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AMERICAN NUCLEAR SOCIETY

TRANSACTIONS

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TRANSACTIONS

OF THE
AMERICAN NUCLEAR SOCIETY

1977 ANNUAL MEETING

Statler Hilton Hotel | June 12-16, 1977 | New York, N.Y.

TECHNICAL SESSIONS

MONDAY, JUNE 13, 9:30 AM

MONDAY, JUNE 13, 2:00 PM

TUESDAY, JUNE 14, 9:00 AM

*Special Session.

TUESDAY, JUNE 14, 2:30 PM

WEDNESDAY, JUNE 15, 9:00 AM

WEDNESDAY, JUNE 15, 2:00 PM

THURSDAY, JUNE 16, 8:30 AM

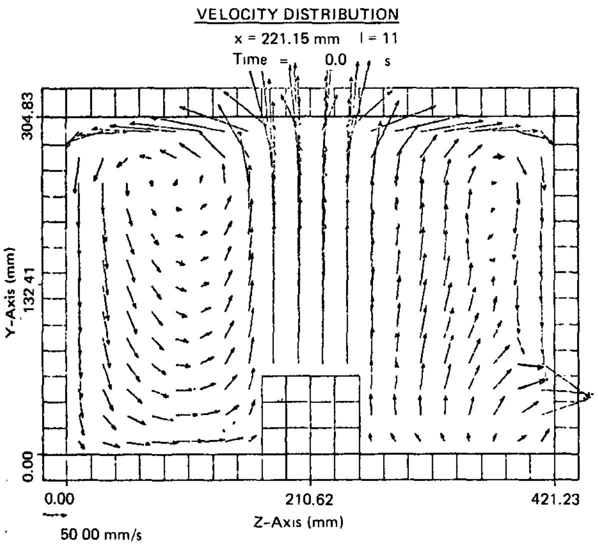

Fig. 2a. Velocity profile at steady state across A-A.

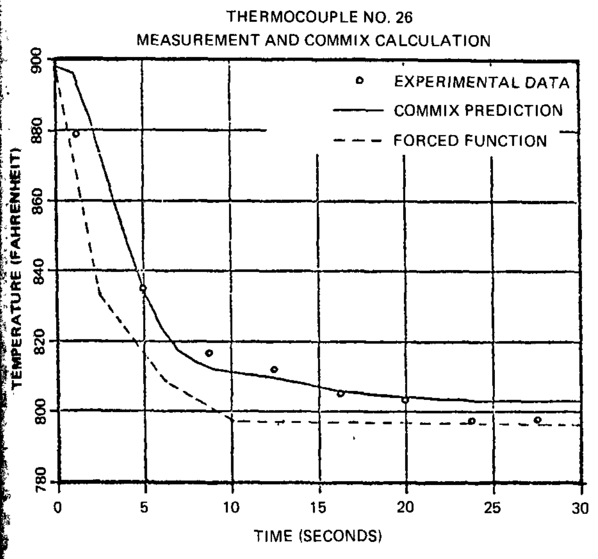

Fig. 2b. Comparison between predicted and measured temperature distribution at exit nozzle.

entering sodium is suddenly increased while the inlet flow rate is maintained constant. The other case is the normal scram in which the density change is accompanied by a flow coastdown to 10% of the initial flow rate. Figure 2a presents the velocity profiles of the first case at the steady state along sections A-A, as shown in Fig. 1. The experimentally measured coolant temperatures[17] at the exit nozzle and the predicted temperatures by the COMMIX code during the transient of constant flow scram with decreasing inlet coolant temperature are shown in Fig. 2b. Agreements between the measured and predicted results are good.

Based on this study, it is concluded that the numerical simulations presented here provide detailed information of the flow field and temperature distribution which would help greatly in design of the outlet plenum.

1. F. H. HARLOW and A. A. AMSDEN, "Numerical Solution of Almost Incompressible Flow," *J. Comp. Phys.*, 3, *1*, 80 (1968).
2. A. D. GROSMAN, W. M. PUN, A. K. RUNCHAL, D. B. SPALDING, and M. WOLFSHTEIN, *Heat and Mass Transfer in Recirculating Flows*, Academic Press (1969).
3. S. V. PATANKAR and D. B. SPALDING, "Numerical Predictions of Three Dimensional Flows," HTS/72/25, Imperial College Mech. Eng. Dept. (1972).
4. B. E. LAUNDER and D. B. SPALDING, *Mathematical Models of Turbulence*, Academic Press (1972).
5. C. W. HIRT and J. L. COOK, "Calculating Three Dimensional Flows Around Structures and Over Rough Terrain," *J. Comp. Phys.*, **10**, 324 (1970).
6. P. J. ROACHE, *Computational Fluid Mechanics*, Hermosa Publishers (1972).
7. "Advances in Numerical Fluid Mechanics," AGARD Lecture Series No. 64, presented at the Von Karman Institute (1973).
8. D. B. SPALDING, "The Calculation of Convective Heat Transfer in Complex Flow Systems," *Heat Transfer 1974*, **IV**, *Proc. 5th Int. Heat Transfer Conf.*, Tokyo, Japan.
9. F. H. HARLOW and A. A. AMSDEN, "Numerical Calculation of Multiphase Fluid Flow," *J. Comp. Phys.*, **17**, 19 (1975).
10. F. H. HARLOW and A. A. AMSDEN, "Flow of Interpenetrating Material Phases," *J. Comp. Phys.*, **18**, 440 (1975).
11. J. W. YANG, "An Analysis of Transient Thermal Response in the Outlet Plenum of an LMFBR," BNL-HUREG-50521 (June 1976).
12. P. WOOD, Private Communication, WARD (1976).
13. J. L. COOK and P. I. NAKAYAMA, "A Computer Program for Calculating Time Dependent Turbulent Fluid Flows with Slight Density Variation," WARD-0-0106 (July 1975).
14. J. J. LORENZ and R. D. CARLSON, "An Investigation of Buoyancy-Induced Flow Stratification in a Cylindrical Plenum," *Pro. 1976 Heat Transfer and Fluid Mechanics Institute*, University of California (June 21-23, 1976).
15. W. T. SHA, H. M. DOMANUS, and R. C. SCHMITT, "COMTHA—A Three-Dimensional, Transient, Two-Phase Flow with Non-Equilibrium Temperatures and Velocities Thermal-Hydraulic Analysis Computer Program," ANL, to be published.
16. W. T. SHA and S. L. SOO, "Multidomain Multiphase Fluid Mechanics," ANL-CT-77-3 (Oct. 1976).
17. J. J. LORENZ, R. D. CARSON, and P. A. HOWARD, "An Investigation of LMFBR Outlet Plenum Thermal-Hydraulic Behavior During Reactor Scram Transients," ANL-CT-76-18 (Sep. 1975).

LR-05497

5. Decommissioning of the SRE, *W. F. Heine, A. W. Graves, B. F. Ureda (AI)*

The sodium reactor experiment (SRE) was a 20-MW(th) sodium-cooled, graphite-moderated reactor which had been mothballed in 1967 and which required complete decontamination and/or dismantling to allow return of the ERDA-optioned reactor site to unrestricted private use.

The SRE, which is located at the Atomics International Nuclear Development Field Laboratory in Santa Susana, California, was built in the mid-1950's and operated with two core loadings until 1964, when it was shut down for initiation of the Power Expansion Program (PEP) to modify and recore the reactor for operation at 30 MW(th). The PEP program was subsequently canceled and the facility mothballed. The irradiated fuel had previously been encapsulated and stored on site.

In 1974, complete dismantling of the facility was initiated as part of the AI Decontamination and Disposition of Facilities Program. This program, which involves the complete decontamination or dismantling of eight ERDA-owned nuclear facilities at Santa Susana, is funded by ERDA Environmental Controls Technology Division.

At the time the dismantling program was initiated, there remained in the facility extensive activation products (>10^4 Ci) contained in the stainless-steel vessels, vessel components, biological shielding, and carbon-steel containment structures; residual primary sodium in the vessel and primary sodium systems; 55,000 lb of contaminated primary sodium in the primary sodium fill tank; residual noncontaminated sodium in the secondary sodium systems; and extensive contaminated liquid and gaseous waste holdup systems.

Calculations demonstrated that in-air gamma radiation levels at the center of the reactor vessel would exceed 1000 R/h. It therefore became apparent that remote tooling would be required for dissection of the vessel. To this end, a rotating mast manipulator was designed and fabricated at AI, mated with a plasma arc cutting system, and installed in a full-scale mockup of the SRE vessel. All cutting and geometry parameters were preprogrammed in the vessel mockup, using sections of each component, including vessel walls, gridplate, core clamps, vessel, bottom, etc. Following completion of the mockup operations, the manipulator-plasma arc system was installed in the SRE vessel to initiate remote underwater cutup.

Extensive preparations were performed in the SRE facility during the time that the special tooling was being developed. The 55,000 lb of primary sodium was transferred into 55-gal drums and subsequently shipped to Hanford, Washington for reuse. The primary and secondary sodium systems were removed, and the residual sodium in the piping and components was passivated. All auxiliary systems were removed. The sodium "heel" was siphoned from the vessel, and the sodium residue was passivated, using an alcohol system which was plumbed into the vessel. The vessel was filled with water, the loading face shield removed, and all removable vessel internals grappled out.

Underwater explosive cutting was selected as the technique for removal of fixed vessel internals, such as sodium piping. Each piece to be cut was mocked up, and the required cuts demonstrated by means of underwater explosive cutting in a test tank. Cutting of the actual piping in the SRE vessel was initiated early in Calendar Year 1977.

The concrete biological shielding will be removed by a combination of explosive demolition and demolition by means of large impact hammers. All activated or contaminated materials are packaged and shipped for disposal by land burial at the licensed burial site at Beatty, Nevada.

An additional requirement of the SRE decommissioning was the headend preparation for reprocessing of the fuel from the two irradiated SRE reactor cores. This fuel could not be reprocessed in its original form because the fuel was thermally bonded to the stainless-steel cladding with eutectic NaK. The fuel assemblies were taken to the AI hot laboratories and, under an inert atmosphere in a hot cell, the fuel was disassembled, declad, cleaned, and reencapsulated in remotely welded aluminum canisters for shipment to Savannah River for reprocessing.

On completion of the SRE decommissioning, all radioactive materials will have been removed to allow conversion of the facility for unrestricted use as a manufacturing facility. The program has advanced the state-of-the-art for nuclear facility decommissioning, principally through the development of techniques for remote cutting of irradiated stainless-steel vessels, the underwater explosive cutting of irradiated components, and the *in situ* passivation of primary sodium in reactor components.

LR-05498

6. Design and Development of the CRBRP Ex-Vessel Transfer Machine, *C. E. Jones, Jr. (AI)*

The fuel handling system for the Clinch River Breeder Reactor Project (CRBRP) utilizes the ex-vessel transfer machine (EVTM) to transfer core assemblies. This paper describes the unique design features adopted and development required during the EVTM design.

The EVTM transfers single irradiated and nonirradiated core assemblies contained in sodium-filled core components pots (CCPs) between the reactor, the ex-vessel storage tank (EVST), and the fuel handling cell (FHC). It also transfers bare, nonirradiated core assemblies from the new fuel unloading station (NFUS) to the EVST. The EVTM is mounted on a trolley which, in turn, is positioned on rails on top of a gantry. The gantry moves on crane rails between the Reactor Containment Building (RCB) and the Reactor Service Building (RSB). The trolley rails are perpendicular to the gantry rails, allowing complete indexing of the EVTM. The basis for the EVTM design is the FFTF-CLEM (close-loop ex-vessel machine).

Heat generated by the irradiated core assemblies is radiated to the cold wall from the sodium-filled CCPS, and is removed by forced- or natural-air convection. Cold wall heaters maintain new core assembly preheat. Extensive testing was required to confirm the 20-kW decay heat capability while assuring a maximum peak fuel-cladding temperature of 676.7°C (1250°F). The major uncertainties in the thermal design were the mode of heat transfer in the CCPs and the effects of sodium-sodium oxide deposition on the emissivity of the CCP and cold-wall surfaces. The test results indicated a two-loop convective heat transfer mechanism in the sodium-filled CCPs, and minimum emissivity changes of the CCP and the cold wall. CCP drying occurs by the time the surface temperature reaches 426.7 to 482.2°C (800 to 900°F).

The EVTM originally was a tall machine with the grapple drive chains remaining out of sodium. To shorten the EVTM to an overall height of 10.4 m (34 ft), the grapple suspension members must be immersed in sodium, and that sodium-wetted member must pass through the drive system. Testing was performed on both tape- and crane-type chain. The crane chain was selected. Initial results indicated excessive chain and drive system wear. The redesigned drive system has resulted in a chain meeting the five-year life goal.

The major problem affecting the structural design of the EVTM and gantry was the seismic design requirement. To meet the requirement, several unique features have been incorporated into the design. A slip joint is utilized at the lower end of the EVTM, allowing both horizontal and vertical motion while remaining sealed.