

PJM Manual 14B:

PJM Region Transmission Planning Process

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Prepared by
Transmission Planning Department

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Current Revision

Revision 41 (04/19/2018):

- Cover to Cover Periodic Review
- Updated Section 1.3 and Attachment H.1 per NERC MOD requirement standard numbering
- Updated Section 2.3.8 bullet formatting
- Updated Section 2.3.13 by removing language regarding winter temperature ratings sets
- Updated Attachment C.5.3.3 to add OVEC to study area definitions
- Updated Attachment C.7.3 to reference low side of transformer in generator deliverability procedures
- Updated Attachment D.2.2 to correct references to contingency types in table 2 and step 3



Section 1: Process Overview

In this section you will find an overview of PJM's transmission planning process that culminates in the Regional Transmission Expansion Plan (RTEP). This process (referred to in this Manual interchangeably as the RTEP process or more generically as the PJM Region transmission planning process) is one of the primary functions of Regional Transmission Organizations (RTOs.) As such, PJM implements this function in accordance with the Regional Transmission Expansion Planning Protocol set forth in Schedule 6 of the PJM Operating Agreement.

As further described in following portions of this manual, the PJM RTEP process consists of baseline reliability reviews as well as analysis to identify the transmission needs associated with generation interconnection and merchant transmission interconnection. PJM implements the planning of interconnections as part of the broader RTEP process pursuant to the PJM Open Access Transmission Tariff (OATT.) The relationship between Interconnection planning and the RTEP is discussed in later sections of this manual and in related manuals.

1.1 Planning Process Work Flow

The Manual 14 series provides information regarding PJM's Planning Process to complement Schedule 6 of the PJM Operating Agreement and the planning provisions of the PJM Open Access Transmission Tariff (OATT.) These agreements can be found on-line at <http://www.pjm.com/media/documents/merged-tariffs/oatt.pdf>.

The PJM planning process activities, culminating in PJM's annual Regional Transmission Expansion Plan, constitute PJM's single, Order No. 890 compliant, transmission planning process. All PJM Open Access Transmission Tariff (OATT) facilities are planned through and included in this open, fully participatory, and transparent process.

PJM planning implements a cycle centered ~~around~~-on activities ~~of-related to~~ PJM's Planning and Market Simulation functions and their interactions with members, regulatory bodies, and other interested parties primarily through the PJM Transmission Expansion Advisory Committee (TEAC), the Subregional RTEP Committees, and the PJM Planning Committee (PC) forums.

Currently, the planning cycle will refer to an 18-month overlapping cycle beginning in September of the prior calendar year and extending to the February of the following calendar year. A new cycle will begin every September, which will overlap the previous cycle (Refer to Exhibit 1). This ongoing process has continued to evolve since 1997, when PJM's Regional Transmission Expansion Planning (RTEP) Protocol (codified in Schedule 6 of PJM's Operating Agreement) was approved by the Federal Energy Regulatory Commission. Since that time, the process has been expanded and enhanced in response to member and regulatory input as documented in the revisions to the OATT, PJM Manual 14 series, and the Operating Agreement Schedule 6. The current PJM Region transmission planning process includes ample opportunity for Stakeholder input through frequent oral and written exchange of information and reviews via the TEAC organizational structure. The process culminates in PJM's presentation of the RTEP for approval by the PJM Board of Managers.

There are four planning paths that ultimately culminate in the PJM RTEP. Facilities in each path allow the opportunity for early, full and transparent participation by interested PJM stakeholders. The four paths are reliability planning, economic planning, interconnection planning, and local planning ([which includes both Supplemental Projects and FERC Form 715 Projects](#)).



Reliability and economic planning facilities are produced from PJM's planning cycle activities described in this manual, Operating Agreement Schedule 6, and portrayed in Exhibit 1. PJM leads this analysis and development of upgrades related to reliability and market efficiency planning for all facilities 100 kV and above. These facilities are designated as Bulk Electric System (BES) facilities and are subject to the NERC requirements and criteria for such facilities. The PJM analyses ensure compliance with NERC, PJM and regional criteria. In addition, the PJM led analyses also include analysis and upgrade of transmission facilities with nominal voltages below 100kV to the extent they are under PJM's operational control (see <http://www.pjm.com/markets-and-operations/ops-analysis/transmission-facilities.aspx>). The TEAC, Subregional RTEP Committees, and stakeholder opportunities to engage in the PJM planning process are described in this manual.

The analysis of OATT transmission facilities below 100kV ~~and that are~~ not under PJM's operational control is led by the PJM Transmission Owners (TOs) as detailed in the OATT, Attachment M-3. This is appropriate since local Transmission Owner operations, maintenance and planning personnel oversee these local systems. These facilities typically provide only local transmission function of interest to the customers in the nearby electrical vicinity. The TO analysis ensures local facilities meet NERC and local reliability criteria. In addition, the local Transmission Owner personnel may also develop recommended modifications to transmission facilities that are not required by PJM reliability, market efficiency or operational performance criteria (~~the non-criteria based upgrades are called~~ Supplemental RTEP Projects). The Transmission Owner ~~will initiate~~ all reliability-based and supplemental upgrade requests for facilities not under PJM's control. All such projects will be introduced to the PJM ~~Regional-planning~~RTEP process through PJM's TEAC and Subregional RTEP Committees. In this way these TO initiated projects will be subject to the same open, transparent and participatory PJM committee activities as PJM initiated projects (see discussion of TEAC and Subregional RTEP Committee.)

Interconnection planning encompasses generator and merchant transmission requests for Interconnections and rerates as well as requests for long-term firm transmission service. Studies of these transmission requests and any resulting transmission modifications are posted to PJM's website in the project queue area (<http://www.pjm.com/planning/generation-interconnection.aspx>). In addition, any necessary facility modifications are brought to the TEAC for presentation and stakeholder participation. Interconnection planning is discussed in more detail in Manual 14A.

1.2 TEAC and Subregional RTEP Committee and Related Activities

The PJM TEAC functions in accordance with its established charter and provisions of Schedule 6 of the Operating Agreement. Additionally, in 2008 PJM began to facilitate more localized planning functions through the Subregional RTEP Committee. With the exception of those projects subject to OATT, Attachment M-3, ~~The~~ the Subregional RTEP Committees, including any local reviews that may be initiated, will follow TEAC procedures and other applicable PJM committee procedures. All PJM stakeholders will be provided with the opportunity for participation in the TEAC and Subregional RTEP Committees and related activities.

The ~~subregional~~Subregional RTEP Committees and any related meetings allow more focused and meaningful stakeholder participation and attention to subregional and local transmission issues. RTEP projects are labeled as Regional RTEP Projects and Subregional RTEP Projects,



as defined in the Operating Agreement, to make an initial categorization and posting of violations and upgrades that



will enable stakeholders to more easily sort through and review issues of interest. Regional RTEP Projects are those transmission expansions or enhancements rated at voltages 230 kV and above. Subregional RTEP Projects are those rated below 230 kV. This differentiation by voltage between Regional RTEP Projects and Subregional RTEP Projects is made only for administrative convenience.

The Subregional RTEP Committee is responsible for the initial review of Subregional RTEP Projects. PJM will facilitate meetings as necessary for TEAC and Subregional RTEP Committee review and evaluation of reliability and market efficiency reinforcements. The Subregional RTEP Committee will forward all Subregional RTEP Projects to the TEAC. TEAC or the Subregional RTEP Committee, as appropriate will also have the opportunity to provide advice and recommendations regarding the study scope, assumptions and procedures at an initial assumptions setting meeting. This meeting will cover both reliability and market efficiency assumptions, as appropriate. Initially, a minimum of three PJM RTEP subregions will be established: one each for the Mid Atlantic, South, and West subregions of PJM. When a Subregional RTEP Committee meeting is scheduled it is understood that this generally will be implemented as a separate meeting for each subregion. In this way, the TEAC and Subregional RTEP Committees provide a transparent and participatory planning process throughout the RTEP development, from early assumptions-setting stages, through discussion of criteria violations, review of recommendations for alternative solutions, and review and comment on the final RTEP facilities.

All RTO stakeholders can participate in any or all subregional activities on a voluntary basis, with one exception. The Transmission Owners that comprise each of the various subregions must participate in the subregional meeting that includes their area. PJM, with stakeholder input, may initiate additional subregional or local review as may be necessary or beneficial. Local meetings or more localized review occurs in the event that PJM, taking into account stakeholder input, decides that it is appropriate to address issues in a forum other than or in addition to the context of one of the initial subregions. In addition to their participation in the TEAC and Subregional RTEP Committee meetings, stakeholders can also provide written comments on the development of the RTEP. Written comments can be forwarded to RTEP@pjm.com.

There are various categories of facilities that enter the PJM plan through distinct paths, however, each path is transparent and open to all interested stakeholder participation through TEAC and Subregional RTEP Committee processes. All four planning paths to the PJM RTEP; [.i.e., reliability planning, economic planning, interconnection planning, and PJM TO local planning \(including Supplemental Projects and FERC Form 715 Projects\)](#), [Local Transmission Owner Planning](#), [M-3 planning](#); [flow through the TEAC and Subregional RTEP Committee planning process.](#)

PJM Committee [\(TEAC and SR RTEP Subregional Committees\)](#) review of all RTEP projects, regardless of the path of origin of the project, will occur during the February through August RTEP Stakeholder analysis and review periods

(see Exhibit 1.) Stakeholders will be provided all the information necessary for full participation in the discussions and evaluations, including: (1) the criteria and assumptions used as the basis for projects, (2) the procedure to access the study information necessary to participate in the project's evaluation and discussion, (3) a detailed description of the timing, need and justification of the project, (4) a description of the cost and construction responsibility for the project, and (5) a detailed description of the proposed modifications to facilities.

[In addition, projects that originate through local Transmission Owner planning will be posted on](#)



the PJM web site. This site will include all currently planned transmission owner ~~RTEP~~-projects (including both newly planned Supplemental ~~AM-3 RTEP-p~~ Projects and [historical](#) Transmission Owner Initiated



projects from past RTEP cycles that are yet to be placed in-service.) This website will provide tracking information about the status of listed projects and planned in-service dates. It will also include information regarding criteria, assumptions and availability of study cases related to local planning.

1.3 Planning Assumptions and Model Development

1.3.1 Reliability Planning

PJM's planning analyses are based on a consistent set of fundamental assumptions regarding load, generation and transmission built into power flow models. Load assumptions are based on the annual PJM entity load forecast independently developed by PJM (found at <http://www.pjm.com/planning/resource-adequacy-planning/load-forecast-dev-process.aspx>.) **This forecast includes** the basis for all load level assumptions for planning analyses throughout the 15 year planning horizon. Generation and transmission planning assumptions are embodied in the base case power flow models developed annually by PJM and derived from the Eastern Reliability Assessment Group processes and procedures pursuant to NERC standard MOD-032. As necessary, PJM updates those models with the most recent data available for its own regional studies. All PJM base power flow and related information are available pursuant to applicable Critical Energy Infrastructure Information, Non-Disclosure and OATT-related requirements (accessible via <http://www.pjm.com/planning/rtep-development/powerflow-cases.aspx> or by contacting the PJM Planning Committee contacts.) Each type of RTEP analysis (e.g., load deliverability, generator deliverability etc.) encompasses its own methodological assumptions as further described throughout the rest of this Manual. Additional details regarding the reliability planning criteria, assumptions, and methods can be found in following sections and this manual's Attachments.

Attachment J contains the checklist for the new equipment energization process to be utilized by Transmission Owners and Designated Entities from inception to energization of upgrade projects.

1.3.2 Market Efficiency Planning

PJM will perform a market efficiency analysis each year, following the completion of the near-term reliability plan for the region. PJM's market efficiency planning analyses will utilize many of the same starting assumptions applicable to the reliability planning phase of the RTEP development. In addition, key market efficiency input assumptions, used in the projection of future market inefficiencies; include load and energy forecasts for each PJM zone, fuel costs and emissions costs, expected levels of potential new generation and generation retirements and expected levels of demand response. PJM will input its study assumptions into a commercially available market simulation data model that is available to all stakeholders. The data model contains a detailed representation of the Eastern Interconnection power system generation, transmission and load. In addition, the market efficiency analysis of the cost/benefit of potential market efficiency upgrades will also include the discount rate and annual revenue requirement rate. The discount rate is used to determine the present value of the enhancements' annual benefits and annual cost. The annual revenue requirement rate is used to determine the enhancements' annual cost. PJM will finalize the market efficiency analysis input assumptions soon after the development of the PJM load forecast that is generally available approximately in late January. Prior to finalizing, PJM will review the proposed assumptions at the PJM Transmission Expansion Advisory Committee. This review will provide the opportunity for stakeholder review of and input to all of the key assumptions that form



the basis of the market efficiency analysis. In this way, PJM will facilitate a comprehensive stakeholder review and input regarding RTEP study assumptions. All final assumptions and analysis parameters will be presented to the TEAC for discussion and review and to the PJM Board for consideration.

1.3.3 End-of-Life Facility Planning

The ~~Transmission~~ Transmission Owner's process specific to End-of-Life (EOL) facilities may be memorialized as criteria under the Operating Agreement, Schedule 6, in its FERC Form 715 or under OATT, Attachment M-3 individually through its local planning criteria.

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1.4 RTEP Process Key Components

PJM's goal is to ensure electric supply adequacy and to enhance the robustness of energy and capacity markets. Achieving these objectives requires the successful completion of PJM's planning, facility construction and operational and market infrastructure requirements.

Key components of PJM's 15-year transmission planning process discussed in this Manual include:

1. Baseline reliability analyses:

The PJM Transmission System ("PJM System") provides the means for delivering the output of interconnected generators to the load centers in the PJM energy and capacity markets. Baseline reliability analyses ensure the security and adequacy of the Transmission System to serve all existing and projected long term firm transmission use including existing and projected native load growth as well as long term firm transmission service. RTEP baseline analyses include system voltage and thermal analysis, and stability, load deliverability, and generation deliverability testing. These tests variously entail single and multiple contingency testing for violations of established NERC reliability criteria regarding stability, thermal line loadings and voltage limits. Baseline reliability analyses are discussed in more detail in Section 2 and Attachment C.

2. Generation and transmission interconnection analyses:

All entities requesting interconnection of a generating facility (including increases to the capacity of an existing generating unit) or requesting interconnection of a merchant transmission facility within the PJM RTO must do so within PJM's defined interconnection process. In addition to the baseline analyses discussed above, as resources or merchant transmission requests interconnection, deliverability in the local area of the request is restudied and updated. The generation and transmission interconnection process and deliverability testing procedures are discussed in Attachment C and Manual 14A. The evaluation of generation and merchant transmission interconnection requests is codified in the PJM Open Access Transmission Tariff (available on the PJM Web site at <http://www.pjm.com/>).

3. Market efficiency analyses:

In addition to reliability based analyses PJM also evaluates the economic merit of proposed transmission enhancements. These analyses focus on the economic impacts of security constraints on production cost, congestion charges to load and other economic measures of market impacts. PJM's market efficiency analyses are



discussed in Section 2 of this Manual and Attachment E. PJM development of economic transmission enhancements is also codified under Schedule 6 of the PJM Operating Agreement.



4. Operational performance issue reviews and accompanying analyses:

Maintaining a safe and reliable Transmission System also requires keeping the transmission system equipment in safe, reliable operating condition as well as addressing actual operational needs. On an ongoing basis, PJM operating and planning personnel assess the PJM transmission development needs based on recent actual operations. This may lead to special studies or programs to address actual system conditions that may not be evident through projections and system modeling.

To ensure that system facilities are maintained and operated to acceptable reliability performance levels, PJM has implemented an Aging Infrastructure Initiative to evaluate appropriate spare transformer levels and optimum equipment replacement or upgrade requirements. This initiative, based on a Probability Risk Assessment (PRA) process, is intended to result in a proactive, PJM-wide approach to assess the risk of facility failures and to mitigate operational and market impacts. Section 2 of this manual provides further discussion of the PRA process.

5. End-of-Life Analyses

Maintaining the Transmission System also requires a transparent and replicable process for determining that a transmission facility should be replaced or subject to other capital improvement in accordance with good utility practice due to End-of-Life (EOL) issues. The RTEP process shall incorporate TO planned Form 715 and Supplemental Projects in a manner that supports transparency and cost effective regional planning.

5.6. The final RTEP Plan:

Based on all of the requirements for firm transmission service on the PJM System, PJM annually develops a Regional Transmission Expansion Plan to meet those requirements on a reliable, economic system development and environmentally acceptable basis. Furthermore, by virtue of its regional scope, the RTEP process assures coordination of expansion plans across multiple transmission owners' systems, permitting the identification of the most effective and efficient expansion plan for the region. The RTEP plan developed through this process is reviewed by PJM's independent Board of Managers who has the final authority for plan's approval and implementation. The following Section 2 describes the PJM RTEP Process analysis.

1.5 Planning Criteria

1.5.1 Reliability Planning

Stakeholders have the opportunity at a national level through the participatory standards development process of the North American Electric Reliability Corporation (NERC) to influence the industry planning criteria that form the basis of PJM's planning process (found at <http://www.nerc.com/Pages/default.aspx>.) NERC regional criteria development, applicable to PJM, is also open to stakeholder input through the open and participatory process of ReliabilityFirst Corporation (found at <https://www.rfirst.org/standards/Pages/StandardsDocuments.aspx>.)

Additionally, regional and local criteria that go beyond and complement the NERC obligations can be created and incorporated into PJM planning through participation in PJM's Planning Committee and other related stakeholder processes (please refer to <http://pjm.com/committees-and-groups/committees.aspx>.) In this manner, PJM, as the independent planning authority,



avails stakeholders full opportunity to participate in the planning process from assumptions setting to the final plan. The PJM annual regional plan is based on the effective criteria in place at the time of the analyses, including applicable standards and criteria of the NERC and the applicable regional reliability [council-corporations](#), the various Nuclear Plant Licensees' Final Safety Analysis

¹ The ReliabilityFirst Regional Reliability Corporation (RRC) for the PJM Mid-Atlantic and Western Regions (which replaced the former ECAR, MAAC and MAIN RRCs on January



Report grid requirements and the PJM and local Reliability Planning Criteria (Attachment D.) Section 2 details the specific criteria applicable to each transmission planning process study phase. Criteria are comparably applicable to all similarly situated Native Load Customers and other Transmission Customers.

1.5.2 Market Efficiency Planning

Market efficiency planning is an evaluation process that results in facilities planned to achieve economic efficiencies rather than an analysis that produces violations measured against criteria. This process compares alternative plans' cost effectiveness in improving transmission efficiency and produces RTEP recommendations from this process. The metrics of economic inefficiency include historic and projected congestion. The measures of historic congestion are gross congestion, unhedgeable congestion, and pro-ration of auction revenue rights. The measure of projected congestion is based on a market analysis of future system conditions performed with a commercially available security constrained, economic dispatch market analysis tool. This market analysis results in future projections of the congestion and its binding constraint drivers. These congestion measures are posted and available to stakeholders by binding constraint and form the basis for PJM and stakeholder development of remedies. Transmission plans from the reliability analysis or a new plan presented that economically relieves historical or projected congestion are candidates for market efficiency solutions. The successful candidates will be those facilities that pass PJM's threshold test and bright line economic efficiency test. This test specifies that a proposed solution's savings must exceed its projected revenue requirements, on a 15 year present worth basis, by at least 25% (the threshold cost/benefit test). Each of this process' elements, its underlying assumptions and its methods is described in more detail in the accompanying sections of this manual 14B and in Attachment E.

1.5.3 EOL Planning

The EOL decision making process is driven by each PJM TO transmission Owner and memorialized through either a PJM TO transmission Owner's FERC Form 715 criteria under the Operating Agreement, Schedule 6 or individual transmission owner local planning criteria under OATT, Attachment M-3. Such EOL criteria should include articulable objectives that are measurable and replicable and, to the extent available, quantifiable (e.g., asset replacement prioritization schedule). Such criteria should be provided by each TO to PJM for posting 30 days in advance of the assumptions meeting for the applicable RTEP cycle.



Section 2: Regional Transmission Expansion Plan Process

In this section you will find an overview of the PJM Region transmission planning process covering the following areas:

- Components of PJM's 15-Year planning
- The need and drivers for a regional transmission expansion plan
- Reliability planning overview
- Specific components of reliability planning and the Stakeholder process
- Interconnection request drivers of RTEP
- Cost responsibility for reliability related upgrades
- Market efficiency planning review
- Specific components of market efficiency planning and the Stakeholder process.
- Operational performance driven planning
- Specific components of operational performance driven planning

2.1 Transmission Planning = Reliability Planning + Market Efficiency + Public Policy + EOL

Effective with the 2006 RTEP, PJM, after stakeholder review and input, expanded its RTEP Process to extend the horizon for consideration of expansion or enhancement projects to fifteen years. This enables planning to anticipate longer lead-time transmission needs on a timely basis.

Fundamentally, the Baseline reliability analysis underlies all planning analyses and recommendations. On this foundation, PJM's annual 15-year planning review now yields a regional plan that encompasses the following:

1. Baseline reliability upgrades, discussed in this Section 2;
2. Generation and transmission interconnection upgrades, discussed in Attachment B of this manual and Attachment B of Manual 14A.
3. Market efficiency driven upgrades, discussed in this Section 2.
4. Operational performance issue driven upgrades, discussed in this Section 2.

5. Public Policy Requirements based elements via State Agreement Approach.

~~5.6. EOL Local Area Planning discussed in this section 2, provided that the should includes any TO should TO should identification by each PJM TO any EOL projects, to the extent known, five years forward.~~

2.8 Evaluation of EOL Issues

For each EOL project, dependent on the TO's process and to the extent available, each PJM TO should: (i) identify the owner of the asset(s); and (ii) provide an asset-specific condition assessment (e.g., assessments, photographs, etc.) that supports the need and proposed

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solution for the EOL replacement facility or capital improvement consistent with the TO's criteria.