

1.0 Preparing VFD House for Engine Start

Getting the VFD House, Cold-Start Compressor & one of the Engine-Generator set ready for start-up.



- Step 1.1:** Turn the Emergency Backup Lights **ON**.
- Step 1.2:** Turn **OFF** all circuit breakers in the VFD Lighting and the 480V Power Distribution Transformer Feeder Panels.
- Step 1.3:** **OPEN** the load circuit breakers & turn **OFF** the 2-transformer feeder circuit breakers.
- Step 1.4:** On the GEN control panel, press the **IDLE** button on the generator being powered up.
- Step 1.5:** On GEN 2 control panel, turn the knob on the **GEN SYNC SW** to the generator being powered up.
- Step 1.6:** Connect the air hose that goes from the Lubster to the isolation air-pressure valve at the bottom of Engine Skid #1.
- Step 1.7:** Connect air hose that goes from the floor isolation air-pressure valve of engine Skid #1 to the engine that is going to be powered up.
- Step 1.8:** **CLOSE** (Turn OFF) the three isolation air-pressure valves.

2.0 Starting an Engine-GEN after a Rig Move

- Step 2.1:** Start the Cold-start Compressor engine.
- Step 2.2:** When air-pressure reaches 120-125psi, **CLOSE** (Turn ON) the three isolation air-pressure valves from Steps 1.6 - 1.7.
- Step 2.3:** From the engine's EIP, turn the engine control knob to **AUTOSTART**, let self-check run twice.
- Step 2.4:** Turn the engine control knob to **MANUAL START**, the engine will start, let the engine warm up.



- Step 2.5:** Perform a walk around safety inspection. Check for leaks on engine & diesel tank, **CLOSE** (Turn OFF) the three isolation air valves.

3.0 Bringing the First Generator On Line

The engine has warmed up and is ready to be moved from **IDLE** mode to **RUN** mode.



From the GEN control panel of the running engine:

- Step 3.1:** Press the **RUN** button. Listen for the engine to speed up.
- Step 3.2:** Adjust the speed to 60 hertz and the voltage to 600 volts. Move the locking tab to the left to **unlock** the knob. After adjusting, move the locking tab back to the right to **lock** the knob in place to prevent vibrations from moving the knob.
- Step 3.3:** On the GEN load circuit breaker pull the charge breaker handle until the yellow **CHARGED SPRING** flag appears. **Stand to the side of the circuit breaker when charging the breaker.**
- Step 3.4:** On the GEN control panel, press the **PUSH TO CLOSE** button. **Stand to the side of the circuit breaker when pressing the button.** The generator is now On Line.
- Step 3.5:** Turn the **GEN SYNC SW** back to **BUS**.

4.0 Turning on the VFD House Lights & AC

The VFD house lights, UPS and AC's are supplied by circuit breakers in the two VFD panels.

- Step 4.1:** Turn **ON** the Lighting and VFD Power Distribution transformer feeder circuit breakers. 
- Step 4.2:** In the VFD Lighting Panel, **CLOSE** the circuit breakers for the VFD house lighting & UPS. 
- Step 4.3:** In the VFD 480V Power Distribution Panel, **CLOSE** the circuit breakers for AC Units 1 & 2.
- Step 4.4:** In Control Cubicle #1, turn **ON** the UPS.

5.0 Starting a subsequent Engine-Gen Set

Choose which engine will be the 2nd engine started. Perform the following from the selected engine's EIP and corresponding VFD house GEN control panel.

- Step 5.1:** From inside VFD House, verify that the GEN load circuit breaker is **OPEN**, the green **OPEN** flag and the white **DISCHARGED SPRING** flag should be displayed, then on the GEN control panel, press the **IDLE** button.
- Step 5.2:** From the Engine-Generator Skid, connect the air hose from the floor isolation air-pressure valve of Engine-Generation Skid #1 to the engine being powered up, **OPEN** the isolation air-pressure valves.
- Step 5.3:** Turn engine control knob to **AUTO START**, the engine self-checks will run. Then turn the engine control knob to **MANUAL START**, the engine will start, let the engine warm up.



- Step 5.4:** Perform walk around inspection: Check the engine for leaks, turn **OFF** the isolation air-pressure valves, then remove and properly store the hose.
- Step 5.5:** Press the **RUN** button on the GEN control panel. Listen for the 2nd engine to speed up.
- Step 5.6:** On GEN 2 control panel, turn the **GENSYNC SW** knob to the **GEN** being powered up.
- Step 5.7:** Unlock the **GEN 2 SPEED ADJUST** knob, adjust the speed to 60 Hertz, then re-lock the knob.
- Step 5.8:** Unlock the **GEN 2 VOLTS ADJUST** knob, adjust the voltage to 600V, then re-lock the knob. 

6.0 Synchronize & Bring Generators Online

Generator synchronization should not be attempted during periods of heavy electrical usage, such as tripping and reaming.

Step 6.1: On the GEN load circuit breaker that will be put on line, pull the charge breaker handle until the yellow **CHARGEDSPRING** flag appears. **WARNING: Always stand to the side of the circuit breaker when charging the breaker.**

Step 6.2: While watching the Synchroscope, use the **SPEED ADJUST** knob on GEN control panel, to make the meter's arrow move slowly in a clockwise direction.



Step 6.3: When the synchroscope meter points straight up (12 o'clock position), press the **PUSH TO CLOSE** button on the GEN control panel. **WARNING: Always stand to the side of the circuit breaker when pressing the PUSHTOCLOSE button.**

Step 6.4: Turn the GEN SYNC SW to **BUS**.



Step 6.5: Compare **KVAR** levels of 1st GEN & 2nd GEN, if not the same, use the **VOLTS ADJUST** knob of 2nd GEN to make both KVAR values the same.

Step 6.6: Check that voltage for both generators is 600 volts. To do this, switch the **GEN SYNC SW** knob to each GEN and adjust using the **VOLTS ADJUST**.

Step 6.7: After completing the adjustments, re-lock all of the **SPEED ADJUST & VOLTS ADJUST** knobs to prevent vibration from moving the knobs.

Step 6.8: To put another generator online repeat the above process.

7.0 Shutting down a single Engine

Step 7.1: Ask the driller if removing a generator at this time will negatively impact current load requirements. If not, continue to next step.

Step 7.2: **OPEN** the GEN Load circuit breaker for the generator being powered down.

Step 7.3: Place that same generator in **IDLE** mode.

Step 7.4: Place the engine that is being powered down in **COOLDOWN** mode. After the engine cools down the engine will shut off.

Step 7.5: Turn engine control switch to **OFF/RESET**.

8.0 Shutdown Sequence for last Engine.

Step 8.1: In the MCC House, Turn **OFF** the starters, then **OPEN** the circuit breakers.

Step 8.2: In the VFD House, **OPEN** the MCC and the two VFD load circuit breakers.

Step 8.3: Turn **OFF** the UPS.

Step 8.4: Turn **OFF** all circuit breakers in the VFD Lighting and the VFD 480V Power Distribution transformer feeder panels. The Emergency Lights will come on.

Step 8.5: Turn **OFF** the Lighting & the VFD 480V Power Distribution transformer feeder circuit breakers.

Step 8.6: **OPEN** the GEN Load circuit breaker for the final generator to be powered down. Press the **IDLE** button on the GEN control panel.

Step 8.7: Power down the final engine.

Step 8.8: Turn **OFF** both VFD Emergency Lights.

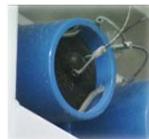
9.0 Cables, Plugs, and Cable Receptacles

Step 9.1: Disconnect and secure cables coming from the MCC cable bridge going to the VFD power distribution panel.

Step 9.2: Disconnect and secure the cables coming from the engines going to the VFD house engine-generator plug panel.

Step 9.3: Visually inspect the cables and verify that cables with caps are secured.

Step 9.4: Visually inspect the receptacles and verify that receptacles with caps are secured.



Quick Reference Card VFD Power Generation

Pre-Operations: RIG-UP Power Generation

H&P's Power Generation and Distribution System consist of five major components, they are:

1. **VFD House:** Provides all of the generated electrical power to the entire rig operations.
2. **MCC House:** Is the main distribution point for the power of the Rig, and houses most circuit breakers and HOA switches.
3. **Engine (2or3)** currently Caterpillar 3512C, generates 1400hp each, providing the 600V at 60Hz electrical power to VFD House.
4. **Cold-Start Compressor** housed on Lubster skid: Provides air pressure needed to start engines.
5. **Fuel Tank:** Provides diesel fuel to engines.



RIG-UP: Powering Up after a Rig Move

- 1: Position all Power & Distribution components.
- 2: Install all ground rods and ground cables.
- 3: Position fire extinguisher at designated locations.
- 4: Verify all circuit breakers are **OPEN** (OFF) and all required LOCK OUT/ TAG OUT are in place.
- 5: Connect & secure all cables from the MCC cable bridge to proper equipment & sources.
- 6: Connect engine-generator cables to VFD House.
- 7: Check oil and diesel levels on cold-start compressor and all engine-generator sets.
- 8: Connect fuel lines and hoses between engines and fuel tank.
- 9: Open fuel valves from fuel tank to engines, check for oil or diesel leaks, check coolants levels on engines.
- 10: Connect air-pressure hoses from the Lubster to Engine Skid #1 and from the isolation air-pressure valve on the floor of Engine Skid #1 to the first engine to be started.