ORNL/LTR-2023/2898
M3LW-23OR0402017

Replacement of Hydraulic Power Units in the Fracture Mechanics Laboratory of Oak Ridge National Laboratory

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June 2023

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Light Water Reactor Sustainability Program

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Prepared by
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Oak Ridge, TN 37831
managed by
UT-BATTELLE LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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DOE	Department of Energy
FML	Fracture Mechanics Laboratory
HPU	Hydraulic Power Unit
LWRS	Light Water Reactor Sustainability
ORNL	Oak Ridge National Laboratory

ACKNOWLEDGMENT

This work was sponsored by the US Department of Energy (DOE), Office of Nuclear Energy, Light Water Reactor Sustainability (LWRS) Program, Materials Research Pathway. We appreciate the programmatic support from the LWRS technical integration officer, Bruce Hallbert, and DOE federal program managers, Sue Lesica and Jason Tokey. In addition, we would like to acknowledge the technical support from April Case, DL Greise, and other ORNL facility and operation staff members who contributed to the successful installation.

ABSTRACT

The fracture mechanics laboratory (FML) at ORNL underwent a major upgrade of its hydraulic power units. The old hydraulic pumps, dating back to the 1970s, were replaced by an MTS SilentFlo™ Model 515.30 Hydraulic Power Unit (HPU), which supplies hydraulic power to four servohydraulic frames in the FML. The upgrade also involved installing an accumulator assembly, water cooling kit, distribution manifold assembly, replacing hydraulic fluid, and servicing existing accumulator assemblies. The new HPU enhanced the operational efficiency and reliability of the four servohydraulic frames in FML, which are essential for supporting various projects within the LWRS program and other DOE programs.

1. BACKGROUND

The Fracture Mechanics Laboratory (FML) is a part of the Materials Science and Technology Division at Oak Ridge National Laboratory (ORNL). The FML conducts experimental research on various aspects of fracture mechanics, such as automated testing, failure analysis, irradiation and environmental effects, and test method development. The FML also develops miniature specimens for testing metallic and nonmetallic materials that are used in different energy systems.

The FML research group uses four servohydraulic testing machines to conduct experiments related to their main research topics. These machines can apply different levels of force, from 10 kip to 300 kip, and are powered by two hydraulic pumps that were installed in the 1970s (see Figure 1). However, these pumps have become unreliable and prone to problems such as oil leaks, which have caused delays and interruptions in the testing process. Therefore, the LWRS program and other DOE programs have funded the replacement of the old pumps with a new MTS HPU, which will improve the performance and efficiency of the servohydraulic testing machines. This report summarizes the installation process of the MTS HPU.

Figure 1 Photo of one of the legacy hydraulic pumps

2. MTS HPU SPECIFICATIONS

The replacement HPU belongs to MTS SilentFlo product line with a model number 515.30. Figure 2 shows the exterior view of the unit. The specifications of the unit are summarized in Table 1. Additional features include:

Figure 2 MTS SilentFlo Model 515.30 HPU

- Flow rates of 113.5 lpm (30 gpm) for 60 Hz models, and 100.7 lpm (26.6 gpm) for 50 Hz models at 21 MPa (3000 psi).
- Noise rating of 63 dB(A).
- Variable volume pumps help save energy and reduce operating costs.
- Designed to eliminate ambient heat load, reducing HVAC requirements.
- Compact design fits through a standard doorway.
- Optional Remote-Mounted Water shut-off valve saves water when the unit is shut down.
- Efficient heat transfer technology reduces cooling requirements with standard water cooling. An optional air-cooling system is available.
- Advanced programmable logic controls (PLC) enable options for control and monitoring.
- Engineered for remote monitoring and multi-pump control options.
- Optional high-pressure filter available for additional system filtration at the outlet of the pump.
- Optional output accumulation is available for HPU models 515.20 through 515.180.
- Designed and tested to relevant EN, ISO, NFPA, and CAN/CSA standards for electrical safety and electromagnetic compatibility (EMC); CE compliant; TÜV-Rheinland certified.
- Safety engineered to achieve EN ISO 13849-1 Performance Level-d (PLd) when operated in Stand-alone mode.
- Optional air coolers supplied under the Air-Cooling Option are matched to the SilentFlo in both capacity, voltage, and power frequency.

Table 1 Specifications of MTS HPU Model 515.30

Pressure	20.7 MPa (3000 psi)
Power Frequency	60 Hz
Flow Rating	113.6 lpm (30.0 gpm)
Voltage (3 Phase)	460 V (AC)
Unit Full Load Amperage	75 Amps
Motor Start Technique	Y-Delta (MTS Standard)
Orientation	Small
Cooling Method	Water-Cooled Ready
Minimum Required Water Flow	45.4 lpm/12.0 gpm at 21.1 °C/70 °F
Port Connection Type	-16 JIC
Hydraulic Oil Requirements	208 L (55 gal) Minimum / 340 L (90 gal) Maximum

3. INSTALLATION OF MTS HPU

3.1 Removal of legacy hydraulic pumps

The two obsolete hydraulic pumps had to be removed and replaced through a series of steps. The first step involved checking both pumps for any signs of exposure to radioactive or beryllium materials. The next step required draining the hydraulic oil from both pumps, disconnecting the electrical power from the units, and removing the old breaker box. The last step consisted of removing the pumps from the FML, and cleaning and preparing the location for the installation of the new MTS HPU. The layout of four servohydraulic frames and two legacy hydraulic pumps in the FML, as well as the location for the new MTS HPU, is shown in Figure 3.

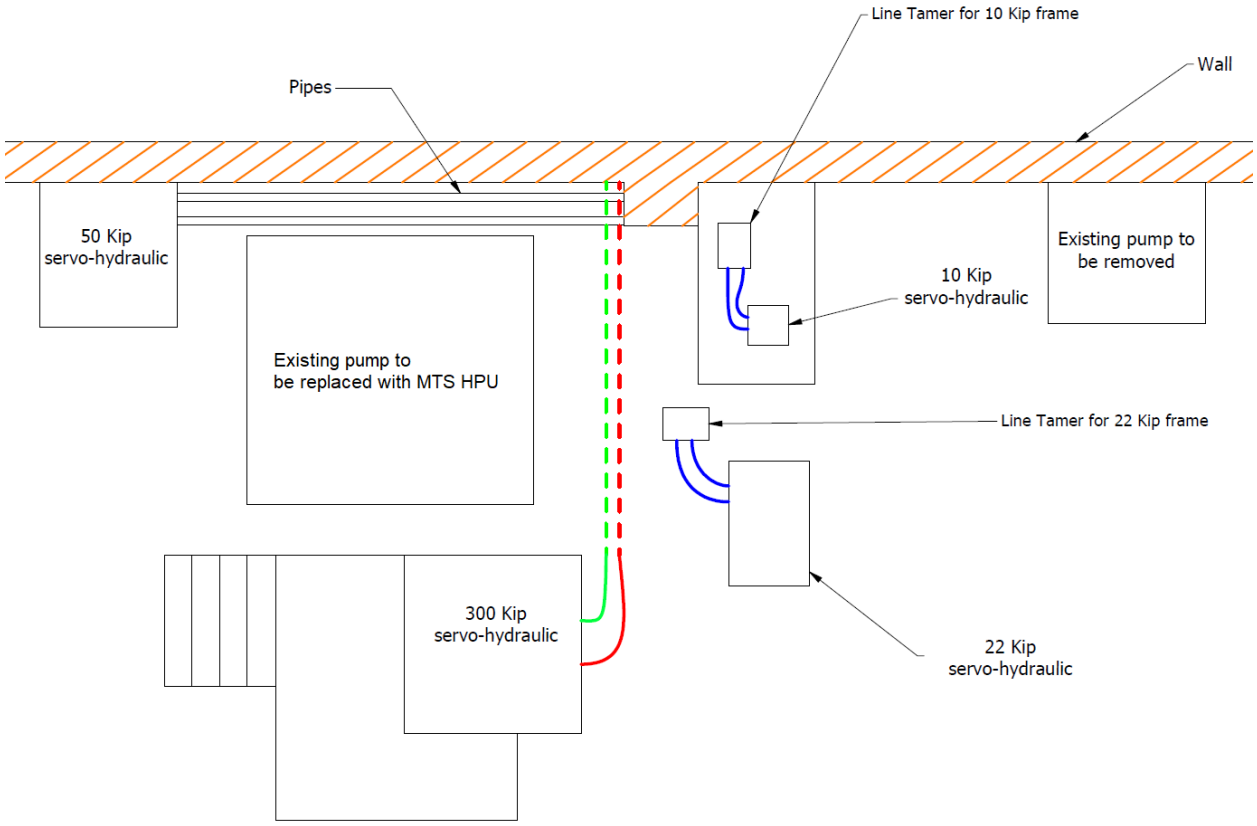

Figure 3 Layout of four servohydraulic frames, two legacy hydraulic pumps, and the location for the new MTS HPU in the FML

3.2 Installation of new MTS HPU

Similar to removal of the legacy hydraulic pumps, the installation of new MTS HPU consists of several steps. First, a new breaker box with electrical power supply was installed. Next, plant-supplied water and a drain line were connected to the HPU to provide open loop cooling. Afterwards, the HPU and accumulator assembly manifold positionings were finalized in accordance with Figure 3. Lastly, all hose connections were made, hydraulic fluids were filled, and initial verification tests were performed. After the installation, the MTS HPU provided hydraulic power to all four servohydraulic frames as indicated in Figure 4.

Figure 4 The newly installed MTS HPU provides hydraulic power to all four servohydraulic frames

3.3 Operation of new MTS HPU

The MTS HPU is designed to be simple and user-friendly. Figure 5 shows the three steps required to start the HPU: (a) open the water-cooling valve, (b) activate the HPU control panel screen and press RUN, (c) click HIGH PRESSURE when you hear a clunking sound. To stop the HPU, press the HIGH PRESSURE and then the STOP buttons shown in Figure 5(c).

(a)

(b)

(c)

Figure 5 Three steps to turn on the MTS HPU. (a) turn on cooling water valve, (b) activate the HPU control panel screen and press RUN, (c) click HIGH PRESSURE after hearing a clunking sound

4. CONCLUSIONS AND FUTURE WORK

The hydraulic power units (HPU) at the Fracture Mechanics Laboratory (FML) of the Oak Ridge National Laboratory (ORNL) have been upgraded recently. The new HPU is an MTS SilentFlo™ Model 515.30 HPU, which replaced the old hydraulic pumps that were installed in the 1970s. The HPU provides hydraulic power to four servohydraulic frames in the FML, which are used for various projects within the Light Water Reactor Sustainability (LWRS) program and other DOE programs. The upgrade improved the operational efficiency and reliability of the four servohydraulic frames in the FML. The next step is to switch the cooling water supply for the HPU to a closed loop chilled water system, which will increase the water flow rate and reduce the water usage compared with the current once-through plant supplied water system.