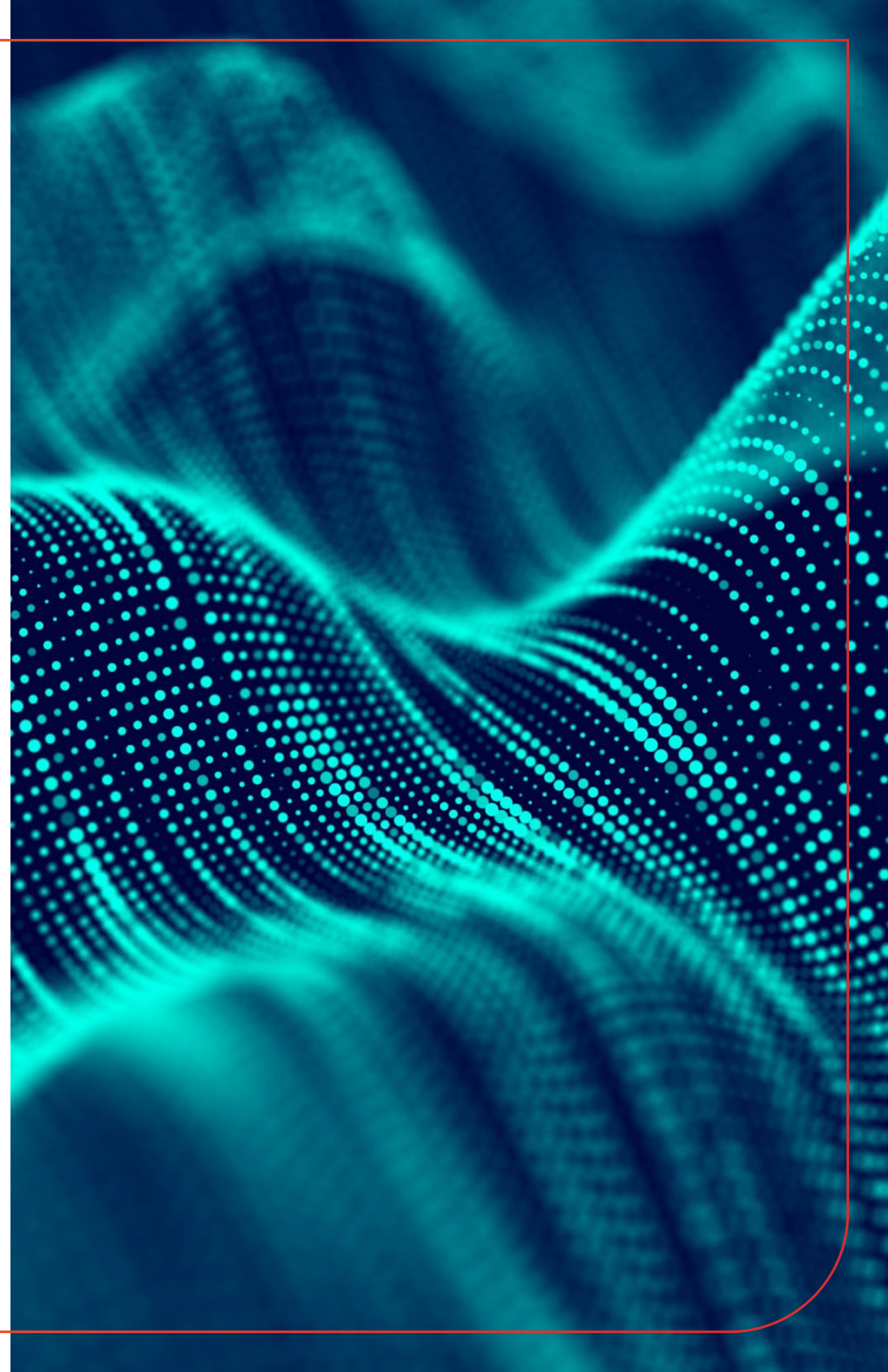
Bus Flow Considerations and Approach

Presented to WECC SRS

October 10, 2024



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Introduction

- Jameson Thornton, P.E. (Ca)
- Senior Project Manager 1898 & Co., Part of Burns & McDonnell, 2022 – Present
- Pacific Gas and Electric 2011 – 2022
  - 2011 – 2018 Transmission Planning
  - 2018 – 2022 Grid Innovation (DER Integration and Microgrids)
- WECC involvement
  - SRWG, TSS, StS, Chair ADSTF (2016)
- NERC SIPDER WG studies Sub-Group co-Chair (2018-2019)
- If you have additional questions or would like to discuss further, please feel free to contact me:
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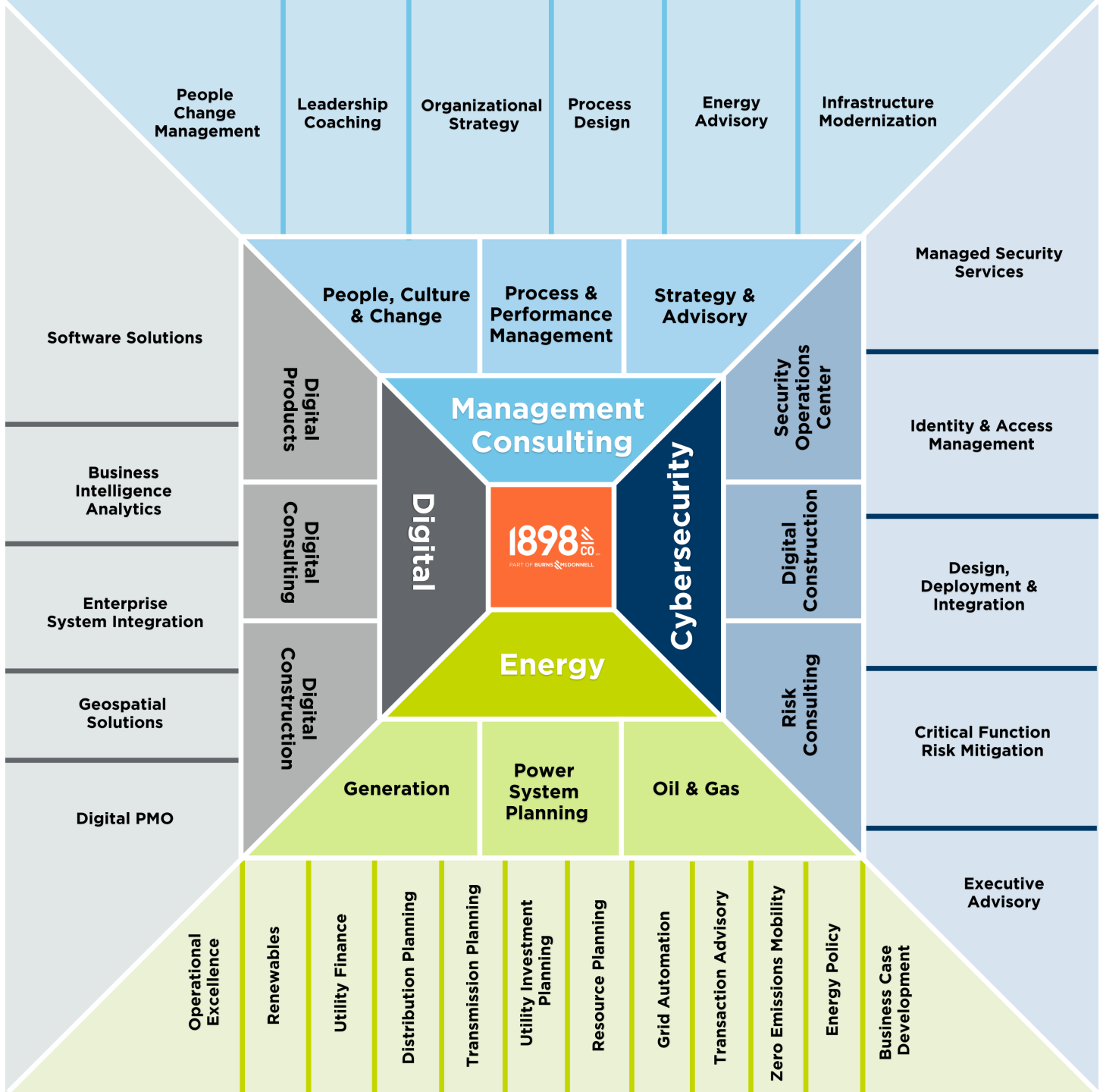
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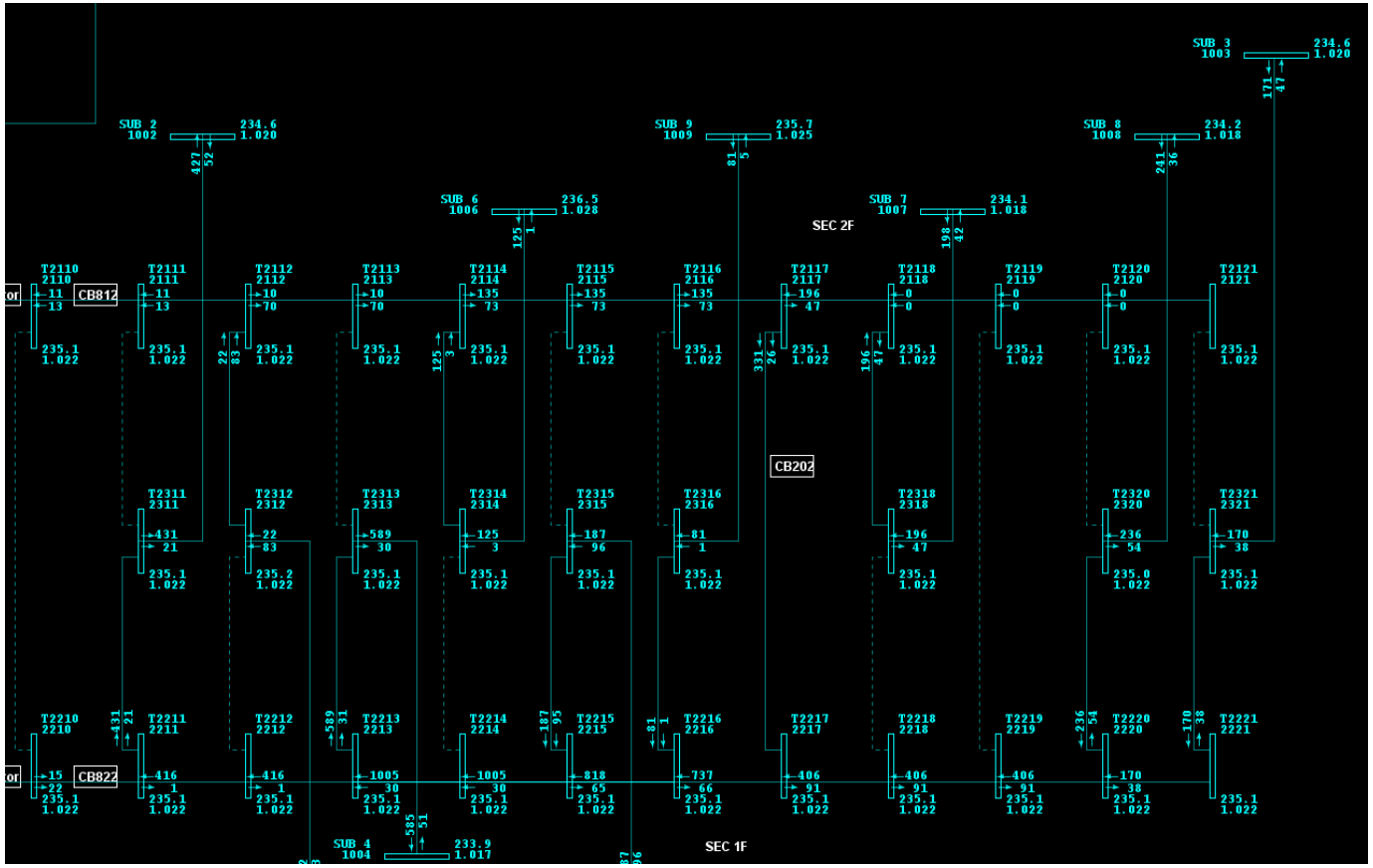
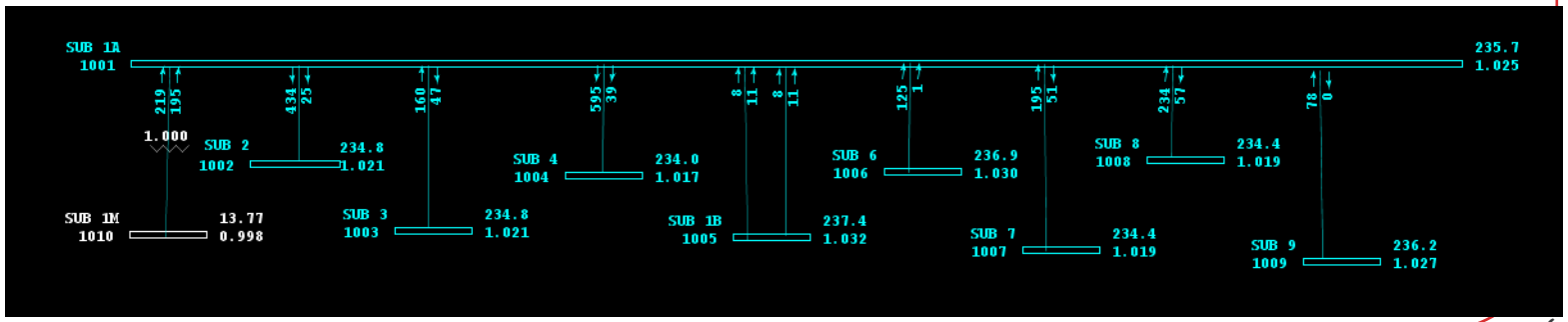
What is “Bus Flow”

- Our term for explicit detailed power flow modeling of substation layouts and connection; effectively break-node modeling for a single substation in a bus-branch case.
- this introduces a new bus for every node and a new branch for every breaker or switch



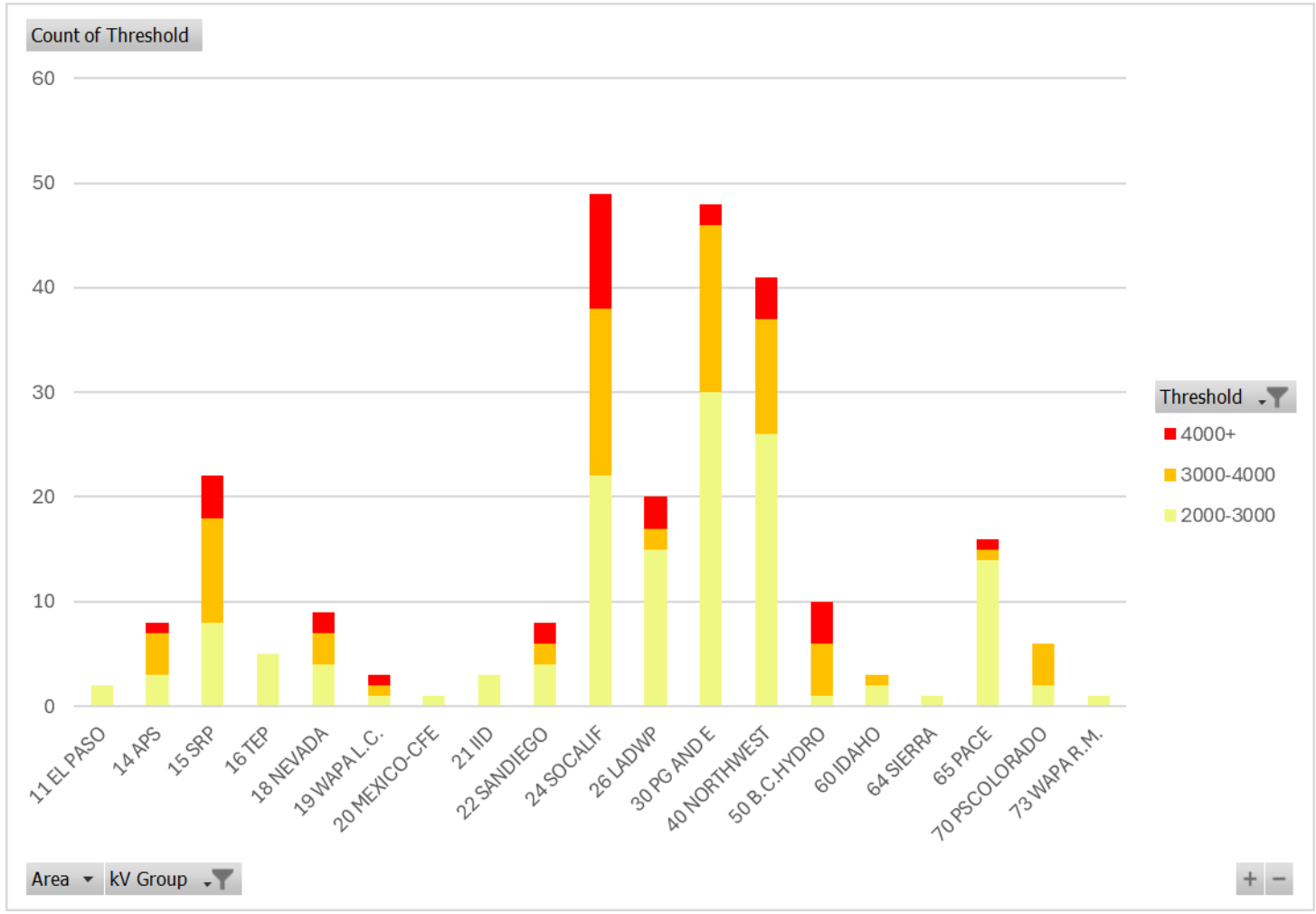


Substation Selection

- Due to the expansive modeling, we should be judicious with what stations we break out into this level of detail.
- A screening analysis is performed to identify substations that the bus loadings may potentially exceed the ratings of the bus or circuit breakers.
- Calculate total flow into a substation where there are interconnection projects in the vicinity area.
- Determine the list of substations for bus flow analysis based on the total inflow and the increase of the inflow.
- Strong consideration for generation studies, especially with cluster studies.
- Compare pre-project cases with post-project cases (as applicable) to evaluate contributions by the current project(s).

Initial Screening on WECC 2029 HS Case

- Initial Screening results for WECC Case to the right
- Areas of high generation are the likeliest to be impacted
- Most regions have at least a handful of high Amps (>2000), some have a few dozen.
- Threshold of concern may vary depending on utility practice and substation design (voltage class)
- 230 kV and 500 kV tend to have highest flows



Additional Changes

- Due to expanded model with new bus numbers additional change are likely needed
- Updated contingency files with new bus numbering
  - More complex than a simple find replace, as what was previously a single bus number is now many
  - Requires a look-up translation of lines
- Bus and breaker outages will be handled differently as well
  - Additional consideration of P2-2, and P2-3 contingencies will require enhanced definitions
- Recommend visual draw file to aid in review of results
  - This will help in understanding the physical flows, likely sources and potential mitigations

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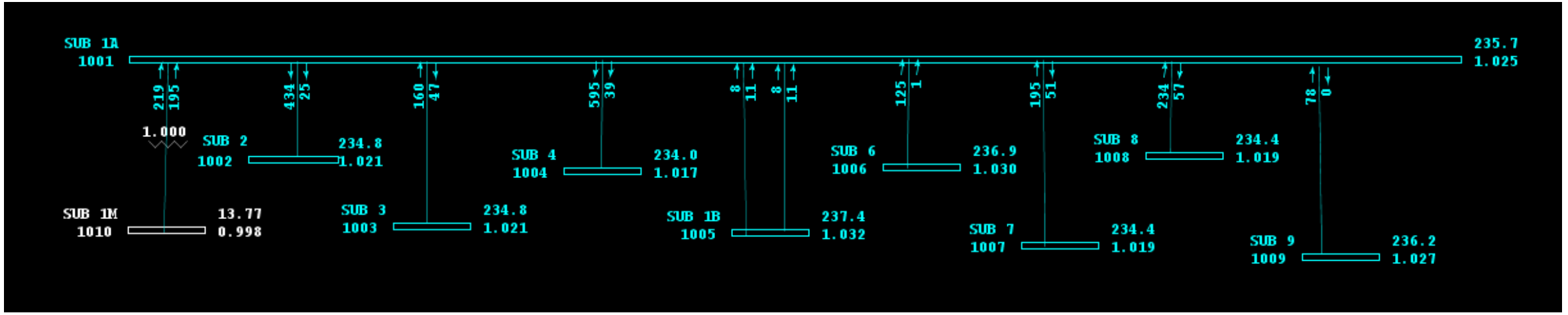
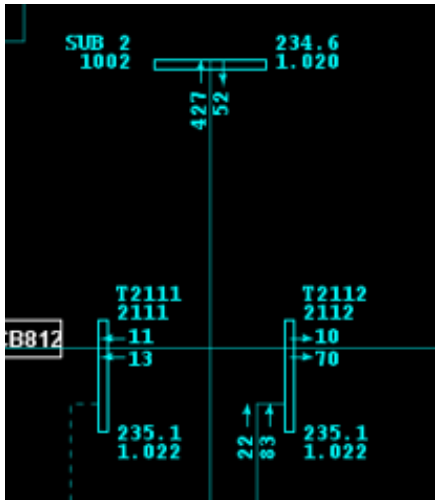
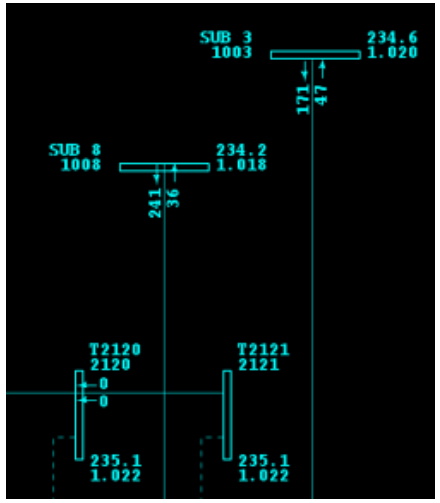
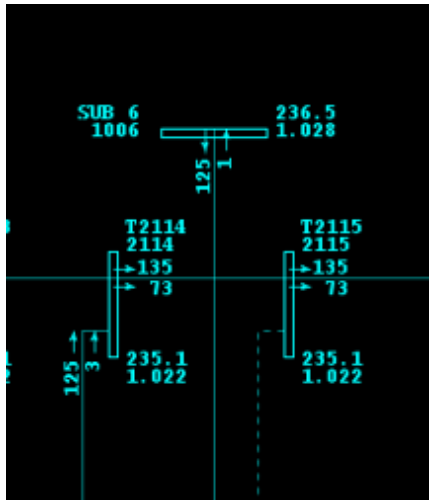
External lines before and after Bus Detail



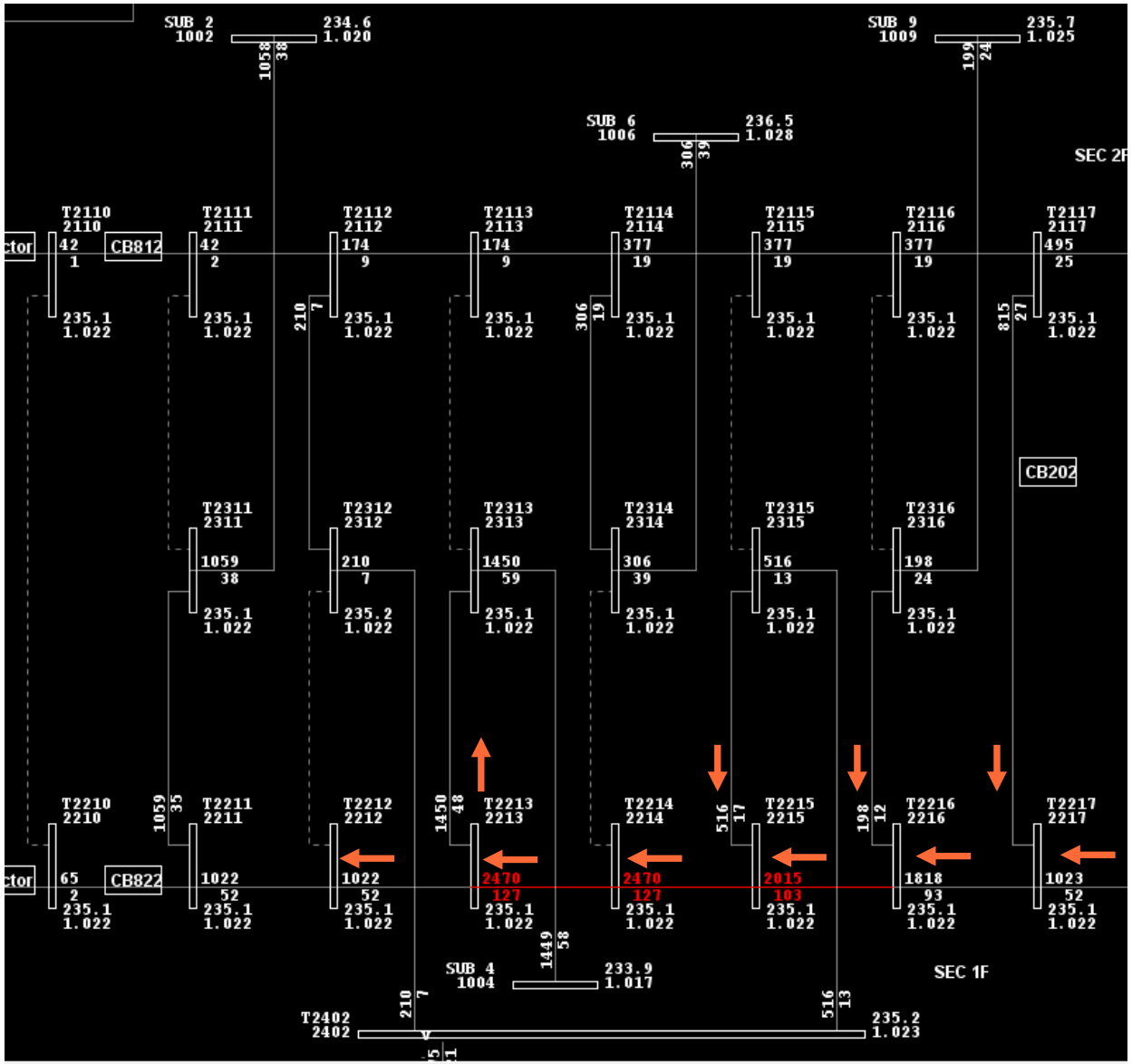






Example

- This highly active 230 kV bus shows a P-0 normal overload on the bus section (rated at 1950 A)
- This is not possible to detect using the standard bus-branch model!
- Because this station has 500/230 and because it had numerous lines to other station it is a central point for flows from gens and to loads



Mitigation Options

- Operational
  - Reconfigure the line connections into the station
  - Will require additional study to determine acceptable layouts considering both flows and reliability.
- Increase capacity
  - For buses we can increase the schedule conductor size (usually). Many buses can have ampacities above 5000 A
  - For breakers increasing to a 2k ,3k, 4k continuous rating is feasible (provided space constraints). >4k A likely would be a custom build
- Limit flows
  - Installing bus or line reactors can alter the flow as needed. This may also be desirable in the instance of high fault duty from high generation levels
- Split the station
  - This is an extreme version of rearranging the bus and can also incorporate the other options implicitly.

Questions? Comments!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