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Liquid Fuel Test Rig:

Failure-to-Fire is perhaps the single most common alarm that occurs on a gas turbine. Another way to put it, **firing** the gas turbine is perhaps the most difficult thing to do during a start-up. Think about all the things that must happen correctly in order to light off the machine:

- Diesel must start. Ratchet must stroke continuously. Clutch must engage.
- Diesel must accelerate the turbine to minimum firing speed (we need air flow).
- Fuel system must be “told” to fire. That is, **VCE** (or **VCO** on older machines) must increase.
- Fuel by-pass valve must stroke to correct position (or fuel pump must stroke, as applicable).
- Flow divider must begin to turn (freewheeling).
- Liquid fuel check valves must open at the correct pressure.
- Fuel nozzles must atomize the fuel into a fine, conically-shaped mist.
- Atomizing air system (if applicable) must assist in the vaporization of the fuel.
- Compartment heaters must keep the fuel lines warm for proper ignition (colder climates).
- Ignition transformers must be told to fire and sparkplugs must actually provide ignition.
- Cross firing between adjacent combustion chambers must occur.
- Flame must be sensed (if U-V detectors are used) or exhaust temperature must rise to indicate flame is present (older machines).
- Fuel flow must be cut back to the warm-up level after flame is sensed.

A tool devised by Mr. Art Sulham (retired gas turbine supervisor from CVPS-Rutland) assisted him in determining if all of the aforementioned devices have functioned properly. Rutland, VT is a cold place in the winter. The CVPS machine (circa 1961 installation) originally had a universal liquid fuel system with a **Roper** flow divider driven by an **Oil Gear** hydraulic motor in the middle. The twin banks of five flow elements were hydraulically driven. Art had problems occasionally over the years, so he invented his test rig to troubleshoot the fuel system. See Figure 1 below.



Fig. 1: Art's Milking Machine temporarily mounted on walkway

The first task when testing the system was to remove the ten fuel-check valves (CV). They could then be inspected, cleaned or replaced. The CV's were designed to open at approximately 65 psig of fuel pressure. Then the test rig, *Art's Milker* as it came to be known, would be installed with its ten clear plastic (low-pressure) hoses. Fuel would then be directed from the tubing lines at the discharge of the flow divider to ten individual one-gallon clear jugs. See photos.



Fig. 2: Art's Milker showing hoses

Once the setup was completed, the sparkplug power leads could also be disconnected (or the entire sparkplug units are removed and placed on the walkway for testing). This could be done independently, if required. Disarming of the sparkplugs was done for safety reasons.

The turbine control panel switch was then placed in the **FIRE** mode and a start signal was initiated. Once the turbine reached firing speed, the one-minute firing cycle would begin. Approximately **2.5 gallons** of fuel should flow, as it was diverted to the ten plastic jugs. In other words, approximately **.25 gallons per jug**, or one quart) would collect during the test if the fuel system was working correctly. The turbine was then shut down.

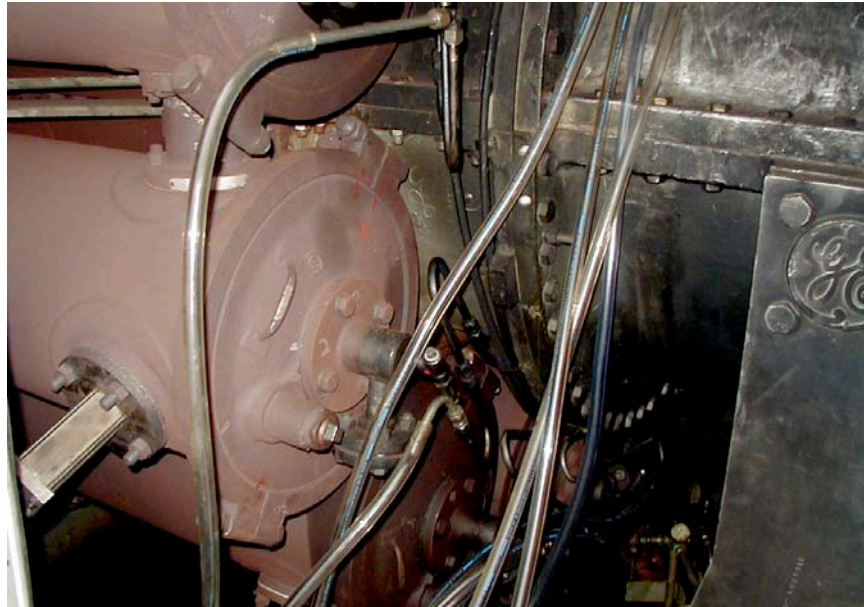


Fig 3: Clear plastic hoses are connected once check valves are removed

The fuel flow test was used to prove the operation of virtually all of the aforementioned elements and helped to “cut to the chase” during the troubleshooting process. Once again, Yankee ingenuity demonstrates how a simple and inexpensive tool like “Art’s Milker” could be used in troubleshooting gas turbine fuel system problems.

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