

## Bus Configuration

Stations may have the options for future expansion capabilities for future growth and expansion (e.g., converting ring bus to a breaker and a half as terminals are added). If the solution/ design include future expansion capabilities, the expansion should be outlined for potential evaluation.

For the bus configuration, an element is classified as a line, or an equipment connection including transformers and devices providing reactive support (capacitor banks, shunt reactors, SVC, or other FACTS devices), which have a direct connection to the bus. Equipment connected to a line such as a shunt reactor, series reactor or series capacitor bank nor does it include high voltage station service voltage transformers (SSVTs) or instrument transformers connected to the bus are not considered elements. Every element shall have a form of high side protection device with fault clearing capabilities. The failure or maintenance of an element cannot remove a transmission line from service for any time increment. **Refer to Figure 1 for a depiction of elements and non-elements on a One-Line diagram.**

All elements inside the substation must include a fault clearing device to limit the exposure of failures to only the affected line/ equipment. Isolation or maintenance of an element should not affect the operation of another element.

The bus design and configuration must meet the PJM criteria in terms of stability, voltage, maintenance and N-1 conditions on the system.

Voltages less than 200kV must at a minimum meet the criteria outlined above in the bus configuration.

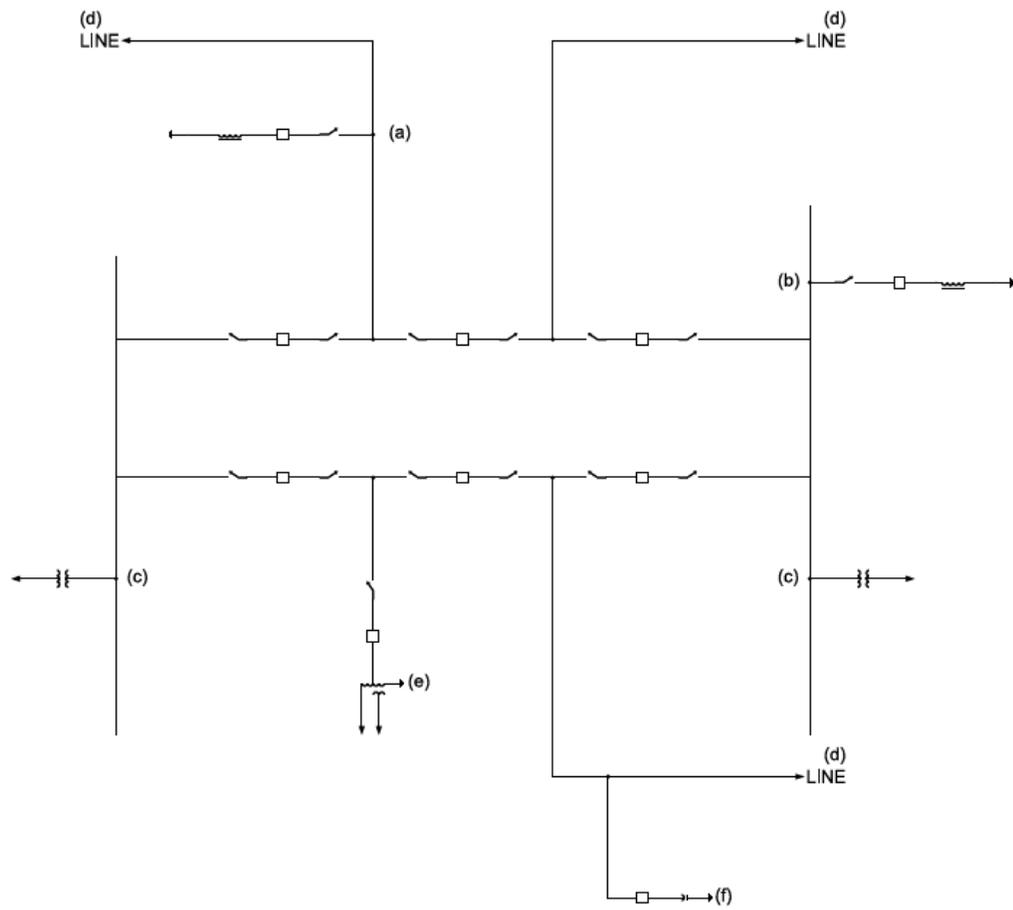
For less than 200kV, it is recommended to follow the below criteria for greater than 200kV, but is not required.

Voltages greater than 200kV must be designed at a minimum based on the following parameters:

- 3 to 6 elements connected – requires a ring bus connection at a minimum
- 7 elements connected or more – requires a breaker and half design at a minimum

Deviations from the above minimum design criteria are acceptable if required to meet all NERC, PJM, and Transmission Owner criteria without jeopardizing operating standards and reliability. As all of the above are minimums, each project design can be designed to higher reliability and operating standards based upon the specific project needs.

Three terminal lines are not permitted in the PJM footprint.



- (a) SHUNT REACTOR CONNECTED TO LINE (NOT AN ELEMENT)
- (b) SHUNT REACTOR CONNECTED TO BUS (ELEMENT)
- (c) STATION SERVICE VOLTAGE TRANSFORMER (NOT AN ELEMENT)
- (d) LINE (ELEMENT)
- (e) POWER TRANSFORMER (ELEMENT)
- (f) SHUNT CAPACITOR BANK (NOT AN ELEMENT)

Figure 1 – One-Line diagram showing elements and non-elements