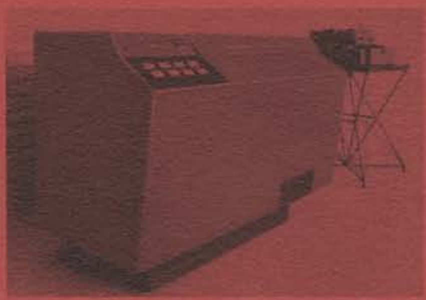
NUCLEAR REACTOR MONITORING



A new application of the
RW-300 Digital Control Computer

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY
a division of Thompson Ramo Wooldridge Inc.

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RUPTURED FUEL ELEMENT DETECTION SYSTEM

A system incorporating two RW-300 Digital Control Computers will be utilized to detect and locate ruptured fuel elements in the first commercial nuclear reactor in France. The system will monitor the radioactivity of the cooling gas flowing through the reactor. A pinhole, split, or other fault in one of the 1, 148 fuel slugs will cause a gradual increase in the radioactivity of the gas flowing through the associated cooling channel. This condition must be detected before the radiation becomes dangerous to personnel or damages the reactor.

The thermal reactor, designated EDF-1, will have a rated output of 300 megawatts of heat and 80 megawatts of electricity. For approximately one year after initial startup, it will be the largest nuclear reactor operating in the world. It will require 100-150 tons of natural uranium as fuel and 1, 200 tons of graphite as moderator. Carbon dioxide at a pressure of 360 psig will be the coolant. The reactor will go critical this summer with one RW-300 computer connected to the detection system, but will not be placed in full, normal operation until the second RW-300 is added to the system during the fall.

The nuclear power plant is being constructed near Chinon, France, by Electricite de France, government-owned electric power utility, with technical assistance from the French Atomic Energy Commission. Intertechnique, a prominent French electronics and instrumentation company, has the primary responsibility for engineering and fabricating the detection system. Ramo-Wooldridge Division of Thompson Ramo Wooldridge Inc. has manufactured one of the RW-300 computers, and Intertechnique is building the other RW-300 for this system. Ramo-Wooldridge developed this advanced transistorized computer for on-line control, data reduction, and data logging applications.

In addition to the two RW-300 computers, the ruptured fuel element detection system consists of seven automatic typewriters, a paper tape punch, a paper tape reader, radiation detectors, electronic binary counters, electronic input-output equipment for the computers, and sequencing and timing equipment. (See Figure 1.) Five of the typewriters will print out computed radioactivity values, one will log reference values, and one will indicate equipment breakdowns.

The computers will continuously scan the binary counters, which are connected to detectors (radiation detecting devices) in the cooling channels. Using the data obtained, the computers will calculate a radioactivity value for each channel, compare this value against a predetermined limit, actuate alarm and warning devices when the limit is exceeded, and print out the calculated values and other information.

For scanning purposes, the 1,148 cooling channels in the reactor will be divided into 287 groups of four each. Every minute 12 channels

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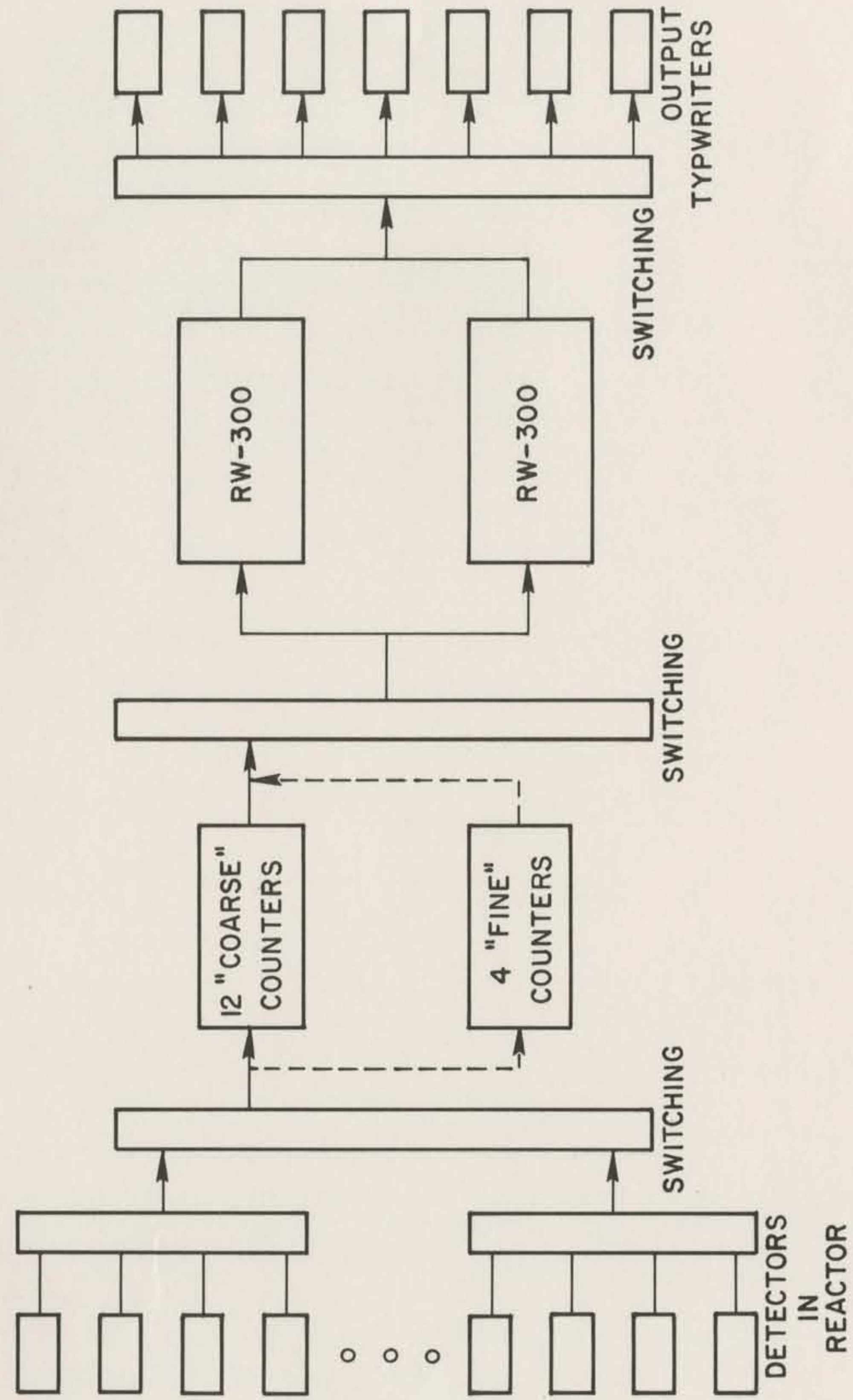

Figure 1. RW-300 Nuclear Reactor Monitoring System

in different groups will be switched to 12 detectors for a "coarse" scanning cycle. All groups will be scanned in 24 minutes.

The binary counters will accumulate and present to the computers two sets of measurements: a background gas activity count and a relative gas activity count. From these data and from the measurements of general activity in the reactor, the computers will calculate the change in the radioactivity of the cooling gas in each group of channels. That value will be logged and will be checked for a slight increase above normal. When the value exceeds the normal limit, all four channels in the group will be switched to one of four additional detectors for a "fine" scanning cycle. The computers will calculate a normalized radioactivity value for each of these channels, and if any of these figures exceeds an upper limit, a warning signal will be given. If the condition continues beyond a safe level, an alarm device will be actuated. All four channels will be scanned in four minutes.

To ensure that this protection is available without interruption of any kind, the RW-300 computers will operate in parallel, with both machines receiving all input data and making all calculations. Only one computer, however, will operate the automatic typewriters, the alarm devices, and the other output devices. If that computer stops or makes an error, the other computer will take over the output devices. Each of the computers will check its own operation once a minute.

The RW-300 computers used in this system are standard models equipped to operate on 50-cps, 127-volt power. Each computer incorporates approximately 500 transistors and 4000 semiconductor diodes, extensive printed wiring, modular construction, and a large magnetic drum memory. Only 36 inches high, 56 inches long, and 29 inches deep, the machine weighs approximately 600 pounds.

OTHER NUCLEAR APPLICATIONS OF THE RW-300

In addition to reactor monitoring, the RW-300 Digital Control Computer has a variety of other applications in the field of nuclear energy. Some important uses are data logging, alarm scanning, on-line computation, data reduction, sequencing, and automatic control. A typical RW-300 computer system is shown in Figure 2.

For power reactors, RW-300 systems can perform control and sequencing functions as well as providing data meaningful for plant operation. For example, an RW-300 computer control system could exercise fast and accurate control of the steam-generating equipment in a nuclear power plant. Thus, since steam plant operation is tied directly to the control of the reactor, fluctuations in load demand could be quickly determined and automatically passed along to the reactor control system.

In conjunction with research reactors, computer systems can be used to facilitate testing and data handling. Since the RW-300 can be connected directly to measuring and sensing instruments, it can automatically read temperatures, pressures, flows, neutron fluxes, and other quantities. It can also reduce this data as it is being collected, providing quick-look data while the test is in progress and final data soon after it is completed. Another function that an RW-300 system can perform is to pre-program control adjustments and to make new adjustments as the effects of previous actions are detected by the system. In this way, more tests can be run in a given time.

The computer, which is being installed in closed-loop control systems for a number of commercial chemical plants and oil refineries, can be used in a similar manner to control the operations involved in fuel processing and reprocessing. Since these operations involve highly radioactive materials and are therefore remotely controlled, a complex control and safety monitoring system is essential. The use of an RW-300 can provide comprehensive, sophisticated control of entire processes.

The RW-300, which incorporates a general-purpose digital computer and a matched analog-digital conversion unit, is especially designed for high reliability of operation. In addition, it has the speed, accuracy, and flexibility required for reactor monitoring, testing, and supervisory functions.

Experienced systems engineers from The Thompson-Ramo-Wooldridge Products Company, a division of Thompson Ramo Wooldridge Inc., are available to discuss nuclear applications of the RW-300 Digital Control

Computer. To arrange for a conference and to obtain additional technical information, please write Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P. O. Box 90067 Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

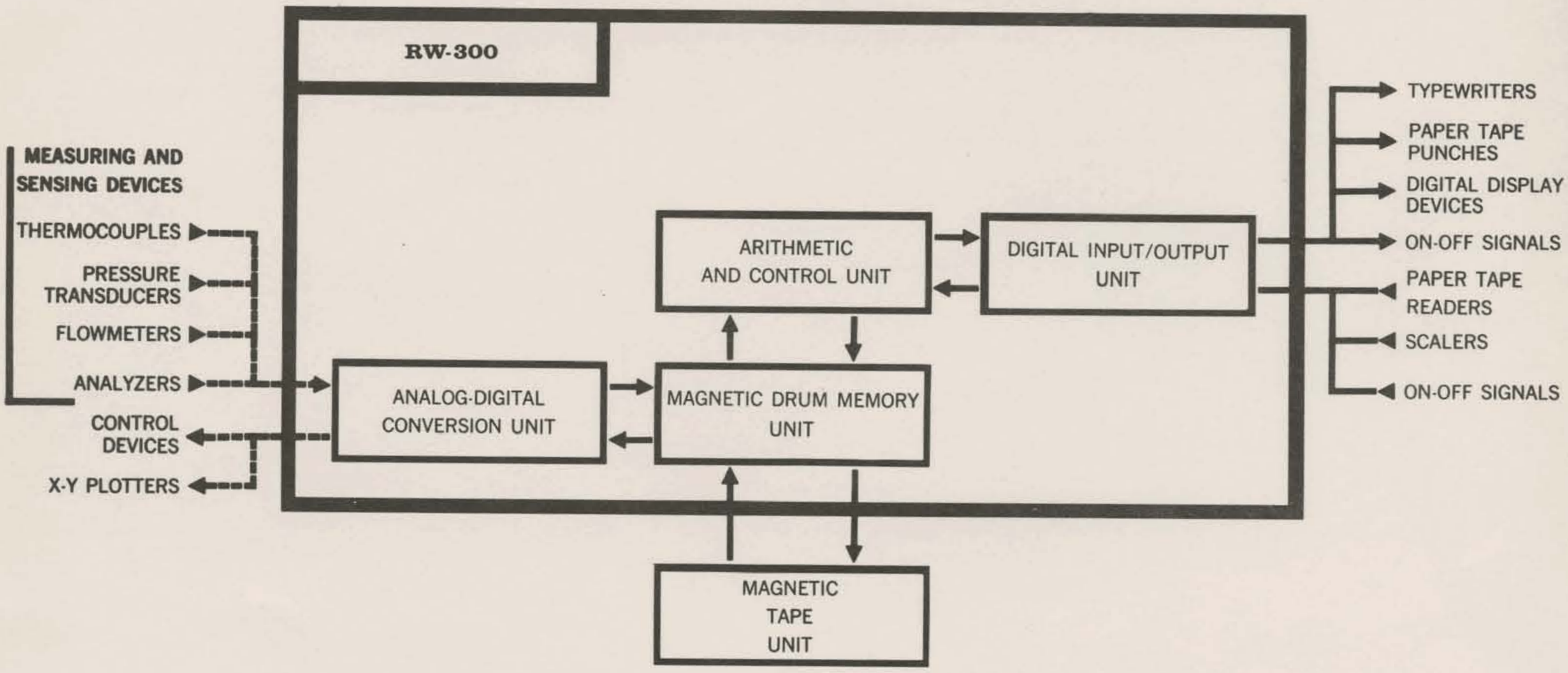

Figure 2
TYPICAL RW-300 COMPUTER SYSTEM

COMPUTER CONTROL SYSTEMS
DATA-LOGGING AND SCANNING SYSTEMS
SYSTEMS ENGINEERING

For further information, call or write

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