a HISTORY
of the ROBOTICS and PROCESS SYSTEMS DIVISION (FUEL RECYCLE DIVISION)

William D. Burch and June S. Redmond

September 1992

Compiled as Part of the Celebration of the 50th Anniversary of the Formation of the Oak Ridge National Laboratory

ORNL/M-2134

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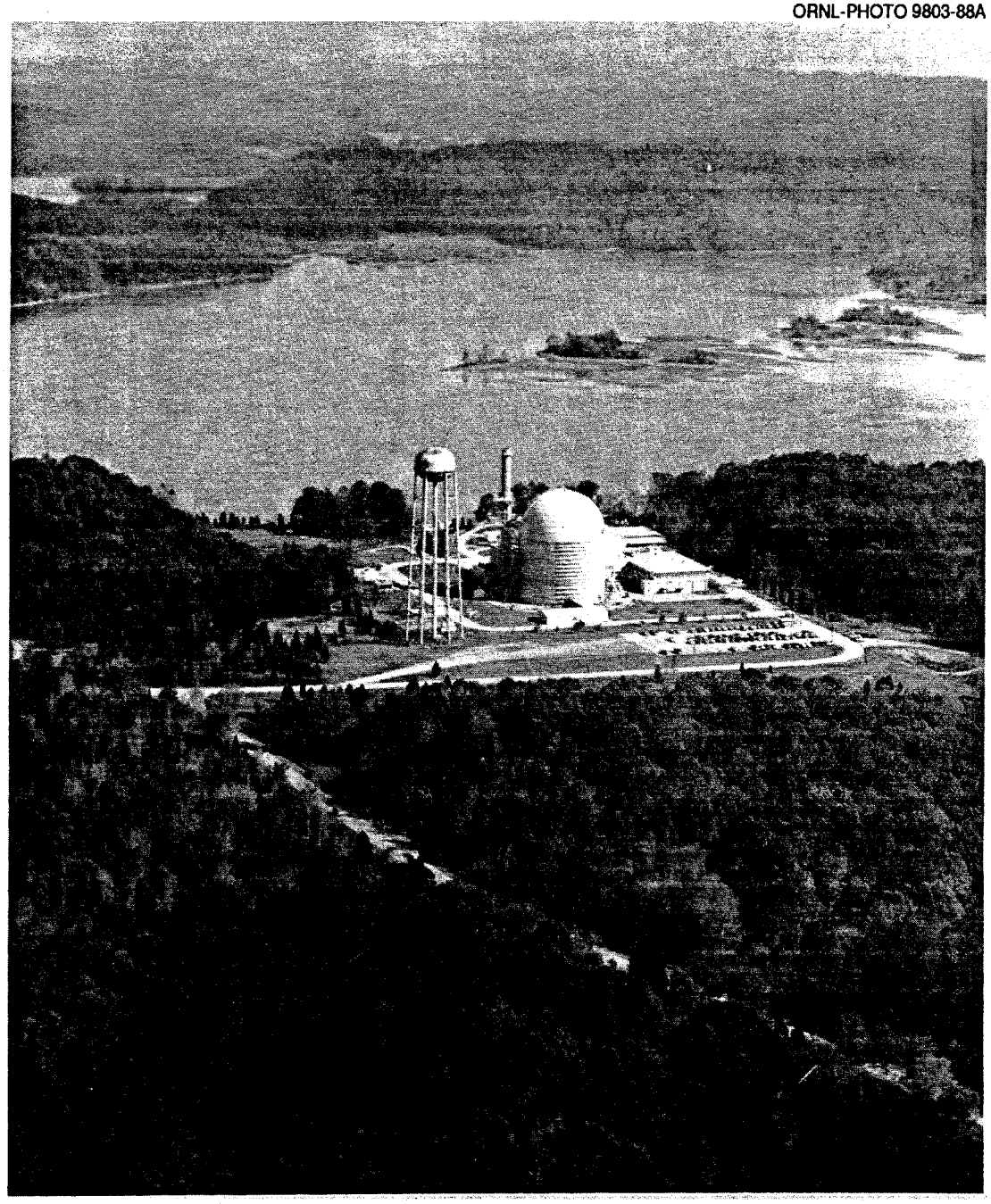

BACKGROUND

EARLIER REPROCESSING AND NUCLEAR FUEL CYCLE R&D IN OTHER DIVISIONS AT ORNL

The history of the Robotics & Process Systems Division (RPSD) builds from its predecessor programs and divisions. RPSD was formed in September 1990 after the existing Fuel Recycle Division (FRD) and a section from the Instrumentation and Controls (I&C) Division had been combined. The lifetime of FRD was only a brief decade; however, its predecessor organizations existed in Building 7601 since 1974, evolving from a small development/program team [known as the Consolidated Fuel Reprocessing Program (CFRP) for most of the period] organized to develop technology for the fast reactor fuel cycle. During this period, the Department of Energy (DOE) and its predecessor agencies were rapidly pushing ahead with breeder reactors and their fuel cycles. The decision to combine the I&C group and FRD into a new division was made after several years of discussion and study. Work in the I&C section, primarily in the field of robotics, meshed well with similar ongoing activities in the Fuel Recycle Facility. These robotics activities had largely developed over the preceding 5 to 10 years, with a major component of that supporting the remote maintenance activities of FRD. As applications for robotics in other remote environments developed, existing expertise was turned to research and development (R&D) in a diverse set of programs sponsored by other agencies. Since the major robotics-related hardware was physically located in Building 7601 (home of FRD) and adequate experimental space existed for a large expansion, the new organizational entity was a logical outgrowth.

Work on the nuclear fuel cycle was a major mission of the Oak Ridge National Laboratory (ORNL) from its World War II beginnings. The site was developed to build the first nuclear reactor to produce kilogram quantities of plutonium and develop separations processes for recovery and decontamination of the plutonium. This background is described in more detail in the history of the Chemical Technology Division (CTD), which did much of that work in the 1940s, 1950s, and 1960s. Following the

war-time crash program, further developments continued in the late 1940s and early 1950s on new, improved processes. The classical PUREX (plutonium-uranium extraction) process, now used throughout the world both in weapons activities as well as in all civilian commercial reprocessing plants, was developed and pilot planted at ORNL in the early 1950s. By the mid-1950s, the future of civilian nuclear power generation was envisioned and it included a closed nuclear fuel cycle. Thus, reprocessing work was refocussed on civilian nuclear power reactor fuel. Since this fuel was in the form of large mechanical assemblies built of corrosion-resistant materials instead of the simple aluminum-clad slugs used in early weapons reactors, new mechanical processing steps were required. The first large-bundle shear to break down fuel elements was developed in the late 1950s, and this technology was incorporated into the first U.S. and worldwide commercial reprocessing plant, the Nuclear Fuel Services plant near Buffalo, New York. With the startup of this plant, the Atomic Energy Commission (AEC) decided that reprocessing was a commercial activity and most R&D at ORNL was terminated for about a decade.

Work that continued in the 1960s largely focussed on fast reactors with even more complex fuel to handle. The Fast Flux Test Facility (FFTF) was built at Hanford, Washington; plans were formulated for a follow-on demonstration reactor, ultimately the planned but not completed Clinch River Breeder Reactor (CRBR); and the role of fuel recycle was recognized with the establishment of a new major program at ORNL [Liquid-Metal Fast Breeder Reactor (LMFBR) Fuel Recycle Program] to fully develop that technology.

While the scope of this work was quite limited prior to 1974, at that time an organization originating from CTD was started in Building 7601 and ultimately became FRD. FRD was formed as a Division on March 1, 1981, evolving from a small program/experimental team in 1974 to a major development organization of over 100 staff that managed all DOE activities in civilian reprocessing development. However, the United States decided in the mid-1980s to slow down the breeder reactor program, and that action severely impacted the programs in FRD. Today, the future of breeders is completely clouded. Long-term needs still appear clear; however, short-term interest and activities are quite limited, mainly still in existence because of a major international agreement with Japan in this technology.

ROLE OF U.S. FAST REACTOR PROGRAM

Fast reactors were envisioned as the reactors of the future as early as 1950. The first such reactor, the Experimental Breeder Reactor-I (EBR-I), was built in about 1950 in Idaho and was also the first reactor to produce electric power, albeit only about 200 kWe. The term "fast reactor" comes from the "fast" neutron spectrum. In contrast, water-moderated reactors, such as present light-water reactors (LWRs) which predominate throughout the world as producers of electricity, are "thermal" reactors. Three other fast reactors have been built in this country: (1) a larger experimental reactor, the Experimental Breeder Reactor-II (EBR-II), in Idaho; (2) the Fermi commercial power reactor, built in Monroe, Michigan, and operated for a short period by Detroit Edison before some problems halted operation; and (3) the FFTF, a 400-MW(t) reactor placed into operation at Hanford Engineering Development Laboratory (HEDL).

While U.S. efforts to continue with a demonstration reactor (CRBR) were halted in the mid-1980s, other major programs in the United Kingdom, France, and Japan have continued, although at a slower pace. Demonstration reactors of about 250 MW(e), similar to the planned CRBR, operate in the United Kingdom and France today, and MONJU is nearing operation in Japan. France has the only large commercial fast reactor, the 1000-MW(e) Super-Phoenix.

While much of the technology for reprocessing fast reactors is similar to that for thermal power reactor fuel, the incentives for reprocessing are much stronger. The much larger inventory of fissile material in fast reactors makes long-term storage and direct disposal of spent fuel, as now planned for thermal reactor fuels, totally unacceptable in the fast reactor fuel cycle. The only practical fuel cycle relies on recovery and recycle of the fissile plutonium to the reactors with out-of-reactor cycle times in the range of 1 to 3 years.

Thus, the fast reactor fuel cycle and the U.S. program to develop fast reactors were the driving forces for establishing FRD. Program/division activities were locked to the U.S. strategy for fast reactors and waxed and waned as the impetus for the reactors changed.

BUILDING THE ORGANIZATION

In 1974, at the time AEC (later to be called Energy Research Development Agency and now known as DOE) was developing plans to expand the fast reactor and fuel cycle work, ORNL was very much involved in the discussions. Floyd L. Culler, then ORNL's Deputy Laboratory Director, and Donald E. Ferguson, Director of CTD, convinced AEC management that the program should be located at ORNL because of ORNL's long history of such activities and the expertise still existing in several organizations. In May 1974, Don Ferguson contacted William D. Burch, who had left the Laboratory to join Union Carbide's private sector in an effort to develop a private enrichment business with Westinghouse and Bechtel, to offer him the position of directing the new program. [Union Carbide Nuclear Division (UCND) was ORNL's management contractor during this period.] Bill Burch returned to ORNL to lead the LMFBR Fuel Recycle Program, and William E. Unger, who had guided the earlier small fast reactor fuel cycle efforts as well as many other programs in CTD, remained as Burch's assistant until his retirement in 1982.

In seeking a place to house the new organization, the Experimental Gas-Cooled Reactor (EGCR) site (Building 7601) seemed the perfect location. The site was first named the Fuel Recycle Facility, then the Consolidated Fuel Reprocessing Facility, and more recently changed to the Robotics & Process Systems Complex. EGCR had been authorized by Congress in 1959 but was never operated when the AEC decided to focus future commercial power reactors on the LWR concept. ORNL was responsible for much of the R&D associated with the reactor and for detailed design of fuel elements and control rods, but the facility was to be operated by the Tennessee Valley Authority. Unoccupied since the demise of the reactor project in the mid-1960s, a large experimental hall where the steam turbine had been located was almost ideal for large hardware experiments. Office space was not large, but many areas of the original complex (reactor control room, drafting room, and other nooks and crannies) were readily

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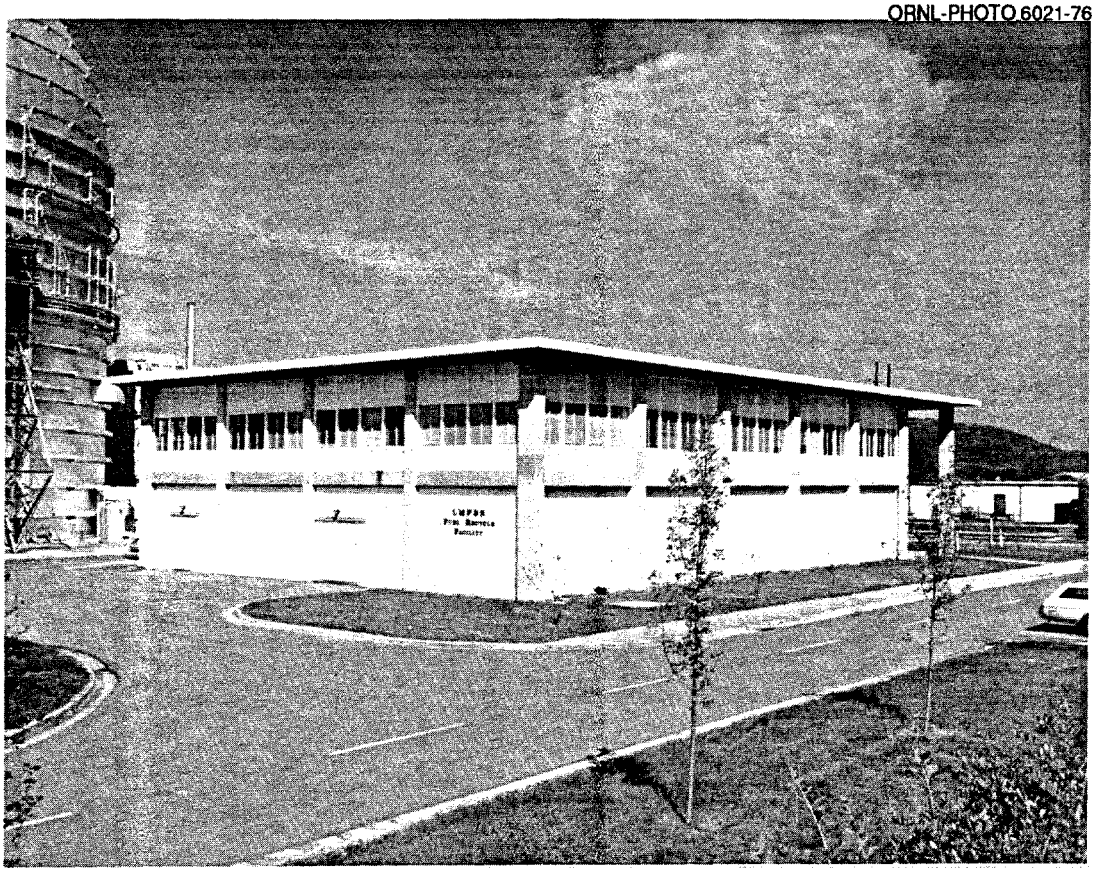
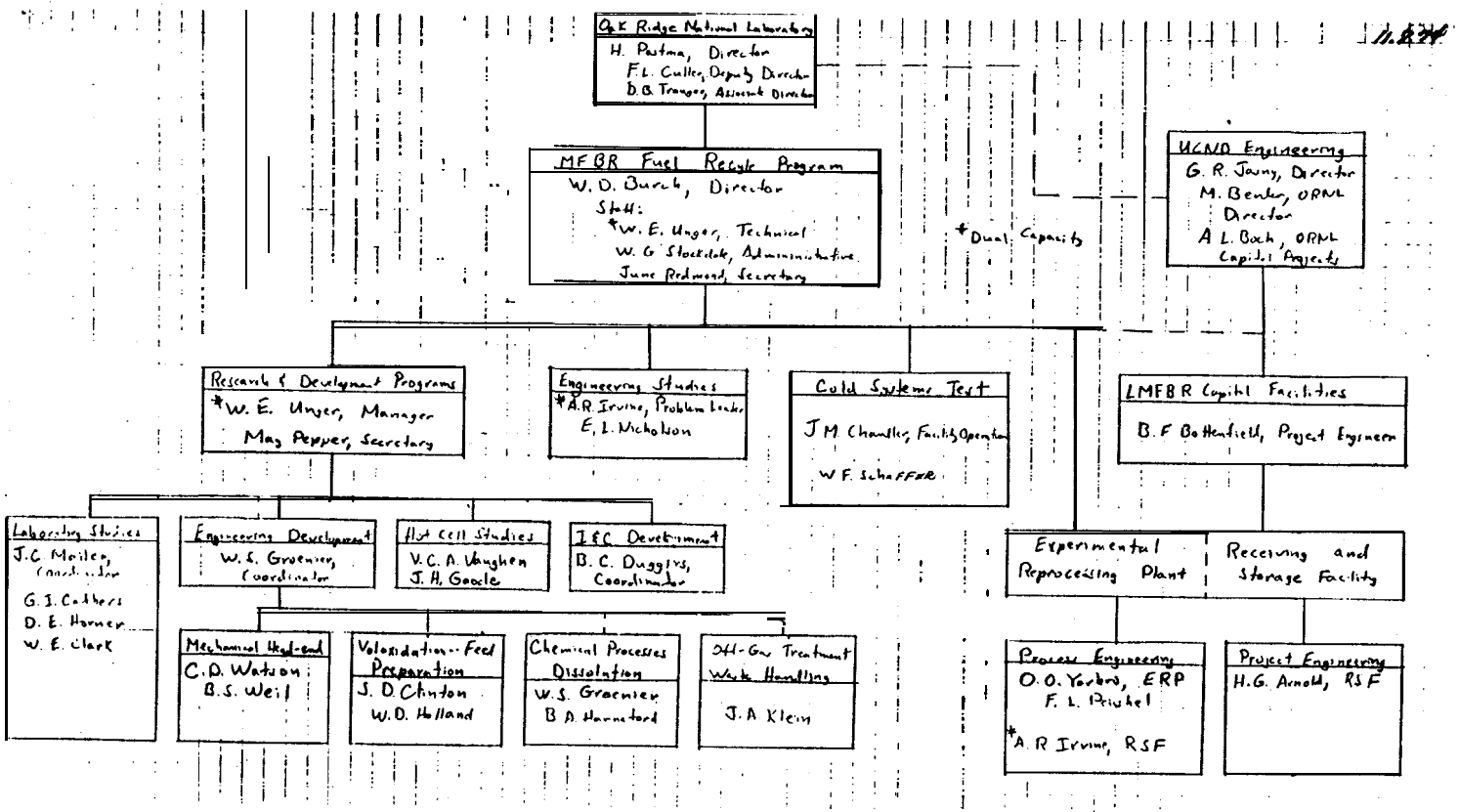


convertible as the organization developed. First impressions were not too great with cobwebs everywhere, window blinds falling down, evidence here and there of mice and other varmints, and generally not well maintained conditions. But the pluses by far outweighed the minuses, and the facility has proved to be immensely satisfactory for the activities to date and those planned for the future.

In November 1974, Burch, Baird Bottenfield, John Chandler, Al Irvine, Ed Nicholson, Frank Peishel, May Pepper, June Redmond, Bill Schaffer, Walt Stockdale, Bill Unger, and Orlan Yarbro picked up their possessions in Building 4500 and moved into the new complex. (See copy of the hand-written first draft organization chart.) Things were simple in those early


Oak Ridge National Laboratory
H. Postma, Director
F.L. Culler, Deputy Director
D.B. Trauger, Assistant Director
MFBR Fuel Recycle Program
W.D. Burch, Director
Staff:
*W.E. Unger, Technical
W.G. Stockdale, Administrative
June Redmond, Secretary
*Dual Capacity
UCND Engineering
G.R. Jones, Director
M. Bender, ORNL Director
A.L. Boch, ORNL Capital Projects
Research & Development Programs
*W.E. Unger, Manager
May Pepper, Secretary
Engineering Studies
*A.R. Irvine, Problem Leader
E.L. Nicholson
Cold Systems Test
J.M. Chandler, Facility Operation
W.F. Schaffer
LMFBR Capital Facilities
B.F. Bottenfield, Project Engineer
Laboratory Studies
J.C. Mailen, Consultant
G.I. Cathers
D.E. Horner
W.E. Clark
Engineering Development
W.S. Groenier, Coordinator
Hot Cell Studies
V.C.A. Vaughen
J.H. Goode
IFC Development
B.C. Duggins, Coordinator
Experimental Reprocessing Plant
Receiving and Storage Facility
Mechanical Head-end
C.D. Watson
B.S. Weil
Volatilization-Feed Preparation
J.D. Clinton
W.D. Holland
Chemical Processes Dissolution
W.S. Groenier
B.A. Hannaford
Off-Gas Treatment Waste Handling
J.A. Klein
Process Engineering
O.O. Yarbro, ERP
F.L. Pritchet
*A.R. Irvine, RSF
Project Engineering
H.G. Arnold, RSF

days when we usually "yelled down the hall" instead of using the intercom and lighted only the one corridor of the second floor since the entire staff was located there. It soon became obvious that we needed one of the most important amenities of a well-planned office complex. May Pepper suggested that we combine resources and acquire a good Bunn automatic coffee maker. These first members of the FRD "family" pooled $10 each to purchase the unit that is still being used in the main lunch room today.

With so few occupying a previously deserted building in a remote site, the family atmosphere was enjoyed. It was almost like a country home with deer grazing occasionally in the nearby fields, groundhogs playing in the front yard, a skunk who often pranced up the sidewalk in the morning in front of the first to arrive, and more than one snake discovered in the building. The staff enjoyed occasional covered-dish lunches and often took turns stirring that pot of beans cooking on the stove in the kitchen.

Plans were made to move hardware programs to Building 7601, and within a couple years the organization had grown to a staff of approximately 50 and was responsible for the major experimental activities in the program. Photographs on pages 12 and 13 indicate the extent to which the building was altered and renovated to become one of the major experimental hardware R&D facilities at ORNL in the 1980s. Top left: The new roof line created when the roof over the experimental area was raised in two stages over 20 ft. The roof was raised to accommodate the height requirements of a typical simulated reprocessing cell with its overhead crane and bridge system for the advanced servomanipulators developed here. The three interior views of the large experimental hall show it as it was when we first moved in; in the early stages, when only a small area was used; and then the busy, crowded, and fully utilized space of recent years (bottom left, top right, and bottom right respectively).

Formed as a Program team initially, the organization had a true multidimensional identity in the early days. Burch and June Redmond, his secretary, were members of the Central Management Office organization reporting to Donald E. Trauger, Associate Laboratory Director for Reactor and Engineering Sciences; Baird Bottenfield was from the UCND

Engineering organization; and the others were members of CTD. This group later became a section in CTD with Burch filling a dual role of ORNL Program Director and CTD Section Head.

Building the Staff with Technical Strengths from UCND Engineering and ORNL'S CTD, ETD, and I&C

The team formed from within ORNL had a long history of fuel cycle and closely related activities, in many cases dating back to the very early days of that type work at ORNL. Burch had begun his career working as a young engineer on shift in the PUREX pilot plant. Unger, Nicholson, Irvine, and others go back to even earlier days and represented the core of expertise in overall facilities, processes, and design. A large number of the staff came from the TRU (transuranic) facility, the last major project built at ORNL (circa 1965) for separations work with irradiated nuclear materials. From that program came Burch, Peishel, Yarbro (who headed the TRU operations in the initial days and later became Section Head of the Integrated Equipment Test (IET) Facility Operations Section in FRD), and John Van Cleve. The need for a broad-based expertise in reprocessing brought talent from other ORNL divisions such as criticality and safeguards expertise from ETD; control expertise from I&C; and plant design from Bottenfield, who also worked with the TRU design team, and others in UCND Engineering.

The Idaho Connection

Recognizing the strengths and knowledge that existed elsewhere, Burch began contacting other national laboratories doing fuel cycle work. From contacts in the American Nuclear Society (ANS), the broad range of work under way associated with EBR-II fuel recycle was known. At an ANS meeting in Washington in November 1975, Burch asked Mel Feldman, who headed the Idaho fuel cycle work, if he had any staff members who might be interested and would profit by joining ORNL to help in these activities.

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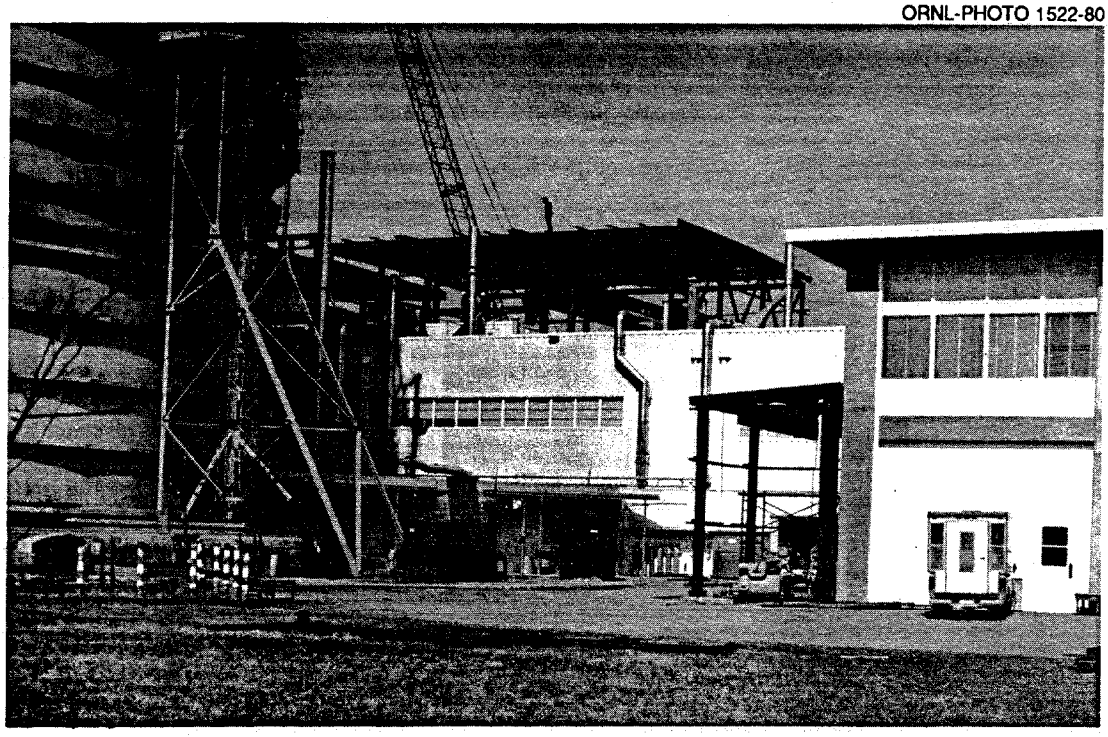

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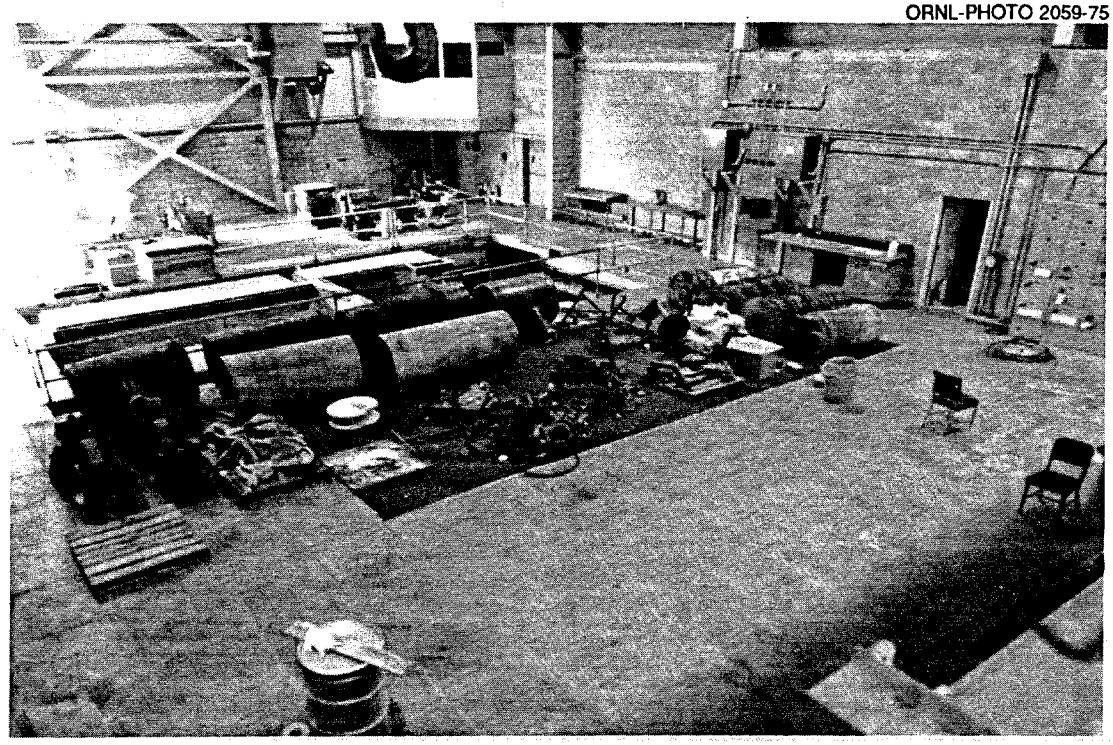

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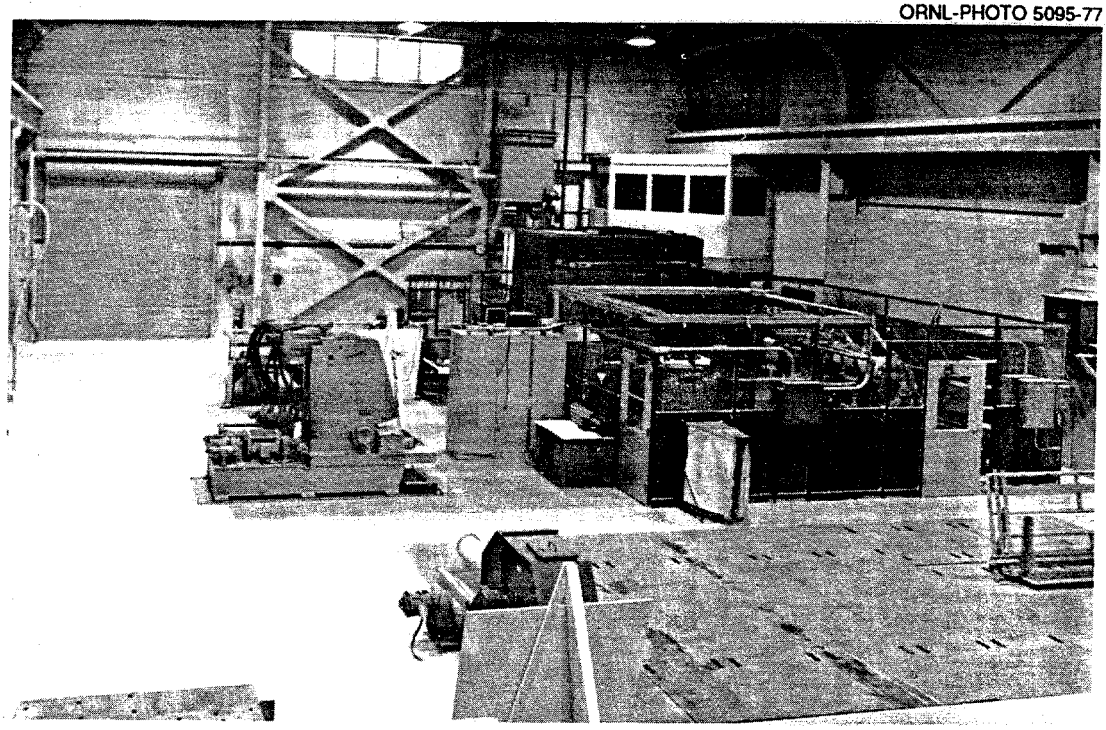

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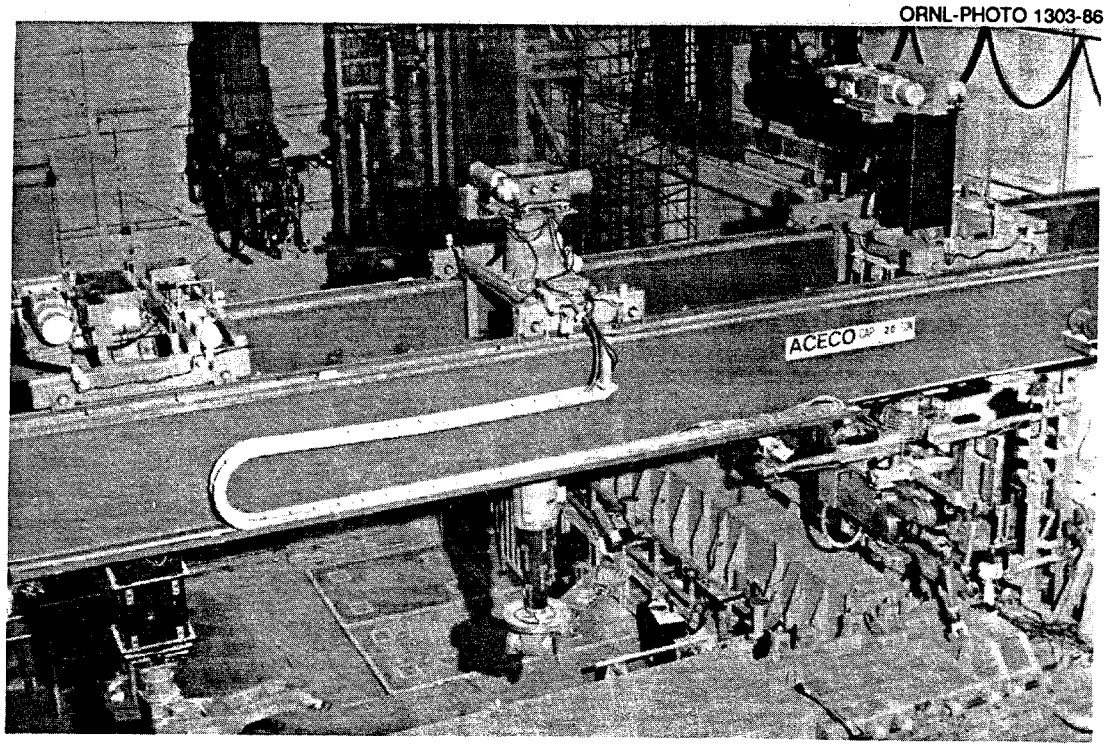


His reply was, "If you are asking me if I would come to work with you, the answer is 'yes.'" That conversation started a connection that eventually brought six key experienced people from that Idaho team to Oak Ridge (Feldman, Norb Grant, Don Hampson, Howard Harvey, and John White to CFRP and Doug Macdonald to UCND Engineering). Their contributions to the overall effort have been invaluable.

Involvement with Industry

The prospects for commercial reprocessing appeared quite optimistic in the 1970s. The Nuclear Fuel Services plant had operated for some 6 years, Allied General Nuclear Services (AGNS) was designing and building a plant in South Carolina, and Exxon was planning a plant in Oak Ridge. Recognizing the talent in these teams, ORNL asked these organizations (as well as Westinghouse and General Electric) if they would like to send experienced people to ORNL to be part of the fast reactor reprocessing development program, add their competence to the staff, and eventually benefit by what their people learned. All accepted the offer and over the years sent such talented people as A. L. Olson (AGNS); G. E. Borsheim, J. B. Kendall, and C. H. LaMaster (Exxon); T. Bowers, J. Garin, S. A. Meacham, D. J. Racki, J. E. Richardson, S. L. Schrock, and D. W. Williams (Westinghouse); and Ross Eberle (General Electric). Sam Meacham and Steve Schrock remained in Oak Ridge to become ORNL employees and, later, Section Heads and then Meacham became the Division Director in April 1990 when Burch stepped down. Another stalwart from industry was E. D. (Ned) North, who was employed directly after a long leadership role at the Nuclear Fuel Services plant. K. E. Plummer, one of the few people to have worked at most of the fuel reprocessing plants in the United States, joined the division in later years and presently serves as a Section Head.

Key Players in the Support Team

In many ways the effectiveness of organizations is directly related to the actions of a dedicated group of support staff who see that the building functions, that the development areas are well maintained and kept versatile, that needed services are readily available and done well, and that administrative functions are properly handled. Several FRD/RPSD staffers became known for providing that kind of strength to the organization. Of all, Don Dunning will be remembered longest for how he handled so many diverse roles effectively—from coordinating office moves and telephone arrangements to his role as Division Safety Officer/Radiation Control Officer. In the early days, John Chandler saw that the place was made livable in his role of Facility Manager, a task that was later passed to the capable hands of Waldo Evans. June Redmond, who served as the Director's secretary from 1974 to 1991, was known for leading one of the most dedicated and efficient clerical teams at ORNL. She is presently the Division's Administrative Assistant, now focussing entirely on the administrative functions. Carol Scott, in later years, handled many of the administrative matters of the Collaboration with Japan in her position as secretary to the Technical Coordinator, Grant Stradley. In this she fell heir to a role as the "mother figure" to many of our young Japanese assignees who needed help with some nuance of the English language, suggestions as to how to handle personal business in Oak Ridge, or just help dealing with administrative matters at ORNL. Carol replaced Dunning as Division Safety Officer when he retired in 1991.

A PROGRAM THAT BECAME A DIVISION IN 1981

As noted earlier, the embryonic organization that is now RPSD in Building 7601 began in the fall of 1974 as an emerging new major fuel cycle program staff with only limited functional responsibilities. Closely associated with the program planning, coordination, and management roles was a support team of process designers from the CTD Design Section, who also moved into the complex in 1974. Much of the design work associated with breeder fuel cycle activities had been under way for years as was other experimental work in other sections in CTD on a smaller scale. At that time, the important thing was getting the program organized; we worried little about organizational niceties. As the scope and focus of the program became clear and the utility of the experimental spaces within the building was realized, plans were made to gradually move all hardware development activities to Building 7601. The facility was not capable of handling significant radioactive materials but could be readily adapted to testing a shear, dissolvers, and solvent extraction systems with normal or depleted uranium. The "hot-cell" work remained as it had been with CTD.

The Major Transitions

The organization existed 7 years prior to becoming a division and was known by the following names:

- LMFBR Fuel Recycle Program
- LMFBR Fuel Reprocessing Program
- Advanced Fuel Recycle Program
- Consolidated Fuel Reprocessing Program

We became a new ORNL division, the Fuel Recycle Division, on March 1, 1981. A copy of the formal announcement and organization chart are shown on pages 18 and 19 respectively.

Oak Ridge National Laboratory
Oak Ridge, Tennessee AR-675

OFFICIAL BULLETIN

February 2, 1981

Formation of ORNL Division: Fuel Recycle Division

I am pleased to announce the formation of a new ORNL division, the Fuel Recycle Division, and the appointment of William D. Burch as director, effective March 1, 1981. This new division will carry out design and prototype hardware development activities of the Consolidated Fuel Reprocessing Program. In addition to being division director Burch will continue as Director of the Technical Management Center which manages all fuel reprocessing development activities for the Department of Energy, including the LMFBR and HTGR. He will report directly to me.

The division will consist of three sections which are structured similarly to the present Consolidated Fuel Reprocessing Program organization. M. J. Feldman, now Program Manager for Engineering Systems, will become Section Head responsible for the line-management role for these functions in the new division and will retain his existing programmatic responsibility. Similarly, W. S. Groenier, now Program Manager for Process and Engineering Research and Development, and O. O. Yarbro, Program Manager for Integrated Equipment Test Facility Operations, will become Section Heads in their respective areas and will retain their existing programmatic responsibilities.

The Consolidated Fuel Reprocessing Program, which was established two years ago, is an outgrowth of earlier work within the Chemical Technology Division which has had a leading role in fuel reprocessing since the Manhattan District Project during World War II. The Chemical Technology Division originally developed the processes which are used by all of the fuel reprocessing plants in the world today. It will continue to provide technical support to the new division.

This organizational change is being made at this time primarily to strengthen the management of the major ongoing Consolidated Fuel Reprocessing Program. The new division will have a staff of 41 technical and 23 nontechnical members and will have 33 assignees from other ORNL divisions, UCC-ND installations, and other organizations.

Mr. Burch, as Director of the Consolidated Fuel Reprocessing Program Technical Management Center, will continue to have responsibility for programmatic work at Savannah River Laboratory and at the General Atomic Company in addition to work in the Fuel Recycle Division and several other ORNL divisions.

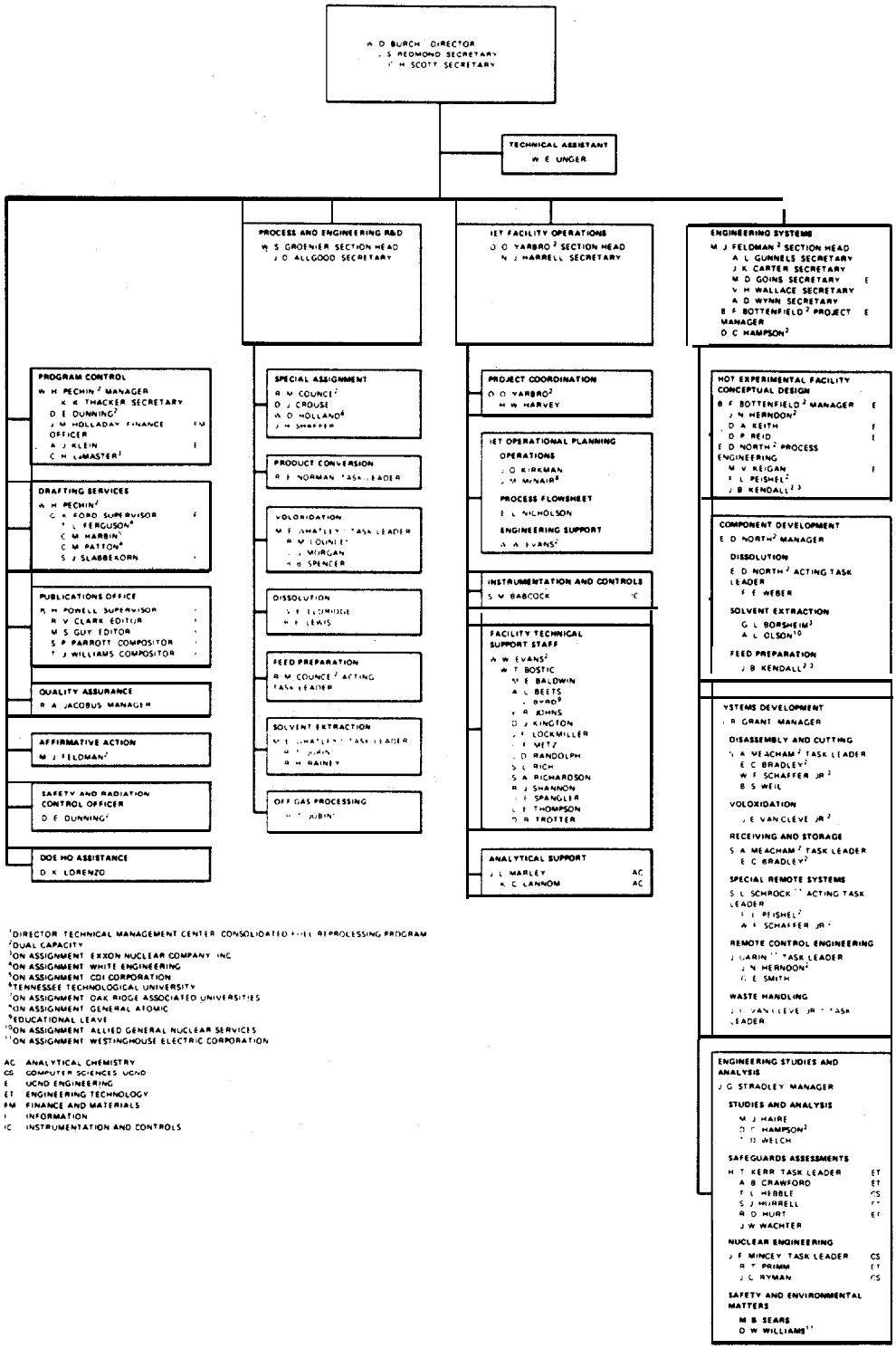
D. B. Trauger

D. B. Trauger

Distribution:
Res & Supv Staff

FUEL RECYCLE DIVISION

MARCH 1, 1981



[1] DIRECTOR, TECHNICAL MANAGEMENT CENTER, CONSOLIDATED FUEL REPROCESSING PROGRAM
[2] DUAL CAPACITY
[3] ON ASSIGNMENT, EXXON NUCLEAR COMPANY, INC.
[4] ON ASSIGNMENT, WHITE ENGINEERING
[5] ON ASSIGNMENT, CDI CORPORATION
[6] TENNESSEE TECHNOLOGICAL UNIVERSITY
[7] ON ASSIGNMENT, OAK RIDGE ASSOCIATED UNIVERSITIES
[8] ON ASSIGNMENT, GENERAL ATOMIC
[9] EDUCATIONAL LEAVE
[10] ON ASSIGNMENT, ALLIED GENERAL NUCLEAR SERVICES
[11] ON ASSIGNMENT, WESTINGHOUSE ELECTRIC CORPORATION

AC ANALYTICAL CHEMISTRY
CS COMPUTER SCIENCES, UCND
E UCND ENGINEERING
ET ENGINEERING TECHNOLOGY
FM FINANCE AND MATERIALS
I INFORMATION
IC INSTRUMENTATION AND CONTROLS

During this period and continuing today, the organization managed the overall aqueous breeder fuel cycle program for the United States while carrying out major hardware development and design activities. The proportion of program work handled within the Division varied from as little as about 30 to nearly 100% in recent years. Managers in the program organization and the functional division organization handled dual responsibilities, responsible for similar areas in both organizations. This greatly simplified the normal program/functional organizational interfaces.

Working Closely with AEC/ERDA/DOE - The Glue that Held Things Together

A history of this division is not complete without reference to its ties to program sponsors both in the Washington Headquarters Offices and at Oak Ridge Operations (ORO). Along with other divisions at ORNL, it underwent the transitions from sponsorship by AEC (established on August 1, 1946) to the Energy Research and Development Administration (ERDA) in 1974 to DOE in 1977. These transitions had no major effect on FRD. Early leadership in Washington was provided by Dr. "Woody" Cunningham, who then directed the nation's effort to develop a breeder reactor with its associated fuel cycle. Down in the ranks were two stalwarts: Harry Schneider, who died in 1979, and Dr. W. H. (Bill) McVey, who remained active until his retirement at the end of 1991. The real leadership was provided by two middle managers with whom we developed excellent working relationships and personal friendships. Wade W. Ballard guided the program through the hey-days of the early 1980s and into the difficult days of the mid-1980s, when it was not clear if the Program or Division would survive. He was known personally by many in the Division from his frequent trips to Oak Ridge. Because of his special interest in the work here, he was selected to present the formal address to dedicate the IET Facility, the major prototype hardware test system, at a Division Information Meeting in 1982. His departure left a real sense of loss when he chose to pursue other roles, first in the DOE effort to implement a waste repository. Subsequently, he moved to a senior management role at Pacific

Northwest Laboratories and then on to the private sector where he is now a Regional Director of IT Corporation. On Ballard's departure the reigns fell into the good hands of David E. Bailey, who succeeded in negotiating a five-year Collaboration with Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan, which provided the life-blood for the Division in 1986. Dave Bailey also became well known to many of the Division staff through his positive interactions with us.

R&D FOCUS THROUGH CONCEPTUAL DESIGNS

Throughout the history of the Division, significant efforts were placed on understanding the status of technology and identifying research needs through developing conceptual plant designs. By focussing sufficient resources on the details of a plant, weaknesses and flaws in the known technology became evident. Even prior to the major expansion in 1974, a report examining the concept for a large breeder reprocessing plant had been done. This proved controversial in many respects because there were many skeptics about the pace with which breeders would come on line. Time has certainly proved the skeptics correct.

As a basic breeder program assumption, we were asked in 1976 to develop a concept for a plant that would be capable of handling fuel from four to six 1000-MW(e) reactors by the early 1990s. This resulted in the design we called the Hot Experimental Facility (HEF). It was to be capable of handling both the conventional plutonium/uranium fuels and the anticipated thorium/^{233}U fuels. Through this program we developed a close working relationship with the Bechtel Corporation, hired as the architect/engineer for the design. In subsequent phases the concept was refined and simplified, but it became abundantly clear that the United States was not going to need anything like HEF soon.

Nevertheless, the exercise proved extremely valuable for it did identify the technology that we needed to work on. With delays in the deployment of breeders, the program focussed on a facility that would deal only with fuel from FFTF and CRBR. Since a new, large, heavily-shielded facility existed at HEDL without the mission for which it was built, it became the obvious "home" for the new project. We worked with Westinghouse Hanford for 2 to 3 years and came up with a good working arrangement and concept, known as the Breeder Reprocessing Engineering Test (BRET), only to once more be stymied by further uncertainties and delays.

Our latest efforts at conceptual design were associated within the ongoing Collaboration with PNC, which will build a facility known as the Recycle Equipment Test Facility (RETF) as their initial experimental breeder reprocessing facility. This Collaboration is discussed fully in a later section.

Through its history, the Division focussed on four major research areas: (1) plant conceptual designs; (2) head-end operations of fuel dismantling, dissolution, and off-gas treatment; (3) advanced solvent extraction hardware, chiefly centrifugal contactors; and (4) remote maintenance systems and the integration of the process and maintenance systems into an overall plant.

Plant Conceptual Designs

The plant conceptual designs area was the backbone of all efforts, providing insights into research needs while addressing plant designs that would have become real plants had the breeder program proceeded as envisioned. (These were described on page 23.)

Fuel Dismantling and Dissolution

Studies dating back to the mid-1950s chose shearing as the preferred mode for breaching power reactor fuel cladding to permit the initial chemical step of dissolution. The early shear was developed at ORNL, and a replica of the development shear was used at the Nuclear Fuel Services plant. That development shear was used in early breeder fuel shearing experiments, under Clyde D. Watson, in its original location in CTD. It was moved to Building 7601, the Fuel Recycle Facility, and was used by Watson and others in many follow-on experiments.

Since people debated whether breeder fuel should be sheared directly or partially disassembled prior to shearing, the Program examined this issue in detail. The option chosen was to remove the hexagonal sheath on the fuel element and shear the pin bundle. A project team was formed under

Sam Meacham's leadership to design, build, and test a high-power laser disassembly system and bundle shear.

We developed and tested concepts for continuous dissolvers for breeder fuels, and this work is preeminent throughout the world. Three major prototype dissolvers have been built and tested over the past 15 years. Orlan Yarbro, Bill Groenier, and Ben Lewis have been the key leaders in this technology. The first dissolver was a single-stage machine designed to test some hardware transport features and examine corrosion phenomena. When the concept appeared workable, a prototype was built to the 0.5-ton/d scale of HEF. It showed that sheared fuel could be moved through a rotating dissolver countercurrent to the acid used for dissolution and largely proved the idea. A few problems remained to be worked out when, through the desires of PNC, ideas for a critically-safe machine were developed. This resulted in a working prototype model in 1990 of about half the capacity (10 kg/h) of the prior unit.

Centrifugal Contactors

Developers of the larger-scale but more complex contactors used at the Savannah River Plant for many years envisioned improvements in the design. Working with Argonne National Laboratory (ANL) and Savannah River Laboratory (SRL), Ned North, Marv Whatley, and, later, Bob Jubin guided a program where important contributions were made from all three sites. The major pilot plant phase for three generations of machines (the final just under way) was done at FRD. This type contactor is much more compact than the mixer-settlers and pulse columns used in the past and is seen by all in the field now as the future contactor for reprocessing plants. Development programs have been established with the United Kingdom at the Dounreay Nuclear Research Establishment in addition to the Collaboration with Japan.

Remote Maintenance Systems

The very strong focus of the Division's work on plant remote maintenance features can be traced to the background and expertise of the people who planned and organized the early work. Coming from working "hot" facilities, they realized the dominant place that remote technology played in maintaining a plant. The Oak Ridge contingent had its roots in reprocessing from the Transplutonium Processing Plant (a CTD facility, known formerly as TRU, now as REDC), which had completed about a decade of operation. The Idaho contingent had similar experience in the EBR-II facilities. The background of this group made it one of the world's most experienced in this field.

With the full support of sponsors, this expertise focussed on revitalizing remote technology. Their work resulted in several major accomplishments: (1) refinement and development of servomanipulators, (2) application of digital control to such manipulators for the first time, (3) major prototype hardware test systems that examined the maintenance features of the actual prototype process hardware, and (4) major input to plant concepts based on these working R&D programs. All future major "hot" facilities in the world will utilize some of the fruits of these efforts.

Mel Feldman guided this work for a decade as Section Head. Major support was provided by an I&C group headed for many years by Bill Hamel, who moved his entire group, then a section in I&C, to be a part of FRD in 1990. Joe Herndon started his career at FRD in this field and has since moved up to head ORNL's Robotics and Intelligent Systems Program (RISP), working very closely with RPSD.

COOPERATION WITH HEDL IN BRET

Much of the work of the Division involved close alliances with other organizations. Within the ranks of the staff in Building 7601 were people from many other ORNL divisions and assignees from other companies. Cooperation had ensued with other major DOE contractors (SRL, ANL, HEDL, and others). With the focus in the 1982–1985 period on the BRET Facility at Hanford, a strong collaborative effort was required with Westinghouse Hanford. Westinghouse had built the Fuel Materials and Examination Facility (FMEF) to develop and test breeder fuels. With the outstanding performance of breeder fuels, the function for which FMEF was built was no longer needed. However, a cursory assessment, done cooperatively with HEDL, showed that FMEF could still be used. This also required the close cooperation of the two DOE site offices, ORNL, and HEDL. Each had its role to play with the reprocessing expertise in Oak Ridge and the facility knowledge at Hanford.

A project team was organized with Carl W. Burgess of HEDL as Project Manager and Sam Meacham of ORNL as Deputy Project Manager. Sam spent many months at Hanford working out the administrative, project, and technical problems. While the project was at Hanford and directed by a HEDL employee, the key technical expertise was in Oak Ridge and strong forceful leadership and technical support from the ORNL participants were required to make the collaboration work. A working conceptual design was developed that provided adequate cost estimates for the project to proceed. This was one of the few designs developed in the world for a small breeder reprocessing plant. Unfortunately, cancellation of the CRBR project in Oak Ridge and further delays in the overall breeder program stymied further progress on BRET.

Broad-scale international cooperation in the breeder fuel cycle began with a small meeting of about 40 technical specialists, 20 from some 6 to 8 countries outside Russia, organized by the International Atomic Energy Agency in Leningrad in 1976, at which progress and plans in major countries were described. Bill Burch chaired that meeting and described the embryonic program at Oak Ridge. Follow-up contacts and discussions led to the first technical exchange with the United Kingdom Atomic Energy Authority (UKAEA) about a year later. Several areas of common interest were defined and provisions for exchange of information and reciprocal staff assignments were agreed to. Many engineers from both organizations visited facilities and learned much from their foreign colleagues for more than a decade. A limited technical exchange continues *even* today, and close personal international friendships have resulted as a spin-off from the business interactions.

Initial contacts were made with Japan in 1980–1981. Michael J. Lawrence, who guided the program from DOE-Washington for a brief time and later rose through the DOE ranks to head the Richland Operations (RO) Office, suggested that Burch accompany him on a visit to Japan to table ideas for a collaboration between the United States and Japan. PNC, the fuel cycle development corporation in Japan, was very interested in a technical exchange. Visits by technical teams followed, and a formal agreement was in place within a year. The initial agreement limited exchanges to two areas—remote technology and experimental criticality. The latter was of keen interest to Japan because the United States had operational critical experimental facilities and Japan did not. Major financial support ($6M) for that criticality collaboration was provided by Japan. The remote technology program exchanged information on programs but restricted the flow of detailed hardware designs. However, it stimulated PNC to adopt many of the ideas developed at ORNL, and frequent requests were made by PNC to enlarge the scope of these exchanges. Finally, in 1985–1986, as the U.S.

program was down-sized, DOE made collaboration with other countries a major new policy initiative. Dave Bailey and Bill Burch worked out with PNC the general framework of a major collaboration that would eventually provide about $30M in the five-year program, which began in 1987. Until late in 1991, Grant Stradley handled the demanding role as the Technical Coordinator for the Collaboration. While plans were well developed for a second five-year phase to begin in 1992, it now appears that this Collaboration will not continue because of DOE's lack of financial support. In the early planning, there was hope that the Collaboration could be the basis for Japanese support to the BRET program, but the focus had to change to facilities that would be built in Japan.

The impact of this Collaboration on Japan's breeder reprocessing program has been substantial. Japan has built and successfully operated a small LWR reprocessing plant since 1976, and construction of a large thermal reprocessing plant is under way. However, its work on breeder fuels considerably lagged that of the United States, and the Collaboration permitted it to catch up and to use the work developed at Oak Ridge. Since the United States was not going ahead in the near term, little could be lost by providing Japan technology previously developed under these Collaboration terms. In the future, we envision reciprocal sharing of technology developed both in the United States and Japan and demonstrated in Japan. Many of the concepts developed in the United States will now be tested "hot" for the first time in Japan. In the minds of those who negotiated the Collaboration, ties through the operating phases of the facilities in Japan are of high priority in order to gain an understanding of the successes and failures of the concepts that originated in the United States.

The United States, the United Kingdom, and Japan shared more than technical expertise in their collaborations and technical exchange agreements. Several members of the U.K. and PNC staffs were assigned to CFRP for long- and short-term assignments. Andrew Dumbreck, Martin Grady, Peter Harrop, Robert Jolly, Peter Poulton, and others from the United Kingdom spent many months on assignment with us at

Building 7601. The British sipped hot tea with the Americans, and the Americans, in turn, insisted that their British friends try iced tea. John Kirkman spent a 3-month assignment at Dounreay working at the U.K. Fast Reactor Reprocessing Plant, and Dave Campbell (CTD) spent a year at Harwell as a CFRP representative. Because of the differences in the cultures of Japan and the United States, there was much to share. Tomio Kawata was always willing to explain Japanese traditions to those who questioned, and some thought he knew more of the culture of East Tennessee than many natives when he left ORNL to return to Japan. T. Yamana, an early assignee, sang "Rocky Top" (accompanying himself on the guitar) in our honor at a division-wide meeting. Grant Stradley hosted several boating parties for Japanese assignees and their families, and a few tried water skiing for the first time on Tennessee's Tellico Lake. Larry Ladd invited Japanese friends to his Roane County farm for their first experience with hunting dogs and rifles. A group attended a luncheon at June Redmond's home during the Christmas season so that they might know how a typical Tennessee family decorates for the holidays. Others enjoyed camping trips and outdoor cooking lessons with some of our co-op students. These everyday interactions helped to promote an excellent working atmosphere and cultivated lasting friendships.

While PNC assigned over 20 staff members to ORNL, we managed to send only 4 of our staff to Japan. Ji Young Chang, J. E. Dunn, J. H. Saling, and R. G. Upton worked with the PNC staff in Japan and enjoyed many Japanese courtesies. The Dunns became the parents of two baby girls while assigned there and their first, Christine, was known as the first USDOE/PNC baby born in Japan. There were celebrations on this side of the ocean, too, as babies were born to the PNC assignees. The first Japanese assignee baby born here was the son of Shin and Yuki Kawatsuma. The baby became an immediate University of Tennessee fan after receiving a U.T. warm-up suit as a gift from our staff. Some of the women connected with CFRP invited wives of the Japanese assignees to join them at an American-style baby shower for Misae and Yoshinori Ueda. These ladies were later guests in the Ueda home for Michael Nori's first birthday party, a special time in the life of a Japanese child.

Other technical arrangements have been formalized with France and Germany. With France, a small but important exchange in the development of radiation-hardened control systems for servomanipulators was put in place 4 years ago and is continuing. Many informal discussions were held with German engineers at Karlsruhe and with the designers of the proposed, but now abandoned, German reprocessing plant. An overall formal agreement for a technical exchange was even put in place between DOE and the German agency (BMFT), but no formal programs were carried out.

THE TECHNOLOGY BRIDGE TO ROBOTICS

Development of servomanipulators in the Division in the early 1980s built teams with experience closely related to the emerging robotics field. While there are many similarities, there are also vast differences. Servomanipulators use a "man in the loop" for controlling motions of the hardware, while robots normally employ some form of computer control based on earlier programmed inputs. Robots generally are fixed devices, using heavy mechanical structures to permit very precise alignments, while servomanipulators require mobility and thus light-weight structures. But, the expertise that was built up in developing servomanipulators and understanding how they can be used was a very strong base for continuing similar work in pure robotics. Experts see a merging of these technologies in the future.

As early as 1986, several ORNL staff members who had worked together in earlier years on servomanipulators began talking about how to cooperate to build a multidivision robotics program at ORNL. The initial effort was called the Telerobotics Task Force and involved FRD and I&C. Since others in the Engineering Physics and Mathematics (EPM) Division were interested in participating, a Robotics and Automation Council was formed with participants from all three Divisions with the intentions of further close alignments to promote ORNL capabilities. Burch, Feldman, and Meacham of FRD were involved. Bill Hamel, then heading a section in I&C, and Chuck Weisbin of EPM also participated.

In the meantime, many individuals were out "beating the bushes" for new work in a fairly uncoordinated fashion. ORNL management made an attempt to focus on and strengthen these efforts in 1987–1989. RISP was organized with Weisbin as its initial director, but efforts to coordinate these activities remained elusive. Weisbin left ORNL to join the Jet Propulsion Laboratory in 1990 and Joe Herndon, who had been involved with all the servomanipulator programs in FRD, took over as RISP Director. Finally in

early 1990, at the time Burch was stepping down as FRD Director, decisions were made to align the major hardware groups in FRD and I&C together as part of an expanded division, now RPSD, with Sam Meacham as Director. Those steps were taken on April 1, 1990, with the transfer of the Telerobotics Systems Section from I&C (see pages 37–40).

Staff/Technology Spin-Offs to Private Industry

A history of the organization is not complete without mention of two private companies started by ex-staff members and based largely on remote technology developed in the Program. In 1981, John White, who came with the Idaho contingent and managed the design work for the HEF while here, left to form a local private company (REMOTEC). His firm, employing some 15 to 20 people, provides consultant services and remote technology hardware. In the ensuing years, it became known worldwide in such diverse areas as (1) assisting Germany in developing concepts for their planned reprocessing plant, (2) developing new remote electromechanical manipulators, and (3) developing a line of small remotely tracked vehicles for dealing with emergencies and hazardous situations.

Similarly, Lee Martin, who was assigned here by I&C for many years to work in the instrumentation area, formed TeleRobotics International, Inc. in the late 1980s. This firm, while still small, appears to be getting a firm hold on a variety of commercial hardware and software projects, principally in remote technology.

MARTIN MARIETTA ENERGY SYSTEMS, INC

February 5, 1990

Fuel Recycle Division Staff

Organizational Change

Over a year ago, Bill Burch indicated his desire to step down as director of the Fuel Recycle Division at the end of 1989. Arrangements have been worked out now for him to do so on April 1, 1990. I am pleased to announce that Sterling A. (Sam) Meacham will become the new division dtrector on that date.

Bill has led ORNL's nuclear fuel reprocessing development activities for the past 15 years. the last nine as dtrector of the FRD since its formation. Bill's long career here and his efforts in the field of nuclear fuel recycle have been recognized worldwide and have been significant factors in maintaining ORNL's preeminent position in nuclear fuel cycle R&D. Recently Bill has become Involved in re-examining the concept of actinide burning. His enthusiasm and keen interest in the subject coincide with DOE's exploration of this concept as a possible new initiative that may have exciting implications for the future of nuclear energy. Effective immediately, Bill will head the ORNL effort to help DOE develop plans for this program and will manage the ORNL program. He will report to me in this capacity. After he steps down as division director, he will remain a member of the Fuel Recycle Division and, in addition to his managing the actinide burning effort, will assist in the ongoing technical and program work in fuel recycle.

Sam has been section head of the Remote Systems Development Section of FRD for the past 4 years. He has been at ORNL for the past 14 years, working Initially on assignment from Westinghouse, and for the past 10 years as a member of Fuel Recycle Division. Prior to being named section head, he led several important efforts in FRD, including a major role in coordinating FRD efforts on the BRET project with HEDL. He has been active in promoting work in robotics, and has been instrumental recently in positioning ORNL as a leader in robotics R&D for Environmental Restoration and Waste Management efforts nationwide.

Alex Zucker

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC

February 8, 1990

Distribution

Organizational Change

Programs sponsored by DOE and other Federal agencies in robotics and related technologies have grown considerably over the last few years to become an important area of emphasis for ORNL. Currently, the work in robotics is conducted in three divisions: Fuel Recycle, Instrumentation and Controls, and Engineering Physics and Mathematics. All three organizations have brought expertise to bear jointly on challenging problems in development of this frontier technology.

The Telerobotic Systems Section of I&C has contributed to nearly every aspect of the Laboratory's work in robotics through frequent collaboration with the other two divisions. Their work in robotic control systems research and development has produced national and international recognition and awards, including an R&D 100 award shared with Fuel Recycle Division. More recently they have led the development of major robotics activities with NASA and DOD. This past year, the Remote Systems Development Section of Fuel Recycle Division and the Telerobotic Systems Section were instrumental in bringing to ORNL a major national program on robotics technology development in support of environmental restoration and waste management efforts nationwide.

Currently, the Robotics and Intelligent Systems Program (RISP) provides a programmatic focus for robotics and related activities, and the Laboratory has enjoyed considerable success in the areas of remote technology and robotics. To further encourage and enhance the development of this important technology requires divisional focus as well; therefore, the following organizational changes will take place. Effective immediately, the charter of the Fuel Recycle Division will be expanded to provide greater emphasis on work in the robotics and remote technology areas. Effective April 1, 1990, the Telerobotic Systems Section, now located in Instrumentation and Controls, will be transferred to the Fuel Recycle Division where it will provide a strong foundation for this increased commitment to robotics and remote technology. At that time, the Fuel Recycle Division will be recast to match its expanded charter and staff.

Please join me wishing the staffs of these organizations well in these exciting changes.

Alex Zucker

Distribution: Res and Supv Staff

MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

September 21, 1990

Robotics & Process Systems Division Staff

Finally, It's Official

Alex Zucker informed me on Wednesday that we are now officially the Robotics & Process Systems Division (RPSD). I suggested this name change because I believe it reflects the future of the division while also tying to our prominent heritage.

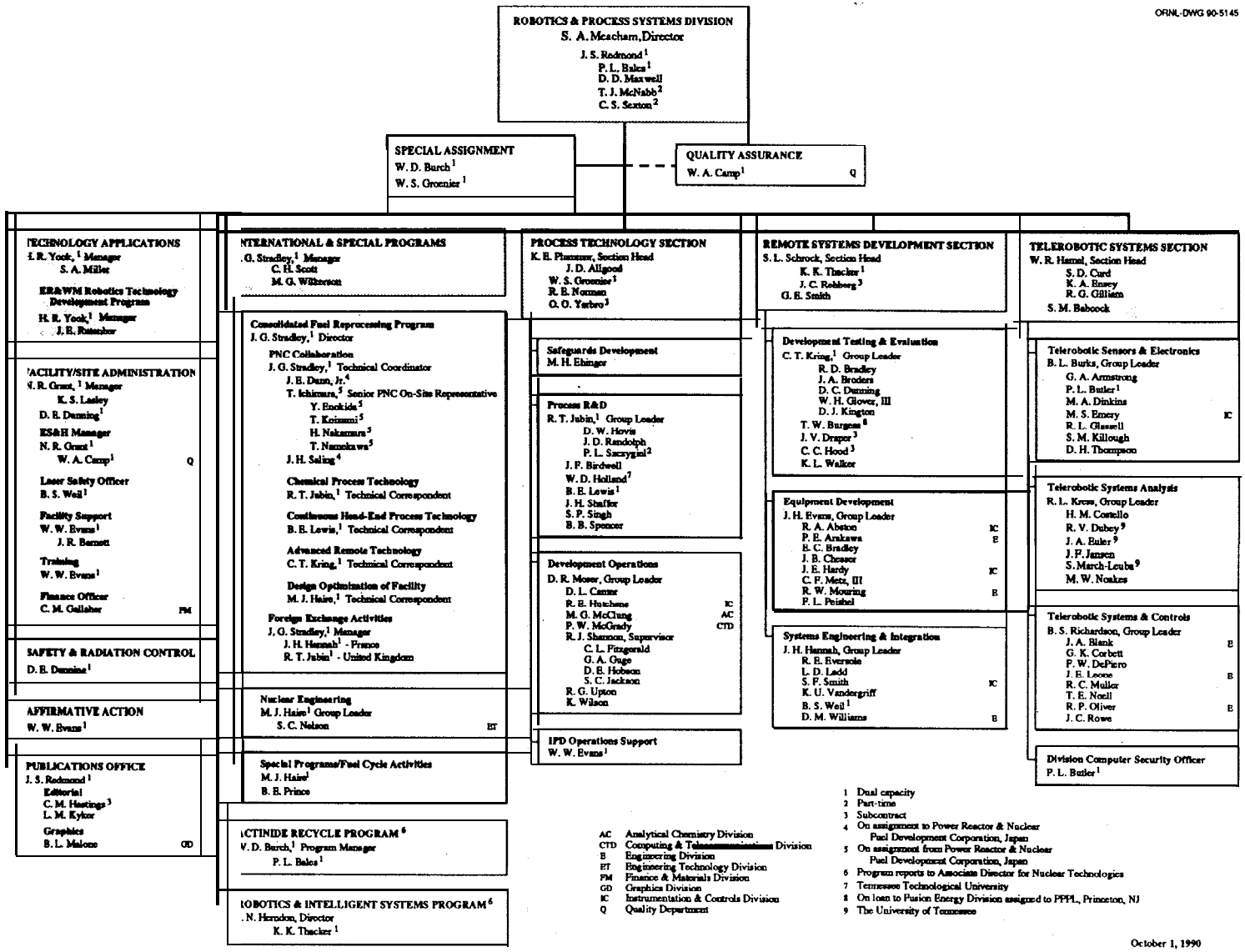
The new organization chart should be available in a few days, and other necessary changes (business cards, signs, etc.) will happen in time. The secretaries have begun answering the telephones with "Robotics & Process Systems Division" so our new title should become familiar very quickly.

S. A. Meacham, 7601, M/S 6305 (4-7065)

SAM:JSR

cc: A. Zucker
File-RC

ORNL-DWG 90-5145



AC Analytical Chemistry Division
CTD Computing & Telecommunications Division
E Engineering Division
ET Engineering Technology Division
FM Finance & Materials Division
GD Graphics Division
IC Instrumentation & Controls Division
Q Quality Department

1 Dual capacity
2 Part-time
3 Subcontract
4 On assignment to Power Reactor & Nuclear Fuel Development Corporation, Japan
5 On assignment from Power Reactor & Nuclear Fuel Development Corporation, Japan
6 Program reports to Associate Director for Nuclear Technologies
7 Tennessee Technological University
8 On loan to Fusion Energy Division assigned to PPPL, Princeton, NJ
9 The University of Tennessee

October 1, 1990

The Division staff has been a proud and hard-working group since its inception. The many budgetary problems through the years prompted Burch to select "Hang in there, Baby" as an early motto. A picture of a tiny kitten clinging to a limb with that motto printed below hung in his office for years. Because of its talented and dedicated staff, the Division has been known as a group able to focus on a task and succeed—no matter the adversities.

This "Hang in there, Baby" attitude was acknowledged by Herman Postma when he announced that his choice for Director's Division of the Year Award for 1986 was FRD. The plaque, immediately placed in an honored spot in the building, reads: "In recognition of outstanding R&D and collaborative national and international program accomplishments." At a division-hosted celebration party on June 16, 1987, where our former and present Laboratory Associate Directors attended along with Postma, Herman shared that he selected FRD for his 1986 recipient and dubbed us the Phoenix Division because we survived by establishing a major collaboration with Japan when many felt there was no chance for our survival.

Another special occasion for the division was the dedication ceremony for the IET Facility where Herman Postma operated a mechanical arm to turn on a switch that, in turn, activated the high-powered laser to cut the ribbon. (A copy of *an* article from *The Oak Ridger* is shown on following page.)

We have enjoyed the prestige of being a favorite stop for special tours and have always prided ourselves in the way we present our facility and our abilities to the visitors. Many famous people throughout the United States and the world have found our work and our facility intriguing. (Photos of some of our guests are shown on pages 43–55.)

ORNL waste facility 'appropriate'

By RICHARD MERRITT

In a cavernous gray chamber, bright orange, yellow and blue cranes and mechanical arms demonstrated to the assembled group of nuclear fuel reprocessing specialists the feasibility of handling highly radioactive materials and components safely and efficiently.

And to show off another aspect of the project, the ceremonial ribbon was severed by a laser beam that was guided by gold-plated mirrors from its source in another part of the building through a number of rooms and finally out through a hole cut in a door. The ribbon-cutting laser was activated by Oak Ridge National Laboratory director Herman Postma, who used one of the mechanical arms to activate a specially installed button on the wall.

The occasion was Tuesday's official dedication of the Intergrated Equipment Test (IET) Tuesday in the location of the former Experimental Gas-Cooled Reactor project, about two miles from the main facilities at ORNL.

Although the equipment at IET was operational about six months ago, the dedication was delayed so it could correspond to the first annual information meeting of the Fuel Recycle Division of ORNL.

In general terms, the IET is a scaled-down demonstration facility to test new equipment and procedures for handling fissionable elements -- plutonium and uranium -- from advanced nuclear power power plants, primarily breeder reactors.

With closed-circuit television systems, techincians operate the massive mechanical arms, shears, and laser beams, without risking exposure to highly radioactive materials.

The technicians operate from a shielded control room, and all the equipment and nuclear components that are to be taken apart for their recoverable materials are located in a huge "canyon," above which and within separate mechanical arms operate.

It was this "canyon" that separated the gathered scientists from local and Washington-based Department of Energy and Union Carbide Nuclear Division officials who officially dedicated the IET

"This facility is a lot of fun," said ORNL director Herman Postma, who shortly thereafter manuevered (with not too much difficulty) one of the mechanical arms to press the specially installed button activating the ribbon-cutting laser.

"This type of facility is so appropriate for a national laboratory," Postma said. "It's important, large, complex, with the latest state-of-the-art equipment. This is what a national laboratory should be doing."

Joseph A. Lenhard, assistant manager for energy research and development for DOE's Oak Ridge Operations, said that this project is a unique DOE project in one respect: Namely, "It was brought in (completed) under the $16 million budgeted for it. The construction contractor did a miraculous job," Lenhard said, citing inflation, and the four years of President Jimmy Carter's administration, when "we couldn't even talk of (nuclear fuel) reprocessing."

"All the frustration of the past four years," W. Wade Ballard, director of DOE's Nuclear Fuel Recycle Division when the IET project began, said of the Carter years. "They wanted to stop nuclear reprocessing because of fears of nuclear proliferation."

Ballard also cited the "importance of IET in the whole scheme of fuel reprocessing."

From DOE headquarters in Washington, Kermit O. Laughon, director of the Office of Spent Fuel Management and Reprocessing Systems, told the group that the "Reagan administration is strongly in favor of reprocessing and closing the nucelar fuel cycle."

Postma praised the ability of the project to survive in an atmosphere where federal "budgets go up and down by a factor of two every year."

Ballard also commented on the annual battles during the budget process. "It's difficult to operate under these conditions, but our battles have been justly rewarded."

"Watching it (IET) evolve has been most gratifying," Ballard said. "(This type of) new techonolgy is necessary for the long term advancement in nuclear fuel reprocessing."

William D. Burch, director of the Fuel Recycle Division, said that the "initial ideas originate with the program people," and then the engineers are brought in, "which makes us honest. This program is an example of the excellent cooperation of the program and engineering divisions."

The Consolidated Fuel Reprocessing Program (CFRP) in a national DOE prgram responsible for the development nationwide of nuclear fuel reprocessing technologies. About two-thirds of the national CFRP research is carried at ORNL, and about two-thrids of that work is handled by the Fuel Recycle Division.

Fuel reprocessing involves the chemical extraction of the fissionable materials from spent nuclear fuel and the isolation of the radioactive by-products of the fission process. The spent fuel, which is contained in bundles of 12-foot-long metal rods, is first cut into small pieces by the mechanical shear.

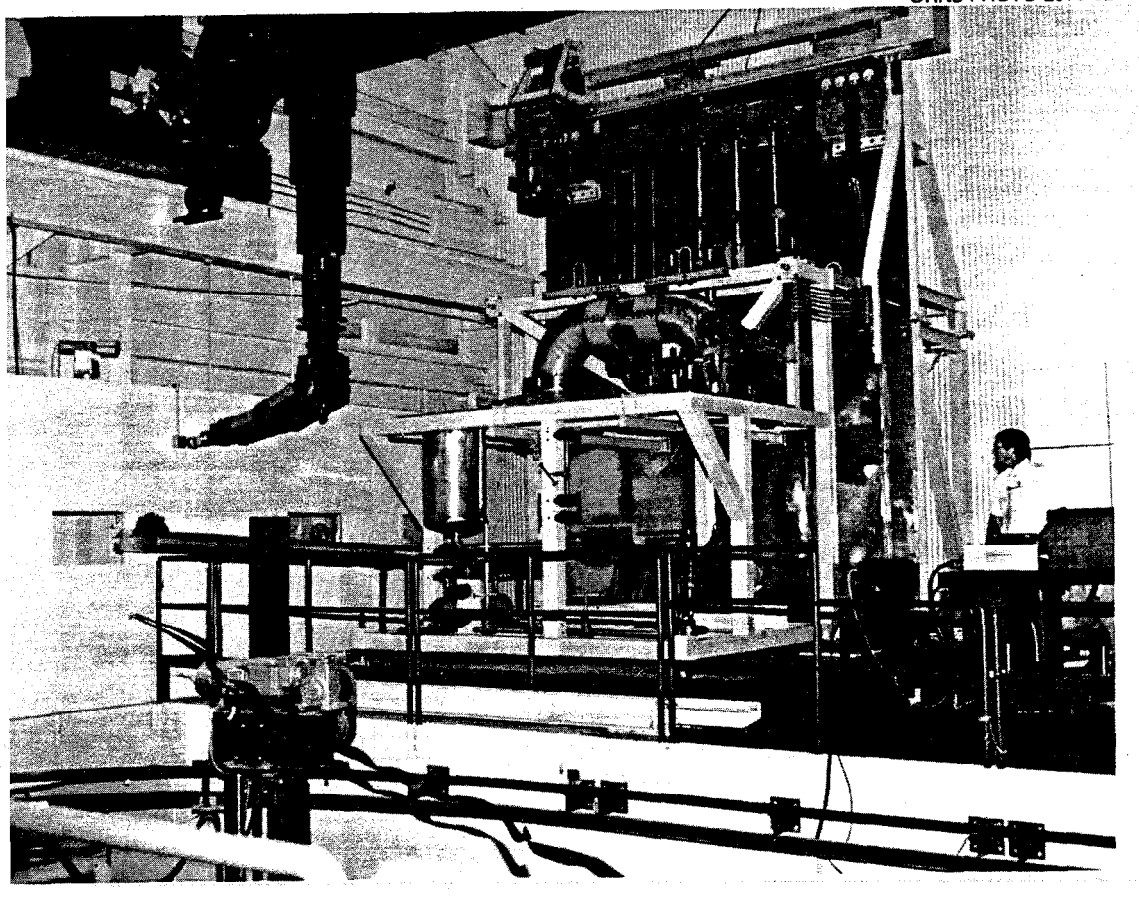
Laser cutting systems are being applied to assist in the disassembly of the extraneous hardware prior to shearing the fuel into small pieces which can be dissolved in the acid baths. The usable fuel is extracted chemcially and can be refabricated into new fuel for reactors.

ORNL is the lead facility for nuclear fuel reprocessing research, which includes such facilities across the country as the Pyrochemical and Dry Processing Methods Program at Argonne National Laboratory, the Converter (Light Water Reactor) Program at Savannah River Laboratory, and High Temperature Gas-Cooled Reactor Fuel Reprocessing Center at General Atomic Co.

The CFRP began in 1974 when the 7600 Building complex at ORNL was chosen as the lead research site, and work on the IET component of the program began in 1976. More than 120 people are now working on CFRP, representing more than ten ORNL divisions and other UCND organizations.

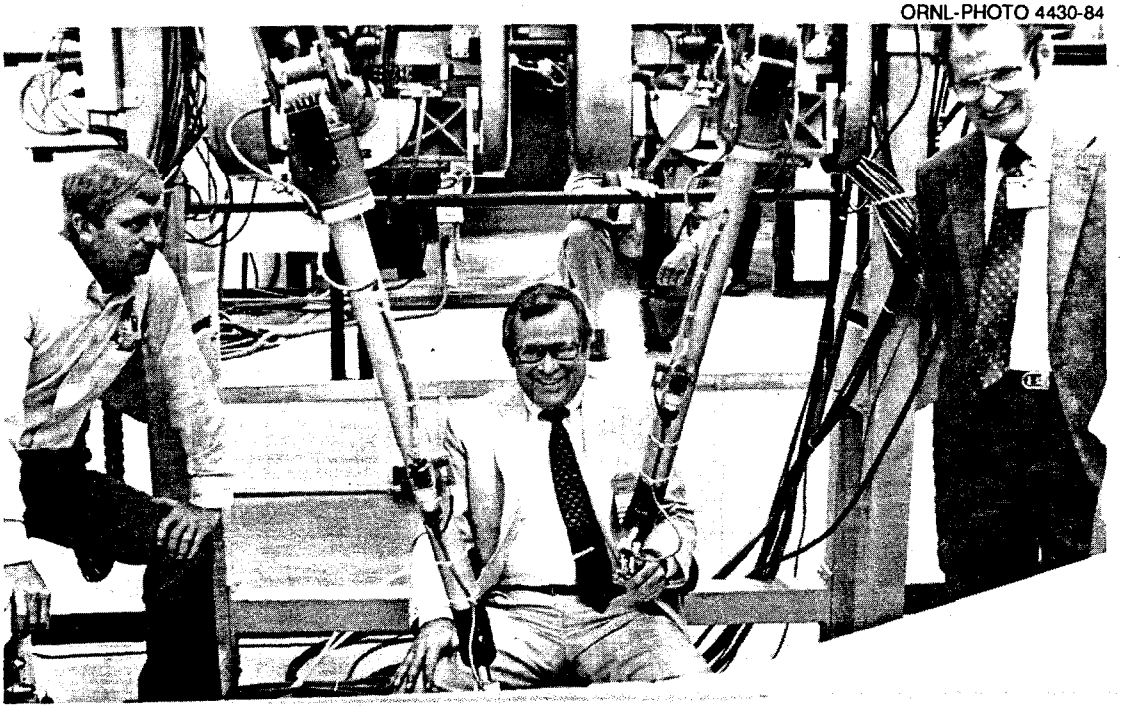
When CFRP was conceived, its original intent was to reprocess mixed uranium-plutonium oxide fuels from liquid metal fast breeder reactors, but since that time, its scope has been expanded to include research and development on a broader range of fuels that might be used in breeder reactors.

ORNL-PHOTO 2573-82



Herman Postma activates the ribbon-cutting laser remotely via one of the mechanical arms. A mockup of a nuclear fuel component to be dismantled by the IET to recover nuclear fuel is shown at left.

ORNL-PHOTO 4430-84



ORNL-PHOTO 7385-92

ORNL-PHOTO 3672-81

Howard H. Baker, Jr. visited the facility many times during his time in the Senate and, later, in the White House. Top left: Shown here in a 1984 visit, it's obvious that Baker is enjoying his training on the M-2 servomanipulator from Dan Kington (left). *Bill Burch watches from the right. Bottom left: Dave Bailey (DOE/HQ) and S. Watanabe sign after a program review meeting in Japan. Above: This May 29, 1981, photo shows U.S. Senate Majority Leader Baker touring the CFRP with (from left): Roger F. Hibbs, UCND President; William D. Burch, Directorof the CFRP; Robert J. Hart, Manager, and Joseph A. Lenhard, Assistant Manager of DOE ORO; and Herman Postma, ORNL Director.*

ORNL-PHOTO 5645-80

Technical exchanges dating back to 7977 provided ***opportunities*** *for the Division staff to visit many facilities in the United Kingdom, including their breeder reprocessing facilities at Dounreay in Northern Scotland.* ***It*** *also brought many staff from the UKAEA and British Nuclear Fuels Limited (BNFL) here for numerous meetings. These visits provided an opportunity for a long series of go/f matches. But, unfortunately, the U.S. team* ***usually*** *went down in defeat. Here Harry* ***Allardice*** *(far right), who headed the UKAEA breeder fuel cycle program, and Herbert* ***Taylor*** *(second from left) of BNFL are receiving their "golf winnings" from Wade Ballard (far left) of DOE- Washington and Bill* ***Burch.***

ORNL-PHOTO 3488-85

On numerous occasions, teams from FRD visited the PNC facilities at Tokai-mura and Japanese teams visited ORNL to review programs. This photo shows a typical "signing of minutes" ceremony at the end of a review session in Oak Ridge. Heading this PNC team was H. Kashihara, then Manager of the Recycle Technology Development Section at Tokai, who rose to now head the PNC-Headquarters Nuclear Fuel Cycle Development Division in Tokyo. Shown from left to right (front row) are: Clint Bastin (DOE/HQ), H. Kashihara, and Mel Feldman. Back row: Joe Herndon, Ji Young Chang, Lee Martin, M. Maeda, K. Amano, Y. Fujita, T. Kawata, Y. Ohtani, Martha Rohr (DOE ORO), Norb Grant, Bill Burch, and Dick Philippone (DOE ORO). (Philippone's close working relationship with our staff earned him the pet title of "DOE's Friendly Spy. ")

Bottom left: In the courtyard of a Japanese restaurant after a typical Japanese dinner. Front row (left to right): Grant ***Stradley,*** *K. Matsumoto, Geisha girl, and Bill Burch. Back row (left to right): Geisha girl,* ***S.*** *Hayashi, Jim Dunn (CFRP staff member on assignment to PNC), and* ***Y.*** *Kishimoto.*

Bottom right: One group with ***T. Ishiwatari*** *"hamming it up" at the end of the evening. Front center:* ***T.*** *Ishiwatari. Back (left to right): Ji Young Chang, Bill Burch, Clint Bastin, Keith Kibbe,* ***Marv Whatley,*** *Sam Meacham, Grant* ***Stradley,*** *and Frank Peishel.*

ORNL-PHOTO 7391-92

Through visits to PNC we learned many of the social customs of Japan, including the importance in their society of personal friendships with business associates. Many of the Division staff were royal/y entertained on visits to Japan where they enjoyed special evening entertainment at dinner; sightseeing at temples, in the mountains, in the large cities; and visits to private homes. Never were we more impressed than on an occasion when PNC President Ishiwatari traveled by train late one afternoon to Tokai just to host us for dinner, on/y to return to Tokyo ear/y the next day.

ORNL-PHOTO 7387-92

ORNL-PHOTO 7791-89

Yoichiro Kishimoto and other PNC staff members present gifts to our clerical staff. (Left to right: Tomozo Koyama, Tammie **McNabb,** *Janice Al/good, Karen* **Thacker, Atsushi** *Aoshima, Delphine Wilkerson, Kazuhiko Tanaka, June Redmond, Hisao Ojima, Yoichiro Kishimoto, Setsuo Kinoshita, Carol* **Scott,** *Yoshi* **Ueda,** *Kim* **Lasley,** *Takami Yasu, and* **Kazuo** *Ohashi.)*

While the BRET project at Westinghouse Hanford was never built, the design was a significant accomplishment for the Division and **Program—even** *though the work was accompanied by many frustrations. Not the /east of* **these** *frustrations was our continual search for the "rock" that was never accurately described by the RO DOE office, who had overall responsibility within DOE for the project. Sam Meacham was brave enough*

ORNL-PHOTO 7386-92

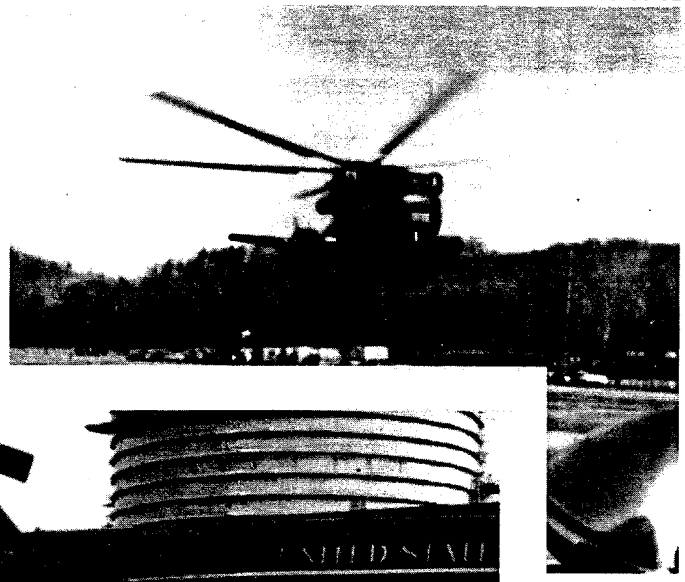
one day to carry a sizeable rock he spied lying in the curb beside the DOE building into the wind-up meeting with DOE that week and deposit it on the conference tab/e. No words were needed for the message to hit home. Even the "big wheels" of RO got a charge out of this irreverence for their methods. The Rock was made into a forma/ plaque (see photograph above), presented to Burch, and remained on his desk for many years.

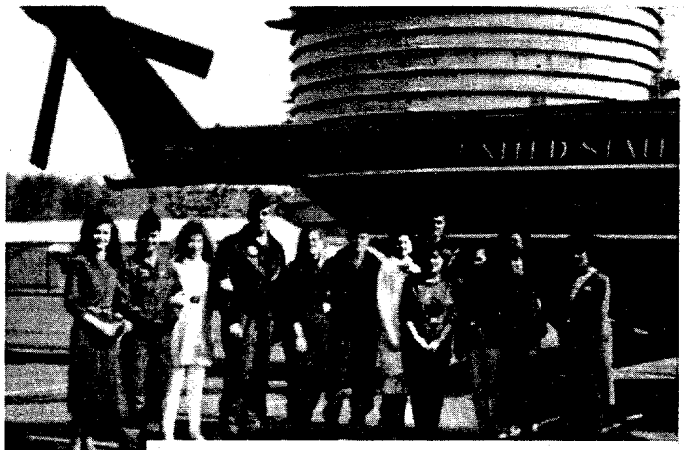
One day T. Kawata spotted The Rock, questioned Burch about the significance of the plaque, and enjoyed the story so much that he wrote a 'feature article about it for their in-house journal, Donen. *In the article he to/d of /earning about the history of the rock 'glittering" on the desk of the director of the FRD-a director kno wn to the Japanese as a sincere and tall gentleman who we/comes visitors with a strong-grip handshake. The photo above is the photo used in the Japanese article.*

The Rock continues to reside in the Division Director's office. Bill Burch entrusted The Rock to Sam Meacham *when Sam succeeded him as Division Director.*

On February 79, 1992, ORNL was honored with an official visit by President George Bush, principally to participate in the signing of a new cooperative agreement in materials science at the High Temperature Materials Laboratory So, what was the connection of that visit to RPSD? Turns out that we had the best landing field (our parking lot) for the fleet of five helicopters required for the President, Secret Service, and accompanying news media. Many rumors and official pronouncements came our way the day before the visit. We were to park inside the fence, c/earing the parking lot for the helicopters-TRUE. We were not to look out the windows to give the impression we were not working-FALSE. We would not be allowed outside the building during the Z-hour visit-HALF-WAY TRUE. (The marines came into the building to find beverage machines, met one of our staff members, and offered guided tours of the President's helicopter. How convenient that the RPSD staff member became an "instant little sister" to the ranking marine. Sure/y she and her friends could accept the invitation for a personal tour of the helicopter by her "brother" pilot, especially since the Presidentialguards were approving. Hundreds of ORNL staff members stood in the cold for hours to hear the President speak, but only RPSD gals toured the President's helicopter. That seemed to be fair payment for the parking fee!) Opposite page: Top: One of the helicopters lands in our parking lot. Middle: RPSD staff members pose with the Marines after touring the Presidential helicopter. Bottom: ORNL Fire Department staff members pose in front of the helicopter.

ORNL-PHOTO 7388C-92





MARTIN MARIETTA

Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

February 18, 1992

All Robotics & Process Systems Complex Personnel and Visitors

Visit of President Bush

As you probably know by now, President Bush will be arriving and departing for his visit to ORNL using our parking lot for his helicopters tomorrow morning. Although he will probably not visit this area, security will be extremely tight during the arrival, departure, and the intervening time.

Everyone arriving tomorrow will be checked as they come in, and no one will be allowed into the area after 9 a.m. until after the President leaves (estimated departure time at 11 a.m.), There will be no parking in the front lot, and everyone will bring their cars into the area inside the gates and park East of the 7600 complex. There will be people directing you to parking places. No one will be allowed to be outside at any time after 9 a.m. (not even to go back and forth between here and the P&E shop):

It is recognized that we will be somewhat inconvenienced tomorrow, but please help our Security people make the President's visit as smooth as possible. Thank you.

S. A. Meacham, 7601, M/S 6305 (4-7065)

SAM:NRG:mgw

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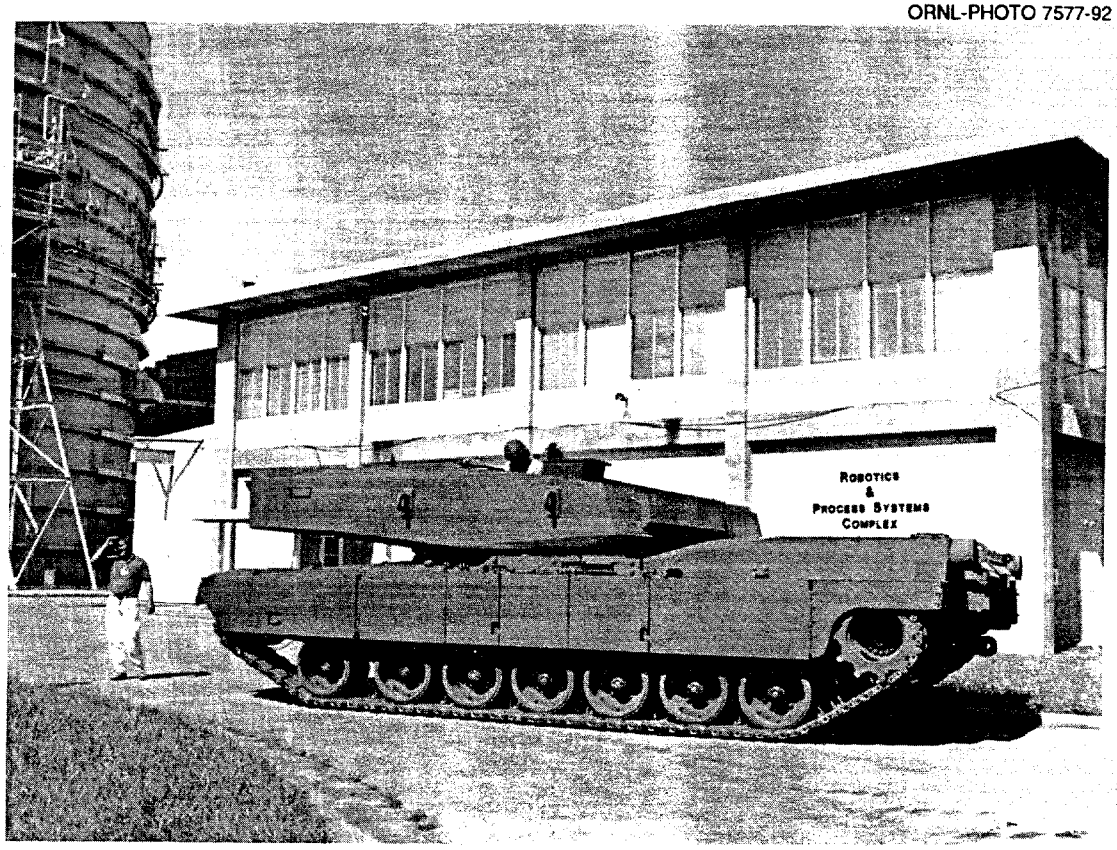
ORNL-PHOTO 7577-92



Not all important visitors to the 7600 Complex have been human. Developing the remote systems expertise and technology necessary for work to be performed in the hostile fuel reprocessing environment has provided an opportunity for us to get involved in several development projects for the U.S. Army. As part of one project, the Army loaned RPSD an M1A1 tank, which several project team members were required to learn to drive and operate. This photograph shows the M1A1 tank being maneuvered about the RPSD complex by development team members.

THE ORGANIZATION AND MISSIONS TODAY

RPSD remains as one of the small research divisions at ORNL. In its first year, the missions of the old FRD were still the largest activity and provided the majority of all funding. However, efforts in robotics are becoming a Division priority. The Collaboration with PNC may continue at a reduced scope, but long-term plans for the second five-year phase beginning in 1992, with a third phase to follow at the time the RETF begins operations, now only appear as a fond hope. Plans had envisioned a team of engineers participating in the initial start-up years, but DOE interests and support have waned and the end of the Collaboration may be just over the horizon.

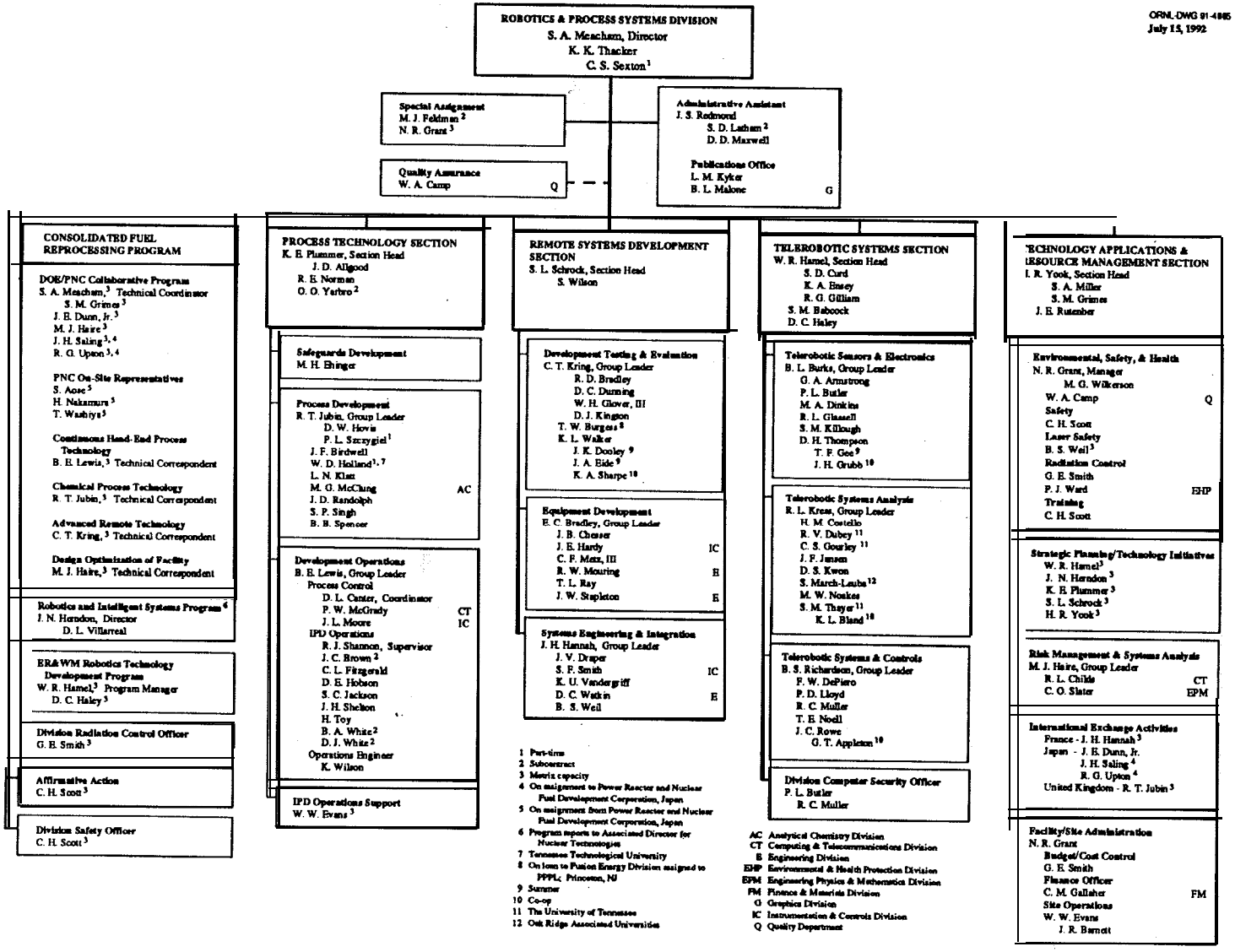
The prospects for vitality and significant growth are clearly in the robotics area. Here, several significant programs are proceeding or are in early formative stages. A program to develop and build a prototype servomanipulator or robot for potential space applications has been highly successful. Although the role of this prototype in future space missions is not clear, it has provided follow-on activities.

Ties to military needs have become important opportunities. A major program is under way to develop hardware for automated loading of tank artillery shells in conjunction with two Army posts.

Two DOE programs provide other opportunities that are being exploited. As part of the overall waste management and site restoration efforts, a robotics development task was organized with ORNL and Sandia National Laboratories as principal technical organizations. Work is going forward on various robotics assists to clean up activities, including a vehicle to scan and monitor underground waste sites, robots for assisting in removing sludge from tanks, and robotics-assisted mapping in Fernald silos.

Finally, worldwide collaboration in fusion appears as a potential avenue for ORNL and RPSD to develop technology for maintaining large future fusion machines.

As true of so many organizations, the future is seen through a hazy window. But, the newly emerging activities in robotics, hopefully combined with a revitalization of nuclear power in the future, may be catalysts for long-term contributions from RPSD to the research needs of the nation. Our "Hang in there, Baby" motto is still appropriate today, and there is no doubt that we will continue to succeed.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2 Subcontract
3 Merit capacity
4 On assignment to Power Reactor and Nuclear Fuel Development Corporation, Japan
5 On assignment from Power Reactor and Nuclear Fuel Development Corporation, Japan
6 Program reports to Associated Director for Nuclear Technologies
7 Tennessee Technological University
8 On loan to Fusion Energy Division assigned to PPPL, Princeton, NJ
9 Summer
10 Co-op
11 The University of Tennessee
12 Oak Ridge Associated Universities
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CT Computing & Telecommunications Division
E Engineering Division
EHP Environmental & Health Protection Division
EPM Engineering Physics & Mathematics Division
FM Finance & Materials Division
G Graphics Division
IC Instrumentation & Controls Division
Q Quality Department