FERC Form No. 715
Part 4

UGI UTILITIES, INC.

REGIONAL SUPPLY SYSTEM

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1.0 SCOPE

Regional Supply System extends from the high side of the 230/66 kv transformers to the high side of the 66/13 kv transformers and include 66 kv lines and switching, generation connected to the 66 kv system, and supply to 66 kv customers.

2.0 PRINCIPLES

The Regional Supply System is designed with the recognition that each of its various types of equipment components have a different likelihood of failing, their outage affects the operation of the system to different degrees, and they have different repair times to return them to service when they do fail. The components of equipment whose outage have the greatest impact on impairing the operating capability of the system are given the best quality backup (i.e., continuous versus a manually switched in second source) while those which affect the capability of the system to a lesser degree are supported by a proportionately lesser quality backup system.

As is the case with the Area Supply System there is a natural lessening in system reliability as the transition is made from the high concentration of facilities to serve the system's load centers to the scattered facilities which serve the system's light load areas. When the source is farther removed from the load, more opportunity exists for something to go wrong with the transmitting system and less opportunity exists to provide a second source to support the load if a component of the system fails.

Developing plans for expanding the Regional Supply System involving melding together many areas of consideration, each on a basis unique to the region being studied. These include the following:

1. Existing facilities in the region.
2. The location of the existing facilities with respect to the load to be served.
3. The type and amount of load to be served.
4. The regions forecasted load growth.
5. The availability of sufficient right-of-way.
6. System design requirements.
7. System reliability.
8. System operation.
9. Provisions for future expansion of the system.
10. Compatibility with the surrounding environment.
11. Economic attractiveness of alternatives.

The extent to which each of these considerations affects a proposed system expansion varies with each region. The final choice of the plan of expansion is made with the intent of optimizing the summation of the impacts of each of these considerations to achieve an overall balanced system design. As a minimum requirement, regional facilities are planned to provide adequate supply to all load levels throughout the daily load cycle under the following conditions:

1. Normal operation of the system shall not load any facility beyond its normal rating.

2. With the system fully intact, any single failure (including a double circuit on a single structure) should not result in:

   a. Loss of load in excess of the limits specified in Table 2.2
   b. Loading of facilities above their emergency rating for the prevailing conditions.
   c. A sustained voltage drop of more than 10 % at the customer service.

3. The outage of a second most critical facility while the first is taken out of service may result in overloaded facilities and loss of load beyond that shown in Table 2.2. If this second outage occurs during a short maintenance or construction outage, additional load may be dropped. These maintenance and construction outages have an 8-hour or less return to service requirement.

4. Long scheduled outages for construction or maintenance shall be considered individually, and abnormal measures for this interval shall be based on the probability and consequences of another contingency. These scheduled outages have greater than an 8-hour return to service time and reinforcements may be required to reduce the amount of exposure during these outages.

For planning purposes the outage of Hunlock generation shall be treated a normal system condition and not considered as a single failure for inclusion in 2 and 3 above. In Table 2.2 below are listed the maximum acceptable loss of load for various lengths of time as a result of equipment failures. Past experience with the component parts of the regional supply network allows for judgmental evaluation of the likelihood of interruptions relative to their severity and duration. The more frequently a failure might be expected to occur which results in customer Interruptions, the smaller the amount of interrupted load that is acceptable.

REGIONAL SUPPLY SYSTEM
TABLE 2
MAXIMUM ACCEPTABLE MW LOAD INTERRUPTION AND DURATION

	Repair Time:	**Up to 8 Hours (Until Repairs Are Made)**	**Up to 4 Hours Sectionalizing is Completed**
Facility Failed:			
66 KV Single Circuit		0	30 MW[(1)]
66 KV Terminal or Bus Section (66/13 KV Substation)		0	30 MW[(1)]
66 KV Double Circuit on a Single Structure		0	60 MW
66 KV Terminal or Bus Section (230/66 KV Substation)		0	60 MW
66 KV Bus OCB		0	60 MW
230-66 KV Transformer		0	0
230-66 KV Substation		0	0

[(1)]The greater of 30 MW or the loss of two Type I substations is acceptable.

3.0 PRACTICES

3.1 INSTALLATION OF REGIONAL SUPPLY FACILITIES

Regional supply facilities shall be planned to be installed the same year they are needed in order to meet the criteria as stated in Table 2.2.

3.2 REGIONAL SUPPLY SUBSTATIONS

3.2.1 SUBSTATION SITE IDENTIFICATION

Studies of the Regional Supply System should be made for system load levels reflecting a time frame of ten years in the future. The site for a regional supply substation should be selected at least eight years in advance of its need. This will allow sufficient time prior to the start of any construction to acquire the needed property and right-of-way to fully develop the site.

3.2.2 STEPS IN DEVELOPMENT

Figure 3.3 is a functional one line diagram showing the two steps normally taken in developing a 230/66 kv substation. The two steps are described below. Although a two transformer substation may be developed from the onset, the two step mode of development as shown allows closer matching of the system's capabilities to the region's needs.

STEP NO. 1

Providing that its load can be supported via 66 kv ties to other 230/66 kv substations in the event of its outage, a single 150 MVA rating transformer will be installed. The transformer will be connected to two 66 kv operating buses and a transfer bus through circuit breakers (OCB's). The 66 kv transfer bus will have manually operated tie switches to the 66 kv lines emanating from the substation

STEP NO. 2

A second 150 MVA transformer will be added, connected to the opposite ends of the 66 kv operating buses through two OCB's.

3.2.3 230/66 KV TRANSFORMER CAPABILITY

The standard 230/66 kv transformer is a 150 MVA FOA 65 temperature rise unit with plus and minus 5% tap changing under load (TCUL) capability. For planning purposes, the thermal capability used is as shown in Table 3.2.

TABLE 3.2
TRANSFORMER RATING - PERCENT OF NAMEPLATE

Loading Period	Normal	6-Month	8-Hours
Summer	120	130	140
Winter	135	145	160

The long-term rating takes into account daily load cycling. The short-term rating is for continuous loading. It is recognized that a failed transformer of this type may take six to twelve months to replace or to repair and return to service if it needs to be returned to the factory. However, the drop in load during the off-peak season and transfer of load to other sources should allow the remaining transformer to operate within its capability for the duration of the outage. Eight hours is the worst case time duration from the moment of failure until system rearrangement can be done to unload the remaining transformer.

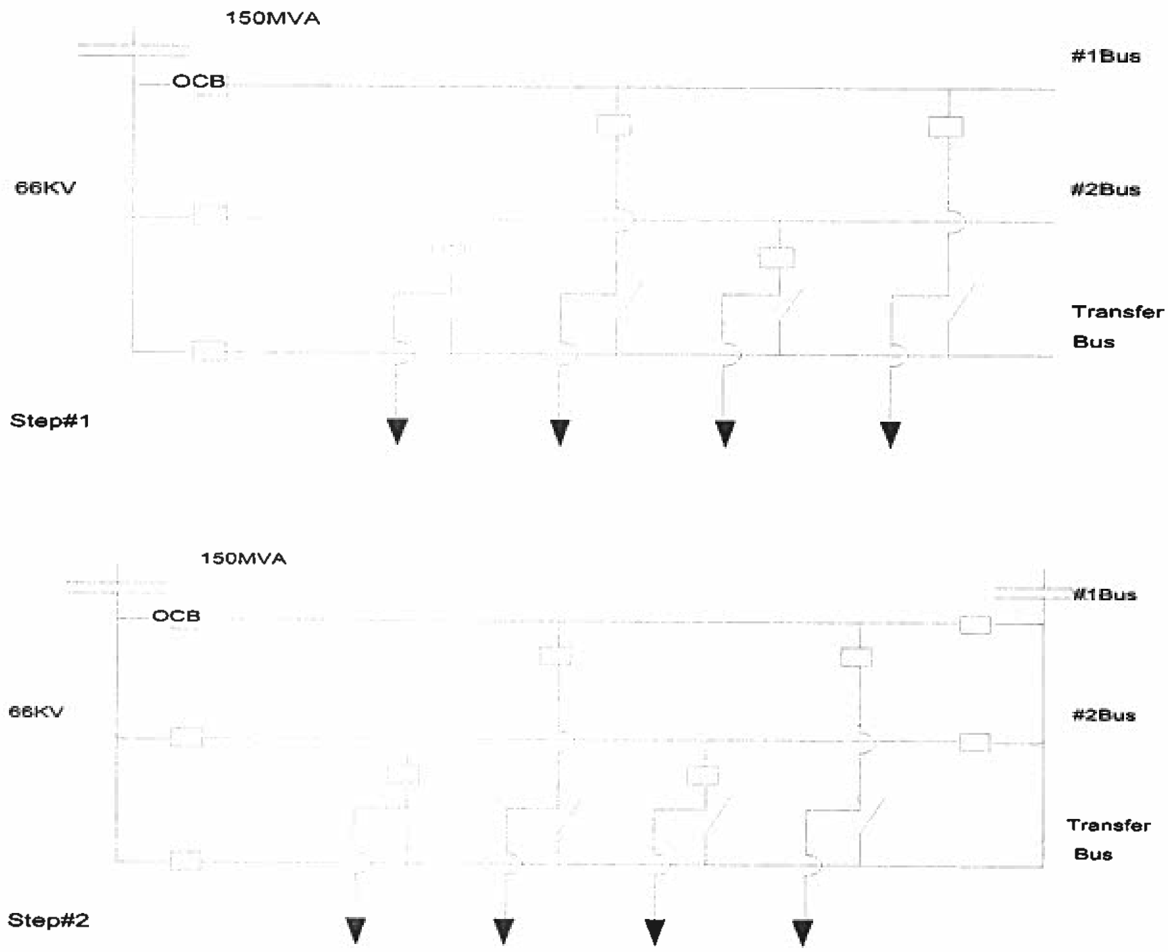

Figure3.3

3.2.4 66 KV SUBSTATION FACILITIES - SHORT CIRCUIT AND LOAD CARRYING CAPABILITY

The 66 kv bus, circuit breakers and associated facilities shall be designed for short circuit duty of 3500 MVA with the minimum load carrying capability as shown in Table 3.3. In all cases the substation terminal equipment and line equipment should not limit the operating capability of the 66 kv lines. Similarly, the substation equipment should not limit the operating capability of the transformers.

TABLE 3.3

(MVA AT 66 KV)

Bus	1500 (170 MVA)	1800 (205 MVA)	1700 (195 MVA)	2100 (240 MVA)
Transformer	1500	1800	1700	2100
Line Breaker	1200 (140 MVA)	1200 (140 MVA)	1200 (140 MVA)	1200 (140 MVA)

3.2.5 SUPERVISORY CONTROL

Supervisory control from the System Operator's room will be provided at all 230/66 kv substations to perform the following:

1. Open, close and indicate position of each 66 kv circuit breaker.
2. To change the tap position of each transformer.
3. To control and indicate the position of station alarms.

3.2.6 TELE-METERED INFORMATION

Tele-metered information from each 230/66 kv substation to the System Operator's room will be provided for following information:

1. Transformer MW and MVAR.
2. Transformer accumulated MWH (IN and OUT).
3. Transformer tap position.
4. 66 kv bus voltage.
5. 66 kv line currents.
6. 66 kv line MW and MVAR.

3.2.7 RELAYS AND PROTECTIVE EQUIPMENT

The protective requirements for regional supply substations are detailed in the Relaying Practices of these Principles and Practices. In general, relays and protective equipment will be provided to clear faults at any location on the 66 kv system within the withstand capability of the facilities. Backup coverage on 66 kv lines will be provided where it can be obtained as a natural function of primary relays installed for other purposes. Separate backup protection will be provided to prevent damage to 230/66 kv transformers and to protect the reliability of the bulk power system according to its criteria.

3.3 66 KV LINES

3.3.1 DEVELOPMENT OF THE 66 KV SYSTEM

With the development of the Bulk Power System, the function of the 66 kv system has changed from transmission to subtransmission. The 66 kv system, once operated almost entirely as a network, is now being operated as a spot network or as a radial system. In each case of proposed expansion of the Regional Supply System, the cost and operational advantages of network versus radial System must be considered. In no instances should the 66 kv system limit the operation of the overlaying Bulk power System. However, radial lines with normally opened ties should be capable of network operation if network operation will be beneficial during an extended outage of other facilities in the region.

3.3.2 LINE ROUTES

Line routes shall be selected to facilitate:

1. Inter-ties to adjacent regional supply systems.
2. Development of Type II area supply substations.
3. Development of ties as alternate sources to area supply substation within a region.

Line routes should be chosen at least six years prior to actual need for the line to allow time for regulatory approval as required and for acquisition.

3.3.3 NEW OVERHEAD LINES

The choice of circuit arrangement and construction used will take into account the various needs placed on the circuit. The engineering, environmental and economic considerations of each line are weighed against each other to optimize the best choice all total while maintaining the overall system reliability within the criteria of Table 2.2.

Generally, a double circuit on a single structure makes maximum use of right-of-way. Double circuits are advantageous where a higher transfer capacity than that of a single circuit is required between two points or where a common right--of-way is used for some distance along the route for lines to serve separate independent areas. These independent areas should not rely on the opposite line on the common structure as its backup source of power so that in the event of a double circuit outage both areas are outaged until repairs are made.

Two single circuits, paralleled on one right-of-way, are more reliable than a double circuit on a single structure because it eliminates almost all common mode outages. Also, it provides the flexibility of being able to work on one circuit without the requirement of taking the parallel circuit out for clearance.

Because of the greater independence they provide, two circuits on separate structures is the preferred method of supplying a Type II substation. The two circuits of a double circuit line will be accepted for the supply sources to a Type II substation only when they are existent and readily available to the substation site or when right-of-way limitations prevent building separate circuits to the site.

The conductor size chosen is based on the expected load on the line over the life of the conductor. The conductor should not be required to be changed out over its expected life because of being insufficient to carry its load. In general, in high growth areas using the largest conductor capable of being supported by a given structure system is most economical and maximizes the ability of the circuit as constructed to transfer power.

The standard conductors used for 66 kv line construction are shown in Table 3.4. The 266.8 MCM ACSR conductor is used for tapping the main line to serve one or two transformers. The 336.4 MCM ACSR conductor is the standard size conductor for older construction. It can be used if economical in areas of moderate growth. The 556.5 MCM ACSR conductor is the standard size conductor for new high capacity lines. It is compatible with our standard 66 kv line and terminal equipment.

TABLE 3.4
66 KV LINE CONDUCTORS

Conductor	Summer				Winter			
	Normal		Emergency		Normal		Emergency	
	AMPS	MVA	AMPS	MVA	AMPS	MVA	AMPS	MVA
266.8 MCM	500	57	650	74	540	62	680	78
336.4 MCM	580	66	750	86	630	72	780	89
556.5 MCM	815	93	1030	118	885	101	1070	122
1/0 Cu*	340	39	380	43	425	49	455	52
4/0 Cu*	520	59	590	67	655	75	705	81

3.3.4 OLD LINES

Lines constructed to standards now obsolete shall be modernized as needed to meet capacity and reliability requirements. The design criteria for new overhead lines applies to modernizations as well.

3.3.5 SECTIONALIZING SWITCHES

Sectionalizing switches will be installed so that the system has the operating flexibility to provide clearance to maintain a 66 kv line section or switch under peak load conditions without using the mobile 66/13 kv substation. This type of flexibility may require using the 13 kv system, an alternate 66 kv source, or some combination of both in order to maintain or restore service to the load during such outages. The switch used should be capable of carrying load at least equal to the applicable emergency rating of the line. The type of switch installed will depend on its intended use: whether or not it is to be used for parallel switching, energizing or de-energizing lines and transformers, or dropping and picking up load. Sufficient flexibility in switching should exist to transfer the supply of a substation from one source to an alternate source when needed without interruption of service to that substation and without de-energizing the lines to accomplish the switching.

3.4 VOLTAGE CONTROL

The voltage maintained on the Regional Supply System is coordinated with that of the Area Supply System to provide voltage to the customers within the limits as specified in Area Supply section of these Principles and Practices. The voltage control points on the Regional Supply System are used for primary control of the system voltage while the voltage control devices on the distribution system adjust the voltage of the service to the customer. Adjustment is then made to minimize var flow and system losses. In general, the voltage at the 66 kv terminals of a 66/13 kv transformer should not be allowed to go 3% below 66 kv during normal operation and 57, below 66 kv during emergency operation after all available corrective measures have been taken.

3.5 REACTIVE SUPPLY

Sufficient sources of reactive power will be provided locally in each region so that at a minimum under normal system conditions at all load levels approximately unity power factor can be maintained on the high voltage side of the 230/66 kv transformers. These and other additional reactive sources will be installed as required to maintain the system voltage within the above stated limits.