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OVERVIEW OF SNS TARGET STATION AMBIENT SERVICES MONITORS AND CONTROLS

D J CLARKE, G H EATON

COMPUTER SYSTEMS

The SNS Target Station has a cooling plant comprising around nine separate water circuits, on which there are more than 200 remotely operated valves and almost as many sensor points. We do not attempt to provide organised hardwired display of this data but feed it into the computer system, and use programmes to show the status of the plant, both past and present, on TV monitors driven from graphics modules.

The main computer is a GEC 4070 minicomputer running GRACES. This is similar to those used on the rest of the SNS (but entirely dissimilar from the VAX computers used for data collection on the experiments). We also use an Intel single-board microcomputer of a certain age to scan around critical parameters and deliver them 'in bulk' to the GEC 4070 minicomputer. This relieves the minicomputer of a tiresome duty, leaving it able to do more interesting things like drawing pictures for the operators to look at it.

The system is now running well. It does sieze up occasionally but its behaviour is otherwise predictable and consistent. We use the programmes to monitor the state of the water circuits to check for shifts in performance, but, as yet, it is too early to see any interesting changes. The minicomputer is networked to the SNS machine control computers so that it is possible to monitor the target station plant from the SNS Main Control Room. However, we still man the Target Station Control Room as certain other systems are not automatic (Shutters, ventilation).

DISPLAY AND CONTROL SYSTEMS

The Target Station plant is controlled from a 'control desk' in the Target Station Control Room. The intention is that the Target Station should run unattended, but a desk is needed for startup and shutdown of the plant, as well as for the setting-up and shakedown going on at present.

The desk hardware used is similar to that elsewhere on the SNS, but we have not indulged in the luxury of touch-screen or colour graphics. Basic equipment is as follows.

VDU 1 - Connected to IGRC*
VDU 2 - Connected to AGRC*
TV 1 - Connected to GREEN
TV 2 - Connected to RED
TV 3 - Connected to BLUE
} Separate outputs from CAMAC Video generators USED AS 3 MONOCHROME SCREENS
TV 4 - Connected to display beam diagnostics

TRACKBALL - Drives cursor on 'GREEN' screen
TWIN 'KNOBS' - For adjusting parameters
TELEPHONE - Used for commissioning all equipment.

* GRACES allows for several concurrent tasks. IGRC and AGRC are both driven from a VDU with keyboard (AGRC, IGRC are but two of six or more current tasks running on the GEC Minicomputer).

DATA ACQUISITION HARDWARE

Because of the fairly respectable radiation dose from activation in the cooling plant, all the sensors and actuators are free of electronic components. This means that all the amplifiers and so on are in the Control Room, (and not distributed about the plant).

Because the computer system is a little prone to crashing, we provide local displays and controls for nearly all the parameters, but there is no attempt to organise them beyond labelling the interface/display with the identifier of the device to which it is connected. This is because we use the computer to organise and display the data for us. (see below).

In order to provide hardwired trips for use on the interlock systems, many of the measured parameters have individual panel meter/trip displays. These are standard commercial hardware. For some tasks e.g. flowmeter readout, proportional valve control and on/off valve control, we have designed and built our own interface hardware.

All communication between the computer systems and the hardware is via MPX hardware, which is an SNS-standard CAMAC-like system. This is fully operational and works well.

SOFTWARE FOR CONTROL AND MONITORING

The complex system of ambient temperature cooling circuits of the SNS Target Station is monitored and controlled by an equally complex suite of computer programs running on the GEC 4070 target station computer. For operator convenience, the large number of programs are menu-driven from the TV monitors according to the desired function i.e.

Start-up/Shutdown and Optimisation of Plant.
Routine monitoring and Optimisation of Plant.
Plotting and Averaging Routines for Plant Parameters.

These menus are used during operation of the ambient systems and have been commissioned successfully during the June-July 1985 period. Reliable and stable operation of both the ambient circuits and the control system has been amply demonstrated. In addition to these menu-driven operational programs, a separate menu-driven suite of programs has been written for filling and draining of the ambient circuits, prior to and after operation. These have also been successfully debugged and commissioned and greatly facilitate these tasks as well as minimising the occurence of operator error.

These programs are all run from the Target Station Control Room. Full descriptions of the Computer Control system is given in RAL-84-103.

Routine monitoring of the ambient circuits and of the two cryogenic moderators, will be handled soon from the SNS Main Control Room (MCR), using two programs specially developed for this task.

The first program displays in the MCR all the critical ambient circuit parameters monitored by the microprocessor computer system.

Should any parameter approach a fault level, this is indicated in the MCR and the operator is able to reoptimize the appropriate circuit in the Target Station Control Room using the full suite of optimisation programs.

A similar program displays the important parameters for the (cryogenic) methane and hydrogen moderators.

INTERLOCKS

The interfaces which deliver digitised parameters to the computer are also, in many cases, fitted with trip outputs in the form of relay closures. These are used to provide hardwired protection against certain calamities. Here is an outline of the interlock system into which these trips are fed.

Target Beam Trip System (TBT).

For those flows and pressures that we consider to be the most sensitive indicators of healthy cooling of the target, and also for the target plate thermocouples, we connect trip contacts in series, in a set of modules known as the Target Beam Trip (TBT) Systems. These are very simple but provide a means of formalising the connections so that faults are easily found and rectified. It is also hard to put an invisible 'frig' onto the system.

The two TBT Systems are now operational and providing a beam-permit signal to the SNS accelerator.

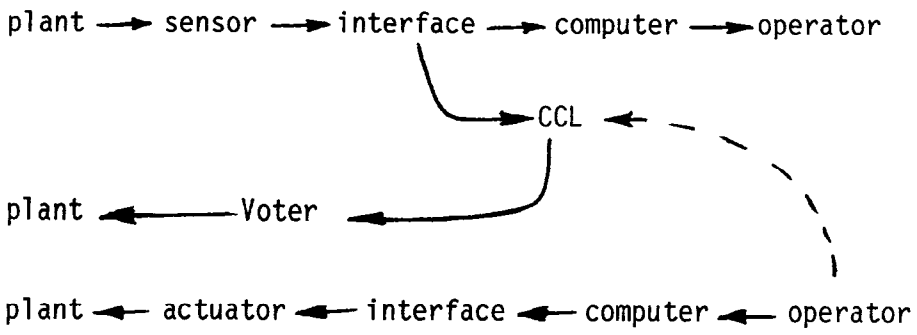
Coolant Control Logic (CCL)

The second type of interlock system on the Target Station is the Coolant Control Logic (CCL).

This will, when completed, provide safety actions by means of three (triple-redundant) Programmable Logic Controllers (PLCs). At present, the wiring of these is about half-complete, but the actuators on the plant are operational, allowing us full control of the plant during startup and shutdown.

The aim of the CCL is to prevent certain actions, by disabling parts of the plant (eg. drain valves) when their operation is not required. This is done at present using 'manual' operation of the CCL actuators by means of simulator boxes plugged in place of the PLCs.

The key to the design of the CCL is that voting (to determine the final outcome of the logic) is done on the plant in a way which is direct. This minimises the effect of single failures, wherever they may occur. The flow of information is therefore as follows:



BIBLIOGRAPHY

1. =SNS TARGET STATION SAFETY ASSESSMENT
   =
   =ED A CARNE
   =SNS/PC/P6/82
   = 1982

2. =PROPOSAL FOR AN ON-LINE CLAD FAILURE DETECTION SYSTEM FOR THE
   =SNS TARGET STATION USING HIGH RESOLUTION GAMMA RAY SPECTROSCOPY
   =G H EATON
   =SNS/TS/N10/82
   = 1982

3. =FOR THE PROVISION OF A DEPENDABLE ELECTRICITY SUPPLY
   =FOR THE SNS TARGET STATION
   =D J CLARKE
   =SNS/TS/N4/82
   =APRIL 1982

4. =NODDY'S GUIDE TO MPX MODULES ON THE SNS CONTROL SYSTEM
   =
   =R P MANNIX
   =PRIVATE COMMUNICATION (AVAIL. AUTHOR)
   =APRIL 1984

5. =SNS TARGET STATION CONTROLS BEAM TRIP
   =MECHANISMS - REVISION 2
   =D J CLARKE
   =SNS/TS/N20/83
   =DEC 1983

6. =PRESSURE DROP OF THE TARGET SUBJECT TO FLOW AND
   =GAP BETWEEN PLATES
   =J BLOMBACH
   =SNS/TS/N21/83
   =DEC 1983

7. =SNS TARGET STATION SOFTWARE OPERATORS MANUAL
   =
   =ED M R GEARY
   =RAL-84-103
   =DEC 1984

8. =DISPLAY PROGRAMME FOR THE CONTROL OF THE SNS TARGET STATION
   =
   =G H EATON
   =SNS/TS/N1/82
   =FEB 1982

9. =SOME FEATURES OF THE COMPUTER CONTROL SYSTEM FOR THE
   =SPALLATION NEUTRON SOURCE (SNS)OF THE R A L
   =T R M EDWARDS
   =SNS/CON/N1/84
   =JAN 1984

10. =ON THE QUESTION OF HUMAN INTERVENTION IN THE
    =(SNS) TARGET STATION CONTROLS
    =J BLOMBACH D J CLARKE G H EATON K H ROBERTS
    =SNS/TS/N1/84

11. =SNS TARGET STATION CONTROLS SAFETY SURVEY
    =
    =D J CLARKE
    =SNS/TS/N3/81
    =JULY 1981
    =LOOKS AT THE IDEAS BEHIND MAKING A SYSTEM SAFE

12. =GRACES MANUAL
    =P HASKELL
    =RL-84-043
    =JULY 1984
    =SOFTWARE MANUAL FOR USERS OF THE GRACES LANGUAGE

13. =GRACES HANDBOOK
    =
    =P HASKELL
    =--
    =JULY 1984
    =PROVIDES HELP WITH HOW TO USE GRACES

14. =OUTLINE OF OPERATION OF VALVE CONTROL INTERLOCKS
    =ON SNS TARGET COOLING PLANT
    =D J CLARKE
    =SNS/TS/N9/85
    =JULY 1985

15. =CONCERNING THE INTEGRITY-BY-DESIGN OF THE SNS
    =TARGET STATION CONTROLS
    =D J CLARKE   A J H GODDARD
    =SNS/TS/N6/83
    =JUNE 1983

16. =THE SELECTION OF RADIATION-HARD SENSORS FOR THE
    =MONITORING OF THE SNS TARGET SERVICES PLANT
    =D J CLARKE
    =SNS/TS/N7/82
    =MAY 1982

17. =STRUCTURE OF THE SNS TARGET STATION CONTROLS
    =
    =D J CLARKE
    =SNS/TS/N7/81
    =NOV 1981

18. =CONCERNING COMPUTER CONTROL OF THE SNS EXTRACTED PROTON
    =BEAM AND TARGET STATION
    =D J CLARKE   G H EATON
    =SNS/TS/N6/81
    =SEPT 1981

19. =TARGET TEMPERATURE MONITORING
    =
    =D J CLARKE
    =SNS/TS/N5/81
    =SEPT 1981

20. =FAIL-SAFE FEATURES OF THE TARGET STATION MONITORING
    =CONTROL AND INTERLOCK SYSTEMS
    =D J CLARKE G H EATON
    =SNS/TS/N17/83
    =SEPT 1983
    =

21. =SNS TARGET STATION HAZARD SURVEY
    =
    =SNS TARGET STATION STAFF
    =SNS/ENV/N1/ REV1
    =SEPT 1983