Transformer Design Guidance

Reference to LANL Engineering Standards Manual (ESM) Chapter 7—Electrical,
Section D5010, Electrical Service & Distribution

1.0 Scope
This guidance is for separately derived systems, also typically referred to as “lighting
transformers.”

2.0 Background
Transformers have specific design requirements, and not all of these requirements (e.g.,
NFPA 70) are captured in software analysis packages like SKM or ETAP.

3.0 Common issues found in transformer designs
A. The “grounding” conductor that runs between the transformer and the first
means of overcurrent protection is called a Supply Side Bonding Jumper (SSBJ)
and is covered in NEC 250.102(C). This conductor is sized per NEC
T250.102(C)(1). Some analysis software sizes this conductor per NEC T250.122,
but this usually results in too small of a conductor.

B. The transformer secondary conductors must be sized to carry at least as large a
current as the overcurrent protection that they feed. This is covered in NEC
240.21(C); the next-size-up rule does not apply to transformers.

4.0 Other considerations -- refer to attached detail (schematic and table)
A. The neutral on the secondary side is not included in the detail. The neutral can
be sized per NEC 220.61. This allows the neutral to be sized to carry the
imbalance. If the neutral is also part of the effective ground-fault current path,
the neutral must also be at least as large as the value in NEC T250.102(C)(1).

B. In the graphic detail, the System Bonding Jumper (SBJ) is in the transformer.
This is a requirement of the LANL ESM. Having the SBJ here allows transformers
to feed multiple panels and results in more consistent installations. Also, having
the SBJ here means that the neutral between the transformer and the first
means of overcurrent protection is not a part of the effective ground-fault
current path.

C. In the table, some of the transformer sizes have multiple entries for overcurrent
protection (OCP) sizes. The primary of a 75 kVA transformer, for example,
shows that OCP of 100, 115, or 125 can be used. A 100 Amp OCP might be
chosen if that is all that is available. Whichever OCP is chosen determines the
sizes of the associated conductors. On some of the larger devices, multiple
choices of conductor sizes are possible. For example, if 400 amp OCP is chosen
on the secondary side, either single 600 kcmil conductors or parallel 3/0
conductors can be used.
### PRIMARY

<table>
<thead>
<tr>
<th>KVA</th>
<th>480 volt</th>
<th>480 volt</th>
<th>480 volt</th>
<th>480 volt</th>
<th>480 volt</th>
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<tbody>
<tr>
<td></td>
<td>FLA</td>
<td>FLA</td>
<td>ecc</td>
<td>ungrounded</td>
<td>EGC</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>22.5</td>
<td>25</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>36</td>
<td>45</td>
<td>45</td>
<td>8</td>
<td>10</td>
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<tr>
<td>75</td>
<td>90</td>
<td>112.5</td>
<td>100</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>112.5</td>
<td>135</td>
<td>168.75</td>
<td>175</td>
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<tr>
<td>150</td>
<td>180</td>
<td>225</td>
<td>225</td>
<td>4/0</td>
<td>4/4</td>
</tr>
<tr>
<td>225</td>
<td>270</td>
<td>337.5</td>
<td>35C</td>
<td>1 x 500</td>
<td>1 x 3</td>
</tr>
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<td></td>
<td></td>
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<td>2 x 1/0</td>
<td>2 x 3</td>
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### SECONDARY

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<tr>
<th>KVA</th>
<th>typical FLA</th>
<th>FLA</th>
<th>ungrounded</th>
<th>50%I</th>
<th>Grounding Electrode Conductors, NEC 250.82</th>
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</thead>
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<tr>
<td>15</td>
<td>4.1</td>
<td>52.1</td>
<td>6</td>
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<td>8</td>
</tr>
<tr>
<td>30</td>
<td>56.3</td>
<td>104.1</td>
<td>3</td>
<td>8</td>
<td>8</td>
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<tr>
<td>45</td>
<td>125</td>
<td>156.3</td>
<td>1</td>
<td>6</td>
<td>6</td>
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<tr>
<td>75</td>
<td>280.3</td>
<td>300.4</td>
<td>2</td>
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<td>2</td>
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</tbody>
</table>

### GENERAL NOTES:
1. Transmitters may be acceptable for a receiver. Protection with conductors sized for conductors to the receiver should be used. For example, a 15 kVA transformer primary is usually protected by a 10 kVA, ungrounded device, but a 15 kVA device may be all that is required. This is acceptable.

### KEYED NOTES:
1. Equipment grounding conductor, NEC 250.117.
2. System bonding jumper, see NEC 250.117 (A) (B) (C), 250.117 (D) (E), 250.117 (F).
3. Grounding electrode conductor, NEC 250.82 and table 250.82.
4. Supply side bonding jumper, NEC 250.117.
5. Over current protection.
6. Install terminal box for grounding conductors in accordance with NEC 250.14 if not supplied by the equipment manufacturer.
7. These transformers have a total change of drop for both the primary and secondary. A particular choice on the primary side is not meant to correspond to a choice on the secondary.