1.0 INTRODUCTION

This document summarizes the Distribution Planning Criteria and Strategy that will be used by the Liberty Utilities East ("LUE") Engineering Department to review and evaluate the performance of its distribution system for each Planning Study Area ("PSA").

2.0 EQUIPMENT RATINGS

Thermal limits are recognized for all system elements in conducting planning studies. Current in equipment and lines are limited so that voltage drops are held to reasonable values; so that conductors will not be severely annealed or damaged; so that switches, connectors, etc. will not be overloaded and that clearances are not exceeded. Several factors are taken into account, including: 1) ambient temperatures, 2) load cycles, 3) wind velocities, and 4) potential loss of life of equipment.

LUE's Distribution Planning Department maintains equipment ratings for all major equipment, including transformers, overhead lines, and underground cables. Overcurrent protection system settings are also taken into account where applicable.

Tables 1 summarizes the Equipment Rating criteria:

Table 1. Equipment Rating Criteria Summary

	Overhead Conductors		Underground Cables		Transformers	
Condition	**Duration**	**Design Criteria**	**Duration**	**Design Criteria**	**Duration**	**Design Criteria**
Normal	Continuous	• The maximum value for normal peak loads on all new and rebuilt feeders • Temperature limit for 100% ampacity for normal operating conductor is 176°F/80°C for bare conductors and 167°F/75°C for spacer cable, tree wire, & covered conductors	Continuous	• Maximum loading that does not cause the conductor temperature to exceed its design value at any time during a 24-hour load cycle • Normal cable ampacities are based on a 90° insulation operating temperature.	Continuous	• Level for the peak hour in the 24-hour load cycle causes a cumulative (24 hour) 0.2% loss of Transformer life, or • The Top Oil Temperature exceeds 110 °C, or • The Hot Spot Copper temperature exceeds 180 °C
LTE	24 Hours	• The absolute maximum ampacity allowed for a given conductor and should not be exceeded at any time. • Temperature limit for 100% ampacity for operating at an elevated temperature during emergency conditions limited to a 24 hour period is 194°F/90°C for both bare and spacer cable, tree wire, & covered conductors	100 - 300 Hours	• Maximum loading that does not cause the conductor temperature to exceed its design value over several consecutive 24-hour load cycles. • Emergency cable ampacities are based on 130° insulation operating temperature.	1 - 300 Hours	• Level for the peak hour with the emergency load added in the 24-hour load cycle causes a cumulative (24 hour) 3.0% loss of Transformer life, or • the Top Oil Temperature exceeds 130 °C, or • the Hot Spot Copper temperature exceeds 180 °C
STE	As Needed	• Estimated conservatively using seasonal ambient data along with circuit specific information by the Engineering Department	1 - 24 Hours	• Maximum loading that does not cause the conductor temperature to exceed its allowable emergency value at any time during a 24-hour load cycle. • Emergency cable ampacities are based on 130° insulation operating temperature.	15 minutes	• The one hour operation of the transformer at that level for the peak hour in the 24 hour load cycle causes a cumulative (24 hour) 3.0% loss of Transformer Life, or • a hot spot copper temperature exceeding 180°C. • Maximum STE rating is limited to twice the transformer's "nameplate" rating (200%).

2.0 PLANNING CRITERIA

For normal loading conditions on distribution feeders and transformers, the planning criteria is based on facilities to remain within 75% of normal ratings at all times. For subtransmission lines, facilities are to remain within 90% of normal ratings.

For N-1 contingency situations, the planning criteria is based on interrupted load returning to service within a reasonable time via system reconfiguration through switching, installation of temporary equipment, such as mobile transformers or generators, and/or by repair of a failed device. Where practical, switching flexibility is integrated into the system design to minimize the duration of customer outages to meet reliability objectives.

The following criteria summarized in Table 2 shall guide loading and contingency planning on the distribution system:

Table 2. Distribution System Planning Criteria Summary

Condition	Sub-Transmission	Substation Transformer	Distribution Circuit
Normal	• Loading to remain within 90% of normal rating. • Voltage at customer meter to remain within acceptable range. • Circuit phasing is to remain balanced.	• Loading to remain within 75% of normal rating. • Voltage at customer meter to remain within acceptable range. • Circuit phasing is to remain balanced.	• Loading to remain within 75% of normal rating. • Voltage at customer meter to remain within acceptable range. • Circuit phasing is to remain balanced. • Each feeder should have at least three feeder ties to adjacent feeders.
N-1 Contingency, which results in facilities operating above their Long Term Emergency (LTE) rating but below their Short Term Emergency (STE) rating.	• Load must be transferred to other supply lines in the area to within their LTE rating. • Repairs expected to be made within 24hrs. • Evaluate alternatives if more than 36 MWhr of load at risk results following post-contingency switching.	• Load must be transferred to nearby transformers to within their LTE rating. • Repairs or installation of Mobile Transformer expected to take place within 24 hours. • Evaluate alternatives if more than 60 MWhr of load at risk results following post-contingency switching.	• Load must be transferred to nearby feeders to within their LTE rating. • Repairs expected to be made within 24hrs. • Evaluate alternatives if more than 16 MWhr of load at risk results following post-contingency switching.
N-1 Contingency, which results in facilities operating above their Short Term Emergency (STE) rating	• As Needed – Typically 15min for OH conductors and 1-24 hours for UG cables	• Loads must be reduced within 15 minutes to operate within their LTE rating	• As Needed – Typically 15min for OH conductors and 1-24 hours for UG cables

Application of these criteria will result in somewhat less load at risk than previous criteria which generally limited load at risk to between 4 and 20 MW pending the installation of a mobile device. Therefore it is expected that the Load Relief budgets will increase from historic levels for a given load growth rate. The capital cost associated with meeting the new criteria for both normal and N-1 contingency conditions are shown in Table 4:

Table 4. Estimated Capital Costs of New Criteria

	($ Millions)	15 Year Annualized ($Millions)[1]
Total Substation Scope	$16.5	$1.1

Other Distribution Line Scope	$3	$0.2
Total Cost over 15 Years	$19.5	$1.3

1. Assumes 15% carrying cost

The new criteria may result in an increase in capital requirements up to $1.3M/year over the existing criteria for the 15-year period studied.

Liberty Utilities has refined the distribution planning criteria to better fit LUE's strategy and scale of facilities. The table below provides a summary of the changes to LUE's new criteria from the previous criteria under National Grid.

Table 5 – Summary of Planning Criteria Changes

New Criteria	Previous Criteria	Reason for Change
During normal operation, all distribution feeders to remain within 75% of normal ratings.	During normal operation, all distribution feeders to remain within 100% of normal ratings.	Reflects LUE's strategy to proactively plan for sufficient capacity to meet changes in demand.
During normal operation, all sub-transmission lines to remain within 90% of normal ratings.	During normal operation, all sub-transmission lines to remain within 100% of normal ratings.	Reflects LUE's strategy to proactively plan for sufficient capacity to meet changes in demand.
During normal operation, all transformers to remain within 75% of normal ratings.	During normal operation, all transformers to remain within 100% of normal ratings.	Reflects LUE's strategy to proactively plan for sufficient capacity to meet changes in demand.
For the loss of a distribution feeder, if more than 16MWhrs of load at risk results for a single feeder fault evaluate alternatives to mitigate.	No Change.	Existing targets are adequate given size of a typical Liberty distribution feeder.
For the loss of a sub-transmission supply line, the quantity of load at risk of being out of service following post contingency switching should be limited to 20MW combined. If more than 240MWhrs of load at risk results for a single line fault evaluate alternatives to mitigate.	For the loss of a sub-transmission supply line, the quantity of load at risk of being out of service following post contingency switching should be limited to 1.5MW combined. If more than 36MWhrs of load at risk results for a single line fault evaluate alternatives to mitigate.	Reflects Liberty's strategy and scale of facilities.
For the loss of a transformer, the quantity of load at risk of being out of service following post contingency switching should be limited to 10MW combined. If more than 240MWhrs of load at risk results for a single line fault	For the loss of a sub-transmission supply line, the quantity of load at risk of being out of service following post contingency switching should be limited to 2.5MW combined. If more than 60MWhrs of load at risk results for a single line	Reflects Liberty's strategy and scale of facilities.

evaluate alternatives to mitigate.	fault evaluate alternatives to mitigate.	
Every effort must be made to return the failed sub-transmission line to service within 12 hours.	Every effort must be made to return the failed sub-transmission line to service within 24 hours.	Reducing normal loading to 90% for sub-transmission lines allows for adequate capacity on adjacent lines to restore load post-contingency.
N/A	Every effort must be made to return the failed distribution feeder to service within 24 hours.	Establishes a new limit for repairing feeder faults on Liberty's distribution feeders.

3.0 PRIMARY CIRCUIT VOLTAGE CRITERIA

The normal and emergency voltage to all customers shall be in line with limits specified by the state of NH and within the limits of ANSI C84.1-2006.

These upper and lower voltage ANSI limits, as measured at the customer's meter, are listed below in Table 6:

Table 6. Voltage Requirements for LU

For 120 V – 600 V Systems				
Nominal Voltage (V)	Service Voltage (V)			
	Range A		Range B	
	Max	Min	Max	Min
120	126	114	127	110
240	252	228	254	220
480	504	456	508	440

Source: ANSI

Voltage at the customer meter will be maintained within 5% of nominal voltage (120V). Voltage on the feeders is controlled by the station load tap changer or station regulators on feeders, the application of distribution capacitor banks, and the application of pole or pad mounted line regulators.

4.0 DISTRIBUTION CIRCUIT PHASE IMBALANCE CRITERIA

This criterion is established to limit the load imbalance among the three phases of a primary distribution circuit. These criteria call for the correction of phase imbalances of existing and new distribution circuits. Phase imbalance is defined on the basis of connected KVA (CKVA) load for that circuit as:

$$\%imbalance = \frac{(phase\ load - average\ phase\ load)}{average\ phase\ load} X\ 100$$

Two criteria should be met for the circuit to be considered for corrective action:

1. The calculated neutral current should not exceed 30% of the feeder ground relay pickup setting.
2. The loading between the low and high phase should not exceed 100A