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United States General Accounting Office

Report to the Honorable
Albert Gore, Jr., U.S. Senate

October 1987

SOFTWARE DISTRIBUTION

Review of the Department of Energy's National Energy Software Center

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Information Management and
Technology Division

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October 14, 1987

The Honorable Albert Gore, Jr.
United States Senate

Dear Senator Gore:

In your May 22, 1987, letter and in subsequent discussions with our office, you asked us to answer specific questions concerning the Department of Energy's National Energy Software Center. This request was prompted by your interest in the transfer of federally funded technology to the United States marketplace, and in the shipment of federally funded computer technology to foreign countries. Summarized below are a description of the National Energy Software Center and responses to the questions raised by your office on the Center's operations. Details on our objective, scope, and methodology are provided in appendix I.

Description of the Center

The National Energy Software Center, operated by the Argonne National Laboratory, is the Department of Energy's software exchange and information center. One of its major responsibilities is the management and control of the transfer of computer software to other governmental agencies, the private sector, and foreign recipients. Policy guidance for the Center is provided by the Department of Energy's Office of Scientific and Technical Information, at Oak Ridge, Tennessee. As of August 1987, the Center had approximately 1,400 computer programs in its library. During calendar year 1986, the Center's 11 employees distributed 417 programs to requesters. Details on the Center's responsibilities and overall operations are shown in appendix II.

Responses to Questions

Our responses to your questions concerning the activities of the National Energy Software Center are summarized below.

1. What are the top 30 computer programs being distributed to domestic and foreign requesters and what national laboratories are responsible for their development?

The most popular computer program distributed to domestic or foreign requesters during the 18-month period, October 1985 through March 1987, was a programming system implementing common algebraic functions (69 domestic and 10 foreign requests were filled). This program

was produced at Lawrence Livermore National Laboratory. Other popular computer programs included a large collection of FORTRAN mathematical subprograms produced at Sandia National Laboratories (42 domestic and 4 foreign requests were filled), an analytical laboratory information system program produced at Oak Ridge National Laboratory (11 domestic requests were filled), and a set of computer programs for the analysis of energy consumption in buildings by Lawrence Berkeley Laboratory (10 domestic requests were filled). Each of the Center's remaining computer programs were distributed 9 or fewer times to domestic or foreign recipients. Appendix III contains details of the 65 computer programs most frequently requested by domestic and foreign recipients during the 18-month period, including their abstracts.

2. Do the most popular programs fall into specific categories, such as programs that predict the properties of materials or programs that control processes that may be applicable for industry use? Does domestic or foreign popularity depend on program size—for example, programs designed for a personal versus a mainframe computer?

Each of the programs distributed by the National Energy Software Center is placed into 1 of 26 descriptive categories. With some modifications many of the programs in these categories are applicable for industry use. During the 18-month period ending March 31, 1987, the most requested computer programs were in the category "General Mathematical and Computing Systems Routine" (23 programs). Other popular categories included "Heat Transfer and Fluid Flow" (10 programs); "Radiological Safety, Hazard, and Accident Analysis" (7 programs); and "Deformation and Stress Distribution Computations, Structured Analysis, and Engineering Design" (7 programs). Each of the remaining categories of the most popular programs contained 4 or fewer programs. Appendix IV contains a description of the Center's 26 categories of programs and highlights the categories that contain the most frequently requested programs.

The Center's Director told us they have never noticed a correlation between the popularity of a computer program and its size. However, the Director stated that most of the Center's programs are designed for mainframe computers.

3. Are there blanket orders for categories of software, particularly from foreign countries?

According to Center records, no blanket orders were received for categories of software during the 18-month period ending March 31, 1987. The Center's Director also stated that the Center has never received blanket orders for categories of software programs. Requesters must order specific programs. There is no limit, however, on the number of programs that can be ordered as long as the requester pays the applicable fees and is eligible to receive the requested programs.

4. Does the Center keep records of further distribution by foreign recipients to other countries—particularly to Communist Bloc nations? If not, is the Center aware of a recipient's intent to re-export computer programs?

The Center does not keep such records. The Center's Director and an Assistant Director of the Office of Scientific and Technical Information told us that they were not aware of any instance in which foreign recipients redistributed software to other countries. Requesters receive programs from the Center with several stipulations, one of which is that the programs will not be passed to another user outside the requester's organization without approval from the Center. However, these officials said that they have no way of knowing whether a requester intends to redistribute a program without approval from the Center or when a violation of the stipulation takes place. The Center's Director also emphasized that, barring any special agreements between the United States and a foreign country, only programs that have been designated available for unlimited distribution are sent to foreign requesters. Details of the Center's distribution classifications are discussed in appendix V.

5. Does the Center keep records of the domestic or foreign recipient's improvements and upgrades of software distributed by the Center? Do such improvements lead to commercialization?

The Center does not keep such records. According to the Center's Director, one of the conditions for receipt of a program is that the requester submit a copy of any modified version of the program to the Center. Other requesters seeking to obtain the modified version of the program should then obtain it from the Center. The Director stated that in many instances the Center has received modified programs but acknowledged that the Center has no way of knowing if violations are occurring.

Regarding whether software improvements lead to commercialization, officials within the Office of Scientific and Technical Information stated that improving and upgrading a program often leads to its commercialization, but no records are available on the extent of this practice. The Department, however, recently developed and is nearing completion of a draft guideline to encourage more Department of Energy national laboratory contractors to obtain a copyright on certain computer programs that may, with modifications, have application to government and nongovernment users. The Department hopes that this guideline will remove the incentives for unauthorized upgrading and commercialization of programs. Details on this draft guideline are contained in appendix VI.

6. What computer programs has the National Energy Software Center shipped to Italy in recent months?

During the 18-month period ending March 31, 1987, five computer programs were shipped to requesters in Italy. Three of the five were sent to a single requester (ENEA Computing Program Library, Bologna, Italy). The remaining two programs were distributed to two other requesters. These programs were for aiding software development, process engineering, the measurement of the strength of aerosol particles, and the simulation of heavy gas dispersion in the atmosphere. Appendix VII contains a table showing each recipient, a description of each recipient's program, how long the Center had the program in its library, and the date the program was shipped.

7. What computer programs are contained in the Center's more sensitive categories "F" and "I"? Also, which of these programs have been shipped to foreign requesters in recent months?

Categories "F" and "I" are 2 of 26 categories used by the Center to classify its library of computer programs. Because of their subject matter, these categories have a potential for providing sensitive data to United States or foreign recipients. Category "F" is "Space-Time Kinetics, Coupled Neutronics-Hydrodynamics-Thermodynamics, and Excursion Simulations," and contains 27 computer programs. Of the 27 programs in this category, for the 18-month period ending March 31, 1987, only 4 have been provided to requesters, and three of the four recipients were foreign. Category "I" is "Deformation and Stress Distribution Computations, Structural Analysis, and Engineering Design Studies," and contains 99 programs. Of the 99 programs in this category, for the 18-month period ending March 31, 1987, only 21 have been shipped to

requesters. Fifteen of the 21 programs were sent to eight foreign countries. Appendix VIII contains a listing of the programs in these categories and an abstract of those sent to foreign requesters.

We discussed the information in this report with the Deputy Director of Administration, Department of Energy, the Manager of the Department's Office of Scientific and Technical Information, and the Center's Director. These officials agreed with the accuracy of the information presented and made some clarifying comments. We have incorporated their comments as appropriate.

As arranged with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 7 days from the date of the document. At that time, we will send copies to other interested congressional members and committees and to the Secretary, Department of Energy. We will also make copies available to others on request.

Sincerely yours,

Howard G. Rhile
Associate Director

Contents

Objective, Scope, and Methodology

Our objective was to answer a series of questions on certain operations of the Department of Energy's National Energy Software Center. Specifically, we obtained information on the Center's most popularly requested computer programs by domestic and foreign recipients, the Center's descriptions of their computer program categories, the distribution procedures for programs received by the Center, computer programs shipped to Italy, and details of the computer programs contained in the Center's more sensitive categories, "F" and "I". Information in this report covers the 18-month period ending March 31, 1987, and therefore encompasses all information during fiscal year 1986 and all information available for fiscal year 1987 at the time of our review.

To accomplish our objective, we interviewed personnel in the Department of Energy's Office of Scientific and Technical Information, which has policy-making responsibilities for the Center, and contractor personnel at the Argonne National Laboratory, who are responsible for the Center's operations. We also interviewed, in person or by telephone, selected contractor personnel at the Argonne, Lawrence Livermore, and Oak Ridge national laboratories who have either contributed to or received programs from the Center. In addition, we reviewed pertinent documents and guidelines obtained from the Office of Scientific and Technical Information and from the Center itself.

We did not evaluate the management and other operational and administrative aspects of the Center, nor did we attempt to interpret the usefulness or significance of the programs included in the Center's library. Also, we did not audit data provided by the agency or contractor officials; however, our inquiries and review of documentation have not provided any evidence to contradict those data. Our review was conducted from June 22 to August 27, 1987.

Description of the National Energy Software Center

The National Energy Software Center was formed in 1973 and is the Department of Energy's software exchange and information center. It is operated by the Argonne National Laboratory, Argonne, Illinois. The Center operates under the guidance of the Department of Energy's Office of Scientific and Technical Information, located at Oak Ridge, Tennessee.

The Center has four responsibilities: (1) operating a software and resource center for acquiring, processing, announcing, and distributing computer software and data compilations sponsored by the Department of Energy; (2) acquiring software produced in foreign countries for the Department's use; (3) providing assistance to the Department's computer facilities in identifying needed software not funded by the Department; and (4) managing and controlling the transfer of Department developed software to other governmental agencies, foreign organizations, and private-sector U.S. commerce and industry, in compliance with federal laws and regulations.

Since 1973, the Center has gone from a fully funded operation to a fully self-financed operation. The Center began charging for its services and products in fiscal year 1983. Currently, the cost to obtain one of the Center's 1,412 computer programs ranges from about $50.00 to $4,500.00 depending upon such things as the size and complexity of the particular program selected, the costs associated with verifying that the program will perform as advertised, and whether the recipient is a nonprofit, commercial, or foreign entity. In fiscal year 1987, the Center, which has 11 employees, had estimated operating costs of about $700,000.

The National Energy Software Center's Most Popular Computer Programs and Their Abstracts

The following tables show, for the 18-month period ending March 31, 1987, the most popular computer programs and their abstracts that were distributed to domestic and foreign recipients by the National Energy Software Center. The tables designating the most popular programs also contain the code number assigned to each program by the Center, the laboratories that produced the programs, the category code for each program, and the number of copies distributed. Although we were asked to identify the 30 most popular programs distributed to domestic and foreign requesters, we identified, as agreed to by your office, the 41 most popular domestically distributed programs and the 24 most popular foreign-distributed programs. We identified 41 domestically distributed programs because there were 41 programs that were requested two or more times (only 20 of these were requested three or more times). We identified 24 foreign-distributed programs rather than 30, because only these 24 programs were distributed to more than one requester. Eighty-five other programs sent to foreign recipients were only requested once. In the following tables, the information is provided first for domestic requesters and second for foreign requesters.

Table III.1: Most Popular Computer Programs Requested by Domestic Recipients for the 18-Month Period Ending March 31, 1987

Code number	Program name	Production laboratory	Category code[1]	Copies distributed
9847	DOE-MACSYMA, computer algebra system	Lawrence Livermore National Laboratory	P	69
820	SLATEC3 0, mathematical subroutine library	Sandia National Laboratories, Albuquerque	P	42
G9637	ANALIS, analytical lab information system	Oak Ridge National Laboratory	U	11
782	DOE2 1C, building energy consumption analysis	Lawrence Berkeley Laboratory	T	10
972	NJE4 00, VAX/VMS IBM NJE protocol emulator	Argonne National Laboratory	P	9
9631	VAXIMA computer algebra system under UNIX	Lawrence Berkeley Laboratory	P	8
9787	SIG, signal processing, analysis, and display	Lawrence Livermore National Laboratory	T	8
534	EISPACK3, matrix eigenvalue/vector package	Argonne National Laboratory	P	7
9688	KIVA 2- and 3-d reactive flows with fuel sprays	Los Alamos National Laboratory	U	7
886	EQ3/6, geochemical modeling of aqueous systems	Lawrence Livermore National Laboratory	R	7
800	LINPACK, simultaneous linear algebraic equations	Argonne National Laboratory	P	6
R1066	COMMIX 1B, 3 d single-phase thermal hydraulics	Argonne National Laboratory	H	5
818	CONTEMPT4/MOD5, PWR and BWR containment analysis	Brookhaven National Laboratory	G	5
623	SETS, set equation transformation system	Sandia National Laboratories, Albuquerque	P	5
9695	SALT ANL, systems analysis process simulation	Argonne National Laboratory	T	4
9935	ODEPACK, a collection of ODE system solvers	Lawrence Livermore National Laboratory	P	4
510	VIM2/13, continuous energy MC neutron transport	Argonne National Laboratory	C	3
1056	TOOLPACK1, software tools for FORTRAN 77	Argonne National Laboratory	P	3
R9861	DIF3D 5 3, nodal diffusion and transport theory	Argonne National Laboratory	C	3
9923	NIKE2D static and dynamic response of 2d solids	Lawrence Livermore National Laboratory	I	3
784	DSNP, dynamic simulation nuclear power plants	Argonne National Laboratory	K	2
847	DISPL1, 1,2-d kinetics diffusion PDE solution	Argonne National Laboratory	P	2
R885	SWAAM2 LMFBR sodium-water reaction analysis	Argonne National Laboratory	G	2
9717	SCIENTIFIC WORKSTATION EVALUATION BENCHMARK	Argonne National Laboratory	P	2

(continued)

Code number	Program name	Production laboratory	Category code[1]	Copies distributed
R275	PDQ7, 1,2 or 3-d few-gp diffusion depletion	Savannah River Laboratory	D	2
1034	ISDMS, INEL scientific data management system	Savannah River Laboratory	M	2
9772	ARCHIVE, NOS2 2 permanent file backup system	Fermi National Accelerator Laboratory	P	2
602	LENSDES, nonlinear least sq lens design system	Los Alamos National Laboratory	W	2
939	MAPPER, report quality graphics on command	Los Alamos National Laboratory	N	2
948	SOLA-VOF, transient fluid flow free boundaries	Los Alamos National Laboratory	H	2
9672	CGS, Los Alamos common graphics system	Los Alamos National Laboratory	P	2
9979	SALE3D, ALE treatment of 3-d fluid flows	Los Alamos National Laboratory	H	2
592	LSODE, ordinary differential eqn system solver	Lawrence Livermore National Laboratory	P	2
968	SLIC, interactive graphics 3-d mesh generation	Lawrence Livermore National Laboratory	P	2
9827	PRAISE-B, LWR piping reliability assessment	Lawrence Livermore National Laboratory	I	2
517	HEATING5, 1,2, or 3-d heat conduction program	Oak Ridge National Laboratory	H	2
678	MORTRAN2, macro-based structured FORTRAN	Stanford Linear Accelerator Center	P	2
1006	MAEROS, multicomponent aerosol time evolution	Sandia National Laboratories, Albuquerque	R	2
R1075	HECTR1 5, hydrogen event containment response	Sandia National Laboratories, Albuquerque	G	2
9689	GKS minimal graphical kernel system C Binding	Sandia National Laboratories, Albuquerque	P	2
9918	DASSL, a differential/algebraic system solver	Sandia National Laboratories, Livermore	P	2

[1]The "Category Code" column shows which of the categories a program has been placed in by the Center The titles of the categories are as follows:

C Static Design Studies
D Depletion, Fuel Management, Cost Analysis, and Power Plant Economics
G Radiological Safety, Hazard, and Accident Analysis
H Heat Transfer and Fluid Flow
I Deformation and Stress Distribution Computations, Structural Analysis, and Engineering Design Studies
K Reactor Systems Analysis
M Data Management
N Subsidiary Calculations
P General Mathematical and Computing System Routines
R Environmental and Earth Science
T Electronics, Engineering Equipment, and Energy Systems Studies
U Chemistry
W Physics

Table III.2: Abstracts of the Most Popular Programs Distributed to Domestic Requesters During the 18-Month Period Ending March 31, 1987[1]

Code number	Copies distributed	Program description
9847	69	DOE-MACSYMA—A large computer programming system used for performing symbolic as well as numerical mathematical manipulations. The user can differentiate, integrate, take limits, solve systems of linear or polynomial equations, factor polynomials, expand functions in Laurent or Taylor series, solve differential equations (using direct or transform methods), compute Poisson series, plot curves, and manipulate matrices and tensors
820	42	SLATEC—A large collection of FORTRAN mathematical subprograms brought together in a joint effort by the Air Force Weapons Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Magnetic Fusion Energy Computing Center, National Bureau of Standards, Sandia National Laboratories (Albuquerque and Livermore), and Martin Marietta Energy Systems Incorporated at Oak Ridge National Laboratory
G9637	11	ANALIS—An analytical laboratory information system
782	10	DOE2.1C—A set of computer programs for the analysis of energy consumption in buildings. Programs are included to calculate the heating and cooling loads for each space in the building for each hour of a year, to simulate the operation and response of the equipment and systems that control temperature and humidity and distribute heating and cooling to the space, to model primary energy conversion equipment that uses fuel (for example oil, gas, or sun) to provide the required heating, cooling, and electricity, and to compute the life-cycle cost for building operation based on economic parameters
972	9	NJE4.00—A communications software code developed to enable a VAX VMS system to communicate with standard IBM networks by emulating the Network Job Entry protocol.
9631	8	VAXIMA—A large computer programming system written in LISP, used for performing symbolic as well as numerical mathematical manipulations
9787	8	SIG—A general-purpose signal processing, analysis, and display program. Its main purpose is to perform manipulations on time- and frequency-domain signals
534	7	EISPACK3—A collection of 75 FORTRAN subroutines, both single-and double-precision, that compute the eigenvalues and eigenvectors of nine classes of matrices. The package can determine the eigensystem of complex general, complex Hermitian, real general, real symmetric, tridiagonal, special real tridiagonal, and generalized real symmetric matrices. In addition, there are two routines that use the singular value decomposition to solve certain least squares problems
9688	7	KIVA—A program that solves the equations of transient, multicomponent, chemically reactive fluid dynamics, together with those for the dynamics of an evaporating liquid spray. The program has been developed with applications to internal combustion engines specifically in mind and contains a number of features to facilitate such applications. However, most of the program structure is quite general and can be adapted to a variety of other applications with only minor modifications
886	7	EQ3/6—A set of computer programs and supporting data files, used in modeling aqueous geochemical systems
800	6	LINPACK—A collection of FORTRAN subroutines that analyze and solve various classes of systems of simultaneous linear algebraic equations. The collection deals with general, banded, symmetric positive indefinite, triangular, and tridiagonal square matrices, as well as with least square problems and the QR and singular value decompositions of rectangular matrices
811066	5	COMMIX-1B—A program that performs steady-state or transient, single-phase, three-dimensional analysis of fluid flow with heat transfer in a single-component or multicomponent system
818	5	CONTEMPT4/MOD5—A program that describes the response of multicompartment containment systems subjected to postulated loss-of-coolant accident conditions
523	5	SETS - A program that is used for symbolic manipulation of Boolean equations, particularly the reduction of equations by the application of Boolean identities. It is a flexible and efficient tool for performing probabilistic risk analysis

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Code number	Copies distributed	Program description
9695	4	SALT-ANL—A systems-analysis and process-simulation program for steady-state and dynamic systems, which can also be used for optimization and sensitivity studies. Employs state-of-the-art numerical techniques including a hybrid steepest-descent/quasi-Newtonian multidimensional nonlinear equation solver, sequential quadratic programming methods for optimization, and multistep integration methods for both stiff and nonstiff systems of differential equations. It has been applied to the study of open-cycle and liquid-metal magnetohydrodynamic systems, fuel cells, ocean thermal energy conversion, municipal solid-waste processing, fusion, breeder reactors, and geothermal and solar-energy systems.
935	4	ODEPACK—A systematized collection of five general-purpose programs for solving the initial value problem for systems of ordinary differential equations
510	3	VIM2/13—A program that solves the three-dimensional steady-state multiplication eigenvalue or fixed source neutron transport problem. It was designed for the analysis of fast critical experiments
1056	3	TOOLPACK1—A program that contains software tools for use with FORTRAN 77 programs
R9861	3	DIF3D-5 3—A program that solves multigroup diffusion theory eigenvalue, adjoint, fixed source, and criticality (concentration, buckling, and dimension search) problems in 1-, 2-, and 3-space dimensions for rectangular, cylindrical, triangular, and hexagonal geometries
9923	3	NIKE2D—A vectorized, implicit, finite-deformation, large strain, finite-element code for analyzing the response of two-dimensional axisymmetric and plane strain solids
784	2	DSNP—A dynamic simulation for nuclear power plants
847	2	DISPL1—A software package for solving second-user, nonlinear systems of partial differential equations including parabolic, elliptic, hyperbolic, and some mixed types. The package is designed primarily for chemical kinetics-diffusion problems, although not limited to these problems
R885	2	SWAAM2—A program designed for analysis of the major consequences of large-scale sodium-water reactions in the secondary system of an LMFBR
9717	2	SCIENTIFIC WORKSTATION EVALUATION BENCHMARK—A package that includes 16 programs that are executed in a well-defined scenario to measure the following performance capabilities of a scientific workstation: implementation of FORTRAN 77, processor speed, memory management, disk I/O, monitor (or display) output, scheduling of processing (multiprocessing) and scheduling of tasks (spooling)
R275	2	PDQ7—A series of programs designed to solve the neutron diffusion-depletion problem in one, two, or three dimensions.
1034	2	ISDMS, Idaho National Engineering Laboratory's Scientific Data Management System—A generalized scientific data processing system designed to meet the needs of the various organizations at the laboratory. The data requirements at the laboratory are primarily for time series analysis
9772	2	ARCHIVE,NOS2 2 permanent file backup system—A subsystem designed to back up permanent files on CDC Cyber machine systems.
602	2	LENSDES, nonlinear system that nonlinear least squares lens design system— A system that analyzes the performance of optical lenses by computing the image errors found when bundles of skew rays are traced from object points to the image surface
939	2	MAPPER—A program designed to provide a command language whereby users who are not trained programmers can produce report quality visual aids
948	2	SOLA-VOF, transient fluid flow free boundaries—A program for the solution of two-dimensional transient fluid flow with free boundaries, based on the concept of a fractional volume of fluid
9672	2	CGS—A library of FORTRAN-callable subroutines that provides general-purpose, device-independent graphics primitives.
9979	2	SALE3D—A program that calculates three-dimensional fluid flows at all speeds, from the incompressible limit to highly supersonic
592	2	LSODE, ordinary differential equation system solver—A package of subroutines for the numerical solution of the initial value problem for systems of first order ordinary differential equations

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Code number	Copies distributed	Program description
968	2	SLIC, interactive graphics three dimensional mesh generation—An interactive graphics mesh generator developed for use with finite-element and finite-difference method application programs
9827	2	PRAISE-B—A probabilistic fracture mechanics code used to estimate the probability of a double-ended guillotine break in light water reactor piping due to the growth of cracks at welded joints.
517	2	HEATING5—A code designed to solve steady-state and/or transient heat conduction problems in one, two, or three dimensional Cartesian or cylindrical coordinates or one dimensional spherical coordinates
678	2	MORTRAN2, macro based structured FORTRAN—A FORTRAN language extension that permits a relatively easy transition from FORTRAN to a more convenient and structured language
1006	2	MAEROS—A code that calculates aerosol composition and mass concentration as a function of particle size and time.
R1075	2	HECTR1 5—A lumped volume containment analysis program that is most useful for performing parametric studies. Its main purpose is to analyze nuclear reactor accidents involving the transport and combustion of hydrogen, but it can also function as an experiment analysis tool and solves a limited set of other containment problems
9689	2	GKS, minimal graphical kernel system for the C Language Binding—A package that is both an American National Standard and an ISO international standard graphics package
9918	2	DASSL, a differential/algebraic system solver—A package that is designed for the numerical solution of implicit systems of differential/algebraic equations written in the form F(t,y,y')=0, where F, y, and y' are vectors, and initial values for y and y' are given

[1]The abstracts of the most popular programs distributed to domestic requesters were obtained from the Office of Software Development and Information Technology federal software exchange catalog or from the National Energy Software Center

Table III.3: Most Popular Computer Programs Requested by Foreign Recipients for the 18-Month Period Ending March 31, 1987

Code number	Program name	Production laboratory	Category code[1]	Copies distributed
9847	DOE-MACSYMA, computer algebra system	Lawrence Livermore National Laboratory	P	10
893	SHAFT 79, 2-phase geothermal reservoir model	Lawrence Berkeley Laboratory	H	4
722	CRAC2, reactor accident consequence model	Sandia National Laboratories, Albuquerque	G	4
820	SLATEC3.0, mathematical subroutine library	Sandia National Laboratories, Albuquerque	P	4
972	NJE4 00, VAX/VMS IBM NJE protocol emulator	Argonne National Laboratory	P	3
917	RELAP5/MOD1/029, LWR loss of coolant analysis	Savannah River Laboratory	G	3
9688	KIVA, 2- and 3-d reactive flows with fuel sprays	Los Alamos National Laboratory	U	3
9827	PRAISE-B, LWR piping reliability assessment	Lawrence Livermore National Laboratory	I	3
432	COBRA4I, rod bundle and core thermal-hydraulics	Oak Ridge National Laboratory	H	3
641	SAP4, structural analysis of linear systems	Argonne National Laboratory	I	2
784	DSNP, dynamic simulation nuclear power plants	Argonne National Laboratory	K	2
891	ANALYZE, hydrothermal reservoir test analysis	Lawrence Berkeley Laboratory	H	2
895	WELBORE, transient wellbore fluid flow model	Lawrence Berkeley Laboratory	H	2
3699	RELAP4/MOD7/101, thermal and hydraulic phenomena	Savannah River Laboratory	G	2
1031	TRAC-BD1, best-estimate analysis BWR LOCA	Savannah River Laboratory	G	2
9979	SALE3D, ALE treatment of 3-d fluid flows	Los Alamos National Laboratory	H	2
968	SLIC, interactive graphics 3-d mesh generation	Lawrence Livermore National Laboratory	P	2
9725	NIKE3D, static and dynamic response of 3d solids	Lawrence Livermore National Laboratory	I	2
9766	T-HEMP3D, elastic-plastic flow in 3-d and time	Lawrence Livermore National Laboratory	H	2
9910	DYNA2D, explicit 2-d hydrodynamic FEM program	Lawrence Livermore National Laboratory	I	2
99[illegible]	NIKE2D, static and dynamic response of 2d solids	Lawrence Livermore National Laboratory	I	2
9935	ODEPACK, a collection of ODE system solvers	Lawrence Livermore National Laboratory	P	2
387	CITATION, 1,2,3-d diffusion depletion multi-gp	Oak Ridge National Laboratory	K	2
979	ASPEN, Advanced system for process engineering	Morgantown Energy Technology Center	U	2

[1]The "Category Code" column shows which of the categories a program has been placed in by the Center. The titles of the categories are as follows:

G Radiological Safety, Hazard, and Accident Analysis
H Heat Transfer and Fluid Flow
I Deformation and Stress Distribution Computations, Structural Analysis, and Engineering Design Studies
K Reactor Systems Analysis
P General Mathematical and Computing System Routines
U Chemistry

Table III.4: Abstracts of the Most Popular Programs Distributed to Foreign Requesters During the 18-Month Period Ending March 31, 1987[2]

Code number	Copies distributed	Program description
9847	10	See abstract for domestic requesters
893	4	SHAFT 79 (Simultaneous Heat and Fluid Transport)—An integrated finite difference program for computing two-phase non-isothermal flow in porous media.
722	4	CRAC2—A revision of the CRAC (Calculation of Reactor Accident Consequences) program developed in support of the Reactor Safety Study, WASH-1400, to assess the risk from potential accidents at nuclear power plants.
820	4	See abstract for domestic requesters.
972	3	See abstract for domestic requesters.
917	3	RELAP5/MOD1/029—A code developed to describe the behavior of a light water reactor subjected to postulated transients such as loss of coolant from large or small pipe breaks, pump failures, and other accidents
9688	3	See abstract for domestic requesters
9827	3	See abstract for domestic requesters
432	3	COBRA4I—A code that performs steady-state and transient thermal-hydraulic analysis of rod bundle nuclear fuel elements and cores via the subchannel analysis method.
641	2	SAP4, Structural analysis of linear systems—A structural analysis program for determining the static and dynamic response of linear systems.
784	2	See abstract for domestic requesters
891	2	ANALYZE—A history matching program designed for the analysis of both interference tests and production tests in single phase, fluid saturated reservoirs
895	2	WELBORE—A code to solve transient, one-dimensional two-phase or single-phase non-isothermal fluid flow in a welbore
3699	2	RELAP4/MOD7/101—A thermal and hydraulic phenomenon
1031	2	TRAC-BD1—A code that performs best estimate analysis of loss-of-coolant accidents and other transients in boiling water reactors
9979	2	See abstract for domestic requesters
968	2	See abstract for domestic requesters
9725	2	NIKE3D, Static and dynamic response of 3d solids—A vectorized, fully implicit, three-dimensional, finite-element program for analyzing the finite-strain, static and dynamic response of inelastic solids, shells and beams
9766	2	T-HEMP3D, Elastic-plastic flow in 3 dimensions and time—A code that solves problems in solid mechanics involving dynamic plasticity and time-dependent material behavior and problems in gas dynamics
9910	2	DYNA2D, Explicit 2-dimensional hydrodynamic FEM program—A vectorized, explicit, two-dimensional, axisymmetric and plane strain finite element program for analyzing the large deformation dynamic and hydro-dynamic response of inelastic solids
9923	2	See abstract for domestic requesters
9935	2	See abstract for domestic requesters
387	2	CITATION, 1,2,3-dimension diffusion depletion multi-gp—A package designed to solve problems using the finite-difference representation of neutron diffusion theory, treating up to three space dimensions with arbitrary group-to-group scattering
979	2	ASPEN—An advanced system for process engineering

[2]The abstracts of the most popular programs distributed to foreign requesters were obtained from the Office of Software Development and Information Technology federal software exchange catalog or from the National Energy Software Center

The National Energy Software Center's Computer Program Categories

The following are descriptions of the 26 categories used by the National Energy Software Center to categorize the computer programs in its library.

A	Cross Section and Reasonance Integral Calculations— Computation of reaction cross sections by Breit-Wigner or multilevel theory, determination of differential scattering cross sections, cross-section evaluation and compilation programs
B	Spectrum Calculations, Generation of Group Constants, Lattice, and Cell Problems—Determination of the slowing down density or thermal spectrum, weighting and averaging of cross sections, and related quantities for the production of group constants, and evaluation of design parameters by lattice and cell calculation
C	Static Design Studies—Calculation of the reactivity and flux distribution of the reactor system, and adjustment of design parameters to prescribed specifications, that is, criticality and power distribution search procedures
D	Depletion, Fuel Management Cost Analysis and Power Plant Economics—Includes burnup programs, isotope and fission product buildup and decay computations, and optimization studies
E	Space-Independent Kinetics—Studies of the time behavior of reactors including delayed-neutron effects and feedback mechanisms, and transfer function evaluation
F	Space-Time Kinetics, Coupled Neutronics-Hydrodynamics-Thermodynamics and Excursion Simulations—Programs that consider spatial design characteristics and accompanying effects in studying time behavior of the reactor.
G	Radiological Safety Hazard, and Accident Analysis— Calculation of internal and external dose rates, determination of reactor thermodynamic and hydrodynamic properties following an accident, for example, release of radioactive materials, coolant-system blowdown steam-generator rupture
H	Heat Transfer and Fluid Flow—Steady-state and transient-heat transfer computations, fluid-flow studies and calculations of thermodynamic properties
I	Deformation and Stress Distribution Computations, Structural Analysis, and Engineering Design Studies— Includes fuel-element design evaluations, core configuration studies, and composite structure analysis
J	Gamma Heating and Shield Design—Gamma and photon transport calculations, computation of heat-generation rates, and penetration analysis and leakage calculations for shielding
K	Reactor Systems Analysis—Combinations of programs, designed as systems, for solving correlated problems from several of the categories A through I
L	Data Preparation—Generation of program parameters, checking, editing, and formatting of problem input information
M	Data Management--Construction, maintenance, and retrieval of data files, for example, cross-section libraries management systems such as payroll personnel, and financial systems, property and equipment systems, network-oriented project management, indexing and retrieval systems, and others

(continued)

N	Subsidiary Calculations—Plotting, editing, and display routines that process output data from other programs
O.	Experimental Data Processing—Programs designed to process data directly acquired from an experimental situation or to assist the experimenter in the design of the experiment
P	General Mathematical and Computing System Routines— Calculation of mathematical functions, statistical analysis, special-language routines with general data-processing capabilities, and software systems.
Q	Materials—Measurements and computations of the physical and mechanical properties of materials, simulation of radiation damage processes, corrosion studies, and determination of crystallographic functions.
R.	Environmental and Earth Sciences—Environmental impact studies, geology, seismology, geophysics calculations, hydrology and ground water studies, bioenvironmental systems analyses, meteorological calculations relating to the atmosphere and its phenomena, studies of airborne particulate matter, climatology, and other related studies.
S	Space Sciences—Analysis of orbits and trajectories, astronomy and astrophysics computations, wave propagation studies, and the calculation of reentry parameters.
T	Electronics, Engineering Equipment, and Energy Systems Studies—Automated design of electronic equipment, computer-aided design and manufacturing, process control programs, systems analysis and engineering computations for numerically controlled machine tools, and energy consumption analysis in buildings, industry, and transportation
U	Chemistry—Chemical analysis, mass spectroscopy, radiation chemistry, radiolysis studies, and other related studies.
V	Particle Accelerators and High Voltage Machines—Programs relating to the design, development, and operation of high voltage machines and particle accelerators such as Van de Graaff generators, linear accelerators, cyclotrons, synchrotons, and others
W	Physics—Calculations relating to theory of atomic or molecular structure or properties, charged particle collision studies that involve phenomena such as charge exchange, excitation, ionization, and dissociation; elementary particle theory and models, scattering theory, quantum field theory and quantum electrodynamics studies, and general relativity and gravitation theory computations
X.	Magnetic Fusion Research—Electric discharge phenomena and plasma physics computations, and electrodynamics and magnetic hydrodynamic studies
Y	Biology and Medicine—Biological, medical, and radiological studies of the structure, functions, chemistry, biophysics, reproduction, and heredity of bacteria, plants, laboratory animals, and humans
Z	Data—Data prepared in specific program formats for program testing and evaluation, benchmark studies, or library use

Categories of the Most Popular Programs

The following table shows which of the National Energy Software Center's 26 computer program categories contain the most frequently requested computer programs, as identified in appendix III and appendix IV.

Table IV.1: Computer Program Categories Containing the Most Frequently Requested Programs

Category code	Category	Number of individual programs requested October 1985—March 1987 by type of requester	
		Domestic	Foreign
P	General Mathematical and Computing Systems Routine	18	5
H	Heat Transfer and Fluid Flow	4	6
G	Radiological Safety, Hazard, and Accident Analysis	3	4
I	Deformation and Stress Distribution Computations, Structural Analysis, Engineering Design	2	5
U	Chemistry	2	2
T	Electronics, Engineering Equipment, and Energy Systems Studies	3	0
K	Reactor Systems Analysis	1	2
R	Environmental and Earth Sciences	2	0
C	Static Design Studies	2	0
D	Depletion, Fuel Management, Cost Analysis, and Power-Plant Economics	1	0
M	Data Management	1	0
N	Subsidiary Calculations	1	0
W	Physics	1	0

Information on the Redistribution of Computer Programs Received From the National Energy Software Center

According to the Director, the National Energy Software Center keeps no records of instances where a recipient further distributes a program obtained from the Center, and the Center is usually unaware of a recipient's intent to distribute computer programs.

When a requester receives a computer program from the National Energy Software Center, it comes with a transmittal letter stipulating that the requester should not reproduce the program for distribution to others outside the requester's own organization without prior approval from the Center. Agency officials from the Center told us that it was a matter of professional ethics whether a recipient complied with the stipulation. They said that a recipient could ignore the conditions and pass a program on to anyone it chose, and the Center would probably never know. The officials knew of no examples where this situation had occurred. They emphasized, however, that the Center provides foreign recipients with only those programs that are categorized for unlimited distribution. The officials also told us that most programs shipped to foreign requesters are several years old, and some are over 20 years old. Also, they said that many of the programs are related to nuclear safety and that the Nuclear Regulatory Commission wants such programs disseminated worldwide.

The three distribution classifications[1] that restrict the dissemination of software programs are:

R—Restricted to use on either official U.S. government or commercial (nonmilitary) applications at a U.S. installation.

G—Limited to use on U.S. government contracts.

S—Limited to a special list of designated organizations.

A fourth classification is simply the absence of one of the above restrictions. If no restriction exists, the program is said to have "unlimited distribution." We reviewed a listing of all Department programs in the Center's library and found that 229 programs, or 16.2 percent, have one of the above three classifications. Specifically, 211 had an "R" classification, 12 had an "S" classification, and 6 had a "G" classification. A total of 1,183 programs had no classification. According to the Center's

[1]These distribution classifications provide limitations on the distribution of computer programs to recipients, and should not be confused with the National Energy Software Center's computer program categories described in appendix IV.

Director, only programs having an "unlimited distribution" or an "S" classification are shipped to foreign governments or firms.

Information on Improvements Made by U.S. and Foreign Recipients to Computer Programs Received From the National Energy Software Center

The only record of improvements and upgrades made to software programs by recipients are copies of the improved programs submitted to the Center by the recipients. Such submissions are made in order to comply with a Center stipulation that the Center receive copies of upgrades to its programs. Subsequent parties desiring a copy of the upgraded version are then supposed to obtain it from the Center. Agency officials told us that they suspect some recipients have upgraded programs and commercialized them, but they had no records or examples to support their suspicions.

While the stipulation requiring submission of upgraded versions of programs to the Center has been complied with in some instances, as is evidenced by the presence of upgraded versions in the Center's library, officials admit that there probably are some instances of noncompliance. They stated that they have had no means of determining when noncompliance occurs or any authority to enforce compliance. Information on the number of upgraded programs submitted to the Center was not readily available.

At the close of our review, the Department of Energy's Office of General Counsel and Office of Scientific and Technical Information had jointly prepared and were processing a draft guideline that they believe will, among other things, remove some of the incentive for noncompliance with the above-mentioned stipulation. The guideline is designed to encourage Department of Energy contractors to obtain copyrights on, and to commercialize, certain Department programs that may, with modifications, have application elsewhere in the Department, in other government agencies, and in private industry.

Agency officials within the Office of Scientific and Technical Information told us that other objectives of the guideline were to 1) enhance the dissemination of Department-developed scientific and technical information to other industries (in accordance with the Federal Technology Transfer Act of 1986, Public Law 99-502, amending the Stevenson-Wydler Technology Innovation Act of 1980, Public Law 96-480); 2) enhance the Department's control over the dissemination of computer software, especially to foreign recipients; and 3) increase the percentage of Department software being submitted to the Center by Department of Energy national laboratories.

However, to accomplish these objectives without discouraging the wide dissemination of federally funded software to the public, the draft

guideline requires that, when obtaining a copyright, a contractor must meet the following conditions:

- The contractor must agree to make the copyright subject to one of two government licenses. If a "broad Government license" is chosen, the government retains the right to distribute the upgraded program to anyone it chooses, but there is no limitation on the price the contractor can charge others for the upgraded product. If the contractor chooses to make the copyright subject to a "limited Government license," then the government's right to distribute the upgraded program is limited to distribution to its contractors and their subcontractors. Under this license, however, the contractor holding the copyright is significantly restricted in the amount of profit that can be received from the sale of the copyrighted program. A primary objective of these licenses is to prevent the contractor from reaping a windfall profit from the sale of software programs that were developed primarily with federal tax dollars.
- The contractor must prove that its own investment in the program, via the upgrade, will be significant. Also, a program will not be eligible for a copyright if it is already in the public domain.

Computer Programs Shipped to Italy

During the 18-month period ending March 31, 1987, five computer programs were shipped to Italy. The following table identifies the recipients, the programs shipped to each, the date each program was placed in the Center's library, and the shipping dates.

Table VII.1: Computer Programs Provided to Italy

Recipient	Program description	Date shipped
Dr Raimondi, Italy-Snamprogetti S. P A.	ASPEN—An advanced system for process engineering. This program became available at the Center in October 1984	3/13/86
ENEA Computing Program Library, Italy	NRTS ENVIRONMENTAL SUBROUTINES—A collection of environmental subroutines designed to aid the programmer by providing extensions to the FORTRAN language, data management services, and programming aids This program became available at the Center in April 1975	3/13/86
ENEA Computing Program Library, Italy	ASPEN—An advanced system for process engineering This program became available at the Center in October 1984	6/19/86
Commission of the European Communities Joint Research Centre, Italy	FEM3 Heavy gas dispersion incompressible—A numerical model developed primarily to simulate heavy gas dispersion in the atmosphere, such as the gravitational spread and vapor dispersion that result from an accidental spill of liquified natural gas. This program became available at the Center in October 1983	8/15/86
ENEA Computing Program Library, Italy	DISPER1, Aerosol particle transport study—A program to determine the aerosol particle source strength outside an enclosure due to a release of aerosol particles within the enclosure This program became available at the Center in August 1978.	1/08/87

Computer Programs Contained in the National Energy Software Center's Categories "F" and "I" and Their Foreign Recipients

List of All Programs in Categories "F" and "I"

Because of their subject matter, categories "F" and "I" are 2 of the more sensitive categories in the Center's 26 categories of programs. Category "F", which, as of March 31, 1987, contained a total of 27 programs, relates to "Space-Time Kinetics, Coupled Neutronics-Hydrodynamics-Thermodynamics, and Excursion Simulations." Category "I", which, as of March 31, 1987, contained 99 programs, relates to "Deformation and Stress Distribution Computations, Structural Analysis and Engineering Design."

The following tables show the title of each program and the code number assigned to it by the Center for all the programs in categories "F" and "I", respectively.

Table VIII.1: Category "F" Programs Included in National Energy Software Center Library

Code number	Title
174	FORE2, fast reactor excursion calculations
274	WIGL2, 1-d 2-gp space-time diffusion 3-geom
309	TSN spatially-dependent reactor kinetics
310	GAKIN2, 1-d multigroup time-dependent diffusion
338	TWIGL 2-d 2-gp space-time diffusion feedback
352	RAUMZEIT, 1-d time-dependent diffusion calculation
370	GAKIT, 1-d multigroup kinetics with temp feedback
371	NOWIG, 1-d 2-gp kinetics temperature feedback
389	STINT3, single-channel space-time synthesis
400	SAS1A, fast reactor power and flow transients
405	NOAH, 1-d one-gp space-time diffusion feedback
415	CEXE,INCEXE, 1-gp 3-d xyz xenon oscillation
474	QX1, quasistatic spatial reactor kinetics code
488	NOISY1, auto- and cross-spectral densities
494	ADEP, 1-d 2-d few-group space-time kinetics
511	VENUS2 2-d coupled neutronics-hydrodynamics
550	REXCO-H, 2-d hydrodynamic response to excursion
615	REXCO-H2, 2-d hydrodynamic response to excursion
700	MELT3 fast reactor transient overpower study
708	WIGL3, 1-d space-time diffusion with feedback
756	TIMEX 1-d time-dep multigp discrete ordinates
862	FX2-TH, 2-d time-dependent reactor kinetics
868	PECS3 probabilistic evaluation cladding life
870	BNWIGL (UNIWIGL), 2-group time-dependent 1-d diffusion
901	PAD, 1-d coupled Sn neutronics and hydrodynamics
9640	LIMBO2 liquid metal boiling dynamic model
9965	SIMMER2, 2-d Sn neutronics and fluid dynamics

Table VIII.2: Category "I" Programs Included in National Energy Software Center Library

Code number	Title
80	SOR3, stress analysis shells of revolution
251	SAFE-AXISYM, stress analysis axisymmetyric load
252	SAFE-PLANE, plane stress analysis, 2-d bodies
253	SAFE-SHELL, stress analysis thin shells
266	CYGRO2, stress analysis cyl fuel element
282	SEALSHELL2, shell stress analysis axisym load
283	MO552, dynamic analysis linear elastic systems
300	SAFE-CREEP, viscoelastic analysis of concrete
329	MO457,PIPE, elastic stress of piping system
332	SAFE-3D, 3-d composite structure stress study
337	STEM, matrix generation for a system of beams
344	GEM, eigenvalue problem for vibrating systems
378	TUBE, U-tube heat exchanger stress analysis
379	SAFE-2D, plane and axisymmetric stress analysis
383	MO266, linear elastic structural dynamics
391	SORSDB, pressure vessel stress and fatigue
397	GAPL3, inelastic large deflection stress study
402	SABOR4, discrete-element analysis thin shells
404	FINEL, finite-element study 2,3-d structures
412	MANE1, rectangular magnetic network solution
449	CYGRO5, oxide fuel rod stress and deformation
451	SAFE-CRACK, viscoelastic analysis of concrete
452	SHELL5, thin shell 3-d structural analysis
460	LIFE3, mixed-oxide fuel element performance
468	BUBL1, fuel swelling and gas release simulation
481	BUSHL, cyl shell buckling collapse analysis
503	DUZ2, 2-d axisymmetric and plane elastic plastic
537	FUGIT, dynamic response of elastic structures
539	STRAP, static and dynamic structural analysis
542	PSA2, stress analysis multianchor pipe system
568	BEHAVE2, oxide fuel performance finite-element
570	STRIPE, fuel rod clad strain and pellet cracking
581	SLADE-D, dynamic analysis of thin shells
597	MATUS, 3-d finite-element elastic analysis
598	PELEN, fuel pellet temperature and deformation
604	TCBO1, creep-buckling of tubes under pressure
611	CHILES, linear elastic singularity modeling
618	GAPCON-THERMAL2, fuel rod thermal performance
627	TOODY2, 2-d Lagrangian eqns of motion solution
641	SAP4, structural analysis of linear systems

(continued)

Code number	Title
643	NUBOW, structural analysis bowed reactor cores
648	LUGS, stress for integral attachments to pipes
650	ELBOW-ORNL, pipe stress and flexibility calc
657	LINDA, evaluation of strain-gage data
667	BUCKLE, creep buckling of initially oval tube
672	HONDO2-SLA, large deformation dynamic response
682	GNATS,MESH2,GPRINT, 2-d nonlinear analysis
689	FLANGE-ORNL, analysis of flanged joints
701	BEAMCRP, finite-element beam creep analysis
707	CREEP-PLAST, 2-d inelastic structural analysis
715	IMPAC2, B shipping container impact analysis
735	PIRAX2, simplified inelastic piping analysis
740	PLACRE, FEM inelastic structural analysis
750	CURT2, curved tubes or elbows and attached pipes
759	CORTES, thermal and mechanical analysis of tees
770	GAPCON-THERMAL3, fuel ss and transient behavior
785	AXICRP, finite element code for creep analysis
790	NUBOW2D-INELASTIC, bowed reactor core analysis
795	SHOCK, dynamic response of lumped-mass systems
810	CREEP-PLAST2, 2-d inelastic structural analysis
817	COVE1, creep collapse for oval fuel pin tube
828	SWAP9, stress-wave analysis in 1-d strain
842	SUPAN, analysis of beam-type piping supports
906	DSTRESS, transient fuel model for clad strain
974	NONSAP-C, nonlinear stress concrete structures
980	BENDPAC, stress analysis of flanged pipe bends
999	FAMREC, fuel assembly mechanical response code
1012	THREAD, concentration factors for bolt threads
1077	SMACS, probabilistic seismic analysis system
9603	SANCHO, large deformation inelastic analysis
9655	GRASP, graphic analysis shell pressure loads
9708	ELTEMP, ASME code stress evaluation of piping
9713	CHERN R1045, 1-d inelastic structural analysis
9719	EPACA, 3-d thick shell elastic-plastic-creep
9725	NIKE3D, static and dynamic response of 3-d solids
9731	FURFAN, fuel and blanket pin failure analysis
9741	ASEP, CRBR axial support structural evaluation
9752	DYNALSS, CRBR control assembly scram dynamics
9754	SCRAM, control rod-guide duct interference
9762	PCON, fuel-pin failure analysis pellet contact
9768	DILATE, fuel assembly duct dilation analysis

(continued)

Code number	Title
9769	DENS, CRBRP fuel rod densification analysis
9775	EQUILIN, temperature distribution for concrete
9779	RESPECTPLOT, response spectra calculation
9780	CODES, design of concrete walls and shells
9783	HOTDAMAGE, thermal transient structural damage
9784	FRST, fuel rod strains due to transients
9806	WRAPUP, LMFBR fuel cladding interactions
9816	GSCRAP, LMFBR reactor core seismic analysis
9821	LIFE4 REVO, fast reactor fuel pin performance
9827	PRAISE B, LWR piping reliability assessment
9909	DYNA3D, explicit 3-d hydrodynamic FEM program
9910	DYNA2D, explicit 2-d hydrodynamic FEM program
9923	NIKE2D static and dynamic response of 2-d solids
9930	MODQKE,MDOF, generate design response spectra
9946	CERL2, stresses in hemisphere—nozzle shells
9947	MDSFP, FEM elastic solution of 3-d structures
9948	ROBOT3, in-pile 3-d bowing of cyl fuel rods
9958	CREEP80, creep analysis of concrete structures

Programs in Categories "F" and "I" That Have Been Shipped to Foreign Recipients

Of the 27 programs in category "F", for the 18-month period ending March 31, 1987, only 4 have been requested and shipped. Three of the requests were from foreign countries: one from Egypt and two from Brazil (see table VIII.3).

Table VIII.3: Programs Distributed to Foreign Requesters From Category "F" and the Name of Each Foreign Recipient

Description of program shipped	Recipient
FORE2—A coupled thermal hydraulics point kinetics digital computer code designed to calculate significant reactor parameters under steady-state conditions, or as a function of time during transients	Brazil—Instituto de Estudos Avancados
SAS1A—A code used for the analysis of fast reactor power and flow transients	Brazil—Instituto de Estudos Avancados
REXCO-H—A code that calculates the two-dimensional hydrodynamic response of primary reactor containment to a high energy excursion	Egypt—Nuclear Power Authority

Of the 99 programs in category "I", for the 18-month period ending March 31, 1987, only 21 have been requested and shipped. Of the 21, 15 programs were shipped to foreign countries as shown in table VIII.4.

Table VIII.4: Programs Distributed to Foreign Requesters From Category "I" and the Name of Each Foreign Recipient

Description of program shipped	Recipient
ELBOW-ORNL—A code that calculates the stresses, stress indices, and flexibility factors for in-plane and out-of plane bending of elbows and curved pipe subjected to internal pressure	Egypt— Nuclear Regulatory Safety Centre, Atomic Energy Authority, Cairo
HONDO2-SLA—A code used to compute the time dependent displacements, velocities, accelerations and stresses within elastic or inelastic, two-dimensional, or axisymmetric, or planar bodies of arbitrary shape and materials.	France—NEA Data Bank
GAPCON-THERMAL3—A code that calculates the thermal and mechanical behavior of the fuel and cladding in a nuclear fuel rod during normal operation for both steady-state and operational transients	Yugoslavia—J. Stefan Institute
NUBOW-2D Inelastic—A program that solves two-dimensional mechanical equilibrium configuration of a core restraint system, which is subjected to radial temperature and flux gradients, on a time-increment basis	Brazil—Instituto de Estudos Avancados
SMACS (Seismic Methodology Analysis Chain with Statistics)—A system of computer programs that is one of the major computational tools of the U.S NRC Seismic Safety Margins Research Program.	Korea—Power Engineering Company, Seoul, Korea
NIKE3D—A vectorized, fully implicit, three-dimensional, finite-element program for analyzing the finite-strain, static and dynamic response of inelastic solids, shells, and beams.	France—NEA Data Bank Japan—Hitachi Zosen
PRAISE-B—A probabilistic fracture mechanics code used to estimate the probability of a double-ended guillotine break in light water reactor piping due to the growth of cracks at welded joints	Japan—Nuclear Data Corporation Korea—Korea Advanced Energy Research Institute France—NEA Data Bank
CREEP80—A finite element program for the analysis of creep effects in concrete structures	Japan—Hitachi Zosen
SAP4—A structural analysis program for determining the static and dynamic response of linear systems	Egypt—Nuclear Regulatory Safety Centre, Atomic Energy Authority, Cairo Yugoslavia—J. Stefan Institute
DYNA2D—A vectorized, explicit, two-dimensional, axisymmetric and plane strain finite element program for analyzing the large deformation dynamic and hydro-dynamic response of inelastic solids. Two copies were requested: one for a VAX system and one for a Cray system	France—NEA Data Bank
NIKE2D—A vectorized, implicit, finite-deformation, large strain, finite-element code for analyzing the response of two-dimensional axisymmetric and plane strain solids. Two copies were requested, one for a VAX system and one for a Cray system	France—NEA Data Bank
STRAP—A code to analyze the response of structural systems to static and dynamic loading conditions	Brazil—Nuclebras Centre de Desenvolvimente da Tecnologia Nuclear
TOODY2—A code used to compute wave propagation in two dimensions in rectangular or cylindrical coordinates	Pakistan—Chashma Nuclear Power Project

(continued)

Description of program shipped	Recipient
FAMREC— A code that calculates the lateral mechanical response of a row of fuel assemblies while allowing for two types of nonlinearities	China—Institute Atomic Energy
DYNA3D—An explicit, three-dimensional, finite element program for analyzing the large deformation dynamic response of inelastic solids.	Japan—Nuclear Data Corporation

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