendar Days. The MHVDC Facilities Study is typically done in two parts: the Connection Facilities study and the Necessary Upgrades study.

Within fifteen (15) Calendar Days of receiving the draft MHVDC Facility Study report, the MHVDC Connection Customer and Transmission Owner may provide written comments to MISO to be included in the final report. MISO will then issue a final MHVDC Facilities Study report within ten (10) Calendar Days of receiving comments or notification that comments will not be provided.

For MHVDC Transmission Connection Requests that include Injection Rights, additional Facility Studies will be performed in accordance with Attachment X and BPM-015 Generation Interconnection to determine the time and cost estimates to construct any additional Network Upgrades.

MISO may determine whether a Facilities Study restudy is required before the TCA is filed with FERC, in which case this will be communicated to the MHVDC Connection Customer with additional explanation and study cost estimate. The restudy might be triggered if any material changes arise that could affect the previously identified facilities, costs, schedules, or reliability outcomes, including but not limited to: (i) withdrawal of higher- or equally-queued requests; (ii) changes to transmission topology, ratings, or protection; (iii) Affected System study updates; (iv) Interconnection Customer or Connection Customer modifications (capacity, POI/POC, station configuration, controls/reactive capability, schedule); (v) modeling or criteria updates; (vi) Transmission Owner design/cost revisions; or (vii) correction of study errors. MISO will notify the Ad-Hoc Study Group of restudy initiation, scope, and any schedule impacts.

4.4 Study Payment or Refunds

MISO will charge the MHVDC Connection Customer for the actual costs of the MHVDC Connection Studies. Any difference between the study deposit (\$100,000) and the actual cost of the applicable studies will be paid or refunded as necessary. Invoices for MHVDC Connection Studies will include a detailed and itemized accounting of the cost of each MHVD Connection Study. Payments should be made within thirty (30) Calendar Days of receipt of an invoice.

5. Connection and Construction Agreements

5.1 Transmission Connection Agreement

The MHVDC Transmission Connection Agreement (Appendix 2 to Attachment GGG) will document Connection Facilities, Necessary Upgrades, the Point of Connection, and Injection Rights, if applicable. The TCA contains terms and conditions for ownership, system

interconnection, operation, maintenance, and future modifications between the MHVDC Transmission Line and the Transmission System and coordination between the relevant parties.

The Transmission Connection Agreement grants MHVDC Transmission Connection Service; it does not confer Transmission Service or Interconnection Service. The following outlines the contents of a TCA:

Article 1 – Definitions

Article 2 – Effective Date, Term, and Conditions Precedent

Article 3 – Regulatory Filings

Article 4 – Purpose and Scope

Article 5 – System Connections

Article 6 – Operations and Maintenance

Article 7 – Emergencies and Environmental Releases

Article 8 – Modifications or Operational Changes

Article 9 – Information Reporting, Access, and Audit Rights

Article 10 – Metering and Telemetry

Article 11 – Assignment

Article 12 – Force Majeure

Article 13 – Limitation of Liability, Indemnification, and Insurance

Article 14 – Default and Termination

Article 15 – Labor Relations

Article 16 – Subcontractor

Article 17 – Confidentiality

Article 18 – Dispute Resolution

Article 19 – Notices and Communication

Article 20 – Billing and Payment

Article 21 – Reliability Standards

Article 22 – Joint Operating Committee

Article 23 – Miscellaneous Provisions

Appendix A – Point of Change of Ownership and Point of Connection

Appendix B – Connection Facilities and Necessary Upgrades

When a draft TCA is first tendered, the MHVDC Connection Customer and Transmission Owner have thirty (30) Calendar Days to provide comments and complete required sections.

5.1.1 Necessary and Network Upgrades

Necessary Upgrades identified via MHVDC project studies refers to specific system enhancements directly required to mitigate reliability issues caused by the MHVDC project connecting to the Transmission System.

Necessary Upgrades are tightly scoped, addressing only impacts brought on by the MHVDC connection, such as but not limited to local voltage, short-circuit, or stability issues identified during study. These upgrades may include reactive devices, short-circuit strengthening equipment, interface controls, or other upgrades strictly attributable to the MHVDC Transmission Connection Request.

Network Upgrades may be identified while studying the project for Injection Rights via Attachment X or for long-term transmission service requests via Module B.

The Attachment GGG definitions of Network Upgrade and Necessary Upgrade are as follows:

Necessary Upgrades: The additions, modifications, and upgrades to the facilities owned by the Transmission Owner required at or beyond the point at which the Connection Facilities connect to the Transmission System to accommodate the interconnection of the MHVDC Transmission Line.

Network Upgrades: The additions, modifications, and upgrades to the facilities owned by the Transmission Owner required at or beyond the point at which the Connection Facilities connect to the Transmission System to accommodate the interconnection of the MHVDC Transmission Line and to provide any Injection Rights.

5.1.2 Balancing Authority, Regional Transmission Planning and Transmission Provider Authority

The MHVDC Transmission Line should have certifications for its Balancing Authority at least thirty (30) days prior to the Commercial Operation Date. The boundary between the MHVDC Transmission Line's Balancing Authority (BA) Area and MISO's BA Area is at the Point of Connection.

The MHVDC Connection Customer should notify MISO and the corresponding Transmission Owner of the regional transmission planning process in which it will participate and identify the entity responsible for performing the functions identified in the NERC Reliability Functional Model.

The MHVDC Connection Customer should provide transmission service on the MHVDC Transmission Line or may delegate its transmission provider responsibilities to a qualified entity.

5.2 Facilities Construction Agreement

The Facilities Construction Agreement (FCA) for MHVDC Transmission Connections is the FCA used in Appendix 8 to Attachment X of the MISO Tariff. The FCA is used when an MHVDC Transmission Connection Request causes the need for the construction of Network Upgrades on the transmission system of an Affected System.

5.3 Multi-Party Facilities Construction Agreement

The Multi-Party Facilities Construction Agreement (MPFCA) for MHVDC Transmission Connections is the MPFCA used in Appendix 9 to Attachment X of the MISO Tariff).

A MPFCA is used when multiple MHVDC Transmission Connection Requests and/or Interconnection Requests cause the need for the construction of Common Use Upgrades (CUU) on the Transmission System or the transmission system of an Affected System and share cost responsibility for such upgrades.

A separate MPFCA will be developed for a CUU on each TO's system. A CUU may consist of multiple Network Upgrades and/or System Protection Facilities. The MHVDC Connection Customer's TCA will include in Appendix B the facilities that are required and corresponding milestones that must be completed prior to commencement of service under the TCA.

6. Post-TCA Phase

6.1 Treatment in Other MISO Planning Processes

This section defines when and how a MHVDC Connection Customer's Connection Facilities with an executed Transmission Connection Agreement (TCA) is represented in MISO modeling and planning processes (e.g., MTEP, LRTP, JTIQ, and resource adequacy / economic studies), and what prerequisites govern that inclusion.

6.1.1 Modeling Status After TCA Execution

Planning Model Status: Upon TCA execution, the MHVDC Connection Customer's Connection Facilities (and any Necessary Upgrades identified in the Attachment GGG study results and/or TCA exhibits) will be modeled as a planned facility in the appropriate steady-state, stability, and short-circuit base cases for the next feasible planning case build, subject to data sufficiency and milestones below in Section 6.1.2 of this BPM.

Data Requirements: Inclusion is contingent on receipt of final/near-final electrical characteristics and ratings, POI specifics, topology, terminal controls (high-level), and in-service dates for both the MHVDC facility and all prerequisite upgrades.

Operational Assumptions: Until Injection rights are established via Attachment X and withdrawal rights are established via Module B or other Tariff provisions, as applicable, MHVDC dispatch in planning/economic models is neutral or study-specific (e.g., stress or sensitivity cases), and flows may be constrained to honor reliability limits and interim operating conditions.

6.1.2 Milestone Triggers and Timing

Trigger	What changes	When it shows up
TCA executed (with COD and upgrade ISDs identified)	Facility & Necessary Upgrades flagged as <i>Planned</i> in power flow/stability/short-circuit case builds	Next case build cycle after complete data receipt (steady state/stability/SC)
All Necessary Upgrades approved and scheduled	Network topology/ratings updated; constraints/operating guides reflected	Same as above; iterative updates as dates/ratings firm up
Module B TSRs confirmed (Withdrawal)	PROMOD/market/economic cases may model directed HVDC schedules consistent with TSR paths/limits; deliverability sensitivities updated	First economic study cycle after TSR confirmation and model inputs delivered
Limited Operations/Interim deliverability (if/when Tariff allows)	QOL/AERIS/AID limits reflected in operating guides and sensitivities	First cycle after notice and study artifacts are available
Commercial Operation (COD)	Model status converts from Planned → In-Service; base cases and limits updated	Next routine model refresh after COD confirmation

6.1.3 Process-Specific Treatment

The post-TCA modeling treatments and study integrations described in Section 6.1.3 (including, without limitation, assumptions for inclusion in MTEP/LRTP/JTIQ/ERAS cases, model status transitions, and any associated operating conditions) are effective only to the extent consistent with, and subject to, the MISO Tariff as accepted by FERC. If any provision of Section 6.1.3 is determined to be inconsistent with the MISO Tariff, or if FERC issues an order (including on complaint) that establishes different requirements or processes, the MISO Tariff and applicable FERC order(s) shall control. MISO will update this BPM to align with any such determinations and will communicate material changes through the established stakeholder notice process.

MISO recognizes that certain issues relating to merchant transmission treatment in planning models are the subject of pending or potential FERC proceedings. Any process descriptions herein are non-precedential and do not create or confer rights beyond those provided under the MISO Tariff. Where a BPM step references a filing or a Tariff change (e.g., Limited Operations provisions, modeling status, or case inclusion criteria), the step is effective only upon FERC acceptance of the relevant Tariff provisions and on the effective date specified in the FERC order.

Until any Tariff changes become effective, MISO will

- (i) apply the current Tariff and applicable planning/modeling practices,
- (ii) implement reasonable interim operating or modeling conditions (e.g., case annotations, caps, or status flags) necessary to maintain reliability and transparency, and
- (iii) adjust study schedules or assumptions as needed to reflect FERC-directed outcomes.

Nothing in this BPM obligates MISO to include a facility in any planning model or case prior to satisfying Tariff-specified criteria or FERC-directed conditions.

6.1.3.1 MISO Transmission Expansion Plan (MTEP)

- **Representation:** The HVDC facility and its Necessary Upgrades appear as Planned elements once the TCA is executed and minimum data are provided.
- **Use:** Included in reliability analyses (thermal/voltage/stability) and in economic/benefit screenings where applicable. Where Module B TSRs are not yet established, HVDC flows are handled via neutral or bounded sensitivities.

6.1.3.2 Long-Range Transmission Planning (LRTP)

- **Representation:** LRTP scenario builds incorporate the MHVDC facility when the TCA is executed and the project is credible within the LRTP horizon.
- **Use:** Treated as exogenous infrastructure; flows may be scenario-directed (e.g., stress transfer, diversity exchange) or bounded by study assumptions until TSRs are set.

6.1.3.3 Joint-Targeted Interconnection Queue (JTIQ) / Interregional Planning

- **Eligibility:** If the MHVDC project participates in interregional coordination or affects seams flows, it will be coordinated with neighboring RTOs/PCs.
- **Use:** Modeled to the extent needed to reflect cross-border transfer impacts; dispatch assumptions harmonized with partner region processes and any interim operating conditions.

6.1.3.4 Resource Adequacy / Economic & ERAS-type Studies

- **Capacity/RA:** HVDC itself does not receive capacity accreditation; underlying resources connected via HVDC are treated per RA rules.

- **Economic/Production Cost (PROMOD) Studies:** Once TSRs for Withdrawal are established (or an approved interim framework applies), HVDC schedules/limits are reflected in production cost modeling; absent that, HVDC is modeled via neutral or policy-defined transfers in sensitivities.

6.1.4 Dependencies & Caveats

- **Data Completeness.** MISO may defer or limit representation if modeling data are incomplete or materially uncertain (e.g., converter ratings, control modes, terminal impedance, updated ISDs).
- **AFS Coordination.** Where affected-system coordination is required, MISO may condition inclusion on receipt of external approvals or aligned assumptions.
- **Non-Selection for Cost Sharing.** Merchant HVDC inclusion in models does not imply MTEP/LRTP selection or cost allocation; it is modeled for system accuracy only.

6.2 MHVDC Joint Operating Committee

Per Article 22 of the TCA, a Joint Operating Committee comprised of MISO, the Transmission Owner, and the MHVDC Connection Customer should be established at least 120 Calendar Days prior to the MHVDC Transmission Line's Initial Synchronization Date. The purpose of this group is to coordinate operating and technical considerations of the connection provided for in the TCA, including the following:

- Assess readiness of the Connection Facilities to be placed in service per the schedule
- Establish data requirements and operating record requirements
- Review the requirements, standards, and procedures for data acquisition equipment, protective equipment, etc.
- Review the annual forecast of maintenance and planned outage schedules of the Connection Facilities
- Coordinate the scheduling of maintenance and planned outages on the Connection Facilities or other facilities that impact normal operation of the connection
- Ensure information is provided by all relevant Parties and posted on OASIS

6.3 Energization and Real Time Operations

Prior to commencing Trial Operations, the MHVDC Transmission Line and Connection Facilities should be represented in MISO's Network Model and adhere to all relevant MISO Reliability Operating Procedures. MISO uses these to ensure real-time operating reliability of the interconnected bulk electric system as a Reliability Coordinator (RC).

6.3.1 Network & ICCP Modeling

All required model changes should be submitted to MISO at least 150 days prior to Trial Operations, including Inter-Control Center Protocol (ICCP) information associated with

telemetry equipment specified in Appendix D of the TCA, according to the processes outlined in BPM-010 for Network and Commercial Models and the MISO Reliability Data Specification (RTO-SPEC-006). The latter is required to satisfy NERC reliability standards IRO-010-2 and TOP-003-3. More details about metering requirements are included in section 6.5 below.

6.3.2 Commissioning of Transmission

MISO Operating Procedure SO-P-NOP-00-446 guides the Commission and Decommission of Transmission and Generation Facilities and applies to any new MHVDC Transmission Lines connecting to the Transmission System. To summarize, a Transmission Operator should contact the MISO Reliability Coordinator prior to placing any facilities in service, implementing topology changes, or making any changes to inter-BA tie lines. All test plans should be coordinated and approved with MISO Operations.

6.5 Metering & Telemetry Requirements for MHVDC Facilities

The following requirements apply to Merchant HVDC (MHVDC) facilities upon execution of the Transmission Connection Agreement (TCA). They govern revenue-quality metering, operational telemetry, and performance monitoring at each MISO point of Connection (POC), and at other locations as designated in the TCA or operating guides.

The requirements are contingent and will be changed based on the latest NERC and/or FERC filing and decisions, and latest MISO Tariff Language. Currently the main reference of these requirements is based on the NERC BAL-005 and IEEE C37.118.

6.5.1 Revenue-quality metering (settlements meter)

Accuracy class: Meters shall be ANSI C12.20 revenue class 0.2% or better (or IEC equivalent), including CT/PT accuracy to meet composite error requirements over the full operating range.

Quantities: Bi-directional, four-quadrant measurement of MW, MWh, MVar, MVarh, voltage, current, and power factor at each POI/terminal as specified in the TCA.

Time sync: Meters synchronized to UTC via GPS/IRIG-B or PTP; interval data time-stamped to ISO market granularity and traceable to UTC for settlement. MISO could refer to the CAISO practice requires "Revenue Quality Meter Data" to ISO systems

6.5.2 Operational telemetry & control (real-time)

SCADA/ICCP: Continuous telemetry to MISO control centers and applicable TO/TOPs for MW/MVar, bus voltages, currents, status (breaker/valve/converter), available capability, pole status, alarms) and HVDC control mode. Update rates consistent with real-time market/EMS requirements (e.g., 2–6 seconds typical).

Reliability standards: Telemetry supporting ACE and interchange accounting must meet NERC BAL-005 availability and accuracy (e.g., frequency metering 99.95% availability, 0.001 Hz resolution) and redundancy expectations.

PMU (phasor) data (recommended): Install PMUs per IEEE C37.118 at each HVDC terminal bus for wide-area monitoring, oscillation detection, and post-event analysis; stream to MISO as specified in the telemetry specifications.

6.5.3 Intertie/DC-tie precedents and special cases

For DC ties, MISO will apply equivalent expectations as ERCOT and CAISO for MHVDC terminals interfacing external BAs/RTOs (e.g., dedicated intertie meters, tagged schedule telemetry, and controls/limits exposed to operators).

7. Glossary of Terms

Commercial Operation Date: The date on which the MHVDC Transmission Line has commenced transmitting electricity for sale, following completion of any Trial Operations period. OR: The date on which the MHVDC Transmission Line starts operating in a manner consistent with its Transmission Connection Agreement, and after all required testing, commissioning, and documentation (e.g., Trial Operation, meter and control validation) have been completed.

Common Use Upgrade: A Network Upgrade or any other classified addition, alteration, or improvement on the Transmission System or the transmission system of an Affected System that is needed for the interconnection of multiple MHVDC Connection Customers' and/or Interconnection Customers' facilities, and which is their shared responsibility. CUUs are not classified under Attachment FF of the Tariff as a Baseline Reliability Project, Market Efficiency Project, or Multi-Value Project.

Connection Facilities: All facilities and equipment between the MHVDC Transmission Line and the Point of Connection, including any modification, additions or upgrades that are necessary to physically interconnect the MHVDC Transmission Line to the Transmission System. Connection Facilities are sole use facilities. MHVDC Connection Customer's Connection Facilities are between the MHVDC Transmission Line and the Point of Change of Ownership; Transmission Owner Connection Facilities are between the Point of Change of Ownership and the Point of Connection to the Transmission System.

Facilities Construction Agreement (FCA): The form of facilities construction agreement set forth in Appendix 8 to Attachment X of the Tariff. The FCA is used when an MHVDC Connection Customer causes the need for the construction of Network Upgrades on the Transmission System or an Affected System.

Initial Synchronization Date: The date upon which the Connection Facilities (both the customer's and TO's) are synchronized with the Transmission System and upon which Trial Operation begins.



Injection Rights: MISO's pre-certification of the Transmission System's capability to receive capacity and energy from the MHVDC Transmission Line at the requested Point of Connection, specified in MW quantity.

In-Service Date: The date upon which the MHVDC Connection Customer reasonably expects it will be ready to begin use of the Transmission Owner's Connection Facilities.

MHVDC Connection Customer: Any entity that proposes to interconnect an MHVDC Transmission Line with the Transmission System.

MHVDC Connection Customer's Connection Facilities: All facilities and equipment, as identified in Appendix B of the TCA, that are located between the MHVDC Transmission Line and the Point of Change of Ownership.

MHVDC Connection Studies: MHVDC Facility Studies and all other studies required for determining MHVDC Transmission Connection Service.

MHVDC Transmission Connection Service: The MHVDC Connection Customer's right to physically interconnect an MHVDC Transmission Line to the Transmission System.

MHVDC Transmission Line: A merchant high-voltage direct current (HVDC) transmission line external to, and proposed for connection to, the Transmission System.

Necessary Upgrades: The additions, modifications, and upgrades to the facilities owned by the Transmission Owner required at or beyond the point at which the Connection Facilities connect to the Transmission System to accommodate the interconnection of the MHVDC Transmission Line.

Network Upgrades: The additions, modifications, and upgrades to the facilities owned by the Transmission Owner required at or beyond the point at which the Connection Facilities connect to the Transmission System to accommodate the interconnection of the MHVDC Transmission Line and to provide any Injection Rights.

Point of Change of Ownership: The point where the MHVDC Connection Customer's Connection Facilities connect to the Transmission Owner's Connection Facilities, as set forth in Appendix A of the Transmission Connection Agreement.

Point of Connection: The point where the Connection Facilities connect to the Transmission System, as set forth in Appendix A of the Transmission Connection Agreement.

Transmission Owner's Connection Facilities: All facilities and equipment owned by the TO from the Point of Change of Ownership to the Point of Connection, as identified in Appendix B of the TCA.

Transmission System: The facilities owned by the Transmission Owner and controlled or operated by MISO or the Transmission Owner that are used to provide transmission service or Wholesale Distribution Service under the Tariff, as defined in Module A.



8. Appendix

8.1 Appendix A – MHVDC Project Ad Hoc Information Session Request

I. Interconnection Customer

Name:

Title:

Company:

Address:

Phone:

Email:

II. Project Details

MHVDC Project Name:

Size (MW):

Desired COD:

Desired ISD:

Request type:

- ☐ Injection to MISO
- ☐ Withdrawn from MISO
- ☐ Both Injection to MISO and Withdraw from MISO
- ☐ Undecided

III. Site Information

State:

County:



Area Transmission Owner(s):

Point of Connection:

(If not identified, list all options that are being considered)

Distance from the nearest substation or transmission line:

Available Connection Voltage(s):

Site Control: ☐ Yes ☐ Not yet

ROW Required for Interconnection Facilities? ☐ Yes ☐ No

IV. Specific Questions for the Transmission Provider/Transmission Owner (use a separate sheet, if required)

1.

2.

3.

4.

This form can be emailed to help@misoenergy.org or physically mailed to the following address:

Midcontinent Independent System Operator, Inc.

Attn: MHVDC Transmission Access Planning

720 City Center Drive

Carmel, IN 46032-3826