## SECTION 10

## TRANSFロRMER INSTALLATIロNS

## Transformers - General

Our general policy on transformer sizes and types are listed on page $10-3$ and our general policy on U/G vs. O/H and services voltage is discussed on page 1-1. We have now standardized on a low loss transformer design as dictated by our high cost of generation (re losses) and in keeping with international environmental and energy conservation standards.

The low loss transformers are heavier because of the increase in the amount of core steel and winding material required to reduce losses; however, to compensate for this we have reduced the recommended size for three phase banks and will encourage U/G wherever possible.

## Calculating Transformer Loads

The KVA and/or Amperes load is calculated, for any voltage, using the following formulae:-
(a) Single Phase

KVA $\quad=\quad \frac{\text { Amperes } x \text { Voltage }}{1000}$
Amperes $=\frac{\text { KVA x } 1000}{\text { Voltage }}$
(b) Three Phase

KVA $=\frac{\sqrt{3} \times \text { Amperes } x \text { Voltage }}{1000}$
Amperes $=\frac{\text { KVA } x ~ 1000}{\sqrt{3} \times \text { Voltage }}$

| Transformer - Full Load Amperes |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Single Phase |  |  | Three Phase |  |  |  |  |
| KVA | Amperes |  | KVA | Amperes |  |  |  |
|  | H.V. | $\mathbf{2 4 0 V}$ |  | H.V. | $\mathbf{2 4 0 V}$ | $\mathbf{2 0 8 V}$ | 480V |
| 10 | 1.4 | 42 | 75 | 3.5 | 180 | 208 | 90 |
| 15 | 2.1 | 63 | 112 | 5.2 | 269 | 311 | 135 |
| 25 | 3.5 | 104 | 150 | 7.0 | 361 | 416 | 180 |
| 37.5 | 5.2 | 156 | 225 | 10.4 | 541 | 625 | 271 |
| 50 | 7.0 | 208 | 300 | 14.0 | 722 | 833 | 361 |
| 75 | 10.4 | 312 | 500 | 23.0 | 1203 | 1388 | 601 |
| 100 | 14.0 | 416 | 750 | 35.0 |  |  | 902 |
| 167 | 23.0 | 696 | 1000 | 46.0 |  |  | 1203 |
| 250 | 35.0 | 1042 | 1500 | 69.0 |  |  | 1804 |
| 333 | 46.0 | 1388 | 2000 | 92.0 |  |  | 2406 |

## Three Phase: Open Wye - Open Delta

 NO NEW INSTALATIONS MAINTENANCE ONLYMany of our services consist of a large single-phase load (120/240V) and a small three-phase load ( 240 V ); these are normally serviced with a two transformer, three-phase bank (closed delta, open delta). Both transformers carry the three-phase load and one carries the single-phase load. When using a open wye, open delta, each transformer is required to carry $58 \%$ of the three phase load. The transformers are normally referred to as the power transformer (carries three phase load only- smaller transformer and the lighting transformer (carries single phase load in addition to the three phase load - larger transformer).

For example, if a service is required to carry a single phase load of 28 KVA and a phase load of 11 KVA , the required transformer sizes are:-

|  | Large TFMR | Small TFMR |
| :--- | :---: | :---: |
| Single Phase | 28 KVA | - |
| Three Phase (0.58 x 11) | 6.4 KVA | 6.4 KVA |
| Total Load | 34.4 KVA | 6.4 KVA |
| Actual TFMR SIZE | 37.5 KVA | 10.0 KVA |

Another example - assuming a three-phase load requirement (customer) of 203 amperes, 37 amperes and 203 amperes, the transformer sizes can be determined as follows:
(a) The three phase load is 37 amperes;

$$
\mathrm{KVA}=\frac{\sqrt{ } 3 \times \text { amperes } \mathrm{x} \text { voltage }}{1000}=\frac{\sqrt{ } 3 \times 37 \times 240}{1000}=15.4
$$

When using two transformers the requirement is $0.58 \times 15.4 \mathrm{KVA}=8.9 \mathrm{KVA}$ for each of the two transformers. Therefore a 10 KVA is adequate for the power transformer.
(b) The single-phase load is 203 amperes, less the three-phase load of 37 amperes (203 $37=166$ amperes).

$$
\mathrm{KVA}=\frac{\text { amperes } \mathrm{x} \text { voltage }}{1000}=\frac{166 \times 240}{1000}=39.8
$$

(c) The lighting transformer size is now:- Single phase - 39.8 KVA, plus three phase $8.9 \mathrm{KVA}=48.7 \mathrm{KVA}$.

The power transformer (three phase) size is $10 \mathrm{KVA}(\mathrm{load}=8.9 \mathrm{KVA})$ and the lighting or load transformer size if $50 \mathrm{KVA}(8.9 \mathrm{KVA}+39.8 \mathrm{KVA}=48.7 \mathrm{KVA})$.

Since our smallest size transformer is 15 KVA (there may be some older 10KVA's available) we will have to use a 15 KVA for the power transformer; a 50 KVA transformer is satisfactory for the lighting load, however, if additional capacity is required for growth, a 75 KVA will have to be used - now our bank size is a 15 KVA and a 74 KVA .

When calculating the load (KVA) for an existing three-phase (two transformer) bank, use the lighting transformer leg with the higher ampere reading.

## Locating Transformers on the Pole

The location of the transformer(s) on certain structures has an effect on the integrity of structure. Large single-phase transformers should never be placed on the side of a structure but rather on the front of the structure; the location of small transformers is not so important.

The overturning moment resulting from installing the transformer on the side of a pole is substantial; the resulting moment from a 167 KVA transformer Is equivalent to the pressure of a 45 MPH wind on a single phase structure with $2 / 0$ conductor. Unlike wind the overturning moment due to the transformer is continuous and in most cases will cause the pole to lean which in turn will increase the overturning moment.

In some cases where the transformer tank is long or the space on the pole is not as per standards, we may want to lower the transformer location; the overturning moment can be minimized by installing the transformer off line, enough to clear the neutral or the neutral and secondary conductors. The clearance from the transformer tank to the neutral can be minimal as both are at ground potential; however the clearance from the transformer tank to the secondary conductors must be a minimum of 6 inches. With guyed structures (type B) it is normally quite practical to lower the transformer location and maintain the required clearance to the secondary conductors.

The bottom of the transformer shall not be less than $24^{\prime} 0^{\prime \prime}$ from the ground on any structure with communication attachments.

It is a good practice to use only type "A", "B" and "DE" structure types for transformer installations. The installation of transformers on structures type "DV" structures require working around working clearances, guys, cutouts, etc and not recommended.

It is also a good practice to minimize the number of HV connections at a structure; limit the structure to either a HV tap or transformer(s), preferably not both. Although we cannot determine the location of a primary tap, we normally have alternatives for the transformer location, particularly single phase installations.


## Transformer Types

Our specifications call for an internal arrester in all pole-mounted transformers. We do however have number of older transformers with no internal arrester; these transformers will require an external lightning arrester. All pad-mounted transformers will be protected by a lightning arrester at the cable dip.

The standardized size and type of single-phase transformers are:

| Single Phase Transformers <br> SIZE (KVA) TYPE AND VOLTAGE |  |  |  |
| :---: | :---: | :---: | :---: |
| Pole Mounted Transformers |  |  | Padmount <br> Transformers |
| $\mathbf{1 2 0 / 2 4 0 V}$ | $\mathbf{2 2 7 / 4 8 0 V}$ | $\mathbf{1 2 0} / \mathbf{2 0 8 V}$ | $\mathbf{1 2 0 / 2 4 0 V}$ |
| 15 |  |  | 25 |
| 25 | 25 | 25 |  |
| 37.5 | 37.5 | 37.5 |  |
| 50 | 50 | 50 | 50 |
| 75 | 75 | 75 | 75 |
| 100 | 100 | 100 | 100 |
| $* 167$ |  |  | 167 |
| $* 250$ |  |  | 250 |

*Existing but not recommended for future Three Phase banks.

| Three Phase Dead Front - Pad Mounted Transformers <br> SIZE (KVA) TYPE AND VOLTAGE |  |  |
| :---: | :---: | :---: |
| $\mathbf{2 4 0 / 1 2 0}$ Volt For <br> Maintenance only | $\mathbf{1 2 0 / 2 0 8}$ Volt | $\mathbf{2 7 7 / 4 8 0}$ Volt |
| Loop | Loop | Loop |
| - | 75 | - |
| 225 | 225 | 225 |
| 300 | 300 | 300 |
| 500 | 500 | 500 |
|  |  | 1000 |
|  |  | 1500 |
|  |  | 2000 |

## TRANSFORMER INSTALLATIONS

Our overhead three phase transformer bank installations will generally be limited to 300 KVA (3100 KVA's); Open delta banks should be limited to 167 KVA for the lighting transformer.

Pad mounted transformers will generally be used for all three phase loads of 300 KVA and larger; $120 / 208 \& 240 / 120$ volt services are limited to 500 KVA. Our preferred voltage for three phase services, 300 KVA and larger 277/480 volt.

| Transformer Lead Size |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Transformer <br> Rating (KVA) | Primary <br> Lead | Secondary Lead |  | Transformer |
| Ground |  |  |  |  |
| 10 To 50 | \#2 SDBC | Neutral <br> Insulated | Hot <br> I-4/0 AAC <br> Insulated | \#2 SDBC |
| $75 \& 100$ | \#2 SDBC | I-4/0 AAC <br> Insulated | 2-4/0 AAC <br> Insulated | \#2 SDBC |


| Fuse Link and Current Limiting Fuse |  |  |
| :---: | :---: | :---: |
| Transformer Rating <br> KVA | Fuse Link | CLize (7200/1,500 Volts) |
|  | 1.4 SF | CLF |
| 15 | 2.1 SF | 12 K |
| 25 | 3.5 SF | 12 K |
| 37.5 | 5.2 SF | 12 K |
| 50 | 7.0 SF | 12 K |
| 75 | 10.4 SF | 12 K |
| 100 | 14.0 SF | 25 K |
| 167 | 21.0 SF | 25 K |
| 250 | 32.0 SF | 40 K |
| 333 | 46.0 SF | 40 K |


| Transformer Weight \& Height - Pole Mounted |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Rating KVA | Weight Range (lbs) |  | Height Range (lbs) |  |
|  | Standard Loss Older Types | Low Loss New Std. | Older Types | Low Loss New Std. |
| 10 |  |  |  |  |
| 15 |  |  |  |  |
| 25 |  |  |  |  |
| 37.5 |  |  |  |  |
| 50 |  |  |  |  |
| 75 |  |  |  |  |
| 100 |  |  |  |  |
| 167 |  |  |  |  |
| 250 |  |  |  |  |

## GUidelines for Fusing Protection of DISTRIBUTION TRANSFORMERS

## Single-Phase Transformers

(Polemounted or padmounted, in 1-phase or 3-phase applications)

| Tx. Size <br> (kVA) | Fuse size <br> (Amps) | Fuse Type | A.B. Chance <br> Catalogue Number | CUC Stock <br> Number |
| :---: | :---: | :---: | :---: | :---: |
| 15 | 2.1 | SloFast | M2D1SFA23 | LIN 374 000 11 |
| 25 | 3.5 | SloFast | M3D5SFA23 | LIN 374 000 12 |
| 37.5 | 5.2 | SloFast | M5D2SFA23 | LIN 374 000 15 |
| 50 | 7.0 | SloFast | M7D0SFA23 | LIN 374 000 19 |
| 75 | 10.4 | SloFast | M10D4SFA23 | LIN 374 000 20 |
| 100 | 14.0 | SloFast | M14SFA23 | LIN 374 000 17 |
| 167 | 21.0 | SloFast | M21SFA23 | LIN 37400018 |
| 250 | 32.0 | SloFast | M32SFA23 | LIN 374 00013 |
| 333 | 50.0 | T | M50TA23 | LIN 372 000 02 |

Three-Phase Transformers

| Tx. Size <br> (kVA) | Fuse size <br> (Amps) | Fuse Type | A.B. Chance <br> Catalogue Number | CUC Stock <br> Number |
| :---: | :---: | :---: | :---: | :---: |
| 150 | 7.0 | SloFast | M7D0SFA23 | LIN 37400019 |
| 225 | 10.4 | SloFast | M10D4SFA23 | LIN 37400020 |
| 300 | 14.0 | SloFast | M14SFA23 | LIN 37400017 |
| 500 | 21.0 | SloFast | M21SFA23 | LIN 37400018 |
| 750 | 32.0 | SloFast | M32SFA23 | LIN 37400013 |
| 1000 | 50.0 | T | M50TA23 | LIN 37200002 |
| 1500 | 80.0 | T | M80TA23 | LIN 37200003 |
| 2000 | 100.0 | T | M100TA23 | LIN 37200004 |



NOTES:

1. $\stackrel{\perp}{=}$ INOICATES A CONNECTION TO THE POLE GROUND.
2. THE PRIMARY NEUTRAL CONNECTON SHOULD NOT BE GROUNDED.
3. TRANSFORMER RATNG $7200-120 / 240$ VCLT.
4. SECONDARY 2O8V "HIGH" LEG IS DESIGNATED ORANGE IN ACCORDANCE WTH THE NEC. SECTION 230-56.
5. FOR TRANSFORUERS WTTH FOUR EXIERNAL SECONDARY BUSHINGS SEE DIAGRAM PG. 10-10.
6. ADOITIVE POLARITY SHOWN; FOR INCIMDUAL TRANSFORMERS WTH A SUBTRACTVE PQLARITY INTERCHANGE THE X1 AND X3 CONNECTIONS FOR THAT TRANSFORMER.

|  | $\begin{aligned} & \text { rronct } \\ & \text { CUC } \\ & \text { STANDARDS } \end{aligned}$ | OATE: <br> SCAE <br> DRAWN BY <br> Checked by: <br> APPRONED By | Anc: 2011 NTS Du | тиonicr * $\qquad$ <br> DRAWDro * 240/1209 <br> zamur * OT CF OT <br> nalv. $*$ A |
| :---: | :---: | :---: | :---: | :---: |
|  | DRAWING <br> WYE CLOSED DELTA 240/120V |  | DU <br> CJ <br> CuC SC |  |



NOTES:

1. $\perp$ INDIGATES A CONNECTION TO THE POLE GROUND.
2. THE PRIMARY NEUTRAL CONNECTION SHOULD NOT BE GROUNDED.
3. SECONDARY CONNECTIONS SHOWN FOR TRANSFORMER WITH FOUR SEPERATE EXTERNAL SECONDARY TERUINALS.
4. TRANSFORMERS RATING 7200-120/240 VOLT; (4 LV BUSHINGS)
5. SECONDARY 2O8V "HIGH" LEG IS DESIGNATED ORANGE IN ACCORDANCE WTH THE NEC. SECTION 230-56.
6. ADOMVE POLARITY SHOWN; FOR INDIMDUAL TRANSFORUERS WITH A SUBTRACTIVE POLARITY INTERCHANCE THE X1 ANO X3 CONNECTIONS FOR THAT TRANSFORMER.



NOTES:

1. $\xlongequal[=]{\perp}$ INDICATES A CONNECTION TO THE PQLE GROUND.
2. FOR DISTRIEUTION CIRCUTS WTH THE YELLOW (CENTRE) PHASE MORE HEAVLY LOADED THAN THE RED AND THE BLJE PHASE, CONNECT THE LOAD TRANSFORMER TO THE RED OR BLJE PHASE.
3. SECONDARY 208V "HIGH" LEG IS DESIGNATED ORANGE IN ACCORDANCE WTH THE NEC, SECTION 230-56.
4. ADCITIVE POLARTTY SHOWN; FOR INDIMDUAL TRANSFORMERS WITH A SUBTRACTIEE PCLARTY INTERCHANGE THE X1 AND X2 CONNECTIONS FOR THAT TRANSFORMER.


PROTBCT
CUC
STANDARDS

DRAWING


3 PHASE $7200 / 12470$ VOLT MULTI GROUNDED NEUTRAL, WYE CONNECTED SYSTEM.


NOTES:

1. $\stackrel{\perp}{=}$ INDICATES A CONNECTION TO THE POLE GROUND.
2. TRANSFORMER RATNG 7200-277V.
3. ADDIMVE PCLARITY SHOMN; FOR INDIVIDUAL TRANSFORMERS WITH A SUBTRACTIVE POLARITY INTERCHANGE THE X1 AND X2 CONNECTIONS FOR THAT TRANSFORMER.



NOTES:

1. $\underset{=}{\underline{I}}$ INDICATES A CONNECTON TO THE POLE GROUND.
2. TRANSFORMER RATNG 7200-120V: $120 / 240 \mathrm{~V}$ WINCING LEAOS MODIFED NTERNALLY IN THE TEST SHOP TO PROCUCE 120 V ONLY BETMEEN $\times 1 \& \times 3$ TERMNALS.
3. FOR TRANSFORUERS WTH FOUR EXIERNAL SECONDARY BUSHINGS. SEE DIAGRaM Pg. 10-13.
4. ADDITIVE POLARITY SHOWN; FOR INDIVDUAL TRANSFORMERS WITH A SUBTRACTIVE POLARITY INIERCHANGE THE X1 AND X3 CONNECTIONS FOR THAT TRANSFORMER.



## NOT FOR NEW CONSTRUCTION



NOTES:

1. FOR EXISTING TRANSFORMER INSTALLATIONS ON 40' POLES. NEW INSTALLATIONS ARE TO BE INSTALLED ON $45^{\prime}$ POLES.
2. ROTATE EXISTING TRANSFORMERS (APPROX. 22.5' TO 45. SO THAT SECONDARY DOES NOT CONTACT TRANSFORMER


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EXISTING SINGLE PHASE
TRANSFロRMER INSTALLATIDN 15-75KVA





THREE PHASE TRANSFORMER - FULL LOAD AMPERES

| KVA | H.V. | 120 V | $\begin{aligned} & 208 \\ & \mathrm{~V} \\ & \hline \end{aligned}$ | 240 V | 277 V | 480 V |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 75 | 3.47 | 361 | 208 | 180 | 156 | 90 |
| 100 | 4.63 | 481 | 278 | 241 | 208 | 120 |
| 150 | 6.94 | 722 | 416 | 361 | 313 | 180 |
| 225 | 10.42 | 1083 | 625 | 541 | 469 | 271 |
| 300 | 13.89 | 1443 | 833 | 722 | 625 | 361 |
| 500 | 23.15 | 2406 | 1388 | 1203 | 1042 | 601 |
| 750 | 34.72 | 3608 | 2082 | 1804 | 1563 | 902 |
| 1000 | 46.30 | 4811 | 2776 | 2406 | 2084 | 1203 |
| 1500 | 69.45 | 7217 | 4164 | 3608 | 3126 | 1804 |
| 2000 | 92.60 | 9623 | 5551 | 4811 | 4169 | 2406 |


|  | IN RUSH CURRENT |  |  | COLD LOAD PICKUP | ICLP-2 | HOT LOAD PICKUP |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| KVA | Irush-12 | IRUSH-25 | ICLP-6 | ICLP-3 |  | IHLP-12 | IHLP-15 |
| 75 | 41.7 | 86.8 | 20.8 | 10.4 | 6.9 | 41.7 | 52.1 |
| 100 | 55.6 | 115.7 | 27.8 | 13.9 | 9.3 | 55.6 | 69.4 |
| 150 | 83.3 | 173.6 | 41.7 | 20.8 | 13.9 | 83.3 | 104.2 |
| 225 | 125.0 | 260.4 | 62.5 | 31.3 | 20.8 | 125.0 | 156.3 |
| 300 | 166.7 | 347.2 | 83.3 | 41.7 | 27.8 | 166.7 | 208.3 |
| 500 | 277.8 | 578.7 | 138.9 | 69.4 | 46.3 | 277.8 | 347.2 |
| 750 | 416.7 | 868.1 | 208.3 | 104.2 | 69.4 | 416.7 | 520.9 |
| 1000 | 555.6 | 1157.5 | 277.8 | 138.9 | 92.6 | 555.6 | 694.5 |
| 1500 | 833.4 | 1736.2 | 416.7 | 208.3 | 138.9 | 833.4 | 1041.7 |
| 2000 | 1111.2 | 2315.0 | 555.6 | 277.8 | 185.2 | 1111.2 | 1389.0 |

IRUSH-
12
Irush-
25
OOLDOAD PICK UP @ 6 TMES RATED URRENT @ 1 SECOND
Illp-3 COLD LOAD PICK UP @ 3 TIMES RATED CURRENT @ 10 SECONDS
Illp-2 COLD LOAD PICK UP @ 2 TIMES RATED CURRENT @ 900 SECOND
Illp-12 HOT LOAD PICKUP @ 12 TIMES RATED CURRENT @ 0.1 SECOND
lılp-15 HOT LOAD PICKUP @ 15 TIMES RATED CURRENT @ 0.1 SECOND

## SINGLE PHASE TRANSFORMER - FULL LOAD AMPERES

| KVA | H.V. | $\mathbf{1 2 0} \mathbf{~ V}$ | V |
| ---: | ---: | ---: | ---: |
| 10 | 1.39 | 83 | 42 |
| 15 | 2.08 | 125 | 63 |
|  |  |  |  |
| 25 | 3.47 | 208 | 104 |
| 37.5 | 5.21 | 313 | 156 |
| 50 | 6.94 | 417 | 208 |
| 75 | 10.4 | 625 | 313 |
| 100 | 13.9 | 833 | 417 |
| 167 | 23.2 | 1392 | 696 |


|  | IN RUSH CURRENT |  |  | COLD LOAD PICKUP | ICLP-2 | HOT LOAD PICKUP |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| KVA | Irush-12 | IRUSH-25 | IcLP-6 | IcLP-3 |  | IHLP-12 | IHLP-15 |
| 10 | 16.7 | 34.7 | 8.3 | 4.2 | 2.8 | 16.7 | 20.8 |
| 15 | 25.0 | 52.1 | 12.5 | 6.3 | 4.2 | 25.0 | 31.3 |
| 25 | 41.7 | 86.8 | 20.8 | 10.4 | 6.9 | 41.7 | 52.1 |
| 37.5 | 62.5 | 130.2 | 31.3 | 15.6 | 10.4 | 62.5 | 78.1 |
| 50 | 83.3 | 173.6 | 41.7 | 20.8 | 13.9 | 83.3 | 104.2 |
| 75 | 125.0 | 260.4 | 62.5 | 31.3 | 20.8 | 125.0 | 156.3 |
| 100 | 166.7 | 347.2 | 83.3 | 41.7 | 27.8 | 166.7 | 208.3 |
| 167 | 278.3 | 579.9 | 139.2 | 69.6 | 46.4 | 278.3 | 347.9 |

IRUSH-
12
IN RUSH @ 12 TIMES RATED CURRENT @ 0.01 SECONDS
IRUSH
25
IN RUSH @ 25 TIMES RATED CURRENT @ 0.01 SECONDS
Iclp-6 COLD LOAD PICK UP @ 6 TIMES RATED CURRENT @ 1 SECOND
Iclp-3 COLD LOAD PICK UP @ 3 TIMES RATED CURRENT @ 10 SECONDS
Iclp-2 COLD LOAD PICK UP @ 2 TIMES RATED CURRENT @ 900 SECOND
Itlp-12 HOT LOAD PICKUP @ 12 TIMES RATED CURRENT @ 0.1 SECOND
I llp-15 HOT LOAD PICKUP @ 15 TIMES RATED CURRENT @ 0.1 SECOND

