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Revision 0

Thermal Energy Distribution System (TEDS) Startup

December | 2020

Terry Morton
Idaho National Laboratory

IES
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Idaho National Laboratory
Integrated Energy Systems
Idaho Falls, Idaho 83415

http://www.ies.gov

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Thermal Energy Distribution System (TEDS) Startup

Introduction

The **thermal energy distribution system** (TEDS), constructed at Idaho National Laboratory's Energy Systems Laboratory (ESL), demonstrates heat transfer components, distribution systems, instrumentation, and controls that can enable integrated energy system operation. TEDS emulates the distribution of thermal energy, that would be derived from a primary source, such as a nuclear reactor, to the generation of electrical power and/or use in producing non-electrical commodities, such as hydrogen. TEDS is designed to operate either independently or as a subsystem within a broader integrated energy system to demonstrate the operation of integrated components, develop and validate thermal energy transport models and control systems, and study thermal energy inertia and energy storage.

TEDS acts as an intermediate loop that could connect a primary system, such as a pressurized water reactor or other reactor technology, to a thermal energy user. In its initial implementation, physical emulation of the nuclear primary system will not be connected to TEDS. The system instead includes a programmable heater/temperature controller that can be used to emulate the heat input from a variety of primary systems either through pre-determined operational data sets or through virtual connection to primary system test facilities via communications protocol available in the laboratory. Such virtual communications and interconnected operation has previously been demonstrated with the "Real Time SuperLab" concept via digital real time simulators (DRTS). Potential benefits of virtual connections with facilities. such as the NuScale Integral System Test (NIST) facility at Oregon State University, are being assessed currently. Prior to establishing real-time connections, the TEDS programmable heater will be controlled to emulate steady-state operation and transient operation that might be anticipated in the primary system. Future laboratory additions are also expected to include a microreactor test bed that may be physically connected to TEDS via heat exchanger for integrated energy system operation.

System Configuration

Figure 1 provides a rendering of TEDS with major components labeled, while Figure 2 is a photo of the system as it is currently installed within the ESL Systems Integration Laboratory. Figure 3 provides a flow diagram of the TEDS startup configuration. For a complete description of the TEDS design, see INL/EXT-18-51351.

Construction activities necessary to begin commissioning of TEDS have been completed; however, some construction activities remain. Upon installation, the retaining screens in

the thermal energy storage tank were found to have been damaged. This vessel is awaiting warranty repairs from the manufacturer that should be complete in early January. While those repairs are in progress, the start-up team filled the remainder of the system with heat transfer oil and initiated operation of the pump and heater. The system was then heated to 100 °F (38 °C) and run for approximately 30 minutes. Pump discharge pressure and system temperature were recorded. The data collected is reflected in Figure 4. The data in this report is preliminary. This data is intended only to represent system operability and provides no system performance data.

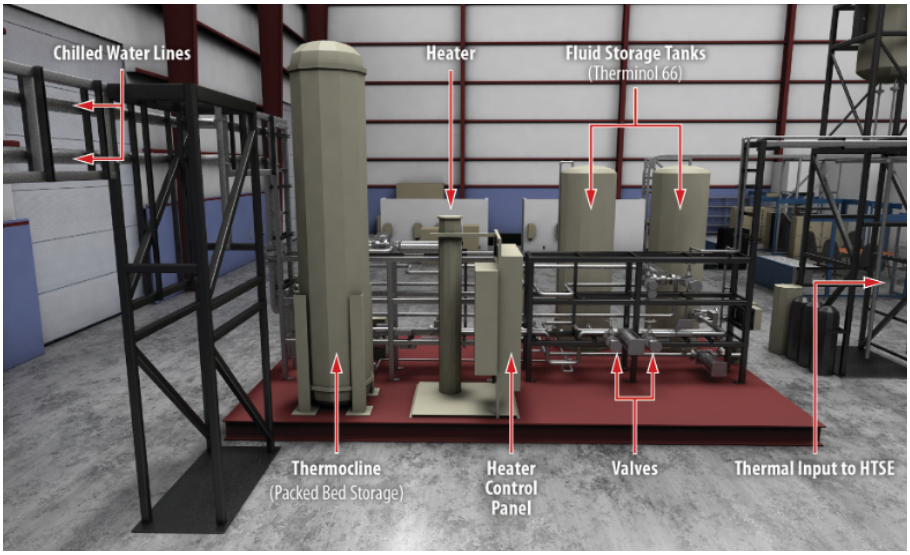

Figure 1: TEDS Rendering with Labels


Figure 2: TEDS Construction Progress Photo

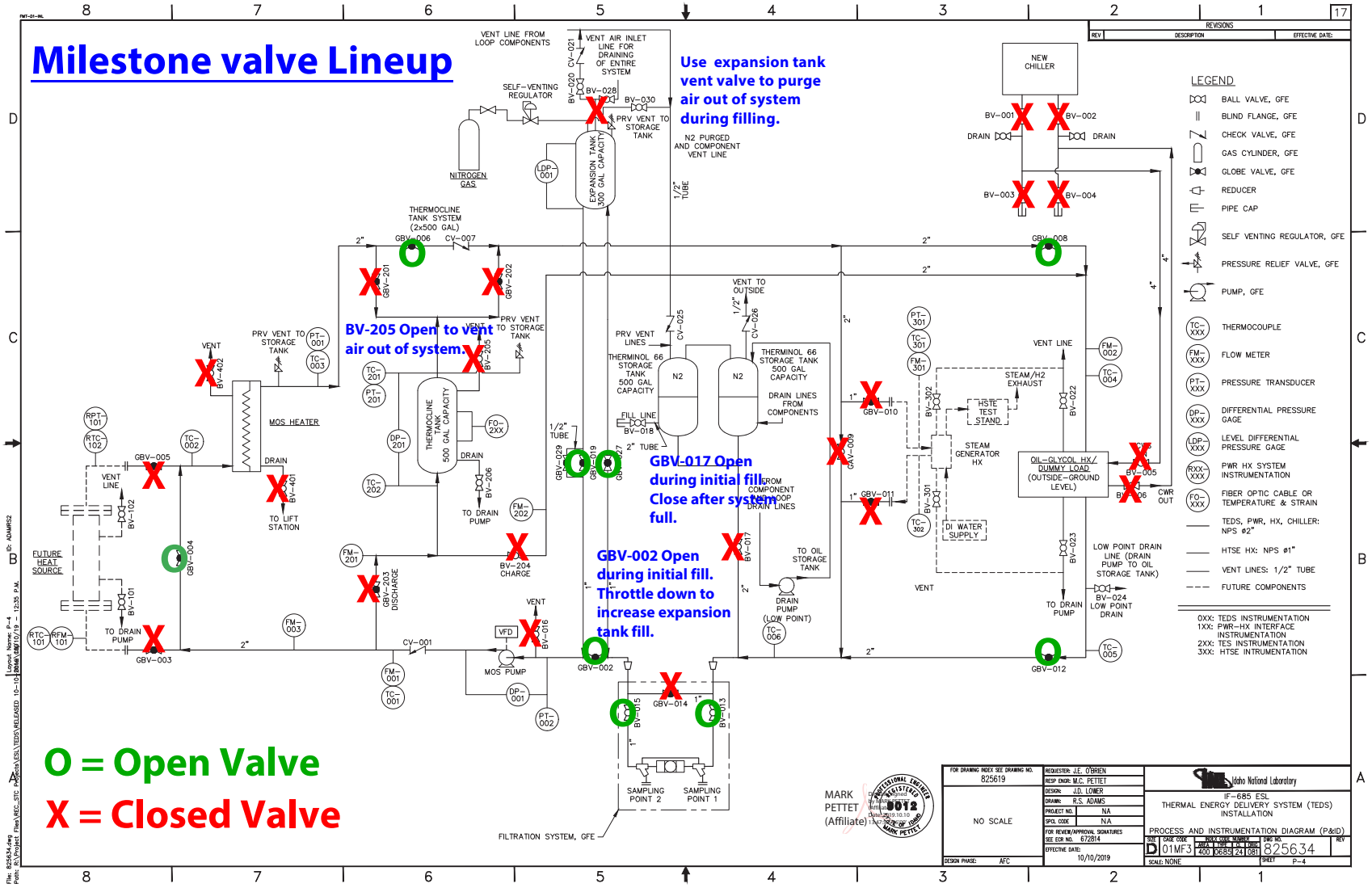

Figure 3: System Configuration/Valve Lineup

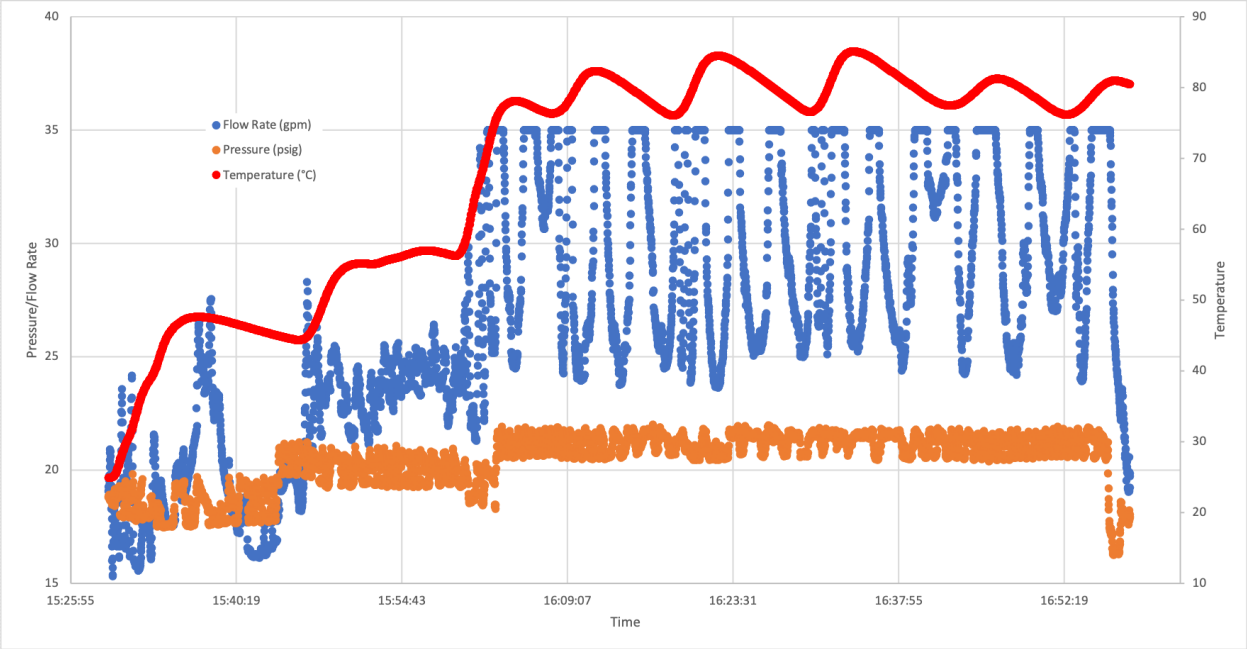

Figure 4: System Operating Parameters

Remaining Construction Schedule

Warranty repairs on the thermal energy storage tank will be completed in early January. Full system commissioning will begin after that repair is complete. The final acceptance test will involve leak checks on all mechanical joints in the system while at nominal operating temperature. Upon completion of that test, the system will be fully insulated. The fully operational TEDS is expected to be turned over to INL early in February to begin system shakedown and characterization testing.