PJM Planning Center: Gen Model User Guide

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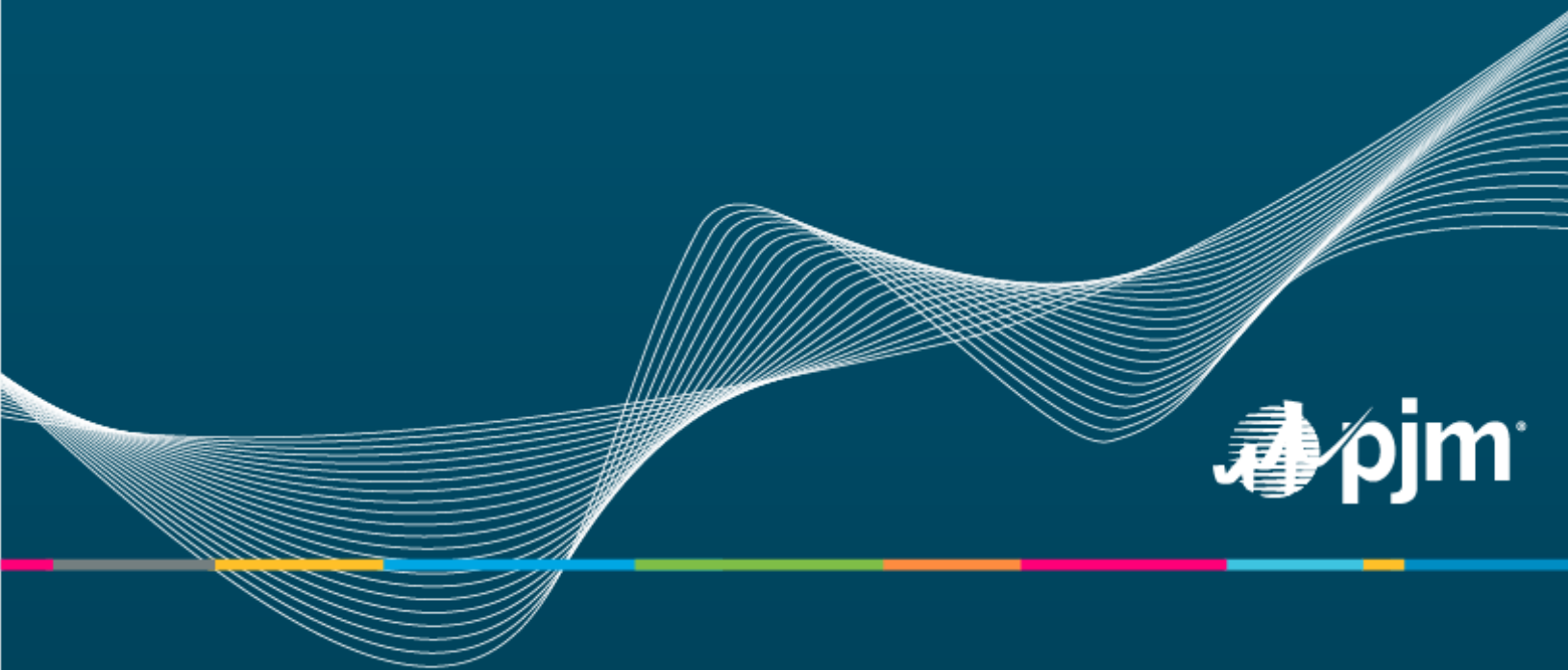

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Introduction

The PJM User Guide will provide instructions for requesting access, instructions on how to use the application, and helpful tips for the PJM internet application, **Planning Center: Gen Model**.

PJM Planning Center: Gen Model is an application that allows users to submit generator data for model builds on the planning horizon in order to support NERC MOD-032, TPL-007, and PRC-024 compliance.

Intended Audience

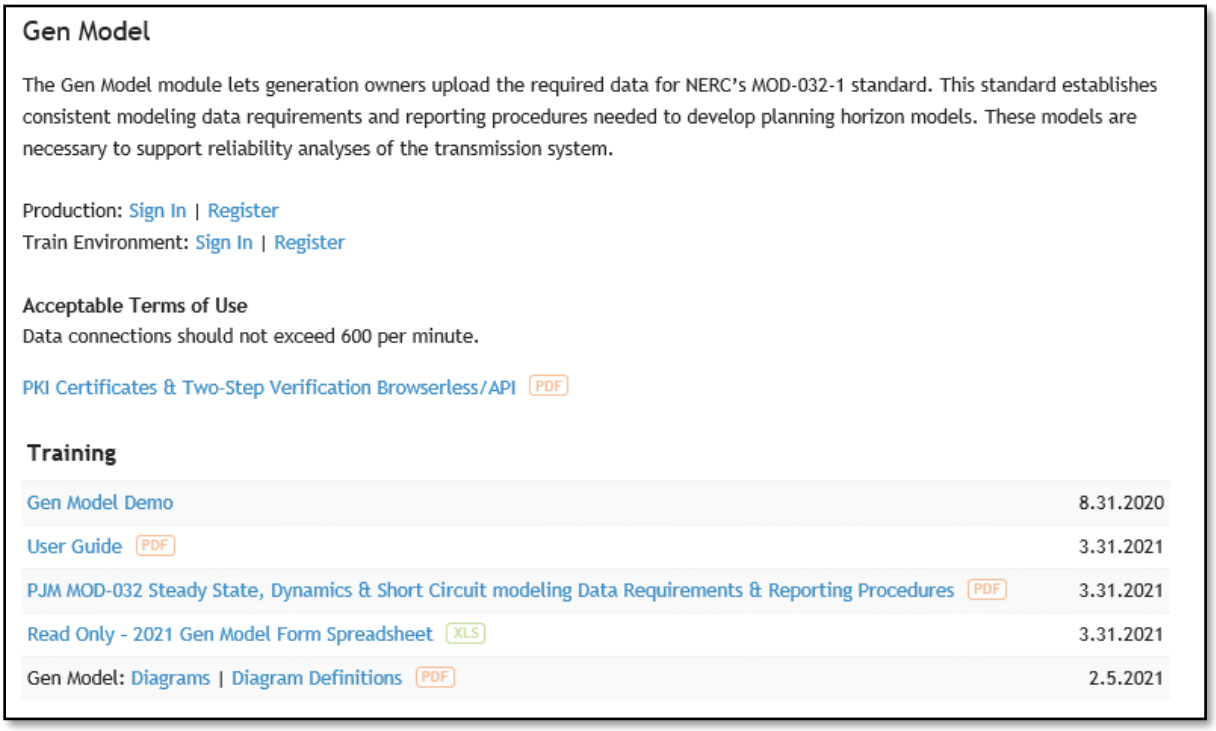
- MOD-032 Requirements and PJM's GO data submittal requirements apply to all in-service generators (new or existing) with either:
  - Capacity rights in PJM's markets **OR**
  - Individual generators greater than or equal to a 20 MW nameplate value
- This is explained further in Section 3.2 of the PJM Planning Modeling Data Requirements and Reporting Procedures document.
- Behind the Meter (BtM) generators should coordinate with the Transmission Owner (TO) with which they interconnect for data requirements
- Pseudo-tied generators must submit data to the Transmission Planner or Planning Coordinator with which they interconnect.
- Pseudo-ties importing into PJM, do NOT submit data to PJM
- Pseudo-ties exporting out of PJM that interconnect with PJM, must submit data to PJM

Navigation

It is important to note that there are hyperlinks on the Figures. Whereever the text "Figure X" appears within the main body of text in this document - you can hold "CTRL" and left click and it should take you to where the Figure is located.

In order to reduce the amount of duplication of instruction amongst the three different types of generators, certain sections will be referenced with hyperlinks to other parts of the document.

Section 1: "Gen Model" Location and Related Documentation on PJM.COM



Gen Model

The Gen Model module lets generation owners upload the required data for NERC's MOD-032-1 standard. This standard establishes consistent modeling data requirements and reporting procedures needed to develop planning horizon models. These models are necessary to support reliability analyses of the transmission system.

Production: Sign In | Register
Train Environment: Sign In | Register

Acceptable Terms of Use
Data connections should not exceed 600 per minute.

PKI Certificates & Two-Step Verification Browserless/API PDF

Training

Gen Model Demo	8.31.2020
User Guide PDF	3.31.2021
PJM MOD-032 Steady State, Dynamics & Short Circuit modeling Data Requirements & Reporting Procedures PDF	3.31.2021
Read Only - 2021 Gen Model Form Spreadsheet XLS	3.31.2021
Gen Model: Diagrams | Diagram Definitions PDF	2.5.2021

Figure 1 – Gen Model Section on PJM.com (Planning Center)

The following link (https://pjm.com/markets-and-operations/etools/planning-center.aspx) will take you to the page as shown in **Figure 1.** This page has a section dedicated to Gen Model.

When you get to the Gen Model section, there are several different types of complementary documents for the benefit of the user. Please continue to check back periodically for any updates.

The main documents that should be reviewed in addition to the User guide include:

- **Read Only – Gen Model Form Spreadsheet** – A read only copy of the current Gen Model Form. This is helpful when preparing for the upcoming Gen Model window.
  - This is **not** a replacement to the Gen Model portal for submitting the MOD-032 data requirements.
- **Gen Model Diagrams** – One-line diagrams related to Gen Model
- **Gen Model Diagram Definitions** –Terms used frequently in Gen Model
- **PJM Data Requirements & Reporting Procedures Document** – PJM's Official document on its data requirements relating to Gen Model and MOD-032.

Section 2: Requesting Access

User and system IDs are created and updated through the PJM Account Manager tool.

Access to Account Manager

Account Manager can be accessed from PJM's Account Manager Page using the following URL:

http://www.pjm.com/markets-and-operations/etools/account-manager.aspx

Users can register for an account or sign in to their existing account from this page. If you are locked out of your account, contact your Company Account Manager (CAM).

Please note that Production accounts differ from Training accounts. Users who do not have accounts in either environment should work with their CAM to provision the accounts or follow the New User Registration within the Account Manager User Guide.

In order to access the PJM Planning Center: Gen Model tool log into Account Manager with your User ID and request access to *Planning Center Gen Model Read/Write Access*. If you do not have the option to request Planning Center Gen Model Read/Write Access in the area, contact your CAM. They will be able to direct you to which organization has the ability to request access to Planning Center Gen Model Read/Write Access. You may be required to create a new user ID under the specific organization provided by your CAM. Depending on what plant you are trying to edit, always make sure to log into the account for the company in which the plant is assigned to in Gen Model.

Frequently Asked Questions
If your CAM is not familiar with the Planning Center Gen Model Read/Write Access, please contact MOD-032@pjm.com.
If a generator is sold and the ownership transfers, contact MOD-032@pjm.com with the new company name exactly as it appears in Gen Model and Account Manager. In addition, log into accountmanager.pjm.com to see what Company (Employer) name your account is under. If your previous Gen Model submissions need to be moved, send screenshot like below to MOD-032@pjm.com.

Section 3: Administrative Issues

Extraneous Entries in Gen Model

If you accidentally create an extra entry (i.e., a second partially completed form), ***there is no need to delete it.*** Only PJM administrators have permission to delete entries. Deletion is not necessary because we only consider submitted entries as official data.

Prior Years' Data Submission

A frequently asked question relating to a prior years' submission is the following, "Why am I not able to edit any data on an already completed entry?"

Previously submitted data cannot be edited. A new entry must be started using the "Begin 20XX Submission" button as shown in **Figure 3**, which will bring up the option to pre-populate the forms with previously submitted data.

All previously submitted data is viewable within Gen Model as long as the Company name of your login matches the Company name of the previous submission.

PJM MOD-032 support (MOD-032@pjm.com) can update the Company name of past submissions if there has been a change to your Company name or if ownership recently transferred.

Entries with No Changes to Plant

A frequently asked question with respect to Gen Model submissions is, "Is the requirement to provide updated or new modeling information only applicable if a GO has "new or updated" modeling info or if there is no new modeling info, what needs to be done by the GO?"

The answer to that question is that if there are no changes, the previously submitted data can be used to populate the upcoming submission. However, the data must be verified and checked for errors before submission of a new entry. There may also be questions added/modified/removed in Gen Model from the previous year. Therefore, there will always be a reason for review.

If you find corrections to Gen Model data outside of the window period, please email MOD-032@pjm.com to determine if the change is significant enough to be made immediately or if it should wait until the next window.

Previously Uploaded Attachments and Files

All previously uploaded attachments and files will carry forward into a newly created Gen Model entry unless the total size of all attachments exceeds 200 MB. Please be mindful of the size of the files and try to keep file sizes as compressed as possible while ensuring that the scanned information is still legible/readable for use.

Evidence of Gen Model Submittals for Compliance Purposes

A frequently asked question with respect to Gen Model entries is, "Is there any way that we can view our MOD-032 uploads after-the-fact and save them?" Gen Model now has the ability to export data in XML format. Please refer to Appendix I for a walkthrough of how to use the exported XML file.

Section 4: PJM Planning Center: Gen Model Screens Walkthrough

Introduction to Planning Center: Gen Model Tool

The Planning Center: Gen Model tool was developed to make it as easy as possible for PJM and Generation Owners (GOs) to satisfy their NERC MOD-032 data obligations. The application allows GOs to quickly and easily initially enter generation data, and then review and verify that data every year after. It also gives PJM the ability to efficiently and effectively review GO submitted data and apply it to planning horizon cases.

Gen Model is designed to let you save data throughout the process, allowing you to break as needed. If you are inactive for more than one hour, however, the system will automatically log you out for security reasons. Any data not saved will need to be re-entered.

Main Gen Model Screen

Upon logging in, you will be taken to the Main Gen Model screen within Planning Center.

This screen will contain all existing submissions for your company. This will include all the data for your company including previous year's data for each plant and current year data. It will display the year of the submission, plant name, submission status, due date, who created the submission, submission date, available actions, and notes for each entry. If it is your first time logging in, or no submissions have been started, none of that data will be populated. To begin the current year's submission, you will have to click on the "Begin 20XX Submission" button indicated by the red arrow in **Figure 2** below.

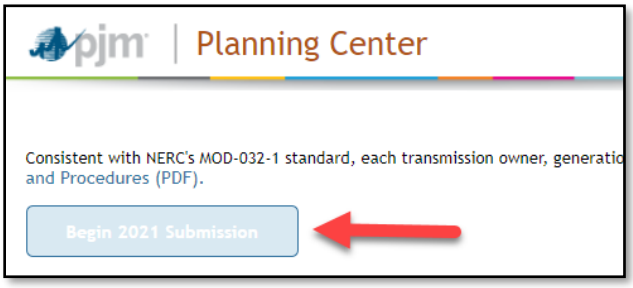


Figure 2 - Main Gen Model Screen

Upon clicking that button, a box will pop up offering two options: "Add New Data" or "Review/Update Existing Data," as shown in **Figure 3**. For plants that already have data entered, you can click "Review/Update Existing Data" to either confirm no data has changed from the previous year or to update the data.

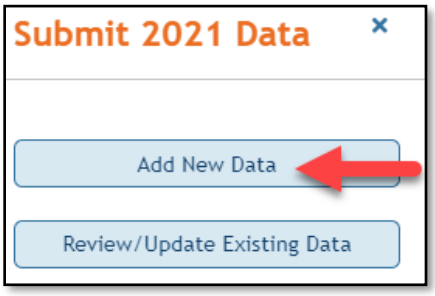


Figure 3 - Choosing "New" or "Existing" data to submit

Approved Queue Point as-built data submissions can be imported into Gen Model by clicking "Review/Update Existing Data", then selecting the approved Queue Point as-built data submission from the drop-down list.

Plant Form Navigation Screen

Upon clicking the "Add New Data" button, you will be navigated to the Plant Form Navigation screen shown below in **Figure 4**. The navigation screen contains the various forms that need to be filled out, their current status, the actions available, and the ability to select which forms are not applicable for the particular plant being submitted. The form statuses include, "Not Started", "In Progress", and "Complete".

There are different forms for the various pieces of data needed for each plant submission:

- **For each plant**, the "General Information" form must be filled out.
- Depending on the type of generator, one of the three forms following it ("Synchronous", "Wind Farm", or "Inverter Based) must also be filled out.
- **Each generator (machine)** requires the "Maximum Facility and Seasonal Output Data" to be filled out.
    - This form includes questions to confirm interconnection agreement values, generator D-curve information, Maximum Facility Output (MFO) and Summer and Winter Output, etc.
- Circuit breakers owned by the GO on the high side of the GSU and operating at 100 kV or greater should be captured in the "Circuit Breakers and Relays" form.
- Relays that monitor voltage and frequency related to PRC-024 are captured on the same Circuit Breakers and Relays forms as the Circuit Breakers.
- Any data for step-up transformers other than the transformer submitted in an earlier form (Synchronous, Wind Farm, Inverter Based) must be submitted in the "Main Transformer" form.
- If the GO owns a transformer for **BES (100 kV or greater)** connected loads at the plant, the "Load Transformer" form must be filled out.
    - If there are multiple large load transformers, the form must be filled out for each one individually.
- If the GO owns any portion of transmission line(s), the "Attachment Line Data" form must be filled out.
    - For generator lead lines less than 0.2 miles, impedance information will not be required. Ratings for each line are required regardless of line length.
- Additional Data Files allows the user to upload any necessary supporting files, including test sheets, etc.

General Information Screen

To begin entering data for a plant, click on the pencil in the actions column for the General Information form, indicated by the red arrow in **Figure 4**.

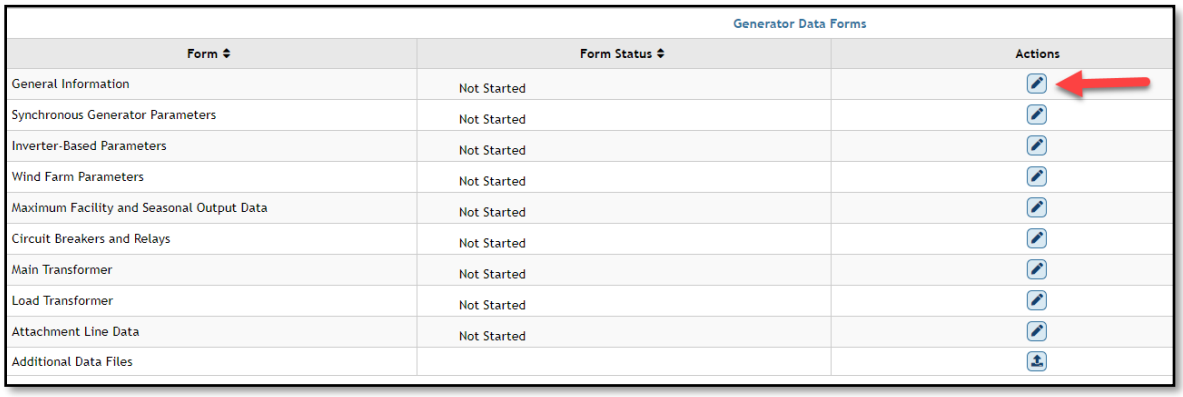


Figure 4 - Selecting the "General Information" form on the main navigation screen

Upon clicking the pencil to enter the General Information screen, you should note that your information was prepopulated using data from the pjm.com credentials. An example of the General Information screen with Individual Complete Data automatically filled can be seen in **Figure 5**.

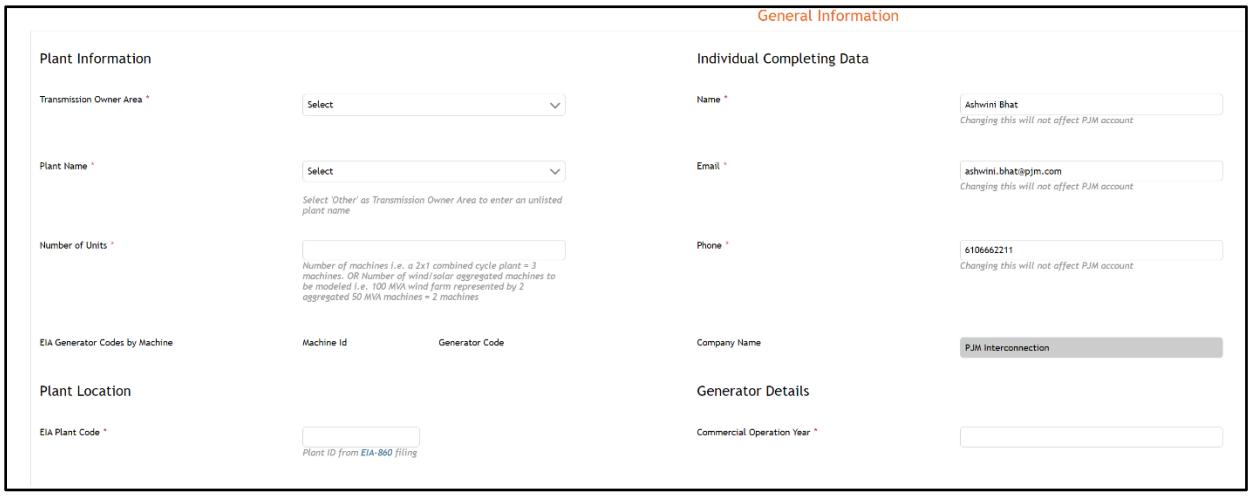


Figure 5 - General Information Screen

To pick the plant you want to add data for, you should first pick the appropriate transmission owner area location. For the example in **Figure 6**, we will pick ATSI as the Transmission Owner Area.

The EIA Plant Code will provide a list of available EIA Plant Codes once you begin typing. This will not be editable after you submit, so please contact MOD-032@pjm.com if you need to make a correction or if your Plant Code is not available from the drop down. The EIA Generator Codes will prepopulate from the machine forms once those are completed.

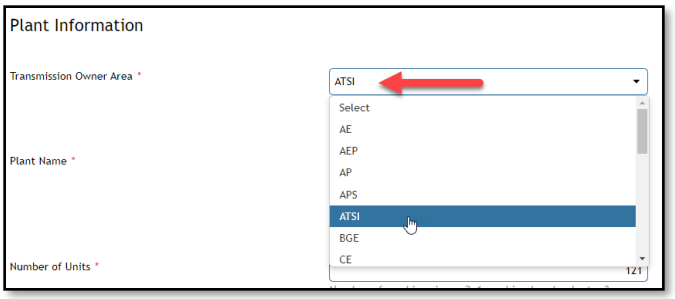


Figure 6 - Selecting Transmission Owner Area

Once the TO area is picked, the plant name dropdown will be prepopulated with a list of plants in that TO area. In the example shown in **Figure 7**, we will select Beaver Valley.

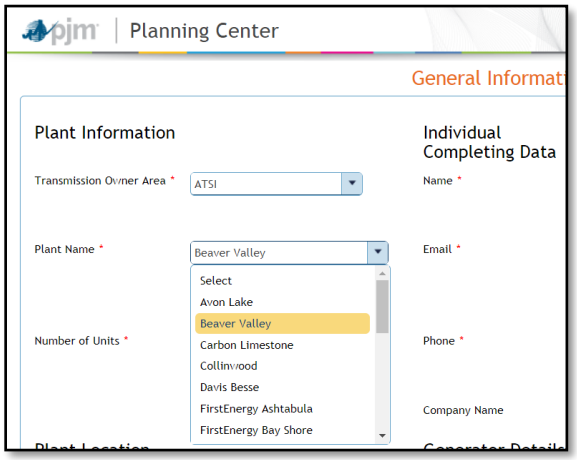


Figure 7 - Selecting Plant Name

If you cannot find your plant listed in the drop down after selecting the correct TO, please change the TO area to "Other" and manually fill out the name of your plant. An example of this can be seen in **Figure 8**.

Figure 8 - Adding a Plant not in the Drop Down

The "Number of Units" is defined as the number of machines at a particular plant. For example, a 2X1 combined cycle plant (Synchronous Generator) could have two gas generators and a steam generator, which would constitute as three units. For wind/inverter-based generators, aggregated machine representations are accepted.

Keep in mind, there are always exceptions to the rule. Generator representations can vary due to many different factors. Wind or inverter based generators should be aggregated if all the same equipment (i.e. same wind turbines or same inverter types) is used and connected through the same "Main Transformer" up to transmission system at the same point of interconnection (POI).

For example, a 100 MW wind farm is aggregated as two (2) generators. Reasons for modeling the wind farm as two generators include:

- Two different types of wind turbine are used at the same plant
- and/or if there are two (2) "Main Transformers" used to generate up to transmission system
- And/or if the each "Main Transformer" is connected to different transmission POIs

Another example to consider is cross-compound steam turbine generator sets. For generators who have provided separate entries for the HP-LP and IP-LP generators in the past, continue to break out the requested data by generator making any reasonable assumptions as necessary.

Note that Gen Model has parameters that must be met in order for the data to be accepted. These fields indicated with an * are mandatory. Constraints for several fields have been implemented to help minimize errors in the submitted data. If the entered data does not fit the constraints, a message will pop up. An example of this is shown in **Figure 9**.

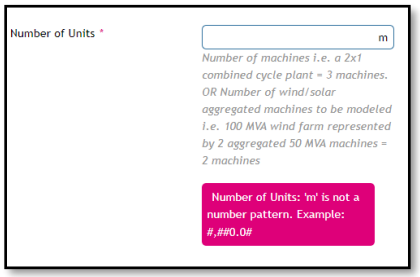


Figure 9 - Example of Error Messages

Save Draft, Back, and Submit Form Buttons

At the bottom of each page of Gen Model, you have three buttons: "Back", "Save Draft", and "Submit" as is shown in **Figure 10**. Clicking "Back" will take you back to the Plant Form Navigation screen. Note that your progress will NOT be saved if you click the back button. Clicking "Save Draft" will save your current data in the form. If you click "Save Draft" and then "Back," your work will be saved. Upon completion of the form, you should click "Submit." If required data is missing or data is outside the constraints of the box, the form will alert you. If the form is complete, you will be returned to the Plant Form Navigation screen and the form status for the specific form will be "Complete."

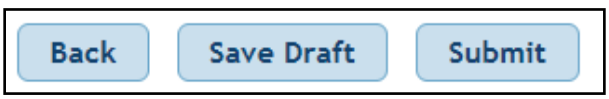


Figure 10 - Back, Save Draft, and Submit Buttons

Synchronous Generator Parameters

In most cases for plants that have a synchronous generator, the "Not Applicable" button should be checked for "Wind Farm Parameters" and "Inverter-Based Parameters." Note that if you have entered data for either and click the "Not Applicable" button, it will remove any data entered. To begin filling out the form, click the pencil icon under the "Actions" column indicated by the red arrow in **Figure 11**.

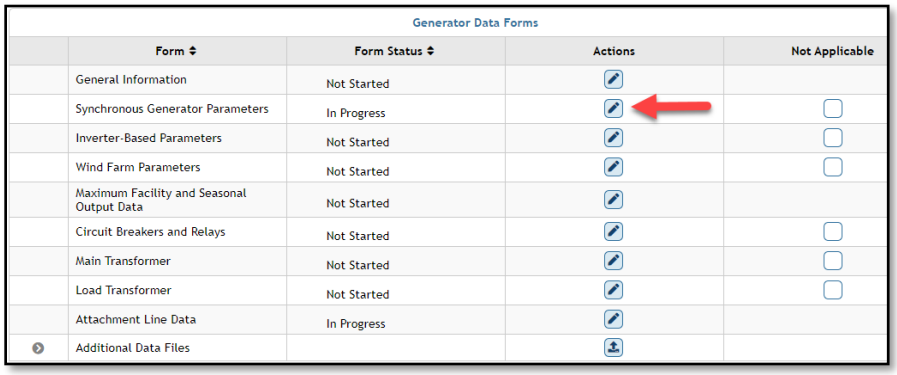


Figure 11 - Selecting Synchronous Generator Parameters Form

Clicking the pencil icon under the "Actions" column will bring you to the screen below. Note that you can submit data for both synchronous machines and for step up transformers. Multiples of each can be entered to suit each plant's configuration. To begin submitting data, pick either "Synchronous Generator" or "Step-Up Transformer" from the drop down as can be seen in **Figure 12**.

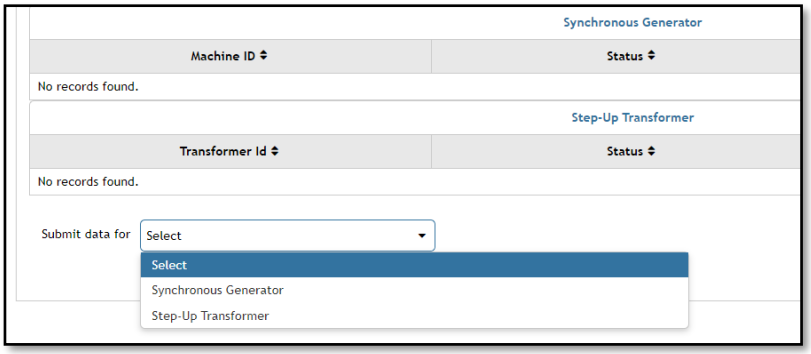


Figure 12 - Synchronous Generator Dropdown

Synchronous Generators

If you click "Synchronous Generator," the form will load the data fields necessary for Synchronous Generators. If the plant has several machines that are also considered "Synchronous Generators", each Machine ID will have to be entered separately as shown in **Figure 13**.

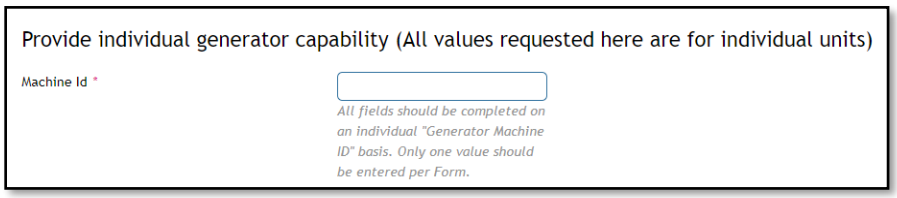


Figure 13 - Inputting Machine ID on the Synchronous Generator Form

However, if additional machines or transformers need to be entered, you can navigate back to the synchronous generator form by clicking the pencil again and you will see your submitted data. You can edit the previous entry by clicking the pencil or delete the entry by clicking the trash can as shown in **Figure 14** with the box in red. To add an additional machine, click the drop down again and select "Synchronous Generator" from the drop down shown in **Figure 14**.

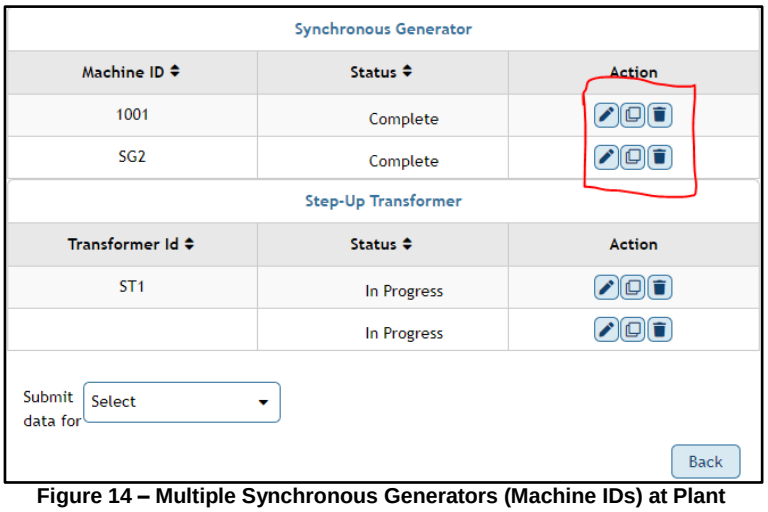


Figure 14 – Multiple Synchronous Generators (Machine IDs) at Plant

It is important to note that you can click "Save Draft" at the bottom of the form and it will save your progress and have a submission status of "In Progress" for that machine as shown in **Figure 15.** You can finish your submission by clicking on the pencil icon next to the machine in progress and then clicking Submit.

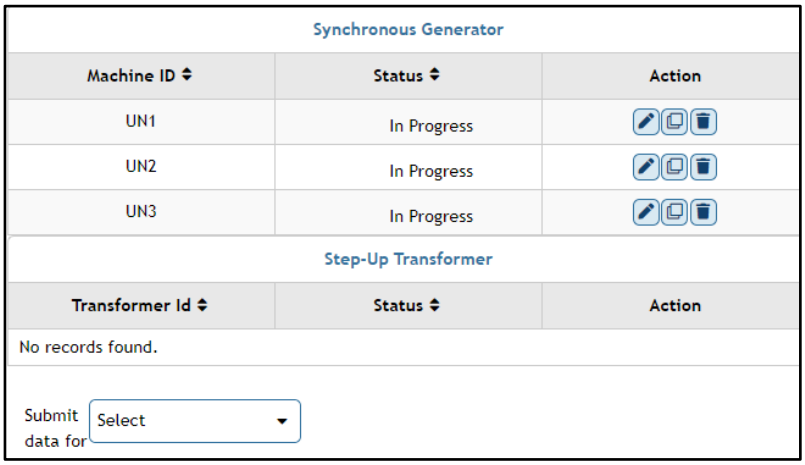


Figure 15 - Inputting Multiple Machine IDs on the Synchronous Generator Form

Figure 16 shows the beginning of the Synchronous Generator form. The terminal voltage (kV) is related to the voltage level as shown at Point A of **Figure 96**.

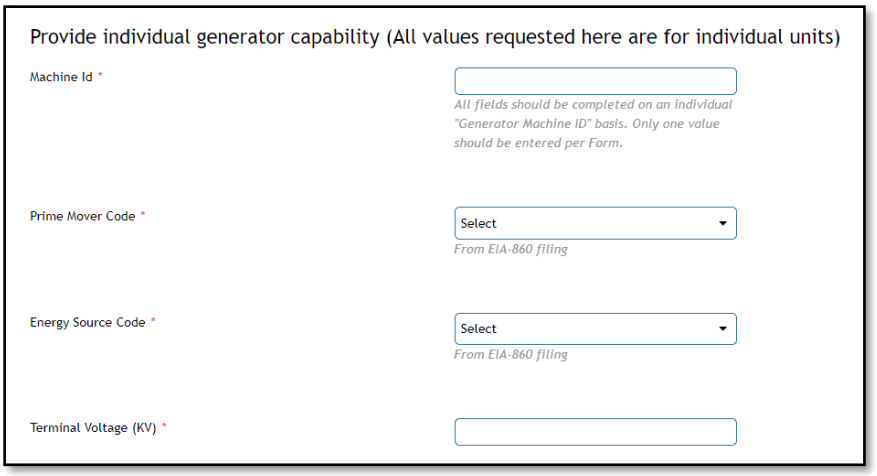


Figure 16 - Provide Individual Generator Capability

The Machine ID identifies the information that relates to that specific generator. It is possible that the EIA Machine ID could be different from the Machine ID for the Gen Model form. In addition, for wind/inverter-based generators, an aggregated machine representation is acceptable as a single Machine ID (if that is the best way to represent the generator).

Regarding the field for Energy Source Code as stated in the EIA-860 filing, Gen Model is currently only looking for the primary fuel. However, it is recognized that EIA-860 entry requires that the Generator Owner identify primary and secondary fuels for dual-fuel units. You may provide comments when the completed forms are submitted to indicate a secondary fuel source.

Figure 17 and **Figure 18** show the remaining portions of the Synchronous Generator form and ask for various parameters necessary for steady state, dynamics, and short circuit model builds.

Generator Parameters (All reactances and resistance values in PU on Machine MVA Base at machine terminal voltage)

Combined Turbine-Generator-Exciter Inertia, H [kWs/kVA]
0.5 <= H <= 15

Speed Damping Coefficient, D
0
MMWG Procedure Manual and NERC Case Quality Metrics require D=0

Generator Saturation

Generator Saturation at 1.0 p.u. Voltage, S (1.0)
0 < S1.0

Generator Saturation at 1.2 p.u. Voltage, S (1.2)
S1.0 <= S1.2

Unsaturated Reactances

Direct Axis Synchronous, Xd(i)
xd < 2.5

Direct Axis Transient, X'd(i)
x'd < 0.5 x xd

Direct Axis Sub-Transient, X"d(i)
x"d <= x'd

Quadrature Axis Synchronous, Xq(i)
xq < xd

Quadrature Axis Transient, X'q(i)
x'q < xq

Quadrature Axis Sub-Transient, X"q(i) *
x"q < x'q

Stator Leakage, Xl
X"d > XL

Negative Sequence, X2(i) *

Zero Sequence, X0(i) *

Figure 17 - Synchronous Generator Form - Generator Parameters

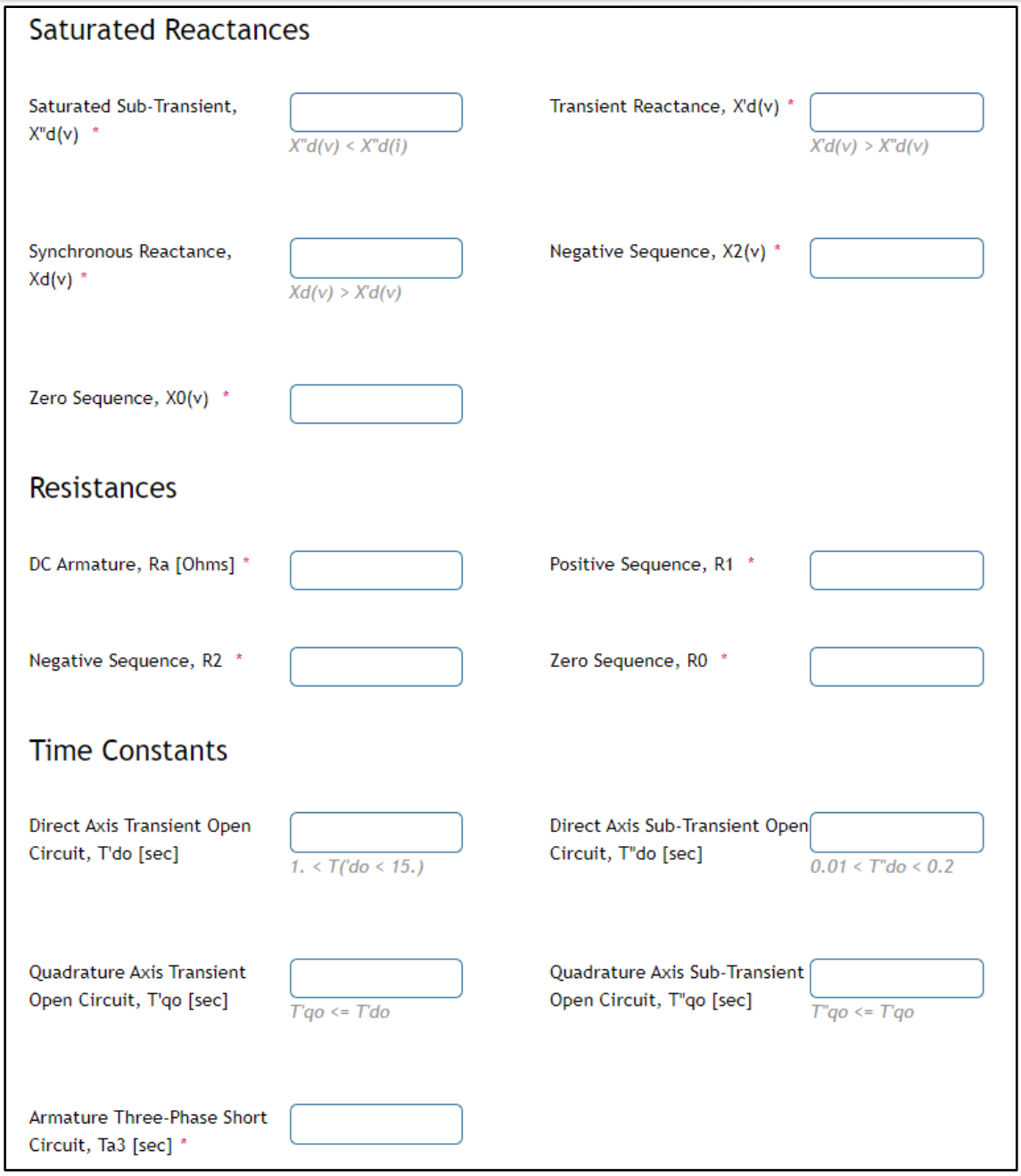


Figure 18 - Synchronous Generator Form - Gen Parameters Cont.

Once Synchronous Generator data is completely and accurately entered, clicking "Submit" will take you back to the Plant Form Navigation Screen with the status of the Synchronous Generator Form as either "In Progress" or complete, depending on whether or not all of the synchronous generator and step up transformer entries were submitted. If there are additional generators/transformers that need to be added, click the pencil icon and follow the steps outlined above to add additional generators or transformers.

Stability / Dynamics Models

Also included as part of the Synchronous Generator form is a section on Stability Models. Make sure to include all relevant information including .dyr files as necessary. This section is shown in **Figure 19**.

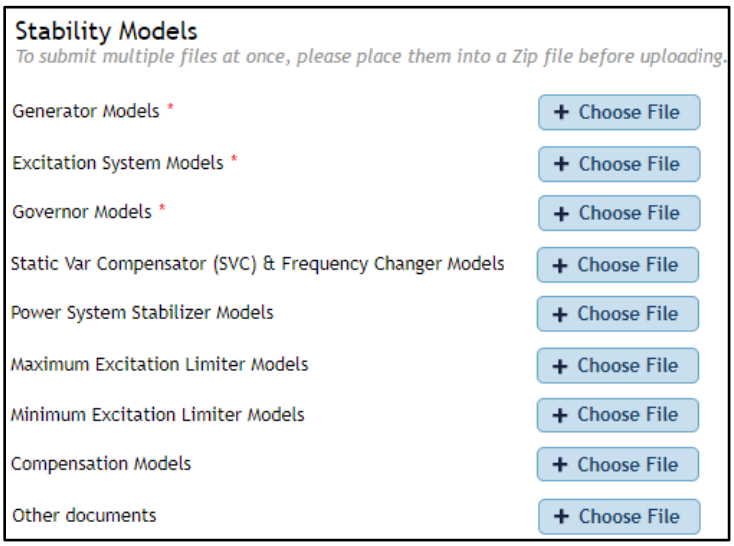


Figure 19 - Types of Stability Models

Dynamics data is to be submitted via Gen Model in Siemens PTI PSS/E Dynamics Model Raw Data File (.dyr) format compatible with PSS/E version 34.7.

Any changes year to year would require an update uploaded via Gen Model. If a change from previously provided .dyr data is submitted, additional justification must be provided in the form of Excel, Word or Portable Document Format (.pdf) documents.

Frequently Asked Question - Is it necessary to also create and submit .dyr files with the changes already being made in the Gen Model portal itself? **Yes.**

- The GO can request from PJM the latest .dyr files that PJM has for the applicable generator units for the submitter to perform a comparison to our data. These requests should be made using the PJM Planning Community for all MOD-026 and MOD-027 activity via requirement 1 (R1): https://pjm.force.com/planning/s/mod-026-and-mod-027-request
- If you are not already registered, you'll need to register for the Planning Community. There is a user guide available for the Planning Community.

Frequently Asked Question - What is each required Stability Model field requesting?

- PJM follows NERC's Acceptable Models List available on the NERC website (Acceptable Models List).
    - For synchronous machines, a generator model (such as GENTPJ1).
    - For generators where a traditional generator model is not applicable, a model that describes the dynamic behavior of the generator such as REGCA1.
    - "Excitation System Models": Exciter model (such as AC8B)
    - "Prime Mover & Governor Models": Governor model (such as GGOV1)

Frequently Asked Question - What if my generator does not have that type of dynamic model (i.e. no governor installed)?

- Upload a document explaining the dynamic behavior of the generator and the reasoning as to why the required model type is not applicable.
    - For example, if the generator is not responsive to frequency deviation because a governor is either not installed or disabled, provide that explanation in a document and upload the document to Gen Model.

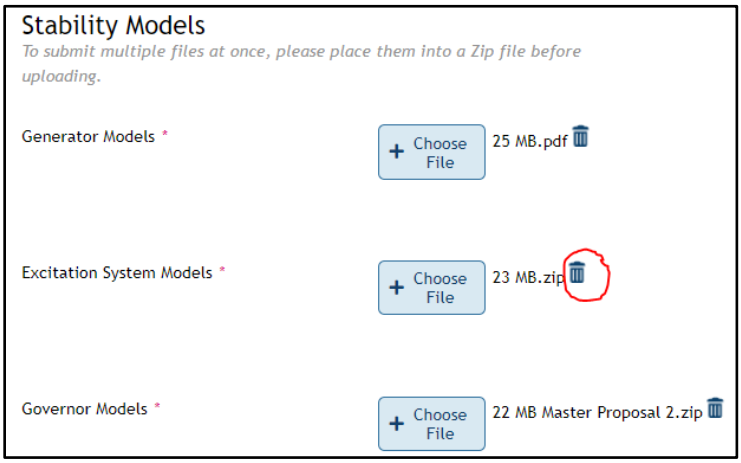


Figure 20 – Attachments for the Stability Models

Please note that attachments used from previous years will be brought over to the current year submittal. To replace or remove those files that may no longer be valid for the current year click on the trash can icon as shown in **Figure 20.** There is a prompt as shown in **Figure 21** to confirm the change to prevent inadvertent deletion.

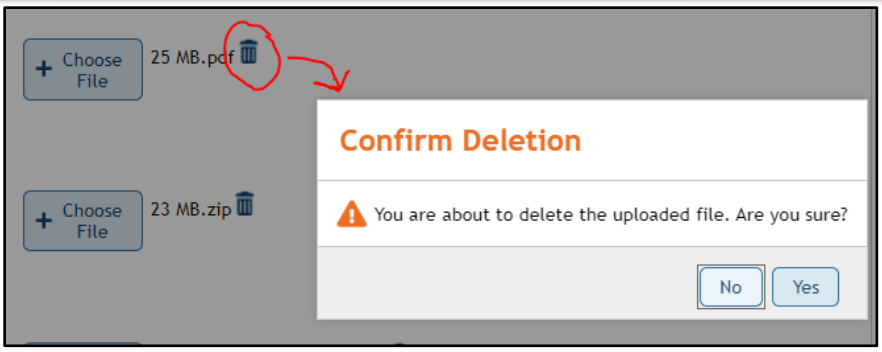


Figure 21 – Delete / Replace Attachment Files Confirmation Prompt

Step-Up Transformer

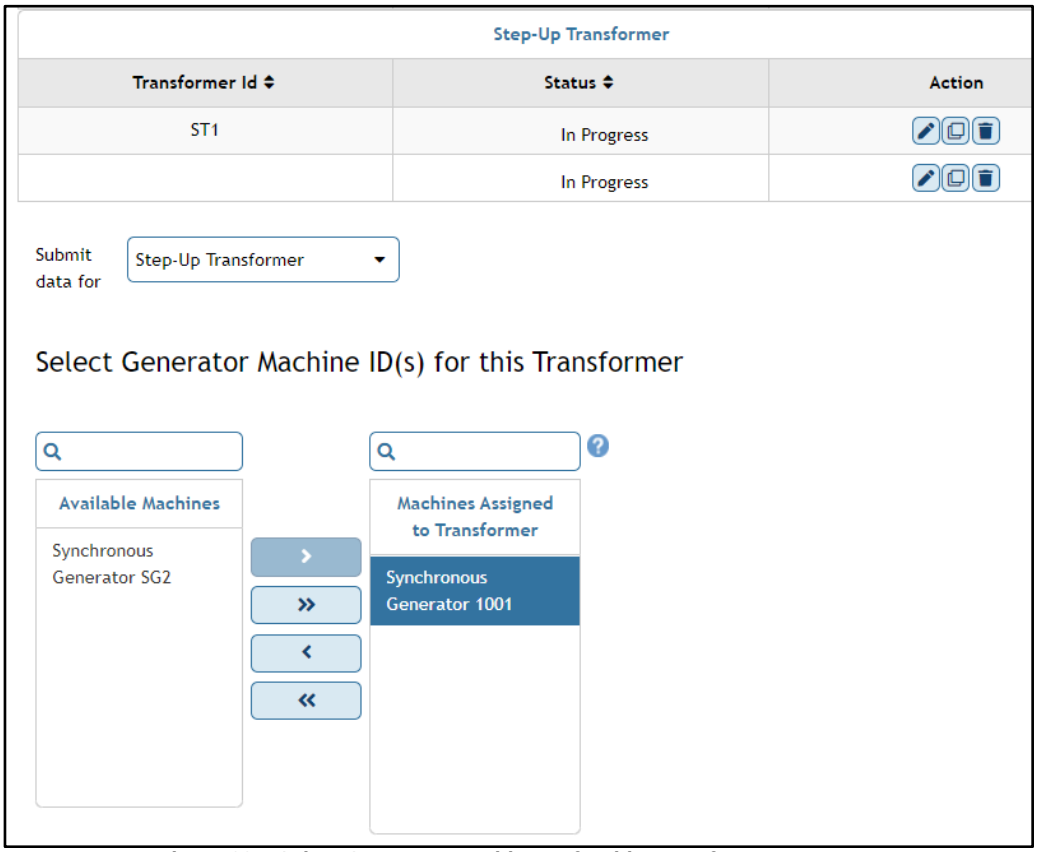


Figure 22 – Select Generator Machine ID for this Transformer

To fill out data for the GSU, once again click the pencil for "Synchronous Generator Parameters" as shown in **Figure 4**. In the drop down box, this time select "Step-Up Transformer" and the form for a transformer will appear as shown in **Figure 22**.

Where it states "Select Generator Machine ID(s) for this Transformer", select the generator(s) that are associated with this Step-Up Transformer.

Upon completely and accurately filling out the form and clicking submit, the user will be taken back to the Plant Form Navigation screen. Additional transformers can be added in a similar fashion to the Synchronous Generators. Data can be edited or deleted for any submitted generators or transformers.

When entering information for the Generator Step-Up Transformer Form, there are a few fields that require additional attention. For the "Select Transformer Windings" field, the options are either "Two Windings" or "Three Windings". When the "Three Windings" option is selected, the MVA Base field expands (shown in **Figure 23**) to be able to provide the MVA base information for all three windings if they are provided on different MVA bases.

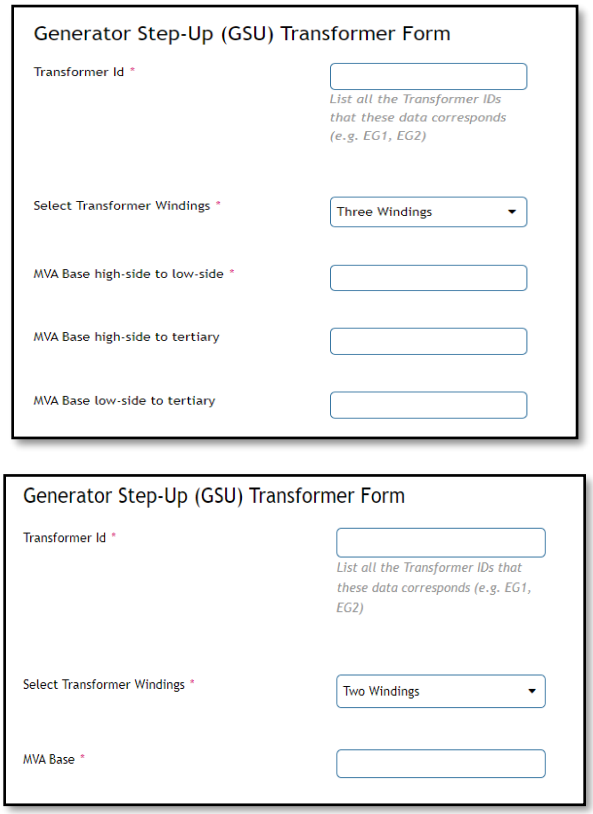


Figure 23 - Select Transformer Windings (2 or 3 Windings)

Similarly for Transformer Ratings as shown in **Figure 24**, depending on the amount of ratings that are provided, the fields will expand to allow the user the ability to provide cooling designation and MVA rating information with respect to the number of windings. For ease of use, there is a checkbox called "Same Rating Set for all three Windings" shown on **Figure 24**, which will automatically populate the rating for the remaining windings if those values are the same.

For more information on the different types of cooling class designations and what they stand for, click on the question icon to the right of the Transformer Ratings bolded text as shown in **Figure 24**.

The fields shown in **Figure 25** are Transformer parameter information relevant to NERC TPL-007 standard. The K factor is not available for many transformers that were built before much was known about GIC. If the K-Factor is not known for a particular transformer, the GO can enter a value of 0.0. PJM will determine a value to use based on the other transformer parameters. The GO should indicate in the Comments field that the K-Factor is unknown.

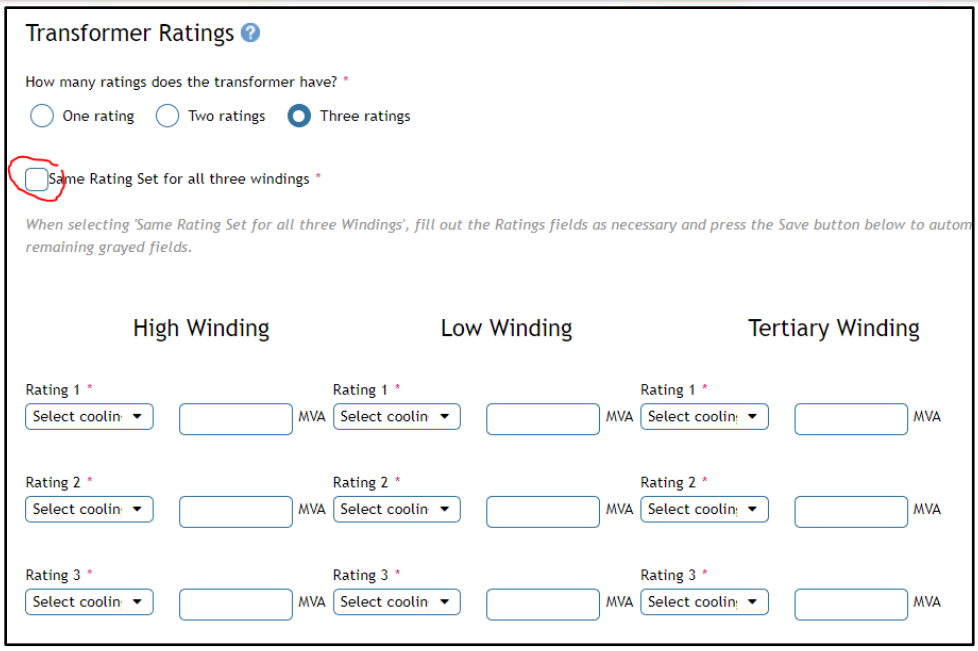


Figure 24 – Transformer Ratings

Frequently Asked Question - Regarding Transformer Ratings - My transformer ratings sheet provides the same cooling class designation at 2 different temperatures, which should I use?

- Use the temperature that is consistent with your transformer ratings methodology under FAC-008.

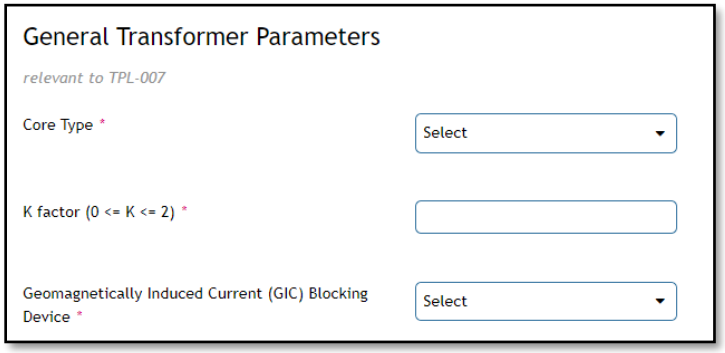


Figure 25 – General Transformer Parameters

For each Generator Step-Up Transformer, please provide necessary diagrams or pictures that are helpful for modeling transformers for the field shown in **Figure 26**. Some examples of what is being requested can be shown in **Figure 99** and **Figure 100**. If photos or screenshots of Step-Up Transformer Nameplate or of the Current Fixed Tap Settings are not easily available, providing a Transformer Factory Test Report is also acceptable.

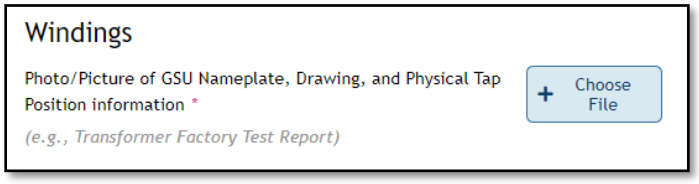


Figure 26 – Request for Transformer Factory Test Report / GSU Information

An example of a "Step-Up Transformer" for a Synchronous Generator, can be seen in **Figure 96** which shows a Plant with Synchronous Generators. The Step-Up Transformer is shown on the one-line as the "Generator Step-Up Transformer". An example of a Step-Up Transformer for the purposes of submitting data for Gen Model is shown in **Figure 27** and **Figure 28**. This example will be used to demonstrate how to fill out the related transformer fields.

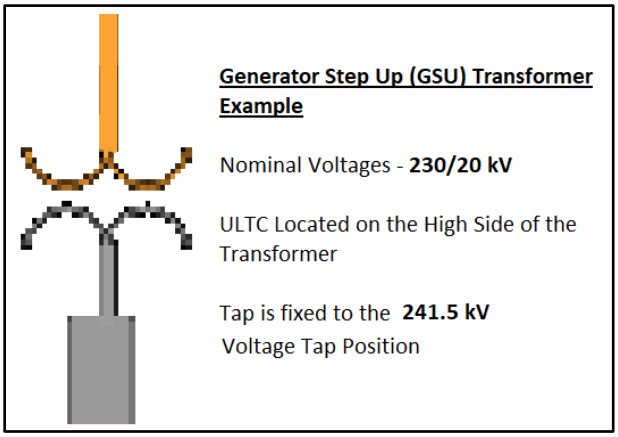


Figure 27 – Example of Transformer (GSU) and ULTC

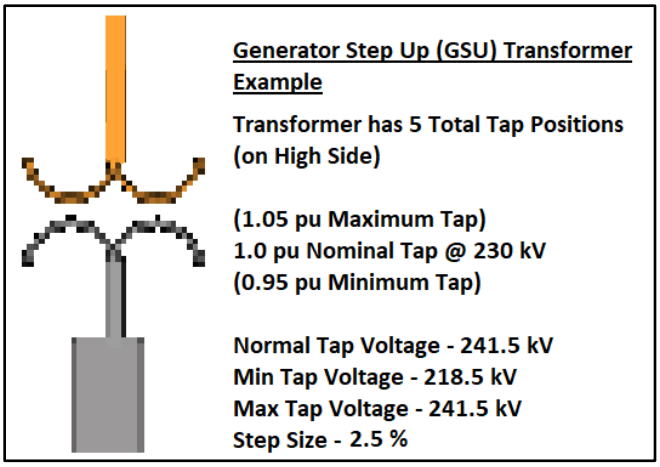


Figure 28 – Example of Transformer (GSU) Continued

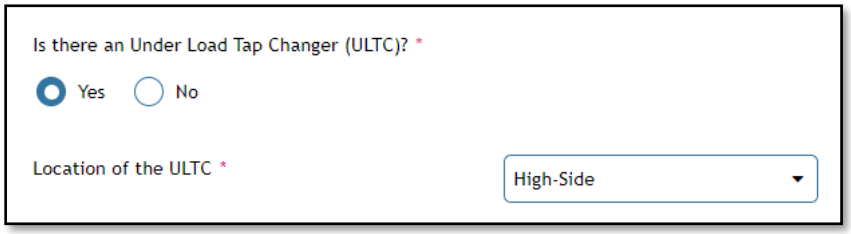


Figure 29 – ULTC Question Prompt

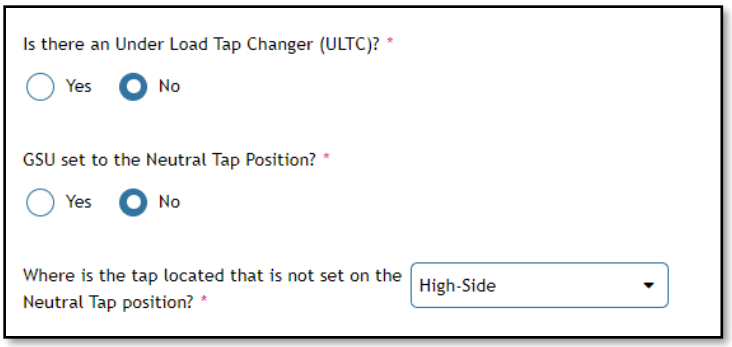


Figure 30 – ULTC Question Prompt – (No ULTC Selected)

The questions shown in **Figure 29** and **Figure 30** are fields that will help clarify how the Generator Step-Up Transformer is currently operating and ensuring that PJM has this represented correctly in our various models.

In **Figure 29**, we are looking to confirm if there is an "Under Load Tap Changer" (ULTC) (also known as an on-load tap changer). If there is a ULTC, indicate where it is located with respect to the transformer itself. If yes is selected, the options for the location include "High-side" which represents the higher voltage side of the transformer, "Low-side" which represents the lower voltage side of the transformer, and "tertiary" which represents the tertiary side of the transformer. "Tertiary" only appears as an option if the transformer is selected as a "Three-winding" transformer. It is common for Wind and Solar installations to have ULTCs to control the bus voltage.

If there is no ULTC identified as shown in **Figure 30**, the GSU could still be set to an Off-load tap position (OLTC) that is different to the nominal voltage tap on one winding. Therefore, if the GSU is not set to the neutral tap position, PJM needs this information to accurately represent this in our models. If the OLTC is different to the nominal voltage tap, please indicate what side of the transformer that this is located.

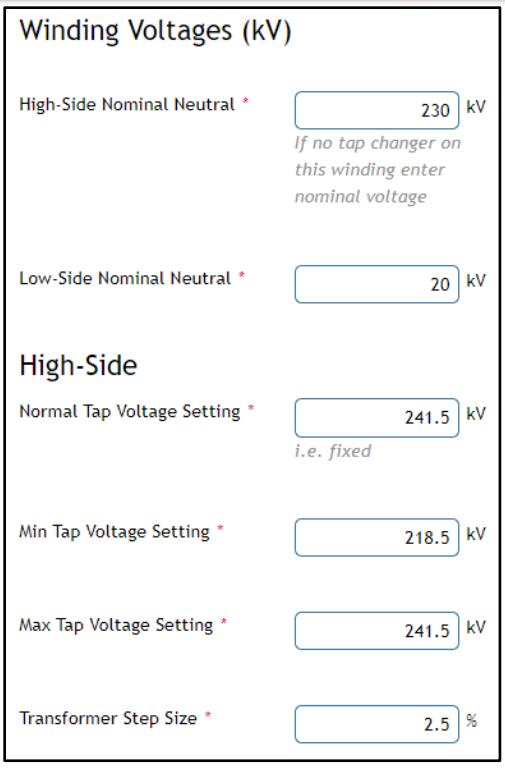


Figure 31 – Transformer Voltage Settings

Continuing with the GSU example shown in **Figure 27** and **Figure 28**, a ULTC is located on the high side of the transformer. Therefore, the information would be filled out as shown in **Figure 31**. Regarding the Normal Tap Voltage setting, that is the tap that the transformer is set normally set to when the generator is operating.

Figure 32 shows questions relating to the "Winding Connection Types". Provide the most accurate description for each side of the transformer and provide additional comments as needed.

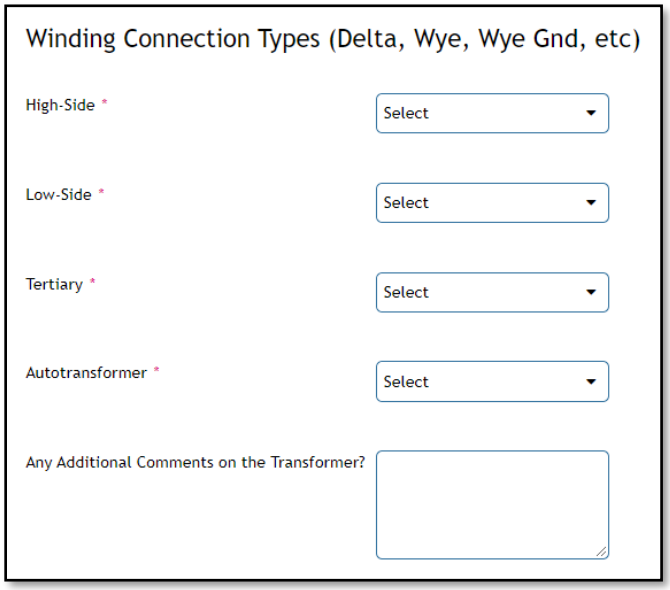


Figure 32 – Winding Connection Types (Delta, Wye, Wye Gnd, etc.)

Gen Model has the ability to automatically calculate transformer impedances using Z% and Transformer Load Loss if the impedances are unknown. If the impedances are known, they can be manually enetered. Either option can be selected as shown in **Figure 33**.

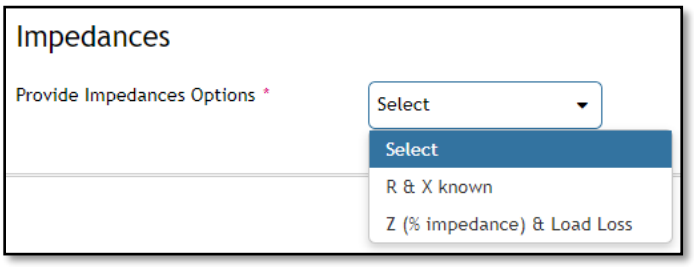


Figure 33 – Transformer Impedance Options

Important Note - If the Generator Step Up Transformer selected is a single phase transformer instead of a three phase transformer - **Please select the "R & X Known" option ONLY.** The "Z (% Impedance) & Load Loss" option is currently designed only for 3-phase transformers.

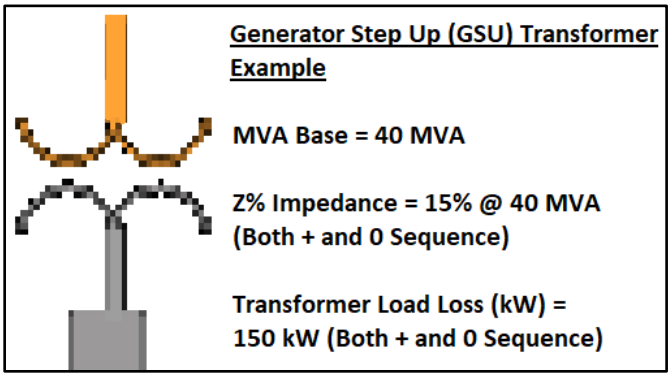


Figure 34 – Example of Calculating GSU Impedance w/ %Z and Load Loss

By selecting "R & X known", the R and jX values for the transformer impedances can be entered manually as shown in **Figure 35**. There is no automation when selecting this option.

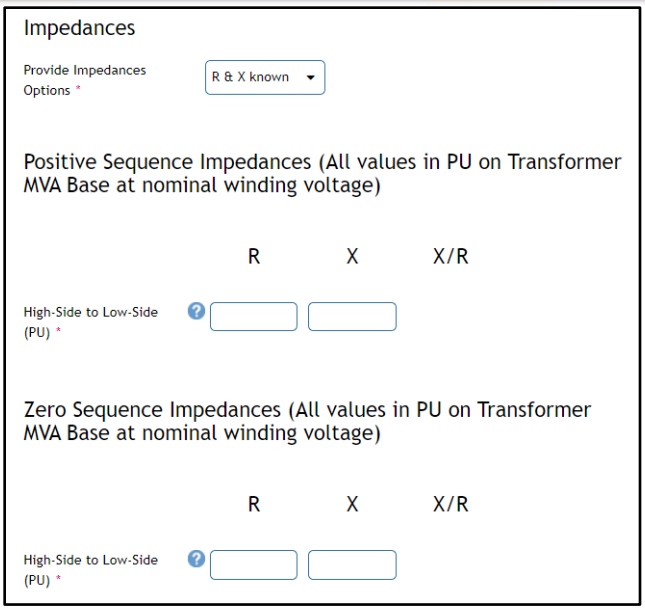


Figure 35 – R and jX known - Transformer Impedance Option

The "Z (% Impedance) & Load Loss" option allows for some automation to calculate R + jX of the transformer based on %Z impedance based on the GSU's MVA base and the transformer load loss value. An example transformer with sample parameter values as shown in **Figure 34**. This information should be available from the Transformer Test Report. An example of values found on a Transformer Test Report can be shown in **Figure 38**.

As shown in **Figure 36** and **Figure 37**, the calculations for the impedance rely on the MVA base, Z% Impedance, and Transformer Load Loss. Once the values are saved by hitting "Save Draft", the R and jX values are automatically calculated as shown in **Figure 39**.

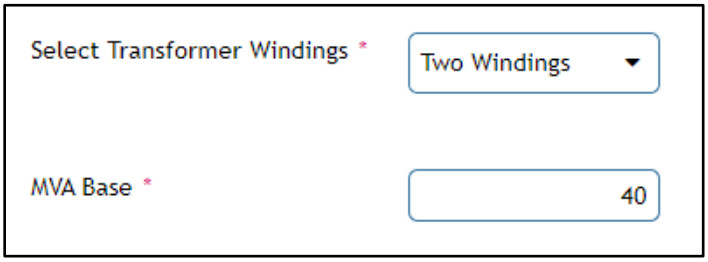


Figure 36 – Z% Impedance and Load Loss (kW) known – Selecting MVA Base

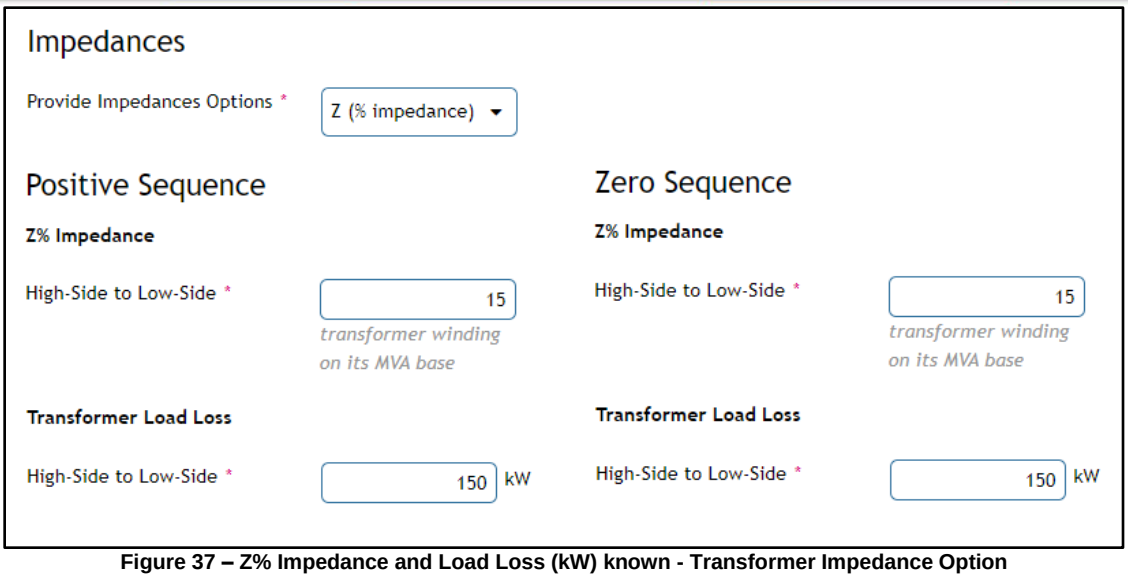
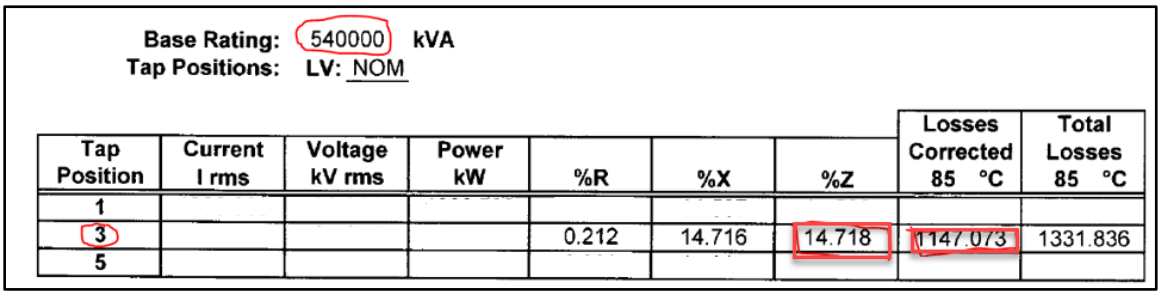


Figure 37 – Z% Impedance and Load Loss (kW) known - Transformer Impedance Option



Base Rating: 540000 **kVA**
Tap Positions: **LV:** NOM

Tap Position	Current I rms	Voltage kV rms	Power kW	%R	%X	%Z	Losses Corrected 85 °C	Total Losses 85 °C
1								
3				0.212	14.716	14.718	1147.073	1331.836
5								

Figure 38 – Example of Z% Impedance and Load Loss (kW) values from a Test Report

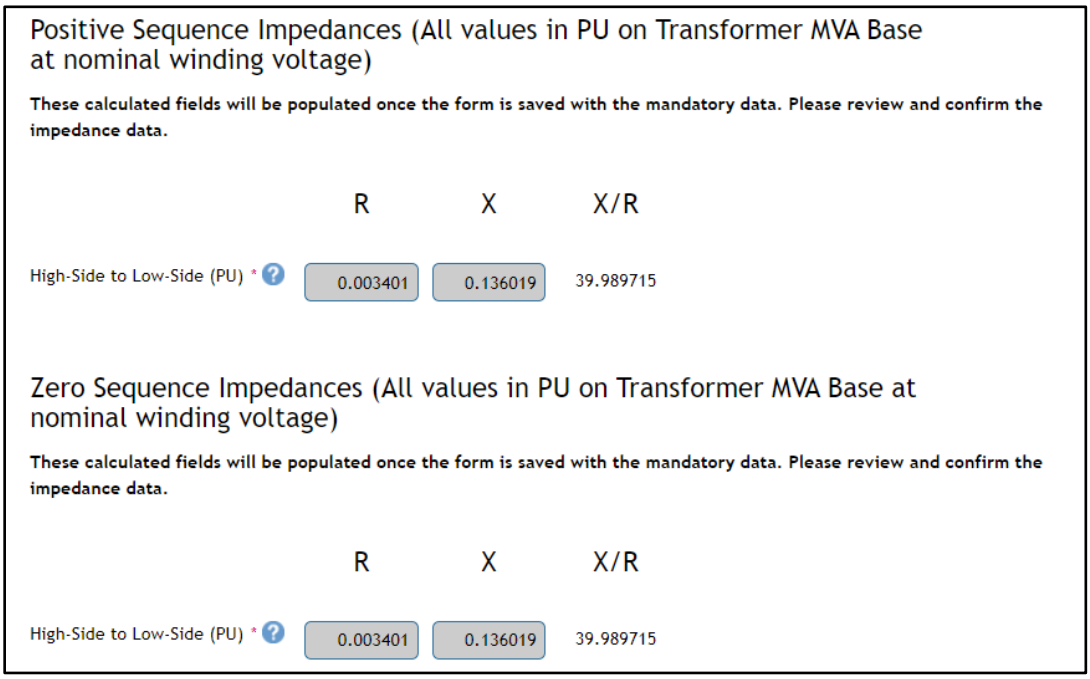


Figure 39 – Z% Impedance and Load Loss (kW) known – Calculation - Transformer Impedance Option

The "Z (% Impedance) & Load Loss" option automation should work for most scenarios as long as the required parameters are filled out. Either option is acceptable.

Figure 40 shows the fields that relate to DC Winding Resistance and Substation Grounding. Regarding the "Substation grounding DC resistance", PJM is looking for the DC resistance of the substation grounding grid itself.

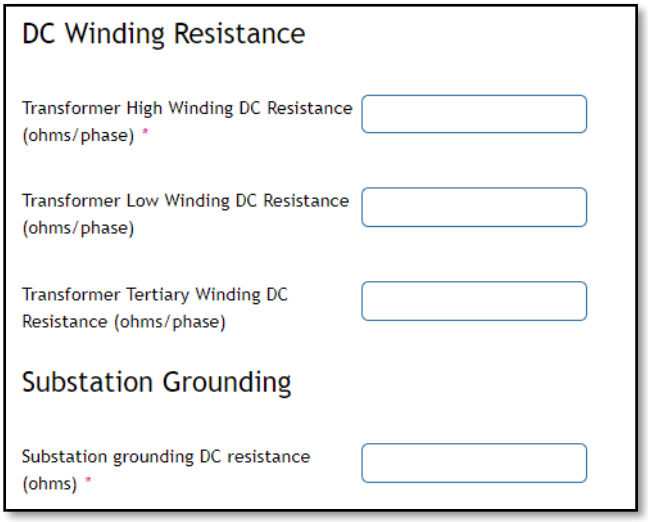


Figure 40 – DC Winding and Substation Grounding Information

Once Step-Up Transformer data is completely and accurately entered, clicking submit will take you back to the Plant Form Navigation Screen with the status of the Synchronous Generator Form as "Complete." If there are additional generators/transformers that need to be added, click the pencil icon and follow the steps outlined above to add additional generators or transformers.

Inverter Based Parameters

A Simplified one-line diagram representing a general substation layout seen at generating stations with Inverter Based Units and can be viewed on the Maximum Facility and Seasonal Output Data form when the user clicks on the Question Icon as shown in **Figure 52**.

The intent of this one line to help clarify the differences between the terms "Main Transformer", "Inverter-Based Transformer", and "Wind Farm Transformer" that are used in Gen Model. This one-line which is shown in **Figure 98**, is an example which may or may not represent your particular unit exactly and should be used only as a reference.

For a plant that is inverter based, generally the "Not Applicable" button should checked for "Synchronous Generator Parameters" and "Wind Farm Parameters." Note that if you have entered data for either and click the "Not Applicable" button it will remove any data entered. To begin filling out the form, click the pencil icon under the "Actions" column in the Inverter-Based Parameters row indicated by the red arrow in **Figure 41**.

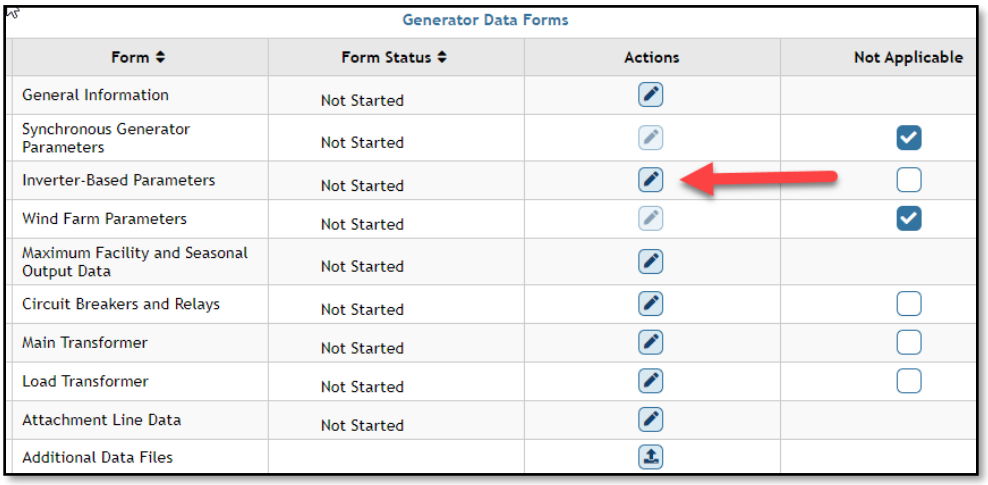


Figure 41 – Plant Form Navigation Screen after entering Inverter Based Parameters

To add an inverter based generator, click the drop down menu and pick "Inverter Based Generator" from the drop down, shown in **Figure 42**.

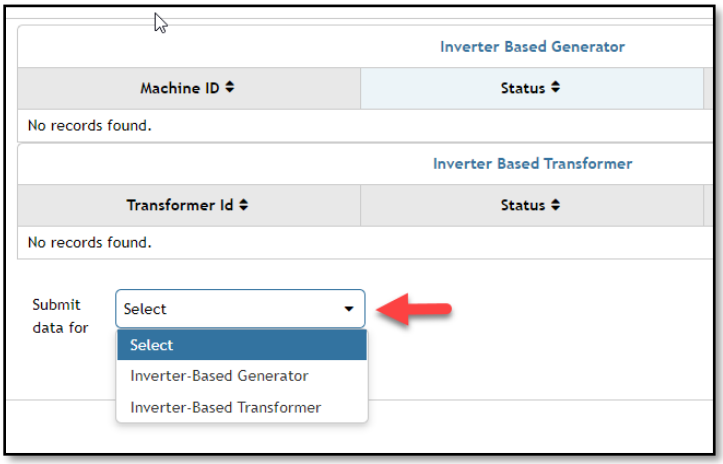


Figure 42 – Inverter Based Parameters Screen

Inverter-Based Generator

If there are multiple inverter based generators at a plant, each machine ID needs to be entered on a separate generator basis. An example of this can be seen in **Figure 43**. **Figure 44** shows the list of questions that are a part of the Inverter Based Generator section.

If you have Voltage or Frequency Relays installed that need to be reported for Compliance purposes, select yes to the radio buttons as shown in **Figure 45**. Please provide all settings and reactive curves as necessary.

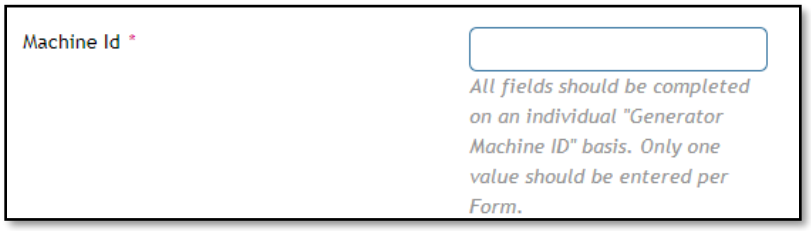


Figure 43 - Machine ID Example for Inverter Based Generators

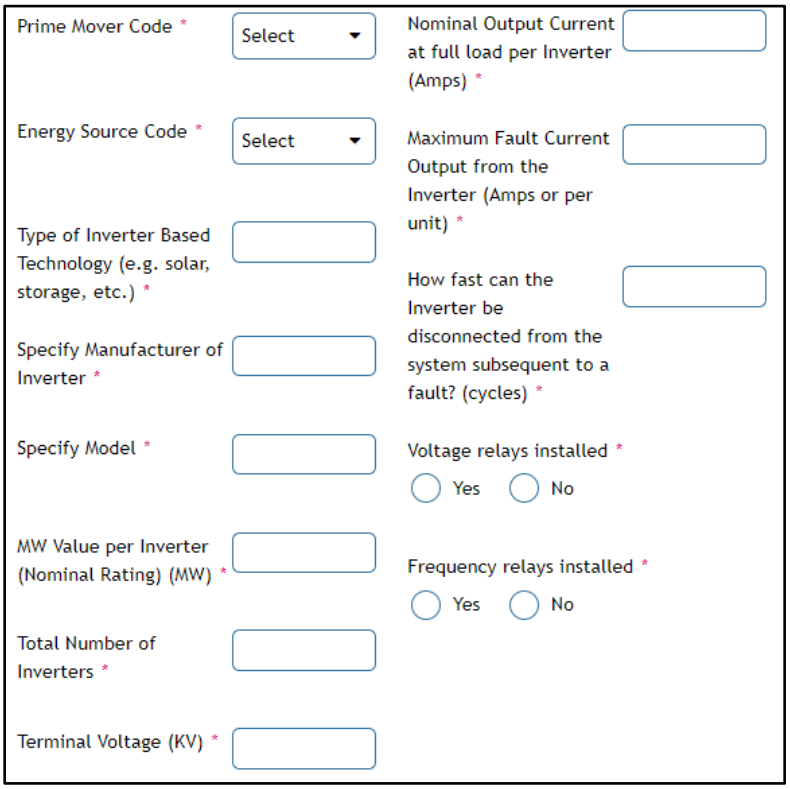


Figure 44: Inverter Based Parameters Form

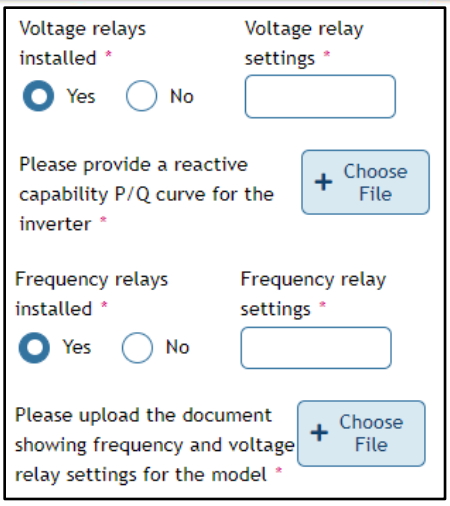


Figure 45: Inverter Based Parameters Form – Voltage/Frequency Relays Installed

Also under the Stability Models section as shown in **Figure 46Figure 46: Stability Models - Inverter Based Parameters Form**, make sure to include all relevant information including .dyr files as necessary to meet MOD-032 requirements. **Refer to the "**

Once Synchronous Generator data is completely and accurately entered, clicking "Submit" will take you back to the Plant Form Navigation Screen with the status of the Synchronous Generator Form as either "In Progress" or complete, depending on whether or not all of the synchronous generator and step up transformer entries were submitted. If there are additional generators/transformers that need to be added, click the pencil icon and follow the steps outlined above to add additional generators or transformers.

Stability / Dynamics Models**" section of the document for additional information.**

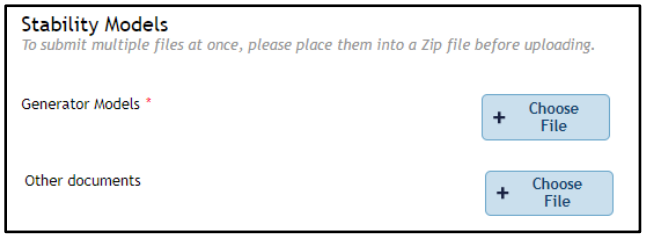


Figure 46: Stability Models - Inverter Based Parameters Form

Inverter-Based Transformer

The transformer data form for Inverter Based Plants is the same as the Synchronous Generator Step Up Transformer section. Therefore, refer to the **Step-Up Transformer section** for guidance on how to fill out transformer data.

An "Inverter Based Transformer" as shown in **Figure 98** steps up from individual inverter terminal voltage (i.e. 690 volts) to a collector system voltage (i.e. 34.5 kV) and then a Main Transformer will step from collector system voltage to Transmission System voltage (i.e. 345 kV).

If required data is missing or data is outside the constraints of the box, the form will alert you. If the form is complete, you will be returned to the Plant Form Navigation screen and the form status for the "Inverter Based

Parameters" form will be "In Progress". A transformer must be submitted for wind farms in order for the status to be complete, so you will have to return to the Inverter Based Parameters form.

Once transformer data is completely and accurately entered, clicking "Submit" will take you back to the Plant Form Navigation Screen with the status of the Inverter Based Generator Form as either "In Progress" or "complete", depending on whether or not all of the inverter based generators/transformers entries were submitted. If there are additional Inverter based generators/transformers that need to be added, click the pencil icon and follow the steps outlined above to add additional inverter based generators or transformers.

Wind Farm Parameters

A Simplified one-line diagram representing a general substation layout seen at generating stations with Inverter Based Units and can be viewed on the Maximum Facility and Seasonal Output Data form when the user clicks on the Question Icon as shown in **Figure 52**.

In general for a plant that contains a wind farm, the "Not Applicable" button should checked for "Synchronous Generator Parameters" and "Inverter Based Parameters." Note that if you have entered data for either and click the "Not Applicable" button, it will remove any data entered. To begin filling out the form, click the pencil icon under the "Actions" column indicated by the red arrow in **Figure 47**.

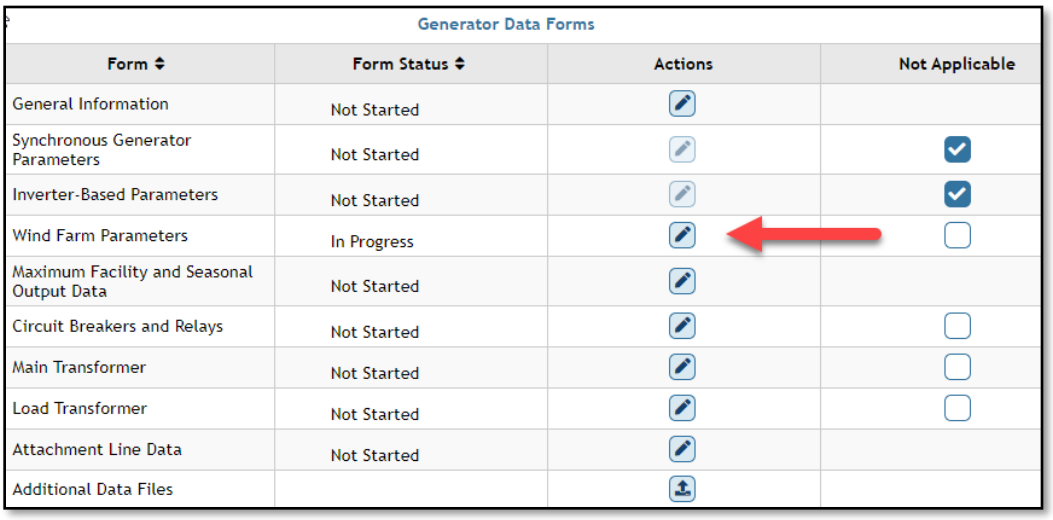


Figure 47 – Selecting Wind Farm Parameters Form

Wind Farm Generator

To add a generator, select "Wind Farm Generator" from the drop down shown in **Figure 48** and the form, shown below will load underneath.

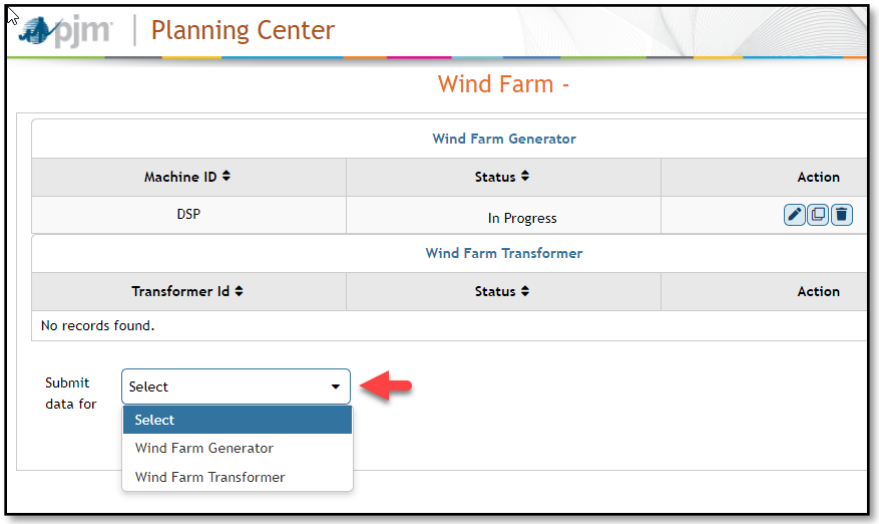


Figure 48 – Wind Farm Screen

The Wind Farm Generator data form for Wind Farm Plants is the same as the Inverter Based Generator section. Therefore, refer to the **Inverter-Based Generator section** for guidance on how to fill out generator data.

Wind Farm Transformer

The transformer data form for Wind Farm Plants is the same as the Synchronous Generator Step Up Transformer section. Therefore, refer to the **Step-Up Transformer section** for guidance on how to fill out transformer data.

A "Wind Farm Transformer", as shown in **Figure 97**, steps up from individual inverter terminal voltage (i.e. 690 volts) to a collector system voltage (i.e. 34.5 kV) and then a Main Transformer will step from collector system voltage to Transmission System voltage (i.e. 345 kV).

If required data is missing or data is outside the constraints of the box, the form will alert you. If the form is complete, you will be returned to the Plant Form Navigation screen and the form status for the "Wind Farm Parameters" form will be "In Progress". A transformer must be submitted for wind farms in order for the status to be complete, so you will have to return to the Wind Farm Parameters form.

Once transformer data is completely and accurately entered, clicking Submit will take you back to the Plant Form Navigation screen and will show the status of the Wind Farm Parameters Form as "Complete." If there are additional Wind Farm generators/transformers that need to be added, click the pencil icon and follow the steps outlined above to add additional inverter based generators or transformers.

Maximum Facility and Seasonal Output Data

Background on Need

This form is the newest addition to Gen Model. The Summer/Winter Output values that were originally placed in the individual forms (Synchronous Generator, Wind Farm Generator, Inverter-Based Generator) along with questions related to the Maximum Facility Output (MFO), have been moved into this form.

PJM is a Planning Coordinator and Transmission Planner under NERC requirements. In its role, PJM is responsible for accurately modeling the bulk electric power system and applicable non-bulk electric power system located within PJM's footprint. One of the responsibilities necessary to accomplish this task is to accurately model generation. To accurately model a generator, conformity of generator parameters is needed between the interconnection agreement (IA), which establishes rights and requirements, and the data a generator is required to provide PJM for modeling purposes.

PJM also has compliance obligations under MOD-032 and one of those is verification of the data used to build our models. As the NERC PC and TP, PJM is now responsible to obtain accurate generator owner data. Prior to MOD-032, TOs worked directly with the GOs to obtain data under MOD-010 and MOD-012.

PJM is verifying alignment with GO rights and requirements under agreements, to the data submitted under Gen Model, to the data currently in PJM's power flow, dynamic, and short circuit models. The goal is to obtain fidelity among all three. By tying data with the interconnection agreements, PJM can confirm the ownership transfer delineations. Under MOD-032 each facility owner is required provide PJM the data regarding their interconnection facilities.

In addition to confirming the interconnection agreement, PJM is requiring the GOs to specifically validate their MFO, Power Factor (PF) and Leading and Lagging requirement values, and the measurement location of the generator output per the interconnection agreements.

MFO establishes the limits for both real and reactive capability that PJM Planning has studied a generating unit. The MFO or maximum net power a generator can inject onto PJM's system, is the upper limit studied in Planning.

A facility's gross electrical output generation curve is at pre-assumed conditions. Generally, those conditions are provided by the original equipment manufacturers (OEM) at rated thermal input and generally assume ideal facility conditions; for example no condenser fouling, no equipment degradation. A gross electric output curve is driven primarily by thermal input and ambient conditions. Gross electric output curves are provided at the generator leads and represent the gross electrical output of the generator.

Net electrical output is determined by subtracting the generator's auxiliary load and station power (station parasitic loads) from the gross output. Power losses between the generator and the point where the power is delivered to the system, or Point of Interconnection (POI), must also be subtracted. If the measurement is at the low side of the generator step-up transformer (GSU) the meter reading must be mathematically adjusted to reflect the power delivered to the POI on the high side of the GSU. By subtracting the auxiliary load, station power, and losses (i.e., loads) from the gross electric curve, the resultant curve represents the maximum net electric output curve (refer to **Figure 49**, which assumes constant parasitic loads).

Figure 50 shows a typical Seasonal Generator Output plotted against Ambient Temperature. In general, the MFO value, is greater or equal to the Winter output value. The winter output typically should be greater than the Summer output.

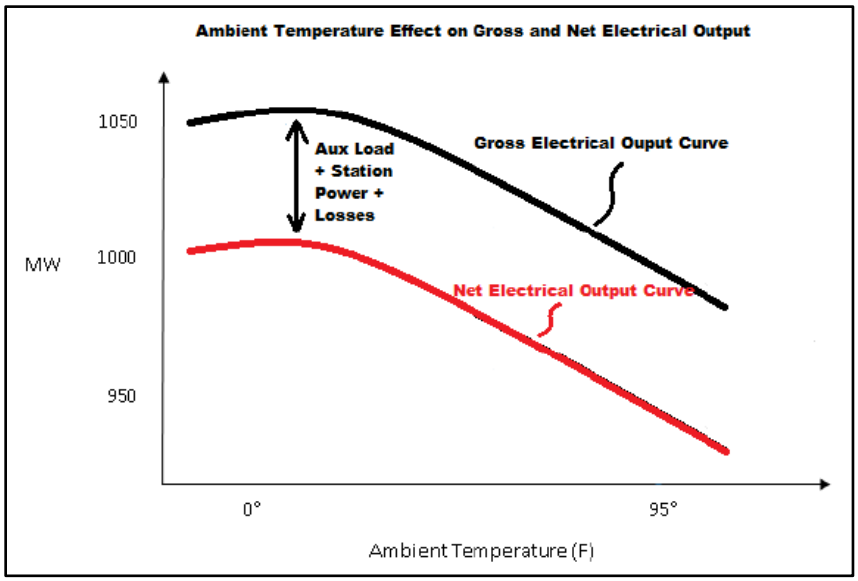


Figure 49 – Ambient Temperature Effect on Gross and Net Electrical Output

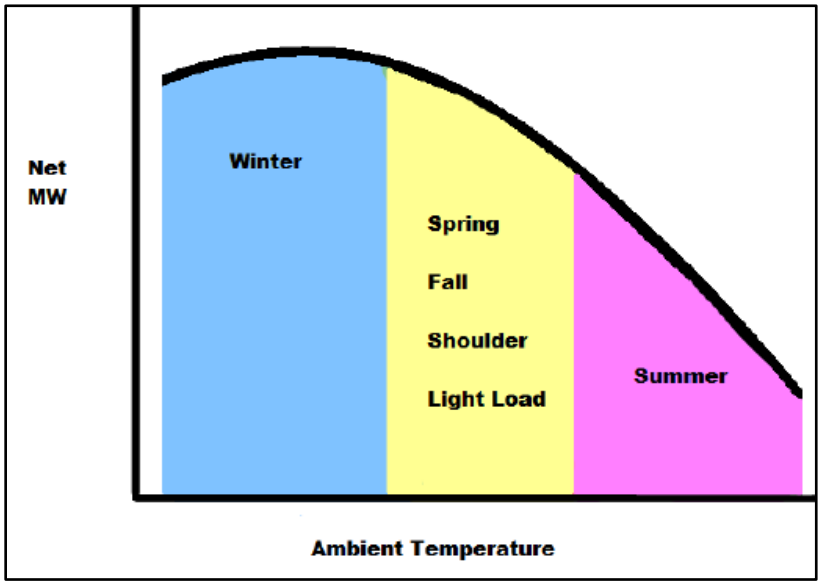


Figure 50 – Seasonal Generator Output (MW) against Ambient Temperature (F)

Submitting Data for Max Facility & Seasonal Output Form

In order to begin this form, you will need to at least have saved an In-Progress "Synchronous Generator", "Wind Farm Generator", or "Inverter-Based Generator" form as shown in **Figure 51**. In this example, a generator "UN1" is at least in the "In-Progress" stage.

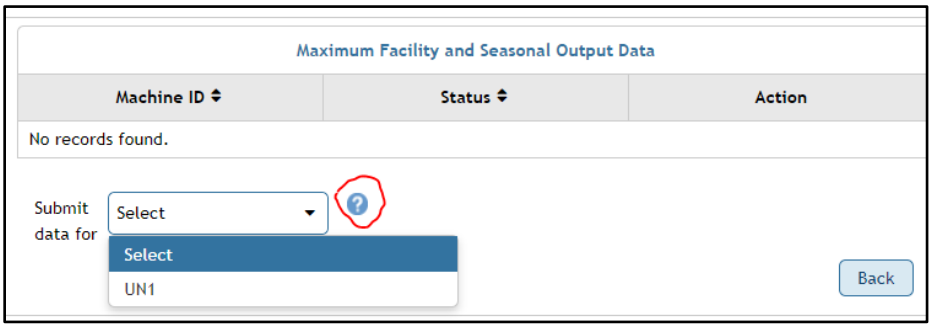


Figure 51 – Max Facility & Seasonal Output Data Form – Unit 1

Each generator (Machine) requires their own Maximum Facility and Seasonal Output form data to be completed. As shown in **Figure 52**, if a "Max Facility & Seasonal Output" form has been created for all generators, it will show the message "No Available Generators".

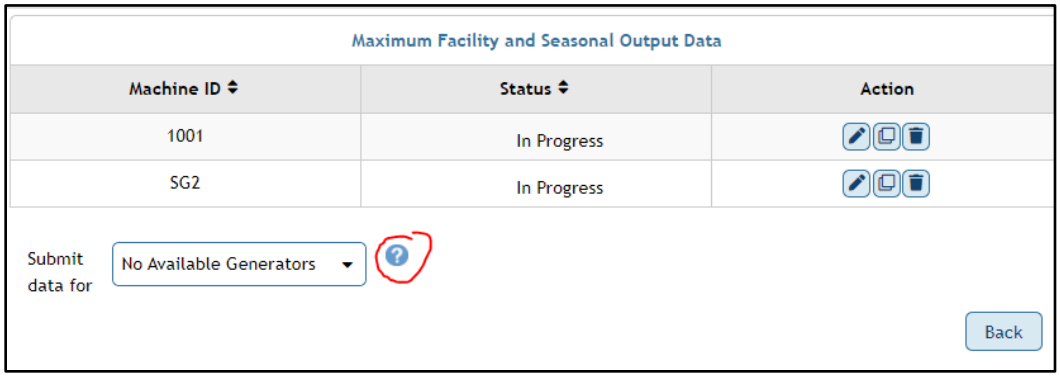


Figure 52 – Max Facility and Seasonal Output Form – No Available Generators

One Line Diagrams

A Simplified one-line diagram for each of the different generator types (Synchronous, Wind Farm, and Inverter-Based) as shown in **Figure 53**, is included when the user clicks on the Question Icons as shown in **Figure 52**.

Those one-line diagrams are also included within this document for ease of use.

- **Figure 96** – Synchronous Generator
- **Figure 97** – Wind Farm Generator
- **Figure 98** – Inverter Based Generator

These one-lines are examples of a simplified generator station, which may or may not represent your particular unit exactly and should be used only as a reference.

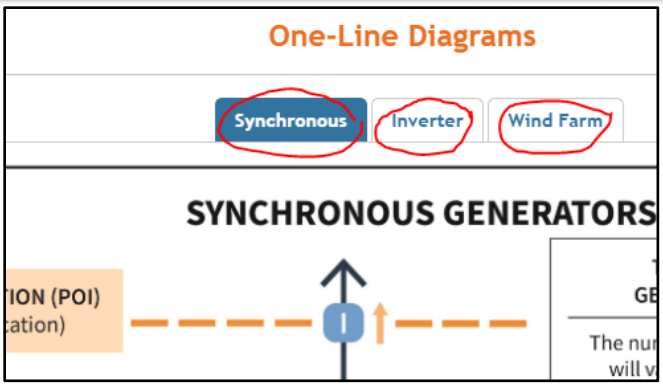


Figure 53 – One-Line Diagrams in Gen Model

Interconnection Agreement Related Questions

There is a group of questions under "Interconnection Agreement Information" section which relate to the interconnection agreement of the generator to PJM.

To be clear, it is possible to have more than one generator associated with a single MFO/ISA document. It is OK to attach the same document again for each generator.

The question "Identify Agreement that allows interconnection to PJM" is asking the user to indicate the agreement that the customer has made to PJM that allows the unit to generate into the PJM system. If none of the options are applicable to the generator scenario as shown in **Figure 54**, select "Other". If "Other" is selected, please provide additional relevant information.

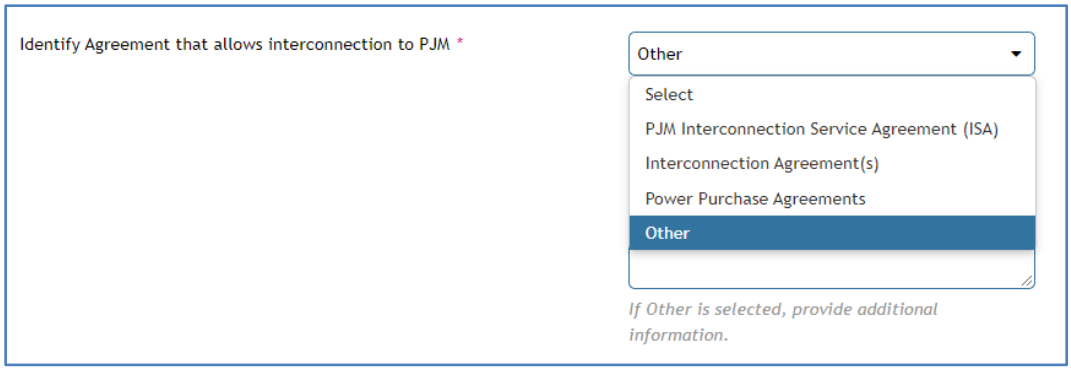


Figure 54 – Agreement for Interconnection to PJM Options

Regarding the question, "Confirm Interconnection Agreement Documentation", the following considerations should be noted:

- It is preferred to include an attachment which contains the latest active agreement relating to the specified generator. This should be attached to the "Interconnection Agreement Documentation" field.
- If the generator went through the PJM Queue Process, please provide EITHER the PJM Queue #, AND/OR a link to the PJM ISA/WPMA Link.
    - You can search https://pjm.com/planning/services-requests/interconnection-queues to identify a PJM Queue number.

- If the generator had an in-service uprate that went through the PJM Queue, provide the latest uprate ISA that indicates the currently effective MFO.
- If the generator predates the PJM Queue, but an in-service uprate went through the PJM Queue, provide the uprate ISA that indicates the currently effective MFO.
  - A generator can only have a single IA or ISA of record. PJM is only seeking the current, active interconnection agreement. PJM does not require any IA or ISA that has been superseded through subsequent interconnection queue activity.

- **If no such interconnection document for the specified Generator exists or is currently available, select "Other" where it says "Identify Agreement that allows interconnection to PJM" AND also provide reasoning in the field that indicates "If no Agreement and/or documentation, provide reasoning".**
  - PJM is requesting an explanation as to why no interconnection agreement exists. If no interconnection agreement exists, SPMS will refer the matter to the Law Department recommending a non-queue ISA get established.
- For projects that received an ISA or WMPA, PJM is only requiring the GO provide the queue position associated with the active agreement. For those GO units that have not been through the queue, PJM requests either a scanned PDF or a link to publicly available IA.
- If the generating unit is operating under a Power Purchase Agreement (PPA), the customer may redact all business sensitive information, but must provide the interconnection requirements.

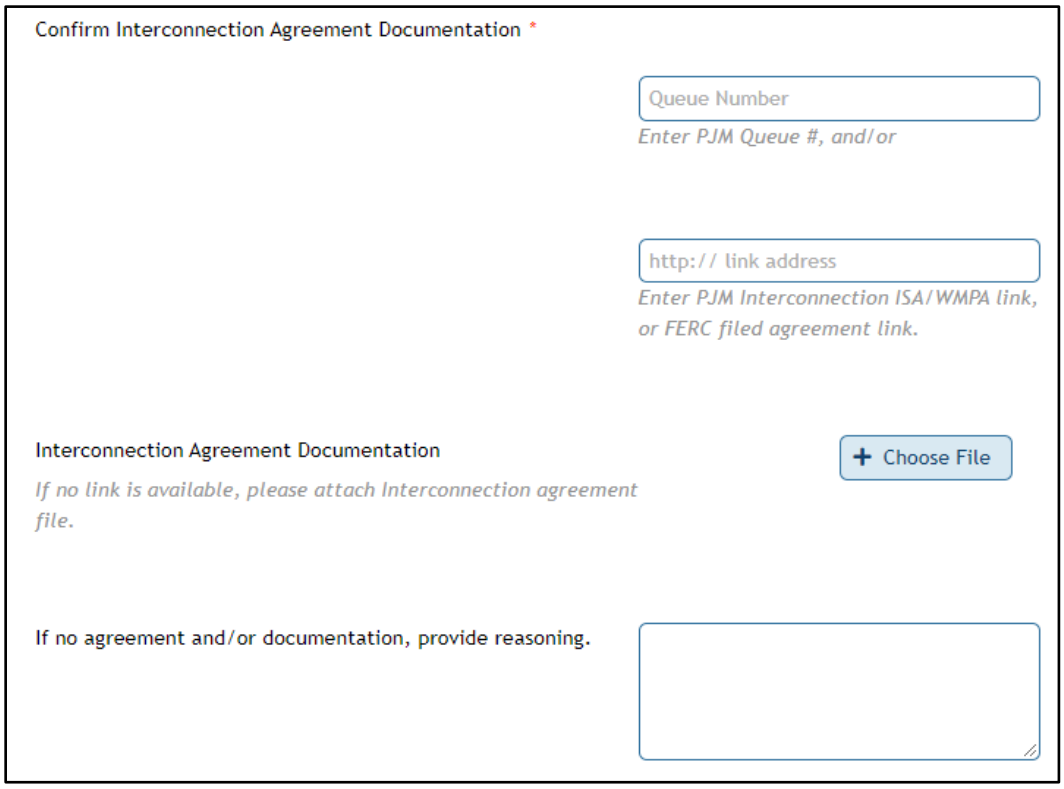


Figure 55 – Interconnection Agreement Information Fields

Generator D-Curve Related Questions

For the next section called "Generator D-Curve Information" as shown in **Figure 56**, PJM is looking for the Generator's D-Curve (which is also known as a Generator Capability Curve) for the individual generator to be attached to the form. An example of a D-Curve is shown in **Figure 58**.

If a D-Curve is not available or cannot be provided, please select "No" and provide additional reasoning as shown in **Figure 57**.

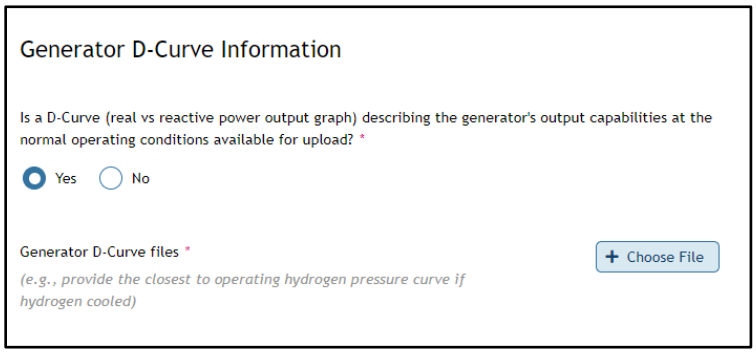


Figure 56 – Generator D-Curve Information Fields

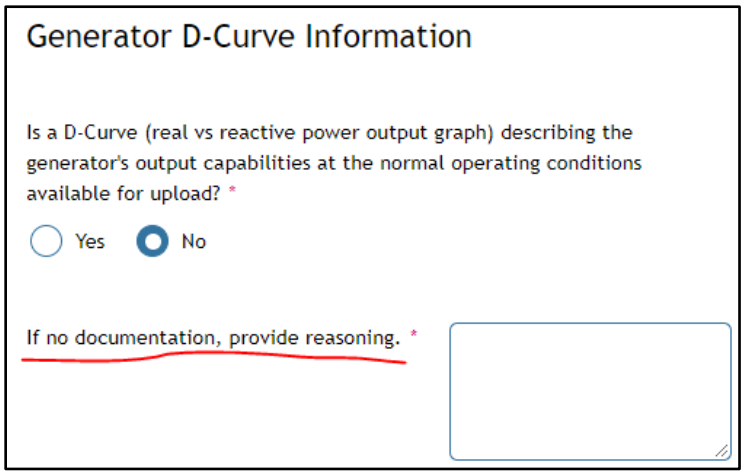


Figure 57 – Generator D-Curve Fields – No D-Curve

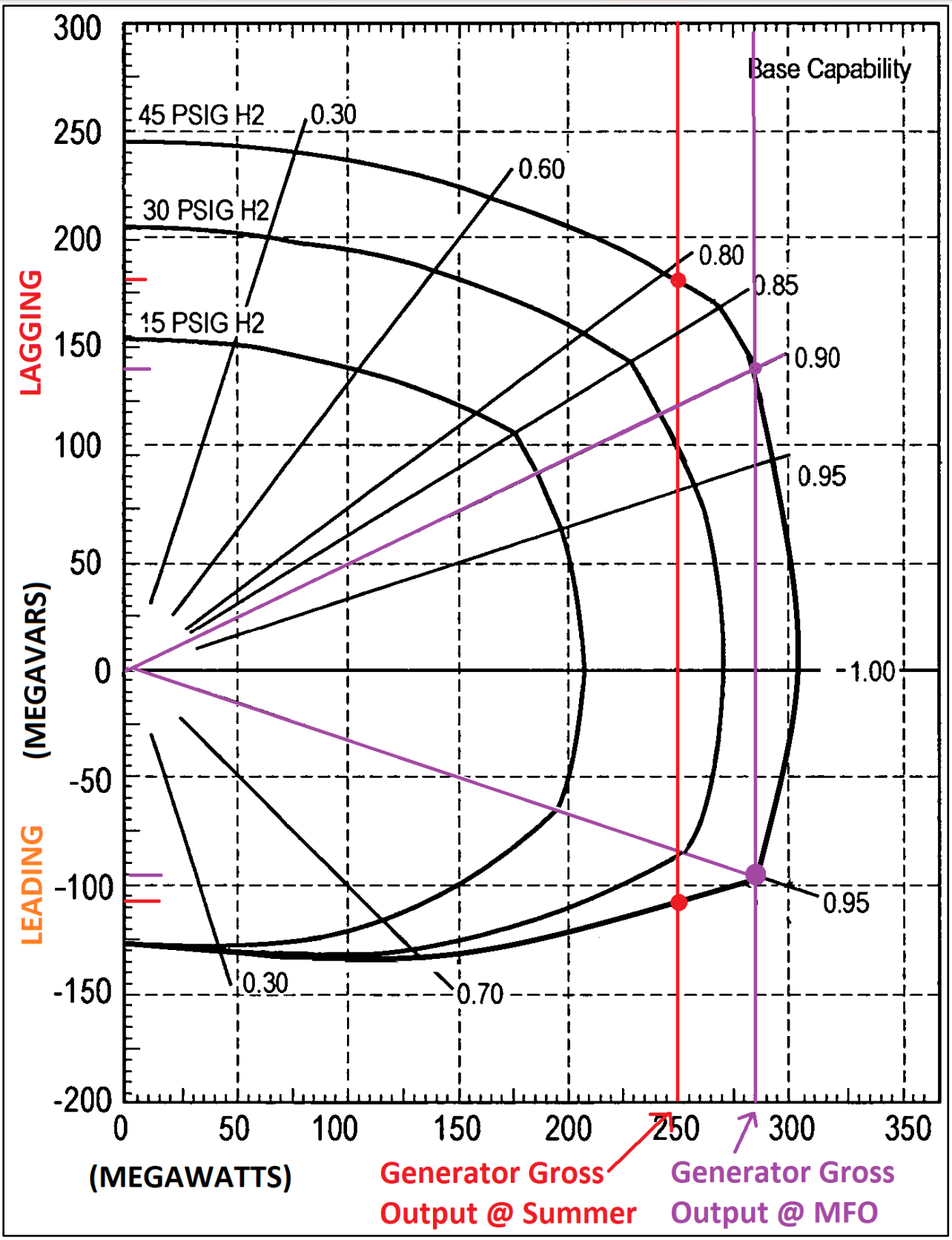


Figure 58 – Generator D-Curve Example

EIA Information Related Questions

The EIA Information section as shown in **Figure 59** is looking for the following parameters, many of which can be found provided to the EIA-860 document.

- EIA Plant Code
  - Each EIA Plant code should have one submission in Gen Model. This will prepopulate based on what was provided on the "General Information" form.
- EIA Generator ID Code(s)
  - Each EIA Generator code should have one machine form as a part of that submission. Please use the appropriate form (either synchronous, inverter-based, or wind farm) to add each machine under your Plant with a valid "Machine Id." Once each new machine is added, you can go to the "Maximum Facility output data form" to assign the newly added units from that form with EIA Generator Code.
  - If the correct EIA Generator Code is not available from the drop-down, please select "New-Generator." PJM will then assign the new generator with the appropriate EIA Generator Code once it is added to the EIA.
- Once a submission is made the EIA codes cannot be changed, even when copying in data from previous years. If an EIA Plant code, Generator code, or a machine ID needs to be changed or added, please email MOD-032@pjm.com.

- Generator MVA Base
- Installed Nameplate Capacity (MW)
  - This value is typically provided in EIA 860 form.
- Nominal Power Factor
  - This value is typically provided for EIA 860 form for Synchronous Generators. Even though this field is not tracked for Wind Farms and Inverter-Based Generators in the EIA-860, we are still looking for the user to provide this value.

Figure 59 – EIA Information Fields

Maximum Facility Output Data Related Questions

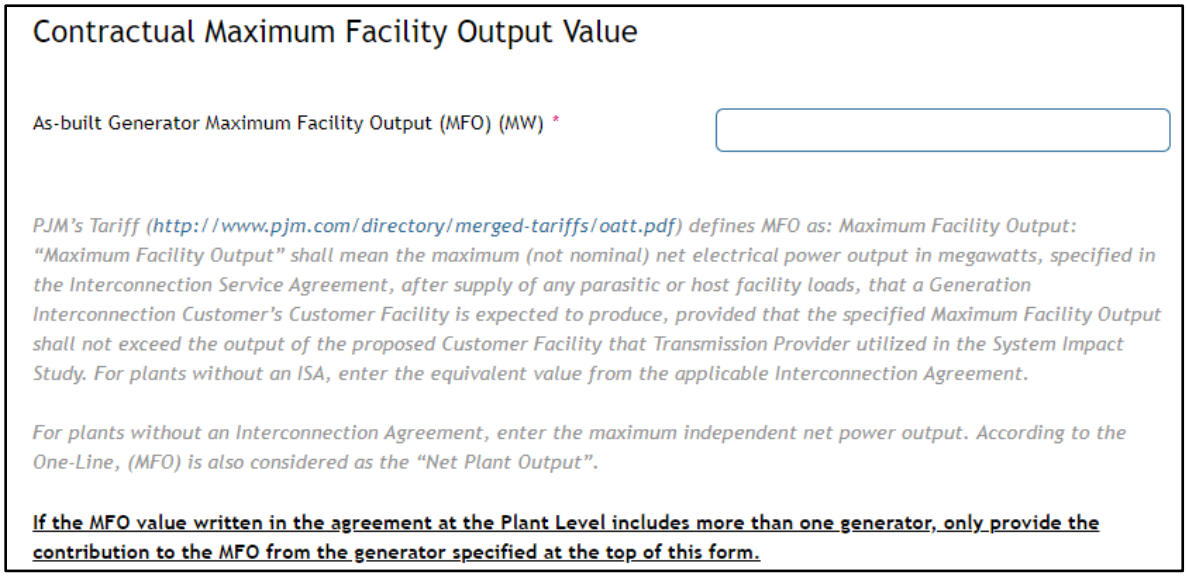


Figure 60 – Maximum Facility Output Value Field

As mentioned in the background information, each interconnected generator must have an interconnection agreement permitting the interconnection and power injection onto the system. A generator can only have a single IA or ISA of record. PJM is only seeking the current, active interconnection agreement. PJM does not require any IA or ISA that has been superseded through subsequent interconnection queue activity.

For the Maximum Facility Output (MFO) value, the definition of how to determine that value is specified in the text shown in **Figure 60**, the MFO field in gray text. Please note that there can only be one value for MFO.

If multiple generating units are covered under a single ISA and the ISA does not identify individual unit MFO, then the GO must provide by unit, the amount of power output towards the total MFO identified in the agreement. In those situations, this information will need to be clarified in **Figure 62Error! Reference source not found.**. **Figure 61** shows an example of an ISA where the MFO values are explicitly stated per generator. This level of detail may not always be included in the ISA so the answers to the questions shown in **Figure 62** may vary.

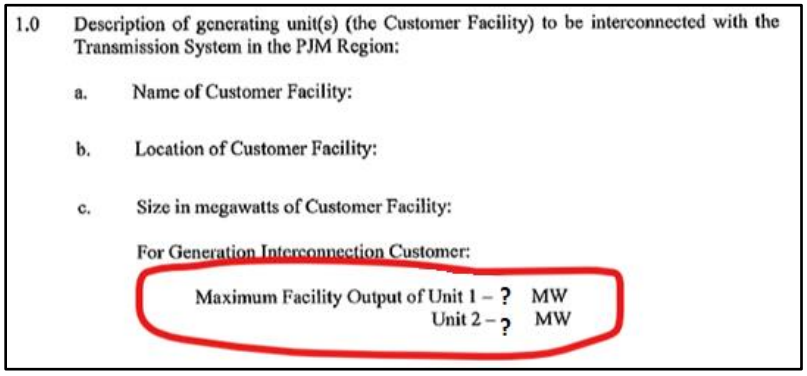


Figure 61 – Clarification of MFO Value with Respect to Other Generators

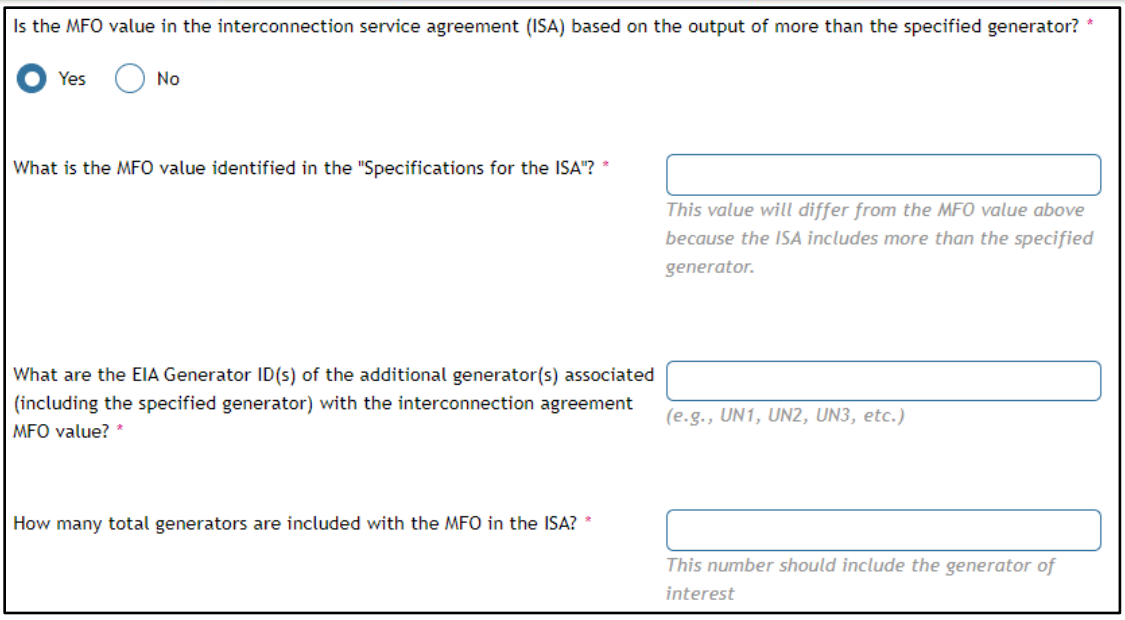


Figure 62 – Gen Model Form - Clarification of MFO Value with Respect to Other Generators

Weather Assumptions Used To Determine MFO

There are a list of questions shown in **Figure 63**, that relate to the weather assumptions used when determining the MFO value. MFO is the seasonally independent maximum net output. There are no "default" values to use when determining the weather considerations used for the MFO, you'll need to consult generator output capability curves. If no capability curves or other documentation is available to determine generator capability, you may estimate MFO from historical data.

Reliability is the primary concern for the collection of this data and our studies will assume the economic conditions are present that would drive the generator to whichever extreme causes the most stress for reliability to ensure the transmission system can handle those conditions.

To be clear, not all these assumptions may apply to your particular unit as shown in **Figure 63**. For example, Wind Farms would not need to consider Cooling Water temperature when determining their generator output.

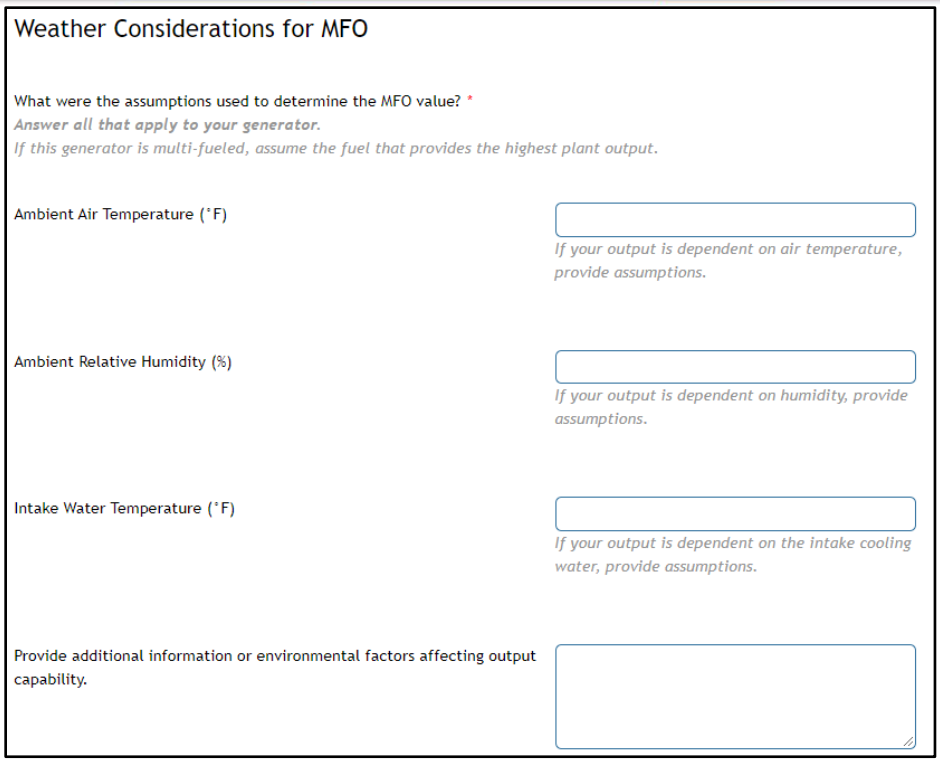


Figure 63 – Weather Considerations to determine the Generator MFO

Reactive Support and Dependent Generator Loads Related to the MFO

If your generator has a reactive support device (i.e., such as a capacitor bank, SVC, etc.) that were installed and used with the specific intent for the particular generator to meet PF requirements, this should be noted in Gen Model as shown in **Figure 64**. This includes devices that may not even be owned by the GO. Provide both the Leading and Lagging portion value (in MVAR) that the capacitor provides support to meet PF requirements.

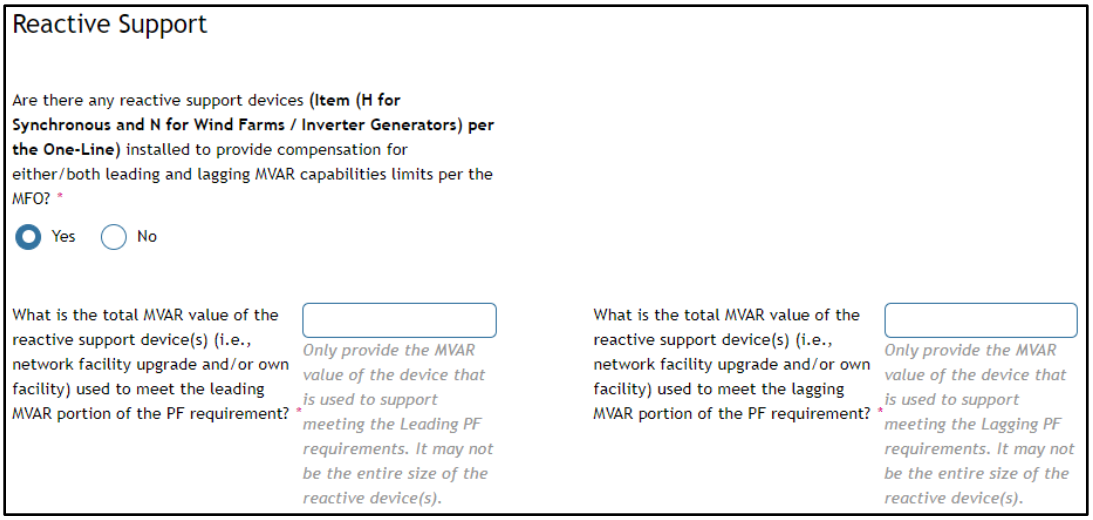


Figure 64 – Reactive Support Device @ MFO Conditions

For the question shown in **Figure 65**, we are looking for the generator gross output value MW at the generator terminals. One the one-line diagrams (Item A1 on the Synchronous Generator one-line diagram and J1 for Wind Farm / Inverter-Based Generators).

This question is specifically asking for the **total gross output** so provide the overall unit MW output regardless if this generator has been uprated in the past.

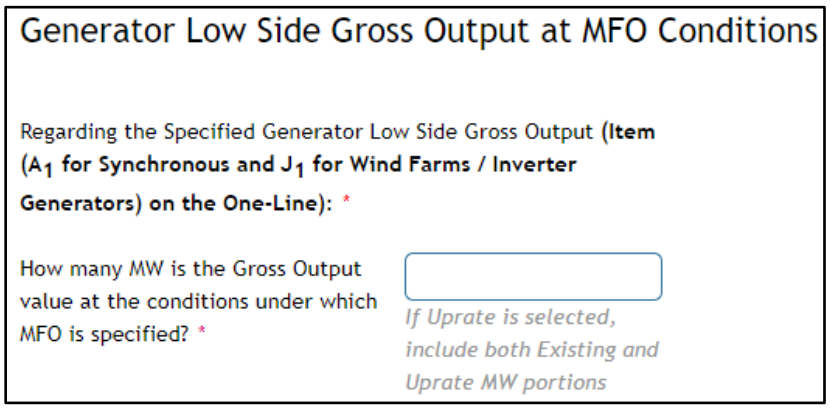


Figure 65 – Generator Low Side Output @ MFO Conditions

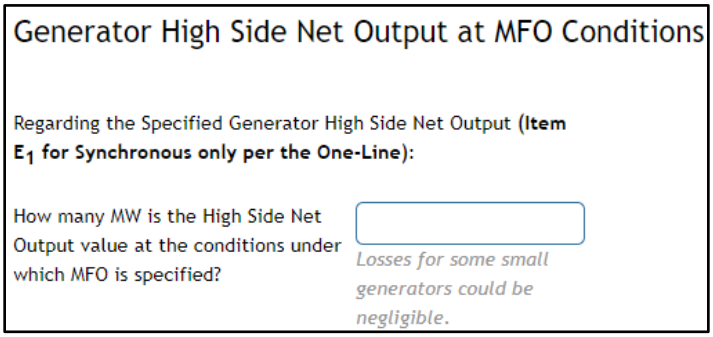


Figure 66 – Generator High Side Net output @ MFO Conditions

The question for **Figure 66**, relates only for Synchronous Generators. Some generators have SCADA data that can provide accurate MW readings of the amount of power flow on the high side of the GSU. This is an OPTIONAL field but helpful for PJM to potentially identify an errors in our model (GSU impedances, etc.).

The next questions shown in **Figure 67** and **Figure 68** are related to loads that are related to the Generator at MFO conditions. Continue to refer to the one-line diagrams for each type of generator as mentioned above which describes the type of load (e.g., High Side Connected Transformer Load, Remotely Connected Transformer Load, Tertiary Load). Also, included in the PJM.COM website as shown in **Figure 1**, are definitions to terms used in the Diagrams.

Another important clarification to note is that for Auxiliary Loads and Station Service Loads, the values should be provided under normal operating conditions. Normal operating conditions do not include plant outages, start up times, load transfers, and emergency condition scenarios.

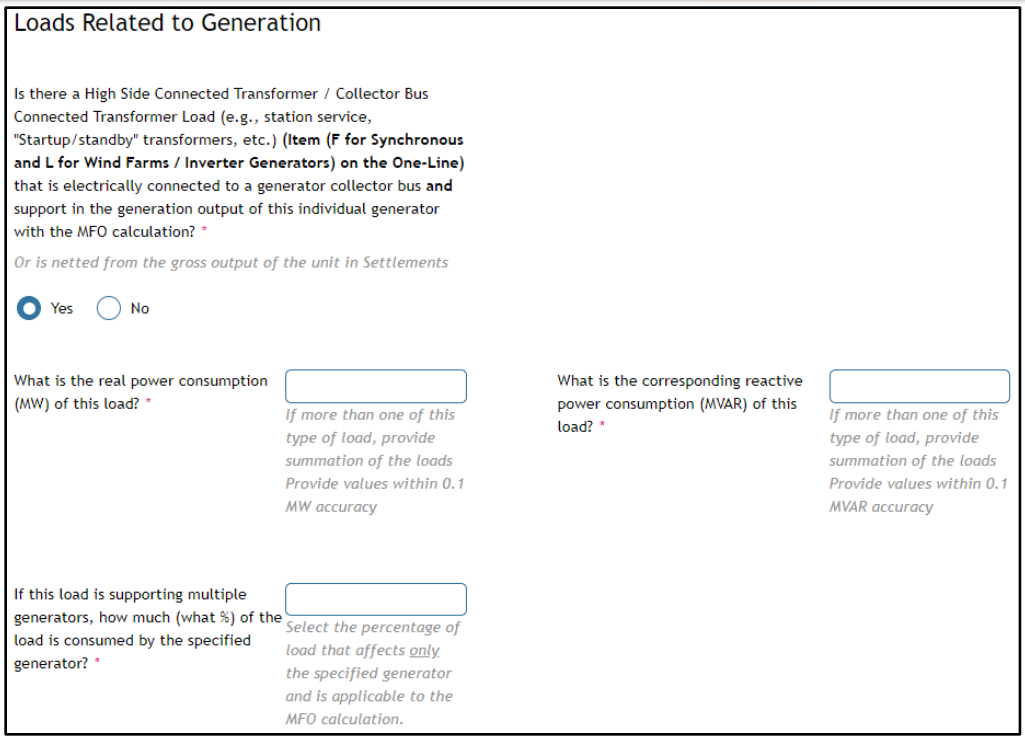


Figure 67 – Loads related to the generator at MFO Conditions

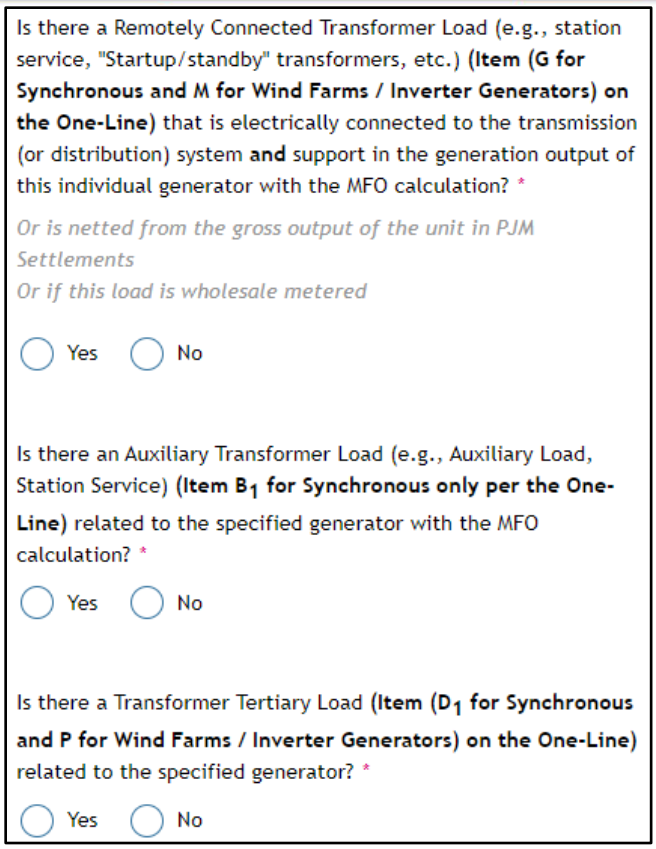


Figure 68 –Loads related to the generator @ MFO conditions Continued

Auxiliary Transformer Loads are only included for Synchronous Generator loads as those values are considered minimal for Wind Farms / Inverter Based Generators.

There are also generating stations where there are loads that are used to support more than an individual generating unit. For those situations, we have offered the ability to take that total load value and perform a simple proportion of that load to the specified generator.

There may be situations where this actually becomes complicated, refer to the Frequently asked Question below and it may be easier to represent those loads in a different fashion.

Frequently Asked Question –

For my particular generator, it is not always possible to neatly subdivide loads to answer the following question, "If this load is supporting multiple units, how much (what %) of the load is consumed by the specified generator."

Consider for example a plant with three generation units and two HS-connected load transformers. The load transformers send 4 MW to Unit #1, 4 MW to Unit #2, and 8 MW to Unit #3 when all three units are simultaneously at the MFO, while also feeding 12 MW to a single piece of equipment (cooling tower) shared by all three units.

In this situation, we believe that the only workable solution is to answer "NO" to this question and apportion the loads as follows (based on the MFOs being 350 MW for Unit #1, 400 MW for Unit #2 and 700 MW for Unit #3):

- 6.9 MW for Unit-1 (= 4 + 12 x 350/(350+400+700)),

- 7.3 MW for U-2 (= 4 + 12 x 400/(350+400+700)), and
- 13.8 MW for U-3 (= 8 + 12 x 700/(350+400+700))

Does PJM agree with approach (applied the same for the MVAR questions)?

- The intent of this question is to ensure that the values of all the loads that are aggregated together along with the gross output should equal the MFO value. If apportioning the loads is easier for the user to meet that intent, then it is acceptable with PJM.
- This approach can also be used for the MVAR values.

Power Factor Requirements

PJM is requiring the GOs to specifically validate their MFO, Power Factor (PF) and Leading and Lagging requirement values, and the measurement location of the generator output per the interconnection agreements. The questions shown in **Figure 69** relate to confirming the PF Requirements.

For generators that have gone through the PJM Queue process AND have a had an uprate. Provide both the Net and Gross MW output for both the "existing" and the "up-rate" portion of the generator.

The terms "existing" and "up-rate" are specifically defined in the PJM IA and can vary due to how the agreement was written. Typically for generators that have not have any uprate through the PJM queue, "existing" refers to the entire generator.

Generators that may have had physical uprates but came into PJM after any uprate, should assume that the entire "generator" is treated for this form as not having an uprate as far as PJM is concerned.

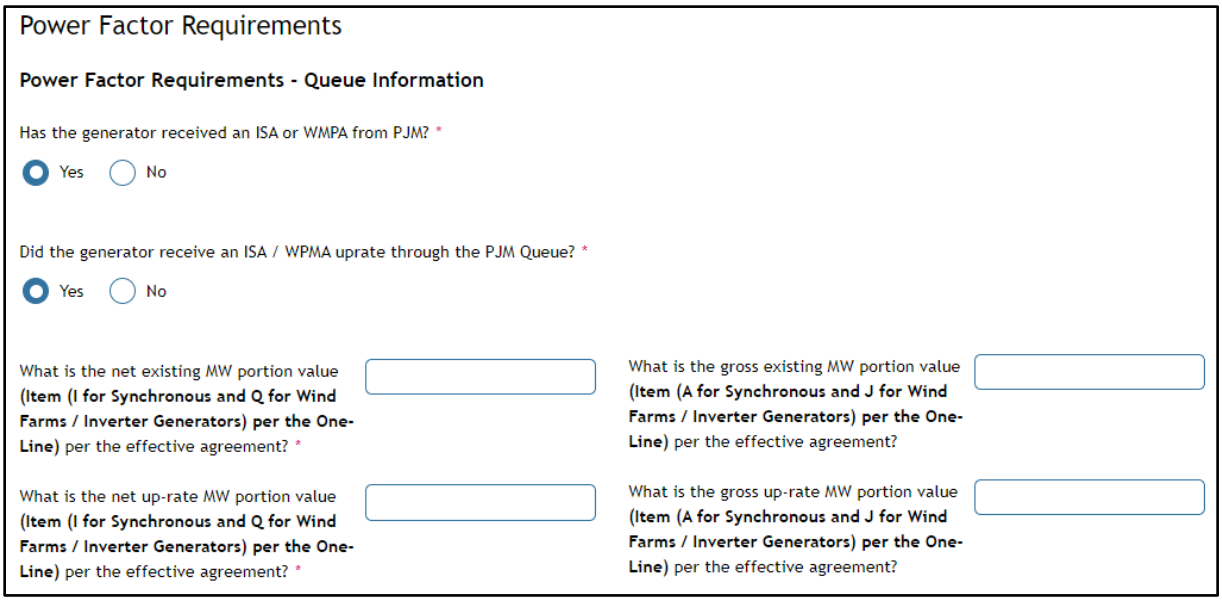


Figure 69 – PF Requirements – When Generator is part of the PJM Interconnection Queue and has had an uprate

The next section of the PF Requirements section is questions (as shown in **Figure 70**) relates to the location of the PF measurement WITH RESPECT TO THE INTERCONNECTION AGREEMENT. Several common locations have been identified in the drop down field. For those who select "Other Location", please provide additional information.

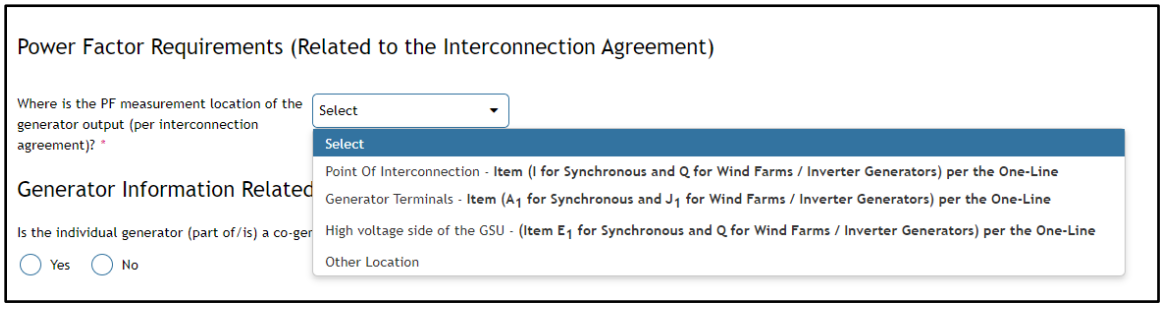


Figure 70 – Location of the PF Measurement (Related to the Interconnection Agreement)

In addition to documenting the location of the PF measurement point with respect to the Interconnection Agreement, PJM is looking to confirm the PF Leading and Lagging values as shown in **Figure 71**. This value can be provided in either MVAR or PF.

As mentioned earlier, if a generator has gone through the PJM Queue with an uprate, the form is looking for the PF requirement values as shown in **Figure 72** for both the "existing" and "uprate" portions PER THE INTERCONNECTION AGREEMENTS (IA).

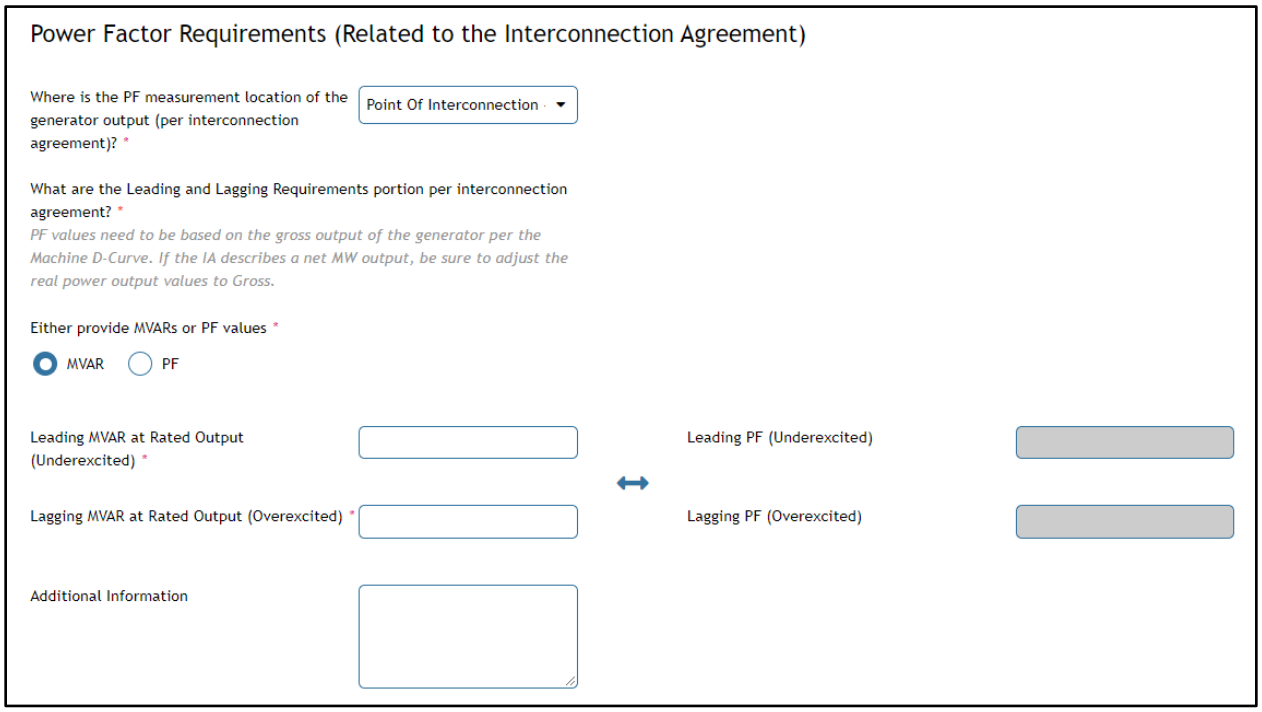


Figure 71 – PF Requirements (Related to the Interconnection Agreement)

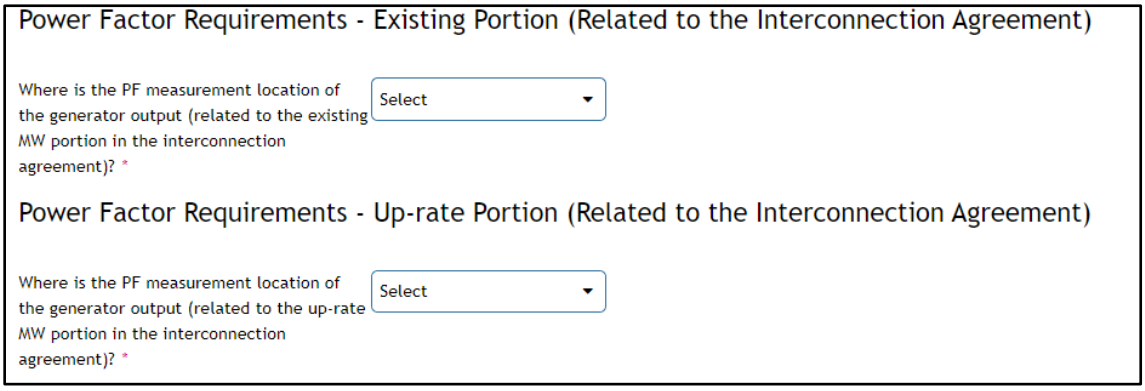


Figure 72 – PF Requirements (Related to the Interconnection Agreement) for generators with uprates

Frequently Asked Question - Regarding the question, "For Leading and Lagging Power Factor Capabilities", the ISA has our generator's capability for Leading as 1.0 (unity) which is based on voltage limitations on the Plant's safety buses (i.e. licensing limits) rather than the D-Curve. What value should we input?

- In this particular case, the generator is limited to unity for leading. You can submit unity leading; because regardless of the generator D curve, the unit is constrained by Nuclear Technical Spec limitations that cannot be violated.
- Please add in a free form comment section a statement such as, "While the generator can produce X MVAR leading, the unit's Tech Specs limit leading to unity due to safety bus voltage limitations."

The last main requirement in this section of questions refers to the "Leading and Lagging MVAR Capabilities" at MFO conditions. These questions relate to the ACTUAL reactive power capability AT MFO conditions as opposed to what is written in the agreement. These questions are shown in **Figure 73**.

This field is looking for the gross MVAR values at MFO conditions for Leading and Lagging capabilities. If the values are calculated anywhere other than the generator terminals, adjust the values as if they were at the generator terminals.

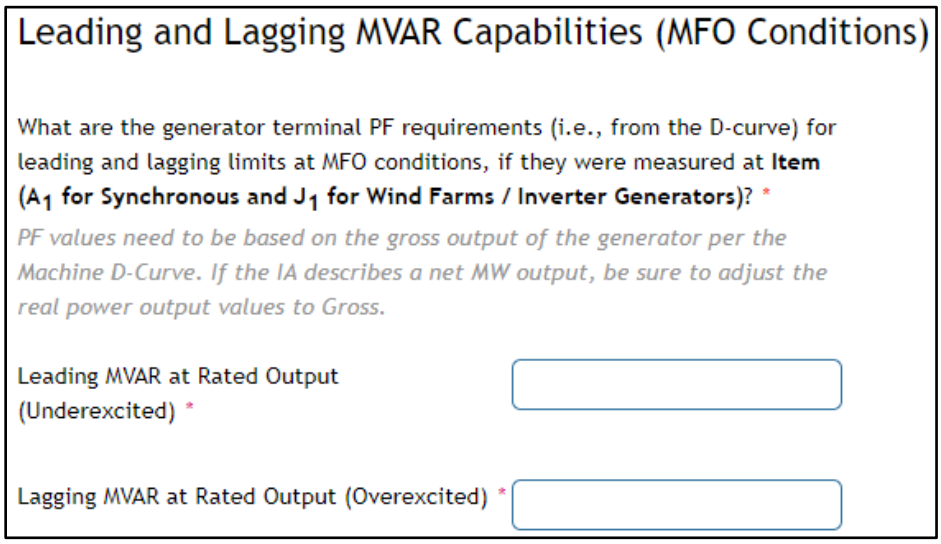


Figure 73 – Leading and Lagging MVAR Capabilities @ MFO Conditions

Process Loads

The questions for "Process Loads" as shown in **Figure 74** only apply for Synchronous generators. For generators that are part of a co-generation plant, they may have Process loads. PJM is looking to better track which generators contain process loads.

If the process load contributes as part of the MFO of the generator, please select yes to the question as shown in **Figure 75**.

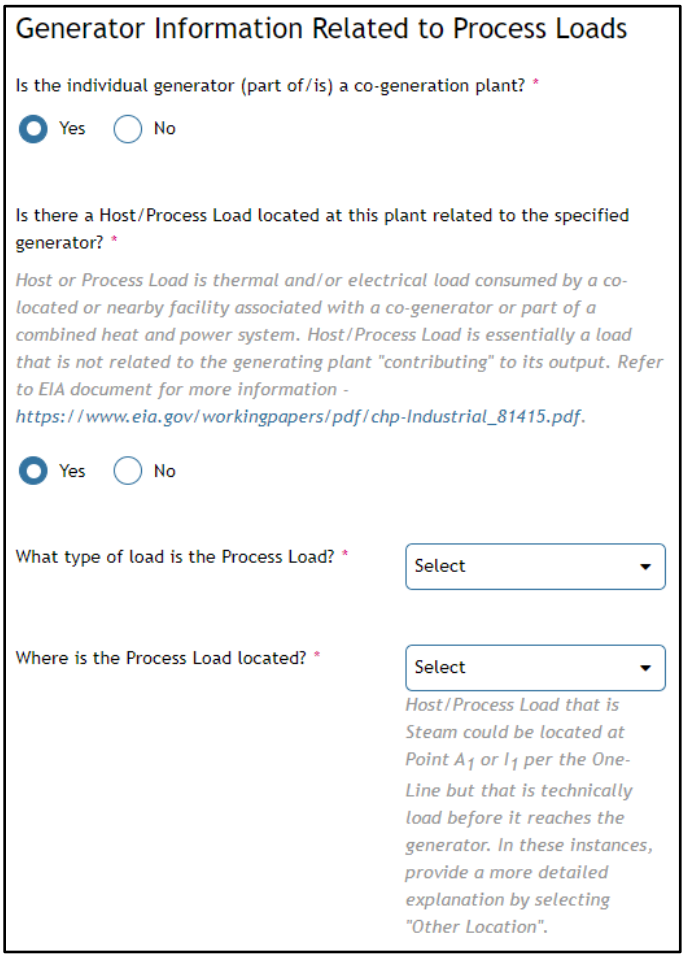


Figure 74 – Process Load Questions related to the MFO

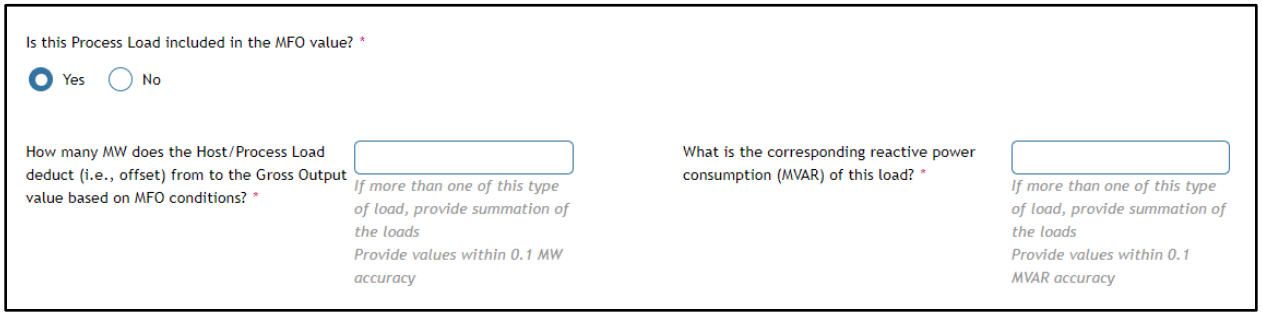


Figure 75 – Process Load Included in MFO

Summer and Winter Peak Output Information

The Generator Owner will need to provide Summer and Winter values for the Maximum and Minimum Gross Output (MW), Installed Capacity (MW), Maximum Net Output (MW), and (MW/MVAR) values for the various loads similar to what was requested under the MFO forms. These questions are shown in **Figure 76**, **Figure 77**, and **Figure 78**.

If you click on each of the question icons shown in **Figure 76**, a pop up box for both Summer and Winter values will appear with assumptions to use when determining these values. Not all these assumptions may apply to your particular unit. For example, Wind Farms would not need to consider Cooling Water temperature when determining their generator output.

As mentioned in earlier sections, the Unit Auxiliary load amount(s) should be provided under normal operating conditions. Normal operating conditions do not include plant outages, start up times, load transfers, and emergency condition scenarios.

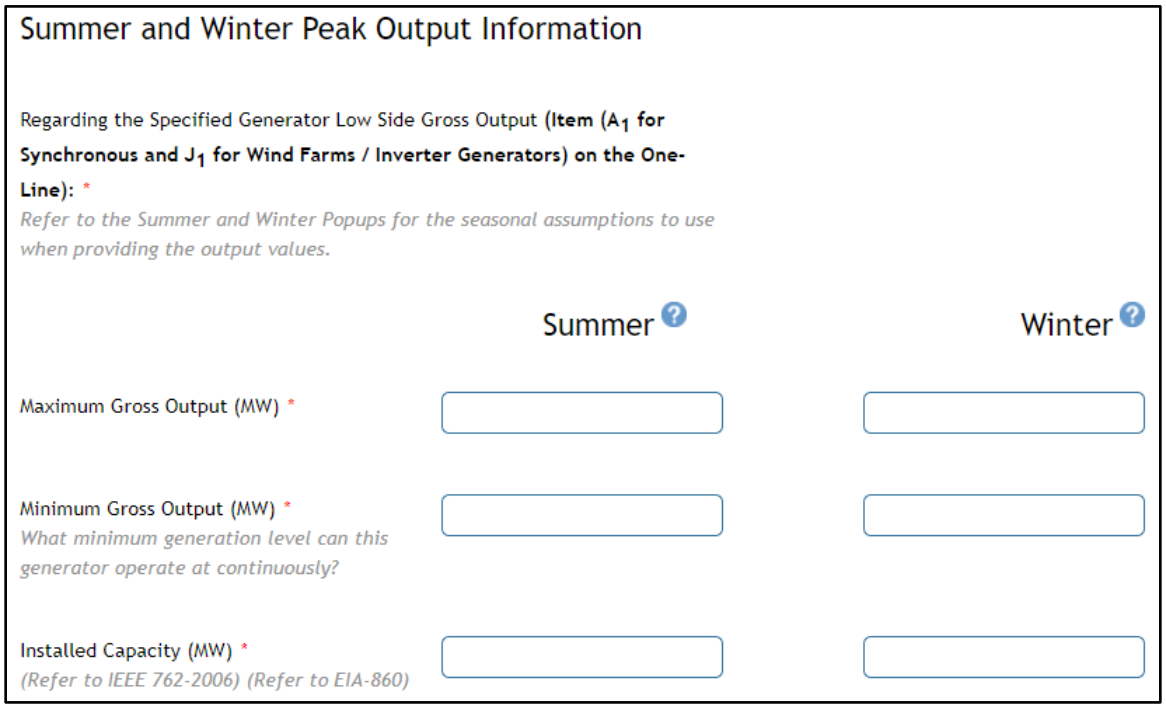


Figure 76 – Summer / Winter Peak Output Values

Frequently Asked Question –

What values for summer and winter output need to be submitted? Generators can typically perform at 2 or more different power levels at a specific condition. For example - Given the summer assumptions provided (Ambient Air= 92 F, Humidity= 45%, etc.) a generator can perform at 100 MW or 110 MW consistently. A gas turbine can use various techniques to achieve this. (Peak fire, fogging, etc.). This number can also be higher than the ICAP value.

- The GO should provide the maximum output the facility can produce trying to maximize profit while assuming an extremely high value per MW under those seasonal considerations. Therefore, the output value used for

Gen Model, should be the power level (e.g., Emergency Max) that provides the maximum money making configuration on a high demand, high MW value day at the assumed environmental conditions.

- In the example, the 110 MW would be the maximum output value. Determining these values should be consistent with the way that a GO operates to fulfill their ICAP obligation. If the GO normally employs capability-enhancing measures such as, but not limited to, compressor inlet cooling, wet compression, peak firing, or boiler overpressure, to meet their ICAP obligation, this should also be assumed when providing output values for the MOD-032 submission. Those same assumptions mentioned above should be used consistently when determining the values of Auxiliary loads, Start Up Units, Station Service loads, etc. that may impact the net output of the generator.

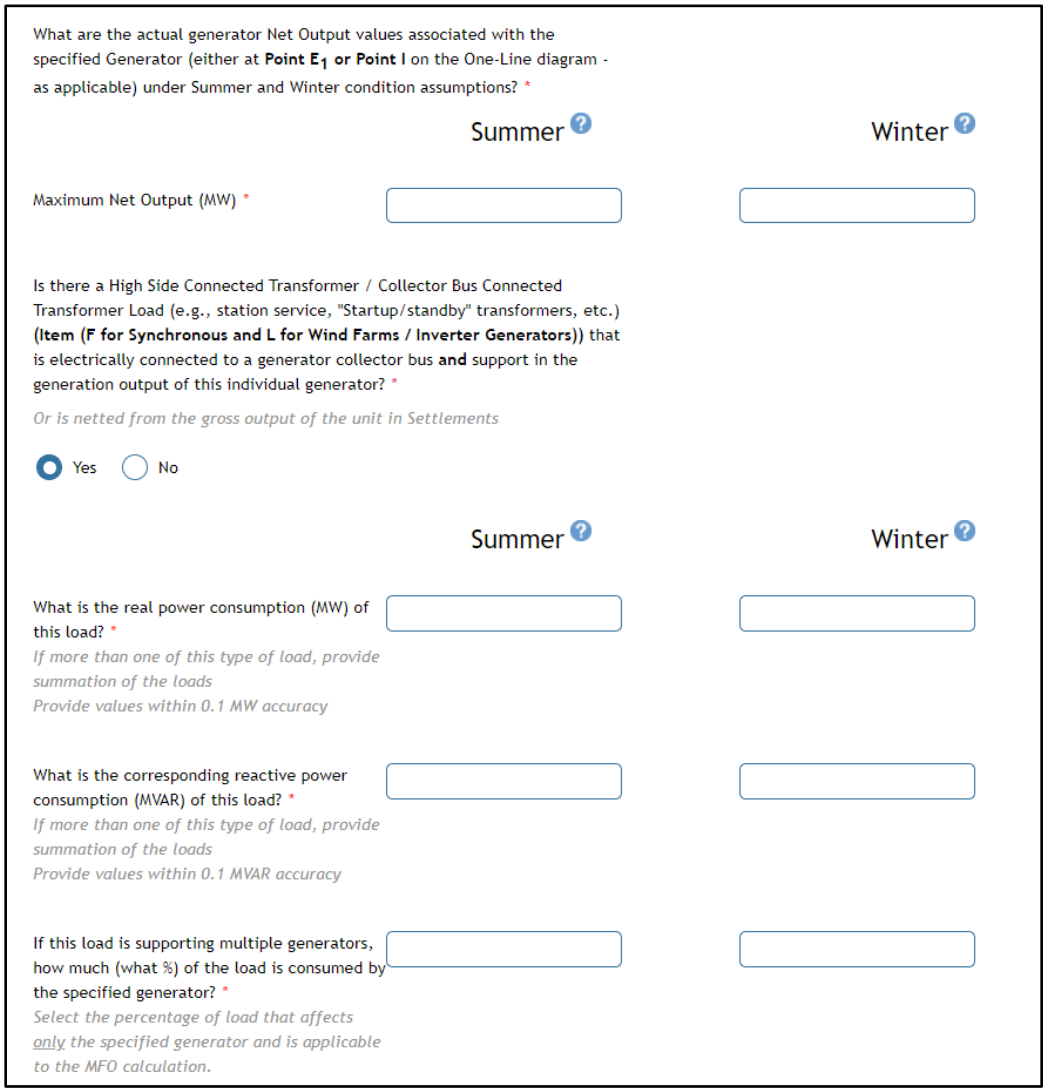


Figure 77 – Summer / Winter Output Values

Is there a Remotely Connected Transformer Load (e.g., station service, "Startup/standby" transformers, etc.) **(Item (G for Synchronous and M for Wind Farms / Inverter Generators))** that is electrically connected to the transmission (or distribution) system **and** support in the generation output of this individual generator? *

Or is netted from the gross output of the unit in PJM Settlements

○ Yes ◉ No

Is there an Auxiliary Transformer Load **(Item B_1 per the One-Line)** related to the specified generator? *

○ Yes ○ No

Is there a Transformer Tertiary Load **(Item (D_1 for Synchronous and P for Wind Farms / Inverter Generators))** related to the specified generator? *

○ Yes ○ No

Figure 78 – Loads that relate to the Generator

Circuit Breakers and Relays

Circuit breakers owned by the GO on the high side of the GSU and operating at 100 kV or greater should be captured in the "Circuit Breakers" form. In **Figure 79**, this would correlate to the B1 breaker. If the GO does not own any such circuit breakers, they should check the "Not Applicable" box.

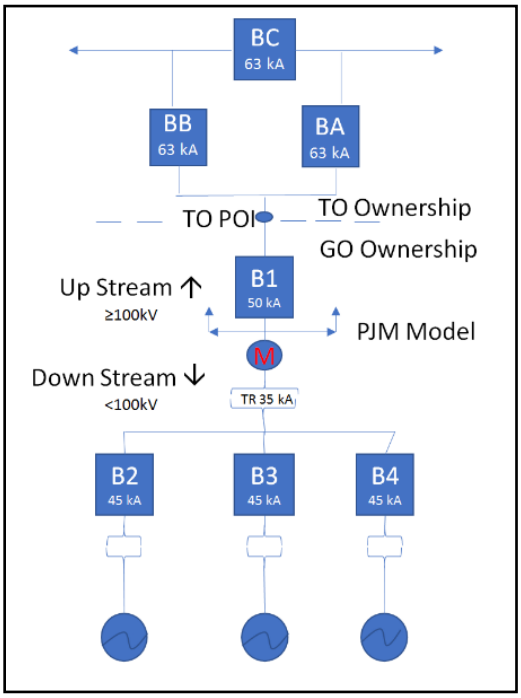


Figure 79 – Wind Circuit Breakers that PJM Models Example

To begin entering circuit breaker data, click on the pencil icon in the actions column and you will be brought to the form shown in **Figure 80**. To add a circuit breaker, click on the drop down and click "Yes" and the circuit breaker form will load, as shown in **Figure 80**. GOs should fill out Nameplate Interrupting Rating in either kA or MVA depending on how their circuit breaker is rated.

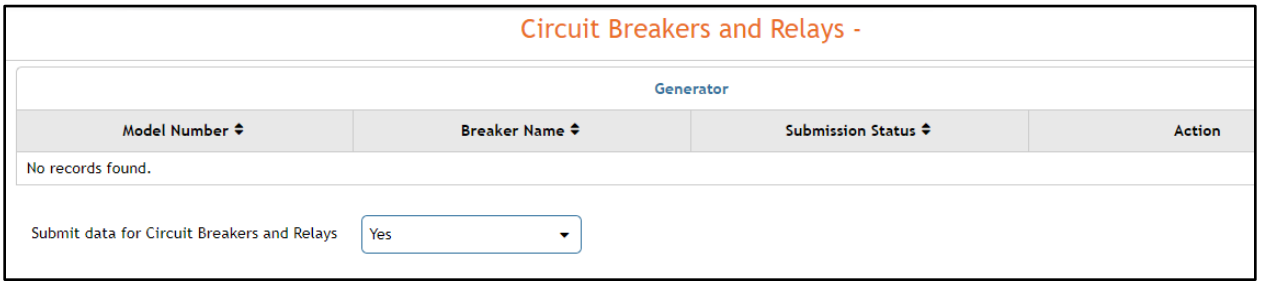


Figure 80 – Circuit Breaker (CB) Screen

Relay information related to PRC-024 compliance is collected on this form as well. PRC-024 Compliance information is represented in the questions that are included in the red box as shown in **Figure 81**. This information is further expanded when the user selects YES on any of the questions as shown below in **Figure 82**.

Please review several of the FAQs mentioned below for additional guidance.

Frequently Asked Question - If a facility has protection relays monitoring electrical quantities but they do not trip a BES breaker and, hence, are not included in PRC-005, should they be included in PJM's Gen Model entries?

- The intent is to capture PRC-024 related information about the most restrictive relay that could take the generator offline due to voltage or frequency deviation from nominal.

Frequently Asked Question - Are V/Hz relays to be included under both the frequency and voltage categories, assuming 60 Hz for the voltage settings and the rated voltage for frequency settings?

- PJM is not requesting V/Hz relays as part of Gen Model at this time.

Frequently Asked Question - If the GO has frequency and/or voltage relays, but the TO owns the breaker, will PJM allow us to upload responses of "N/A" or "Owned by TO," for the CB-related questions of this worksheet, e.g. interrupting rating, K factor etc? If not, how should the GO address this conflict?

- This is a good question, and it is not ideal that we have not yet been able to get these questions re-located to no longer be tied to CBs. Gen Model will not let you skip any of the required fields marked by a red asterisk, however, you can enter "TO owned" for the text fields and use a dummy numerical value (such as 999) for the required numerical fields.

Frequently Asked Question – The GO does not own any applicable circuit breakers. Since this Plant does not have a circuit breaker and relay page in the Gen Model, how do we report our under frequency relay information?

- Please enter the relay information in the "Circuit Breakers and Relays" page as though it were for a CB, but put "relay" for any of the text inputs (such as substation name, manufacturer, etc.) and use "999" as a dummy value for any required numerical inputs that are not applicable to the relays.

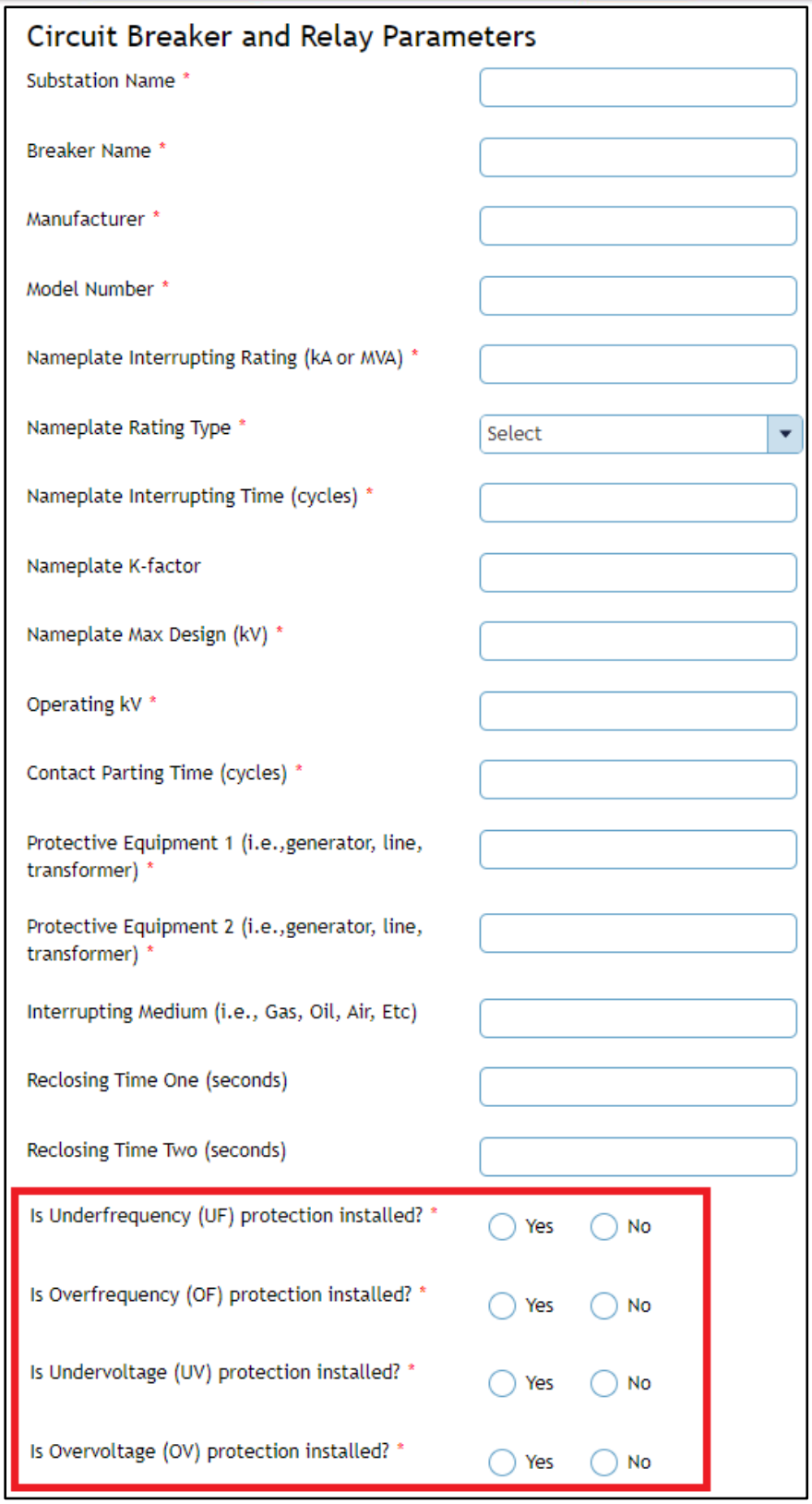


Figure 81 –Circuit Breaker Form

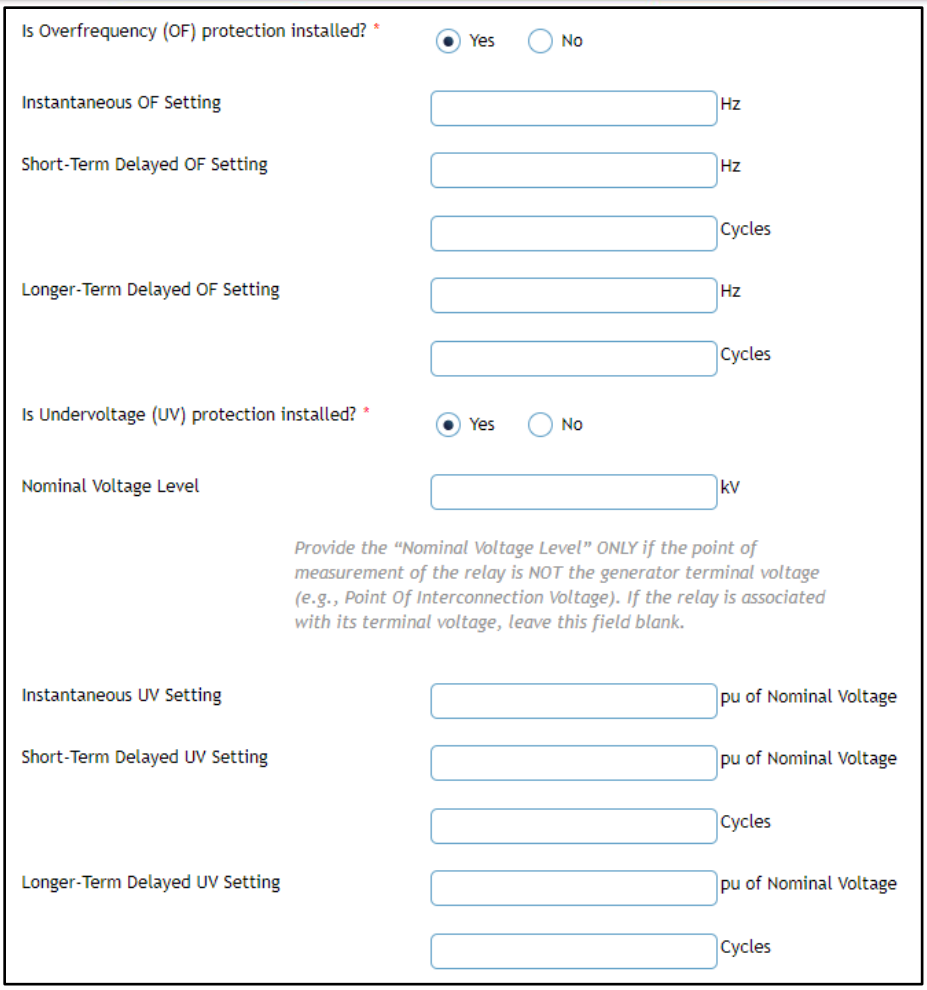


Figure 82 –PRC-024 Information Detailed Form

There are three settings that should be provided (if applicable) – Instantaneous, Short Term Delayed, and Longer Term Delayed for Underfrequency (UF), Overfrequency (OF), Undervoltage (UV), Overvoltage (OV) types of relay protection systems. There may be instances where the relay does not have all three settings and therefore all three types of fields are not mandatory.

Frequently Asked Question - How should we identify "short-term delayed," and, "longer-term delayed," settings for relays with an inverse-time characteristic? Is it OK if we select the appropriate benchmarks, (e.g., 0.5 sec and 2 sec respectively in one case, and 10 and 100 sec in another)?

- Selecting appropriate points along the inverse time characteristic curve is acceptable.

The user can save progress at any time by clicking the Save Draft button. Upon completing the required data, the user can click "Submit." The data will then be submitted and they will be returned to the Plant Form Navigation screen. As soon as one submission is received, the form status for Circuit Breakers will be Complete. However, if more circuit breakers need to be entered, the user should once again click the pencil icon to navigate to the circuit breaker page, and select "Yes" from the drop down menu.

Main Transformer

The Main Transformer sheet may be used to provide data for transformers that were not captured on Synchronous, Wind Farm, or Inverter-Based generator forms. This form can be accessed via the webpage shown in **Figure 83**.

As mentioned in the section **One Line Diagrams**, a simplified one-line diagram for each of the different generator types (Synchronous, Wind Farm, and Inverter-Based). Refer to **Figure 96**, **Figure 97**, and **Figure 98Figure 83** to determine which

- **Figure 96** – Synchronous Generator
- **Figure 97** – Wind Farm Generator
- **Figure 98** – Inverter Based Generator

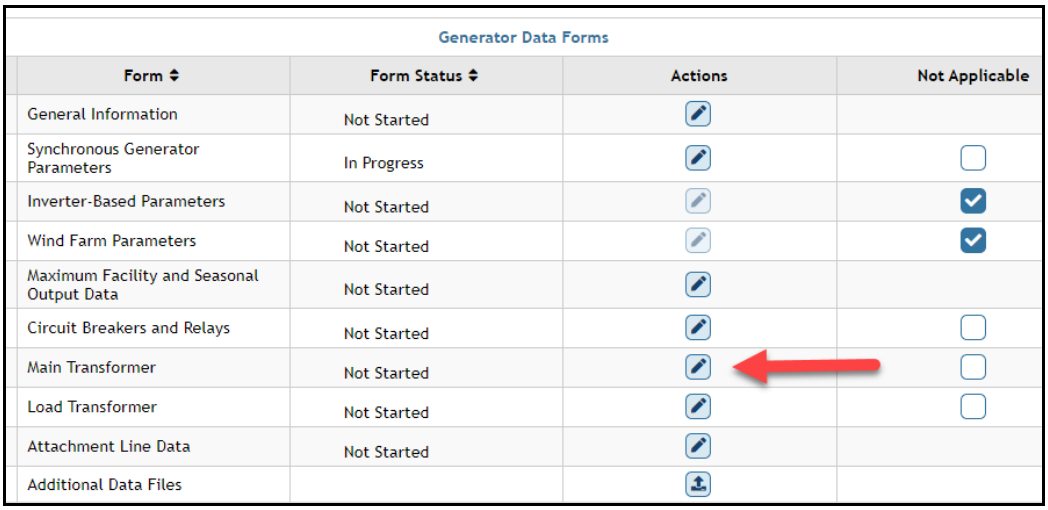


Figure 83 – Main Transformer Form Selection

As shown below in **Figure 96**, Synchronous Generator Step-Up Transformers are submitted in the "Synchronous Generator Parameter form" and therefore does not need to be submitted in the "Main Transformer" form.

The "Main Transformer" form is similar to the Step-Up Transformers are submitted in the "Synchronous Generator Parameter form. For more detailed information on how to submit information in this form, refer back to the **Step-Up Transformer** section.

Similar to the "General Information" form at the bottom has Back, Save Draft, and Submit buttons. Clicking "Back" will take you back to the Plant Form Navigation screen. It will NOT save your progress in the sheet. Clicking "Save Draft" will save your current data in the form. Once all required data is filled out without any errors, you can submit the form. If required data is missing or data is outside the constraints of the box, the form will alert you. If the form is complete, you will be returned to the Plant Form Navigation screen and the form status for the "Main Transformer" form will be "Complete."

Load Transformer

The Load Transformer sheet is for those that have an additional transformer for BES (≥100 kV) connected loads at the plant.

As shown in **Figure 96**, **Figure 97**, and **Figure 98**, Load Transformers could represent Transformers shown as "F" and/or "G" or "L and/or M" on the one-lines. For most submissions, load transformer data is not necessary and the GO can select "Not Applicable," as shown in **Figure 84**.

Frequently Asked Question –

When a load transformer supports two generation units should we fill-out a Load Transformer worksheet for just one of them but not the other, or should we have identical Load Transformer worksheets for both units but using the same transformer ID –

- Just fill in data for the transformer once.

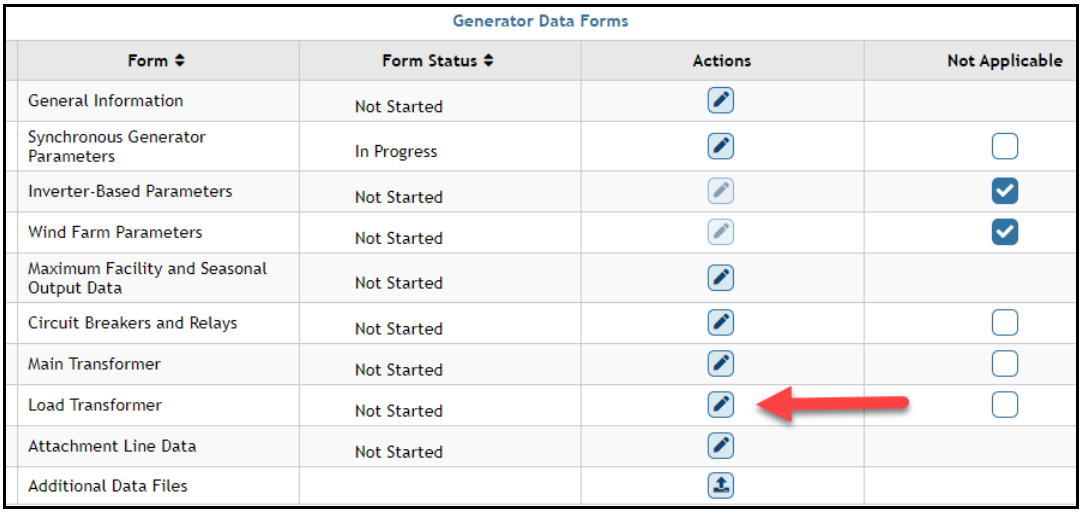


Figure 84 –Plant Form Navigation Screen with Load Transformer checked as Not Applicable

For those situations that a load transformer is owned by the generation owner, click on the pencil and it will take you to the load transformer sheet shown in **Figure 85**. Selecting "Load Transformer" from the drop down, will pull up the form to submit information on the transformer.

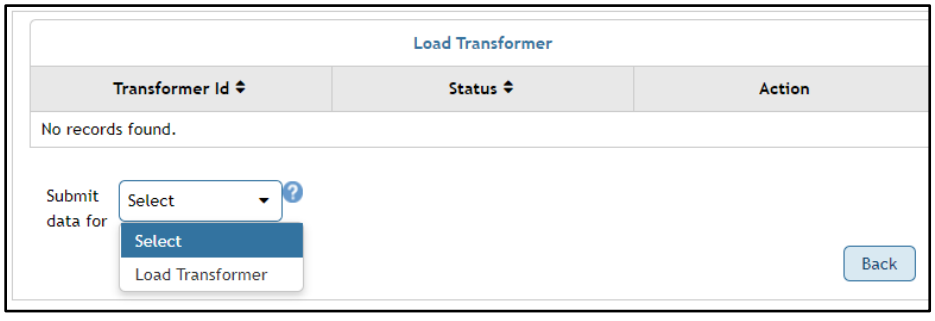


Figure 85 –Load Transformer Screen

Attachment Line Data

For GOs that own the lead line to the generator, the "Attachment Line Data" form should be filled out. To begin entering data for the attachment line, click on the pencil in the actions column for the Attachment Line Data form, indicated by the red arrow in **Figure 86**.

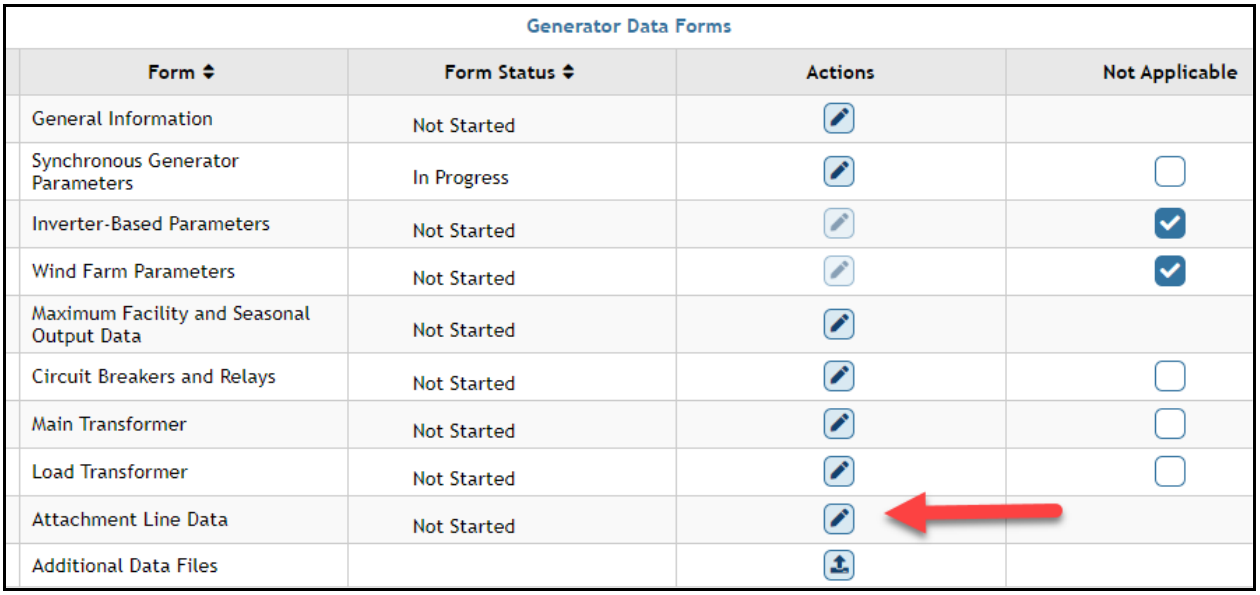


Figure 86 –Selecting Attachment Line Data on the Plant Form Navigation Screen

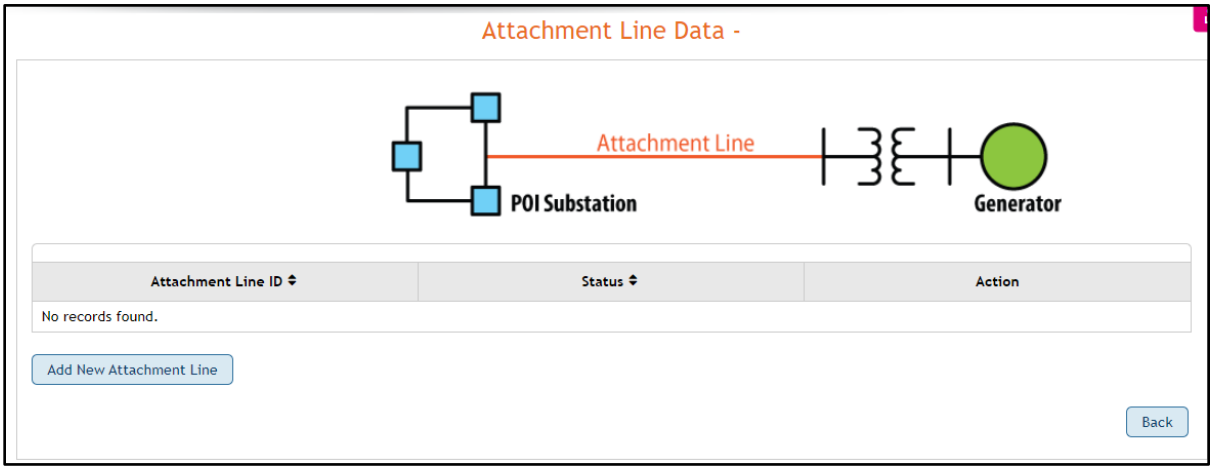


Figure 87 – Attachment Line Initial Display

Figure 87 is how the Attachment Line display looks initially. **It should be noted that there is no "Not Applicable" option for this form, so it must be filled out before being able to submit plant data.** If the generator is directly connected to the substation and there is no lead line or the line length is less than 0.2 miles, click NO where it states, "Is line length greater than 0.2 miles?" as shown in **Figure 88** below. If YES is selected, the form will expand as shown in **Figure 89** to ask for line impedances. Ratings for lines are required regardless of length for FAC-008 compliance as shown in **Figure 90**.

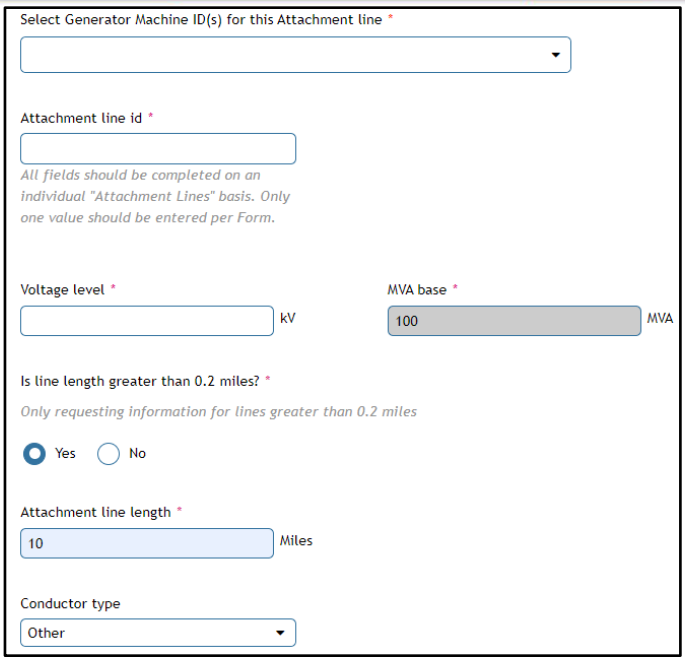


Figure 88 –Attachment Line Data Form Initial

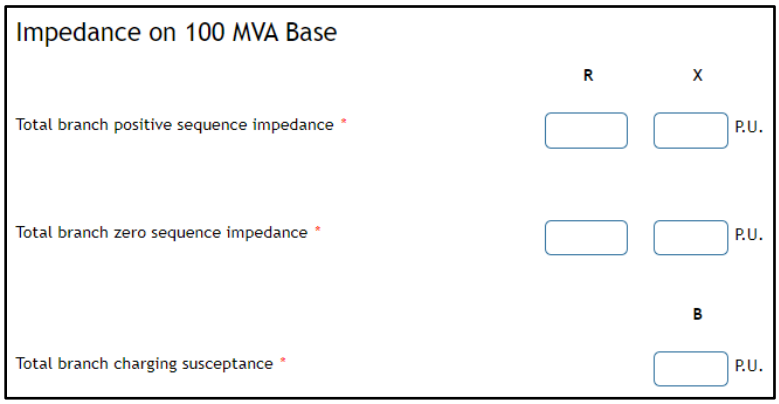


Figure 89 – Attachment Line Impedances Section

Regarding the Ratings for the attachment line, provide the most limiting ratings for either FAC-008 R1 and/or R2. This depends on whether or not the generator owns the portion of the attachment line that includes R1 and/or R2.

The Generator owner is only responsible for providing ratings and impedances for the portion of the line that is owned by the user.

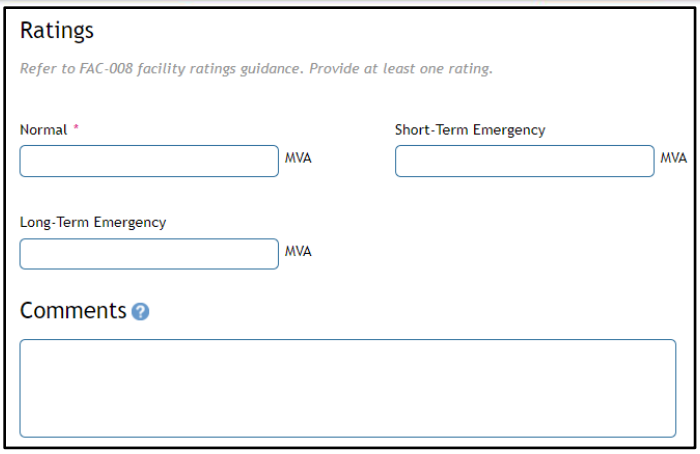


Figure 90 – Attachment Line Ratings

Additional Data Files

This form can be used to submit additional data the generation owner feels could be helpful. Text based (.dyr, .txt, .csv) and binary files are supported on this form. Dynamic model data, relay data, and plant single lines are requested elsewhere in Gen Model.

In order to upload a file you may select the upload icon in the "Actions" column. This will bring up the screen shown in **Figure 91**.

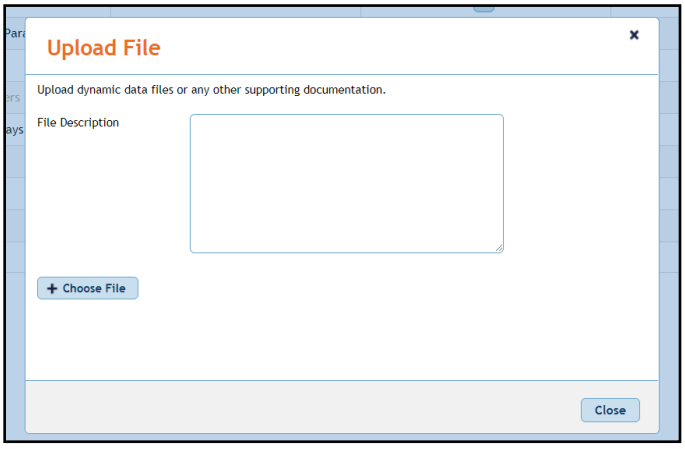


Figure 91 – Additional Data Files Screen

The GO can then select any necessary files by clicking the "Choose" button and then selecting the necessary files. You can also add a file description in the text box.

Section 5: Submitting Generation Data

Once the General Information form is "Complete" and all other forms are either "Complete" or checked as "Not Applicable," click on the Submit button indicated by the red arrow in **Figure 92**.

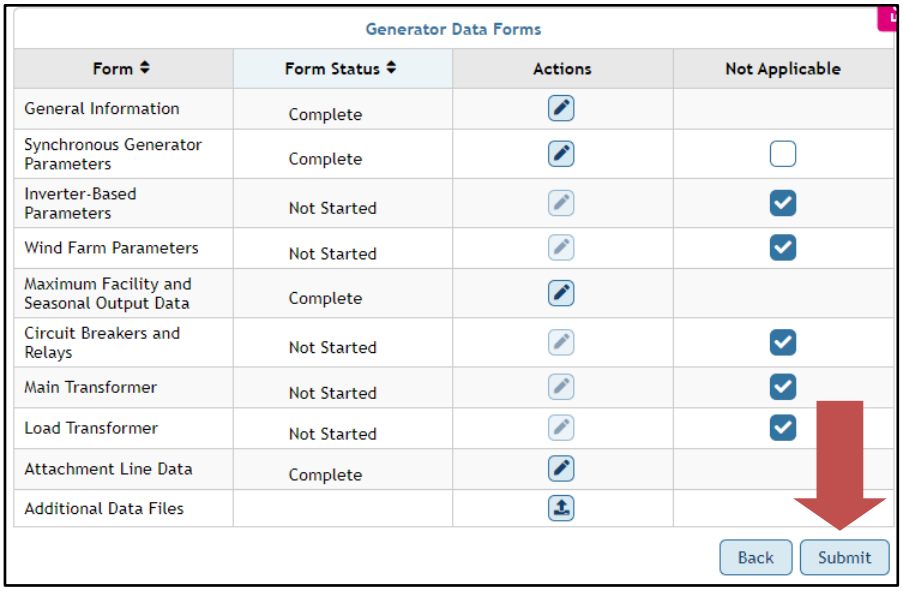


Figure 92 –Complete Plant Form Navigation Screen

After clicking the Submit button, you will be notified that you are about to submit plant data. Type any additional comments in the text box provided. Once you are confident your data is ready for submission, click the Submit button indicated by the red arrow in **Figure 93**.

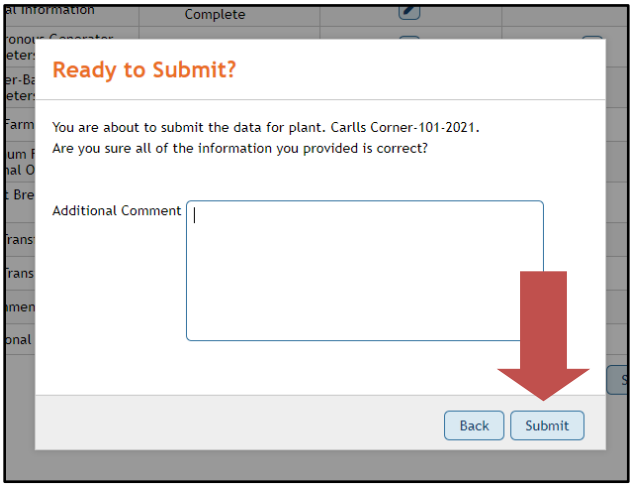


Figure 93 –Submitting Plant Data Screen

After once again clicking the Submit button, you will be taken back to the Main Gen Model screen. You will now see that the submission status of your new plant is "Submitted." An example of this is indicated by the red arrow in **Figure 94**. Once form submission is complete an automatically generated email will be sent confirming receipt.

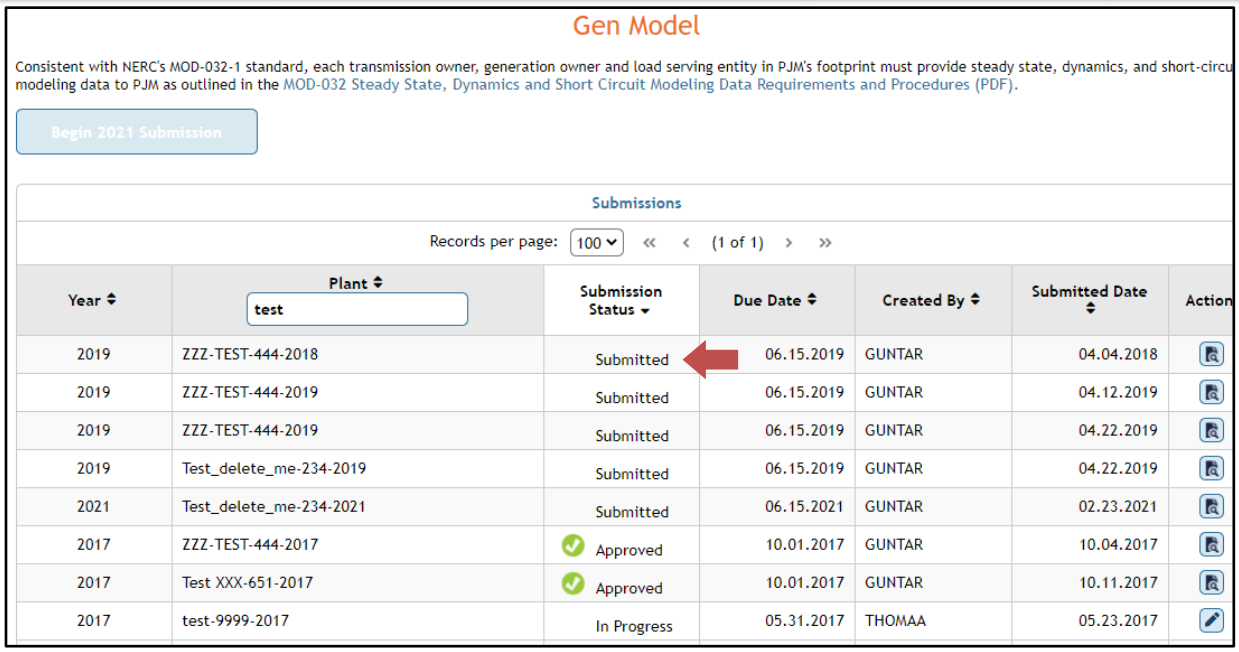


Figure 94 –Main Gen Model Screen after Submitting Plant Data

Congratulations! You have completed your yearly submission!

Section 6: Attachment One-Lines to Gen Model

SEASONAL ASSUMPTIONS FOR GEN MODEL			
TYPES	**SUMMER**	**WINTER**	**NOTES**
Time Period	June 1to Sept.1	Dec. 1 to March 1	
Time of Day	16:00	07:00 or 19:00	Select the time of day when the generator output would be highest.
Cooling Water Temp. (Degrees Fahrenheit)	80°	35°	If applicable. This should be interpreted as intake water temp. assuming max. output and efficiency at cooling towers (Point C), and/or expected water temps. from the cooling body on high-demand days.
Ambient Relative Humidity (%)	45	40	If applicable.
Ambient Air Temp. (Degrees Fahrenheit)	92°	20°	If applicable.

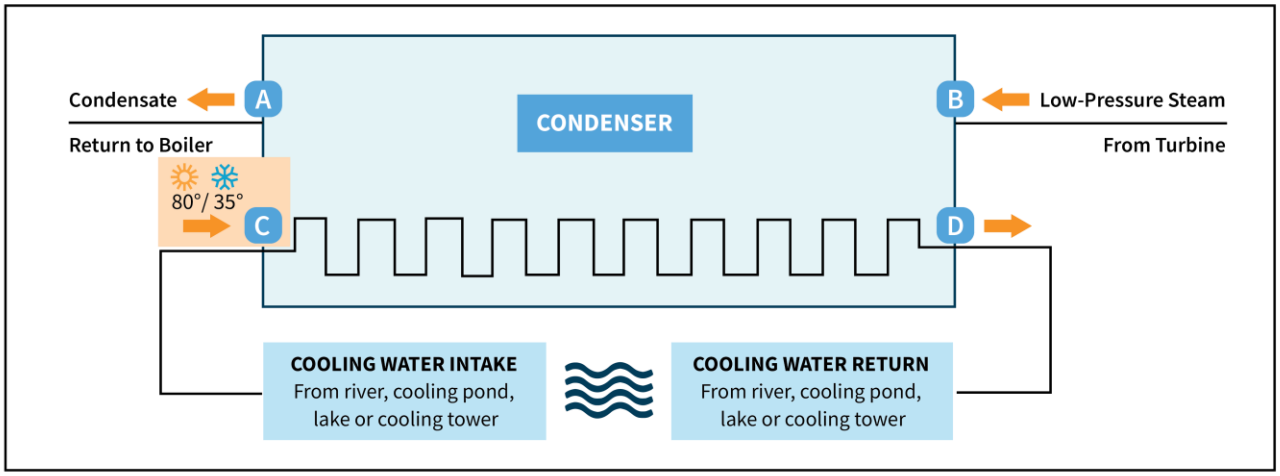


Figure 95 – Summer / Winter Seasonal Assumptions For Gen Model

Additional Comments -

- The Generator Owner will need to review and provide Summer and Winter output values using the seasonal assumptions. Not all these assumptions may apply to your particular unit.
  - E.g., Wind Farms would not need to consider cooling water temperature when determining their generator output.
- For MOD-032 purposes, "Cooling Water Temperature" should be interpreted as "intake water temperature", assuming maximum output and efficiency at the Cooling Towers, and/or expected water temperatures from the cooling body on high demand days.

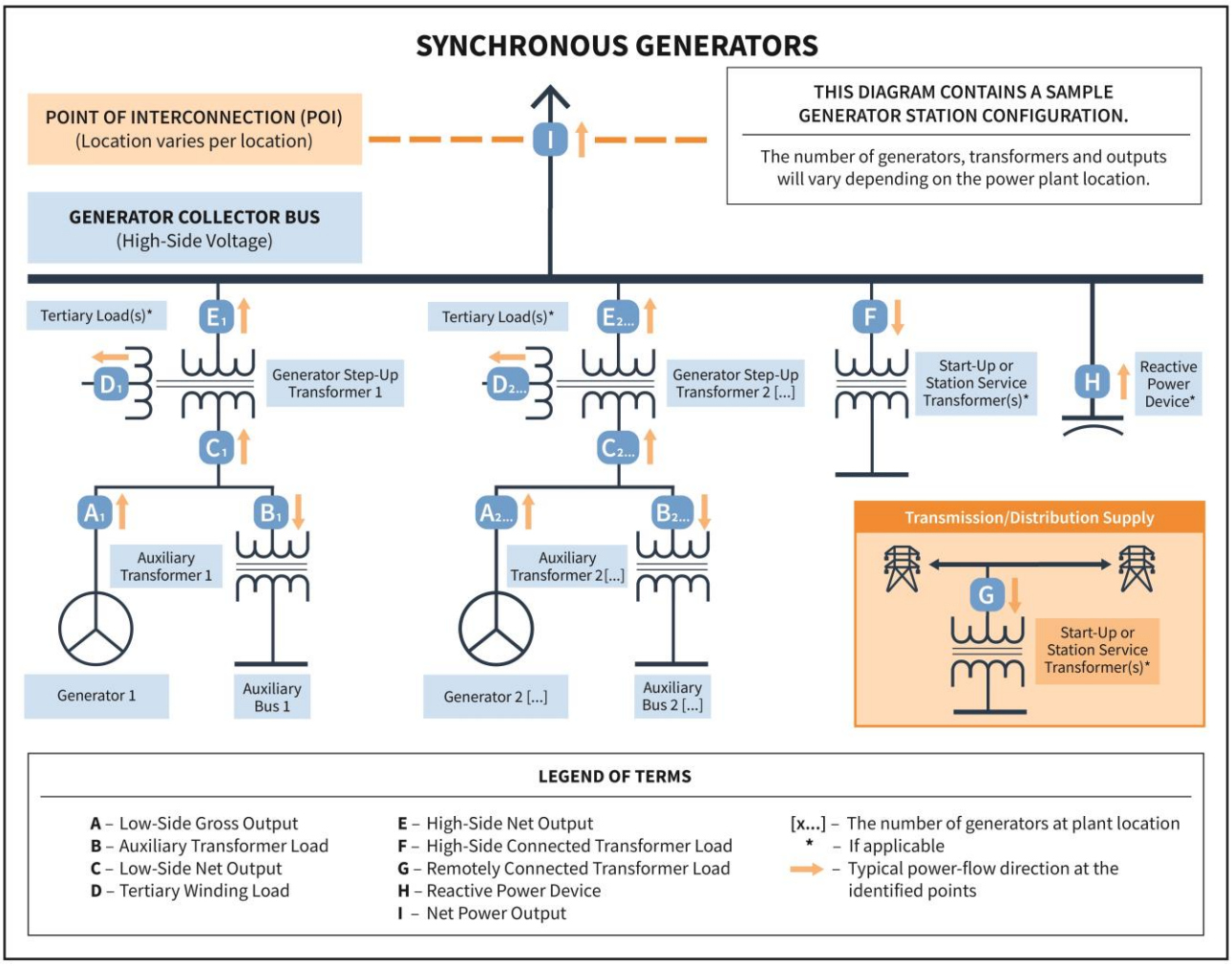


Figure 96 – Synchronous Generator One-Line Diagram

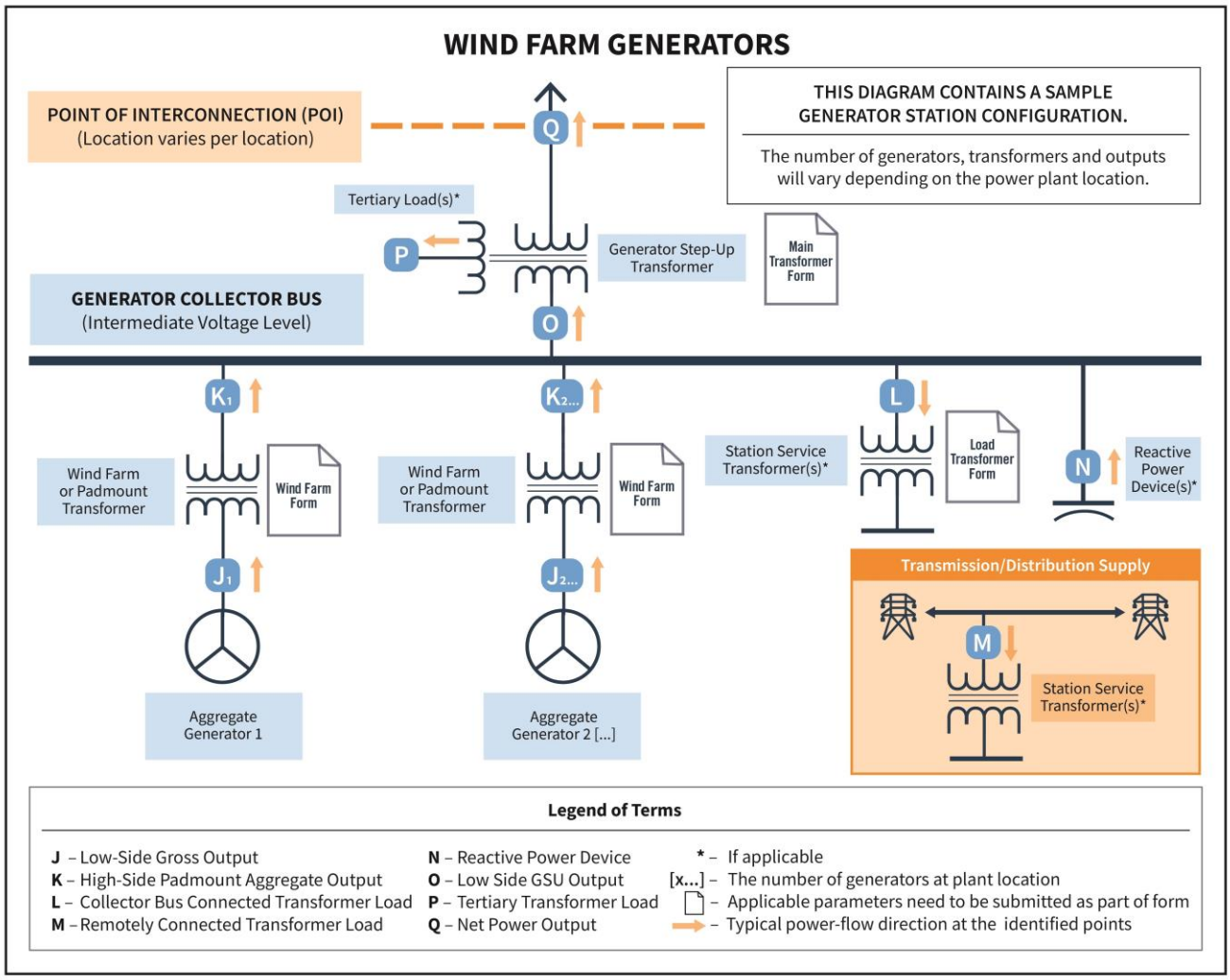


Figure 97 – Wind Farm Generators One-Line Diagram

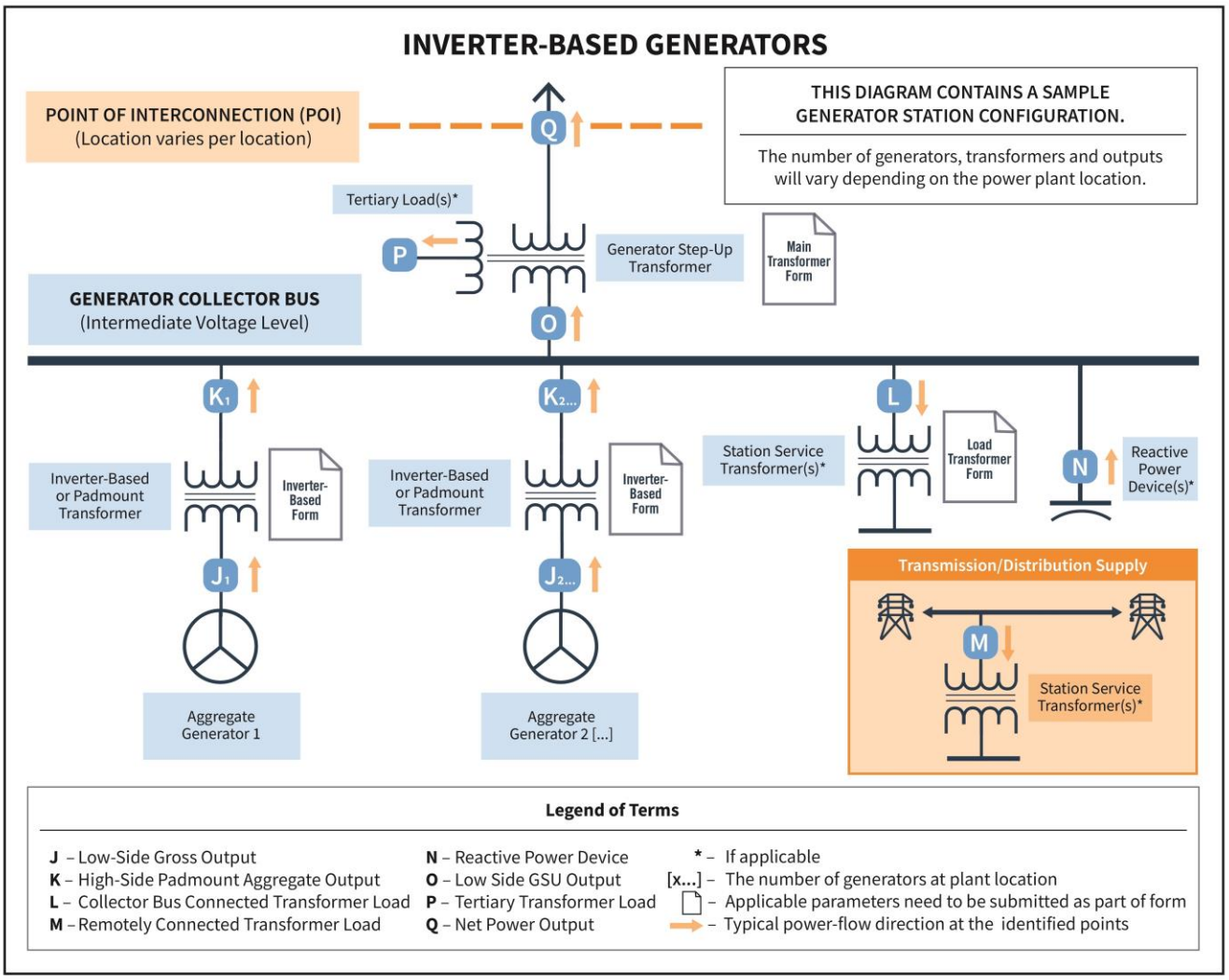


Figure 98 – Inverter Based Generator One-Line Diagrams

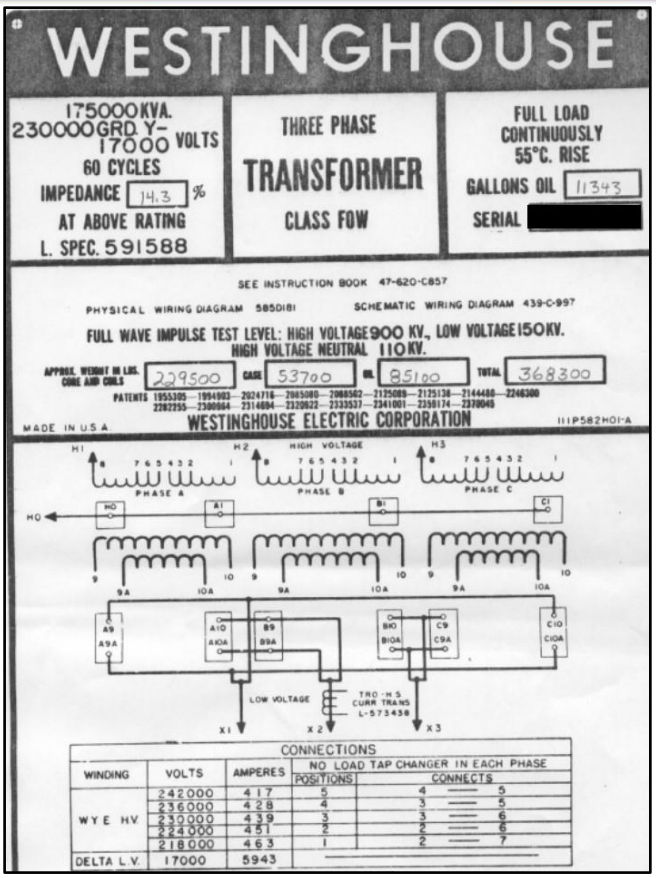


Figure 99 – Example of the Generator Step-Up Transformer Nameplate Picture

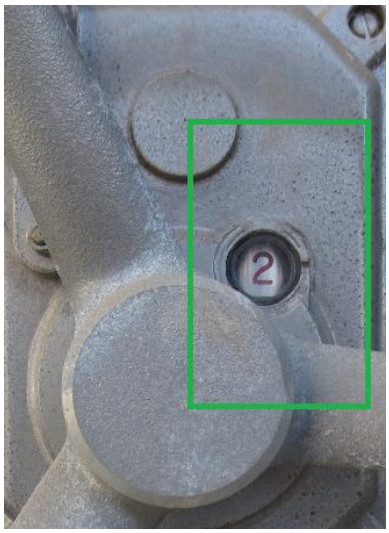


Figure 100 – Example of the Physical Tap Position Picture

Pictures for Figure 99 and Figure 100 come from the NERC Reliability Guideline "Considerations for MOD-032 Data Requirements for Generating Resources".

Section 7: Revision History

Latest Revision:	Date 04/28/2023
Author:	Nicole Bugay
Reviewer(s)	Ashwini Bhat
Approver(s)	David Egan
Reason for Change	This is the 2023 yearly update of the Gen Model User Guide. This update Includes changes related to EIA Plant Code, EIA Machine Code, and data export.

Latest Revision:	Date 04/01/2022
Author:	Nicole Bugay
Reviewer(s)	Kyle Clifford
Approver(s)	David Egan
Reason for Change	This is the 2022 yearly update of the Gen Model User Guide. This update Includes minor text revisions and clarification based on frequently asked questions.

Latest Revision:	Date 04/01/2021
Author:	Alex Lousos
Reviewer(s)	Kyle Clifford
Approver(s)	David Egan
Reason for Change	This is the 2021 yearly update of the Gen Model User Guide. This update Includes guidance on how to use the tool based on the 2021 enhancements to the tool (e.g., Maximum Facility Output & Seasonal Assumptions Page, Transformer Impedance Updates, Attachment Line Data changes).

Revision 03:	Date 04/30/2020
Author:	Alex Lousos
Reviewer(s)	Kyle Clifford
Approver(s)	David Egan
Reason for Change	This is the 2020 yearly update of the Gen Model User Guide. This update Includes guidance on how to use the tool based on the 2020 enhancements to the tool (e.g., Summer/Winter Assumptions, PRC-024 Expansion of fields, Transformer Cooling Class Pop-ups, Three Winding Transformer Updates, Attachment Line Data changes).

Revision Version 02 – (03/29/2019)

Updated snapshots for 2019 Gen Model Enhancements. Minor text revisions.

Revision Version 01 – Draft (04/02/2018)

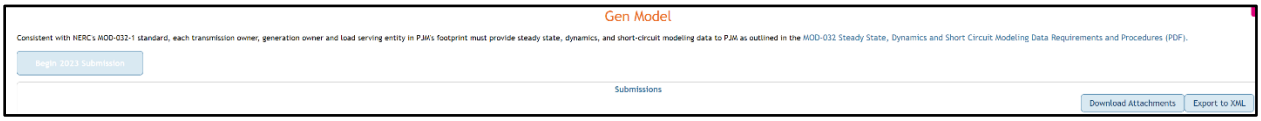
Updated the PJM Planning Center: Gen Model user guide to include information that is more recent and snapshots of the tool.

Revision Version 00 – Draft (04/25/2016)

Created a new document for the PJM Planning Center: Gen Model; this is the first release of the PJM Planning Center: Gen Model User Guide.

Appendix I: Data Export and XML Data Mapping in Excel Walkthrough

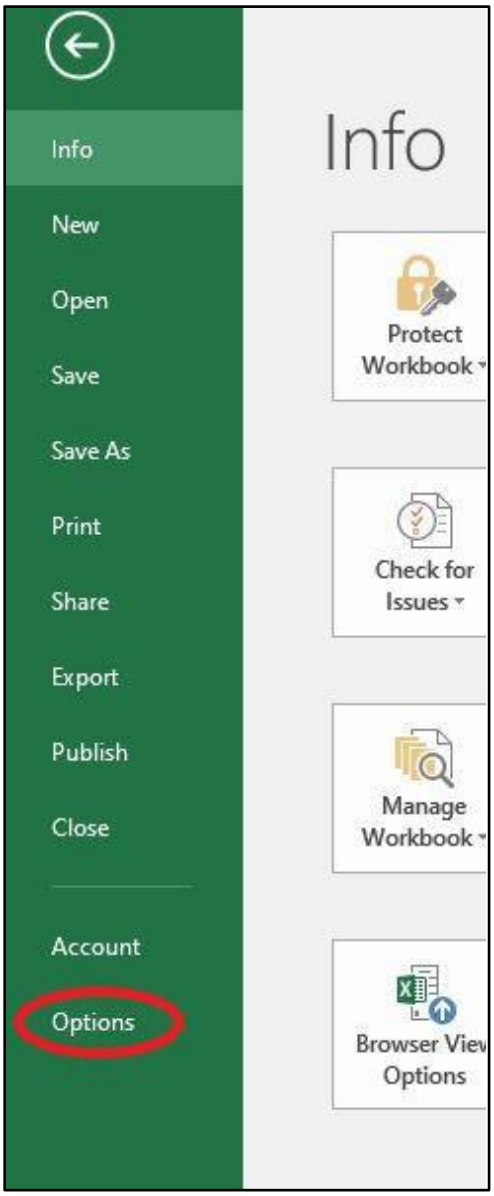
To export your Gen Model data, click “Export to XML” on the main page.



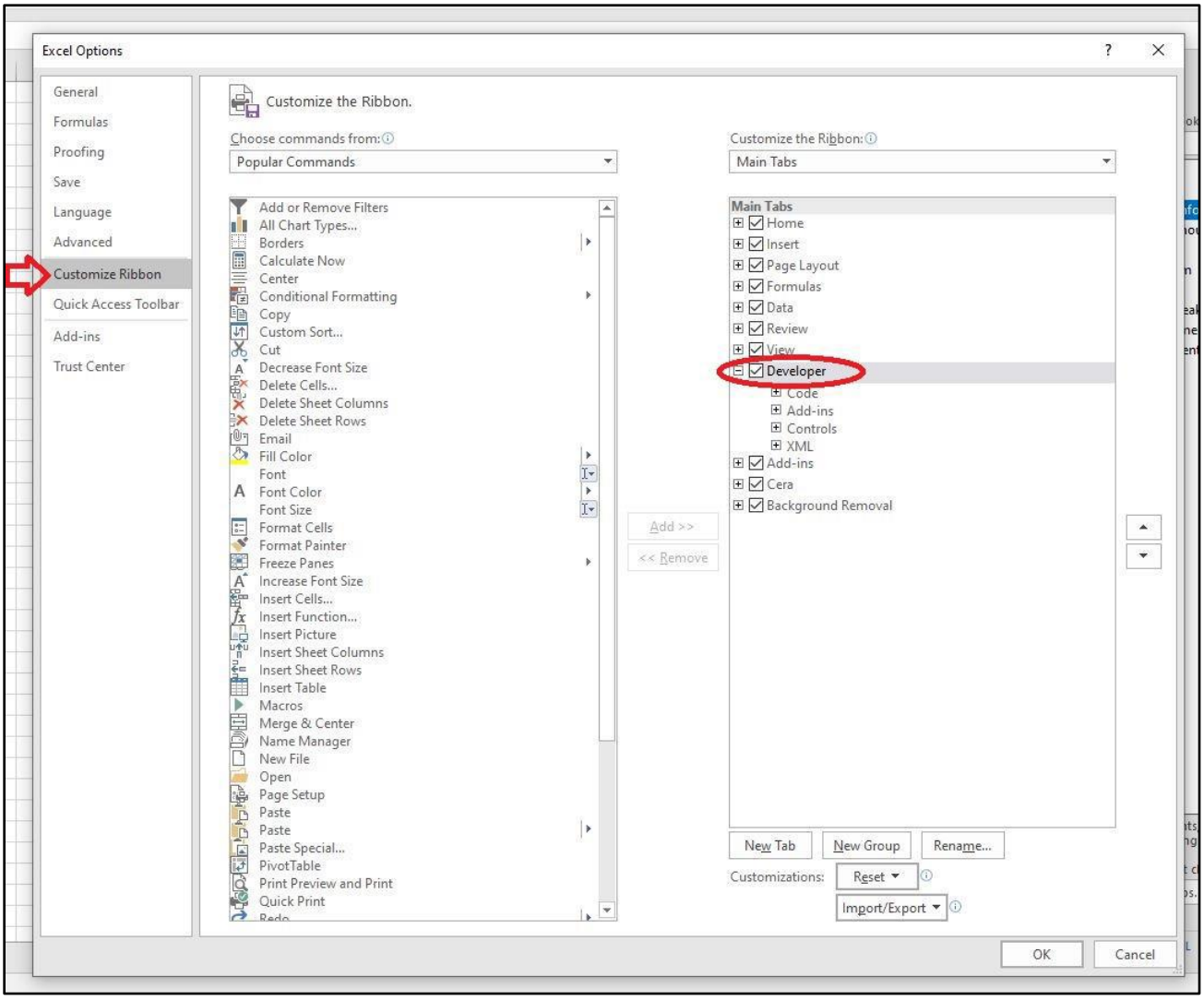
Once you have downloaded the XML file, follow this quick guide for importing the XML data into Excel in an easily searchable and customizable way.

1. Add the Developer tab. If you already have the Developer tab visible, skip to step 2.

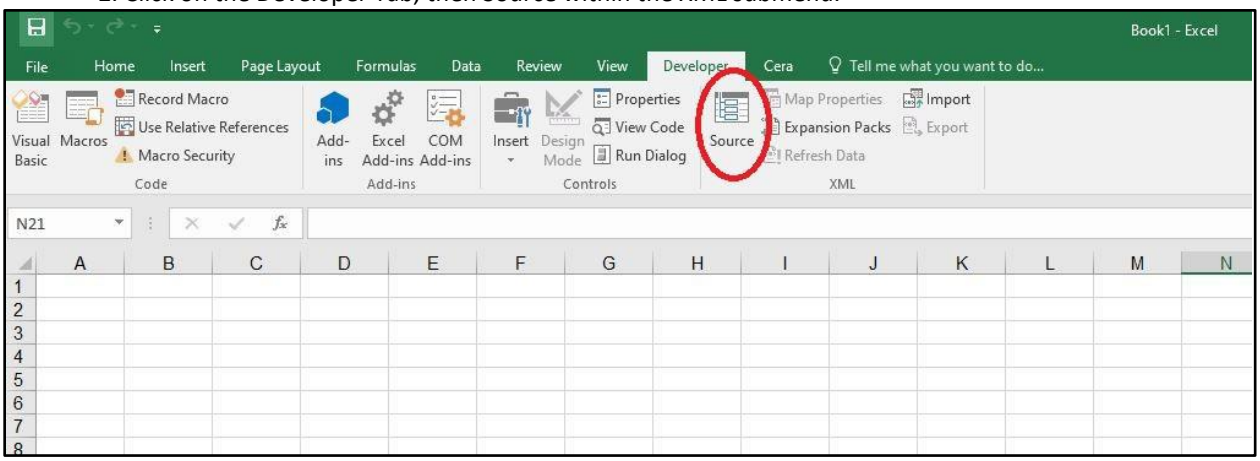
    a. The Developer tab is not displayed by default, but you can add it to the ribbon. On the File tab, go to Options > Customize Ribbon.



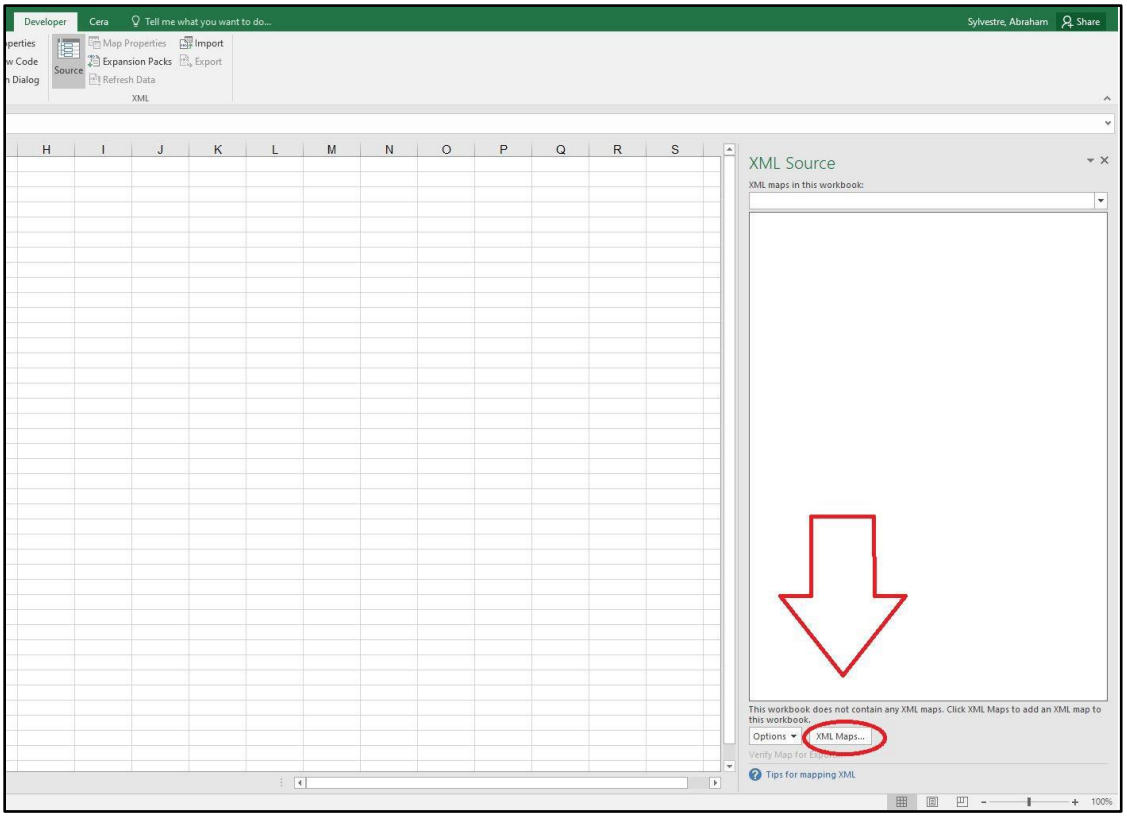
b. Under Customize the Ribbon and under Main Tabs, select the Developer check box.



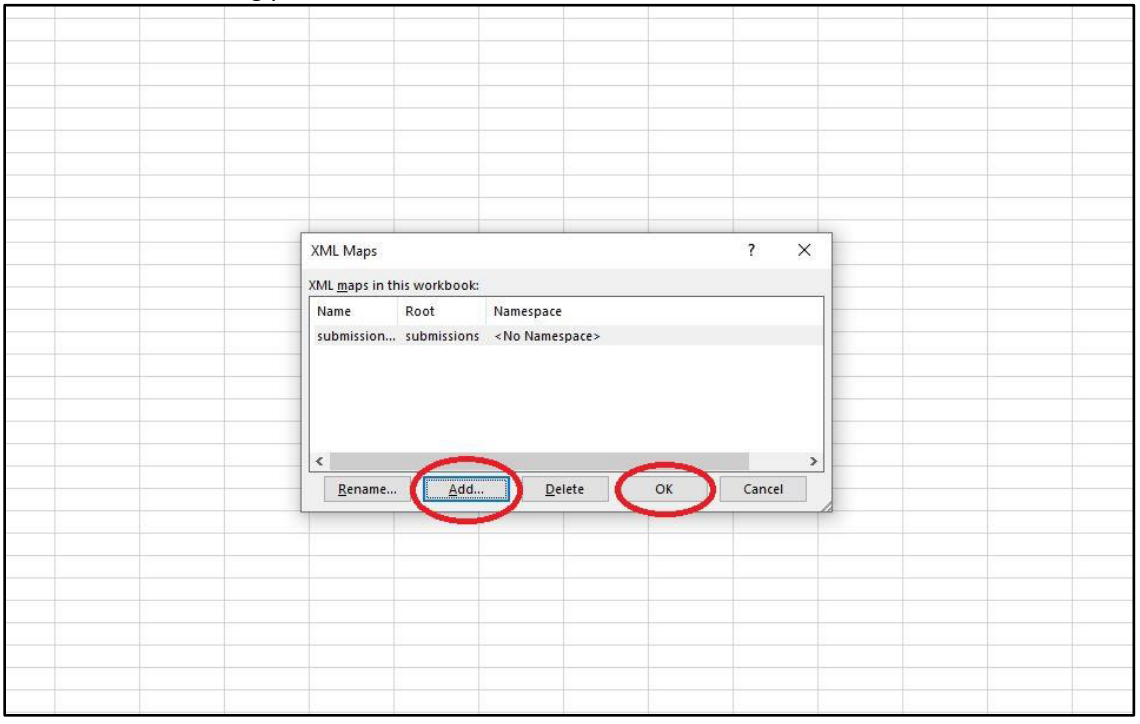
2. Click on the Developer Tab, then Source within the XML submenu.



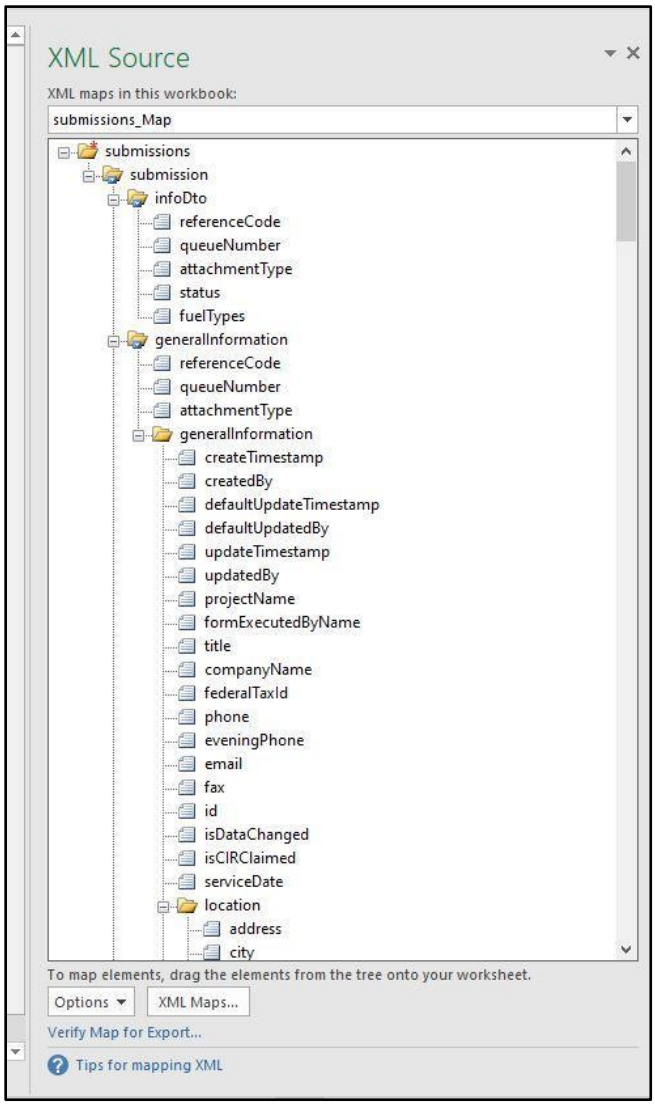
3. Add a new xml map by clicking on the “XML Maps…” button…



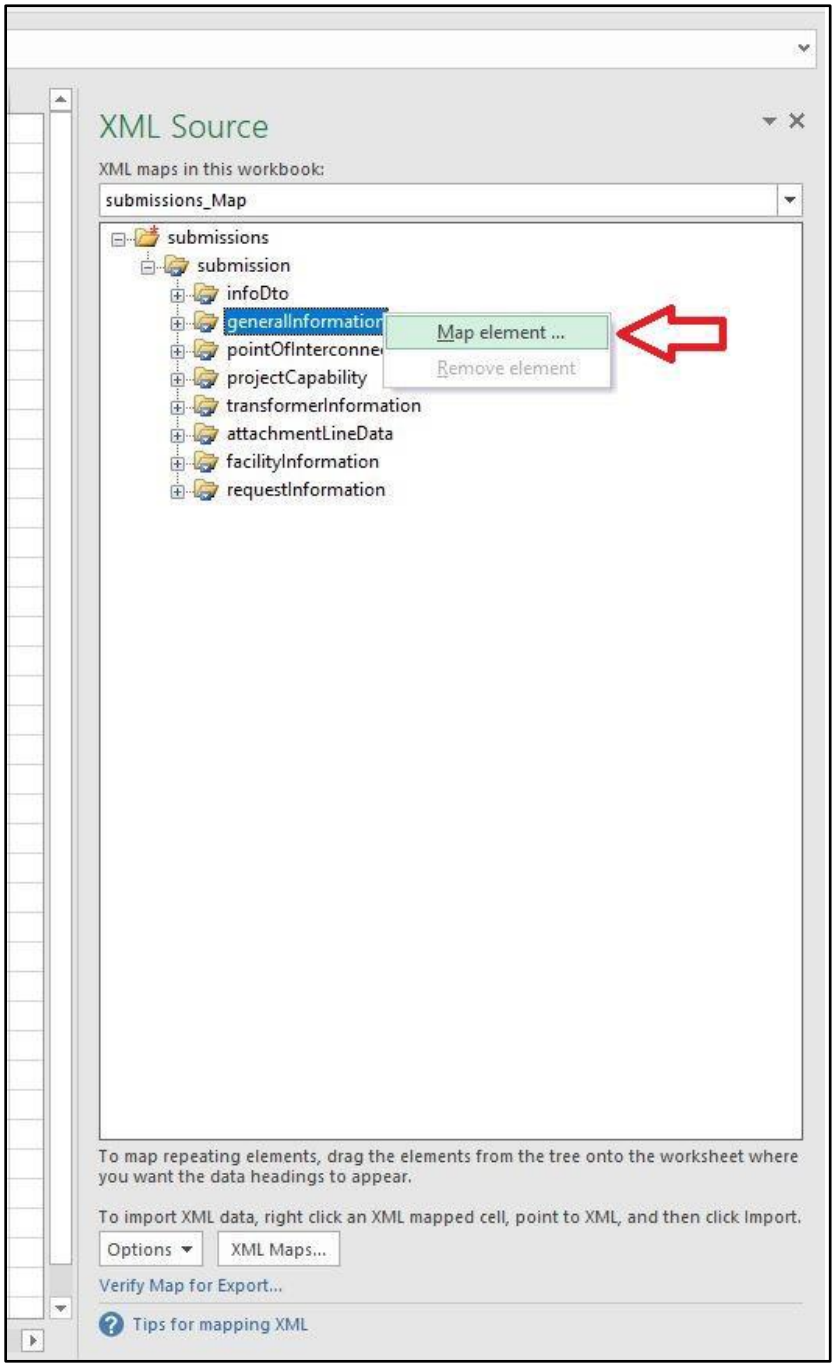
4. …and then adding your XML file, then click OK.



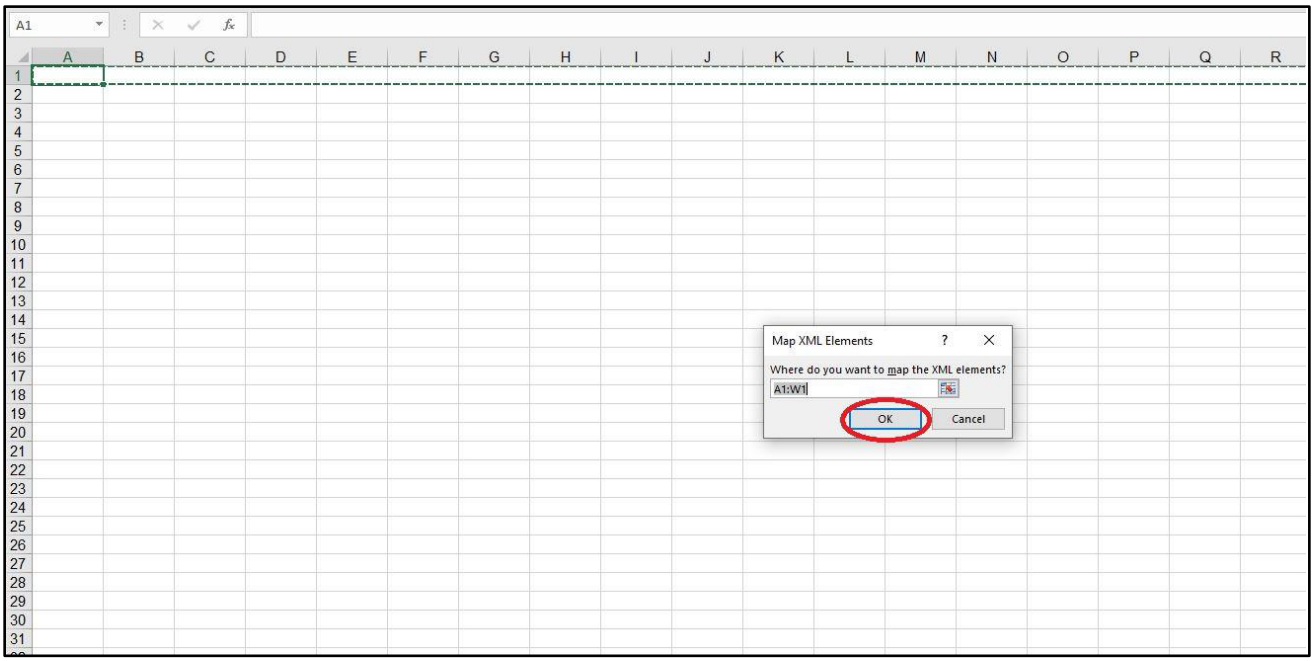
The XML Source at the right is a complete listing of all data fields present in the file. At this point, you can organize the data in Excel in whichever way you would like, although it is recommended you map each subsection to its own worksheet for clean formatting.



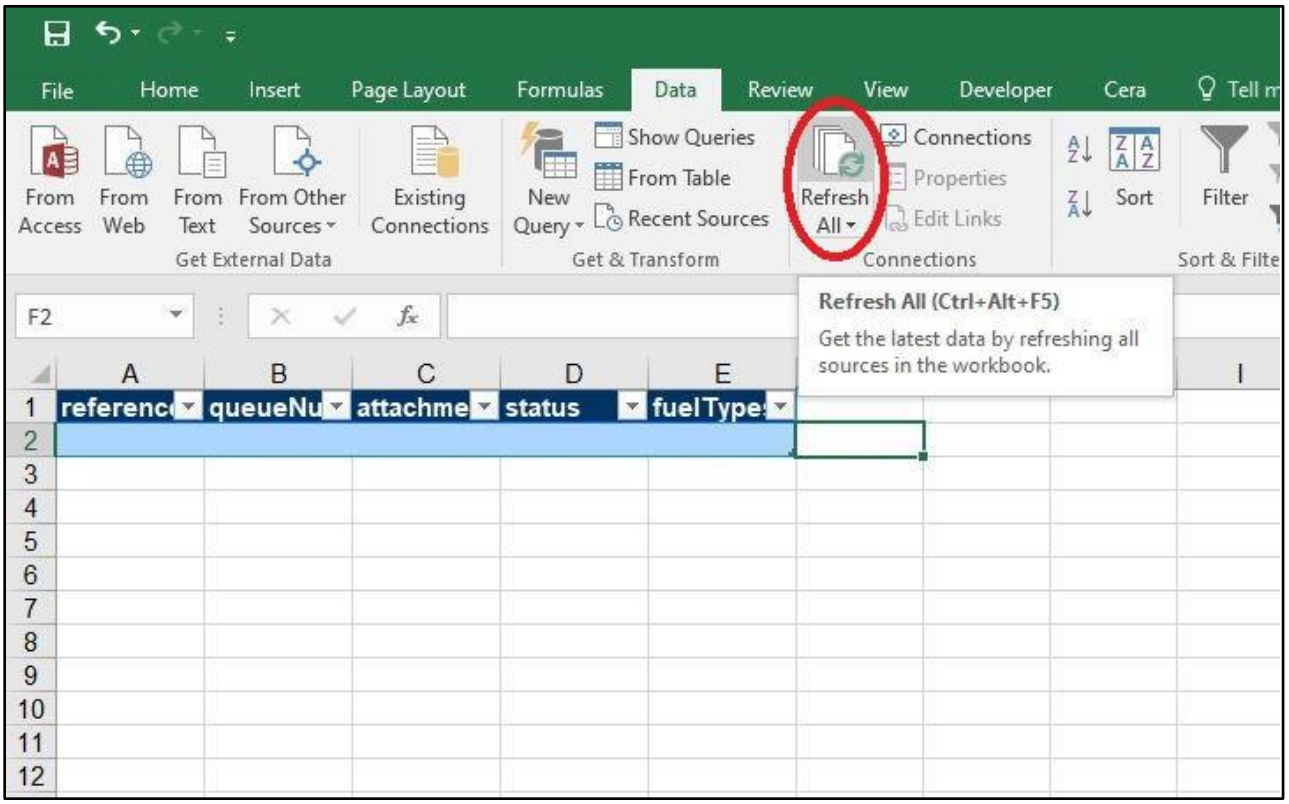
5. Right-click on a subsection of the submission and select “Map Element”



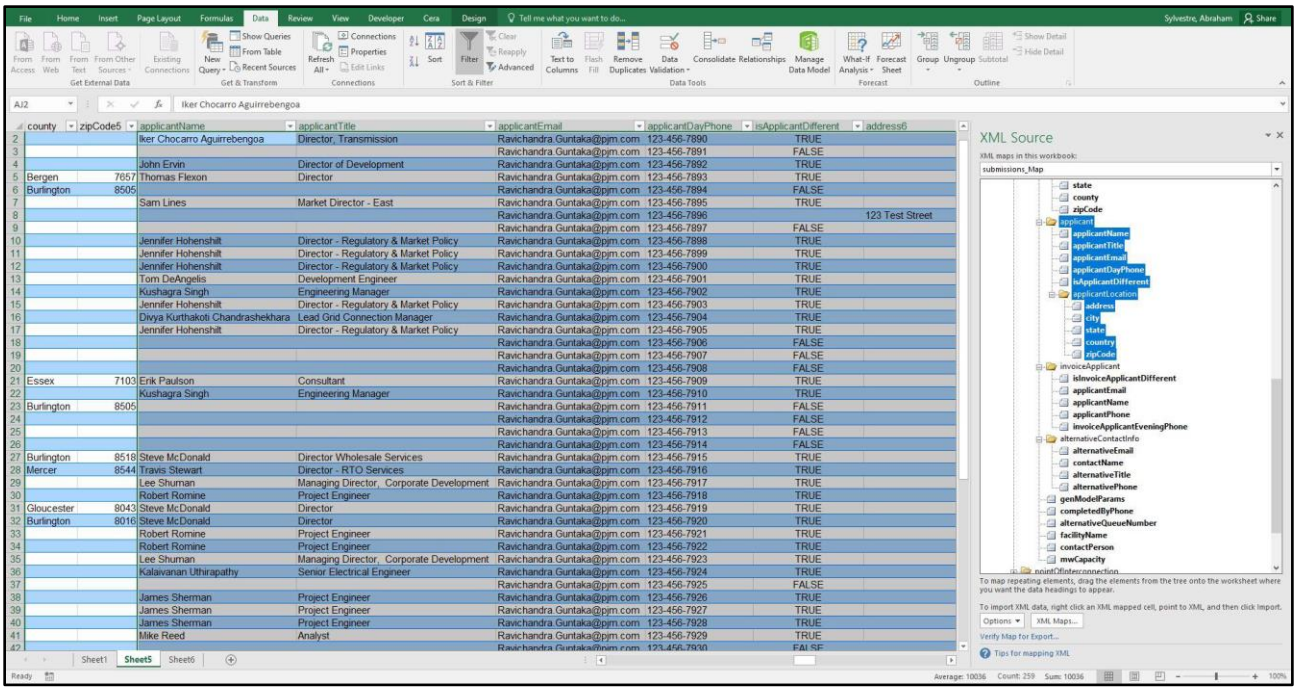
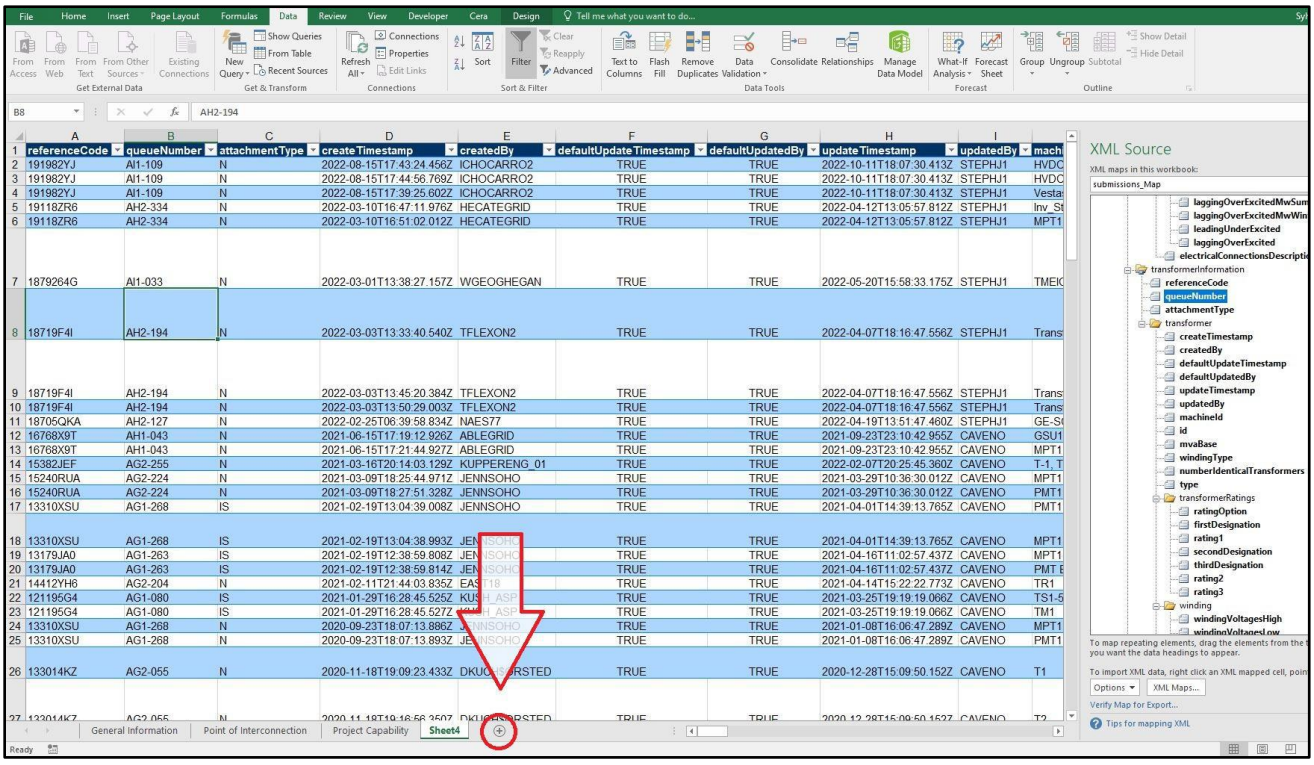
a. A popup box allows you specify where on the sheet you want this table to be placed. Again, you may organize it however you would like, but to keep it simple we will keep the starting cell at A1.



6. Click on the Data tab and the Refresh All to load the data.



All of the data for that subsection will appear in a table similar to the one shown below. The XML Source to the right serves as a handy guide to see all of the columns related to each section. Clicking on a field or folder of fields will highlight them on the table for easier navigation and searching.



To load other subsections of the XML Source just repeat steps 5 and 6. Remember to create a new spreadsheet for easier readability.