Distribution Service Transformer Sub-Group on Standardization Opportunities
Discussion of Deliverables Dissemination

September 13, 2024

Goal #2 and #3: Core Transformer Configuration Matrix and Interchangeability Matrix

- Expectations
  - In depth technical review by larger group
  - Provide comments and edits
  - Identify anything that has been overlooked
- Timeline
  - 2 weeks after receipt of information packet
- Coordination of input
  - Trades to Consolidate their member's input
  - OE and ORNL will facilitate coordinating the Trades input

Goal #2 and #3: Core Transformer Configuration Matrix and Interchangeability Matrix

- Documents Prepared for Distribution:
  1. DT_HowToUse.pdf
  2. Instructions_Configuration_Matrix.pdf
  3. DT_Convening_Configuration_Matrix_Deliverable2.pdf
  4. Working documents
     1. Attributes_Working.xlsx
     2. Configuration Form Combined Grouping.xlsx
     3. Interchangeability_Matrix_Working.xlsx
  5. Instructions_Interchangeability_Matrix.pdf
  6. Configuration_Interchangeability_Matrix_Short_Form_Deliverable.pdf
  7. DT_Convening_Combined_Working_Documents.pdf

Goal #2: Core Transformer Configuration Matrix

Distribution Transformer Working Group: Guide to understanding and using the enclosed information

The focus of this effort was to support the following short term goals in addition to providing information for longer term strategies with input from a selection of Utilities and Transformer manufacturers. Each goal is discussed with some background on why this effort was investigated and some insight on how to interpret the information provided.

GOAL #1: Distribution Transformer Taxonomy Table

In the initial discussions, it was clear that there was need to ensure that everyone in the group was using the same terminology and understanding for different critical components and operations within the this space. A general taxonomy table was derived from IEEE standards, RUS documents, and design specifications to align the baseline terminology and impact to ratings, design, and manufacturing. This table is considered a reference for the transformer attributes to be considered for the remainder of the discussions and provide a clear communication among varying levels of technical understanding.

GOAL#2: Core Transformer Configuration Matrix

This effort began with an investigation into different attributes related to kVA sizing, critical design specifications and accessories. The input provides insight to Utilities and Manufacturers on what the broader peer groups are doing in their individual systems or regions. This could be used to identify transformer sizes or features that can be consolidated or phased out due to increased standardization or electrification in the system. The impact of reducing variations could increase the economies of scale for increased manufacturing efficiency while providing the potential for more streamlined inventory to support areas of mutual assistance. This information led to the creation of specific configurations to identify the minimal components to safely operate as compared to a standard baseline and ultimately the utility customized configuration. The impact of these configurations was reviewed by manufacturers to identify the impact to the manufacturing process and opportunities for increased manufacturing capacity. This document was designed to be used as a starting point by utilities for new transformers to understand each configuration needs and the impact to manufacturing time and complexity that result in tradeoffs of ideal functionality and manufacturing throughput. Using this information for new designs could help decrease the manufacturing time per unit and avoid some critical long lead time components resulting in an increase of overall transformer manufacturing capacity.

GOAL #3: Interchangeability Matrix

Many supply chain influences have been identified throughout this process of defining critical features and configurations which result in significant impacts to the overall lead time. This may be due to sole source vendors, production limitations by preferred vendors, incompatible specifications, or many other factors. Not all utilities and even manufacturers may understand the breadth of the supply chain landscape to understand all the potential vendors available for these critical products. This table provides the opportunity to leverage inputs from multiple transformer manufactures and utilities to identify potential alternatives for compatible or completely interchangeable critical components. This is not an outline of preferred manufacturers, but rather an insight from the broader peer groups as to manufacturing options. This document is intended to be used as a tool to provide more informed and efficient discussions between manufacturers and utilities to support consistent supply of critical components and faster acceptance for identified interchangeable components. This matrix could also be used by manufacturers to proactively work with utilities to approve alternate vendors identified in the matrix to optimize the lead times based on component availability. Utilities could further use these references to leverage a larger knowledge database for critical interchangeability of areas such as fuses to identify alternatives and proper coordination.

- DT HowToUse.pdf
  - 1 Page Document
  - Discussion of Short-Term Goals
    - Brief background
    - Why it was investigated
    - How to interpret
    - How it might be used

Goal #2: Core Transformer Configuration Matrix

- DT HowToUse.pdf
  - Key Benefits
    - Clear communication of critical components, requirements, and functionality
    - Identification of critical attributes and sizing ranges to facilitate:
      - Focus on most important sizes and features for electrification for standardization
      - Identify possible sizes/attributes that might be consolidated to streamline the manufacturing process requirements
      - Reduce the overall variations to increase economy of scale for increased manufacturing efficiency and improved inventory for potential mutual assistance
    - Starting point for review of transformer design configurations compared with manufacturing complexity
      - Identify tradeoffs between ideal transformer design and impact to the manufacturing process and capacity
      - Highlight impact of both labor per unit and lead time of critical long lead time components
      - Isolate critical areas of design impacts to quantity, types, and mix of materials needed including core design and sizing, wire sizing, oil volume, etc.
    - Define critical components that may be lead time constrained, sole sourced, or technologically limited
    - Broaden the knowledge of functionally compatible components from variety of manufacturers and utilities specification to provide some flexibility on critical components
    - Facilitate discussions between Manufacturers and Utilities to support more consistent supply chain and proactive inventory planning
    - Reference the interchangeability matrix for larger database of user knowledge for areas such as fuses to identify new supplier/part family alternatives

Goal #2: Core Transformer Configuration Matrix

Deliverable #2: Broader input request for Configuration Matrix

Transformer Attribute Consolidation background information provided:

Attribute Consolidation designed to identify the most prevalent transformer kVA sizing requested by the utilities as well as opportunities for consolidating for both sizing and selected attributes to minimize the number of transformer variations and streamline the manufacturing process. These opportunities could be the result of electrification which may increase the minimum transformer size from 10/15kVA to 25/50kVA. This was also expanded to rate critical options and accessories along with the potential for aftermarket installation at the utility.

Action:

1. The ask was identification of these sizes, options and accessories rated on a Red/Yellow/Green scale to identify the high running critical sizes and specifications that should be kept or not altered (RED), standard volume with flexibility in functionality or specification that could be altered if broadly agreed (YELLOW), and sizes and specifications that could be removed or exchanged relatively simply (GREEN).
2. Review of the Summary action points in conjunction with any additional input provided above for comments, concerns, and suggestions.

Configuration Matrix and Manufacturer Input to Configuration Matrix

There were several topics identified from the attribute consolidation that required some further refinement on the possible actions that might be considered to support the target goal of increasing the number of transformers that could be manufactured while maintaining the necessary operation and specifications for the utilities. To provide more insight to both the utilities and manufacturers, the Configuration Matrix was developed to help understand what functions and components were necessary for three different configurations:

- Minimalist Configuration: absolute minimum components to safely operate a transformer.
- Standard Configuration: which included minimalist with more streamlined components to ensure full IEEE standard compliance and baseline operation.
- Custom Utility Configuration: fully customizable to each utility specification including component locations, alternate protections, paint/branding, and specific regional requirements.

Manufacturer Input to Configuration Matrix: Once these configurations were defined, the manufacturers were asked to provide input on their impact to manufacturing time to understand the potential impact to increasing the number of deliverable units. This break down is primarily focused on labor, impacts to design, and improved scaling in the factory. The impact of supply chain on the timeline and availability were not the primary focus due to variability among manufacturers though comments are included.

Action:

1. Review and comment on the Configuration categories as described in the accompanying Excel file. The configurations are represented in the three columns so if a component or function is needed for more than one configuration the columns are merged accordingly to show that. Please feel free to mark changes or comments in RED directly in the document or in a column just off to the side. There are separate tabs for single phase overhead, single phase pad mount, and three phase pad mount.
2. Review and comment on input from the manufacturers on the impact of the different configurations mostly targeted to manufacturing labor/scheduling impacts. The impact of supply chain was not accounted for in the percent labor as this is quite variable, but there are some related comments directly addressed.

- Instructions_Configuration_Matrix.pdf
  - 1 Page Document
  - Discussion of Attribute Consolidation
    - Brief background
    - Requested Action
      - Identification of rating definitions for sizes, options, and accessories in accompanying Excel file.
      - Working Document: Attributes_Working.xlsx
      - Review of Summary points from previous input
  - Discussion of Configuration Matrix
    - Brief background
    - Requested Action
      - Review and comment on Configuration categories in accompanying Excel File.
      - Working Document: Configuration_Form_Combined_Grouping. xlsx
      - Review and comment on input of Configurations to Manufacturing process

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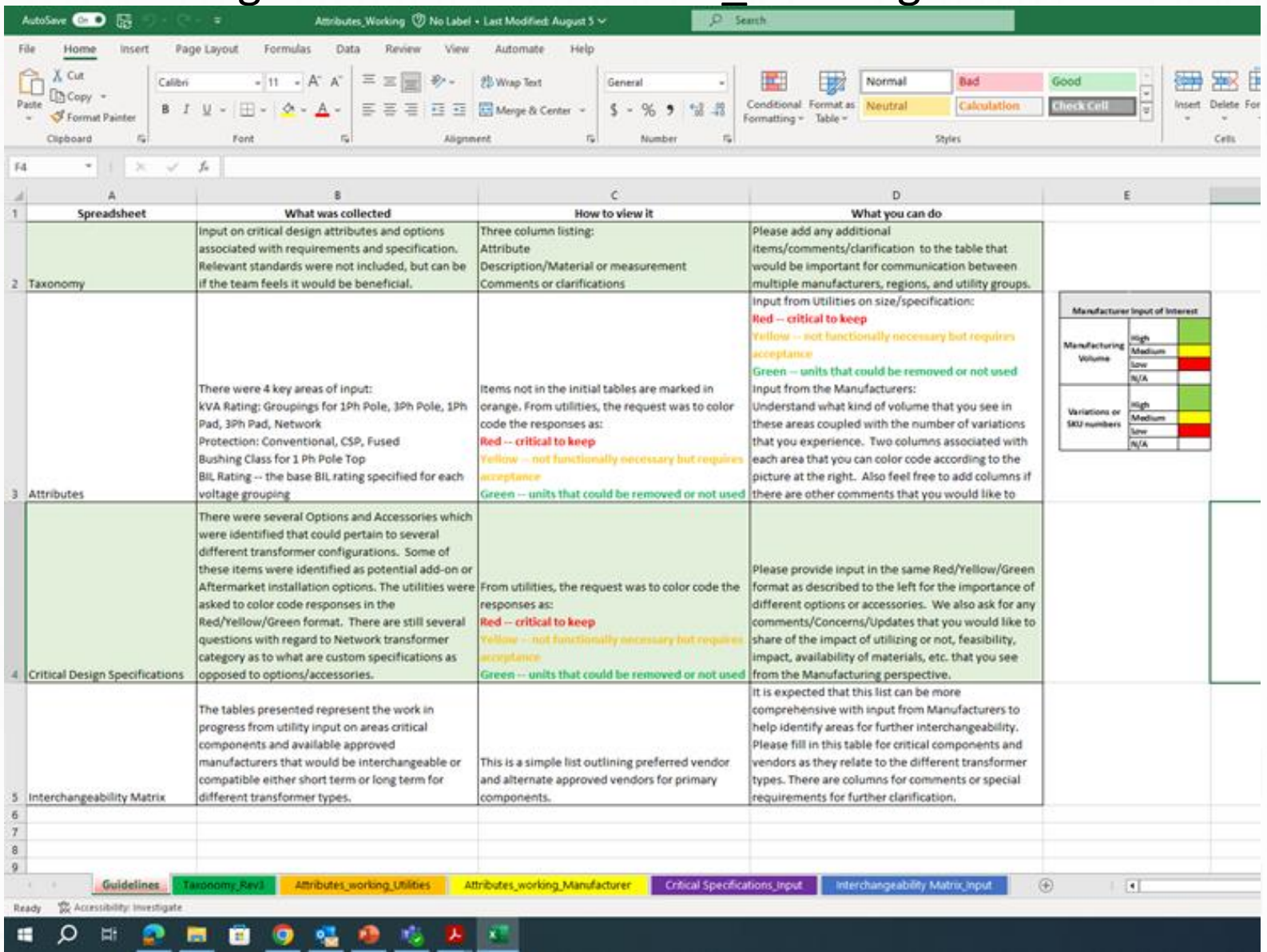
Goal #2: Core Transformer Configuration Matrix

- Instructions_Configuration_Matrix
  - Working Document: Attributes_Working.xlsx



	A	B	C	D
1	**Spreadsheet**	**What was collected**	**How to view it**	**What you can do**
2	Taxonomy	input on critical design attributes and options associated with requirements and specification. Relevant standards were not included, but can be if the team feels it would be beneficial.	Three column listing: Attribute Description/Material or measurement Comments or clarifications	Please add any additional items/comments/clarification to the table that would be important for communication between multiple manufacturers, regions, and utility groups.
3	Attributes	There were 4 key areas of input: kVA Rating: Groupings for 1Ph Pole, 3Ph Pole, 1Ph Pad, 3Ph Pad, Network Protection: Conventional, CSP, Fused Bushing Class for 1 Ph Pole Top BIL Rating -- the base BIL rating specified for each voltage grouping	Items not in the initial tables are marked in orange. From utilities, the request was to color code the responses as: Red -- critical to keep Yellow -- not functionally necessary but requires acceptance Green -- units that could be removed or not used	input from the Manufacturers: Understand what kind of volume that you see in these areas coupled with the number of variations that you experience. Two columns associated with each area that you can color code according to the picture at the right. Also feel free to add columns if there are other comments that you would like to
4	Critical Design Specifications	There were several Options and Accessories which were identified that could pertain to several different transformer configurations. Some of these items were identified as potential add-on or Aftermarket installation options. The utilities were asked to color code responses in the Red/Yellow/Green format. There are still several questions with regard to Network transformer category as to what are custom specifications as opposed to options/accessories.	From utilities, the request was to color code the responses as: Red -- critical to keep Yellow -- not functionally necessary but requires acceptance Green -- units that could be removed or not used	Please provide input in the same Red/Yellow/Green format as described to the left for the importance of different options or accessories. We also ask for any comments/Concerns/Updates that you would like to share of the impact of utilizing or not, feasibility, impact, availability of materials, etc. that you see from the Manufacturing perspective.
5	Interchangeability Matrix	The tables presented represent the work in progress from utility input on areas critical components and available approved manufacturers that would be interchangeable or compatible either short term or long term for different transformer types.	This is a simple list outlining preferred vendor and alternate approved vendors for primary components.	It is expected that this list can be more comprehensive with input from Manufacturers to help identify areas for further interchangeability. Please fill in this table for critical components and vendors as they relate to the different transformer types. There are columns for comments or special requirements for further clarification.

Manufacturer Input of Interest

Manufacturing Volume	High	
	Medium	
	Low	
	N/A	
Variations or SKU numbers	High	
	Medium	
	Low	
	N/A	

Guidelines | Taxonomy_Rev1 | Attributes_working_Utilities | Attributes_working_Manufacturer | Critical Specifications_Input | Interchangeability Matrix_Input

- Current Taxonomy revision
- Consolidated Attributes list show for Utilities' input
  - Please provide input directly in new column for each group per instructions
- Consolidated Attributes list shown for Manufacturer's input
- Worksheet for Critical options and accessories input
  - Please provide input directly in new column for each group per instructions
- Worksheet for Interchangeability Matrix

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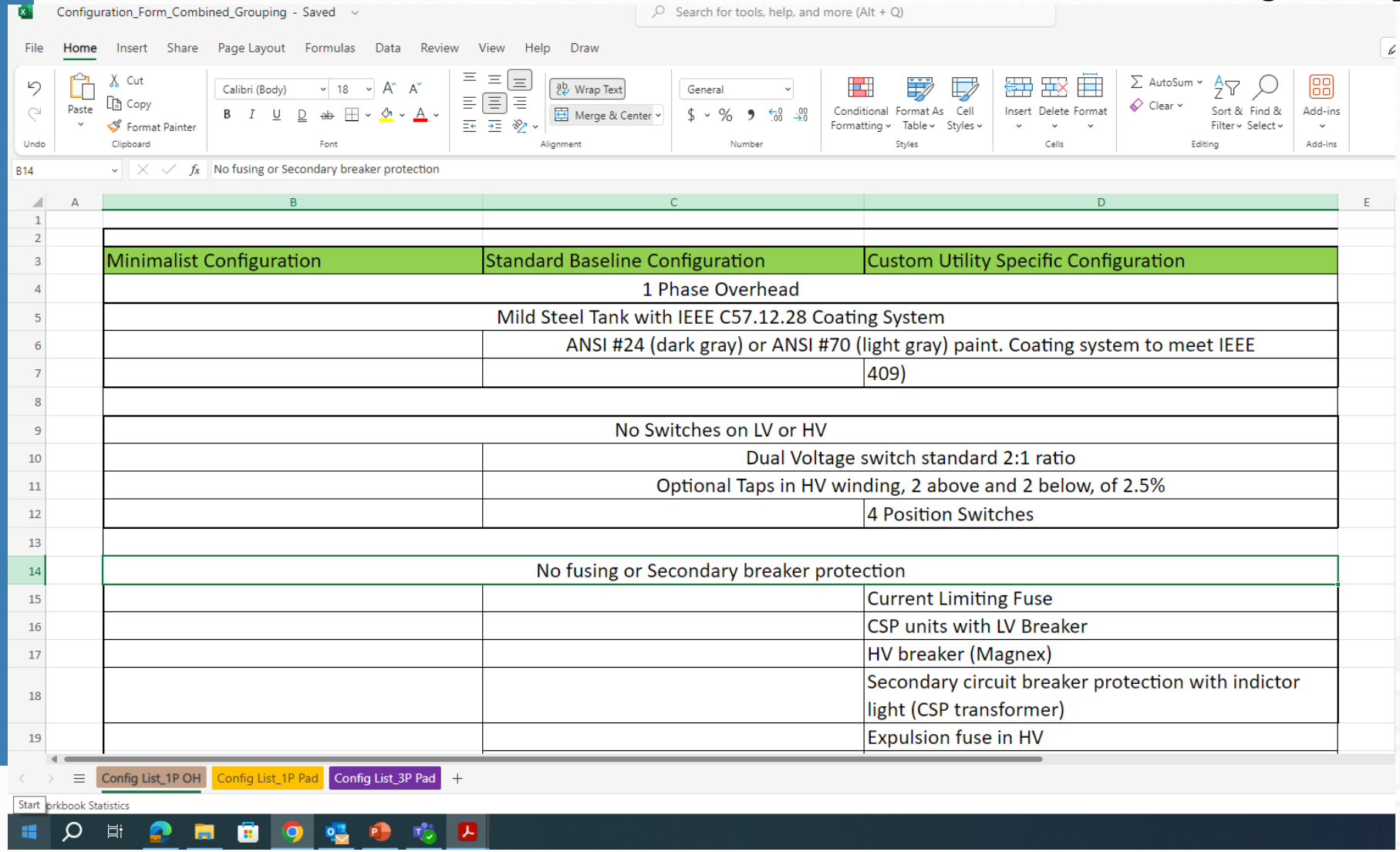
Goal #2: Core Transformer Configuration Matrix

- Instructions_Configuration_Matrix
  - Working Document: Configuration_Form_Combined_Grouping. Xlsx



Minimalist Configuration	Standard Baseline Configuration	Custom Utility Specific Configuration
1 Phase Overhead		
Mild Steel Tank with IEEE C57.12.28 Coating System		
	ANSI #24 (dark gray) or ANSI #70 (light gray) paint. Coating system to meet IEEE	
		409)
No Switches on LV or HV		
	Dual Voltage switch standard 2:1 ratio	
	Optional Taps in HV winding, 2 above and 2 below, of 2.5%	
		4 Position Switches
No fusing or Secondary breaker protection		
		Current Limiting Fuse
		CSP units with LV Breaker
		HV breaker (Magnex)
		Secondary circuit breaker protection with indictor light (CSP transformer)
		Expulsion fuse in HV

- Minimalist Configuration: absolute minimum components to safely operate a transformer.
- Standard Configuration: which included minimalist with more streamlined components to ensure full IEEE standard compliance and baseline operation.
- Custom Utility Configuration: fully customizable to each utility specification including component locations, alternate protections, paint/branding, and specific regional requirements.

Goal #2: Core Transformer Configuration Matrix

- DT_Convening_Configuration_Matrix_Deliverable2.pdf
  - Slide deck outlining:
    - Summary points of the Attribute kVA sizing and frequency
    - Summary points of the Critical options and accessories
    - Topics and actions resulting from Attribute working documents
    - Configuration Matrix request and consolidated information for each transformer type
    - Input from Manufacturers on impact of the different configurations focused on labor hours and impact to overall capacity

Goal #3: Interchangeability Matrix

Deliverable #3: Broader input request for Interchangeability Matrix

Interchangeability Matrix background information provided:

The target of the interchangeability matrix was to provide a listing of critical components that impact the delivery, capacity, or other supply chain impacts. This listing is compiled from input by multiple manufacturers and utilities to provide a broad range of knowledge of standard and suitable alternative suppliers for specific components. In some cases, there are many potential suppliers for a particular component, all manufacturers or utilities may not have a working relationship or have had the need to engage multiple suppliers in the past, so this consolidated listing is meant to provide a starting point for this discussion. This is meant to be a dynamic list to be updated as new vendors, components, or general information becomes available so the input from the broader engineering community is vital to ensure current information. The spreadsheet has a main working tab with all the current inputs with a sortable pull-down menu for each category. To provide more targeted details, there are additional tabs that contain specific categories for quicker reference whether that be fuses, bushing, or other distinct items.

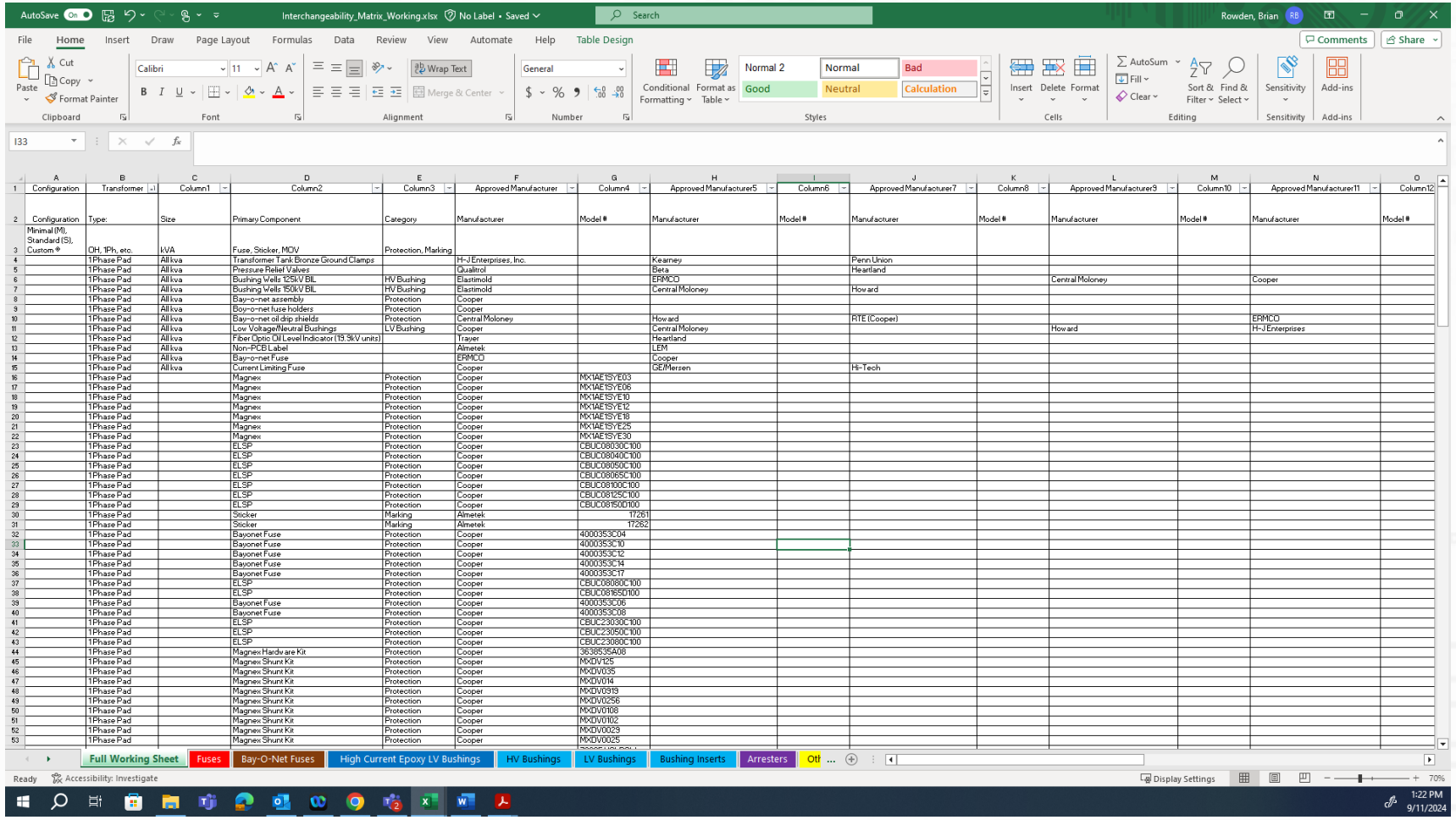
Action:

1. Review and comment on the Interchangeability Matrix as described in the accompanying Excel file. Please comment or make additions in RED text so that we can consolidate all incoming input. If there are components that are not listed that you would like to have added, please make those additions with whatever information that you have available (i.e. you may not have multiple vendors or part numbers, but please input what you do have so that we can get further input from other sources.)
2. Comment on what additional information you think would be helpful in this document to provide sufficient details to proactively coordinate between manufacturers and utilities on what components can be considered interchangeable.

- Instructions_Interchangeability_Matrix.pdf
  - 1 Page Document
  - Discussion of Interchangeability Matrix
    - Brief background
    - Requested Action
      - Review of critical components in accompanying Excel file.
      - Working Document: Interchangeability_Working.xlsx
      - Comments on additional information that would be of interest to include to create a proactive discussion between manufacturers and utilities.

Goal #3: Interchangeability Matrix

- Instructions_Interchangeability_Matrix
  - Working Document: Interchangeability_Matrix_Working.xlsx



- Full Working Sheet Tab has full listing of components that can be viewed in a sortable pull down table
- Additional Component Specific tabs targeted at Protection, Bushings, etc. provide easier direct reference
- Additional components, vendors, or notes can be added based on feedback

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Goal #2 and #3: Core Transformer Configuration Matrix and Interchangeability Matrix

- Configuration_Interchangeability_Matrix_Short_Form_Deliverable.pdf
  - This is a combined document that has the how to use along with some instructions for embedded forms of the excel spread sheets to simplify the request as needed.
  - Feedback was that with several documents some people might be confused or just overwhelmed
  - Simplify the further information feedback request to help encourage comments and engagement

Goal #2 and #3: Core Transformer Configuration Matrix and Interchangeability Matrix

- DT_Convening_Combined_Working_Documents.pdf
  - Slide deck outlining:
    - Consolidated set of meeting slides covering the working discussions from Meetings 1-8
    - Meeting slides for meetings 9-14

Questions

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DT convening group goals

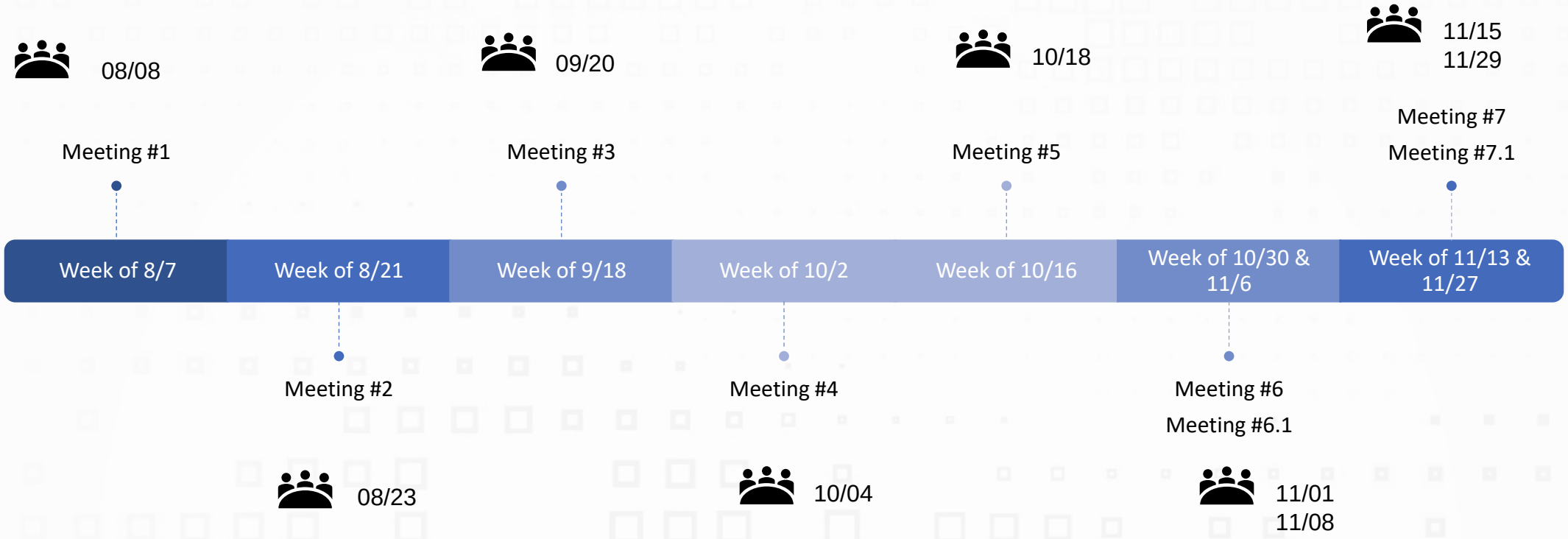
Short Term Goals

- 1. Create a distribution transformer taxonomy- this is to ensure that not only everyone in this group is on the same page, but that we could share with manufacturers and other stakeholders so that we are all speaking the same language.
- 2. Create a core transformer configuration list: This would be broken down into three categories
  - a. Red- spec to keep or to not be altered
  - b. Yellow- spec not functionally necessary but will require an organizational acceptance or can be altered
  - c. Green- spec can be removed or can be exchanged
- 3. Development of the interchangeability matrix

Long Term Goals

- 4. R&D on flexible transformers- Use these discussions to inform R&D on flexible transformers, that could be used interchangeably in the event of extreme weather etc.
- 5. Procurement strategies- Collectively identify enhancements to existing planning and procurement processes necessitated by the emergence of supply chain constraints.

Project Timeline (Separate Utility and Manufacturer Meetings)



Meeting

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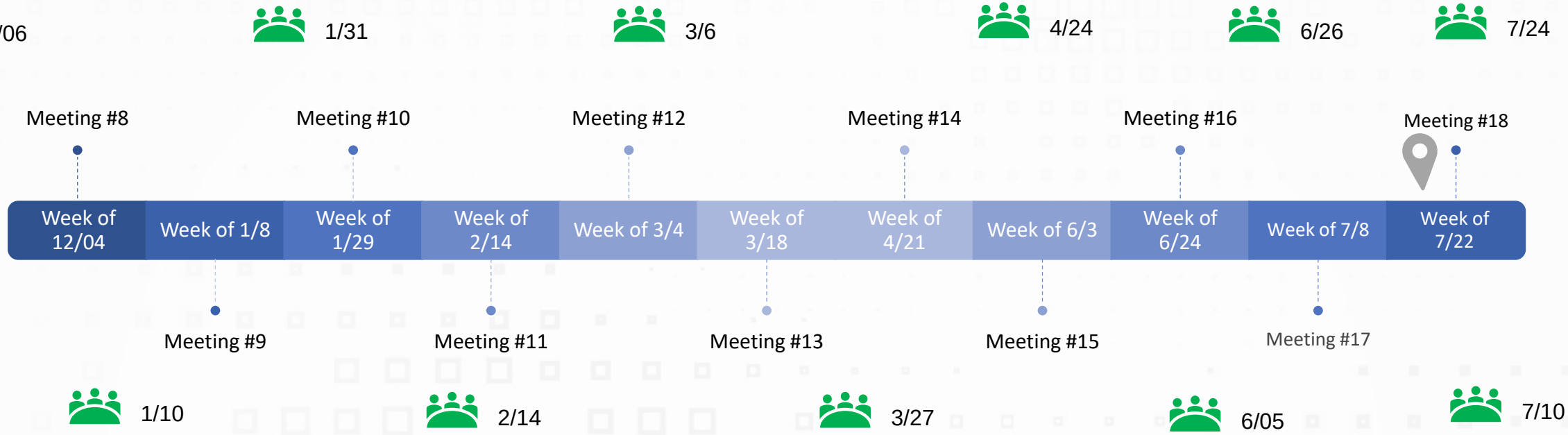
Project Timeline (Combined Utility and Manufacturer Meetings)



Meeting

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Configuration Matrix and Interchangeability Matrix

- Common Configuration Matrix
  - Potential to reduce number of DT types up to 40%
  - Identify areas of electrification that will drive new minimum sizing and impact for example using 25 or 50KVA as compared to smaller 10-15kVA units
  - Improve longer term mutual assistance with more standard offerings
- Improve Manufacturing Efficiency to increase overall capacity
  - Use Configuration Matrix for utilities to understand the drivers for manufacturing complexity
  - Potential to streamline the manufacturing process and improving economy of scale
- Identify Interchangeable components and potential new vendors
  - Provides a listing of critical components that impact the delivery, capacity, or other supply chain impacts for Distribution Transformers.
  - Create Living Library for critical components and vendors