ISO NEW ENGLAND PLANNING PROCEDURE NO. 9

MAJOR SUBSTATION BUS ARRANGEMENT APPLICATION GUIDELINES

EFFECTIVE DATE: May 12, 2008

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1. INTRODUCTION

This planning procedure provides guidance for design of substation bus arrangements that support and promote the reliability of the New England Transmission System. This Planning Procedure provides basic designs that are readily expandable and simplify substation switching to safely isolate facilities and equipment with minimum adverse impact on power flows. The designs also provide operating flexibility that allows for efficient and effective maintenance of substation equipment, provide for a safe working environment, and are cost effective. This Planning Procedure is based on the work of the Transmission Owners and ISO-NE Substation Bus Arrangement Working Group documented in the report dated February 23, 2006. This report was presented at the April 4, 2006 Reliability Committee meeting.

2. PURPOSE

This Planning Procedure provides guidelines for the bus arrangements for Major transmission substations, those that have a reasonable potential of interconnecting more than four Key Transmission Elements such as non-radial ac transmission lines, HV dc converters, autotransformers with connections to 345 kV or 230 kV, phase-shifting transformers, and generator step-up transformers. This Planning Procedure is to be applied to substation buses that are part of the 115 kV or above transmission systems. These guidelines may be appropriate for buses operated at 69 kV on a case-by-case basis.

This Planning Procedure specifies substation bus arrangements that are considered reliable and good utility practice. In specific cases, an alternate substation bus arrangement design may be proposed and accepted as reliable in the New England Proposed Plan Application Process (PPA) and as Good Utility Practice in the New England Transmission Cost Allocation Process (TCA).

These guidelines apply to new substations and substations undergoing a significant modification. These guidelines are not intended to be used as a justification to redesign existing substations not undergoing significant modifications.

3. GENERAL GUIDELINES

The following guidelines are applicable to new substations and substations that are undergoing significant modifications.

1. Where practical, land shall be purchased and equipment shall be arranged to allow for a substation breaker-and-a-half configuration when transmission grid expansions dictate. It is not recommended that in all cases a substation initially be built with a breaker-and-a-half bus arrangement, only that the design of the substation provides for expansion to a breaker-and-a-half bus arrangement when the substation might become a Major substation. In cases where it is determined that the substation will never become a Major

substation, it is not necessary to provide for expansion to a breaker-and-a-half configuration.

2. The use of air-insulated bus is the recommended design; however, the use of gas-insulated bus should be considered Good Utility Practice when it is required to provide for a substation arrangement that conforms to the guidelines.

3. When designing a new substation or designing significant modifications to an existing substation, it is necessary that the Transmission Owner consider the potential for the future termination of transmission elements. For example, if there is vacant space on existing transmission rights-of-way emanating from the substation or the substation is located in an area that is or will be deficient in generation, it may be prudent to plan the substation for additional transmission elements. A discussion of the potential number of transmission elements should be included in the Proposed Plan Application (I.3.9) submitted to ISO-NE.

4. GUIDELINES FOR 345 kV

The following guidelines are applicable to new 345 kV substations and 345 kV substations that are undergoing significant modifications.

1. The recommended design for a Major 345 kV substation bus arrangement is a breaker-and-a-half bus arrangement with space provisions for a series-tie breaker in each bay. This requirement only applies to Major substations, those that have a reasonable future potential of interconnecting more than four Key Transmission Elements. An example of a breaker-and-a-half arrangement is shown in Figure A. The example in Figure A does not indicate the number of bays that need be included in the design of a Major substation. That determination should be made as described in section 3.3 above. Also the example in Figure A does not show every connection to the main bus that is described in this procedure.

   The 345-kV bus configuration may be left as a ring bus until the fifth Key Transmission Element is terminated at the substation or until more than six positions are needed in the ring bus. (i.e. a six- breaker ring bus is consistent with this guideline as long as no more than four of the six transmission elements terminated in the ring are Key Transmission Elements").

2. Where the failure of a 345 kV tie circuit breaker produces unacceptable operational consequences, a series-tie breaker with no switches between breakers, can be included in the substation design if reconfiguration of the interconnecting elements increases cost or reduces reliability.

3. If a series-tie breaker is installed, another transmission element should not be terminated between the two series-tie breakers. Therefore, the space provision for the series-tie breaker should leave sufficient space for the series breaker only, and not for termination of an additional transmission element. No isolating disconnect switches need to be installed between the two series breakers.

4. The following transmission elements should terminate in a designated bay position of a breaker-and-a-half configuration:

a. A transmission line
b. An autotransformer or bank of autotransformers interconnecting the 345 kV transmission grid to the 230 kV or 115 kV transmission grids
c. A generator step-up transformer or multiple step-up transformers where the generators cannot operate separately, e.g. combined cycle units
d. A phase shifting transformer (phase-angle regulator) or bank of phase shifting transformers
e. A SVC, STATCOM or other FACTs device(s)
f. An HV dc converter

5. The following transmission elements may be terminated on a main bus of a breaker-and-a-half configuration but must have their own 345 kV circuit breaker and their own protective relaying that trips this circuit breaker:

a. Capacitor banks
b. Shunt reactors
c. A load serving transformer or bank of load serving transformers (e.g. 345/34.5 kV)

6. Considerations for terminating elements in a breaker-and-a-third configuration are the same as for breaker-and-a-half.

5. GUIDELINES FOR 230 kV AND 115 kV

The following guidelines are applicable to new 230 and 115 kV substations and 230 and 115 kV substations that are undergoing significant modifications.

1. The recommended design for a Major 230 kV or 115 kV substation bus arrangement is a breaker-and-a-half bus arrangement, but with no space provisions for a series tie breaker. This breaker-and-a-half requirement only applies to Major substations. The 230 kV or 115kV bus configurations may be left as a ring bus until the fifth Key Transmission Element is terminated at the substation or until more than six positions are needed in the ring bus.

2. The following transmission elements should terminate in a designated bay position:

a. A network (non-radial) transmission line
b. An autotransformer or bank of autotransformers interconnecting the 230 or 345 kV transmission grid to the 115 kV transmission grid
c. A generator step-up transformer or multiple step-up transformers where the generators cannot operate separately, e.g. combined cycle units
d. A phase shifting transformer (phase-angle regulator) or a bank of phase shifting transformers
e. A SVC, STATCOM or other FACTs device
f. An HV dc converter

3. Some transmission elements may be terminated on a main bus of a breaker-and-a-half configuration but when so connected, must have their own protective relaying and their own a circuit breaker, circuit switcher, or disconnect switch. The protective relaying must be designed to automatically isolate a faulted transmission element and to automatically restore the main bus to service. The elements that may be terminated on a main bus of a breaker-and-a-half configuration are
    a. A load serving transformer or bank of load serving transformers (e.g. 230/23 kV, 115/34.5 kV or 115/13.8 kV)
    b. A 230/69 kV or 115/69 kV autotransformer
    c. A radial transmission line (a line that terminates in a load serving transformer(s))
    d. Capacitor banks
    e. Shunt reactors

4. Considerations for terminating elements in a breaker-and-a-third configuration are the same as for breaker-and-a-half, except that 345-115 kV or 230-115 kV transformers may be terminated directly on a 115 kV bus since additional transformers may be terminated in a bay without a common breaker between any two transformers.

Document History[1]

Rev. 0 App.: RTPC,

[1] This Document History documents action taken on the equivalent NEPOOL Procedure prior to the RTO Operations Date as well as revisions to the ISO New England Procedure subsequent to the RTO Operations Date.

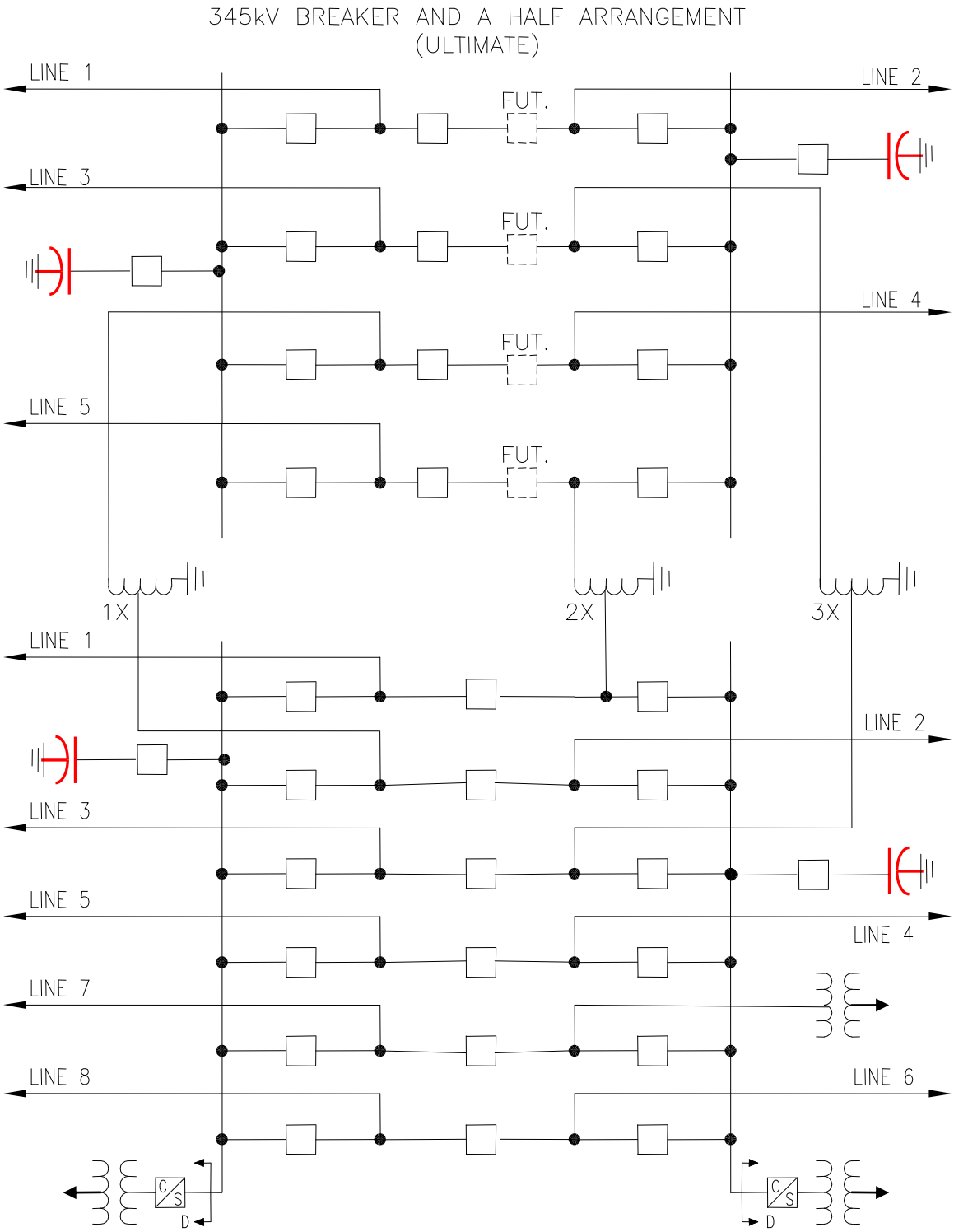
345kV BREAKER AND A HALF ARRANGEMENT
(ULTIMATE)
LINE 1
LINE 2
FUT.
LINE 3
FUT.
LINE 4
FUT.
LINE 5
FUT.
1X
2X
3X
LINE 1
LINE 2
LINE 3
LINE 5
LINE 4
LINE 7
LINE 8
LINE 6
C/S
D
C/S
D
115kV BREAKER AND A HALF ARRANGEMENT
(ULTIMATE)

FIGURE: A

APPENDIX A
DEFINITIONS

Key Transmission Element - Transmission elements such as non-radial ac transmission lines, dc transmission lines, autotransformers with connections to 345 kV or 230 kV, phase-shifting transformers, and generator step-up transformers.

Major Substation - A substation that has a reasonable potential of interconnecting more than four Key Transmission Elements