WANL-TME-183

Serial No. CD-954

PRELIMINARY FUNCTIONAL DESIGN INFORMATION

FOR

PROTOTYPE ETS TEST OPERATIONS CONSOLE

MASTER

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Attachments: WANL Preliminary Drawing 934 J 970
WANL Preliminary Sketch - "Rod Lock and Position Control Schematic"
Functional Description of Manual Rod Control System
Functional Description of Reactor and Engine Panel Controls and Instrumentation

A. E. Margulies
October 31, 1962

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In fulfillment of Action Items 313, 314 and 315 of September Technical Management Meeting, WANL personnel (A. E. Margulies and M. Kendziorek) made contributions to the subject planning at Azusa on October 18-19. They presented Westinghouse planning in the following areas:

- (1) The functions to be performed at the ETS Test Operations Console prior to, during and after an engine test run.
- (2) The WANL proposed functional layout of controls and instrumentation required for the Reactor and Engine Panels of the Test Operations Console.
- (3) A discussion of the manual rod control system wiring diagram prepared at WANL.

Aerojet personnel at this meeting concurred with the general layout and functions at the Reactor and Engine Panels except for the following:

- (1) Location of the manual cooldown controls, which Aerojet personnel felt should be moved to the Engine Panel.
- (2) Individual manual rod controls had been provided at the Reactor Panel for pre-test checkout and zero power physics tests, but no provision had been made for manual bank rod control.

The attached drawing No. 934 J 970 and accompanying Functional Description of Engine and Reactor Panel Controls and Instrumentation reflect the information presented during the October 18 - 19 meetings except that manual bank rod control capability has been added to the Power Controller on the Engine Panel. This change is also reflected on the attached preliminary sketch - "Rod Lock and Position Control Schematic" and accompanying Functional Description of the Manual Drum Control System. (Action Item 323 of October Technical Management meeting)

FUNCTIONAL DESCRIPTION

OF

REACTOR AND ENGINE PANEL CONTROLS AND INSTRUMENTATION

Described below are the panel controls and instrumentation shown on WANL drawing 934 J 970, ETS Test Operations Console, Reactor and Engine Panels Alt. III-A.

Reactor Panel

It is assumed that the Reactor Panel will provide capability for the following functions:

- (1) Pretest checkout of the engine nuclear subsystem including checkout of each rod individually, with associated actuating and control system, low power physics tests, monitoring of reactor protection system checks and simulator readiness runs.
- (2) Monitoring of all essential nuclear subsystem parameters during the test run.
- (3) Monitoring programmed cooldown with manual override controls for backup and performance of post run physics tests.

Functional Description of Reactor Panel Equipment

Twelve Rod Position Indicators for display of individual rod position and for comparison with average rod position indicators.

Twelve Locked - Unlocked Lights - actuated by limit switches to indicate true position of rod mechanical locks.

Twelve Rod Control Potentiometers (R-1 thru R-12) for positioning of each individual rod through full range of travel from 0° to 180°. These are provided for use in performing physics tests.

One control switch (S102), selector with "Physics Test" and "Reactor Ready" positions. In "Physics Test" position it permits manual rod control by means of Potentiometers R-1 thru R-12, provided certain safety conditions have been satisfied. A "Reactor Ready" position is provided to permit transfer of rod control from the Reactor Panel to the Engine Panel.

One Key Switch (S101) with "Rods Locked" and "Run Permissive" positions. The latter position permits the rods to be unlocked using Selector Switch S105 and "Unlock Selected Rod" push button PB-2.

One Rod Selector Switch (S105) permits selected rods to be unlocked by means of Pushbutton PB-2. Pushbutton PB-1 releases (locks) all unlocked rods.

Four Channel Selector Switches (S106 thru S109) one each for source, intermediate and power ranges (4 positions - one each for any of the 3 detectors and one for the auctioneered signal for control) and one for linear power selector (2 position - 2 detectors).

Nine meters of Log N, Period, Linear Power and average drum position.

Five meters of temperature, pressure and flow associated with reactor inlet and outlet conditions.

Six meters of temperature and flow for cooldown monitoring.

One temperature monitor for core structure has auto scanning with a light indicator alarm, a location selector (S104), a Hi - Lo range selector switch and a temperature indicator.

One set of actuator indicators and alarms (details later) including actuator position limits, torque, temperature, and actuation pressure.

Twenty one status lights (details later).

Six "Open" - "Closed" lights for cooldown monitoring of valve position for each of three gaseous coolouts (hydrogen, helium and nitrogen).

Six pushbuttons for override control of cooldown program.

One cooldown mode selector switch (S401) with "manual" and "auto" positions.

Engine Panel

The Engine Panel would contain the controls and indications directly associated with the reactor-engine. It is assumed that the Facilities Section of the Console (no details shown here) will contain all controls for preparation of the Test Stand facilities systems (the shields, ducts, etc.). Thus, with Reactor and Facilities checkouts performed at other than the Engine Console, the Engine Panel would be used for normal "run" initiation, monitoring and shutdown of engine tests.

Functional Description of Engine Panel Equipment

Two Pushbuttons, one SCRAM and one SCRAM Reset. (The SCRAM chain may require other reset features).

One master switch (S202) with a "Run" position permitting programmed or manual control and a "shutdown" position to initiate shutdown sequence.

One Program Control Switch (S203) for "Program Auto", "Experiment Run" and "Hold" modes of operation.

One Program Fire Control Group, for control of automatic program. Includes functions of Program-Reset, Arm or Dis-Arm and Fire. "Ready" and "Fire" indicator lights are closely associated indicator functions.

Two Timers, one range time, one interval (with re-set and start controls for time interval observation).

Twenty Eight status Lights for desired usage.

One Set of Feed System Indicators including Normal and/or Ready indications for Pressurization, Relief, Refill and Purging Systems associated with Facilities. Also, various indications for Valve Position, Run Tank Level and Run Tank Overpressure are included.

Eight Meters for indication of Turbo Pump Pressure, Log-N-Power, Linear Power, Period, Average Drum Position, Chamber Pressure, Chamber Temperature and Mass Flow Rate.

Three Sets of Controls for development of appropriate programs including typical set-point pots, trims and error meters for:

- a. Liquid Flow Control
- b. Power Control
- c. Temperature Control

FUNCTIONAL DESCRIPTION
OF
MANUAL ROD CONTROL SYSTEM

This system provides the functions of single or multiple manual rod control, actuator lock control, and safety interlocks to prevent dangerous manual operations.

One method of single rod control is available in the test cell building. This mode of operation is required to facilitate control system, servo amplifier, and actuator check out and calibration. Since this procedure may be a lengthy time consuming process that must be performed for each reactor, it is desirable to have this capability independent of the control room functions. Thus, work on the control room and console check out can proceed simultaneously with actuator check out. Safety has been the prime consideration in the design of the manual rod control system. Even though manual rod control from the test cell building will only be performed with the reactor safely poisoned, the circuit is so designed that only one rod at a time can be moved from the test cell. This provides an additional margin of safety since the reactor cannot approach criticality by moving a single rod.

This forward control of a single drum has proven very useful in the Kiwi reactor tests performed by LASL and it is felt that the capability should be retained for NERVA.

The operator will select the rod to be controlled by means of selector switch S6. Meter M1 will indicate the position of the selected rod. When key switch S5, is turned to the TEST position, a manual control signal can be applied to any servo amplifiers by means of potentiometer R13 or by an external function generator. At the same time, the selected rod will be unlocked.

A second method of single rod control is available in the main control room at the reactor control panel. Twelve potentiometers, located behind a normally locked sliding panel, control all twelve rods individually. Selector switch S102 must be in the PHYSICS TEST position and the following conditions must be met before the manual control can be activated:

- (1) All potentiometers must be in the zero position. (K7 energized by the bistable amplifier.)
- (2) All rods must be in the zero and locked condition. (K1 deenergized by normally open contacts on the actuator locking pin limit switches.)
- (3) Key switch S101 must be in the START PERMIT position and selector switch S105 must be in the OFF position.
- (4) The reactor power level must be below a preset minimum value. (K6 is energized.)

When all of the above safety conditions have been satisfied, relay K3 pulls in and seals in with contact K3. This applies a voltage to all of the potentiometers and a manual control signal can be sent to the servo amplifiers. The rods may now

be unlocked individually by rotating S105 to the desired rods and pushing PB-2. As each lock is picked up it seals in through the normally open contact on its pin limit switch. Indicator lights, below each rod position indicator, light up to show the condition of each rod lock. The selected rods can now be manipulated at will by means of the twelve potentiometers. If the power level is exceeded, the rods will immediately return to zero because K3 drops out when K6 opens. A scram signal will drop out K4 causing all rods to lock when they return to zero. All locks may be locked by pushing PB-1.

At the conclusion of the physics test, the reactor can be switched to normal operation by means of S102 provided that all potentiometers are at zero and all rods are locked at zero. Then relay K2 will pull in, seal in, and cause K3 to drop out. The servo amplifiers are now ready to receive their signal from the automatic control system.

Key switches S101 and S5, located on the reactor console and in the test cell building respectively use the same key. Thus, it is impossible to control the reactor from both points simultaneously.

A third mode of manual rod control is available at the Engine Control Panel. The reactor may be manually controlled at any power level by adjusting potentiometer R14. In order to switch in or out of manual rod position control, the position demand voltage from the reactor control system must match the voltage set by R14. When the difference between these voltages is near zero, K5 is pulled in by the bistable amplifier which senses the error magnitude. Relay K9 is normally energized and K8 is deenergized. Thus, the control signal comes from the automatic system. If K5 is energized, S203 in the EXPERIMENT RUN position, and S304 in the ROD POSITION CONTROL, relay K8 will pick up. This causes control to be transferred to the Potentiometer R14. K8 will remain energized even when K5 drops out. Automatic control cannot be restored until K5 pulls in again.

M. Kendziorek

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