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FUNCTIONAL AREA													
AD	**AM**	**BO**	**CM**	**CS**	**EA**	**EN**	**EP**	**EX**	**FM**	**GO**	**HR**	**IT**	**OP**
	X												
PC	**QA**	**RE**	**SA**	**SM**	**TQ**	**VM**	**WM**						

ELECTRIC DISTRIBUTION CAPACITY PLANNING GUIDELINES

1 PURPOSE

1.1 The Exelon distribution system encompasses circuits at the 5, 15 and 35 kV levels and distribution substations, which are supplied by 15, 35, 69, 138 and 230 kV level radial circuits and/or networks. For ComEd, the radial taps serving distribution substations operated at 69 and 138 kV are considered distribution lines and as such are included in distribution plans. For PECO, all lines at 69 kV and higher are planned by Transmission Planning. This document is intended to provide guidance for future expansion of the EED Electric Distribution System.

1.2 Section 6 has been divided into the following subsections:

2 TERMS AND DEFINITIONS

2.1 EMERGENCY RATING: The maximum permitted loading to be used for a specific time interval without exceeding established limits for thermal aging, conductor clearance or equipment damage. Loading in excess of the normal rating is to be used infrequently and only during the unplanned

outage of another system component. Emergency ratings are based on the equipment loading prior to the contingency and only intended for use during a limited number of times during the life of the equipment. The higher emergency rating takes into consideration the duration and the frequency of the emergency condition to limit the loss of equipment life to an acceptable level. The magnitude and duration of loading in excess of normal ratings will be monitored in real time to determine the need for corrective or remedial action. Remedial actions such as load curtailment, generation dispatch or re-dispatch, mobile generation, dropping firm load or equipment and local spares should be considered in determining the actions required and plans needed to meet the normal and emergency ratings of the distribution system. Emergency loading of feeders and transformers at adjacent substations is permitted for the unplanned outage of a transformer or feeder and another substation.

A short-term emergency rating may be utilized to permit higher initial loading following a contingency while remediation steps are being undertaken. Following the initial remediation steps, the long-term emergency rating will be utilized while equipment repair or replacement is undertaken.

2.2 NORMAL RATING: The maximum permitted loading when the system is configured with all related facilities in service and during planned equipment outages, typically for maintenance or construction. Loading at this level will result in minimal, if any, thermal aging over the expected economic life of the equipment. Industry practice supports a normal rating that is frequently higher than the nameplate rating. Daily load cycles and seasonal ambient temperature are taken in to account in determining ratings.

2.3 SCOPE: This document describes the general planning philosophy for the following system elements:

- Radial 69 or 138 kV sub-transmission lines that supply High Voltage (HV) distribution substations
- HV distribution substations supplied by 69, 138 or 230 kV lines
- Medium Voltage (MV) distribution substations supplied by 15 and 35 kV class circuits.
- Distribution circuits (5, 15 and 35 kV levels). The terms circuit, feeder and distribution line all have the same meaning for the purpose of this document.

3 RESPONSIBILITIES

3.1 DISTRIBUTION CAPACITY PLANNING DIRECTOR

3.1.1 Owner of the Capacity Planning Process

3.1.2 Reviews and recommends future major Capacity Issues / Projects and Programs.

3.1.3 Owner of the Capacity Expansion Category Forum. See AM-ED-2002, Category Forum Procedure.

3.1.4 Approves exceptions to these guidelines, for limited term specific situations, that are documented in the Annual Capacity Plan.

4 PRECAUTIONS AND LIMITATIONS

4.1 PRECAUTIONS

4.1.1 Main stem circuits, substations, and radial transmission lines will be planned at a capacity sufficient to meet the range of normal and emergency loading conditions likely in a worst case hot weather (one-in-ten year) scenario. Capacity will be provided on a similar basis for winter peaking circuits and substations. The distribution system planning process will be documented and maintained. The process will identify forecast methodology, content of the *Annual Capacity Plan* and a timetable of capacity planning activities. Exceptions to these guidelines, for limited term specific situations, may be approved by the Director of Capacity Planning and will be clearly documented in the *Annual Capacity Plan*. The annual plan will contain specific capacity and system requirements for the both the short and long range planning horizons consistent with specific guidelines for normal and contingency conditions. The resulting plans should produce a distribution system that provides suitable voltage and equipment loading during normal operation and first contingency outages. The system will be planned such that for probable contingency conditions, voltages and equipment loading will not exceed emergency limits. Exceptions may occur on the fringes of the system where backup facilities are limited that will require the installation of portable equipment, such as mobile transformers, to restore service after a first contingency outage.

4.2 LIMITATIONS

4.2.1 None

5 PREREQUISITES

5.1.1 None.

6 PROCEDURE

6.1 FORECAST LOAD

6.1.1 Design Weather

1. The distribution system will be designed for the load that may result from once in 10-year weather conditions. Slightly higher loading will be experienced for weather conditions more extreme than design levels. The insignificant additional loss of life under these conditions is considered acceptable. Forecast loads will be based on weather adjusted historical values, customer service request information, recent load growth activity in an area, economic development activity information, residential construction activity reports and other available information. Contracted reserve capacity obligations for circuits or substations will be included in load forecasts.

6.1.2 Forecast Horizon

1. Load forecast horizons are to be consistent with the lead-time to complete projects. Circuit forecasts are prepared for two years; substation forecasts are prepared for a five-year period.

6.1.3 Distribution Generation

1. If multiple generators are connected to a distribution circuit or substation, and they are dependable or dispatchable, the forecasted load will be determined with all units on, except the largest unit. Dependable generation is defined as on or available for dispatch during peak for the last 3 - 5 years

6.2 HIGH VOLTAGE SUBSTATIONS:

This section describes general criteria for planned capacity at high voltage substations supplied at 69 kV or higher voltages. The loss of a transformer or supply line for a multi-transformer high voltage substation may result in a momentary interruption while load is automatically transferred to the remaining line(s) or transformers(s).

6.2.1 Non-Mobile Ready

1. Loading at non-mobile ready, multi-transformer high voltage substations is limited to the lowest of the following without exceeding regulatory limits for voltage regulation:

   - Normal capacity with all transformers in service.
   - The short term rating of the remaining transformers with the largest transformer out of service, prior to load transfers.

- The long-term emergency rating of the remaining transformers with the largest transformer out of service, for the replacement period plus planned load transfers to other sources.

6.2.2 Mobile Ready

1. Loading at a mobile transformer ready substation is limited to the long-term [normal in East] combined capacity of a mobile transformer plus the remaining transformer(s). A combination of automatic and manual load transfers may be required to limit initial loading following a contingency to the short term rating of the remaining transformer. No customer load will be curtailed for more than 2 hours following a transformer contingency. This case will only apply at those locations where facilities and plans have been developed to permit placing a mobile transformer in-service within 24 hours. A mobile ready substation contains facilities to connect the primary and secondary of the mobile transformer within a 24-hour period without conflicting with the replacement of a failed transformer.

6.2.3 Double Contingencies

1. For substations where it is difficult or impossible to utilize a mobile transformer and where a high level of vulnerability of overlapping transformer outages resulting from transmission line failure(s) exists due to system configuration an additional criterion applies. This generally applies where a substation is supplied by radial underground transmission and there is no high voltage substation bus. Load is limited to the emergency capacity of the remaining transformers, with two transformers out of service, plus planned load transfers to other sources.

6.2.4 Single Transformer Substations

1. Loading on a single transformer HV substation is limited to the lower of the following:

   - The transformer normal rating.
   - The capability of distribution ties to other sources without exceeding the emergency ratings of circuits and transformers. Subsequent cascade load relief, use of alternate emergency feeders or mobile transformer deployment may be required if emergency feeder loadings is expected to last greater than 24 hours.
   - The rating of the mobile transformer.

2. The outage of the transformer or supply line to a single transformer substation may result in an interruption in service of up to 2 hours

while load is being transferred to adjacent distribution circuits and substations. If the capability of the backup circuits used during the transformer replacement period is not sufficient, a mobile transformer will be utilized so that circuit loading can be returned to normal ratings within 24 hours.

6.2.5 Load Transfers

1. Since feeder emergency ratings are based on a 24 hour duration, cascade load relief for feeders loaded to emergency levels, use of alternate emergency feeders, mobile generators or load curtailment may be required to avoid damaging cables or conductors for extended transformer outages. Where this level of redundancy is not practical, contingency plans will be developed to facilitate orderly service restoration in the event of this type of contingency.

6.2.6 Automatic Load Shedding

1. An automatic load shedding scheme will be implemented to protect the remaining transformers from damage for a contingency more severe than the planning criteria or for the failure of communications or automated load transfer schemes to operate promptly. The automatic load shedding schemes may also be used at mobile dependent substations to protect the remaining transformer[s].

6.2.7 Radial Supply Lines

1. Loading on radial lines that supply HV Distribution Substations is limited to the emergency capacity of the remaining lines for the unplanned outage of one line. In the event of the unlikely outage of two circuits on common structures, no more than one substation is at risk of an extended outage until temporary repairs can be completed. No more than 30,000 customers should be exposed to a common mode structure failure where restoration would require greater than four hours.

6.3 MAINTENANCE CONSIDERATIONS

6.3.1 Planned Maintenance:

1. Preventative maintenance outages must be periodically scheduled for substation transformers, bus sections and feeder circuit breakers. Circuit capacity and configuration should be adequate to permit such planned equipment outages during non-peak load conditions without exceeding normal equipment ratings. In some cases, the use of mobile transformers or other equipment may be the most economic alternative to temporary load transfers. Planned work on facilities

that supply multiple customers should not result in a loss of service. Customers with dual or redundant service may be supplied with a single service during planned work.

6.4 SUBSTATIONS SUPPLIED FROM SUB-TRANSMISSION LINES

1. Medium voltage (15 and 35kV class primary) substation transformers (typically under 10 MVA) are planned to be loaded to normal ratings. If the substation has low voltage bus tie circuit breaker(s) and each bus supplies multiple feeders, loading is limited to the emergency rating of the remaining transformer(s). In addition, circuit ties, mobile units, mobile generation, load curtailment or other load management actions will be provided if a medium voltage substation is supplied by a single radial supply line tap, to restore service within two to four hours for the outage of the supply line, wherever practical. A looped or second supply line may be utilized to reduce the number of required low voltage circuit ties

6.5 DISTRIBUTION CIRCUITS

1. Distribution circuits are generally planned to be loaded at no more than 105% of normal capacity for the annual forecast peak load. Where practical, adequate ties among circuits will be provided so that the load can be transferred to no less than two adjacent circuits in the event of the failure of the main stem of the circuit. These ties are provided so that service can be restored, by switching, generally within two to four hours. An automatic sectionalizing device is applied on circuits with greater than 2000 customers to reduce the system frequency of interruptions. Reliability performance and voltage regulation including capacitor control settings and voltage regulator application will be considered when circuits are reconfigured to meet capacity needs.

6.6 AREA PLANNING CONSIDERATIONS

1. A *Planning Area* consists of a group of adjacent substations, the circuits supplied by those substations and adjacent medium voltage substations. A typical planning area contains 2-6 substations with a total load of 300-600 MW. Areas are typically bounded by rivers, interstate highways and other barriers to feeder routes. Substations within the same area have adequate feeder tie capability to permit load transfers among substations. These are utilized when needed for feeder or substation capacity relief and to facilitate load transfers in the event of a feeder or substation transformer failure.

2. The average load to capacity ratio for substations in the same area, should be limited to the 95 - 98% range. Loading at the lower end of the range is appropriate in high load growth areas, while loading at the upper end of the range is adequate in low growth rate areas. This limit is intended to provide sufficient flexibility to restore load in the event of an unplanned transformer or circuit outage and to accommodate unanticipated customer load additions.

6.7 LOW VOLTAGE NETWORK SYSTEMS

1. Loading on low voltage network systems is limited to the lower of the following.

   - Normal capacity with all facilities in service
   - The emergency capacity of transformers and conductors with one circuit or transformer out of service during the summer peak season
   - The emergency capacity of transformers and conductors with the unplanned outage of two circuits during the non-summer peak season, when maintenance is generally performed

6.8 VOLTAGE REGULATION

1. Voltage delivered to customers will be within the limits specified in the state jurisdictional administrative codes. Reference Illinois Administrative Code Section 410.280. Pennsylvania Administrative Code Title 52, Chapter 57.14. In the case of unplanned emergency events, an additional 2.5% voltage reduction may occur, while corrective action is being taken per ANSI Standard C84.1 Range B.

6.9 REACTIVE PLANNING

1. The objective of the system reactive power planning is to coordinate the reactive requirements of the transmission system and the distribution system to satisfy system voltage requirements efficiently. This means ensuring system and local voltage stability, ensuring the distribution system has adequate voltage, and minimizing reactive interchange between the distribution system and the transmission system. System reactive requirements will be determined by Transmission Planning (West) / Transmission Management (East). Distribution Capacity Planning will provide plans for installation of capacitors or other reactive sources at distribution substation buses and on circuits to meet system reactive requirements and distribution system voltage regulation. Capacity Planning is responsible for the no-load substation transformer tap settings to meet customer voltage regulation requirements under normal and contingency conditions for

the range of expected light and peak load conditions. These settings should permit load tap changing equipment to pass through the neutral position periodically to avoid equipment damage. Seasonal switching of feeder capacitors may be required to meet this objective.

7 DOCUMENTATION

1. As part of each capacity planning cycle, an integrated substation and circuit capacity reinforcement project plan (*Area Plan*) for each planning area will be produced including any exceptions to these guidelines, as approved by the Capacity Planning Director.

8 REFERENCES

1. AM-ED-Y013, Capacity Planning and Expansion (Transmission and Distribution)
2. AM-ED-P001, Area Planning Process
3. AM-ED-2002, Category Forum Procedure
4. AM-ED-3002, Short-Range Load Forecasting Procedure
5. AM-ED-3007, Weather Adjustment Procedure

9 ATTACHMENTS

1. None

10 DEVELOPMENT HISTORY

	Revision 0	**Date 10/03/2005**
Writer	Michael Born (Capacity Planning)	
Reviewer(s)	George Karpuk (Capacity Planning)	
FAM Approver(s)	Ronald Donovan	
Reason Written	Migration of Capacity Planning Guideline document dated November 11, 2003, approved by Wanda Reder, V. P. EED Asset Management to EED Management Model format.	

	Revision 1	**Date XX/XX/XXXX**
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