Busway Design
The Easy Way

By: IIEE-ABU DHABI CHAPTER

OBJECTIVES

- **Understand The Busway / Bus Bar**
- **Its Best Value / Advantages**
- **Common Application**
- **How to design**

DEFINITION

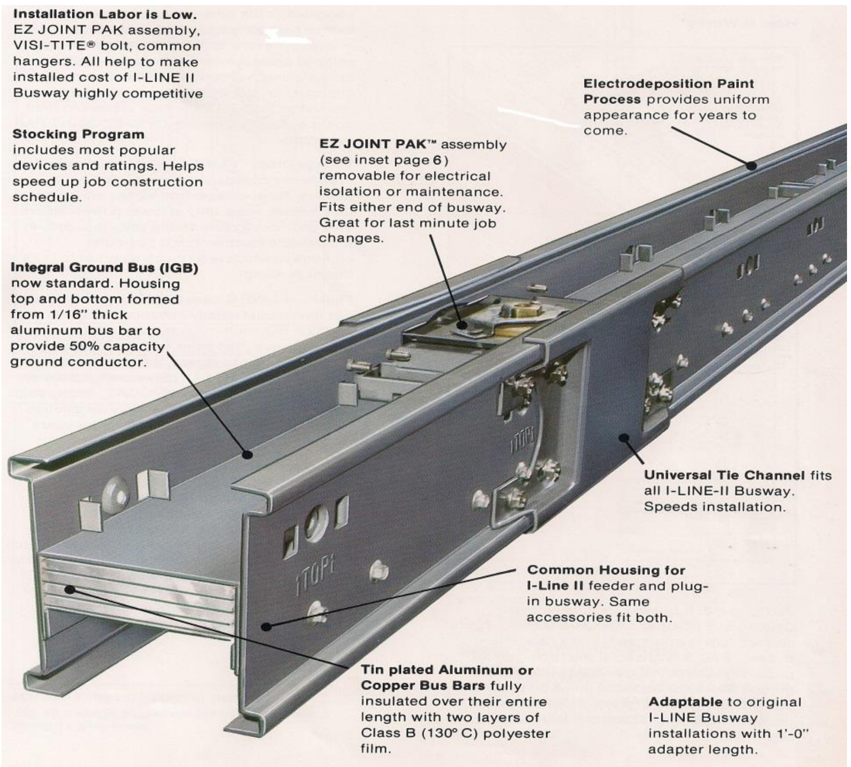
BUSWAY is **defined by the National Electrical Manufacturers Association (NEMA)** ***as prefabricated electrical distribution system consisting of bus bars in a protective enclosure including straight lengths, fittings, devices and accessories.***

Reasons to use Busway:

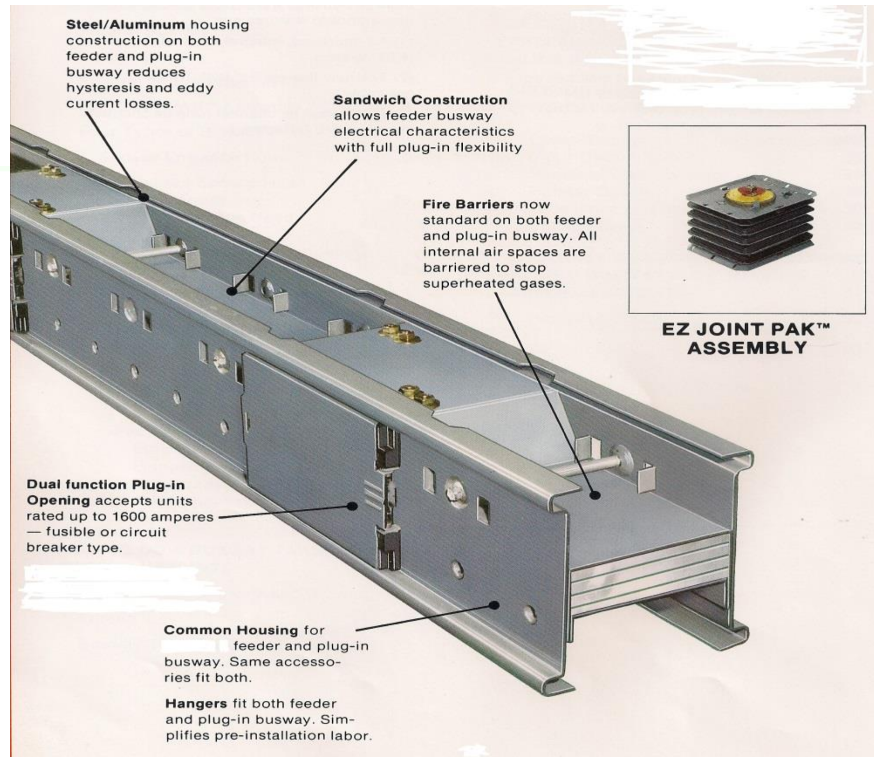
- Commercial and Industrial distribution systems use various methods to conduct electrical energy.
- These methods often include heavy conductors run in trays and conduit.
- Cable and conduit assemblies are time consuming to install. Combining the material and labor, it is costly
- Once installed they are difficult to change.

To eliminate these short comings, power is often distributed using enclosed bus bars, which is referred to, as . . . . .

“BUSWAY”



“Feeder Busway”



“Plug-In Busway”

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Why Busway is your best value?

Today electrical engineers and contractors around the world are specifying busway for more and more industrial and commercial projects.

THE REASONS?

Busway offers a versatility in application and a simplicity in installation that cables and conduit can not match.

More than that, busway offers those benefits, at a total installed cost, very much lower than cable and conduit.

Busway is pre-engineered for easy installation with hand tools and, a minimum of equipment.

Aside from installation cost, there are more ways busway saves time and money, as follows:

- ***100% reusable.*** When building's electrical system needs to be modified, entire busway runs can be taken down and relocated.

- ***Less downtime.*** Simple fast installation and relocation means less downtime for the equipment and system powers.

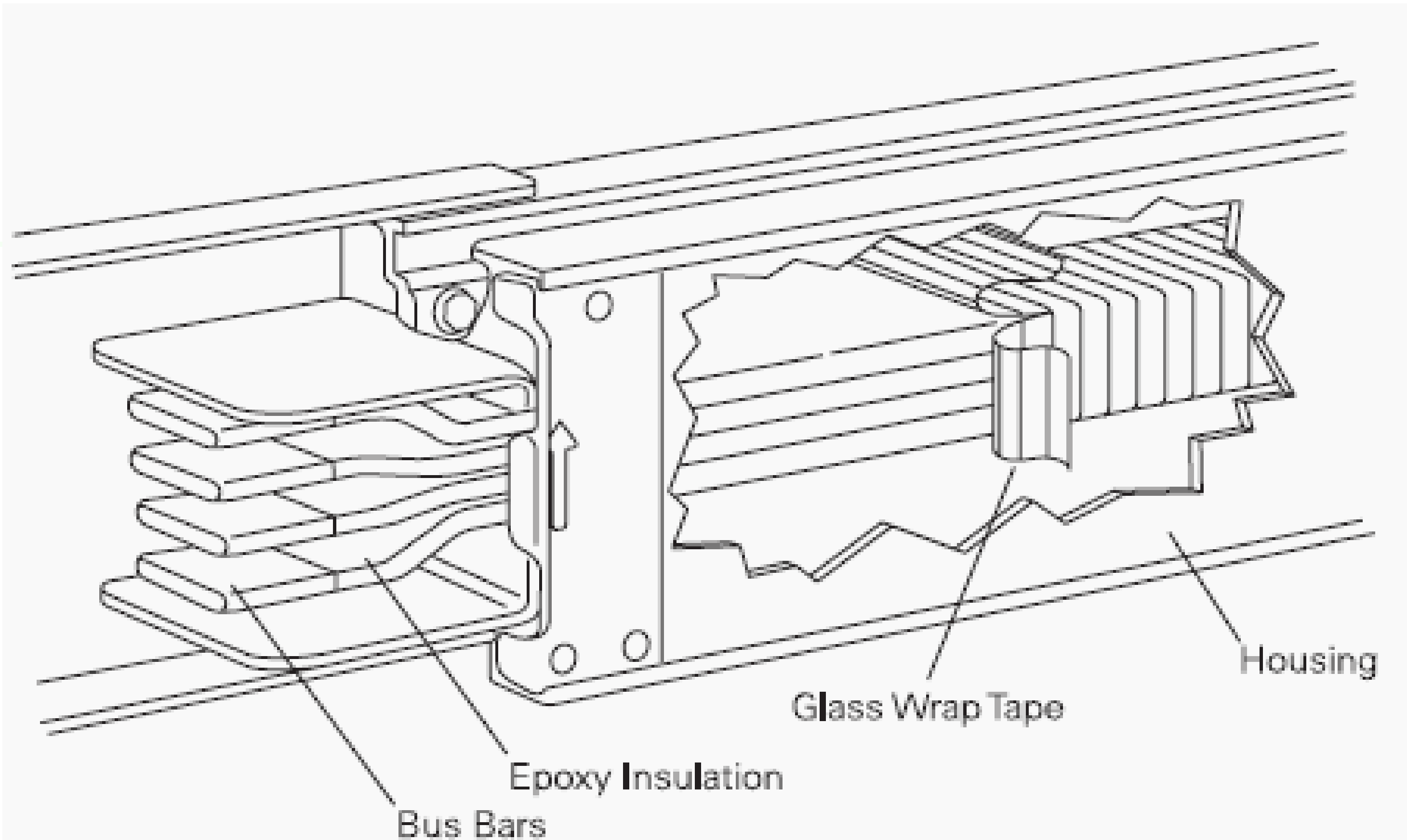
- ***Easily expandable.*** Expanding a system can be done in most cases with standard busway components, mostly available from stock for fast-track delivery.

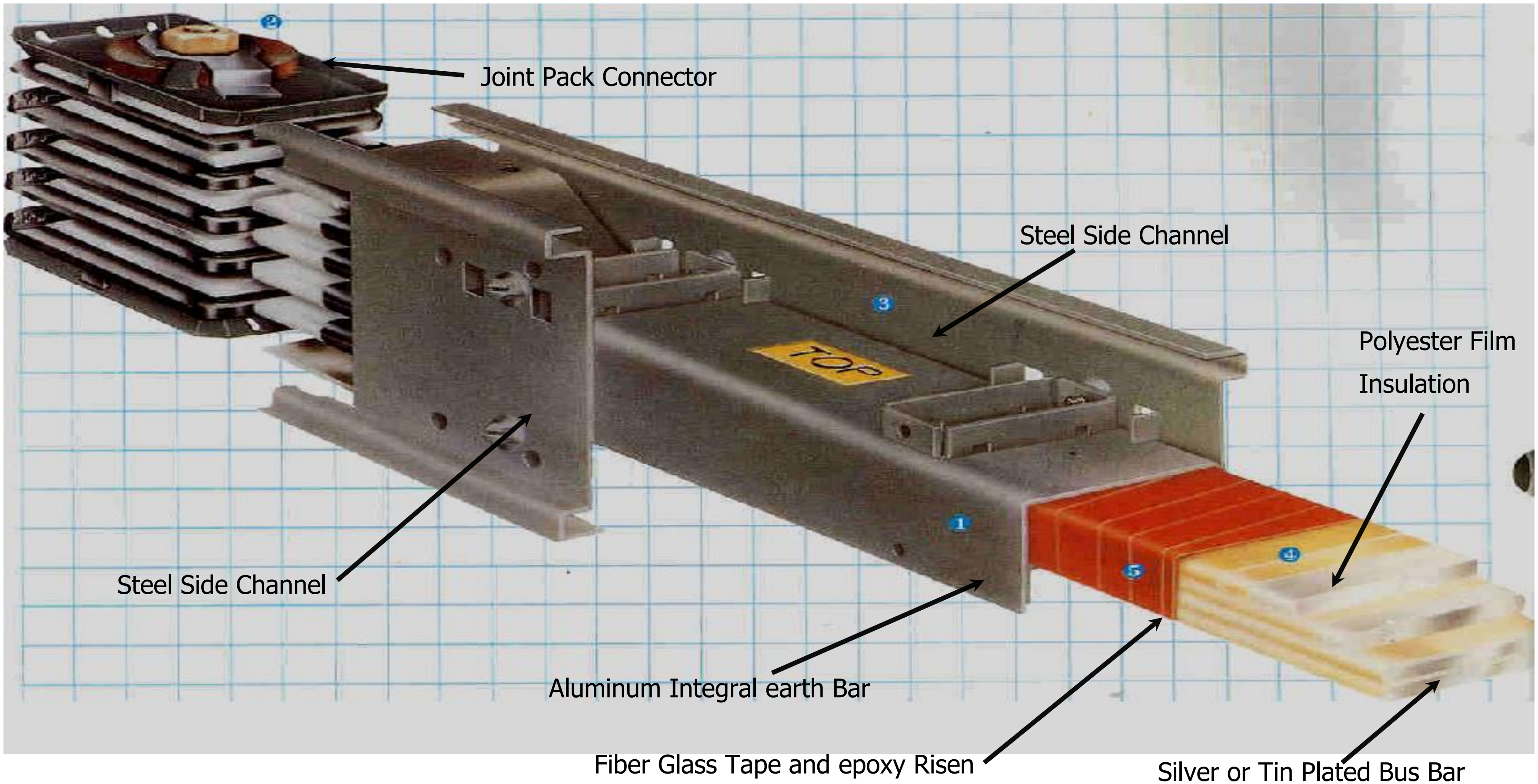
- ***Lower impedance.*** The lower impedance of a busway system means there is lower voltage drop than with the cable and conduit, resulting in lower energy cost.

- ***Light and compact.*** Compared to cable and conduit, busway is lighter weight and compact size help to simplify storage, and make handling and installation easier.

- ***A high degree of safety.*** The conductors are totally enclosed and plug-in units are polarized.

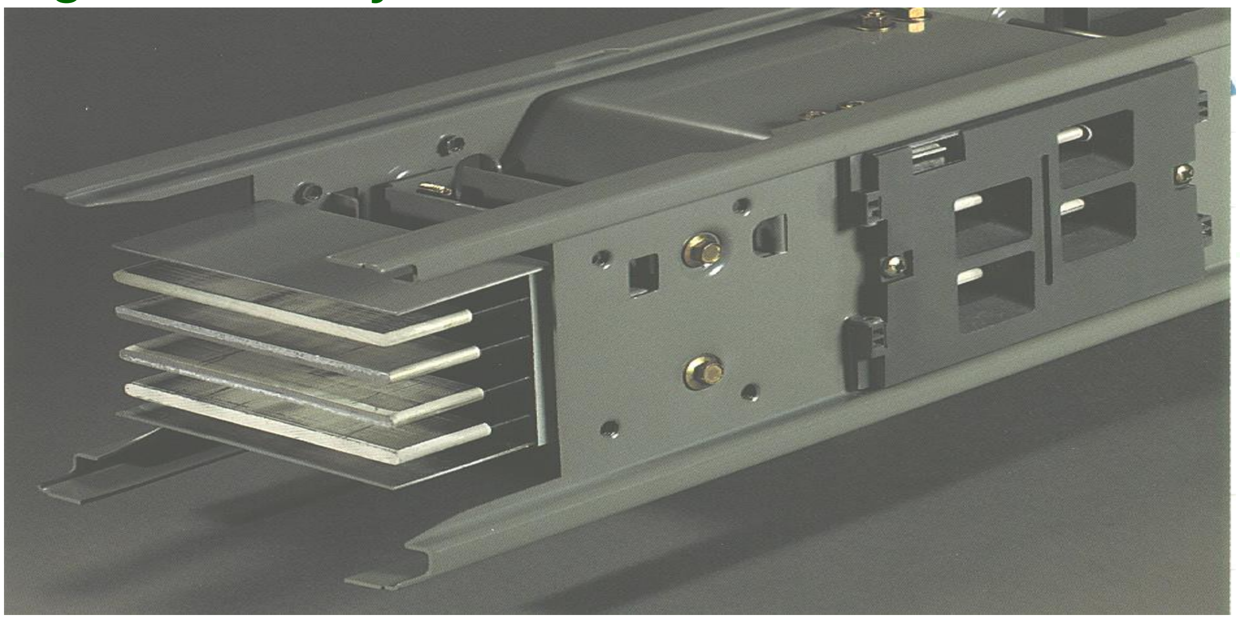
Busway includes bus bars, an insulating and/or support material, and a housing.




Joint Pack Connector
TOP
Steel Side Channel
Polyester Film
Insulation
Steel Side Channel
Aluminum Integral earth Bar
Fiber Glass Tape and epoxy Risen
Silver or Tin Plated Bus Bar

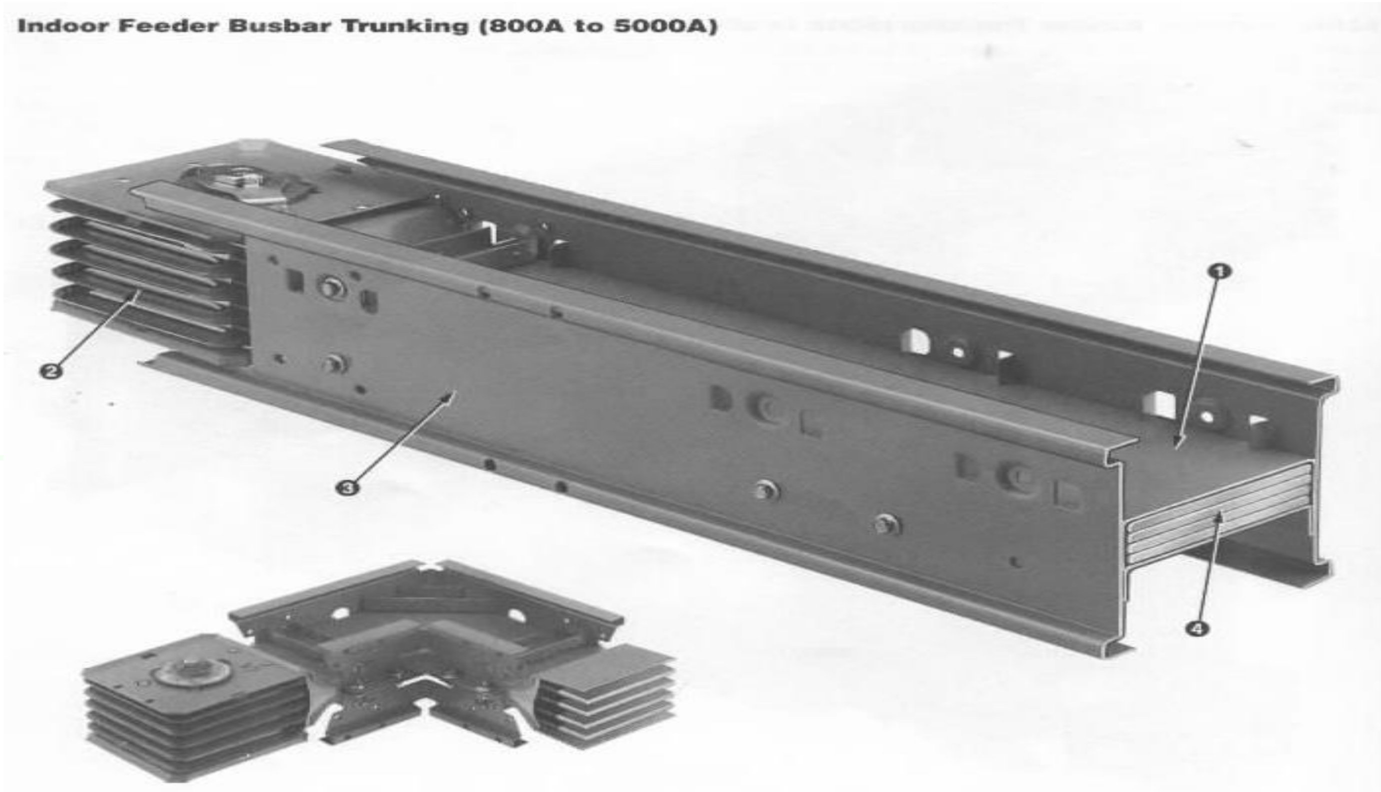
THE TWO BASIC TYPES OF BUSWAY ARE:

1. Plug-In Busway



Versatile and ideal for distributing power over a wide area. It can be used in horizontal and vertical risers. Can be extended at a later time to cater future loads.

2. Feeder Busway



Feeder busway is for distributing loads concentrated in one area. Used in short runs as a service entrance. As tie run from distribution switchboard to motor control center, or components that demand high concentration of power, such as large motors.

OTHER BUSWAY FITTINGS

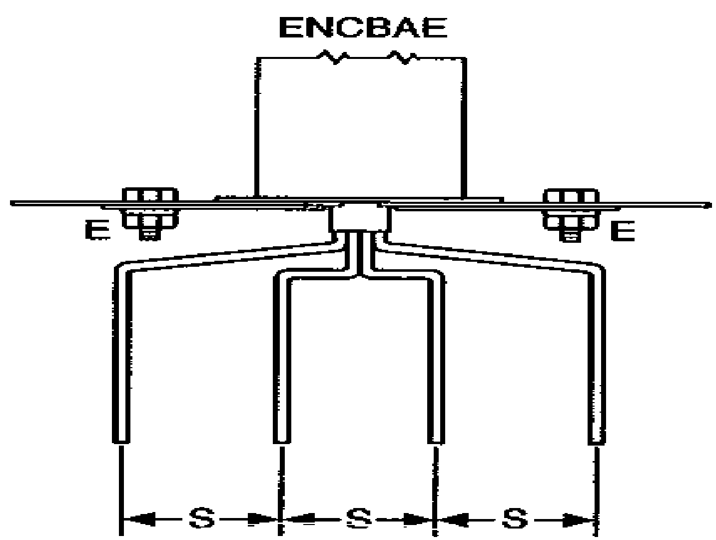
- Flanged End
- Elbow
- Expansion joint
- Joint pack
- Cable Tap Box
- Reducer
- Tap Off Unit
- End Cap or Closure
- Flanged-End-Transformer Tap (FET)
- Flexible Link
- Service Head
- Transformer Tap
- 180° Phase Transition

BUSWAY FITTINGS

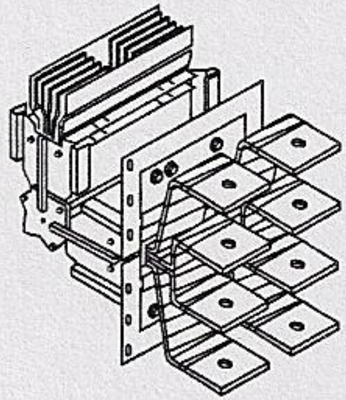
FLANGED END

Connecting switchboards or transformer

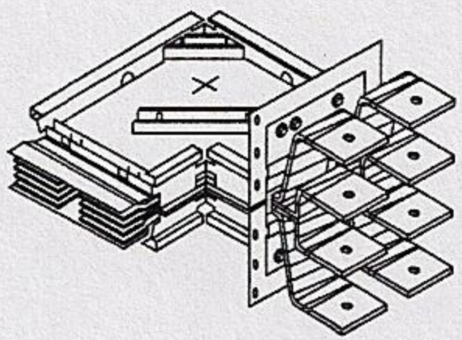
Single bolt connection



□ type LEFE, edgewise elbow plus flanged end



□ type LFFE, flatwise elbow plus flanged end

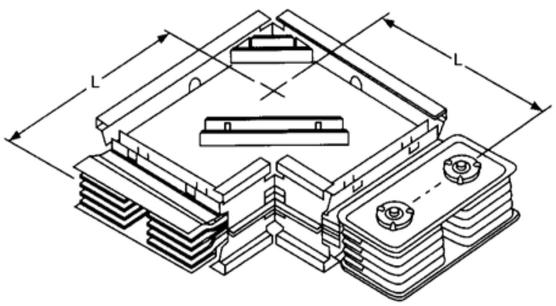


ELBOWS

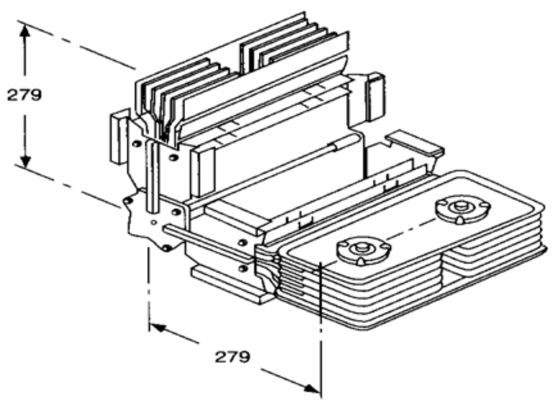
Standard connecting angle： 90º

Any angles or format according to customer’s demand.

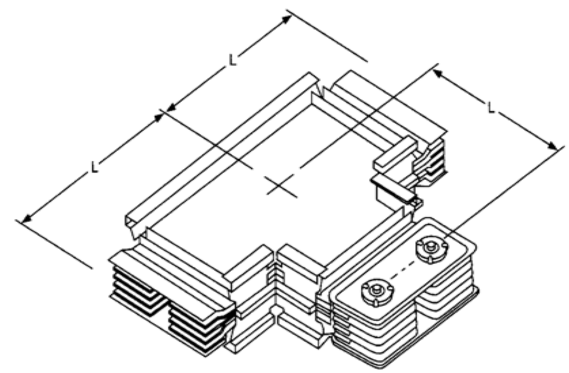
Provide various elbows combination: Double-elbow, Tee



Elbow - Flatwise



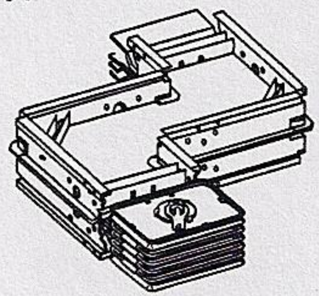
Elbow - Edgewise



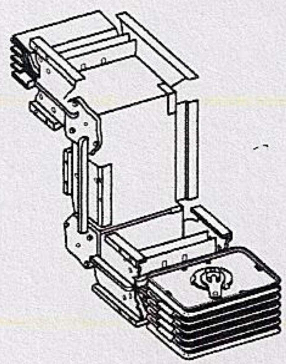
Tees - Feeder

DOUBLE ELBOWS

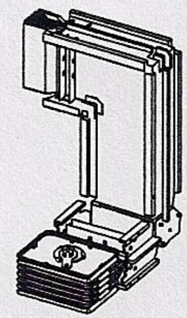
□ type OF, flatwise offset



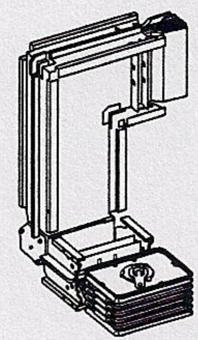
□ type OE, edgewise offset



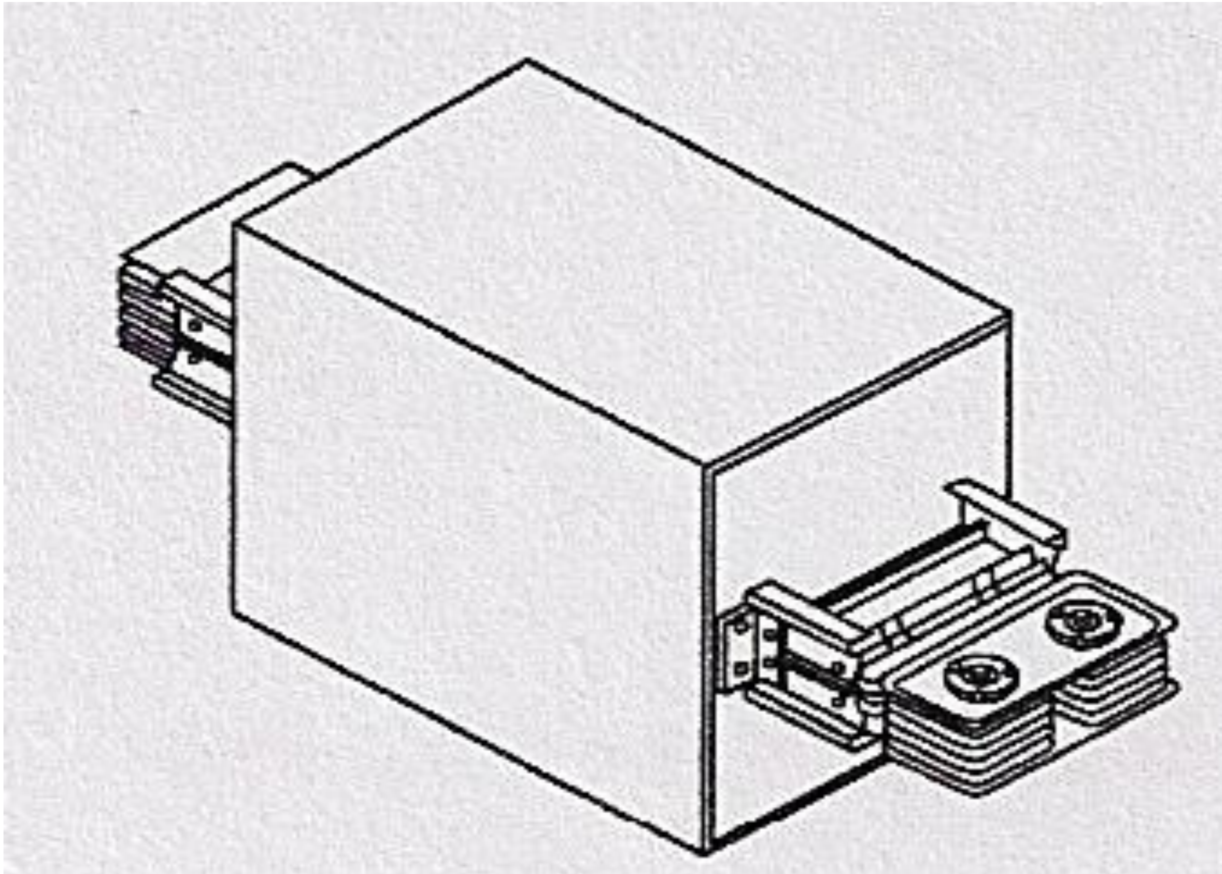
□ type DR, double right elbow



□ type DL, double left elbow



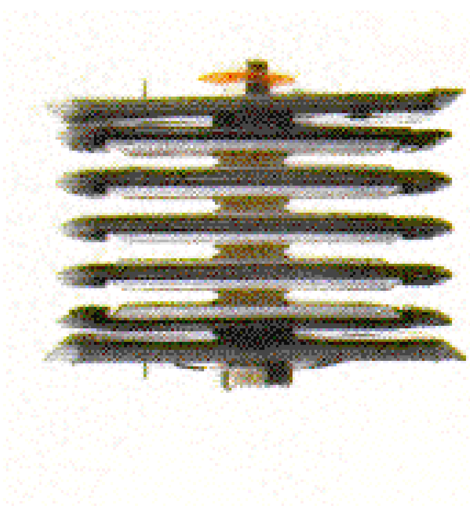
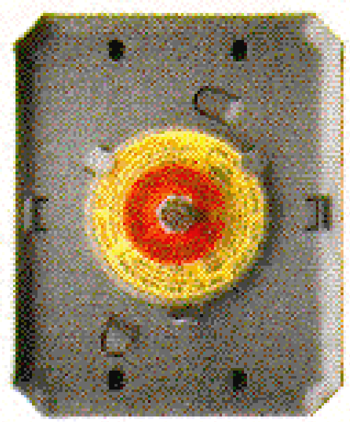
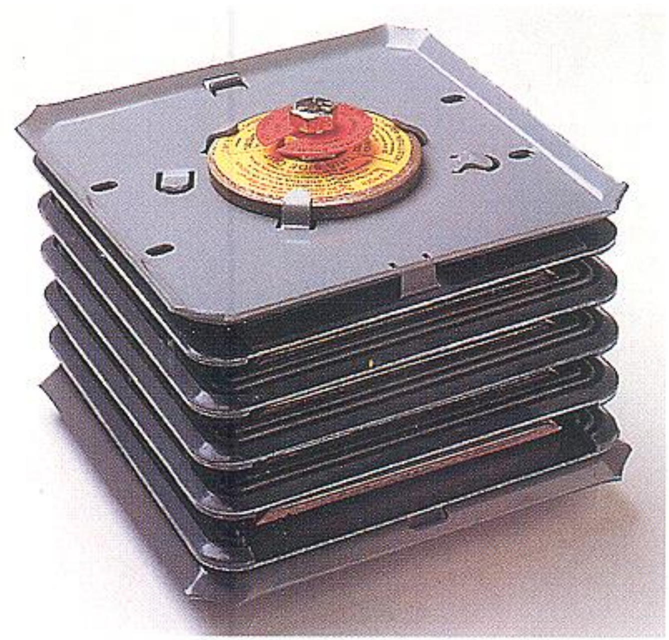
EXPANSION JOINT



A busbar trunking unit permitting axial movement of the busbar conductors due to the different coefficient of expansion of differing materials

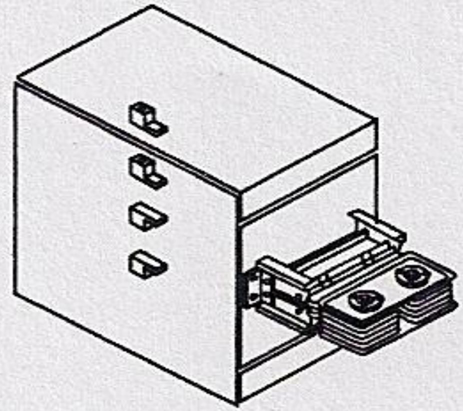
JOINT PACK

- Plated contact surface
- Adjustable range: +/- 3mm

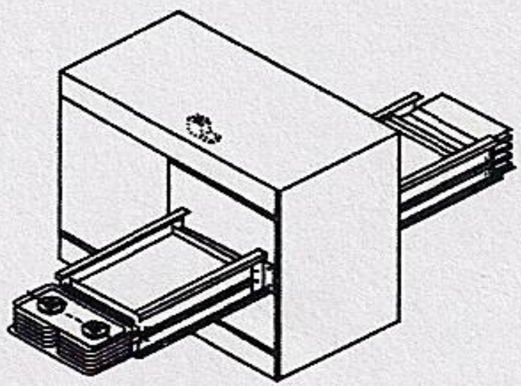




CABLE TAP BOX

□ type ETB, end cable tap box



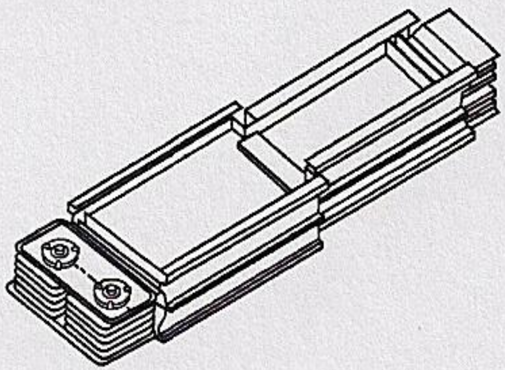
□ type CTB, center cable tap box



REDUCER

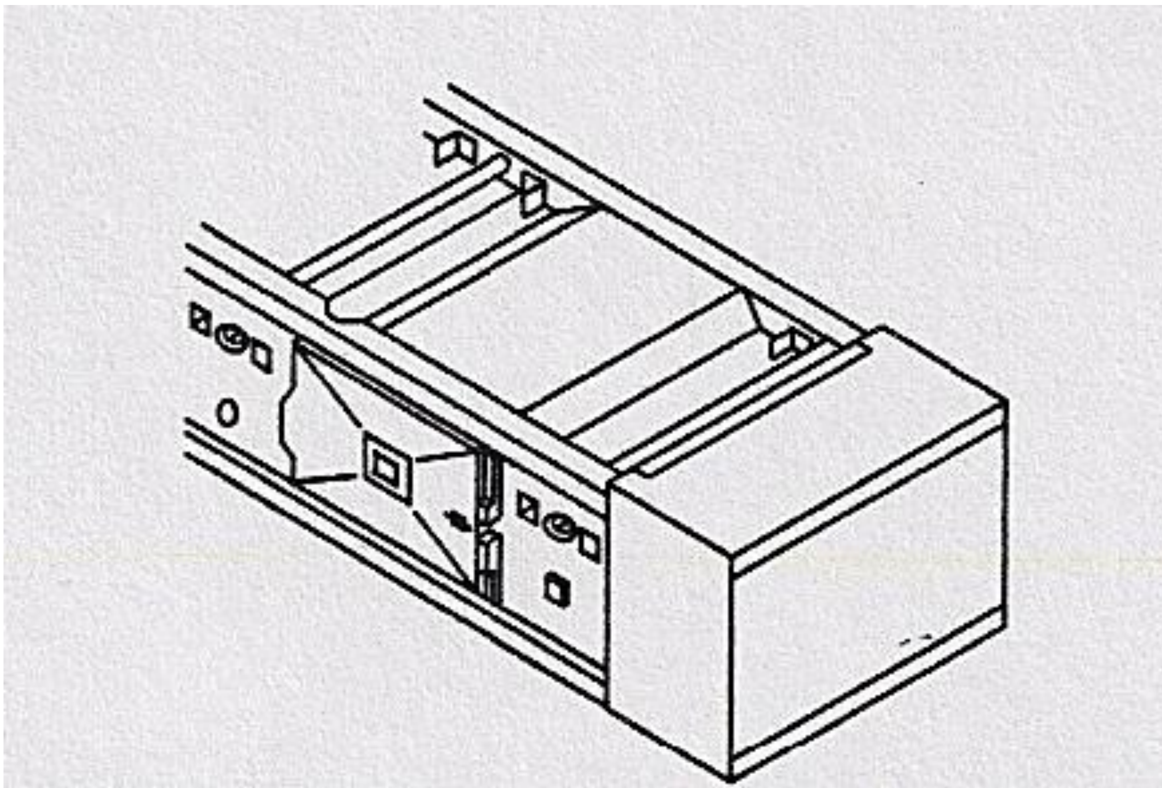
- Connect the high power and low power run
- Best way to save investment
- Standard reducer is non-fusible, reducer with fuse/MCCB is optional

□ type R

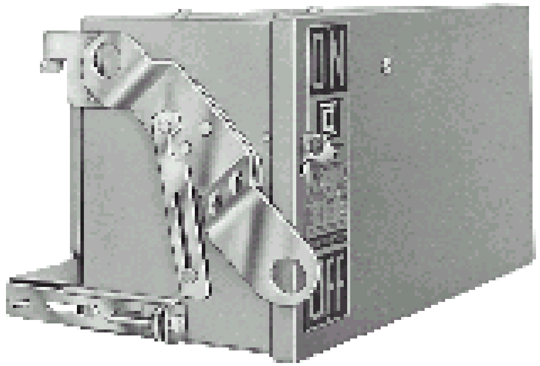


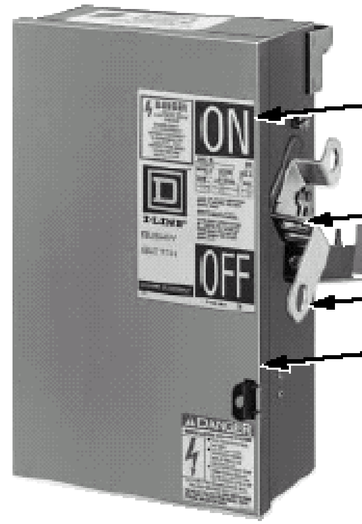
END CLOSURE

The end closure protects and insulates the conductor ends and is fitted to the last plug-in riser section.



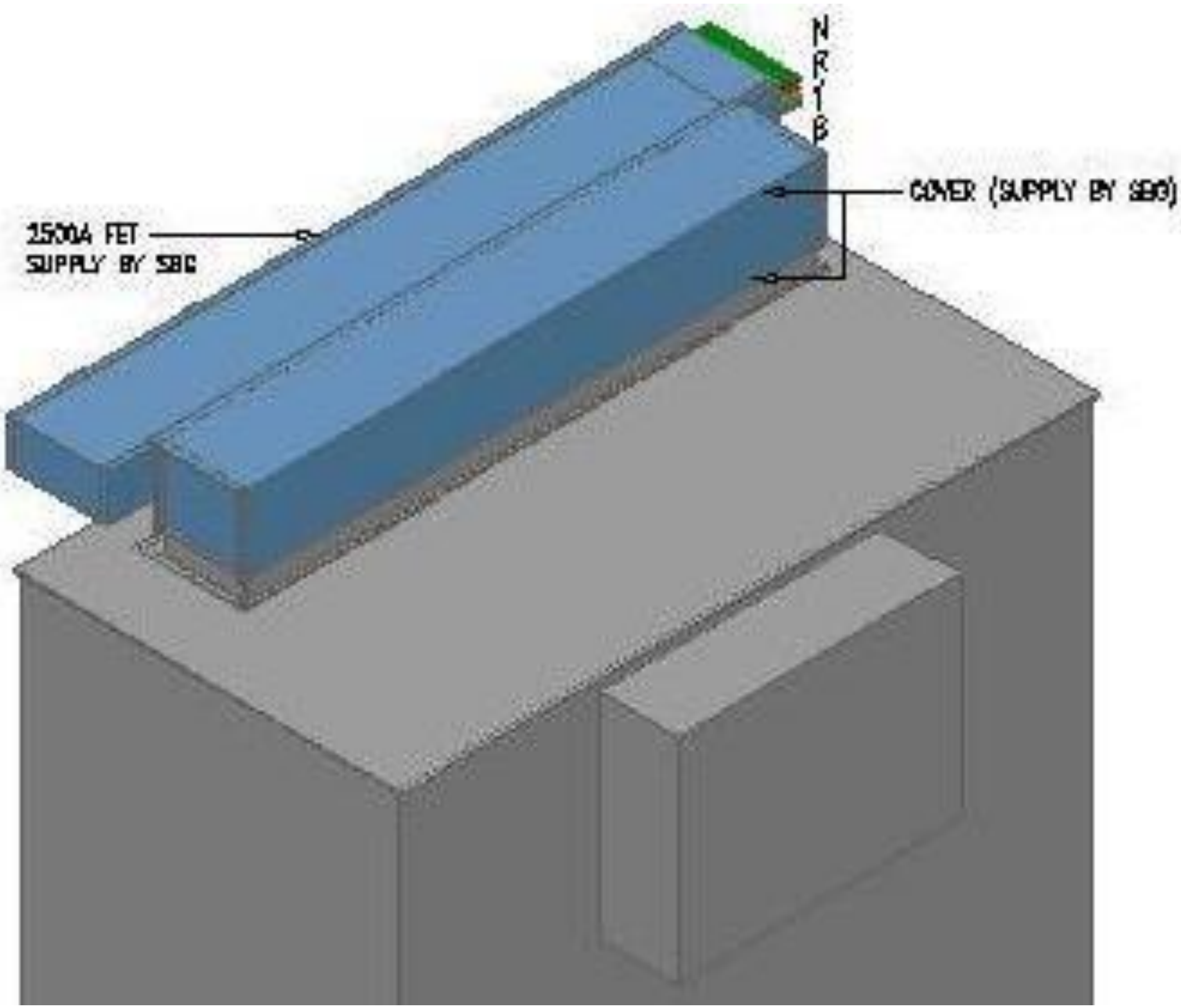
TAP-OFF UNIT or PLUG-IN UNIT



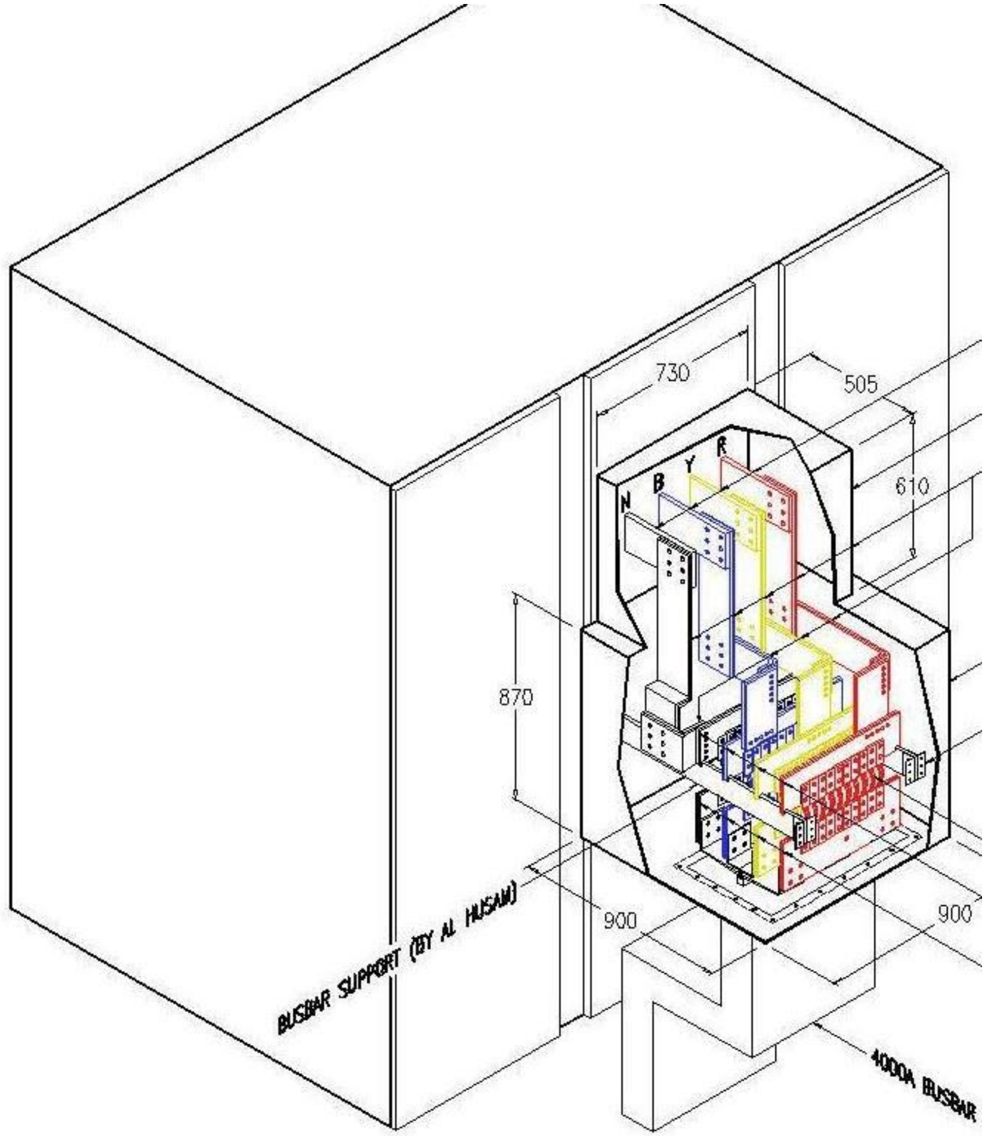


紧凑型 NS 断路器插入箱详图

FLANGED END TRANSFORMER TAP



TRANSFORMER THROAT CONNECTION



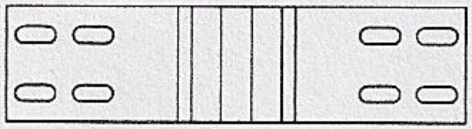
FLEXIBLE LINKS

Flexible link

for the connection between the conducting plates, to reduce the vibration from the transformer.

Connection plates

the conductors of flanged ends are connected via connection plates to the switchboard busbars.



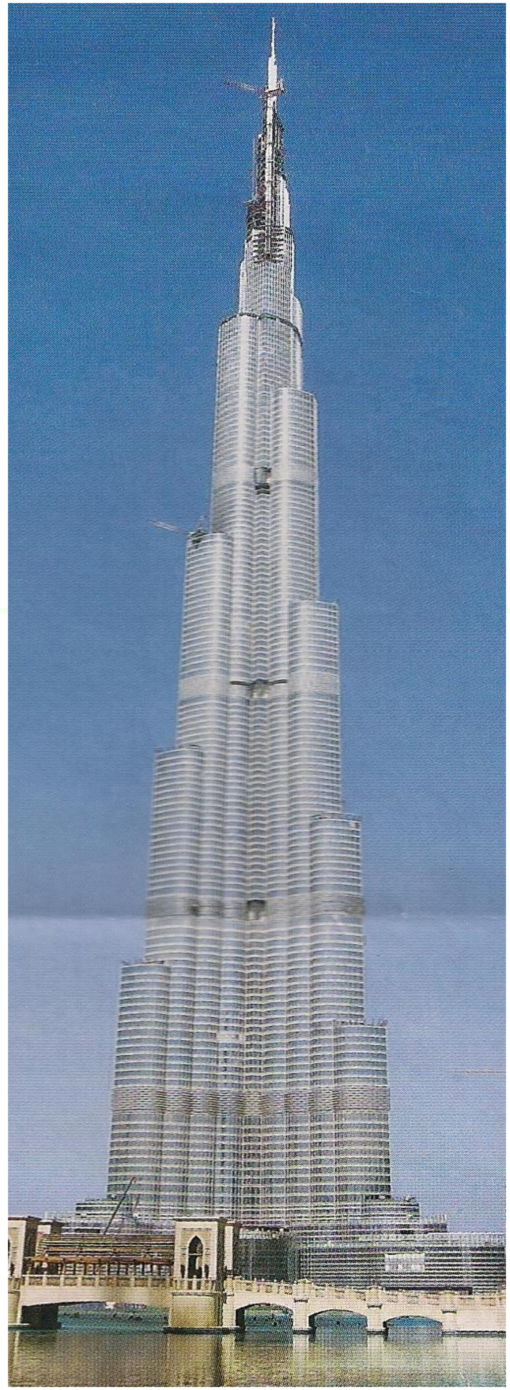
BUSWAY MOST COMMON APPLICATION

- Risers in office / commercial construction
- Large service entrance feeders
- High ampere tie runs between equipment
- Industrial Plug-In Runs

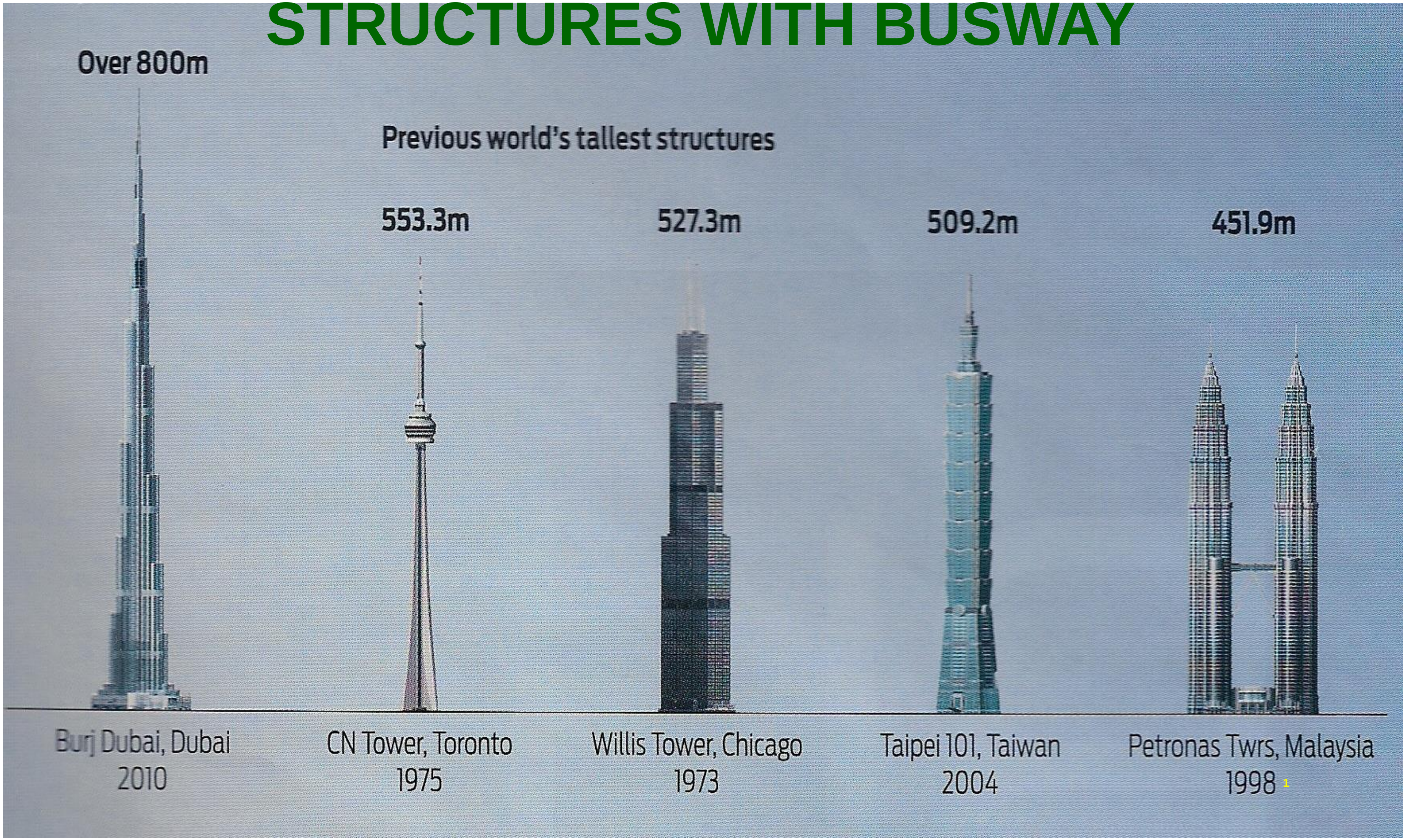
OFFICE / COMMERCIAL CONSTRUCTION

Application
1. Transformer/ Switchboard connection
2. Horizontal distribution, from the substation to the loads in workshop
3. Vertical distribution, from the substation to the loads of each high rise floor
4. Lighting application, in Park place, supermarket, exhibition center, metro ect.

BURJ KHALIFA - WORLD'S TALLEST STRUCTURE



PREVIOUS WORLD'S TALLEST STRUCTURES WITH BUSWAY



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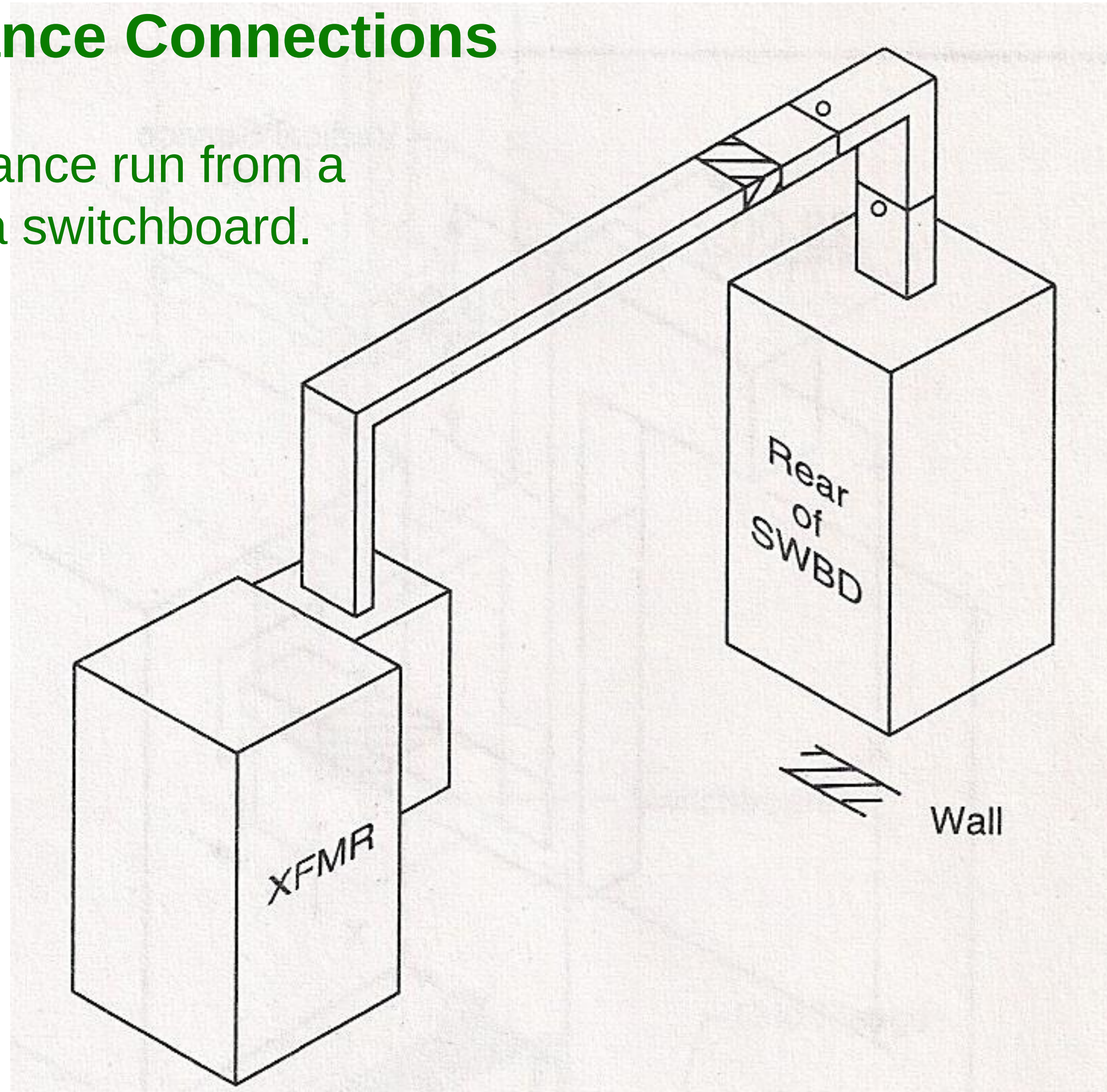
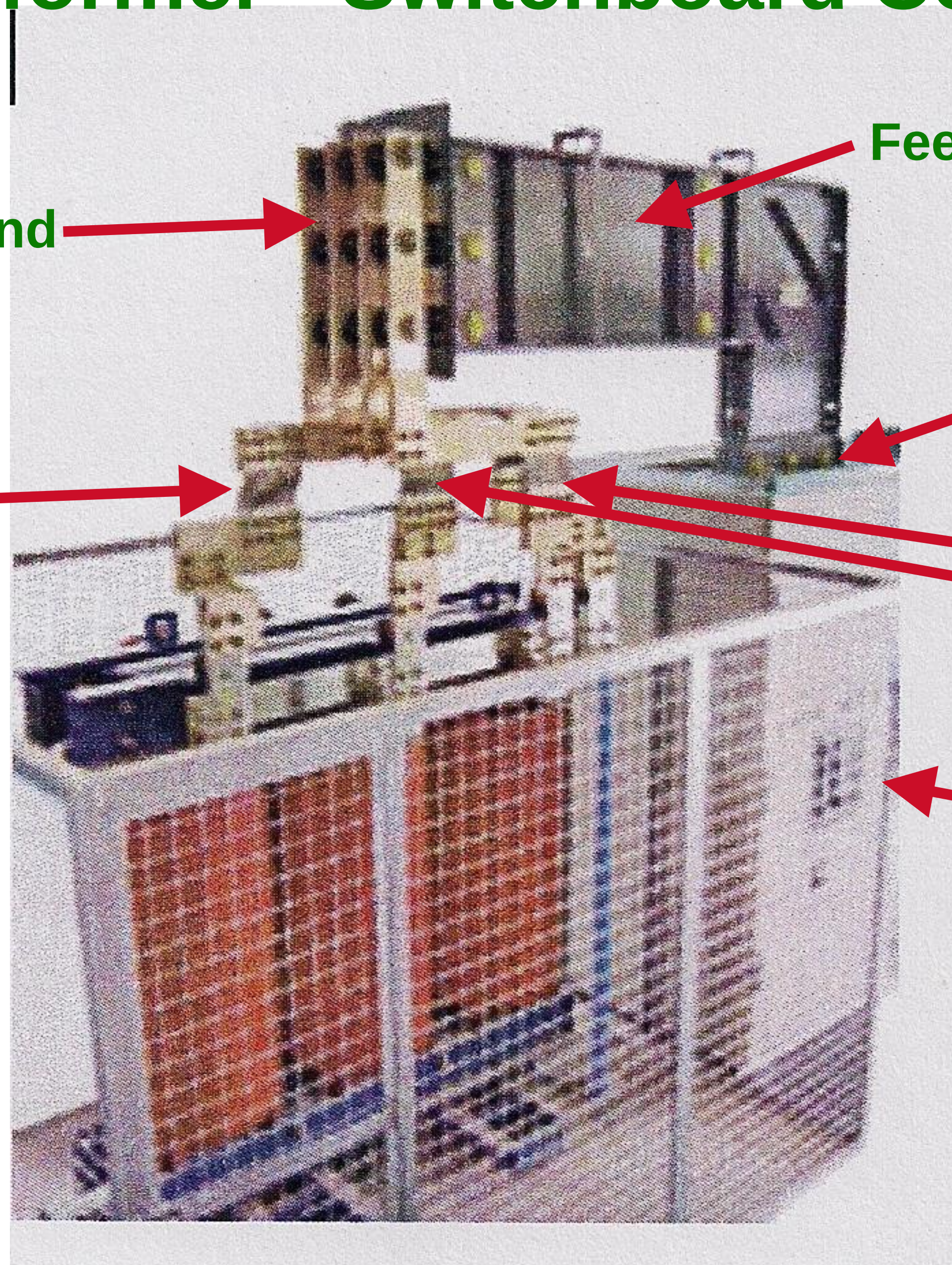
The Four Basic Types of Busway Runs

1 - Service Entrance Connections

A typical service entrance run from a utility transformer to a switchboard.

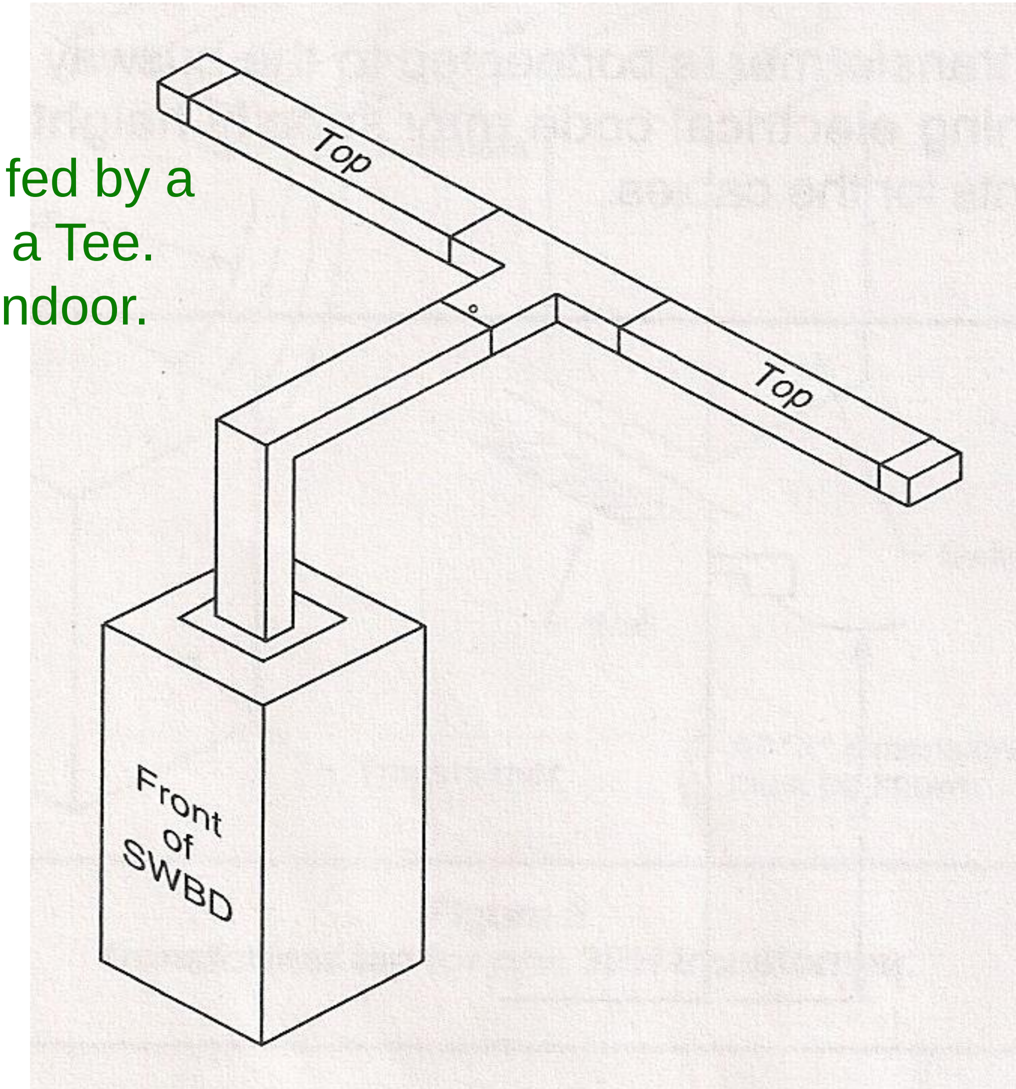


Transformer - Switchboard Connection

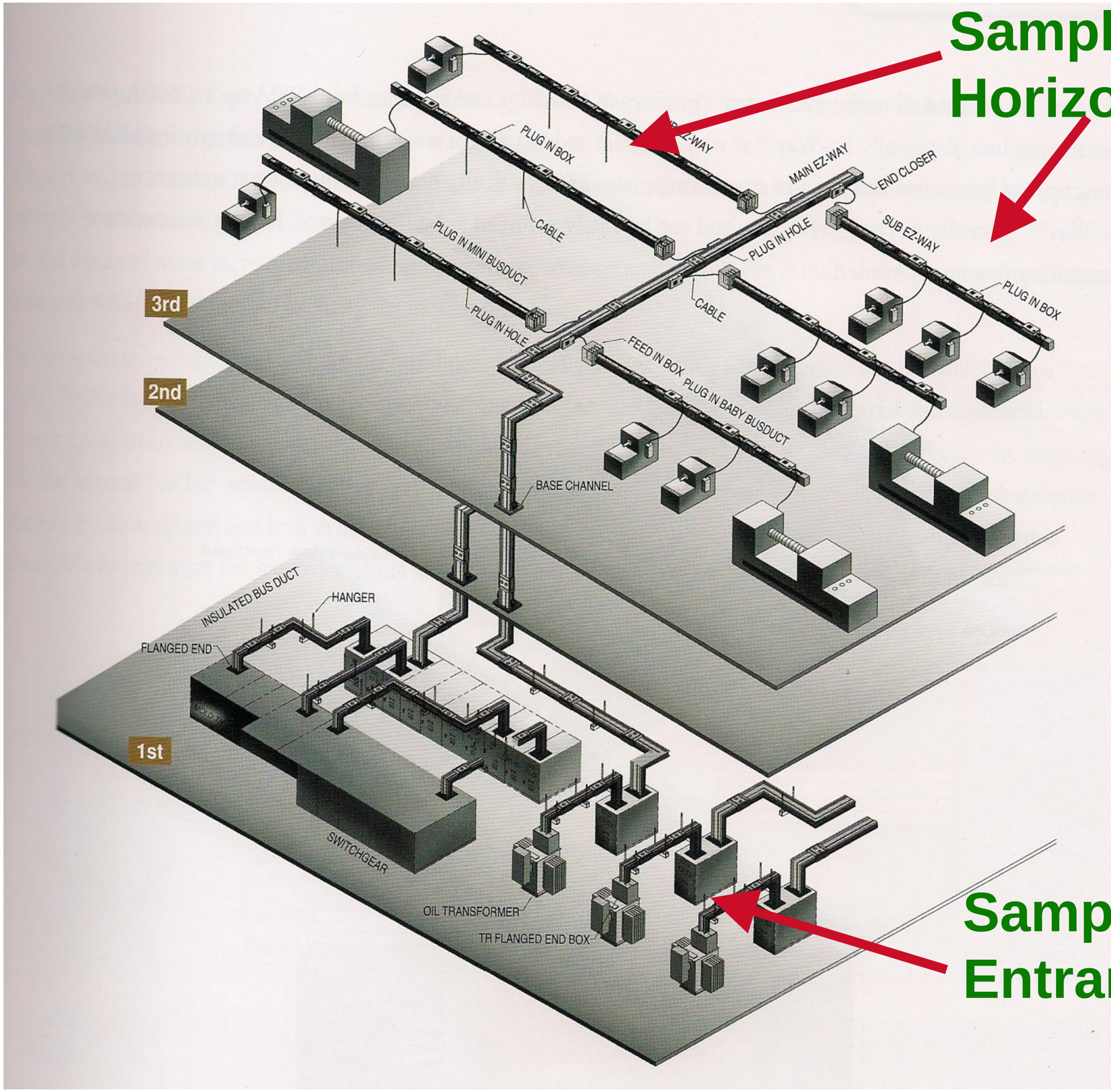


2 - Plug-In Type Horizontal Run

A simply Plug-In run fed by a switchboard through a Tee. (Application always indoor.



Plug-In Type Horizontal Run



Sample of Plug-In Horizontal Run

Sample of Service Entrance Run

3 - Plug-In Type Vertical Riser

A simply plug-in riser fed by a switchboard. (Always an indoor application)

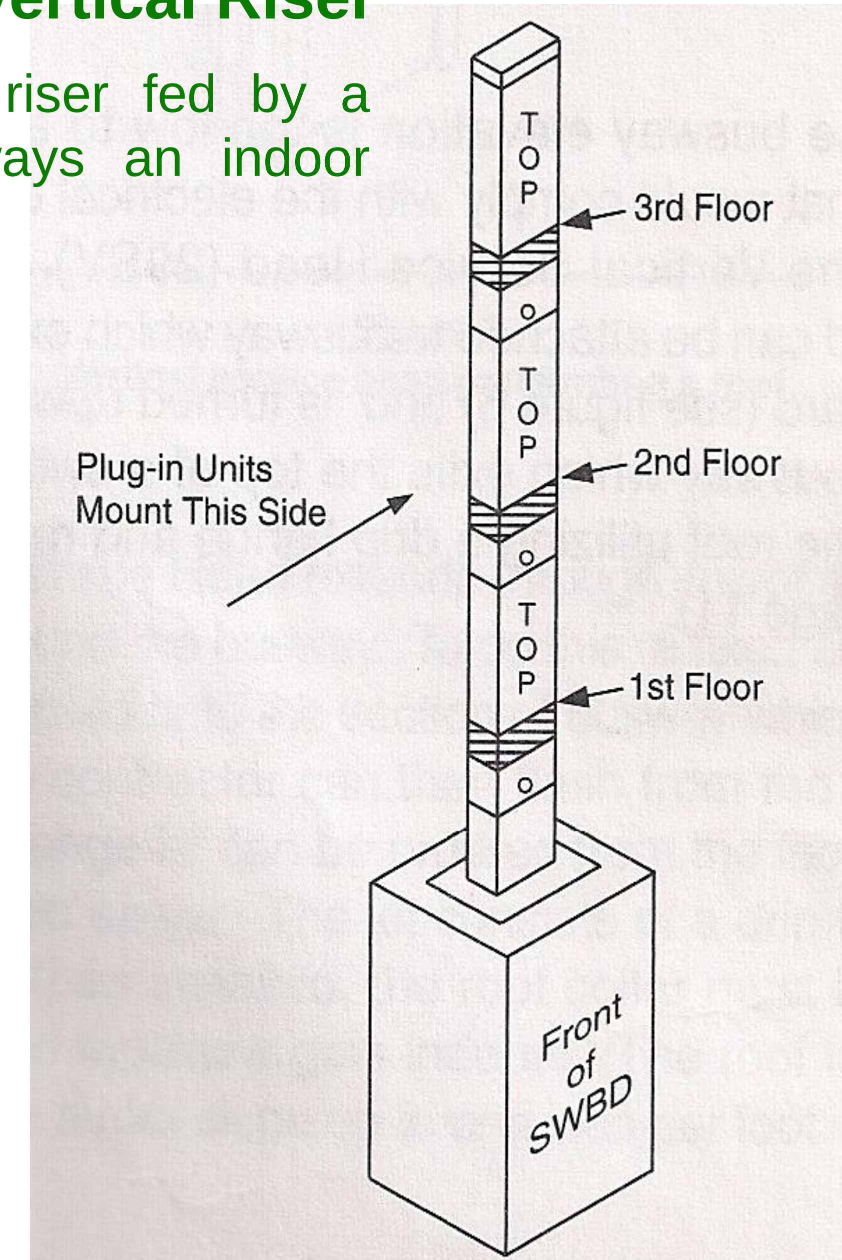
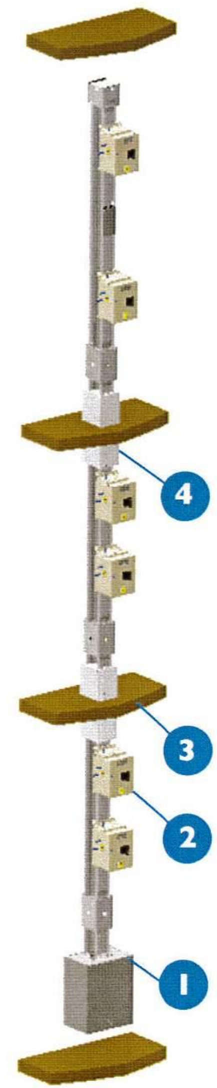
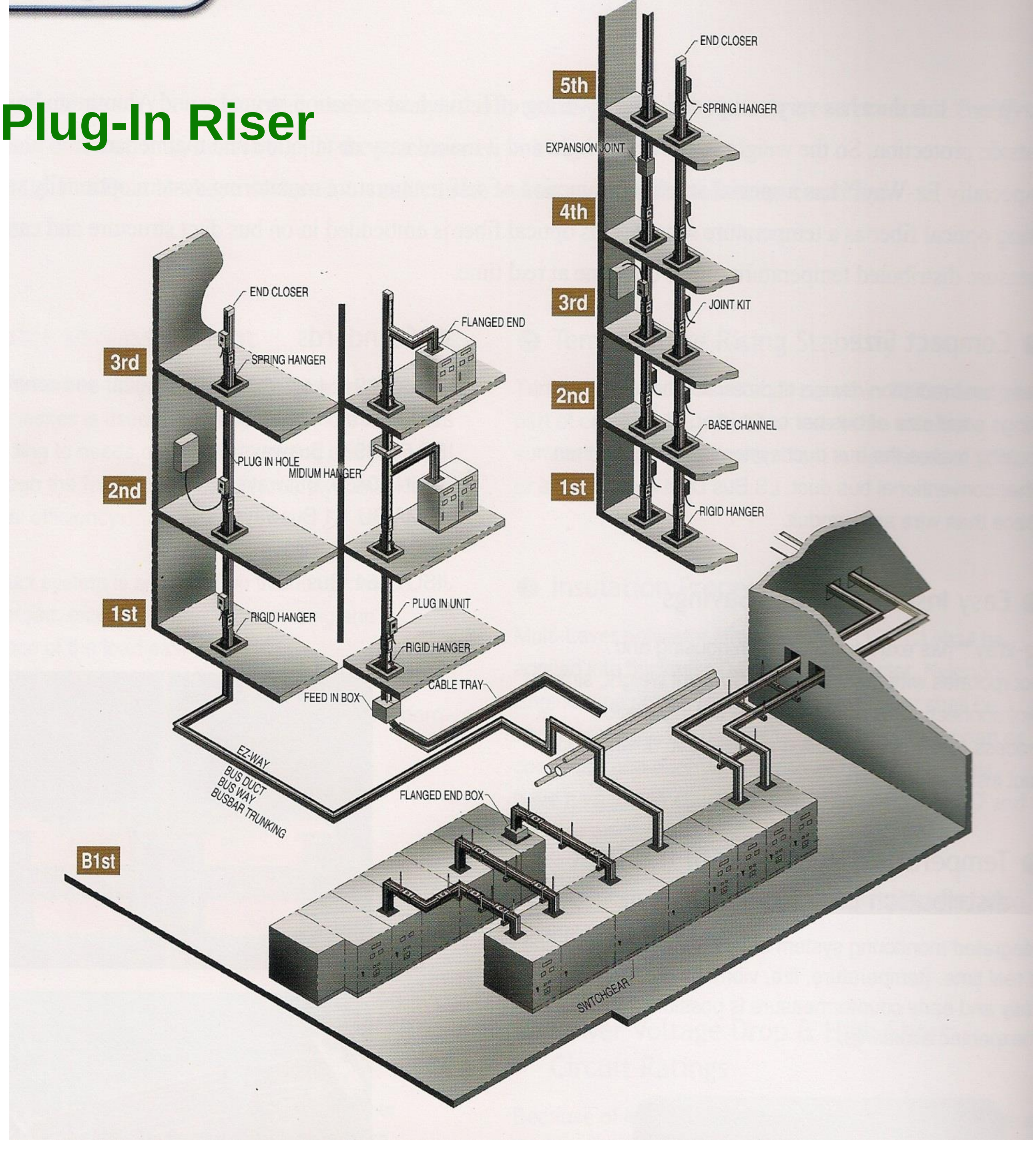


Figure 2:
Typical Busbar Riser Application



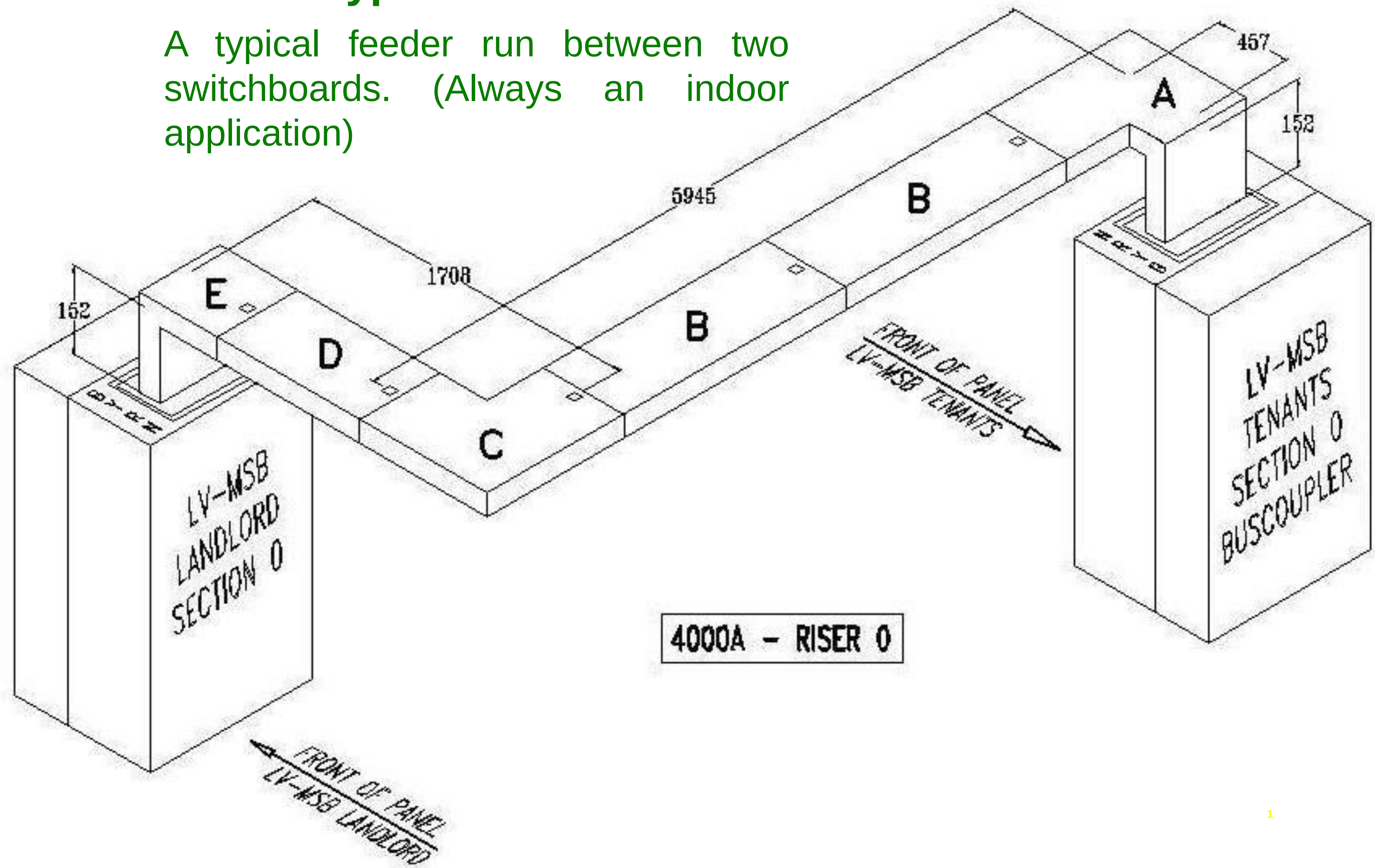
Key:
1 End feed unit
2 tap-off units
3 Floor
4 External fire barrier

Vertical Plug-In Riser



4 - Feeder Type Tie Run

A typical feeder run between two switchboards. (Always an indoor application)



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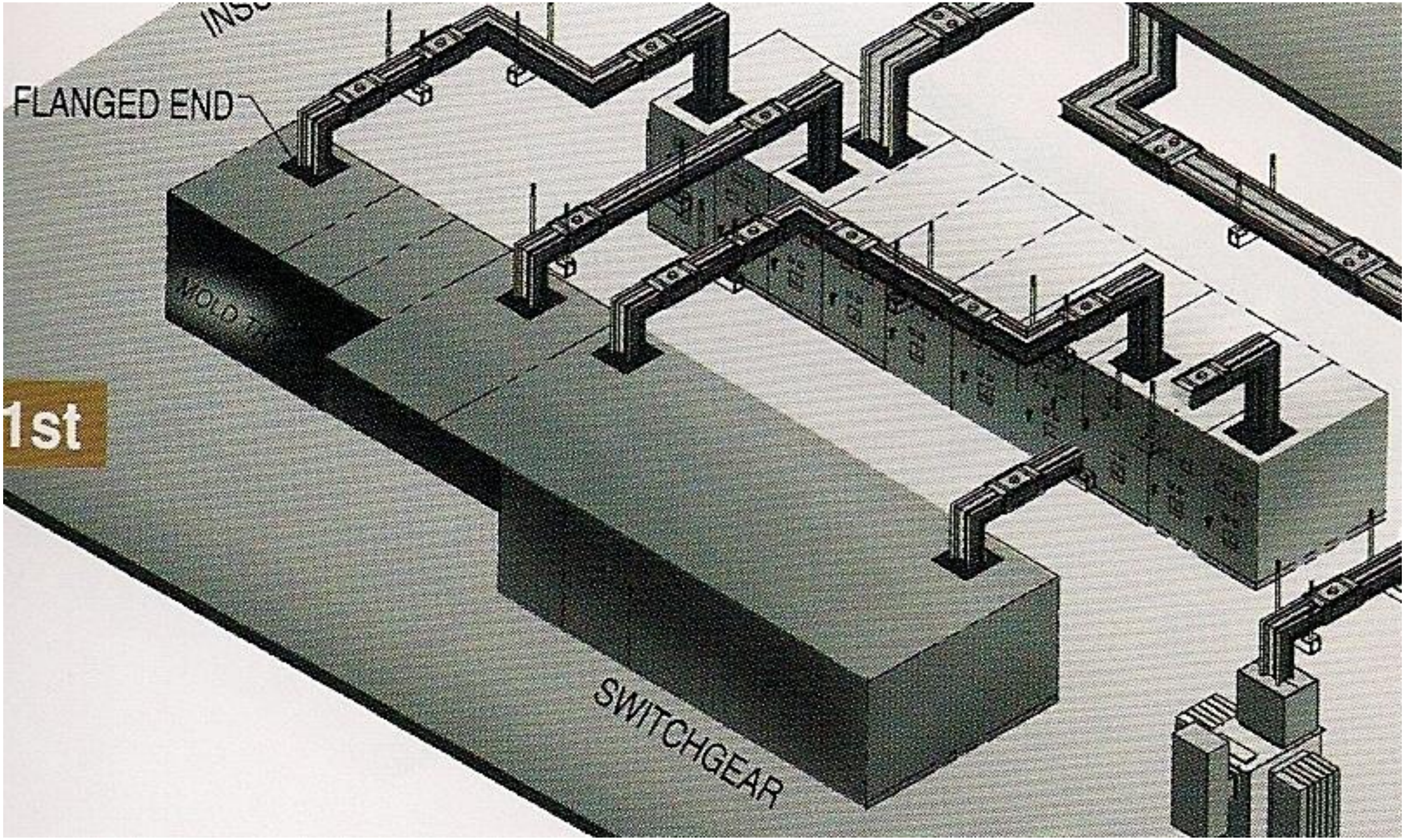
Feeder Type Tie Run



DESIGN GUIDE FOR BUSWAY

DESIGN ORDER:

1 - Determine the current rating (I_b)

2 - Choosing the busbar trunking rating

3 - Identifying the IPxx Protection

4 - Checking the rating with respect to allowable voltage drop

5 - Checking the rating with respect to short-circuit withstand current

6 - Protecting against bus bar trunking overloads

Determine the current rating (I_b):

Calculation of the total current (Ib) absorbed by a run is equal to the sum of the currents absorbed by all of the loads. The loads do not all operate at the same time and as they are not continuously at full load, a stacking or simultaneity factor Ks has to be taken into account:

$$Ib = \sum Ib\ load\ x\ Ks$$

Determining by equipment load, coefficient, Ks:

Application	Number of loads	Ks coefficient
Lighting, heating	-	1
Distribution of main circuits	2...3	0.9
	4...5	0.8
	6...9	0.7
	10...40	0.6
	40 and over	0.5

Caution: *for industrial installations, remember to take into account future increases in the number of machines. A 20 % reserve is recommended.*

Calculation of the total current (Ib) absorbed by one building is equal to the sum of the currents absorbed by all of the loads of all floors.
The floors do not all operate at the same time and, as they are not continuously at full loads, a stacking or simultaneity factor K_s and K_f has to be taken into account:

$$Ib_{floor} = \sum Ib\ load\ x\ Ks\ (as\ above$$

$$Ib = \sum Ib\ floor\ x\ K_f$$

Determining by the floor loads, coefficient, Kf:

Application	Kf coefficient
Apartments	1
Lighting for commerical using	0.9
Elevators and general service	0.7
conference rooms	0.6
Small office	0.5
Large office	0.4

Sample Busway Run in the following page, feeding 16 to 26 floor of the Building. The load per floor is typical.

$P_{TCL} = 126.25kW$

$$Ib = \sum Ib\ load\ x\ Ks$$

Load per floor : $$Ib = \frac{kW\ x\ 1000}{V\ x\ \sqrt{3}x\ p.f}$$

$$Ib = \frac{126.25\ x\ 1000}{400\ x\ \sqrt{3}x\ 0.8}$$

$$Ib = 228A$$

$$Ib = \sum Ib\ load\ x\ Ks$$

Ks @ 0.8 $$Ib = 228A\ x\ 0.8$$

$$Ib = 182.4A$$ Load per floor

$$Ib = \sum Ib\ floor\ x\ K_f$$

Kf @ 0.9 $$Ib = 182.4A \times 10 \times 0.9$$

$$Ib = 1642A$$ Total floor loads

Remember to take into account future increases of load. A 20% reserve is recommended

$$Ib = 1642A \text{ x } 1.2$$

$$Ib = 1970A$$

Selected BUSWAY rating is 2000A

2 - Choosing Busway Rating according to Nominal Current In

Nominal current In (A)	Busbar trunking rating
0 to 800	800
801 to 1000	1000
1001 to 1250	1250
1251 to 1350	1350
1351 to 1600	1600
1601 to 2000	2000
2001 to 2500	2500
2501 to 3000	3000
3001 to 3200	3200
3201 to 4000	4000
4001 to 5000	5000
5001 to 6000	6000

1st characteristic numeral: corresponds to protection of equipment against penetration of solid objects and protection of persons against direct contact with live parts.

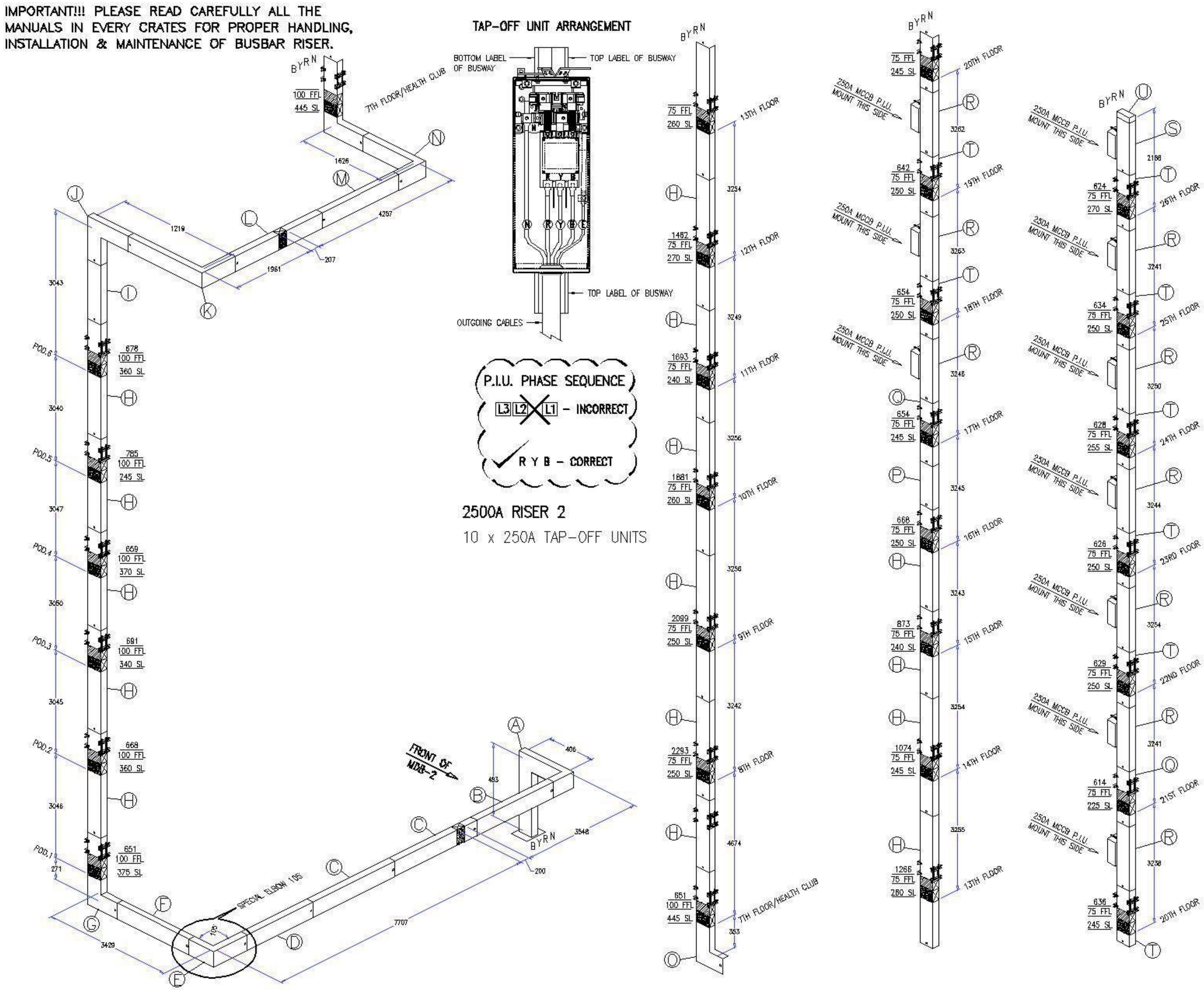
Protection of equipment	Protection of persons	
Non-protected.	Non-protected.	0
Protected against the penetration of solid objects having a diameter greater than or equal to 50 mm.	Protected against direct contact with the back of the hand (accidental contact).	1
Protected against the penetration of solid objects having a diameter greater than or equal to 12.5 mm.	Protected against direct finger contact.	2
Protected against the penetration of solid objects having a diameter greater than or equal to 2.5 mm.	Protected against direct contact with a 2.5 mm diameter tool.	3
Protected against the penetration of solid objects having a diameter greater than 1 mm.	Protected against direct contact with a 1 mm diameter wire.	4
Dust protected (no harmful deposits).	Protected against direct contact with a 1 mm diameter wire.	5
Dust tight.	Protected against direct contact with a 1 mm diameter wire.	6

2nd characteristic numeral: corresponds to protection of equipment against penetration of water with harmful effects.

Protection of equipment	
Non-protected.	0
Protected against vertical dripping water (condensation).	1
Protected against dripping water at an angle of up to 15°.	2
Protected against rain at an angle of up to 60°.	3
Protected against splashing water in all directions.	4
Protected against water jets in all directions.	5
Protected against powerful jets of water and waves.	6
Protected against the effects of temporary immersion.	7
Protected against the effects of prolonged immersion under specified conditions.	8

2 - Identifying the IPxx Protection

Sample plug-in riser busway design



CHECK THE BUSWAY RATING CONSIDERING VOLTAGE DROP requirement in the electrical system. ***(As general rule, voltage drop should not exceed 4% at the furthest outlet)***

Calculate the voltage drop based on the TOTAL Calculated load current, Ib

$$\mathbf{Ib} = 1970\text{A}$$

4 - Check the rating with respect to allowable VOLTAGE DROP

Voltage drop Considerations:

Transformer to MDB = 0.5%

MDB to Busway = 1.5 %

Busway to SMDB = 2.5%

SMDB to FDB = 3%

FDB to furthest load = 4%

$$VD_{avg} = k \times L \times \sqrt{3} \times I \times \left(R_{avg} \cos\theta + X_{avg} \sin\theta\right)$$

Where:

VD = voltage drop of the system (V)

I = Current of the system being considered

L = length of the busway being considered (meter)

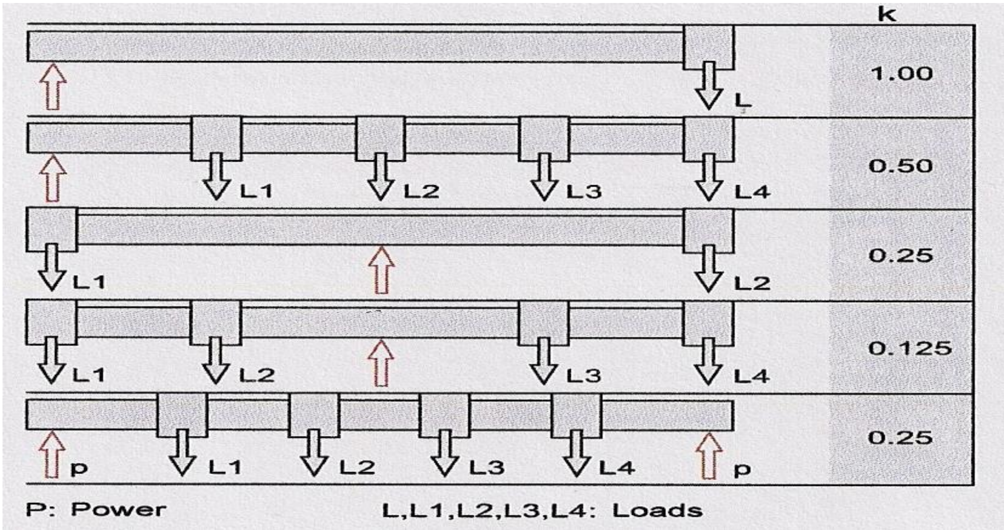
k = load distribution factor

Power factor, (p.f.) = 0.8

R = average resistance, ohms

X = average reactance, ohms

Load Distibution factor, K



Busway Impedance values

The published resistance is at the test ambient of 25°C. Therefore the resistance must be change due to increase in operating temperature from 80°C to 105°C

$R_{t2} = R_{t1} \times [1 + \alpha_{t1} \times (t2 - t1)]$, where

R_{t1}	is the known resistance of the conductor at temperature t1		
R_{t2}	is the desired resistance of the conductor at temperature t2		
a_{t1}	is the temperature coefficient of resistance at temperature t1		
t2	the desired temperature of the conductor		
t1	the known temperature of the conductor		
$a\alpha_{t1}$	0.00313	80	°C
	T_1=80°C	T2= 105°C	
	R_{t1}(mW/m)	R_{t2}(mW/m)	X_{avg}(mW/m)
800A	0.0567	0.0611	0.0280
1000A	0.0497	0.0536	0.0244
1200A	0.0357	0.0385	0.0192
1600 A	0.0268	0.0289	0.0155
2000A	0.0238	0.0257	0.0128
2500 A	0.0165	0.0178	0.0098

Concentrated Load, k factor = 1

$$VD_{avg} = k \times L \times \sqrt{3} \times I \times \left(R_{avg} \cos\theta + X_{avg} \sin\theta\right)$$

$$VD_{avg} = 1 \times 82.75\sqrt{3} \times 1970 \times \left(0.0000238x0.8 + 0.0000128x0.6\right)$$

$$VD_{avg} = 7.54V$$

Distributed Load, k factor = 0.5

$$VD_{avg} = 0.5x35 \times \sqrt{3} \times 1970 \times \left(0.0000238x0.8 + 0.0000128x0.6\right)$$

$$VD_{avg} = 1.6V$$

$$VD_{avg} = 7.54 + 1.6 = 9.14V$$

$$VD_{avg} = 7.54 + 1.6 = 9.14V$$

$$\%VD = \frac{9.14V}{400} \text{ x } 100\%$$

$$VD = 2.28\%$$

Therefore, 2000A busway does not meet the required voltage drop limit of1.5%

Check voltage drop using, 2500A

Concentrated Load, k factor = 1

$$VD_{avg} = k \times L \times \sqrt{3} \times I \times \left(R_{avg} \cos\theta + X_{avg} \sin\theta\right)$$

$$VD_{avg} = 1 \times 82.75 \times \sqrt{3} \times 1970 \times \left(0.0000165x0.8 + 0.0000098x0.6\right)$$

$$VD_{avg} = 5.4V$$

Distributed Load, k factor = 0.5

$$VD_{avg} = 0.5x35 \times \sqrt{3} \times 1970 \times \left(0.0000165x0.8 + 0.0000098x0.6\right)$$

$$VD_{avg} = 0.66V$$

$$VD_{avg} = 5.4 + 0.66 = 6V$$

$$\%VD = \frac{6}{400} \text{ x } 100\%$$

$$VD = 1.5\%$$

Therefore, 2500A BUSWAY IS THE CORRECT RATING

FACTORS AFFECTING BUSWAY RATING

- Ambient Temperature
- Temperature Rise

and

- Harmonics

• Ambient Temperature:

When busway are installed in locations that have temperature above 40° C, the busway should be de-rated in accordance with the manufacturers recommendations, if furnished, or the following table:

Ambient Temperature	Multiplier
40° C (104° F)	1.00
45° C (113° F)	0.95
50° C (122° F)	0.90
55° C (131° F)	0.85
60° C (140° F)	0.80
65° C (149° F)	0.74
70° C (158° F)	0.67

- **Temperature Rise:**

According to IEC 60439-2, standard. The maximum temperature rise within the busway should not exceed 55 deg.C rise above ambient temperature of 50 deg.C.

What is the effect in the busway, if the rise is 35 deg.C above 50 deg.C ambient temperature?

Busway De-rating Due To Temperature Rise

Busbar Trunking Derating Based on Square D Busway (I-Line II)

General

Maximum NEMA Design Ambient Temperature	40	°C
Maximum UL Design Temperature Rise of Bus Bar	55	°C
Maximum Total Temperature of Bus Bar - NEMA & UL	95	°C
Maximum Total Temperature of Bus Bar - Based on Insulation Materials		
	105	°C
Estimated Ambient Temperature	50	°C
Maximum Allowable Operating Temperature	35	°C

Since

From CDA Publication 22, June 1996 "Copper for Busbars", page 17
"Where a busbar system is to be used under new current or temperature rise conditions, the following formula can be used to find the new corresponding new temperature rise or current:"

$$\frac{I_1}{I_2} = \left(\frac{\theta_1}{\theta_2}\right)^{0.61} = \left(\frac{1+\alpha_{20}(T_2-20)}{1+\alpha_{20}(T_1-20)}\right)^{0.5}$$

"where,

I_1=	current 1, A
I_2=	current 2, A
$Ø_1$=	temperature rise for current 1, °C
$Ø_2$=	temperature rise for current 2, °C
T_1=	working temperature for current 1, °C
T_2=	working temperature for current 2, °C
α_{20}=	temperature coefficient of resistance at 20°C"

"If the working temperature of the busbar system is the same in each case (I.e., T1 = T2), for example when re-rating for a change in ambient temperature in a hotter climate, this formula becomes"

$$\frac{I_1}{I_2} = \left(\frac{\theta_1}{\theta_2}\right)^{0.61}$$

Re-Rating Calculations

Specific Applications

Example: For 2500 A busway:

$$I2 = I_1 \, (\varnothing_2|\varnothing_1)^{0.61}$$

$I_2 = I_1$ x[(35/55^0.61)]

$I_2 =$ 2500*(35/55)^0.61

$I_2 =$ 1898 A

Riser 1

Device Types	CRJ2525G	105	ft
	CFJ2525G	262.8	ft

Normal Current Rating	$I_1=$	2500	A
Normal Bus Bar Temperature Rise	$\theta_1=$	55	°C
Allowable Bus Bar Temperature Rise	$\theta_2=$	35	°C
Reduced Current Rating due to High Ambient	$I_2=$	1898	A

Heat Dissipation Calculations

Heat generated by a three phase electrical system is:

$$H = 3 \times I^2 R$$

where H is the heat generated by the system in Watts/m
I is the actual load current in Amps
R is the resistance of the conductor at the operating temperature, in this case 85°C in ohms

The published resistance is at the test ambient of 25°C. Therefore the resistance must be change due to increase in operating temperature from 80°C to 85°C

$R_{t2} = R_{t1} \times [1 + \alpha_{t1} \times (t2 - t1)]$, where

R_{t1} is the known resistance of the conductor at temperature t1
R_{t2} is the desired resistance of the conductor at temperature t2
α_{t1} is the temperature coefficent of resistance at temperature t1
t2 the desired temperature of the conductor
t1 the known temperature of the conductor

α_{t1}	0.00393	80	°C

	T_1=80°C	T2= 85°C	
	R_{t1}(mΩ/m)	R_{t2}(mΩ/m)	X_{avg}(mΩ/m)
1200A	0.0357	0.0364	0.0192
1600 A	0.0268	0.0273	0.0155
2000 A	0.0238	0.0243	0.0128
2500 A	0.0165	0.0168	0.0098
3000 A	0.0146	0.0149	0.0085

Example:	For 2500 A busway:		
R_{t2} =	0.0165*(1+0.00313(85-80))	mΩ/m	
	0.0168		
H=	3*2500^2*0.0168*0.001	Watts/m	Assuming 2500 A load.
H=	315.00	Watts/m	
H=	3*1230.5^2*0.0168*0.001	Watts/m	For specific load 1230 A
H=	76.25	Watts/m	
H=	76.25*(32+80.1)	Watts	for the entire busway Riser 1
	8,548	Watts	

<u>Formula for Current Load Based on Power Delivered</u>

$$I = \frac{P}{\sqrt{3} \times V \times \cos\phi}$$

where,

I =	the load current in amperes
P=	the power delivered
V=	the system phase to phase voltage
cosØ =	the power factor of the system

For Riser No. 1

P =	681.75	kW
cos Ø =	0.8	
V =	400	Vac
I =	(681.75*1000)/(sqrt(3)*400*	ampere
I =	1230.027	

1

Voltage Drop Calculations

Assuming 400 Vac source voltage.

The average phase to phase voltage drop for a given length at rated load current at a specfic load power factor is calculated using:

$$VD_{avg} = L \times \sqrt{3} \times I \times \left(R_{avg} \cos\theta + X_{avg} \sin\theta \right)$$

where,	L=	the length of the run in meters
	I =	the load current in amperes
	Ravg =	the average 3Ø, Ø to N resistance in ohms per meter
	Xavg =	the average 3Ø, Ø to N reactance in ohms per meter
	θ =	the load power factor angle

Example:	For 2500 A busway, Riser 1:	
	VDavg=	(32+80.1)*SQRT(3)*1230.027*(0.0168*0.001*0.8+0.0098*0.001*SIN(ACOS(0.8)))
	%(Vdavg)=	9.96/400

Riser No. 1		Rated Current of Proposed Busway		**2500**	**ampere**			
P =	681.75	kW		Device Type	Length			
cos Ø =	0.8			CRJ2525G	105	ft	32.0	m
V =	400	Vac		CFJ2525G	262.8	ft	80.1	m
I =	(681.75*1000)/(sqrt(3)*400*0.8)				Maximum Temperature Rise			
I =	1230.026706	ampere		Loading	Bus Bar		Housing	
				Rated Full Load	51		34	
H=	76.36	Watts/m		Actual Load	15.944		10.6	
H=	8,561	Watts						
		for the entire busway Riser 1						
Distributed Load								
VDavg=	2.03	volts						
VDavg=	2.03*0.5							
VDavg=	1.02		Distributed Load					
Concentrated Load								
VDavg=	5.09	volts	Concentrated Load					
VDavg=	1.02 + 5.09							
VDavg=	6.11	volts						
%(Vdavg)=	1.53%	for the entire busway Riser 1						1

- HARMONIC CURRENTS

In installation with a distributed neutral, non-linear loads may cause significant overloads in the neutral conductor due to the presence of THIRD-ORDER HARMONICS.

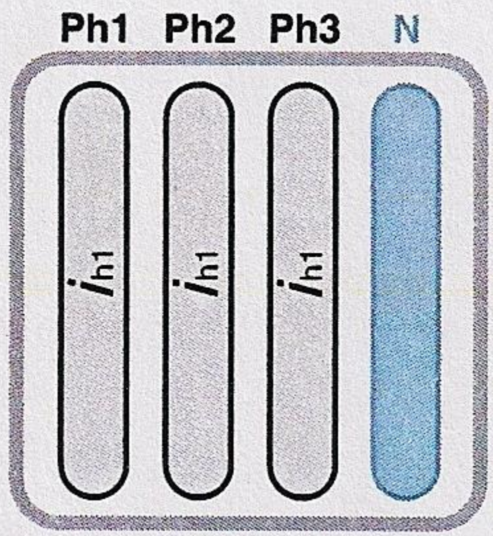
By definition, the fundamental f1 is order 1 (H1)

Third-order harmonics (H3) have a frequency if 150Hz (when f1 = 50 Hz.)

The presence of third-order harmonics depends on the applications involved.
It is necessary to carry out an in-depth study on each non-linear load to determine the level of H3:

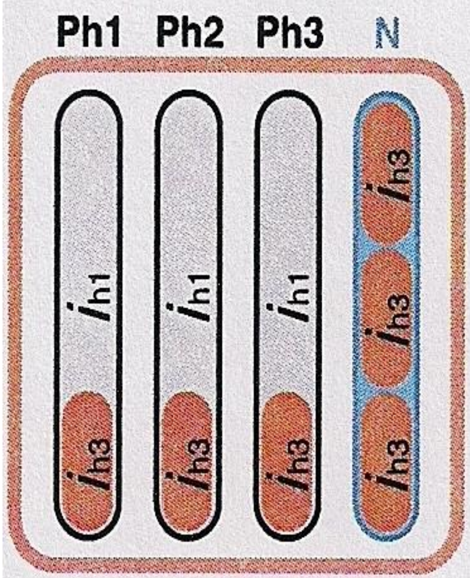
iH3 (%) = 100 x i3 /i1

- i3 = rms current of H3
- I1 = rms current of the fundamental



Fundamental frequency: ih1 (50 Hz)

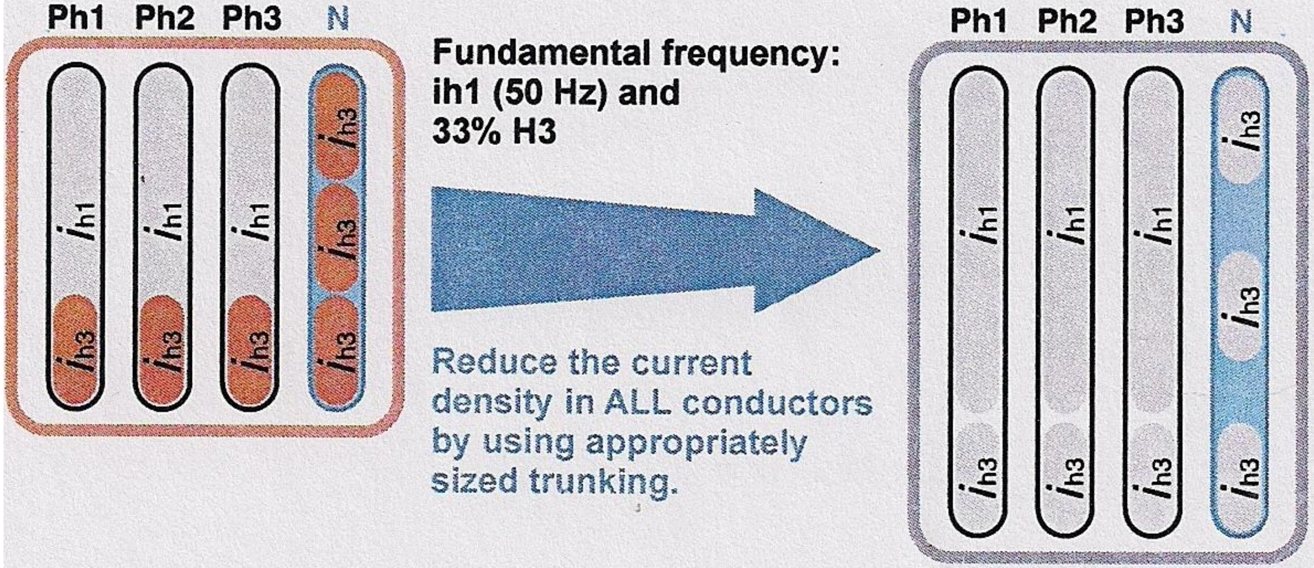
No current in the neutral.
The conductors are correctly sized.



Fundamental frequency: ih1 (50 Hz) and 33% of H3

Abnormal temperature rise in the conductors caused by current at a higher frequency in the phases (skin effect) and current in the neutral caused by summing of the H3 harmonics.

The only effective solution



Busbar-trunking selection

THD ≤ 15 %	15 % < THD ≤ 33 %	THD > 33 %	Busbar trunking	Rating (A)
800	630	400	I-LINE II	800
1000	800	630	I-LINE II	1000
1350	1000	800	I-LINE II	1350
1600	1350	1000	I-LINE II	1600
2000	1600	1350	I-LINE II	2000
2500	2000	1600	I-LINE II	2500
3000	2500	2000	I-LINE II	3000
4000	3000	2500	I-LINE II	4000
5000	4000	3000	I-LINE II	5000
6000	5000	4000	I-LINE II	6000

Example. For a total rms current of 2356 A, (estimation based on power drawn by loads, including harmonics), the operational current is 2500 A.
THD is estimated at 30%. The appropriate trunking is I-LINE II 3000 A.

Short-circuit current at LV side of Transformer

Example:

Transformer rating - 1500kVA
Voltage - 11 / 0.4 kV
% Impedance (Z) - 6
p.f. - 0.8

$$I_{SC} = \frac{kVA\ x\ 100}{400\ x\ \sqrt{3}\ x\ \%Z}$$

$$I_{SC} = \frac{1500\ x\ 100}{400\ x\ 1.732\ x\ 6}$$

$$I_{SC} = 36\ kA$$

5. CHECK THE SHORT-CIRCUIT CURRENT WITHSTAND

Check from the technical catalogue of busway manufacturer the short-circuit withstand of 2500A.

Square D Busway short-circuit withstand.

Icw (t = 1second) = 80kA

Ipk = 198 kA

Maximum short-circuit at the secondary of Transformer is 36kA. Therefore, 2500A busway short-circuit rating, 80kA is far higher. Selection is justified.

6. Protecting against busbar trunking overloads

The busbar trunking is generally protected at its nominal current **Inc** or its allowable **Iz** if the ambient temperature coefficient k1 is applied.

- Circuit breaker protection:
  - Adjust **Ir** of the circuit breaker such that:

$$I_z = I_b \times k1 \leq I_r \leq I_{nc}$$

Circuit Breaker Protection

Determination of design current, I_{MD} considering 20% future load.

$$P_{TCL} = 126.25kW$$

$P_{MDL} = P_{TCL}$ x floor load diversity x Busway diversity

$$SMDB_{Diversity} \text{ per floor} = 0.6$$

$$BUSWAY_{Diversity} = 0.9$$

$$P_{MDL} = 126.25 \times 0.6 \times 0.9 \times 10 \text{ floors}$$

$$P_{MDL} = 681.75kW$$

Circuit Breaker Protection

$$I_{MDL} = \frac{P_{MDL}}{\sqrt{3} x\ V\ x\ pf}$$

$$I_{MDL} = \frac{681.75\ x\ 1000}{\sqrt{3} x\ 400\ x\ 0.8}$$

$$I_{MDL} = 1230\ A$$

Considering 20% future load

$$I_{MDL} = 1230\ A\ \times\ 1.2$$

$$I_{MDL} = 1476\ A$$

Selection of protective device having nominal current rating or setting, In

- Adjust **Ir** of the circuit breaker such that:
- **Iz** = **Ib** x k1 ≤ **Ir** ≤ **Inc**

In = 1600A

Use: 1600A ACB

Circuit breaker protection allows busway to be used at full capacity because the standardized nominal current I_n of the circuit breaker is $I_n \leq I_{nc}/k2$ where is $k2=1$.

How To Do A Busway Take-off From Blueprints

The following guidelines allow you to perform a busway take-off

1. First check the drawing list to confirm you have all the drawings for a complete take-off in the field. Generally, you will need the structural and mechanical drawings to confirm busway run has no obstruction along its route.

2. Carefully read the specifications and note any variations. If there are discrepancies between what is specified and what can be provided, the final quotation must list the exceptions.

3. Check the single line diagram and count the number of busway runs. If the voltage, ampacity, and run designations are stated, list these items. Ensure that the bill-of-material is complete.

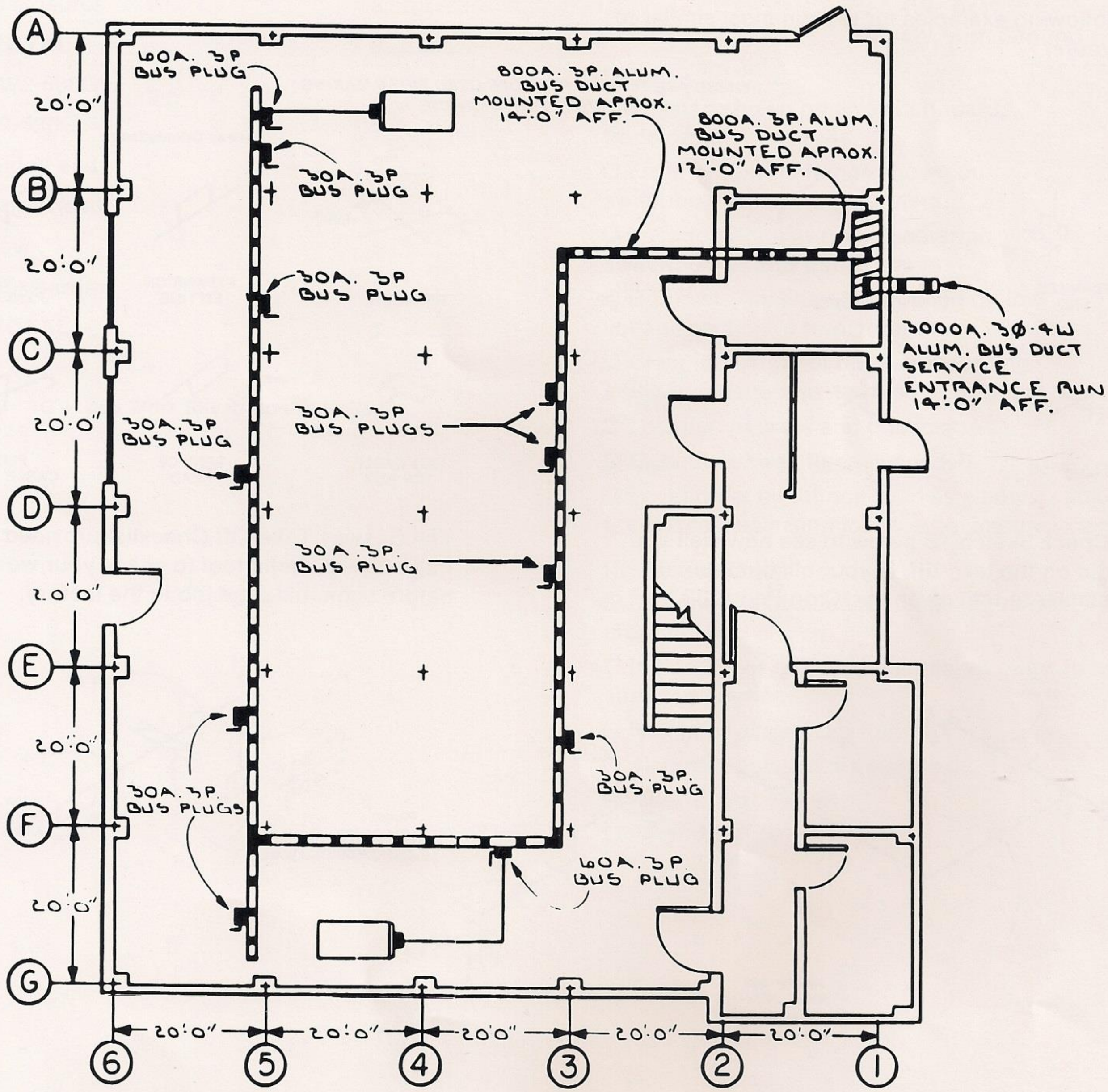
4. If multiple busway runs are shown on each drawing and are continued on subsequent drawings, a complete run-by-run take-off is recommended. Check the scale on each drawing and detail, sometimes they vary.

5. To obtain the busway footage and the number of fittings (i.e. elbows, flanged ends, wall flanged, etc.):
   a. Measure the footage of the busway by scaling to centerline of the busway and fittings.
   b. If time permits, a simple sketch of each busway run is very helpful. Reference dimensions from known column lines to the busway and show them on your sketch, also note the busway elevation.
   c. List the number of fittings for each busway run. ***Be careful when crossing a building expansion joint to include the additional footage.***

6. Once all the busway runs have been grouped according to ampere ratings, the busway footage pricing and busway fittings charges can be utilized to obtain the busway cost.

7. If busway tap boxes and overcurrent devices are not listed as per the take-off, review the drawings carefully and ensure to include these items to complete the list. If prices not available, send inquiry to manufacturer.

Example-1 in the following page illustrates a simple take-off. As previously mentioned in 5(b), a sketch of the busway run being taken off is helpful.



Example 1 - Typical Customer Drawing For A Plug-In Bus Run

NOTE: The switchboard is 7' - 0" high. "AFF" means "above finished floor" due to reproduction error, the drawing is not to scale. Use the columns to approximate the distances.

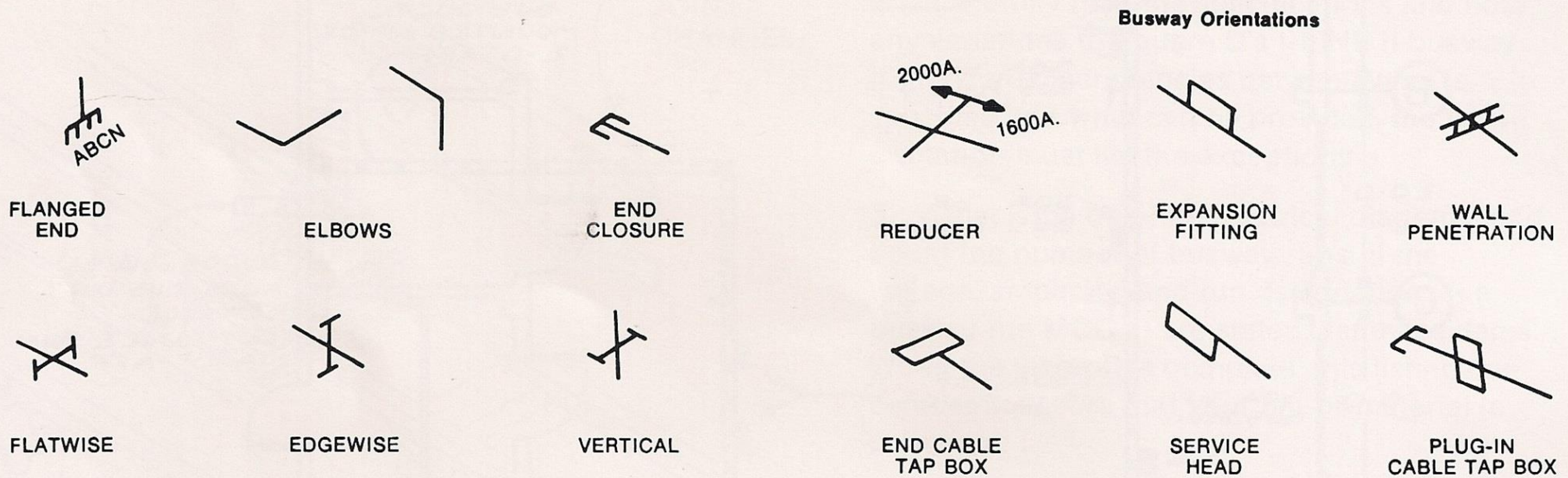
How To Make A Shorthand Drawing (Single line type)

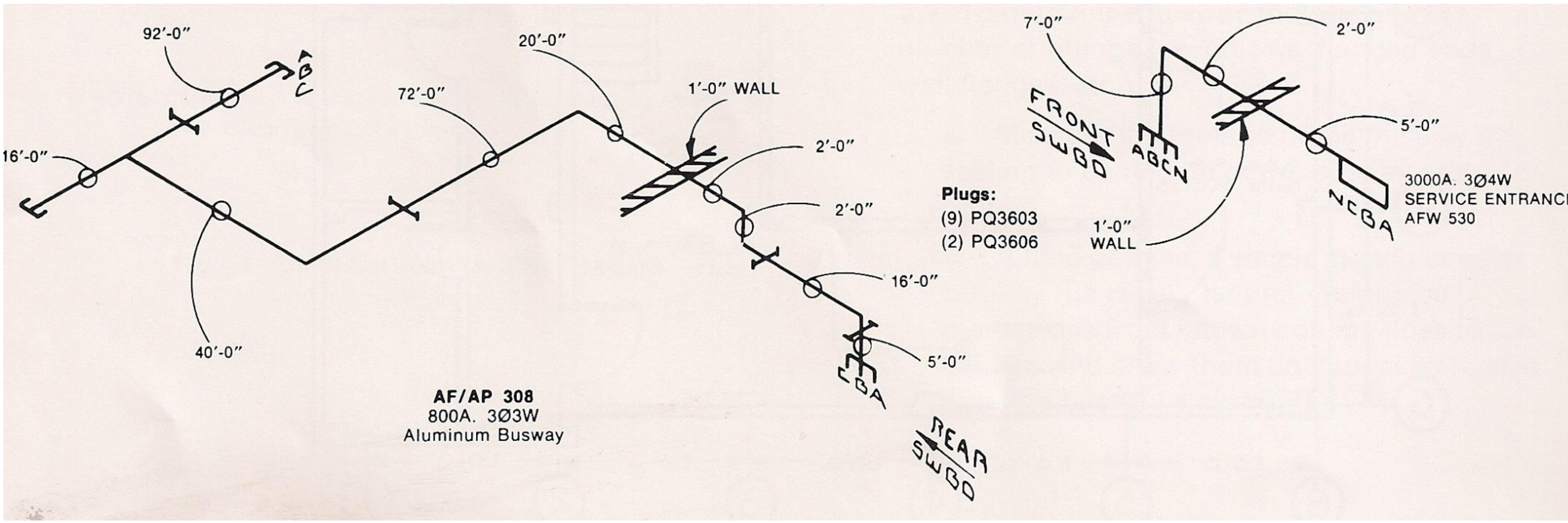
After the take-off has been made, a sketch of the run should be made. Single line drawings are the easiest way to illustrate a run. Remember that you should provide the factory with all pertinent information. The procedure is as follows:

1. Select the type of device you will need to draw (see next pages)

2. Check “Typical single line sketch” in the following examples for the run most similar to yours.

THESE ARE TYPICAL SYMBOLS USED WHEN MAKING A SINGLE LINE DRAWING





1B - Typical Single Line Sketch of Plug-In Run

3. Draw your run. Be sure to label each run and show cross section where applicable

4. Show the phasing at each of the run

5. Show the location of each type of busway (i.e. location of weather proof and plug-in busway)

6. Indicate the quantity and, if necessary, location of plugs.

Busway Take-Off Checklist

I.

- ❑ Ampere rating - 225 Thru 5000A
- ❑ Type of Busway - Plug-In: Std or High Short-circuit bracing
- ❑ Feeder : Indoor or weather proof
- ❑ Busbar Material - Copper
  Aluminum
- ❑ Number of Poles - 3θ, 3W. or
  3θ, 3W. With Ground
  3θ, 4W. or
  3θ, 3W. With Ground

II.

- Phasing shown on all switchboards, transformers and runs.
- Front or rear markings shown on switchboard and transformers.
- Location of busway runs entering switchboards and transformers.
- Complete dimensions supplied on low voltage section of transformer.
- Clear indication of busway mounting positions (edgewise, flatwise or vertical)

- Location of walls and thicknesses.
- Quantity of wall flanged needed.
- Location of all fittings such as elbows, cable tap boxes, expansion joints, tees and reducers.
- Complete dimensions supplied on low voltage section of transformer.

III. Risers Only

- ❑ Designation of side that plugs are to be mounted on.
- ❑ Indication of type and quantity of plugs to be supplied per floor.
- ❑ Height of Plugs from floor.
- ❑ All closet dimensions supplied.
- ❑ Floor slab thickness.

Helpful Hints To Layout And Measure A Busway Job

Laying out and measuring a busway job does not require specialized tools or skills. The following list of tools should handle all applications:

30 meter tape measure	Plumb bob/chalk line
7meter x 25mm tape measure	Felt tip marker or crayon
6ft-wood rule.	

Let us assume our customer wants to feed a new MCC with busway from a new distribution switchboard. Using illustrations, we will go step-by-step through the layout process to determine the busway orientation and dimensions. When completed, we will have a single line isometric drawing showing the proposed busway layout.

Known Information

- Busway rating, system 3ph, 4wire full neutral with ground bar
- Switchboard details, i.e. height, depth and busway location on top of the cubicle.
- MCC details, i.e. height with additional pull box, depth and connection at top center.
- Bottom of busway (BOB) to be illustrated above finished floor unless obstructed.

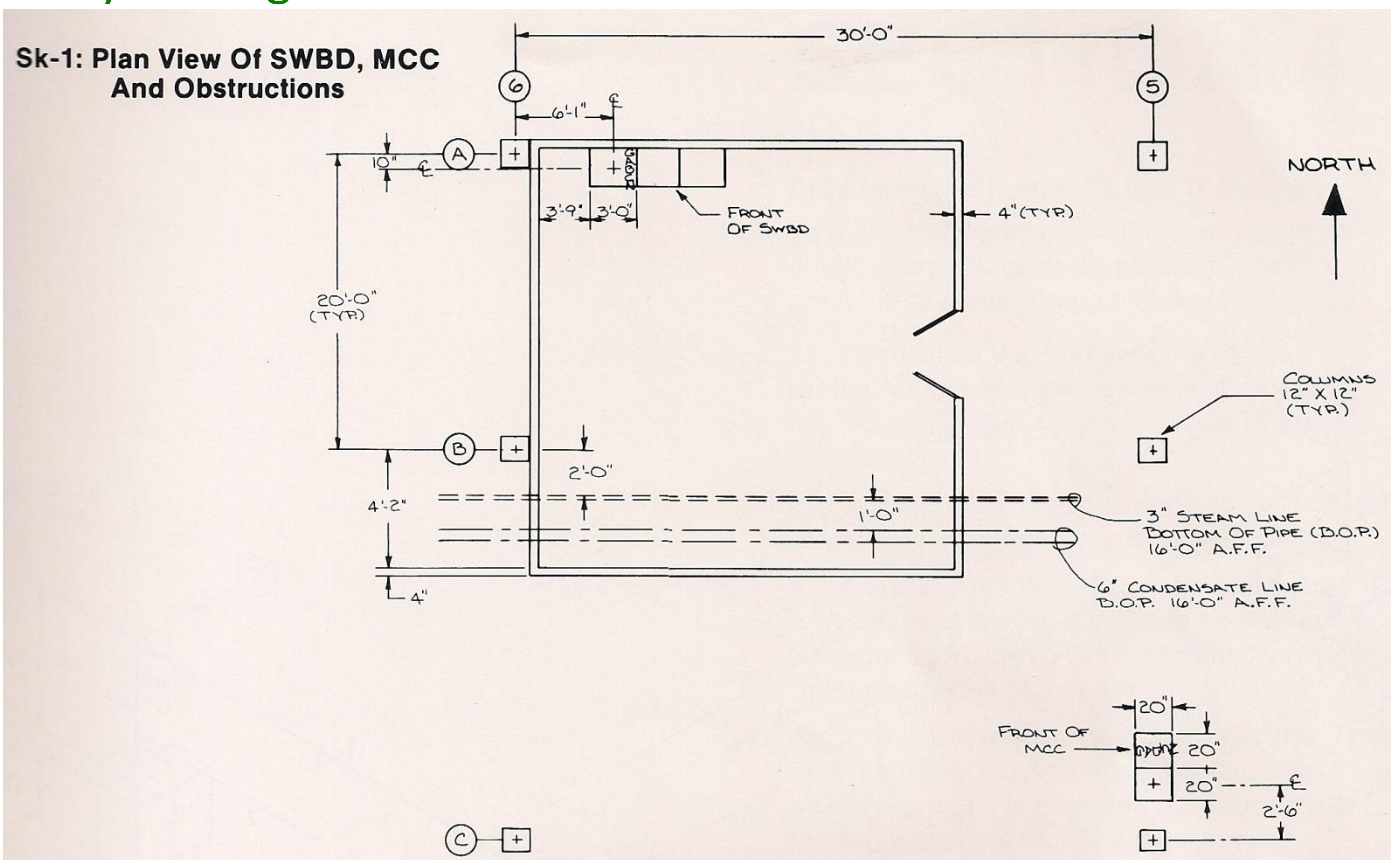
How To Begin

1. Determine the physical size of the busway housing.
2. Review the area where the busway could be installed (if not already specified). Note any special conditions such as building expansion joint, steel changes, plumbing, HVAC equipment, etc.

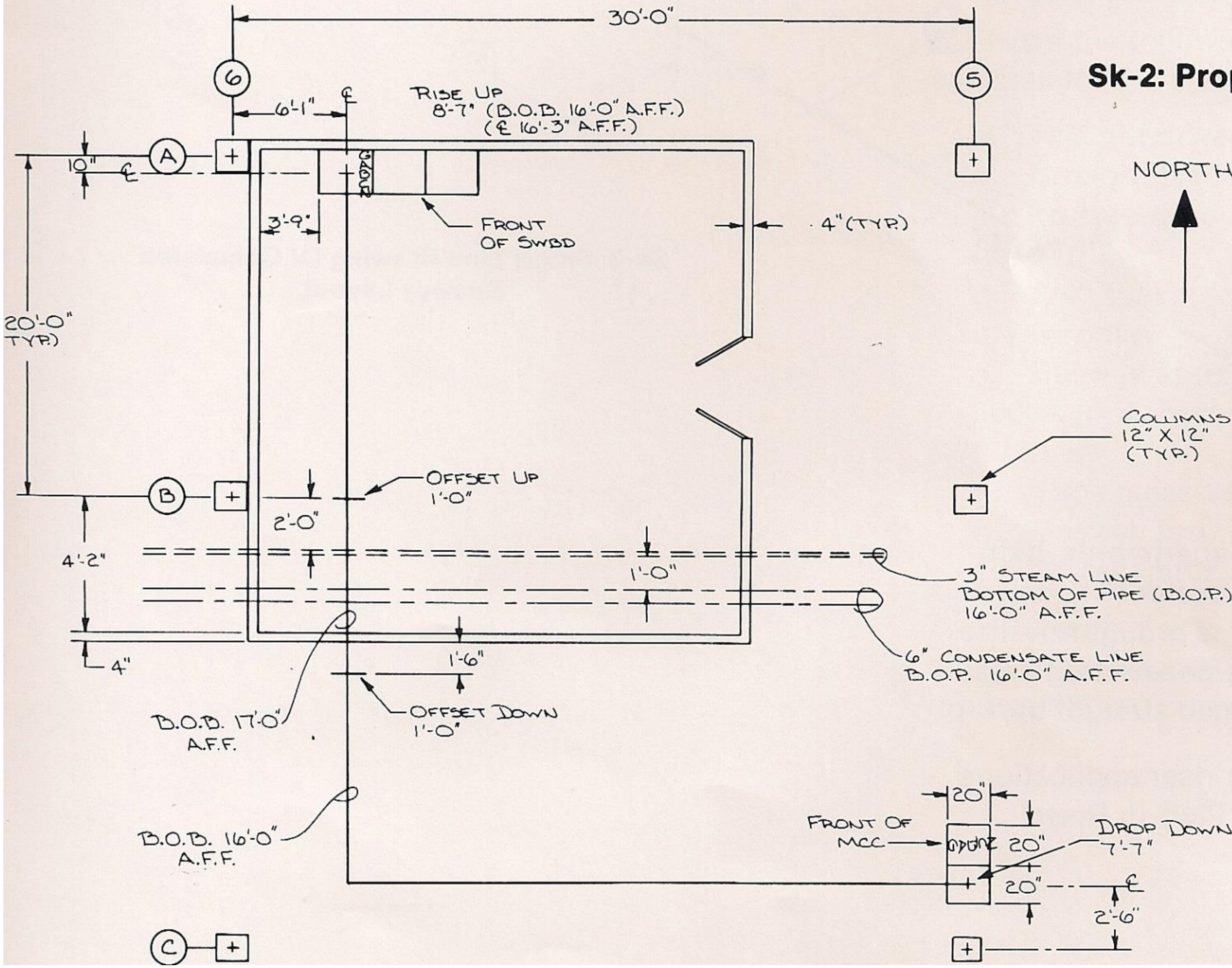
3. All dimensions should be measured from fixed points such as; columns and walls or other building structures. Try to leave 100mm clearance between busway and obstructions.
4. If busway originates from a SWBD, start dimensional layout from the fixed end.
5. Unless specified, for most industrial applications the busway should run above the bottom chord of the building steel. This will protect the busway from damage by fork-lifts or other equipment. Do not route the busway where it cannot be supported. Note that busway must be supported by drop rods.
6. When selecting the elevation for plug-in busway, remember that the over current device (plug-in units) require different mounting clearances.

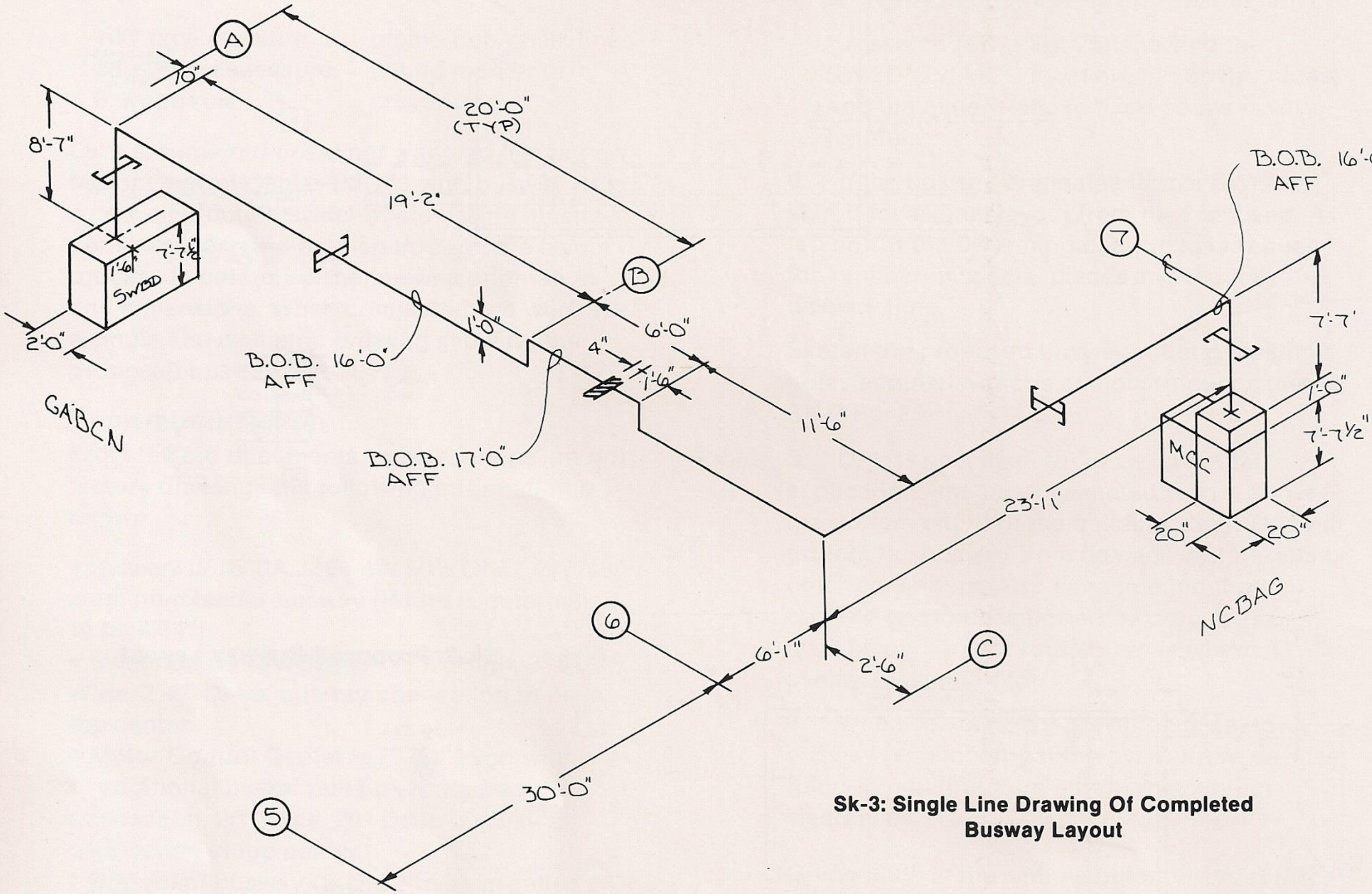
From the sample busway layout (Sk-2) enough information is known to tabulate the amount of busway footage needed and the required fittings (i.e. flanged ends, elbows, etc.)

Sketch, Sk3 on the following page represents a typical dimensioned one-line drawing from which the customer could confirm the busway dimensions and the busway routing.



Sk-2: Proposed Busway Layout





Sk-3: Single Line Drawing Of Completed Busway Layout

Busway Take-Off Sheet

Feedder Busway - 2000A

Nr.	Item Description	Quantity
1.	Flanged end	2
2.	Elbow 90° C	7
3.	Feeder Busway	945” or 78’-9”
4.	Horizontal Hanger	18
5.	Vertical Hanger	nil

Thank You!