**Section 5.3.1 has been updated since the December 2004 publication. Please refer to the on-line version for updates prior to using, see updates in red. InFPL/Power Systems/Reliability/DEO/Publications/DERM**

# 5.3.1 RESIDENTIAL URD SYSTEM

## A. INTRODUCTION

All single-family URD projects (including town homes and some multi-plex units) are now designed by the TRS Group of Distribution Construction Services. The process is named "APD" for Automated Plat Design utilizing CAD and a software that was developed specifically for designing electrical Underground Residential Distribution Systems. This software combines the Geographical Information System (GIS) and electrical analysis for the most economic and technically optimal electric system possible. For more information on APD refer to TRS's website under FPL / Power Systems / Distribution Construction Services / TRS.

## B. GENERAL DESIGN CONSIDERATIONS

### 1. Terminating The Loop

Avoid terminating the two ends of a loop on the same pole or in the same switch cabinet. To do so would put the entire loop out of service if a pole or switch failed. Service to the loop could not be restored until the pole or switch is repaired.

### 2. Cable In Conduit - All Areas

In all FPL service territory, all cable (1000-kcmil, feeder, primary, loops & radials, secondary, service and streetlight) will be installed in a continuous PVC conduit from termination to termination (i.e., riser to transformer pad, transformer pad to transformer pad, etc.).

For all runs of 25 kV, 1000 kcmil cables, a 6" plastic conduit should be installed for each circuit. #1/0 primary cable should be installed in a 2" conduit in a complete unbroken run from riser or pad mounted switch to transformer pad, and from transformer pad to transformer pad. However, on long runs a splice box for cable pulling may be required (as determined by the "Cable Pulling" program section 5.6.3). Install 36" radius bends to facilitate cable pulling. If the circuit consists entirely of three phase transformers, the three #1/0 cables may be installed in one 5" conduit. All secondary service and street light cable should be installed in a 2" PVC conduit. The practice of direct burying cable has been discontinued. The use of spare conduit will not be required.

Installing all cable in conduit will help protect the cable from mechanical damage that could lead to early cable failures. By preventing cable failures, FPL will realize savings by eliminating cable repairs, landscaping replacement and by extending cable life.

The policy of installing a layer of sand in the trench to protect cable is <u>no longer a FPL practice</u> and should not be used.

Vacant conduit should be installed in those cases where the cable installation can be deferred or where the cable may remain de-energized for an extended period of time. All vacant conduits should be plugged.

One potentially attractive benefit we hope to derive from cable in conduit is that the conduit can be installed early (in advance of paving and landscaping) and the cable and equipment can be installed later. If the conduit is to be installed ahead of the cable and transformers or conduit is to be installed by the customer, issue one work request and use a WMS MATL remark to order the conduit. <u>It is no longer a FPL practice to split URD Work Requests into a cable job and a conduit job.</u> The BOM provides this functionality.

#### a. The Conduit Portion of the Job

The conduit portion of the job should consist of all conduit necessary for feeder, primary, secondary/service and street light backbone. The conduit for the service run into the meter from the property corner (the point at which the service trench joins the main trench) and handholes, if required, should not be installed on this job. At the junction of the future service trench with the main trench, the secondary conduit end should be plugged, brought up to service depth (approx. 24" cover), out and away from the other conduits and marked with an electronic cable marker (EMS). Conduits should be elled-up with 90° bends at future handhole and transformer locations and plugged. The precast concrete transformer pad should be installed to protect the elled-up conduits at transformer locations. The ends of the conduit must be stubbed below the top of the pad. An EMS should be installed at future handhole locations to facilitate locating the elled-up conduits when the handhole is to be installed. Also, street light conduit should be 2" PVC. Please note that select backfill (not sand) is still required to protect the conduit from rock damage.

On long cable runs requiring a 48” splice box, the conduit should be cut, ends sealed, an electronic cable marker placed and its exact location identified on the record drawing.

In 24" depth service/secondary trenches, vertically installed 45° and 90° bends will be 24" radius, whereas horizontally installed 45° and 90° bends should be 36" radius.

In 36" depth main trenches, all 2" bends will be 36" radius. This will reduce cable sidewall pressure, assist in cable pulling, and help prevent cutting into the bend with the cable pulling lines.

Bends turned up in handholes should be 24" radius. Use 90° bends for handholes in a 36” or deeper trench. Use 45° bends in a 24” deep trench.

Minimum cover depth for buried conduit is outlined below:

| | MINIMUM COVER DEPTH |
|---|---|
| Primary Feeder Cables | 36" |
| Primary Lateral Cables | 36" |
| Secondary/Service Cables | 24" |
| Street Light Cables | 24" |

b. The Electrical Portion of the Job

The electrical portion of the job should consist of all switches, transformers, terminations, feeder cable and primary cable required for service. Generally, secondary/service cables should not be installed at this time except where handholes are required. In these cases the cable run from transformer to handhole location and the handholes should be installed with the electrical job.

c. The Service and Meter Order/Sketch (SMO)

The service and meter order/sketch will install conduit from the property corner to the customer's meter/junction box down pipe, a 45° or 90° bend as required at the property corner and downpipe, and cable from the transformer/handhole location to the meter.

d. Cable Pulling Design

Feeder cable (1000 kcmil) runs which cannot be pulled from point to point should include a feeder splice box (DCS UN-18.0.0) at an intermediate point. This box should be in an accessible grass area and should be dimensioned from the best available reference point (one that can be located by a repair crew without the aid of a survey crew), as shown in the DCS. A tag should be placed on both ends of a run of cable containing a splice stating, "Splice Box in this Cable Run", or similar. If needed, the 48" polymer concrete handhole may be used as a 1/0 primary splice box.

For 1000 kcmil feeders, termination points are risers, feeder splice boxes, feeder switch pads, pad mounted step-down autotransformers or vaults. The maximum distance between termination points is not to exceed 950 feet to facilitate cable pulling and maintenance activities. Splice boxes are to be installed at this distance regardless of whether or not splices are installed. Feeder splice boxes are to be located in accessible locations avoiding conflicts with other utilities.

For single phase #1/0 primary loops or radials, termination points are risers, switch pads, transformer pads or vaults. Primary cable is to be installed in 2" PVC conduit with minimum 36" bend sections to facilitate cable pulling. On long runs or those with many bends, a 48" polymer concrete handhole should be used as a splice box if required (as determined by the pull program).

There may be cases where a transformer will not be required initially. As a local option, a transformer replacement (dummy) cabinet may be used as a pull location for the primary cable at future transformer locations only. If the future transformer is to be a low style type, elbow terminations can be made inside the dummy cabinet by using the optional feed-thru device (see DCS I-74).

Construction personnel are reminded that it will be necessary to properly install the conduit in the pad opening so the cable pulled in may be connected without excessive bending. This is especially critical for low style pad mounts where the cable arc (radius) must be maintained in order to operate the elbow. When viewed from the front of the low style transformer, conduits must be located as shown in DCS L-17.0.4.

When a cable installed in conduit fails, the entire section of cable should be replaced (i.e., from termination to termination). In case of a dig-in or similar situation, a direct buried splice(s) is to be avoided. The conduit is to be repaired (use the split conduit repair kit) and a new cable section installed.

Local field conditions, sound engineering judgement, and active interfacing between the Engineering, Service Planning, and Operation Departments should prevail in the resolution of local design concerns.

3. Feeder Circuit Design

Design the feeder circuit if required. In practice, feeder design and layout will precede loop design since the constraints of location for feeders, both overhead and underground, are considerably greater than for the loops. Feeders are almost always located on arterial streets on the perimeter of the subdivision and on the main right-of-ways within the subdivision.

As with all large-scale underground distribution feeder systems, two sources of feed are required. For URD feeder systems this requirement is met by looping the feeders using pad mounted switchgear as tie points. These feeder loops are quite similar in principle and in operation to the lateral loops.

There are three basic alternatives available for a satisfactory URD feeder loop system:

1. The two halves of a URD feeder loop are tied to the same OH feeder at different points. There should be at least one OH sectionalizing switch between the UG taps.
2. The two halves of the URD feeder loop are each tied to a different OH feeder. A "normally open" feeder tie point is formed in one of the pad-mounted switches.
3. Two or more underground feeders are provided to serve the area in a loop system with the load divided equally among them. "Normally open" feeder tie points are formed in one or more of the pad mounted switches.

Variations and combinations of the above three basic URD feeder systems are permitted to obtain a safe, workable and economic solution. This requirement may be temporarily waived in some cases. These cases are where the loop will be completed within two years as adjacent developments are added to the system.

The feeder portion of a distribution system must have a high degree of built-in reliability. Thus, paralleling of feeders in close physical proximity should be avoided. If no other alternative is available, paralleled feeders should have a separation of 36 inches, preferred, but never less than 18 inches.

Determination of the numbers of feeders required and their optimum loading is a complex problem involving economics, load characteristics, load growth, reliability requirements, and other factors. This is discussed elsewhere in this manual.

4. Surge Protection of URD Cable and Equipment

Many failures of primary URD cable have been caused, we believe, by deterioration in the basic impulse insulation level (BIL) of our URD cable. In view of this, we desire to provide a greater margin of surge protection to these cables by installing surge arresters according to the following instructions.

a. Arrester Descriptions (See Section 3.6.1, this manual, for further details) Zinc Oxide arresters: There are two types of zinc oxide arresters: distribution type and riser-pole or intermediate type. The latter is really a distribution type with intermediate protection characteristics. Riser-pole arresters should be used for underground riser installations only. The distribution type may be used for the protection of all other distribution facilities and equipment. M&S numbers of zinc oxide distribution arresters are:

    10 kV, 334-17500-2

    18 kV, 334-21500-4

   M&S numbers of zinc oxide riser-pole arresters are:

    10 kV, 334-22100-4

    18 kV, 334-22800-9

   A 15 kV elbow-type zinc oxide arrester, M&S No. 334-01500-5, is also available, for use in 23 kV dead front pad mounted transformers. Silicon Carbide arresters with gaps were until recently the standard application in both distribution and intermediate types. Due to the superior performance of zinc oxide arresters, the silicon carbide arresters have been designated as Purchase Code 2, and will no longer be ordered.

b. All 23 kV URD radial or loop feeds from UG or pad mounted equipment shall be protected, if possible, by a distribution-type arrester at each end or open point. Elbow arresters should be installed in 23 kV dead front pad mounted equipment at normal open points. Their use will enhance URD surge protection.

   All new primary cable risers, whether from 13 kV or 23 kV systems, 1, 2, or 3 phase, shall be protected with intermediate type riser-pole zinc oxide arresters. All riser arresters should be changed to zinc oxide arresters when maintenance is performed, or if the cable has a history of failure.

   If the source is a pad mounted switch cabinet, install a distribution type arrester in each 600-ampere switch compartment per DCS C-26.0.1. This applies to any length of cable section.

c. All autotransformers are to be protected on primary and secondary sides by pole-mounted riser-pole zinc oxide arresters.

d. After a damaged loop cable section is repaired, be sure to switch the open point back to a transformer or switch protected by arresters, if possible. If the normal open point location is protected by elbow arresters, simply relocate the elbow to the temporary open point until repairs are completed.

e. If a URD section is to operate at 7.6/13.2 kV, but conversion to 13.2/23 kV is anticipated, 18 kV distribution arresters should be used in the URD equipment. URD risers designed for 23 kV and operating at 13 kV should have 10 kV zinc oxide riser-pole arresters until conversion is done. At that time, the 10 kV arresters should be replaced with 18 kV arresters.

   Any older type 18 kV arresters on URD circuits operating at 7.6/13.2 kV (installed in anticipation of conversion) will be changed out to zinc oxide arresters when work is being done in the area.

## C. STANDARD LOADS IN KVA

TABLE I

| | 1 TON | 1.5 TON | 2 TON | 2.5 TON | 3 TON | 3.5 TON | 4 TON | 5 TON |
|---|---|---|---|---|---|---|---|---|
| LIGHTS & REFRIG. | 0.71 | 0.74 | 0.78 | 0.82 | 0.86 | 0.99 | 1.14 | 1.50 |
| PARTIAL ELECTRIC (PE) | | | | | | | | |
| 1. PE w/WH only | 2.11 | 2.22 | 2.33 | 2.45 | 2.57 | 2.96 | 3.40 | 4.49 |
| 2. PE w/range only | 2.82 | 2.96 | 3.11 | 3.27 | 3.43 | 3.94 | 4.54 | 6.00 |
| FULL ELECTRIC (FE) | 3.53 | 3.71 | 3.89 | 4.09 | 4.29 | 4.93 | 5.67 | 7.50 |
| AIR CONDITIONER (A/C with EER of 9.5) | 1.26 | 1.89 | 2.53 | 3.16 | 3.79 | 4.42 | 5.05 | 6.32 |
| FE w/ A/C | 4.79 | 5.60 | 6.42 | 7.25 | 8.08 | 9.35 | 10.72 | 13.82 |

Note: If customer's A/C consists of several small units, apply appropriate A/C diversity factor from Table II to A/C kVA above to determine his A/C load.

USE OF TABLE I

The bottom row of the table marked "FE with A/C" gives base kVA loads for full electric customers with the A/C sizes as indicated at the tops of the columns. Base loads for partial electric customers may be obtained by adding the appropriate PE load (in the column under the A/C size) to the A/C load. For example, a mobile home park may have 2 ton A/C's and be partial electric with gas water heating. In this case the base load would be 3.11 kVA (PE) + 2.53 kVA (A/C) = 5.64 kVA total.

Base load for dwelling units having strip heating may be determined by adding the strip heating load (See Step 1) to the appropriate PE or FE load. Thus the base load for the FE dwelling unit having 3 tons of A/C and 10 kW strip heating would be:

4.29 kVA (FE) + 8.0 kVA (strip heating) = 12.29 kVA total.

Use the table below for dwelling units with electric resistance heating:

TABLE IA

| kW Rating | kVA Demand | kW Rating | kVA Demand |
|---|---|---|---|
| 5 | 5 | 15 | 10.5 |
| 10 | 8 | 20 | 14.0 |

For example, a subdivision of single family homes is developed, each home having a 5 ton A/C and a 15 kW strip heater. The homes are full electric. From Table I, base load with A/C is 13.82 kVA. Base load with strip heating is 7.50 kVA (FE) + 10.5 kVA (strip heater) = 18.0 kVA total. The base load with strip heater is 30% greater than base load with A/C. However, winter loading is allowed to be 70% greater than summer due to the lower ambient temperatures (see Section 2.1.8 of this manual). Therefore, the A/C load determines the base load to use in selecting transformer size.

D. TABLE II-A - STANDARD FE LOADS (IN KVA) DIVERSIFIED FOR 1 THROUGH 20 CUSTOMERS

| Num. of Cust. | Diversity Factor (D) | | 1 Ton | | | 1.5 Ton | | | 2 Ton | | | 2.5 Ton | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FE | A/C | FE | A/C | Total | FE | A/C | Total | FE | A/C | Total | FE | A/C | Total |
| 1 | 1.00 | 1.00 | 3.53 | 1.26 | 4.79 | 3.71 | 1.89 | 5.60 | 3.89 | 2.53 | 6.42 | 4.09 | 3.16 | 7.25 |
| 2 | 0.85 | 0.85 | 6.00 | 2.14 | 8.14 | 6.31 | 3.21 | 9.52 | 6.61 | 4.30 | 10.91 | 6.95 | 5.37 | 12.33 |
| 3 | 0.74 | 0.83 | 7.84 | 3.14 | 10.97 | 8.24 | 4.71 | 12.94 | 8.64 | 6.30 | 14.94 | 9.08 | 7.87 | 16.95 |
| 4 | 0.66 | 0.80 | 9.32 | 4.03 | 13.35 | 9.79 | 6.05 | 15.84 | 10.27 | 8.10 | 18.37 | 10.80 | 10.11 | 20.91 |
| 5 | 0.61 | 0.77 | 10.77 | 4.85 | 15.62 | 11.32 | 7.28 | 18.59 | 11.86 | 9.74 | 21.61 | 12.47 | 12.17 | 24.64 |
| 6 | 0.57 | 0.75 | 12.07 | 5.67 | 17.74 | 12.69 | 8.51 | 21.19 | 13.30 | 11.39 | 24.69 | 13.99 | 14.22 | 28.21 |
| 7 | 0.54 | 0.73 | 13.34 | 6.44 | 19.78 | 14.02 | 9.66 | 23.68 | 14.70 | 12.93 | 27.63 | 15.46 | 16.15 | 31.61 |
| 8 | 0.52 | 0.72 | 14.68 | 7.26 | 21.94 | 15.43 | 10.89 | 26.32 | 16.18 | 14.57 | 30.76 | 17.01 | 18.20 | 35.21 |
| 9 | 0.50 | 0.71 | 15.89 | 8.05 | 23.94 | 16.70 | 12.08 | 28.77 | 17.51 | 16.17 | 33.67 | 18.41 | 20.19 | 38.60 |
| 10 | 0.49 | 0.70 | 17.30 | 8.82 | 26.12 | 18.18 | 13.23 | 31.41 | 19.06 | 17.71 | 36.77 | 20.04 | 22.12 | 42.16 |
| 11 | 0.47 | 0.70 | 18.25 | 9.70 | 27.95 | 19.18 | 14.55 | 33.73 | 20.11 | 19.48 | 39.59 | 21.15 | 24.33 | 45.48 |
| 12 | 0.46 | 0.69 | 19.49 | 10.43 | 29.92 | 20.48 | 15.65 | 36.13 | 21.47 | 20.95 | 42.42 | 22.58 | 26.16 | 48.74 |
| 13 | 0.45 | 0.69 | 20.65 | 11.30 | 31.95 | 21.70 | 16.95 | 38.66 | 22.76 | 22.69 | 45.45 | 23.93 | 28.35 | 52.27 |
| 14 | 0.43 | 0.68 | 21.25 | 12.00 | 33.25 | 22.33 | 17.99 | 40.33 | 23.42 | 24.09 | 47.50 | 24.62 | 30.08 | 54.71 |
| 15 | 0.42 | 0.68 | 22.24 | 12.85 | 35.09 | 23.37 | 19.28 | 42.65 | 24.51 | 25.81 | 50.32 | 25.77 | 32.23 | 58.00 |
| 16 | 0.41 | 0.67 | 23.16 | 13.51 | 36.66 | 24.34 | 20.26 | 44.60 | 25.52 | 27.12 | 52.64 | 26.83 | 33.88 | 60.71 |
| 17 | 0.39 | 0.67 | 23.40 | 14.35 | 37.76 | 24.60 | 21.53 | 46.12 | 25.79 | 28.82 | 54.61 | 27.12 | 35.99 | 63.11 |
| 18 | 0.38 | 0.66 | 24.15 | 14.97 | 39.11 | 25.38 | 22.45 | 47.83 | 26.61 | 30.06 | 56.66 | 27.98 | 37.54 | 65.52 |
| 19 | 0.38 | 0.66 | 25.49 | 15.80 | 41.29 | 26.79 | 23.70 | 50.49 | 28.09 | 31.73 | 59.81 | 29.53 | 39.63 | 69.16 |
| 20 | 0.37 | 0.65 | 26.12 | 16.38 | 42.50 | 27.45 | 24.57 | 52.02 | 28.79 | 32.89 | 61.68 | 30.27 | 41.08 | 71.35 |

## USE OF TABLE

The load for one customer is the base load and is taken from TABLE I. The total load ($L_n$) for n identical customers is $L_n$=n (base A/C load $D_n$ (A/C) + (base other load) $D_n$ (other). For strip heating load, substitute strip heater kVA for base A/C load. Use A/C diversity factor ($D_{A/C}$) for all cooling and heating. "Base other load" may be FE, PE, or other customer load not including heating and cooling. Using this formula, the total load for 10 mobile homes in the example under TABLE I would be $L_{10}$=10 (2.53) (0.70) = (3.11) (0.49) = 32.9 kVA.

E. TABLE II-B - STANDARD LOADS (IN KVA) DIVERSIFIED FOR 1 THROUGH 20 CUSTOMERS

| Num. of Cust. | Diversity Factor (D) | | 3 Ton | | | 3.5 Ton | | | 4 Ton | | | 5 Ton | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FE | A/C | FE | A/C | Total | FE | A/C | Total | FE | A/C | Total | FE | A/C | Total |
| 1 | 1.00 | 1.00 | 4.29 | 3.79 | 8.08 | 4.93 | 4.42 | 9.35 | 5.67 | 5.05 | 10.72 | 7.50 | 6.32 | 13.82 |
| 2 | 0.85 | 0.85 | 7.29 | 6.44 | 13.74 | 8.38 | 7.51 | 15.90 | 9.64 | 8.59 | 18.22 | 12.75 | 10.74 | 23.49 |
| 3 | 0.74 | 0.83 | 9.52 | 9.44 | 18.96 | 10.94 | 11.01 | 21.95 | 12.59 | 12.57 | 25.16 | 16.65 | 15.74 | 32.39 |
| 4 | 0.66 | 0.80 | 11.33 | 12.13 | 23.45 | 13.02 | 14.14 | 27.16 | 14.97 | 16.16 | 31.13 | 19.80 | 20.22 | 40.02 |
| 5 | 0.61 | 0.77 | 13.08 | 14.59 | 27.67 | 15.04 | 17.02 | 32.05 | 17.29 | 19.44 | 36.74 | 22.88 | 24.33 | 47.21 |
| 6 | 0.57 | 0.75 | 14.67 | 17.06 | 31.73 | 16.86 | 19.89 | 36.75 | 19.39 | 22.73 | 42.12 | 25.65 | 28.44 | 54.09 |
| 7 | 0.54 | 0.73 | 16.22 | 19.37 | 35.58 | 18.64 | 22.59 | 41.22 | 21.43 | 25.81 | 47.24 | 28.35 | 32.30 | 60.65 |
| 8 | 0.52 | 0.72 | 17.85 | 21.83 | 39.68 | 20.51 | 25.46 | 45.97 | 23.59 | 29.09 | 52.68 | 31.20 | 36.40 | 67.60 |
| 9 | 0.50 | 0.71 | 19.31 | 24.22 | 43.52 | 22.19 | 28.24 | 50.43 | 25.52 | 32.27 | 57.78 | 33.75 | 40.38 | 74.13 |
| 10 | 0.49 | 0.70 | 21.02 | 26.53 | 47.55 | 24.16 | 30.94 | 55.10 | 27.78 | 35.35 | 63.13 | 36.75 | 44.24 | 80.99 |
| 11 | 0.47 | 0.70 | 22.18 | 29.18 | 51.36 | 25.49 | 34.03 | 59.52 | 29.31 | 38.89 | 68.20 | 37.78 | 48.66 | 86.44 |
| 12 | 0.46 | 0.69 | 23.68 | 31.38 | 55.06 | 27.21 | 36.60 | 63.81 | 31.30 | 41.81 | 73.11 | 41.40 | 52.33 | 93.73 |
| 13 | 0.45 | 0.69 | 25.10 | 34.00 | 59.09 | 28.84 | 39.65 | 68.49 | 33.17 | 45.30 | 78.47 | 43.88 | 56.69 | 100.57 |
| 14 | 0.43 | 0.68 | 25.83 | 36.08 | 61.91 | 29.68 | 42.08 | 71.76 | 34.13 | 48.08 | 82.21 | 45.15 | 60.17 | 105.32 |
| 15 | 0.42 | 0.68 | 27.03 | 38.66 | 65.69 | 31.06 | 45.08 | 76.14 | 35.72 | 51.51 | 87.23 | 47.25 | 64.46 | 111.71 |
| 16 | 0.41 | 0.67 | 28.14 | 40.63 | 68.77 | 32.34 | 47.38 | 79.72 | 37.20 | 54.14 | 91.33 | 49.20 | 67.75 | 116.95 |
| 17 | 0.39 | 0.67 | 28.44 | 43.17 | 71.61 | 32.69 | 50.34 | 83.03 | 37.59 | 57.52 | 95.11 | 49.73 | 71.98 | 121.71 |
| 18 | 0.38 | 0.66 | 29.34 | 45.03 | 74.37 | 33.72 | 52.51 | 86.23 | 38.78 | 59.99 | 98.78 | 51.30 | 75.08 | 126.38 |
| 19 | 0.38 | 0.66 | 30.97 | 47.53 | 78.50 | 35.59 | 55.43 | 91.02 | 40.94 | 63.33 | 104.26 | 54.15 | 79.25 | 133.40 |
| 20 | 0.37 | 0.65 | 31.75 | 49.27 | 81.02 | 36.48 | 57.46 | 93.94 | 41.96 | 65.65 | 107.61 | 55.50 | 82.16 | 137.66 |

**USE OF TABLE**

The load for one customer is the base load and is taken from TABLE I. The total load ($L_n$) for n identical customers is $L_n$=n (base A/C load $D_n$ (A/C) + (base other load) $D_n$ (other). For strip heating load, substitute strip heater kVA for base A/C load. Use A/C diversity factor ($D_{A/C}$) for all cooling and heating. "Base other load" may be FE, PE, or other customer load not including heating and cooling. Using this formula, the total load for 10 mobile homes in the example under TABLE I would be $L_{10}$=10 (2.53) (0.70) = (3.11) (0.49) = 32.9 kVA.

F. TABLE III - TRANSFORMER LOADING - FE CUSTOMERS

| TRANSFORMER SIZE | NUMBER OF FULL ELECTRIC HOMES | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 Ton | 1.5 Ton | 2 Ton | 2.5 Ton | 3 Ton | 3.5 Ton | 4 Ton | 5 Ton |
| 25 kVA | 1-12 | 1-9 | 1-7 | 1-6 | 1-5 | 1-4 | 1-3 | 1-2 |
| 37.5 kVA | 13-21 | 10-16 | 8-12 | 7-10 | 6-9 | 5-7 | 4-6 | 3-4 |
| 50 kVA | 22+ | 15-23 | 13-19 | 11-15 | 10-13 | 8-11 | 7-9 | 5-6 |
| 75 kVA | - | - | 20+ | 16-20+ | 14-20+ | 12-18 | 10-15 | 7-11 |
| 100 kVA* | - | - | - | - | - | 19-20+ | 16-20+ | 12-16 |

## USE OF TABLE III

For FE customers, use this table to select transformer size after designing transformer - secondary arrangements. For example, what size transformer is required for five FE customer with 3 ton A/C's? Enter the chart under "3 Ton" and move downward to the row which has 5 customers, in this case "1-5". Move left to "25 kVA".

This table is for standard FE loads based on A/C size. Transformer sizes for PE loads or loads determined by strip heating must be calculated as shown under Tables I and II.

Note that initial loading of transformers is to be kept to 120% of transformer nameplate for homes less than 2500 $ft^2$. 100% initial loading for homes greater than 2500 $ft^2$. (Based on summer load).

G. TABLE IV - VOLTAGE DROP/FLICKER CALCULATIONS

| PERCENT VOLTAGE DROP PER kVA AT 240 VOLTS (Single Phase) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Power Factor | Padmount Transformer kVA (1) | | | | | UG Cables; Per 100 Circuit Feet | | | | | | |
| % | 25 | 50 | 75 | 100 | 167 | #1/0A TPX | #4/0A TPX | #4/0C TPX | 350A | 750A | 1000A | 1000C |
| 100.0 | 0.0547 | 0.0188 | 0.0147 | 0.0100 | 0.0054 | 0.0698 | 0.0351 | 0.0231 | 0.0221 | 0.0122 | 0.0080 | 0.0047 |
| 95.0 | 0.0664 | 0.0285 | 0.0213 | 0.0151 | 0.0090 | 0.0696 | 0.0364 | 0.0251 | 0.0240 | 0.0144 | 0.0104 | 0.0073 |
| 90 (2) | 0.0694 | 0.0318 | 0.0235 | 0.0168 | 0.0103 | 0.0674 | 0.0358 | 0.0252 | 0.0240 | 0.0150 | 0.0111 | 0.0081 |
| 85.0 | 0.0708 | 0.0340 | 0.0249 | 0.0180 | 0.0112 | 0.0648 | 0.0349 | 0.0250 | 0.0238 | 0.0152 | 0.0115 | 0.0087 |

| PERCENT VOLTAGE DROP DUE TO STARTING CURRENT (Flicker) - A/C 240 Volt (Single Phase) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A/C Size | A/C System Starting Current (3) | Transformer kVA; 1-Ph Padmount (1) | | | | | UG Cables; Per 100 Circuit Feet | | | | | | |
| Tons | | 25 | 50 | 75 | 100 | 167 | #1/0A TPX | #4/0A TPX | #4/0C TPX | 350A | 750A | 1000A | 1000C |
| 1.0 | 40 | 0.686 | 0.357 | 0.258 | 0.189 | 0.121 | 0.553 | 0.307 | 0.228 | 0.216 | 0.145 | 0.115 | 0.092 |
| 1.5 | 60 | 1.029 | 0.536 | 0.388 | 0.284 | 0.182 | 0.830 | 0.461 | 0.341 | 0.324 | 0.218 | 0.172 | 0.138 |
| 2.0 | 80 | 1.372 | 0.715 | 0.517 | 0.378 | 0.242 | 1.107 | 0.615 | 0.455 | 0.433 | 0.291 | 0.229 | 0.184 |
| 2.5 | 100 | 1.715 | 0.894 | 0.646 | 0.473 | 0.303 | 1.385 | 0.769 | 0.569 | 0.541 | 0.363 | 0.287 | 0.230 |
| 3.0 | 120 | 2.058 | 1.072 | 0.775 | 0.567 | 0.363 | 1.663 | 0.923 | 0.683 | 0.649 | 0.436 | 0.344 | 0.276 |
| 3.5 | 140 | 2.401 | 1.251 | 0.904 | 0.662 | 0.424 | 1.941 | 1.077 | 0.797 | 0.757 | 0.509 | 0.401 | 0.322 |
| 4.0 | 160 | 2.743 | 1.430 | 1.034 | 0.756 | 0.484 | 2.220 | 1.231 | 0.911 | 0.866 | 0.581 | 0.459 | 0.368 |
| 4.5 | 180 | 3.086 | 1.609 | 1.163 | 0.851 | 0.545 | 2.499 | 1.385 | 1.025 | 0.974 | 0.654 | 0.516 | 0.414 |
| 5.0 | 200 | 3.429 | 1.787 | 1.292 | 0.945 | 0.605 | 2.779 | 1.539 | 1.139 | 1.082 | 0.727 | 0.573 | 0.461 |

NOTES:

1. This chart is based on Padmount Transformers on current order as of 2002/04. For Aerial Transformer chart see section 4.3.2 of DERM.
2. 90% Power Factor is normally used for residential voltage drop calculations.
3. A/C System Starting Current is the maximum allowed coincident starting current of any, or all of the system's components (compressor, condenser fan motor, and air handler blower motor). If the System Starting Current exceeds the values shown, the customer should investigate the installation of either a "hard start" kit or "stage" starting (or other method recommended by the manufacturer) to reduce the starting current to the level for which FPL's distribution system was designed.

H. TABLE V - KWH/KWD CONVERSION CHART (RESIDENTIAL)

| KWh | Summer (May-Oct) kWD | Winter (Nov-Apr) kWD |
|---|---|---|
| 50 | 1.64 | 1.39 |
| 100 | 2.33 | 2.20 |
| 150 | 2.86 | 2.83 |
| 200 | 3.30 | 3.35 |
| 250 | 3.70 | 3.82 |
| 300 | 4.05 | 4.23 |
| 350 | 4.38 | 4.62 |
| 400 | 4.68 | 4.98 |
| 450 | 4.97 | 5.31 |
| 500 | 5.24 | 5.63 |
| 550 | 5.50 | 5.94 |
| 600 | 5.74 | 6.22 |
| 650 | 5.98 | 6.50 |
| 700 | 6.20 | 6.77 |
| 750 | 6.42 | 7.03 |
| 800 | 6.63 | 7.28 |
| 850 | 6.84 | 7.52 |
| 900 | 7.04 | 7.75 |
| 950 | 7.23 | 7.98 |
| 1000 | 7.42 | 8.20 |
| 1050 | 7.60 | 8.42 |
| 1100 | 7.78 | 8.63 |
| 1150 | 7.96 | 8.84 |
| 1200 | 8.13 | 9.04 |
| 1250 | 8.30 | 9.24 |
| 1300 | 8.46 | 9.43 |
| 1350 | 8.62 | 9.62 |
| 1400 | 8.78 | 9.81 |
| 1450 | 8.94 | 9.99 |
| 1500 | 9.09 | 10.17 |
| 1550 | 9.24 | 10.35 |
| 1600 | 9.39 | 10.53 |
| 1650 | 9.54 | 10.70 |
| 1700 | 9.68 | 10.87 |

| kWh | Summer (May-Oct) kWD | Winter (Nov-Apr) kWD |
|---|---|---|
| 1750 | 9.82 | 11.03 |
| 1850 | 10.10 | 11.36 |
| 1900 | 10.24 | 11.52 |
| 1950 | 10.37 | 11.68 |
| 2000 | 10.50 | 11.84 |
| 2050 | 10.76 | 12.14 |
| 2100 | 10.76 | 12.14 |
| 2150 | 10.89 | 12.29 |
| 2200 | 11.02 | 12.44 |
| 2250 | 11.14 | 12.59 |
| 2300 | 11.27 | 12.73 |
| 2350 | 11.39 | 12.83 |
| 2400 | 11.51 | 13.02 |
| 2450 | 11.63 | 13.16 |
| 2500 | 11.75 | 13.30 |
| 2550 | 11.86 | 13.44 |
| 2600 | 11.98 | 13.57 |
| 2650 | 12.09 | 13.71 |
| 2700 | 12.21 | 13.84 |
| 2750 | 12.32 | 13.98 |
| 2800 | 12.43 | 14.11 |
| 2850 | 12.54 | 14.24 |
| 2900 | 12.65 | 14.37 |
| 2950 | 12.76 | 14.50 |
| 3000 | 12.87 | 14.62 |

How to use the kWh/kWD Conversion Chart:

1. Find each customer's kWh usage for month investigated.
2. From Table V above, find kWD corresponding to each customer's kWh usage. Summer loads – Use summer table ---Winter loads – Use winter table.
3. Sum each customer's kWh on the transformer to get total undiversified demand on the transformer.
4. Find coincidence factor for number of customers on transformer.
5. Multiply total kWD (step 3) by coincidence factor.
6. Answer yields peak 15 minute kWD on transformer

Note: this table is a duplicate of Table V-A in Section 4.3.2

For kWh over 3000 use the following formula:

**Winter:** $kWD = .2774\sqrt{kWh} - 0.5702$

**Summer:** $kWD = .2354\sqrt{kWh} - 0.0242$

## I. TABLE VI - URD LOADING TABLE

| MAXIMUM LOADING FOR FUSE SIZE SHOWN | | | MAXIMUM SIZE TRANSFORMER PER PHASE ON LOOP FOR FUSE SIZE SHOWN | | | |
|---|---|---|---|---|---|---|
| LOOP FUSE SIZE | | CONNECTED LOOP kVA PER PHASE | TRANSFORMER FUSE TYPE | | | |
| | | | RTE BAYONET (DF PM TX) | S&C PM (OLD LF PM TXS) | M.E. NX (LF PM TXS & VAULTS) | S&C SM-4 (VAULTS) |
| CIRCUITS OPERATING AT 13 Kv | | | | | | |
| OH TYPE K (RISER POLE) | 40 | 305 | 100 | 167 | 75 | 0 |
| | 50 | 381 | 100 | 167 | 75 | 0 |
| | 65 | 495 | 100 | 167 | 75 | 0 |
| | 80 * | 610 | 750(3ø) | 167 | 100 | 250 |
| | 100 | 762 | 1000(3ø) | 167 | 167 | 500 |
| | 140 | 1067 | 1000(3ø) | 167 | 250 | 2250(3ø) |
| URD SM-4 (SWITCH PAD) | 30 | 229 | 37 | 0 | 50 | 0 |
| | 50 | 381 | 100 | 0 | 75 | 0 |
| | 65 | 495 | 100 | 167 | 75 | 167 |
| | 80 * | 610 | 750(3ø) | 167 | 75 | 250 |
| | 100 | 762 | 1000(3ø) | 167 | 100 | 333 |
| | 125 | 953 | 1000(3ø) | 167 | 167 | 500 |
| | 150 | 1143 | 1000(3ø) | 167 | 250 | 2250(3ø) |
| CIRCUITS OPERATING AT 23kV | | | | | | |
| OH TYPE K (RISER POLE) | 40 | 528 | 167 | | 167 | 0 |
| | 50 | 660 | 167 | - | 167 | 0 |
| | 65 | 858 | 167 | - | 167 | 0 |
| | 80* | 1056 | 1000(3ø) | - | 250 | 500 |
| | 100 | 1320 | 1000(3ø) | - | 333 | 2500(3ø) |
| | 140 | 1848 | 1000(3ø) | - | 500 | 4000(3ø) |
| URD SM-4 (SWITCH PAD) | 30 | 396 | 75 | - | 100 | 0 |
| | 40 | 528 | 167 | - | 100 | 0 |
| | 50 | 660 | 167 | - | 167 | 0 |
| | 65 | 858 | 167 | - | 167 | 250 |
| | 80 * | 1056 | 1000(3ø) | - | 167 | 333 |
| | 100 | 1320 | 1000(3ø) | - | 250 | 2000(3ø) |
| | 125 | 1650 | 1000(3ø) | - | 333 | 3000(3ø) |
| | 150 | 1980 | 1000(3ø) | - | 333 | 4000(3ø) |

### NOTES FOR TABLE VI

1. All new, 1st stage, 13 & 23 kv URD loops should be fused at 80 AMP.
   - Initial loading should be limited to 80% of maximum connected kVA to allow for growth.
   - When fusing beyond a recloser or installing 2nd and 3rd stage fusing, consult with Distribution Planning
2. For existing loops, loading may be based on actual demand kVA if it is less than connected kVA. Consult with Distrbution Plannig for proper fuse coordination.
3. The fuse applications are listed according to the operating voltages. A future 23 kV loop will be fused the same as a 13 kV loop.
4. Max. kVAD = (fuse size) x primary voltage phase to ground (7.62 or 13.2 kV).
5. Maximum size transformer on loop based on largest transformer fuse which will coordinate with loop fuse shown.
6. For fusing UG radial to single transformer locations, fuse at riser pole per I-19, DCS, based on per phase TX size.
7. For loading of OH laterals see section 4.3.3, DERM.

## J. REFERENCE STANDARDS FOR URD DESIGN AND CONSTRUCTION

Symbols

See A-3 through A-12 for Symbols for Construction Drawings

Splices, 600 V

| | |
|---|---|
| L-17.0.7 & | Installation of Handhole Multitap in Service Handhole for Connecting UN-19.0.0 Services |
| UC-6 SH.1 | Wye Splice for 1/c, 600 V. Rubber or Polyethylene Insulated BuriedCable, Size 4/0 or Smaller |

Splices, 15 and 25 kV

| | |
|---|---|
| UE-19.0.0 | Straight Splice, 15 or 25 kV Rubber or Polyethylene Insulated Concentric Cable #1/0A and 1000 kcmil Aluminum |

Cable Terminations

| | |
|---|---|
| UH-14.0.1 | Pole Riser Shield Installation |
| UH-15.3.1 | Feeder Riser Pole |
| UH-15.3.2<br>UH-15.3.3<br>UH-15.3.4 | Primary Riser Poles |
| UH-30.0.1<br>UH-30.0.2 | Elbow Terminator Installed on 15 kV Polyethylene or Rubber Insulated Concentric Cable |
| UH-34.0.1<br>UH-34.0.2 | Cold Shrink Termination on 1/0A, 15 and 25 kV Polyethylene Insulated Cable |
| UH-35.0.1<br>UH-35.0.2 | Cold Shrink Termination on 1000 kcmil Aluminum, 15 and 25 kV Polyethylene Insulated Cable |
| UH-41.0.1&<br>UH-41.0.2 | T-OP-2 Feeder Elbow Terminator For 1000 kcmil, 15 or 25 kV Polyethylene Cable |
| UH-47.0.1&<br>UH-47.0.2 | Elbow Terminator Installed on 25 kV Polyethylene or Rubber Insulated Concentric Cable |

Bonds and Grounds

| | |
|---|---|
| G-9.0.1 &<br>G-9.0.2 | System Neutral Bonding at Riser Poles |
| G-19 | Bonding Method for Jacketed Concentric Neutral Cables at Intermediate Points in Cable Run |
| G-16.0.1<br>G-16.0.2 | Typical Connection for Concentric Neutrals |
| G-11 | Neutral Bonding with Above Ground Communication Company at Transformer Locations - Joint Trench Installations |
| G-17.0.0 | Bonding of Jacketed URD Feeder Cable (1000 kcmil A.) (1/12) Neutral, in Direct Buried and Manhole Installations |

Fuses

| | |
|---|---|
| I-19.0.0 | Transformer Fusing Table, Aerial Fuse Switches |
| I-19.2.0 | Pad mount and Dry Type Transformer Fuse Sizes |

| | |
|---|---|
| UJ-9 | Installation of Refill Unit in S&C Type SM-4S and SM-4Z & SML -4Z Fuse Holders |
| UJ-10.0.0 | Bay-o-net Fuse Assembly for Pad mounted Transformers |
| DERM 5.3.1 TABLE VI | Loop Loading and Fuse Sizes |

Transformers

| | |
|---|---|
| I-62.0.0 | Typical Connections for 1Ø Dead Front Pad mounted Transformer |
| I-64 | Temporary Secondary Grounding for Pad mounted Transformers |
| I-65 | Typical Connections for 1Ø Low Style Pad mounted Transformer |
| I-74.0.1 | Replacement Cabinet Installation for Padmount Transformers |

Switches & Devices

| | |
|---|---|
| C-26 | Typical Installation of 15 or 25 kV, S&C Mark III or EEI Three Phase Pad mounted Switchgear |

Construction

| | |
|---|---|
| UN-15.0.0 | Location of Duct or Cable Ends using Electronic Marker System -Typical Installations Maintenance Only) |
| UN-18.0.0 | Feeder Splice Box |
| UN-19.0.0 | Primary Splice Box |

Cable Operation

| | |
|---|---|
| UV-1 | Bending Radius of Cable |
| UV-3 | Dimensions and Weights of Underground Cable |
| UV-12 | Identification of Underground Cables and Vacant Conduits |
| UV-13.0.0<br>UV-13.0.1<br>UV-13.0.2 | Installation of Automatic Resetting Fault Indicator for Throwover Coordination Application of Line Fault Current Indicators |
| UV-14.0.0 | Installation of Automatic Resetting Type Line Fault Current Indicator on Concentric Neutral Feeder Cable |
| UV-15 | Primary Cable Ampacities |
| UV-17 | Secondary Cable Ampacities |

Engineering Data

| | |
|---|---|
| Z-19 | Terminators for Underground Cables |

Miscellaneous

| | |
|---|---|
| Z-29.0.0 | Installation of Transformer Load Management Tags |
| Z-35.0.0 | Locations of Decals on Pad mounted Equipment |