TVSS Installation

Properly installed TVSS can save ESPs from lightning damage and switching surges and minimize lost production. A TVSS improperly installed can actually cause ESP damage. From many surveys, reports and technical papers on oil-field power distribution the following are necessary for proper installation:

5 Step Grounding Procedure

1. **The TVSS must have a ground wire**
2. **TVSS must ground to the wellhead**
3. **TVSS should be mounted on the junction box**
4. **Power to the ESP should come from ungrounded transformer windings**
5. **Separate ground wires are necessary to prevent TVSS and lightning arrester interaction. Both these devices will conduct backward, i.e. ground high – phase wires low**

Theory, experience and justification

1. Without a ground wire connected to the wellhead that connects to the ESP motor housing, it is impossible to limit voltage impulses phase-to-housing. These are the cause of most insulation failures.
2. Acceptable wellhead grounds are shown in the Figs. 1 and 2 pictures. A service post, Fig. 3, is recommended, but a welded bolt head and ground lug are acceptable. Ground (pipe) clamps are strongly discouraged due to the very poor electrical connection and related safety considerations.
3. Junction box mounting, Figs 4 and 5, puts the TVSS as close to the wellhead as possible thereby providing the best impulse limiting.
4. Ungrounded power has been the industry standard for over 80 years, because oil production is a continuous process and pumping can continue after the first downhole short. Grounding the windings feeding the ESP is always done up on the pole, where connecting wires to the lightning arrester common or shield wire are very short. This increases the likelihood of lightning damage.
5. Separate ground wires only bonded together at the wellhead can prevent the interaction of lightning arresters and TVSS. This interaction is the main reason for uncertainty about TVSS effectiveness. Failure to separate ground wires has caused TVSS to damage ESPs. How grounds should be separated for switchboard ESP operation is illustrated in Fig. 6. For VFD operated ESPs please refer to Figs. 7 & 8.

Fig. 1 - Welded Bolt Head and Ground Lug

Fig. 2 - Service Post Ground, install in lower flange between flange bolts

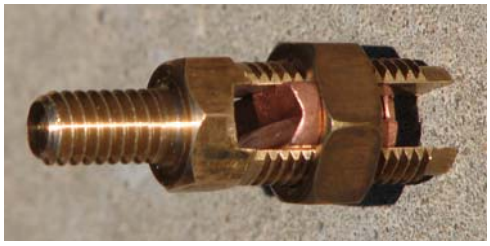


Fig. 3 - Recommended Service Post
Bolt end – 3/8-16 thread, ¾ long
Split bolt end – for two #2 AWG

Fig. 4 – SubSaver-4M Junction Box Mounting

Fig. 5 – Subsaver 6-M Mounting

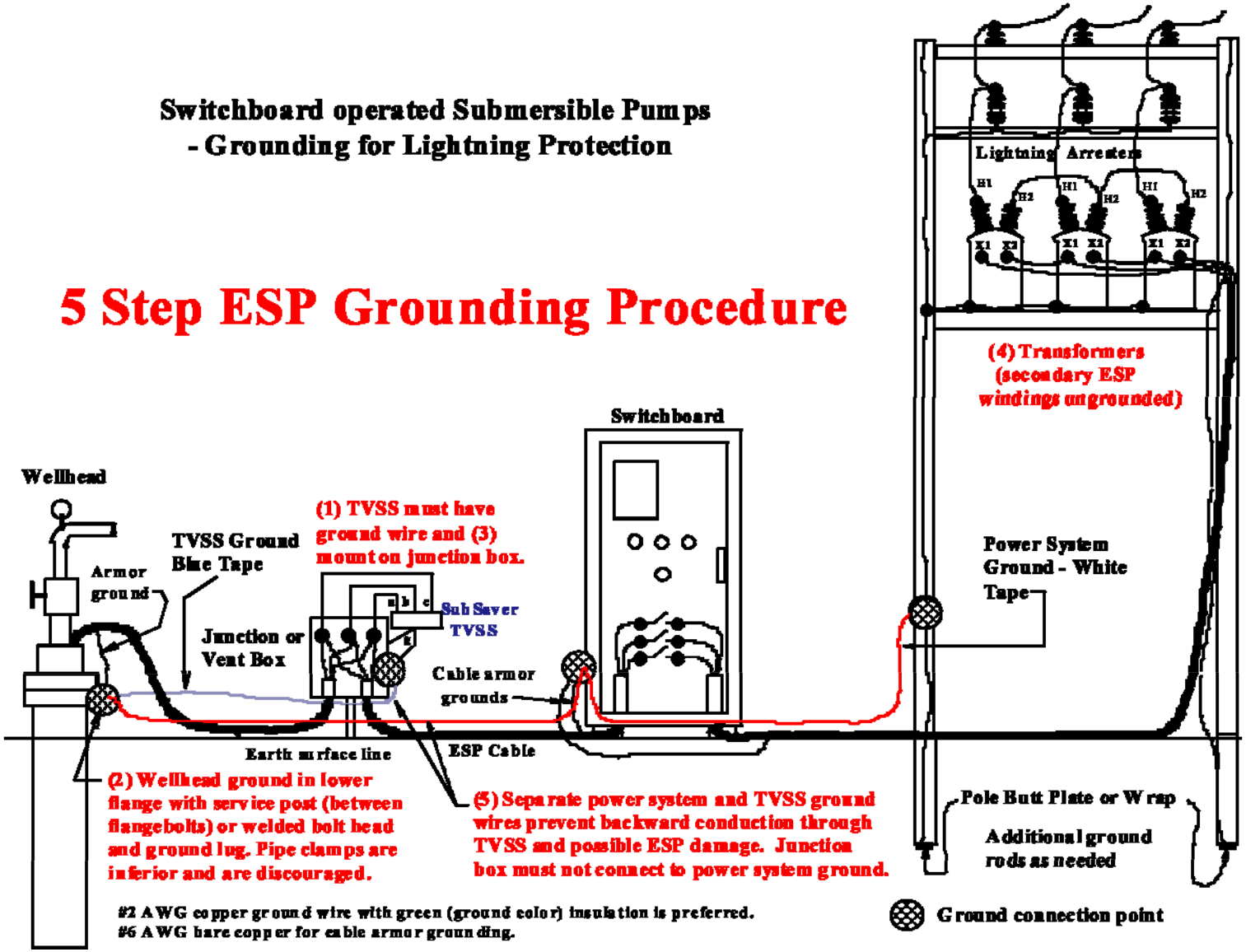


Fig. 6 – Switchboard ESP Operation - A fiberglass junction box makes it easier to separate power system and TVSS grounds

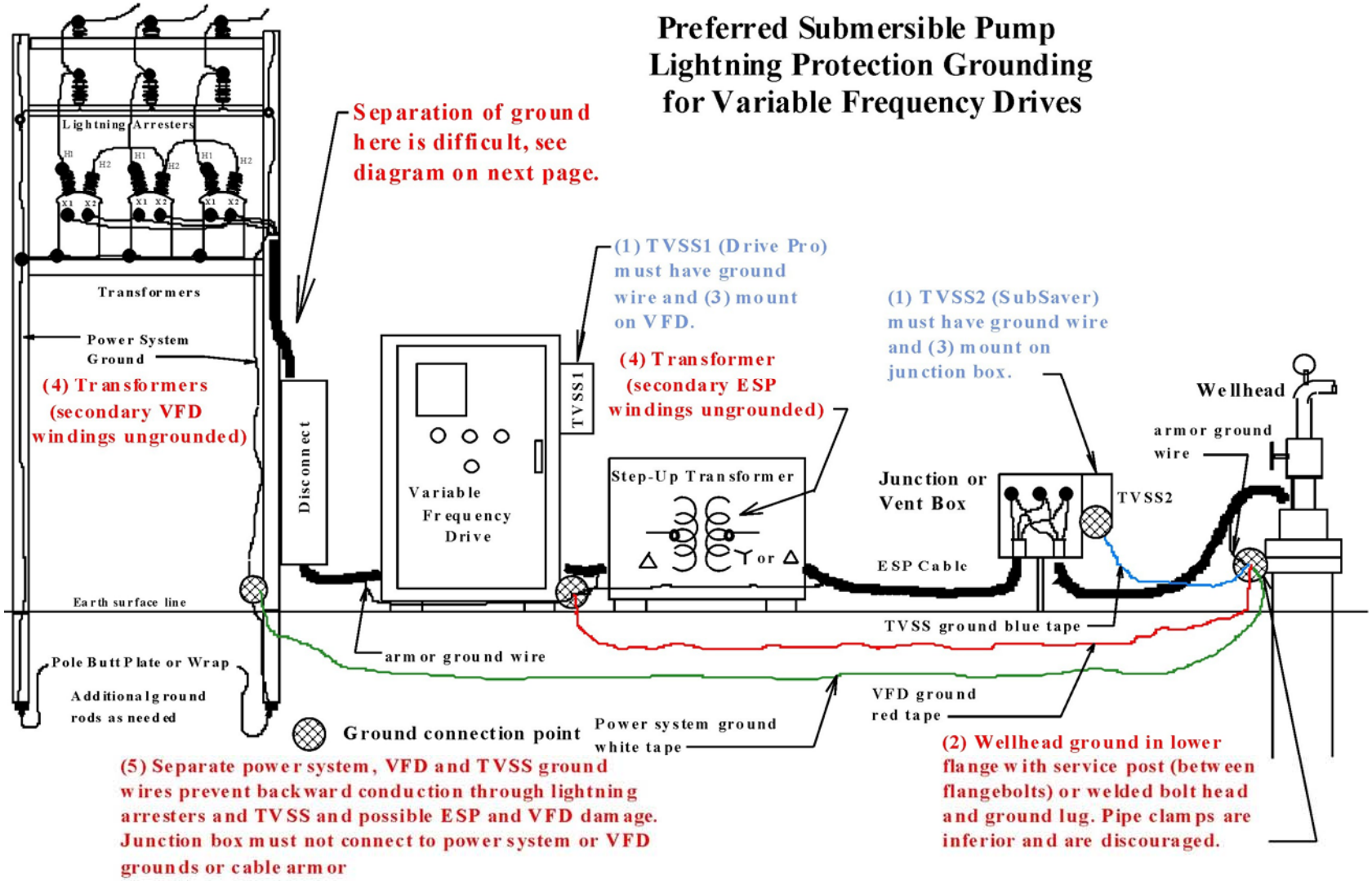
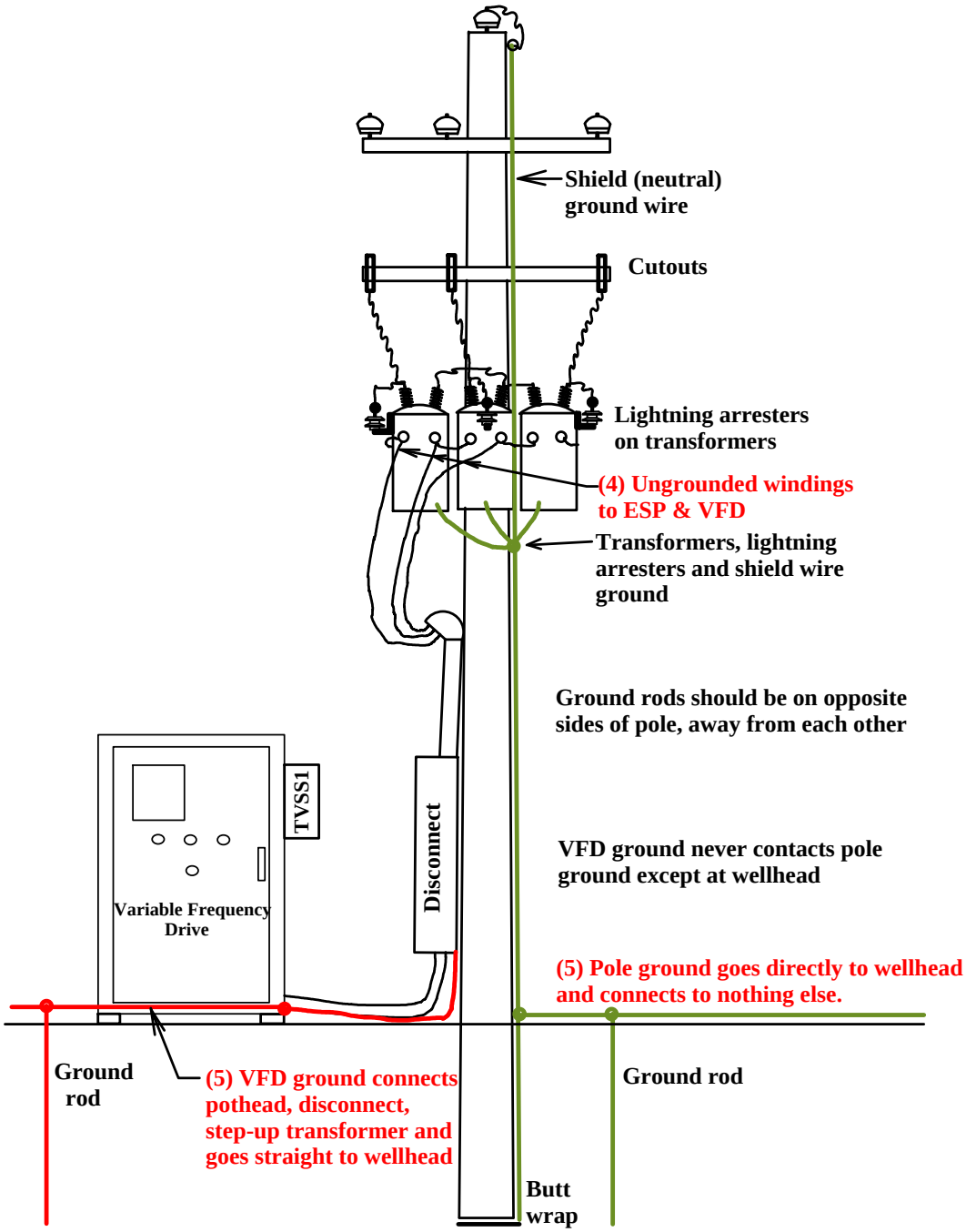


Fig. 7 – Variable Frequency Drive Operation
Ground wire through the disconnect must be broken, cf.
If necessary install additional ground rod at VFD



Variable Frequency Drive Operated Submersible Pumps (Continued)

5 Step Grounding Procedure

Fig. 8 – Separation of Ground Wires at the Pole

Installation Details

All Subsaver® products are factory tested 6 ways, 3 phase-to-phase and 3 phase-to-ground to insure performance to specifications. However, TVSS effectiveness requires close attention to grounding as detailed in the previous diagrams.

Installation of both SubSaver TVSS products is the same. Subsaver-4M (40kA per mode, models B4M) and Subsaver 6-M (40kA per mode, models H6M) were designed for external mounting on a junction box. A large ground lug is provided on the outside of the TVSS for connection of the ground wire. This most important ground wire runs from the wellhead to the TVSS. The external lug makes it easy to check if the ground wires (green THHN insulated, #2 AWG stranded copper) are connected as required. The small green ground wire in the elbow connects internally to the ground lug in a steel junction box or the back plate ground lug in a fiberglass junction box.

Three black phase wires should be cut about 6" longer than necessary and then connected to the three terminals in the junction box. Phase wires are labeled A, B and C for testing purposes. Usually these are connected in order from left to right to the three terminals, but it really makes no difference in what order they are connected.

Cable armor between wellhead and junction box should be grounded at the wellhead with an appropriate size pipe clamp and #6 AWG bare copper wire. Other cable armor should be grounded as illustrated in the previous diagrams with #6 wires. At the junction box armors should not come in contact with each other or a metal box. It is important that no connection between the cable armor and the ESP System Ground contacts the Power System Ground anywhere except at the wellhead. Armor grounding is essential for personnel safety.

Service posts are available from Burndy (model K2C23B1) or Penn-Union (model SCS-4A1). Posts should be installed in the lower flange to avoid workover problems.

A "hot work" permit will be required if natural gas is present. Check that well casing is sealed before attempting a welded bolt head ground. Connection to the lower flange is recommended

If the VFD is trailer mounted the junction box should be fiberglass for electrical isolation.

Once all ground connections are made they should be coated with a sealant (glyptol, etc.) to keep moisture out and minimize corrosion.

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