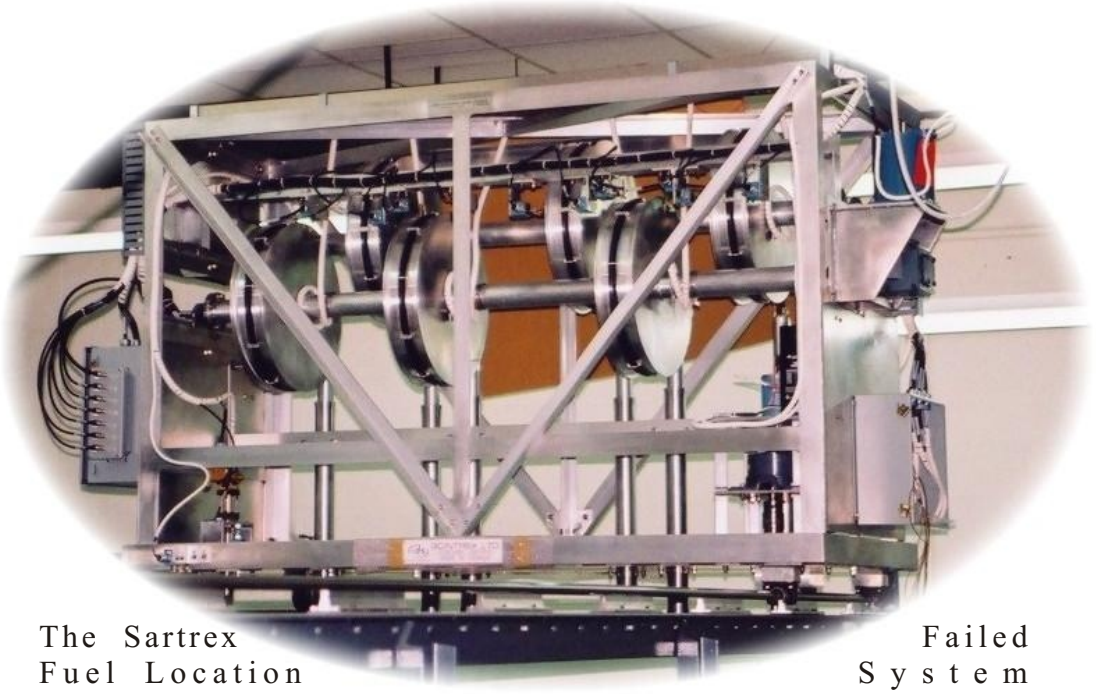
SARTREX
POWER CONTROL
SYSTEMS INC.

Failed Fuel Location System



The Sartrex Failed Fuel Location System (FFLS) identifies a failed fuel channel in a nuclear reactor. It senses neutron decay in the heat transport water (heavy water) leaving the reactor core. During the normal fission process, the fuel rods retain nuclear fuel. If radioactivity escapes from the rods into the surrounding water, the FFLS will detect the high levels of delayed neutron activity.

The process commences by piping the heat transport water from the core to a moderator tank where neutron detectors, suspended in a coil of the piping, can determine the intensity of neutron radiation. These monitor heavy water samples from each reactor channel, individually, to detect a comparatively high level of delayed neutron activity. After circulation through each of the tubes, a header system returns the water to the pump return line.

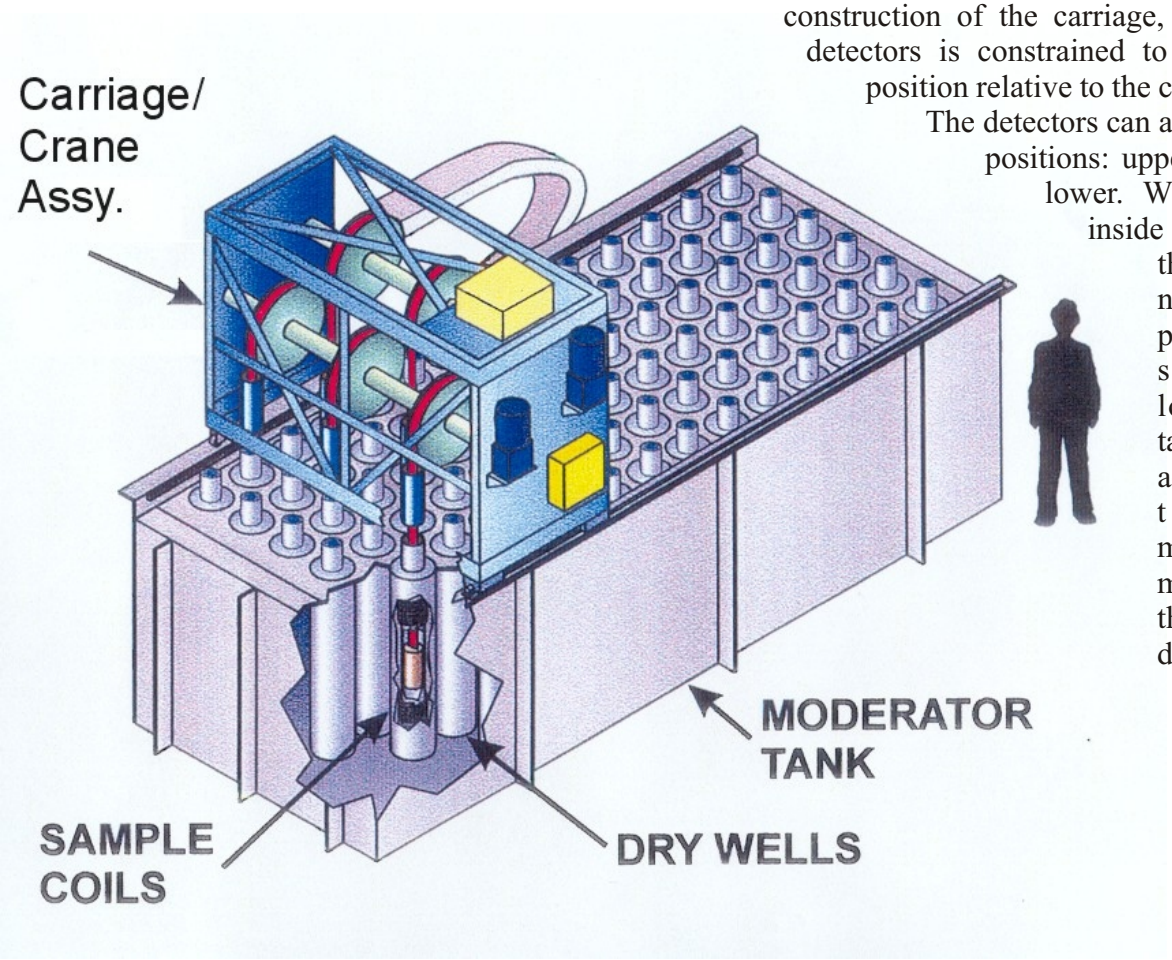
The Programmable Logic Controllers (PLCs) control the electronic control system for the carriages, detectors and data handling. A personal computer workstation is used for the operator interface, as well as to process and store data.

The FFLS consists of several major subsystems as follows.

Moderator Tank with Sample Coil Assembly
Individual pipes bring heavy water samples from each of the reactor channels to the monitoring area. At the end of the process, the collection header assembly collects the heavy water from the sample tubes and the system directs the heavy water back to the reactor system. Sample coils, supported from the tank cover by means of a mounting plate, are suspended in the two large tanks that contain water for the cooling of the coils and to moderate the fast neutrons emitted from the sample coils. A hardware temperature controller controls the moderator tank temperature. The inside of each of the sample coil provides a measurement position for a neutron detector to check for the presence of neutron radiation from fuel fragments in the heavy water.

Carriage
Each carriage transports and positions six neutron radiation detectors along the tank. A stepper motor drives the carriage along the rails fastened to the sides of the tank, and an absolute encoder monitors the position. The carriages are completely independent and are mounted on their own tank rails in separate rooms. When the carriage arrives at a measurement position, a locking pin locks it in place prior to lowering the detectors. Limit switches are placed at the ends of the carriage travel to disable carriage movement beyond these extreme positions. In operation, the carriage is used to sequentially measure each of the tank coils. Each carriage and tank arrangement has electronic support for carriage control, detector signal processing and data handling.

Detectors and Electronics
The neutron detectors, inside the coils, monitor the heavy water samples. Six neutron detectors, in banks of three, are mounted in each of the carriages and are lowered into the coils for measurement. Because of the physical construction of the carriage, each bank of three detectors is constrained to move to the same position relative to the coils and the carriage. The detectors can assume three possible positions: upper (out), middle and lower. When the detectors are inside the carriage (out) they can move to the next measurement point. There are sixteen carriage locations on each tank. Limit switches, activated by pins on the detector movement mechanism, record the position of the detectors.



Control Cabinet

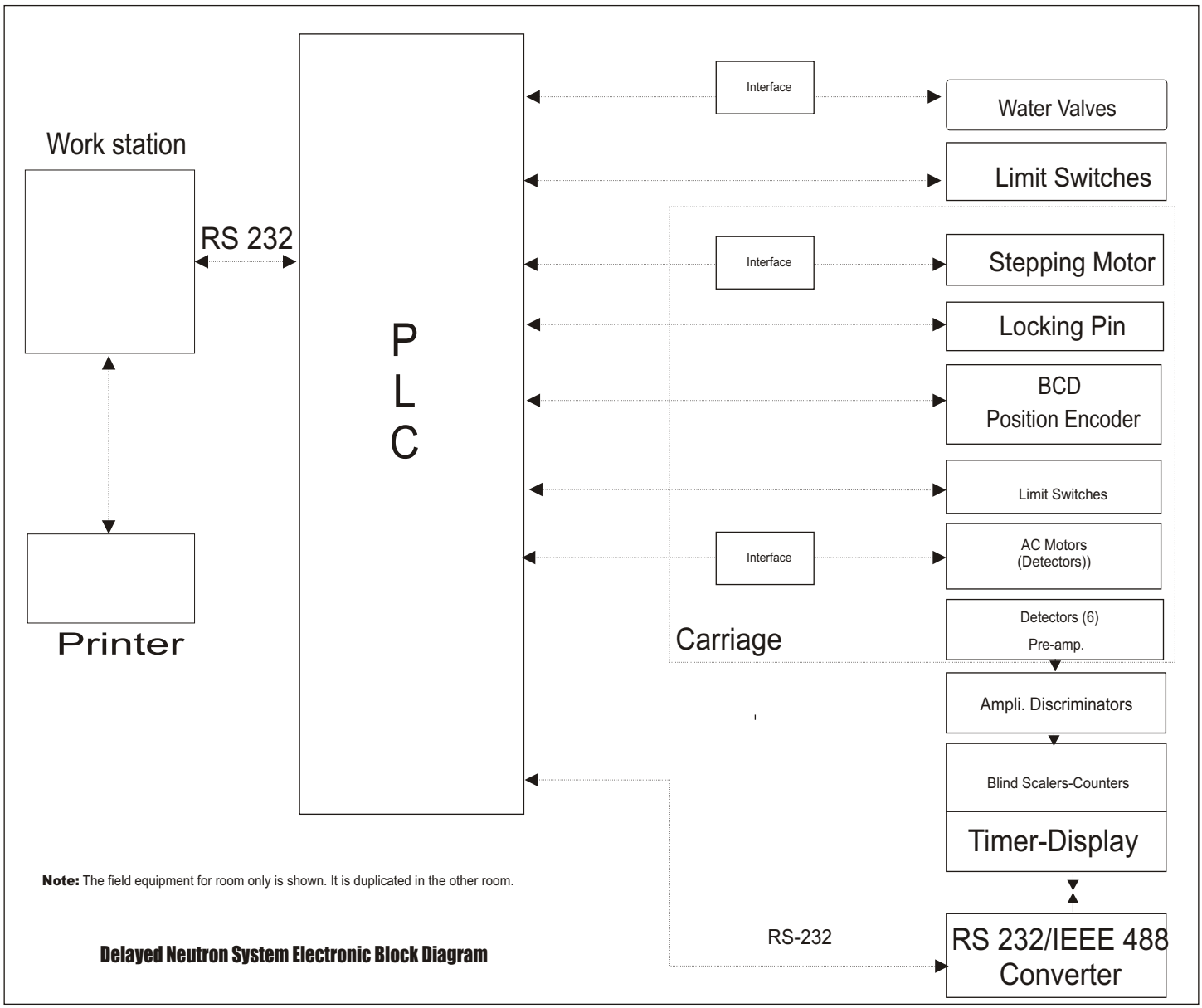
Programmable Logic Controllers
The PLC assembly controls almost all of the electronics for each of the failed fuel location rooms. It regulates the water valves, which allow the heavy water to pass through sections of the sample coils. It also controls and monitors the limit-switches used in the detector and carriage movement assemblies. The PLCs carry out the program functions to ensure safety interlocks and stores all data and information. As well, it performs the communication links between the CPU module and operator workstation.

Wiring and Calibrating PLC

Computer Workstation
A personal computer workstation is used for the operator interface that displays, processes and stores the information. It also controls the carriage position setting, locking pin, detector position and valve. Normal operations feature selection of the mode, room, loop, or scan settings.

Radiation Counters/ Radiation Amplifiers
The neutron detectors and pre-amplifiers are part of the carriage assembly. The amplifier discriminators, the blind scaler counters and timer displays are remotely positioned about 200 feet away from the measurement area. The detector information is transferred to and controlled by the PLCs.

Computer Workstation and Control Cabinet for Programmable Logic



Note: The field equipment for room only is shown. It is duplicated in the other room.

Delayed Neutron System Electronic Block Diagram

Specifications of PLC Components:

Quantity	Description	Model Number	Specifications
1	Power Supply Module	6ES7-407-0KA00-0AA0	10A
1	CPU 414-1	6ES7-414-1XG01-0AB0	72KB RAM
1	CP 441-2	6ES7-2AA00-0AE0	128KB RAM, 1MB Memory Card
2	Digital Input Models	6ES7-421-1BL00-0AA0	24 VDC
2	Relay Output Modules	6ES7-422-1HH00-0AA0	16 outputs
1	FM 453 Positioning Module	6ES7-453-3AH01-0AE0	