Chapter DDM-2: COMMERCIAL/INDUSTRIAL SUBSYSTEMS

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DDM-2 COMMERCIAL/INDUSTRIAL SUBSYSTEMS

2.0 Scope

This standard provides the criteria for designing commercial/industrial (C/I) underground distribution facilities. This includes demand estimating, service point guidelines, transformer selection, cable selection, substructure selection, and C/I looped subsystem examples.

2.1 Design Concept

C/I subsystems on underground circuits are generally designed using 1/0 Cross-Link Polyethylene (XLPE) primary cable, 200A components, and pad-mounted equipment with approximately 1,670 kVA of transformation. The C/I subsystems is typically connected to the feeder by a 200A switch fused connection.

Facility sizing shall comply with the following loading criteria:

Item	**Loading Criteria**
Substructures	Anticipated need for maximum switchgear load capacity
Primary Cable	Standard 3-1/0 Al XLPE
Transformers	Actual and or Anticipated demand for customer(s)
Secondary and Service Cable	Switchgear ampacity. **

** See DDM-4, 4.2F for transformer sizing and secondary/service cable sizing.

2.2 Design Criteria

2.2A Design resources for C/I subsystems

1. Knowledge of the existing distribution system in the area, including the following:
   - A. Nearest primary circuits
   - B. Distance from substation
   - C. Possible feeder interface points, overhead (OH) or underground (UG)
   - D. Existing substructures in the area
   - E. Loading on existing feeders or subsystems
   - F. Master plans for circuits in the area
   - G. Coordination with other projects in area (CADME Block)

2. Design Resources required for application of service.
   - A. One print of the architectural plot plan stamped and signed by the Planning department.
   - B. Completion of the application form for design of electric service. Indicate main panel amperage and voltage, indicate in service date.
   - C. Submit Related Plans: grading plans, street improvement plans, water plans, sewer plans, storm drain plans, and E-sheets, including single line diagram.
   - D. Provide AutoCAD disk or e-mail containing the site plan.

2.2B Underground Electric Distribution Line Policy

RPU recognizes that there are many advantages to having underground, rather than overhead, electric distribution facilities. These advantages include a more pleasing appearance, free use of the area for trees and outdoor activities, enhanced safety, and reduced operating costs.

Because of these advantages, the following underground line policy is to be used to guide all future line construction.

1. **<u>New Areas</u>**

The permanent electric distribution facilities for all newly developed areas shall be under-ground. When passing through undeveloped areas or where future major roadwork is planned, facilities may temporarily be built overhead with Public Utilities Assistant General Manager (AGM) approval.

2. **<u>Existing Overhead Areas</u>**

A. New Services

It is mandatory requirement that services to new buildings will be underground.

B. Upgrading of Existing Services

When a service to an existing building being served overhead is relocated or the main switch is increased in size, the service shall be installed underground unless, in RPU's judgment, there are technical or physical impediments that make under grounding infeasible.

B. Upgrading of Existing Services (Cont..d)

Overhead services are permitted up to 300 KVA (3-100 KVA) which is the largest conventional overhead transformer bank. Service upgrades above 300 KVA should mandate conversion to underground pad-mounted transformer service. Exceptions could be permitted by the Public Utilities General Manager.

C. New Distribution Lines

New feeder and distribution lines in existing overhead areas will be installed underground unless they can be placed on an existing pole line. The existing pole line may be upgraded by replacing poles, if necessary, to accommodate the additional construction. Underground duct banks and structures should be located based on ultimate street widths considering future curb, gutter and sidewalk improvements to avoid future relocation costs.

D. Converting Areas to Underground

Due to the high cost of converting existing areas entirely to underground, these conversions will be done only if the customers in the area agree to pay the cost of the conversion. A used-life credit for the existing overhead line not to exceed one-half the cost of the undergrounding will be subtracted from the charge to the customer.

E. Major Street Improvement Projects

When existing overhead lines need to be completely rebuilt or relocated due to a major road widening funded by federal, state, county or City road construction funds, full consideration will be given to establish an Underground Utility District to convert the lines to underground. The determination of whether or not existing overhead lines will be converted to underground will be made through the Environmental Assessment conducted by Public Works for the overall project. Every effort should be made by the Public Works Department to procure funds to cover electric utility line relocation and underground costs as part of road project grant applications.
If the road is being widened to ultimate width with curb and gutter, underground conversion or overhead relocation is a viable option. If the road is not being widened to ultimate width, only overhead relocation should be considered to mitigate the risk of further relocations.

F. Sensitive Areas

Where existing overhead lines intrude upon sensitive areas in the city such as major entrances to the city, historic areas and scenic thoroughfares, the lines may be placed underground upon Board approval. Due to capital budget constraints, funding may come from non-Utilities sources. Generally, the entire cost of the underground conversion must be paid by others, less a used-life credit for existing facilities which will not exceed one-half of the conversion cost.

G. New Development

Developers must pay all costs for undergrounding distribution for their development as required by the Electric Rules and this may include converting existing overhead distribution class lines to underground. If the lines are not converted to underground at the time of development, conduits and structures will be installed to facilitate undergrounding in the future.

Developers will not generally be required to fund the underground conversion of major feeders adjacent to their projects. For a limited number of projects that the City Planning Department determines that underground conversion is especially desirable, Planning will negotiate an equitable sharing of the costs between the developer and RPU. The cost sharing plan is subject to final approval by the Public Utilities AGM and the Planning Manager.

2.2C Demand Estimating

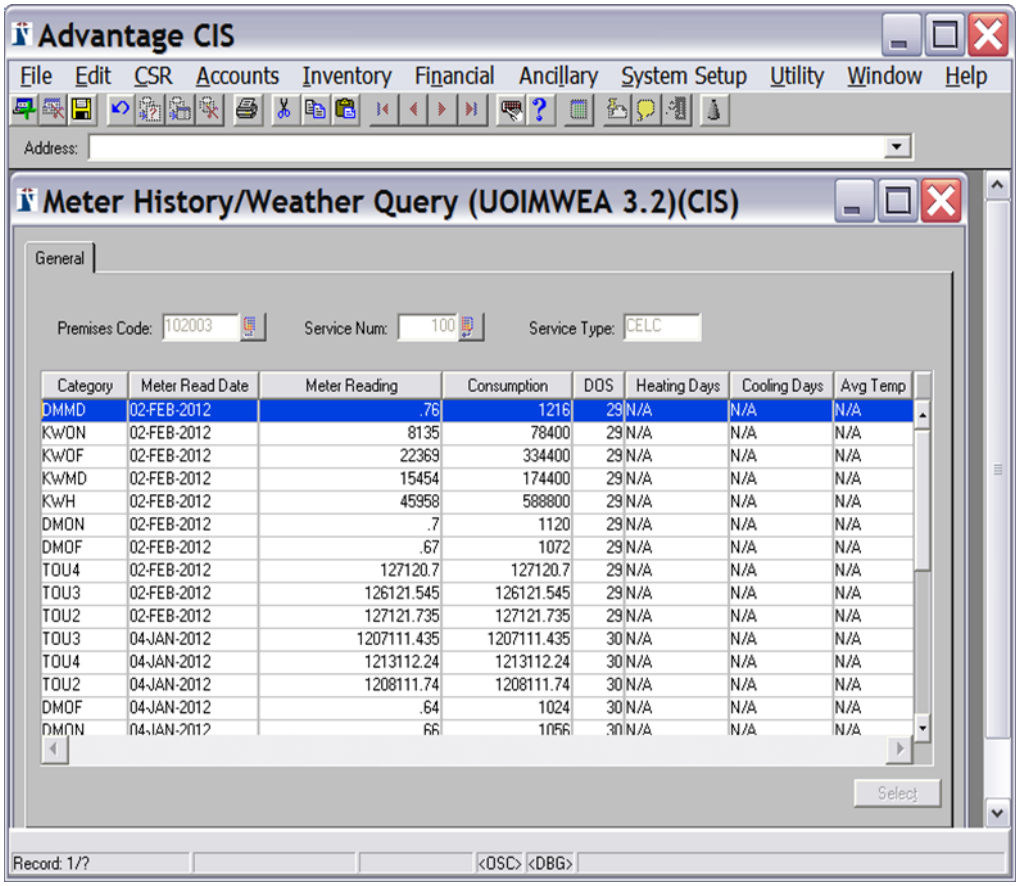
Establishing which size transformer to use in order to provide service to a customer can be done in the following three methods. The three methods in order of preference are as follows:

A. Demand based on Customer Information System (CIS).
B. Demand based on Equipment listed on panel schedule and applying Demand Factors.
C. Demand based on Building Type and Square Footage.

A. Estimate Demand based on Historical Data from CIS.

This method is used when existing demand is available. The procedure is to derive the existing energy use from the CIS Report and add to it the kVA calculated as outlined in Method B above for the additional load. An example of how to interpret a CIS report is shown below:

Example 2.2C-1 of CIS Report for an Industrial Customer



Category	Meter Read Date	Meter Reading	Consumption	DOS	Heating Days	Cooling Days	Avg Temp
DMMD	02-FEB-2012	.76	1216	29	N/A	N/A	N/A
KWON	02-FEB-2012	8135	78400	29	N/A	N/A	N/A
KWOF	02-FEB-2012	22369	334400	29	N/A	N/A	N/A
KWMD	02-FEB-2012	15454	174400	29	N/A	N/A	N/A
KWH	02-FEB-2012	45958	588800	29	N/A	N/A	N/A
DMON	02-FEB-2012	.7	1120	29	N/A	N/A	N/A
DMOF	02-FEB-2012	.67	1072	29	N/A	N/A	N/A
TOU4	02-FEB-2012	127120.7	127120.7	29	N/A	N/A	N/A
TOU3	02-FEB-2012	126121.545	126121.545	29	N/A	N/A	N/A
TOU2	02-FEB-2012	127121.735	127121.735	29	N/A	N/A	N/A
TOU3	04-JAN-2012	1207111.435	1207111.435	30	N/A	N/A	N/A
TOU4	04-JAN-2012	1213112.24	1213112.24	30	N/A	N/A	N/A
TOU2	04-JAN-2012	1208111.74	1208111.74	30	N/A	N/A	N/A
DMOF	04-JAN-2012	.64	1024	30	N/A	N/A	N/A
DMON	04-JAN-2012	.66	1056	30	N/A	N/A	N/A

This example is for an industrial customer. In the above table under the first column labeled "category" there are three categories listed below that are of interest.

DMMD: Demand mid peak

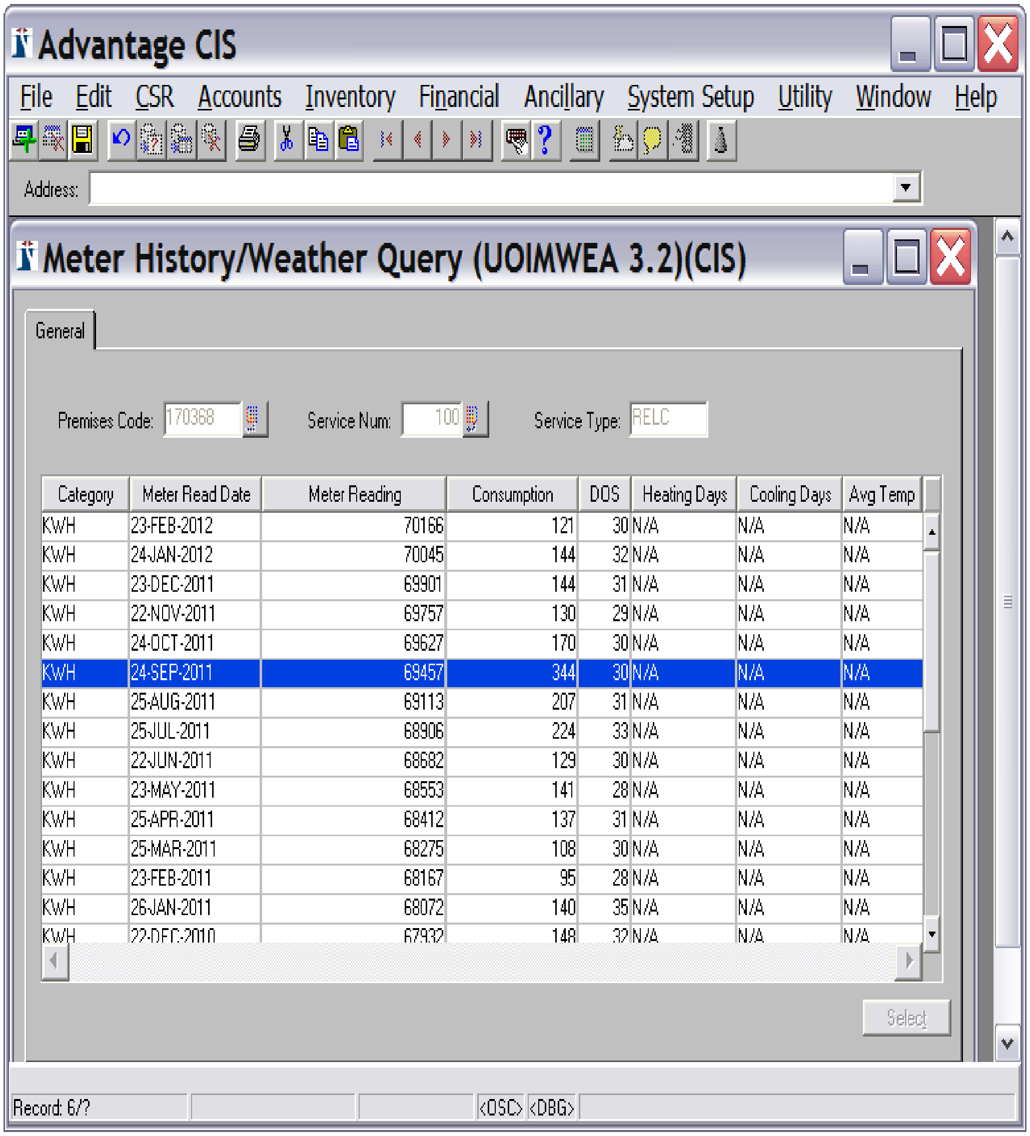
DMON: Demand on peak

DMOF: Demand off peak.

The fourth column labeled consumption shows the respective demand in KW. The first step in the procedure is the designer must take the highest reading in the last 12 months under either one of the categories listed above. In this example the highest consumption was read at DMMD. The demand reading is highlighted in blue as 1216 kW.

The second step in the procedure is to convert the demand from KW to KVA. The designer must multiply 1216 kW by 1.18 which equals 1435 kVA. Please refer to the Conversion Factors listed in DDM–8. As you can see a PF of .85 is assumed with a Motor Efficiency of 85%. It is also assumed that the voltage is 277/480 Volt three phase-four wire.

Example 2.2C-2 of CIS Report for a Residential (Non demand Meter).



Category	Meter Read Date	Meter Reading	Consumption	DOS	Heating Days	Cooling Days	Avg Temp
KWH	23-FEB-2012	70166	121	30	N/A	N/A	N/A
KWH	24-JAN-2012	70045	144	32	N/A	N/A	N/A
KWH	23-DEC-2011	69901	144	31	N/A	N/A	N/A
KWH	22-NOV-2011	69757	130	29	N/A	N/A	N/A
KWH	24-OCT-2011	69627	170	30	N/A	N/A	N/A
KWH	24-SEP-2011	69457	344	30	N/A	N/A	N/A
KWH	25-AUG-2011	69113	207	31	N/A	N/A	N/A
KWH	25-JUL-2011	68906	224	33	N/A	N/A	N/A
KWH	22-JUN-2011	68682	129	30	N/A	N/A	N/A
KWH	23-MAY-2011	68553	141	28	N/A	N/A	N/A
KWH	25-APR-2011	68412	137	31	N/A	N/A	N/A
KWH	25-MAR-2011	68275	108	30	N/A	N/A	N/A
KWH	23-FEB-2011	68167	95	28	N/A	N/A	N/A
KWH	26-JAN-2011	68072	140	35	N/A	N/A	N/A
KWH	22-DEC-2010	67932	148	32	N/A	N/A	N/A

In this example for a non demand residential meter where only KWH is available the demand is calculated as follows:

KVA= Consumption (KWH) / [HRS of Operation X DOS (days of service) X Power Factor (PF)]

KVA= 344 / [24 X 30 X 0.85] = 0.56 KVA

B. Demand based on Equipment listed on panel schedule and applying Demand Factors

This method uses the demand factors of installed equipment for estimating demand for new services. Table 2.2C-3 provides demand factors for various types of C/I loads. Use these demand factors with the customer's load schedule to determine the estimated demand which is determined by multiplying the customer's demand load schedule for each category by the demand factor. Refer to Table 2.2C-5 for an example of load demand based on Equipment and Demand Factor.

Table 2.2C-3: Demand Factors for various types of C/I loads

TYPE OF LOAD	DEMAND FACTOR
Lighting	90%
Receptacles	20%
Refrigeration	70%
Kitchen Equipment	30%
Heaters/Warmers	67%
Air Conditioner	75%
Water Heater	30%
Automatic Gates	5%
Air Compressors	50%
Pool/Sauna Pump	42%
Motor	40%
Elevator	40%
Apartment Elevator	30%
Miscellaneous	40%

C. Estimate Demand based on Building Type and Square Footage.

This method is only used when existing demand and or panel schedules is not available (speculative buildings). This method uses building type. Various commercial and industrial buildings have average volt-amps per square feet (sq.ft). Table 2.4.C-4 provides typical demands in volt-amperes per square foot for different types of occupancies. Use the values for the applicable type of occupancy and square footage to determine the estimated demand.

Formula: kVA = (sq. ft. x VA/sq. ft.) / 1000

There may be large variations between actual and estimated demand calculated from Table 2.4C-4. This variation is primarily due to differences in operations.

Appendix 2-1 (Pages 26-28) provides the description of building types shown in Table 2.4C-4.

Chart 2.2C-6 provides an example of using this method to estimate the demand for a new restaurant.

Table DDM 2.2C-4 Building Type Average Load

Bldg. Type No.	Building Type	Volt - Amps Per Sq Ft
1	Large Office Bldg. (>30ks.f.)	4.70
2	Small Office Bldg. (<30k s.f.)	8.50
3	Fast Food Restaurants (<3k s.f.)	20.50
4	Sit Down Restaurants (>3k s.f.)	14.50
5	Large Retail (>30k s.f.)	4.20
6	Small Retail (<30k s.f.)	8.60
7	Large Food Store (>30k s.f.)	8.50
8	Small Food Store (<30k s.f.)	13.90
9	Refrigerated Whse	17.80
10	Non-Refrigerated with A/C Whse	5.10
10a	Non-Refrigerated, non A/C Whse	0.70
11	Elem. And Sec. School	10.10
12	Colleges and Universities	6.20
13	Hospitals	6.70
14	Health Clinics	6.80
15	Hotels and Motels	4.80
16	Auto Repair Shops	6.70
17	Misc. Repair (TV.etc)	7.30
18	Movie Theatres (indoor)	12.70
19	Bowling Alleys	6.50
20	U.S. Post Offices	6.70
21	Meat Packing	15.70
22	Fruit and Veg. Processing	5.40
23	Bakery Products	10.00
24	Apparel Mfg.	6.00
25	Furniture Mfg.	8.40
26	Paper Prod. (containers. etc.)	7.50
27	Printing/Publishing	9.10
28	Plastic Products	11.40
29	Metal Fabrication	9.40
30	Telephone Comm. Center	11.40

Table 2.2C-5: An example of load demand based on Equipment and Demand Factor

PROJECT LEADER:	Bobby Harris	PROJECT AIDE:	Jose Montoya	
TITLE:	3500 S.F. Custom Home	MAIN SIZE(AMP):	1600	
ADDRESS:	5200 Iowa Ave	SERVICE VOLT:	120/208	3 Phase
W.O #	634210			
P.F (if load sheet is already in KVA, P.F = 1)		0.85		

DESCRIPTION	P1(KW)	P2(KW)	P3(KW)	TOTAL (KW)	D.F (%)	DEMAND (KW)
Lighting	17.13	20.276	18.73	56.136	90%	50.53
Receptacles	11.32	13.9	14.68	39.9	20%	7.98
Refrigeration				0	70%	0
Kitchen Equip				0	30%	0
Heaters/Warmers				0	67%	0
HVAC	2.216	2.216	2.216	6.648	75%	4.99
Water Heater	4.5		4.5	9	30%	2.7
Automatic Gates				0	5%	0
Air Compressors				0	50%	0
Pool/Sauna Pump				0	42%	0
Motor	8.238	5.492	5.492	19.222	40%	7.69
Elevator				0	40%	0
Apart. Elevator				0	30%	0
Miscellaneous	56.038	51.133	52.849	160.02	40%	64.01
TOTAL	99.442	93.017	98.467	290.926		137.9

Chart DDM 2.2C-6: An Example of Load Demand based on Building Type and Square Footage

Name	Square Feet of Building	Building Code*	Building Type*	VA/Sq Ft*	Total KVA
Sizzler	7000	4	Sit Down Restaurants (>3k s.f.)	14.5	101.5

*Located in Table 2.2C-4

KVA= (7000 sq ft x 14.5 VA/sq ft) / 1000 = 101.5KVA

2.2D Service Point Guidelines

The location of the various points-of-service for a C/I development should be established to minimize the number of transformer locations required. Uniform application of service points shall be established using the following criteria

A. Single Enterprise

One building occupied by a single enterprise on a single premise will be provided one point of service at a location determined by Customer Engineering. However, additional points of service may be provided at a location determined by designer for RPU's operating convenience, or where provided for in Electric Rules & Rates. See Electric Rule (11A.4).

All facilities installed on the premise shall be completed under Electric Rule 11, Electric Service Facilities.

B. Multiple Enterprises

One or more buildings in a C/I development occupied by multiple enterprises may, as determined by RPU, be given one point of service per building. Regional shopping centers, malls, and other unusually large buildings are normally sufficiently large enough to make additional services necessary. They require special engineering considerations to determine the number of service points. Voltage drop, service type/voltage, and transformer utilization will be considered to establish service points consistent with good engineering practices.

All distribution facilities installed on the C/I development will be completed under Electric Rule 10, Distribution System Additions and Electric Rule 11 as referenced above.

C. Service Voltages

The applicable service voltages, 120/240, 120/208 and 480/277 volts shall be determined by RPU for any of the service points described above, taking into consideration the customer's load, materials and equipment and available standard transformers. All terminating enclosures for services for each of the types and voltage classes of load to be served shall normally be grouped at one location as determined by RPU.

D. RPU's Operating Convenience

The provision of additional points of service for RPU's operating convenience refers to the utilization of facilities or practices that contribute to the overall efficiency of RPU's operation. It does not refer to customer convenience. It should be noted that the installation of electrical distribution service facilities shall be underground unless otherwise determined by the Utility. See Electric Rule 2, Character of Electric Service.

E. Added Facilities

Added facilities are facilities provided by the Utility which are in addition to, or in substitution for, the standard facilities which the Utility would normally install. See Electric Rule 16, Added Facilities.

2.2E Equipment Selection

A. Transformer

For all new or upgraded underground installations the preferred method of installation is the padmount transformer. For projects under 300 KVA total load, where space is not available for a padmount, the use of transformers in a subsurface vault may be considered with supervisor approval. If the load exceeds 300 KVA , pad mounted service is required. In cases where the transformation must be located in right of way areas, subsurface equipment may be installed in vaults. Transformer capacity shall be a maximum of 100% of all loads to be served.

B. Junctions

Loadbreak Junctions are used in pad-mounted Junction Cabinets (PJC's), underground vaults, and other equipment to sectionalize, establish loops, taps and splices, and to facilitate equipment change-outs where sufficient working space is provided and available for energized operation . Sectionalizing a cable run to find and isolate a cable fault is made easy when a load break junction is used. The load-break junctions are installed on the system to extend and split phases for operational capability by installing downstream of current-limiting fusing.
All local distribution cable (1/0 15kV Class) should terminate at an accessible, load break bushing (LB) with load break elbows. This may be a transformer, pedestal junction cabinet (PJC), or junctions in pull boxes, CST or SE with surface access and operability. The preferred method for new installations is in padmounted equipment.

C. Splicing

Straight Splices are installed in our underground equipment in the distribution system. Straight splices shall only be used when eliminating or not requiring load break junctions in between spans of primary conductors. Please ensure accessibility and maintenance when installing straight splices.

There are certain situations that require a straight splice, a premolded one piece 200A-15kV. These situations are;

1. An existing cable that is terminated with a two piece premolded splice.
2. Extending from a dead ended two piece premolded splice.
3. Making a transition splice between #2 and 1/0.
4. Cutting, extending, or rerouting cable when it is not desirable to pull.
5. Live front to dead front transformer conversion when the existing cables are not practical to replace.

2.2F Structure Selection

Substructures should be installed to accommodate anticipated growth and system needs for transformer load capacity.

1. Transformer Type and Size

a) Slab Box

The following table shows the transformer-pads and slab boxes required for the installation of three-phase padmounted transformers. Determine the slab box size using the maximum size transformer that might be expected considering the installed switchboard capacity.

Table 2.2F-1: Slab Boxes.

Transformer Size KVA	SLAB - BOX (See note 1)	TRANSFORMER PAD (See note 2)
75 150 300 500	SB - 3 6' X 8'	TP-5 6' x 5'6"
750 1000 1500 2000 2500	SB - 4 8' X 10'	TP-7 7'10 X 6'

Notes:

1. See UGS-721 for details and dimensions of the slab-boxes and UGS-723 for installation details.
2. Transformer Pads are NOT to be used on new designs. They may remain in use when replacing existing transformers if applicable.
3. See UGS-620 for details and dimensions of the transformer-pads and UGS-621 for installation details.
4. For the 1500, 2000 and 2500 KVA C/I subsystems there should be an assignment to a fused position. If a normally open position is provided to the adjacent loop, the total kVA load on both loops should not exceed 3340 kVA.

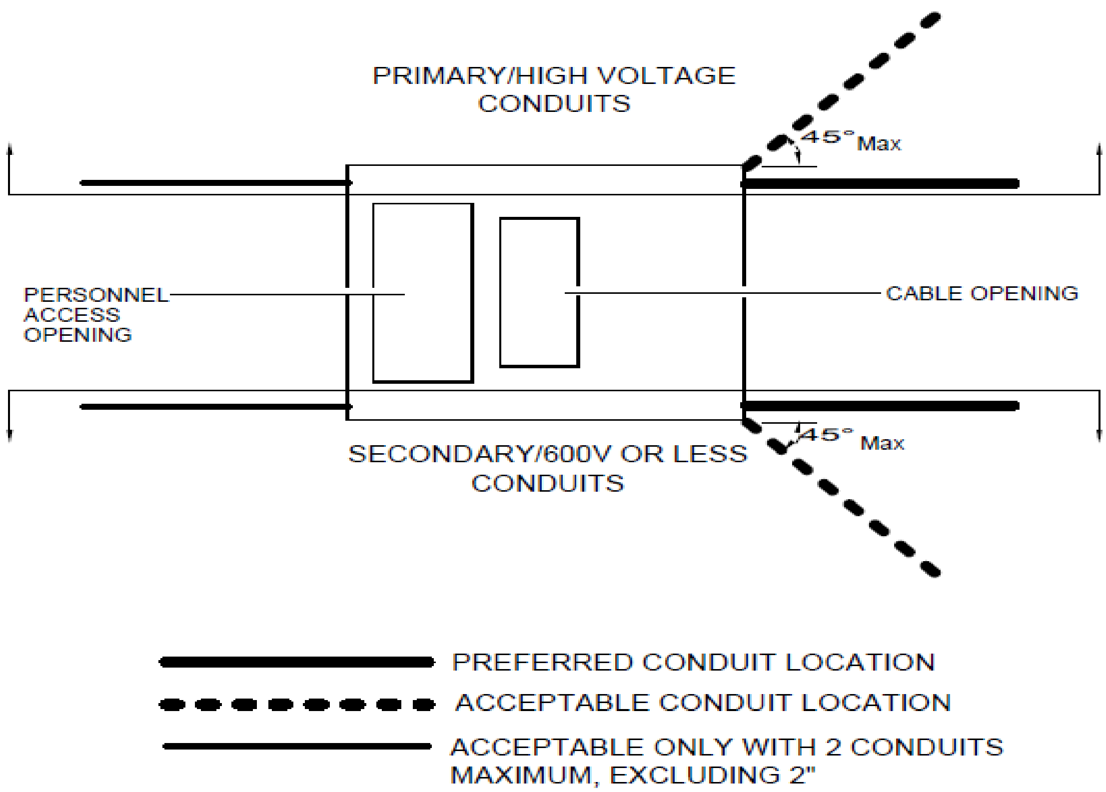
b) Transformers should be located so as to minimize the length of service runs to all appropriate service points. Service runs should be 100 feet or less.

c) In those instances where the service planner desires to install transformers on customer's premises, the customer shall furnish a satisfactory right-of-way for such purposes, and shall provide adequate space for the transformer installation. Pad-mounted transformers shall only be placed in below ground structures with a variance approval from Management as this is non-standard. Pad-mounted transformers may be installed in a transformer room or enclosure provided with adequate access, fire protection and ventilation. BURD transformers may be banked in an underground structure or transformer enclosure if approved by the Public Utilities General Manager.

d) Equipment structures should be located so that vehicle access adjacent to structures will be provided for initial construction and future operation and maintenance needs.

e) When locating pad-mounted equipment, care must be taken to avoid placing equipment where it might create a safety hazard by obstructing the vision of vehicular traffic.

f) When locating transformer padmount structures the orientation of the padmount is important when considering the routing of the primary and secondary conduits. Please refer to the slab box and transformer pad duct entrance diagram below:



2.2F Structure Selection

g) Structures for pad-mounted transformers shall be located a minimum distance from building or other structures in accordance with UGS-295.

h) Pad-mounted equipment must be protected from vehicular traffic. Usually, designated landscape areas or parking lot islands provide protected and accessible structure locations. For screening requirements please reference DDM-1, pg12.

2. Transformer Pad

The following table shows the transformer-pads required for the installation of single-phase padmounted transformers.

Table 2.2F-3 Transformer-Pads

Transformer Size KVA	TRANSFORMER PAD (See note 1,2)
25 50 75 100 167	TP-3 4' X 4'6"

Notes:

1. See UGS-620 for details and dimensions of the transformer-pads and UGS-621 for installation details.
2. Single-Phase Padmounted Transformers are used when high water table is present.
3. 167 KVA transformers should not be used for new designs.

2.2 F-4: Illustrates Underground Structure Applications

	P-XXXXX	TRANSFORMER SLAB-BOX	6'x8'	SB-3
	P-XXXXX	TRANSFORMER SLAB-BOX	8'x10'	SB-4
	P-XXXXX	PRECAST TRANSFORMER PAD	4'x4.5'	TP-3
		PRECAST BOX	30"x17"x12"	
	PJC-XXXXX	PADMOUNTED JUNCTION CABINET 1 PHASE	18"x30"x24"	
	PJC-XXXXX	PADMOUNTED JUNCTION CABINET (3-PH)	96"x66"	
	C-XXXXX	COMMERCIAL SUBSURFACE TRANSFORMER ENCLOSURE	4'x7'x7'	CST-3
	C-XXXXX	COMMERCIAL SUBSURFACE TRANSFORMER ENCLOSURE	5'x8.5'x7'	
		ELECTRIC SERVICE BOX	17"x30"x24"	ESB-6
		ELECTRIC SERVICE BOX	2'x3'	ESB-7

2.2F Structure Selection

B. Junctions

1. PJC Slab box

Two types of PJC Slab Box's are available. Three Phase and Single phase. 3-4 way load break junctions are utilized inside a three phase PJC slab box and 1-4 way junctions are utilized inside a single phase PJC slab box.

2. CST

Junctions are utilized inside CST (Commercial Subsurface Transformer Enclosure) for terminating primary conductors. The load break junctions are mounted to the sides of the CST. The load break junctions are a connection point and primary high voltage source for subsurface transformer installations inside the CST.

3. Pull Box.

Junctions can be found in our existing 3' x 5' or smaller pull boxes as a means for extending or intercepting primary conductors. These are non standard installations and when the designer is working on cable replacement or upgrades these junctions should be removed and replaced with the PJC above grade installation.

4. Vaults.

Junctions are also found in vaults and should only be used where adequate working space is accessible and available for use during energized switching. The designer should understand that this is non-standard and whenever feasible remove the junctions and replace with straight splices and extend the primary conductors to a PJC above grade installation.

C. Duct and Conduit Requirements

a) Four-inch conduit will be required for all primary cable to a single phase or three phase C/I subsystem.

b) New C/I development with a street improvement involving new curb, sidewalk and gutter, Four five-inch conduits are required for primary feeders, Two four-inch conduits are required for distribution and 2-4” conduits are required for fiber communications running along the frontage. The communications conduits will bypass PJC’s and transformer pads and terminate at a 2’x3’ pull box outside of the main electrical room. From the pull box the 2-4” communications conduits will be terminated inside the communications room adjacent to the Electrical main switchgear. The frontage includes the distance from property line to property line. Please check with ESP for any variation to the amount of feeder conduits required along the frontage. The Master Plan will need to be reviewed and verified by ESP.

c) The equivalent straight pull footage of each secondary/primary conduit run should not exceed the maximum allowable straight pull footage for the cable being used as shown in Chapter DDM-5.

d) Service conduits will normally be four or five-inch and will be installed to accommodate the expected main switch or pull section capacity in accordance with Table 2.2F-5 below.

e) For commercial and industrial installations (including speculative buildings), size all conduits and structures to the main switch or pull section capacity as listed below in Table 2.2F-5 below.

Table 2.2F-5 Conduit Requirements

Typical Primary Distribution			
Radial		Loop	
Three-Phase	One or Two-Phase	Three-Phase	One or Two-Phase
2-4"	2-4"	2-4"	2-4"

	TYPICAL SECONDARY DISTRIBUTION					
	SINGLE PHASE			THREE PHASE		
Pull Sect.	Conduit		Service Conductor	Conduit		Service Conductor
Size	Size	Type	Size & # of Runs	Size	Type	Size & # of Runs
100A	3"	Sch40	1/0 Al Tri			
200A	3"	Sch40	4/0 Al Tri	3"	Sch40	4-4/0 AL
400A	3"	Sch40	350 Al or higher	2-4"	Sch40	4-350 AL
600A	4"	Sch40	350 Al or higher	2-5"	Sch40	1 run 4-750 AL
800A	2-4"	Sch40	500 Al or higher	3-5"	Sch40	2 runs 4-500 AL
1000A				4-5"	S 40 E	3 runs 4-750 AL
1200A				4-5"	S 40 E	3 runs 4-750 AL
1600A				5-5"	S 40 E	4 runs 4-750 AL
2000A				6-5"	S 40 E	5 runs 4-750 AL
2400A				7-5"	S 40 E	6 runs 4-750 AL
3000A				9-5"	S 40 E	8 runs 4-750 AL
4000A				11-5"	S 40 E	10 runs 4-750 AL

f) The number of bends along the service conduit route should be kept to a minimum to facilitate pulling of cable and to minimize the need for pulling structures. No more than three 90 degree bends shall be allowed in a service run. See DDM-5.

g) Use 12.5-foot radius sweeps on all conduit runs in a C/I development.

h) For Government Services: (Hospitals, Universities and Colleges).

2-5” conduits are required for fiber communication conduits along the frontage and the conduits will bypass PJC’s and transformer pads and terminate at a 3’x5’ pull box outside of the main electrical room. From the pull box the 2-5” communications conduits will be terminated inside the communications room adjacent to the Electrical main switchgear.

D. Joint Trench

Joint trench construction (with telephone, cable television (CATV), gas, or other utilities should be planned according to good engineering practices and G.O. 128 clearance requirements. Joint trench provides a means to share trenching and paving costs. It can provide savings to the City, other utilities, and the customer. A joint trench agreement will be required and should be reviewed by the City Attorney’s office.

2.2G Cable Selection

A. Primary Cable

Primary cables for a C/I subsystem shall be 3-1/0 Al XLPE in a conventional duct system. Primary cable shall be sized in accordance with DDM–6,Table 2–A.

B. Secondary or Service Cable

Secondary or service cables shall be 600 V Al XLPE sizes 1/0, 4/0, 350 kcmil, and 750 kcmil. The cable shall be installed in a conventional duct system. The cable shall be selected and installed to meet expected demand in accordance with DDM–2, Table 2.2F-5.

C. Voltage Drop

Voltage drops through secondaries and services to the new service point shall not exceed four percent. DDM–7 contains the constants, formulas, and examples necessary to calculate voltage drop.

D. Voltage Flicker

Flicker may be a concern when customers have large air-conditioning equipment, motors (over 100 hp), arc welders, arc furnaces, or other types of equipment with high-starting currents. Consult Electric System Planning to evaluate service to these customers.

Flicker isn’t to exceed 4% for both single-phase and three-phase services under normal circumstances. Changes to transformer and conductor size are used to manipulate flicker.

2.2H Commercial/Industrial Subsystem Design criteria and Example

The following items use the design criteria outlined above to select and incorporate transformers, cable, and substructures into recommended subsystem designs.

a) Pad-mounted transformers located on the customer's premises is the standard installation for serving C/I customers. Transformers installed on available overhead poles, for overhead-to-underground service(s) or straight overhead service(s) are to be designed when economical up to maximum of 400A service ampacity at the standard operating voltage of 120/240 Volts. 600A and above service ampacity must be fed underground by means of standard on-site transformation utilizing a padmount transformer. In this situation, the customer needs to be advised that the operating voltage(s) available are 120/208 or 480/277 volts.

b) Subsystems will be designed to form approximately 1,670 kVA of transformation in each normally open loop segment which equates to 77A at 12.47 kV.

c) Subsystems are fed from a 200A switch position or via 3-4 way LBJ's inside a PJC. The example of this loop subsystem design is shown on next page.

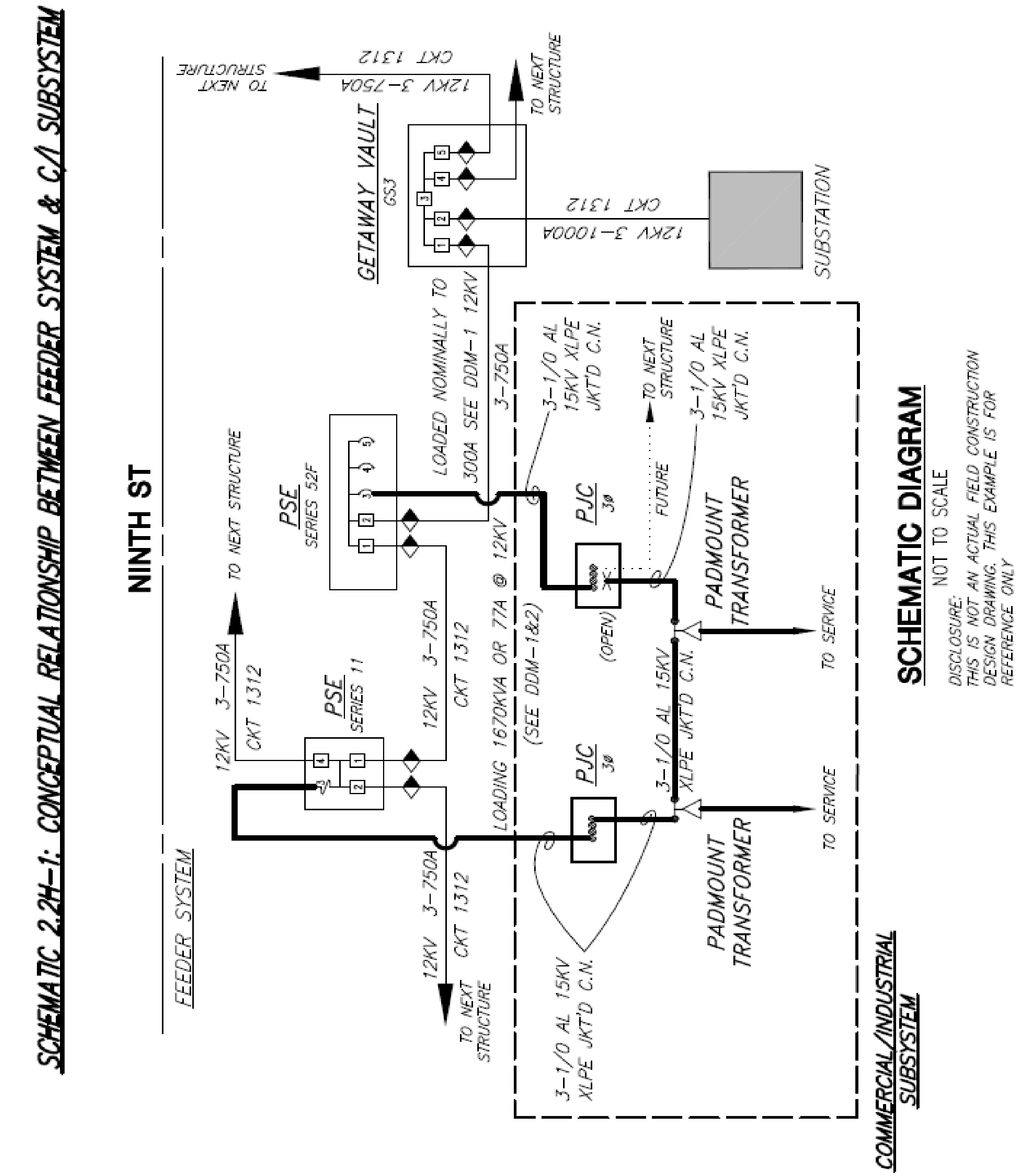
d) Looped subsystems are the standard at RPU.

e) The economic and operating considerations of each specific job should determine the design to be used.

f) All new 12 kV three-phase, dead-front loop-fed transformers (75–500 kVA) shall be connected using load-break elbows. Bushing inserts are required on the single phase padmount transformers.

g) Subsystems will be designed to provide the system of least cost, consistent with the appropriate application of Electric Rules 10 and 11.

An example of the conceptual relationship between Feeder System and Commercial/ Industrial Sub systems is shown in Schematic 2.2H-1


SCHEMATIC 2.2H-1: CONCEPTUAL RELATIONSHIP BETWEEN FEEDER SYSTEM & C/I SUBSYSTEM
NINTH ST
FEEDER SYSTEM
GETAWAY VAULT
GS3
12KV 3-750A
CKT 1312
TO NEXT STRUCTURE
12KV 3-1000A
CKT 1312
SUBSTATION
PSE
SERIES 52F
PSE
SERIES 11
TO NEXT STRUCTURE
12KV 3-750A
CKT 1312
12KV 3-750A
CKT 1312
LOADED NOMINALLY TO 300A SEE DDM-1 12KV 3-750A
LOADING 1670KVA OR 77A @ 12KV (SEE DDM-1&2)
12KV 3-750A
CKT 1312
TO NEXT STRUCTURE
3-1/0 AL 15KV XLPE JKT'D C.N.
TO NEXT STRUCTURE
FUTURE
3-1/0 AL 15KV XLPE JKT'D C.N.
PJC
3Ø
PJC
3Ø
(OPEN)
3-1/0 AL 15KV XLPE JKT'D C.N.
3-1/0 AL 15KV XLPE JKT'D C.N.
PADMOUNT TRANSFORMER
PADMOUNT TRANSFORMER
TO SERVICE
TO SERVICE
COMMERCIAL/INDUSTRIAL SUBSYSTEM
SCHEMATIC DIAGRAM
NOT TO SCALE
DISCLOSURE:
THIS IS NOT AN ACTUAL FIELD CONSTRUCTION DESIGN DRAWING. THIS EXAMPLE IS FOR REFERENCE ONLY

Appendix 2-1: COMMERCIAL BUILDING TYPES

Building No.	Building Type	Building Description
1	Large Office (>30,000 s.f.)	Depository Institutions, Insurance Carrier/Agents, Real Estate, Business Services, Medical Clinics/Offices, Legal Services, Social Services, Business/Labor/Political Organizations, Courts
2	Small Office (<30,000 s.f.)	Same as above
3	Restaurant - Fast Food (<3,000 s.f.)	Eating and Drinking Places
4	Restaurant - Sit Down (>3,000 s.f.)	Same as above
5	Large Retail (>3,000 s.f.)	Building Material and Garden Supplies, Department Stores, Auto Dealers, Clothing Stores, Furniture/ Appliance/Home Furnishing Stores, Misc. Retail (Drug, Sporting Goods, Bicycles, Stationary Gift)
6	Small Retail (<30,000 s.f.)	Same as above
7	Large Food Stores (>30,000 s.f.)	Grocery, Dairy Products, Fruit and Vegetable, Meat and Fish, Retail Bakeries, Liquor Stores
8	Small Food Stores (<30,000 s.f.)	Same as above, "7-11", "Stop-N-Go"
9	Refrigerated Warehouse	Refrigerated Warehousing and Storage, Packaged

COMMERCIAL BUILDING TYPES (continued)

Building No.	Building Type	Building Description
10	Non-refrigerated with Warehouse	Local Trucking With Storage, Public Warehousing AC and Storage, Wholesale Trade - Durable Goods (Motor Vehicles/Parts/Supplies, Tires, Furniture, Lumber, Hardware)
10a	Non-refrigerated Non-AC Warehouse	
11	Elementary and Secondary Schools	Elementary and Secondary Schools, Day Care Services
12	Colleges and Universities	Colleges and Universities, Vocational Schools, Schools and Educational Services
13	Hospitals	Hospitals (Surgical/General/Psychiatric), Nursing and Personal Care Facilities
14	Health Clinics	Medical and Dental Laboratories, Outpatient Clinics
15	Hotels and Motels	Hotels and Motels
16	Auto Repair Shops	Auto Body, Glass, Exhaust, Paint, Tire, Transmission, and Repair Services
17	Miscellaneous Repair	Electrical Appliance Repair (Radio, Television, Refrigerator) Re-upholstery, Watch and Clock
18	Movie Theaters	Indoor Movie Theaters
19	Bowling Alleys	Bowling Alleys
20	U.S Post Offices	U.S Postal Services

INDUSTRIAL BUILDING TYPES

Building No.	Building Type	Bowling Alleys
21	Meat Packing	Meat Packing Plants, Sausages and Other Prepared Meats, Poultry Slaughtering and Processing
22	Fruit and Vegetables Processing	Preserved, Canned, Dehydrated, Pickles, Sauces, Salad Dressings, Frozen
23	Bakery Products	Bread, Cake, Frozen Bakery Products (Except Bread)
24	Apparel Manufacturing	Clothes, Hats, Belts, Fur, Leather, Curtains
25	Furniture Manufacturing	Wood and Metal Household and Office Furniture, Mattresses and Bedsprings, Wood TV Cabinets
26	Paper Products	Containers, Boxes, Can, Drums, Bags, Stationery
27	Print/Products	Newspapers, Periodicals, Books, Greeting Cards, Typesetting
28	Plastic Products	Plastic Films and Sheets, Laminated, Profile Shapes, Pipe, Bottles, Foam, Plumbing Fixtures
29	Metal Fabrication	Cans, Shipping Container, Barrels, Hardware, Doors, Sheet Metal, Screws, Bolts, Nuts, Washers, Stampings, Forgings, Springs
30	Telephone Communication Center	Telephone Communications and Switching Center