DRAFT
DOE/FE-0033
Previous No. DOE/ER-0102

ENERGY MATERIALS COORDINATING COMMITTEE (EMACC)

Fiscal Year 1982

March 1983

ANNUAL TECHNICAL REPORT

U.S. Department of Energy
Washington, D.C. 20545

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U.S. Department of Energy

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OFFICE OF THE ASSISTANT SECRETARY FOR NUCLEAR ENERGY

INTRODUCTION

The DOE Energy Materials Coordinating Committee (EMaCC) serves primarily to enhance coordination among the Department's materials programs and to further the effective use of materials expertise within the Department. These functions are accomplished through the exchange of budgetary and planning information among program managers and through technical meetings/ workshops on selected topics involving both DOE and major contractors. In addition, the EMaCC aids in obtaining materials - related inputs for both intra- and inter-agency compilations.

Membership in the EMaCC is open to any Department organizational unit; participants are appointed by Division or Office Directors. The current membership is listed in Table 1.

The EMACC reports to the Director of the Office of Energy Research in his capacity as overseer of the technical programs of the Department. This annual technical report is mandated by the EMACC terms of reference. In this report are described 1) EMACC activities for FY 1982; 2) a summary of materials funding in the Department from FY 1978 to the present; and 3) on-going materials programs in the Department.

Stanley J. Dapkunas
Office of Advanced Research and Technology
Office of Fossil Energy
Chairman of EMACC, FY 1982

Stanley M. Wolf
Division of Materials Sciences
Office of Energy Research

Fiscal Year 1982 Activities

1. The following meetings were held:

Date	Topic	Speaker
Feb. 19, 1982	Materials Research for Inertial Fusion	Carl Hilland
March 19, 1982	Materials for Photovoltaic Systems	A. Scolaro
May 14, 1982	Structural Ceramics Research Funded by DOE	All Applicable
June 18, 1982	OER/BES Funded Unique User Oriented Facilities	L. Ianniello
Dec. 14, 1982	ERAB Study on Materials Research	All Applicable

2. In addition to the regular membership meetings, a special two day "EMaCC Contractors Meeting on Problems and Opportunities in Structural Ceramics" was held in Germantown on September 29 and 30, 1982. The purpose of this meeting was to apprise the user and research committees of ongoing work as well as to solicit opinions on desired research directions. Approximately 250 people attended this two day meeting.

3. EMaCC served as the mechanism of gathering input for the 1982 COMAT survey of materials research in DOE.

4. EMaCC served as a mechanism for Updating a Summary of DOE Funding in Rapid Solidification Technology (RST) for the COMAT-RST working group.

5. EMaCC provided GAO a summary of FY 82 Materials Research in DOE.

TABLE I
MEMBERSHIP LIST
DEPARTMENT OF ENERGY
ENERGY MATERIALS COORDINATING COMMITTEE
DECEMBER 1982

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
CONSERVATION AND RENEWABLE ENERGY				
Adv. Conservation Technology/ Electrochemical Energy Storage	Stanley S. Ruby	CE-141	5E-052/FORSTL	252-1486
Advanced Technology and Assessment	Richard T. Alpaugh	CE-131	GB-096.FORSTL	252-8055
Buildings Applications Research & Development	Ernest Freeman	CE-115	5G-050/FORSTL	252-9426
Energy Systems Research/ Energy Conversion & Utilization	James J. Eberhardt	CE-142	5E-091/FORSTL	252-1499
Industrial Programs/ Waste Products	Jerome F. Collins	CE-121.2	6G-056/FORSTL	252-2366
Heavy Duty Transport & Fuels/Office of Vehicle Engine R&D	Robert B. Schultz	CE-131	GB-096/FORSTL	252-8064
Renewable Technology/ Biomass Energy	Beverly J. Berger	CE-321	5F-043/FORSTL	252-6750
Renewable Technology/ Geothermal Energy	Leon Lehr	CE-324	5G-030/FORSTL	252-8074
Solar Energy/Ocean Energy Systems	William E. Richards	CE-331	5H-032/FORSTL	252-5517
Solar Energy/ Passive Hybrid	Lawnie Taylor	CE-312	5H-047/FORSTL	252-8103
Solar Energy/Photovoltaics	Anthony Scolaro	CE-333	5E-066/FORSTL	252-5548
Solar Energy/Wind Energy Systems/Conservation & Renewable Energies	Louis V. Divone	CE-332	5E-080/FORSTL	252-5540

TABLE I (Continued)

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
DEFENSE PROGRAMS				
Inertial Fusion/Fusion Research	Carl B. Hilland	DP-232	C-404/GTN	353-3687
Military Application/RD&T	Wm. G. Collins	DP-255.2	B-310/GTN	353-5494
Nuclear Materials Production/ Materials Processing	Louis R. Willet	DP-132	A-203/GTN	353-4959
Waste & Byproducts Management/ R&D & Byproducts	Ray D. Walton, Jr.	DP-123	A-255/GTN	353-3388
ENERGY RESEARCH				
Basic Energy Sciences/ Materials	Louis C. Ianniello/ Stanley M. Wolf	ER-13	J-317/GTN	353-3427
Magnetic Fusion Energy/ Development & Technology/ Materials & Radiation Effects	Gregory M. Haas/ Donald S. Beard	ER-531	J-213/GTN	353-5143
Health & Environmental Research	Gerald Goldstein	ER-74	E-223/GTN	353-5348
FOSSIL ENERGY				
Office of Technical Coordination	S. J. Dapkunas	FE-14	B-127/GTN	353-2748
Office of Advanced Energy Conversion	John Fairbanks	FE-22	E-138/GTN	353-2822
Office of Advanced Energy Conversion	Graham Hagy	FE-22	E-131/GTN	353-2828
Office of Advanced Energy Conversion	Dwight Shelor	FE-22	F-323	353-5910
Office of Surface Gasification	James Carr	FE-23	F-307	353-5985
Office of Coal Mining	N. L. Jenson	FE-24	C-133	353-2722

TABLE I (Continued)

ORGANIZATION	REPRESENTATIVE/ ALTERNATE	ROUTE SYMBOL	ROOM/BLDG.	PHONE NUMBER
NUCLEAR ENERGY				
Breeder Reactor Programs/ Breeder Technology Projects/Materials & Structures	Chester M. Purdy	NE-54	F-414/GTN	353-4486
Breeder Reactor Programs/ Breeder Technology Projects/Fuels	Andrew Van Echo	NE-53	F-421/GTN	353-3930
Breeder Reactor Programs/ Space Nuclear Projects/ Safety & Nuclear Operation	Gary L. Bennett	NE-55	E-419/GTN	353-3197
Converter Reactor Deployment High Temperature Reactor Development	J. Edward Fox	NE-15	E-478/GTN	353-4162
Converter Reactor Deployment/ Light Water Reactor Projects	Peter M. Lang	NE-14	E-451/GTN	353-3313
Naval Reactors/Reactor Materials	Robert H. Steele	NE-60	4E-38/GTN	557-5561
Support Programs/Safety Quality Assurance & Safeguards	Benjamin C. Wei	NE-74	E-427/GTN	353-3927
Terminal Waste Disposal and Remedial Action/Waste Repository Deployment	Warren K. Eister	NE-22	G-450/GTN	353-3188
Uranium Enrichment & Assessment/ Advanced Technology Projects	Robert A. Jones	NE-35	A-178/GTN	353-3933
Uranium Enrichment & Assessment/ Enrichment Expansion Projects	Arnold P. Litman	NE-34	A-188/GTN	353-5777

Materials Funding Trends in the Department of Energy

Support of materials programs from FY 1978 to the present have been compiled from prior EMACC reports and inputs to this one (primarily information for the Inventory of Materials Research and Technology in the Federal Government surveyed in FY 1982 by the OSTP Committee on Materials). It should be noted that in DOE, many materials programs are not identified as separate organization line items. The budgets indicated for these materials programs are estimates, made in some cases by different persons in different years. Thus, year-to-year comparisons can at best be qualitative. Given the above caveat, the materials budgets for FY 1978, 1979, 1980, and 1982 are summarized in Table II. Two trends are apparent. First, the total funding peaked in FY 1980, and FY 1982 funding was 10% lower before accounting for inflation. The FY 1983 DOE budget had not been established at the date of compilation of this report, but FY 1980-1982 trends were continued in FY 1983 budget estimates available. Second, the major portion of this significant decrease has been taken in the energy technology programs.

Funding of individual materials programs for FY 1978 - 1980 and FY 1982 is listed in Table III. This more detailed breakdown also attempts to show the reorganization of materials programs in this period.

TABLE II: DOE MATERIALS RESEARCH, DEVELOPMENT AND ENGINEERING SUPPORT

	FUNDING ($ millions) FOR FISCAL YEAR [1]			
	1978	1979	1980	1982
CONSERVATION AND RENEWABLE ENERGY	36.2	76.1	47.9	38.5
DEFENSE PROGRAMS	83.6	73.9	70.2	98.6 [3]
ENERGY RESEARCH	74.4	81.7	91.2	110.6
FOSSIL ENERGY	30.0	32.1	33.3	15.1
NUCLEAR ENERGY	90.0	94.2	144.8	105.5 [4]
RESOURCE APPLICATIONS	7.0	13.2	13.8	0
TOTAL	321.1	371.8	401.2	368.3
			(459.7) [2]	

1. Data from EMaCC Annual Technical Reports for FY 1978-1980 and from the COMAT Inventory for FY 1982; see note 3 also. Table III lists funding for individual materials programs.

2. The total $459.7 in FY 1980 EMaCC Annual Technical Report includes two funding increments not given in other years. These are a) $28.5 million in the Nuclear Waste Management program under Nuclear Energy related to waste form treatment and geologic core studies, and b) $30.0 million in the Nuclear Materials Production program under Defense Programs related to overall system performance.

3. Modified from the COMAT Inventory to include (a) classified as well as unclassified R&D in the Office of Military Applications and (b) materials work in the Waste and Byproducts Management Division (located and reported under Nuclear Energy in FY 1978-1980).

4. Basis for comparison - FY 1980 funding of $122.8 million (see note 3b).

TABLE III: DOE MATERIALS RESEARCH, DEVELOPMENT AND ENGINEERING SUPPORT

	FUNDING ($ millions) FOR FISCAL YEAR[a]			
	1978	1979	1980	1982
CONSERVATION AND RENEWABLE ENERGY	36.2	76.1	47.9	38.5
- Conservation				
Building Energy Research & Development[b]	new in FY1979	1.1	1.3	2.1
Energy Conversion & Utilization Technologies		-- new in FY1981 --		.7
Energy Storage Technology[c]	5.9	10.4	8.9	1.8
Industrial Programs	1.0	1.7	3.1	0.3
Vehicle and Engine[d] R&D	new in FY1979	11.2	10.1	10.2
- Solar				
Biomass Hydrogen Program	--	--	--	.1
Ocean Energy Technology[e]	4.0	4.4	.4	2.5
Photovoltaics Energy Technology[f]	24.8	47.3	24.1	20.5
Wind Energy Technology[g]	.5	0	0	.3
DEFENSE PROGRAMS	83.6	73.9	70.2[s]	87.6
Inertial Fusion[h]	5.0	6.5	5.5	1.2
Military Applications[i]	78.6	67.4	64.7	86.4
Waste and Byproducts[q]	new in FY1982	--	--	11.0
ENERGY RESEARCH	73.3	80.7	91.2	110.3
Advanced Technology Projects	0	.4	.1	0
Fusion (magnetic)	9.3	10.4	12.9	15.8
Materials Sciences	64.0	69.9	78.0	94.5
Health & Environment[j]	1.1	1.0	.2	.3

TABLE III: DOE MATERIALS RESEARCH, DEVELOPMENT AND ENGINEERING SUPPORT

	FUNDING ($ millions) FOR FISCAL YEAR[a]			
	1978	1979	1980	1982
FOSSIL ENERGY	30.0	32.1	33.3	15.1
Advanced Conversion Technology[k]	20.0	20.0	21.6	4.8
Advanced Research & Technology[l]	6.5	7.4	6.2	8.0
Magnetohydrodynamics	3.5	3.0	5.5	0
Solid Fuel Mining[m]		1.7		
Surface Coal Gasification	new in FY1982			2.3
NUCLEAR ENERGY	90.0	94.2	144.8	105.5
Breeder Reactor Technology[n]	39.0	32.0	40.7	27.4
High Temperature Reactors[o]	10.4	8.7	10.4	5.8
Light Water Reactors	new in FY1980		7.3	1.9
Naval Reactors	35.0	38.0	50.0	60.0
Space Nuclear[p]	4.6	5.5	5.8	3.5
Waste Repository Deployment[q]	1.0	10.0	30.6	6.9
RESOURCE APPLICATIONS[r]	7.0	13.2	13.8	0
Geothermal Energy Technology	4.5	7.1	5.3	--
Electric Energy Systems	2.5	4.0	6.9	--
Uranium Resources and Enrichment	new in FY1979	2.1	1.6	--
TOTAL	321.1	371.8	401.2	357.3

NOTES TO TABLE III

a. Data obtained from EMaCC Annual Technical Reports for FY1978-1980 and from submissions to the Committee on Materials (COMAT) for FY1982.

b. Building and Community Systems in FY1979-1981.

c. Advanced Conservation Technologies in FY1980-1981.

d. Office of Vehicle and Engine R&D in FY1979-1981.

e. - Includes Solar Applications in FY1980 ($.4 million).
   - Part of Solar Technology in FY1978-1979.

f. - Part of Solar Technology in FY1978-1979.
   - Includes Solar Applications in FY1978 ($6 million) and in FY1979 ($1.1 million).
   - Includes Solar Applications for Buildings and Industries in FY1980.
   - Includes Passive Solar R&D FY1978-1980.

g. Part of Solar Technology in FY1978.

h. Laser Fusion in FY1978.

i. FY1982-1983 estimates include classified and unclassified support.

j. - Biomedical and Environmental Research and Environmental Control Technology in FY1978-1979.
   - Under the Assistant Secretary for Environmental Protection FY1978-1980.

k. Fuel and Coal Utilization in FY1978-1980.

l. Coal Conversion in FY1978, Planning and Systems Engineering in FY1979.

m. Reported for only one year as shown.

n. Reactor Research and Technology FY1978-1980.

o. Nuclear Power Development in FY1978-1979 Gas Cooled Reactors in FY1980-1981.

p. Advanced Systems and Materials Production in FY1978. Advanced Nuclear Systems and Projects in FY1979-1980.

q. - Funded Under Nuclear Energy Waste Management Program in FY1978-1980.
   - High level waste transferred to Defense Programs in FY1982.
   - FY1980 support of $59.1 million given in the FY1980 EMaCC Annual Technical Report included waste form treatment and geologic core studies which were not included in this compilation.

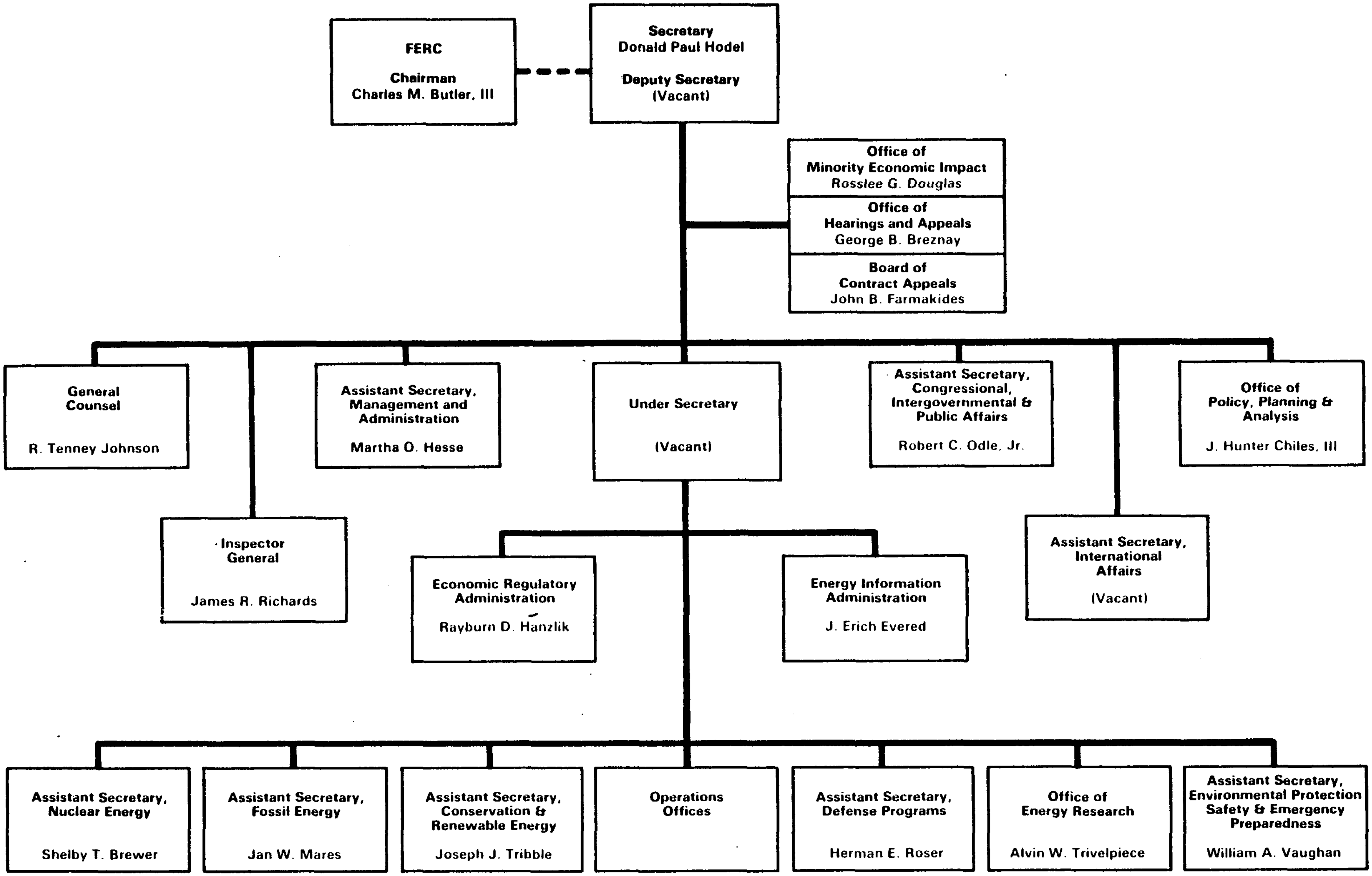
r. Phased out in FY1981.

s. For FY1980 only, the Nuclear Materials Production program indicated $30.0 million support in the FY1980 EMaCC Annual Technical Report. This work has been reevaluated as measuring system performance rather than materials properties and is not included in this total.

Program Descriptions

DOE materials programs are described in brief below based on submissions to the Committee for Materials (COMAT) and in more detail in appendices based on submissions to EMACC. Organization charts of the Department are provided to show the "location" of the various programs.

THE DEPARTMENT OF ENERGY



January 1983

Office of the Assistant Secretary for Conservation and Renewable Energy

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  DEPUTY — Howard S. Coleman
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    - OFFICE OF RENEWABLE TECHNOLOGY — Richard A. Benson, Director
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  - **WESTERN AREA POWER ADMINISTRATION** — Robert L. McPhail, Administrator

* Reports directly to the Secretary on matters relating to P.L. 96-294.

November 1982

OFFICE OF CONSERVATION AND RENEWABLE SYSTEMS

Office of Building Energy Research Development

Contact/Telephone No. - Ernest Freeman/ 252-9426 for Office of Building Energy Research Development

- Others indicated below with specific projects.

Current applied research and development on materials includes:

1 - The phenomenon of Ultraviolet emmissions for mercury vapor lamp gas with various isotope concentrations to improve efficiency. Experiments with various isotope concentrations are conducted to determine efficiency improvements and experiment with photoionization and photo chemical isotope separation techniques. (Contact Robert Boettner, 252-9136).

2 - Development of a high/low temperature advanced insulation for use in appliances and refrigeration systems. Tests and analysis of combinations of materials are performed to understand the heat transfer process occurring in thermal insulation. (Contact Ronald Fiskum, 252-9130).

3 - Thermodynamic effects of refrigerant mixtures in vapor compression systems - the effects of refrigerant mixtures in breadboard systems with multiple heat exchangers are investigated experimentally. (Contact R. Fiskum);

4 - Characterization of advanced absorption fluid pairs for use with absorption heat pumps - studies are developing a computer model for screening and identifying new fluid pairs as well as thermophysical properties data for certain fluids. (Contact - R. Fiskum).

5 - Corrosion data for metallic and nonmetallic materials which are candidates for use in condensing heat exchangers - starting from existing knowledge of materials corrosion properties, selected materials are systematically studied to establish their corrosion resistances to oil condensate that heat exchangers encounter in heating equipment. (Contact Danny C. Lim, 252-9130).

6 - Understanding of energy transport in thermal insulation through development of reliable and representative models for use by researchers - computer models are developed based on theoretical analysis and validated by experimental data. (Contact William Gerken, 252-9191).

7 - Development of devices, including a line-heated guarded hot plate, capable of minimizing unwanted heat flows of testing measurement strategies and edge loss calculations, and of

determining R-value for thick insulation samples - prototype units are being designed, built, and used to conduct heat transfer research, development and test studies. (Contact W. Gerken).

8 - Thermal and mechanical properties of insulating materials in residential applications - R&D Approach: Laboratory and field testing of insulating materials is conducted to improve understanding of their properties. (Contact W. Gerken).

9 - Quantitative smoldering combustion test for cellulosic insulation - a test procedure is being developed based on experimental investigation of smoldering combustion processes in cellulosic insulation. (Contact W. Gerken).

10 - Corrosion test applicable to all thermal insulation materials-tests are being determined based on experimental investigation of corrosive effects of insulating materials on copper, steel, and aluminum. (Contact W. Gerken).

Appendix A contains more details.

Energy Conversion and Utilization Technologies

Contact/Telephone No. - James J. Eberhardt/252-1499

The purpose of the ECUT Program is to support longer-term generic and problem solving research to develop new technologies for increasing energy productivity. Most of the materials effort addresses ceramics and polymerics. Major areas are:

1 - Measurements of friction coefficients and wear rates and determinations of wear mechanisms for dissimilar ceramics sliding against each other in a pin-on-disk test at temperatures up to $1200^{o}F$. Experiments are run in air and dry nitrogen.

2 - Exploration of the limits of the technologies for attaching ceramics to metals and other ceramics for high temperature applications, such as advanced heat engines and high-temperature industrial heat exchangers.

3.- Establishing the feasibility of producing fine, high-purity, sinterable silicon carbide powders via a rotary kiln process; feed materials are carbon and SiO_2.

4 - Development of technologies to permit recycle or reuse of post-consumer plastic scrap by means of consolidation or separation. Present work is concentrated on bonding of plastic components of scrapped auto shreds and shredded beverage containers and on separations of beverage container plastics.

5 - Develop an experimentally verified model to predict the heat transfer and diffusion properties of rigid urethane foam insulation as functions of basic physical and geometric properties of the material; the intention is to indicate improvements in the material which can mitigate the deterioration with time of the materials' insulating capabilities;

6 - Identify commercially available plastic coatings for use on surfaces of low-cost metal heat exchanger surfaces to resist corrosive attack by sulfuric acid condensed from gaseous effluent streams below $200^{o}C$;

7 - Evaluation of the potential of materials such as long-ranged ordered alloys and aluminides for heat engine and steam turbine applications; and;

8 - Review of the current state of the art in superalloy technologies and identify any long-range generic research and development needs or opportunities for energy conservation applications; special emphasis is placed on advanced forming techniques.

Appendix B provides further details.

Division of Energy Storage Technology - Electrochemical Storage Branch

Contact/Telephone No. - Albert R. Landgrebe/252-1483

The objective of the materials reserch and development is to support systems work on secondary batteries and electrochemical energy conversion systems. Major materials areas are electrolyte stability under cyclic charge/discharge conditions and corrosion resistance of components.

Appendix B provides further details.

Office of Vehicle and Engine R&D

Contact/Telephone No. - Robert B. Schulz/252-8064

Structural ceramics and iron-based alloys are being developed for automotive gas turbine, Stirling and adiabatic diesel engines. The FY 1983 Budget Request is for a Ceramic Research Program (under the Energy Conversion and Utilization Technologies Program) and no heat engine development. The final FY 1983 appropriation is expected to continue the proof of concept gas turbines and Stirling engine programs. Major sub-project materials objectives in FY 1982 are:

1 - To evaluate the capability of commercially available ceramics materials to perform satisfactorily in automotive gas turbines and evaluate ceramic components in an existing Heavy-Duty Automotive Gas Turbine Engine, replacing existing metal parts; existing and near-term ceramic technology will be used to improve fuel economy and durability, reduce life cycle costs, and reduce strategic materials content;

2 - To develop an advanced gas turbine engine capable of demonstrating the DOE/NASA goals of improved fuel economy, reduced emissions, and alternative fuel capability; ceramic materials will be used for most or all of the hot-section components.

3 - To develop and evaluate advanced techniques for fabricating and evaluating ceramic components, including improved processing techniques for densifying reaction bonded silicon nitride for injection-molded components;

4 - To develop ceramic materials suitable for application in advanced heat engines, including high temperature, low-thermal-conductivity ceramic materials and transformation toughened ceramics for adiabatic engine applications;

5 - To develop methods of analyzing structural failure mechanisms of ceramic materials and predicting the useful life of ceramic components;

6 - To evaluate high temperature alloys in a simulated Stirling engine environment combining high-pressure hydrogen, high temperature, and combustion products; the effect of high-temperature aging and hydrogen exposure on the creep properties of candidate high-temperature alloys will be determined as well as the hydrogen permeability of commercial and new high temperature alloys; hydrogen "doping" as a method of reducing permeability will be investigated; and

7 - To develop and evaluate improved castable iron-based alloys for Stirling engine applications which will meet performance requirements and reduce both cost and strategic material usage.

Appendix C gives further details.

Office of Industrial Programs

Contact/Telephone No.- Jerome Collins/252-2366
Ralph L. Sheneman/252-2080

Industrial conservation research by DOE is performed to increase process efficiencies, reduce waste production, and utilize industrial wastes and heat forms. This research is undertaken when analysis has shown that the energy benefit is significant compared to the federal research cost; where the technical risk is high, and where the industrial sector cannot undertake the expense completely on its own. In the course of process improvements and wastes utilization, some concomitant materials development may be required as dictated by the process and wastes-oriented research.

The main materials objectives of this program are to determine the feasibility of using cement with controlled particle sized distributions in practical concrete applications, and to investigate potential energy savings that ensure from such use. Previous work on this project has demonstrated that much better use can be made of cement clinker if it is ground by a method which gives a narrower particle size distribution in the product cement. This occurs basically because the very small and very large particles found in ordinary ball milled cement are not fully utilized in the development of strength in the hydrated cement paste, which is the binding element in concrete.

Appendix D gives further details.

Biomass Energy Technology Division - Biological Hydrogen Program

Contact/Telephone No. - Carl Wallace/252-1298

The overall objective of this effort is to provide materials selection and engineering design support ot the photosynthetic bacterial hydrogen production system. The most difficult materials challenge is the identification of a suitably cost-effective transparent covering for the reactors. A wide range of polymers and polymer composites have been screened to identify those few with a sutiable combination of solar transmittance, low permeability to hydrogen and oxygen, high strength, resistance to photo- and bio-degradation, and low cost. These materials will be subjected to a series of durability tests after periods of exposure to realistic conditions of a reactor and evaluated according to performance and cost.

Division of Ocean Energy Technology - Ocean Thermal Energy Conversion Program

Contact/Telephone No. - M. Kim/252-6262

The materials program of the OTEC Program involves the development of a large scale cold water pipe test article and then testing it at sea. The objective is to further develop a cold water pipe technology base to reduce risk in future prototype units. The pipe is made of fiber reinforced plastic and syntactic foam.

Office of Solar Energy/Photovolatics Energy Technology - Material Research

Contact/Telephone No.- Robert H. Annan/252-1720
Anthony Scolaro/252-5548

Materials research supports applied research on properties of photovoltaic material including screening of new materials, material interfaces, reaction kinetics and thermodynamics, defect chemistry, materials stability, etc. Major areas are:

1 - Polycrystalline thin film materials, specifically polycrystalline semiconductors which can be made in thin films of 10 microns or less to understand such key materials properties as defect chemistry, interface interaction and material stability and how to alter these properties to make better solar cells.

2 - Amorphous thin film materials, involving further development of amorphous materials for use in highly efficient multiband gap solar cells; techniques for deposition such as glow discharge, chemical vapor deposition and reactive sputtering will also be studied;

3 - Polycrystalline silicon cells involving study of crystal growth by novel techniques with the goal of growing defect free or defect passivated silicon sheet material, suitable for high efficiency solar cells, at high rates; also study of novel cell structures and/or processes that have the potential to improve the conversion efficiency;

4 - Advanced concentrator concepts such as superlattice cascade cells, and monolithic cascade cells for highly efficient solar cells. There is also considerable study of III-V semiconductor materials and luminescent concentrator materials;

5 - Photovoltaic electrochemical cells, centered on the semiconductor/electrolyte interface with the goal of improving collection efficiency and semiconductor stability; and

6 - Flat plate solar array project, which studies all elements in the formation of crystal silicon photvoltaic modules. The project's activities include the refinement to semiconductor grade of raw silicon, crystal growth, silicon sheet modification (junction formation), and coatings and films to reduce reflection and protect the cells and modules.

Appendix E gives further details.

Wind Energy Technology Division - Large Wind Turbine Research and Technology Development

Contact/Telephone No. - Peter Goldman/252-1776

The objectives of the materials research projects is the attainment of reductions in the cost of energy from WECS (wind energy conversion systems) through testing of blades and other advanced components for large wind turbines.

Materials research currently in progress includes investigations of several properties of advanced composite materials such as wood fiber veneer/epoxy resin laminates (e.g., Douglas fir/epoxy laminates) and hybrid composites (e.g., glass and carbon fiber reinforced cement); joining methods of wood to wood composites and wood composites to steel are being developed and evaluated. Research is also being conducted on structural durability of experimental rotor sub-structures when subjected to ultra high cyclic loading ($4X10^8$ cycles) and extreme environmental conditions.

Appendix E provides further details.

OFFICE OF DEFENSE PROGRAMS

Office of Inertial Fusion - Materials Research

Contact/Telephone No. - Carl Hilland/353-3687

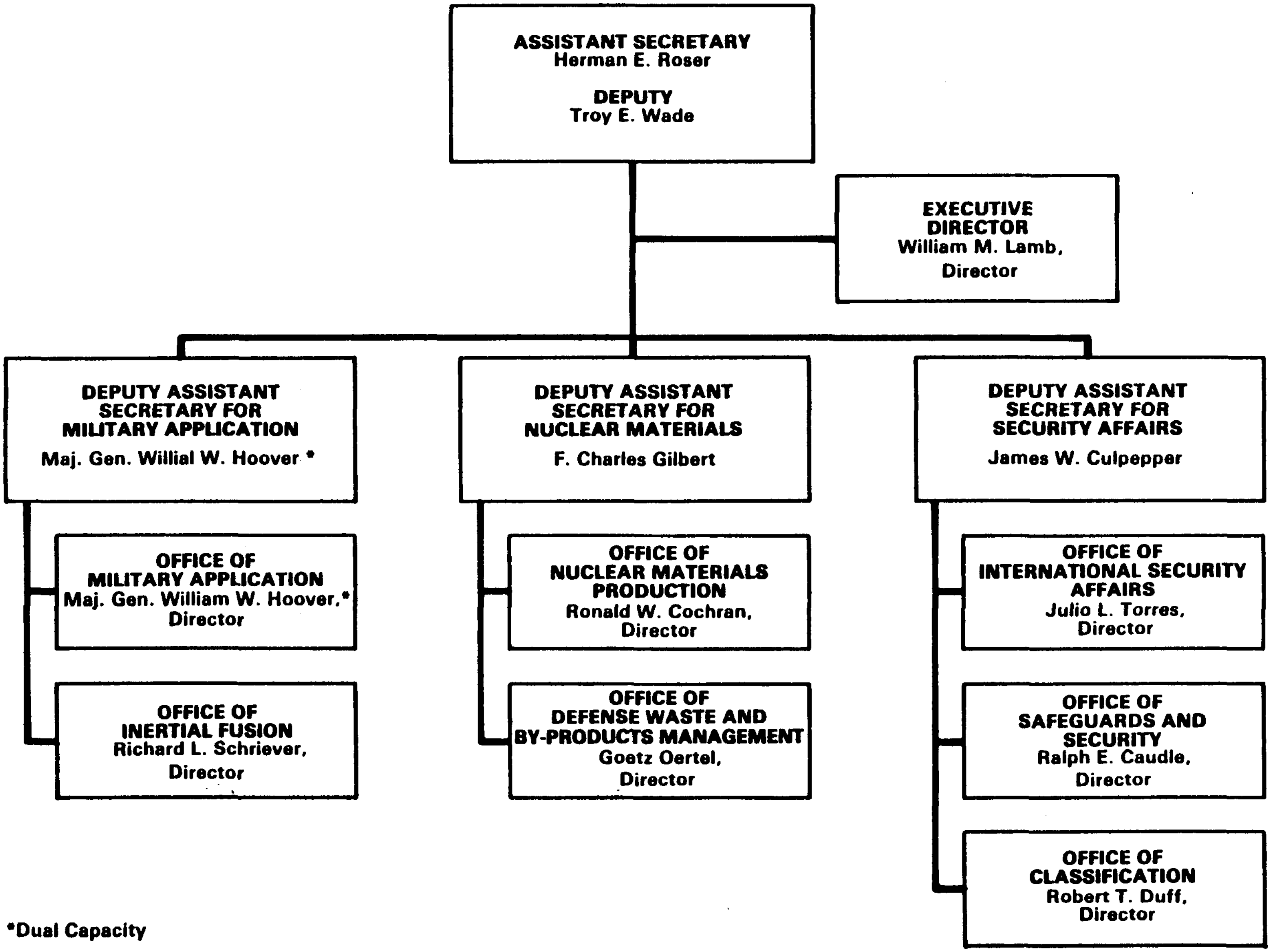
The materials effort consists of applied research and development oriented toward producing controlled thermonuclear fusion reactions in a laboratory environment for military and energy applications. The three major areas (and the materials studied therein) are:

1 - Laser materials and optical components (neodynium glass, metallic optical coatings, and electronic materials);

2 - Fusion reaction materials (ceramics, glass, carbides, carbon), metals (ferrous and nonferrous), optical materials, thermal materials, construction materials; and electronic materials; and

3 - Target fabrication (ceramics, glass, carbon), metals (ferrous and non-ferrous), polymers (plastics) and composites.

Office of the Assistant Secretary for Defense Programs



*Dual Capacity

March 1982

Office of Military Applications - Materials Research

Contact/Telephone No. - William G. Collins, Jr./353-5494

The objective of the materials research sponsored by the program is to develop materials and materials technology for national security uses. This applied research is directed toward material science, the understanding and development of advanced materials and fabrication technology, and the development of materials and processes required to produce nuclear and nonnuclear parts. Major areas are:

1 - Metals, metallurgy activities and superconducting and magnetic materials;

2 - Surface science, coating, welding and joining, fabrication, and materials compatibility;

3 - Ceramics, glasses and amorphous materials;

4 - Polymers, composite and adhesives, and

5 - Materials characterization techniques.

Appendix I provides further details.

Defense Waste and Byproducts Management/R&D and Byproducts Division

Contact/Telephone No. - J. J. Jicha/353-3031

The Defense Long-Term Waste Management Technology program is directed toward implementation of long-term management of DOE radioactive waste. It includes materials development and evaluation for high-level and transuranic waste forms and canisters. Alternative waste forms and compositions are being developed and characterized. This is primarily done with simulated, nonradioactive waste on a laboratory scale. Characterization tests include chemical durability, radiation stability, thermal stability, and mechanical properties. Processes are also being developed to produce alternative waste forms incorporating high-level radioactive waste. Both lab scale radioactive and engineering scale nonradioactive studies are included. Waste forms include glasses and polycrystalline ceramics.

Appendix J provides further detail.

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November 1982

OFFICE OF ENERGY RESEARCH

Office of Fusion Energy (Magnetic) - Fusion Reactor Materials

Contact/Telephone No. - G.M. Haas/353-5143

The research and development on materials addresses needs of magnetic fusion systems and future fusion reactors. The general objective is to provide the materials property data base and where necessary to develop new materials for the design, construction, and operation of fusion reactor systems.

Office of Health and Environmental Research - Physical and Technological Research

Contact/Telephone No. - Gerald Goldstein/353-5348

Develop the basic technology of semiconductory radiation detectors, detector materials, and associated electronics required for many types of radiation measurement in physics, biological and environmental research.

Division of Materials Sciences

Contact/Telephone No. - Louis Ianniello/353-3427

The aim of this basic research program is to increase the understanding of materials phenomena, materials properties and behavior of classes of materials important to the Department of Energy's missions. Some of the research is specific to one energy technology (e.g., photovoltaic pheonomena for solar energy conversion), some is related to many energy technologies simultaneously (e.g., hydrogen embrittlement) while still other research is aimed at long range advancement of materials science (e.g., neutron scattering). In the pursuit of these objectives, new forefront instruments and facilities are developed as needed. It is recognized that this program carries a major responsibility for many of the nation's premier research facilities including several neutron sources, a synchrotron radiation source and frontier electron microscopes. The research is conducted at DOE laboratories, universities, and to a lesser extent at industrial laboratories by metallurgists, ceramists, solid state physicists and materials chemists in about 100 different institutions. There are three subprograms:

1 - Metallurgy and Ceramics: To understand better how metallic and ceramic materials behavior/properties are related and controlled by structure and processing conditions;

2 - Solid State Physics: Directed toward fundamental research on matter in the condensed state, wherein the interactions of electrons, atoms, and defects are tracked with the purpose of determining the critical properties of solids; and

3 - Materials Chemistry: Developing an understanding of the chemical properties of materials as determined by their composition, structure, and environment (pressure, temperature, etc.) and to show how the laws of chemistry may be used to understand physical as well as chemical properties and phenomena.

Appendix K gives further details, as does the DOE publication, Materials Sciences Programs Fiscal Year 1982 (DOE/ER-0143 dated September 1982).

OFFICE OF FOSSIL ENERGY

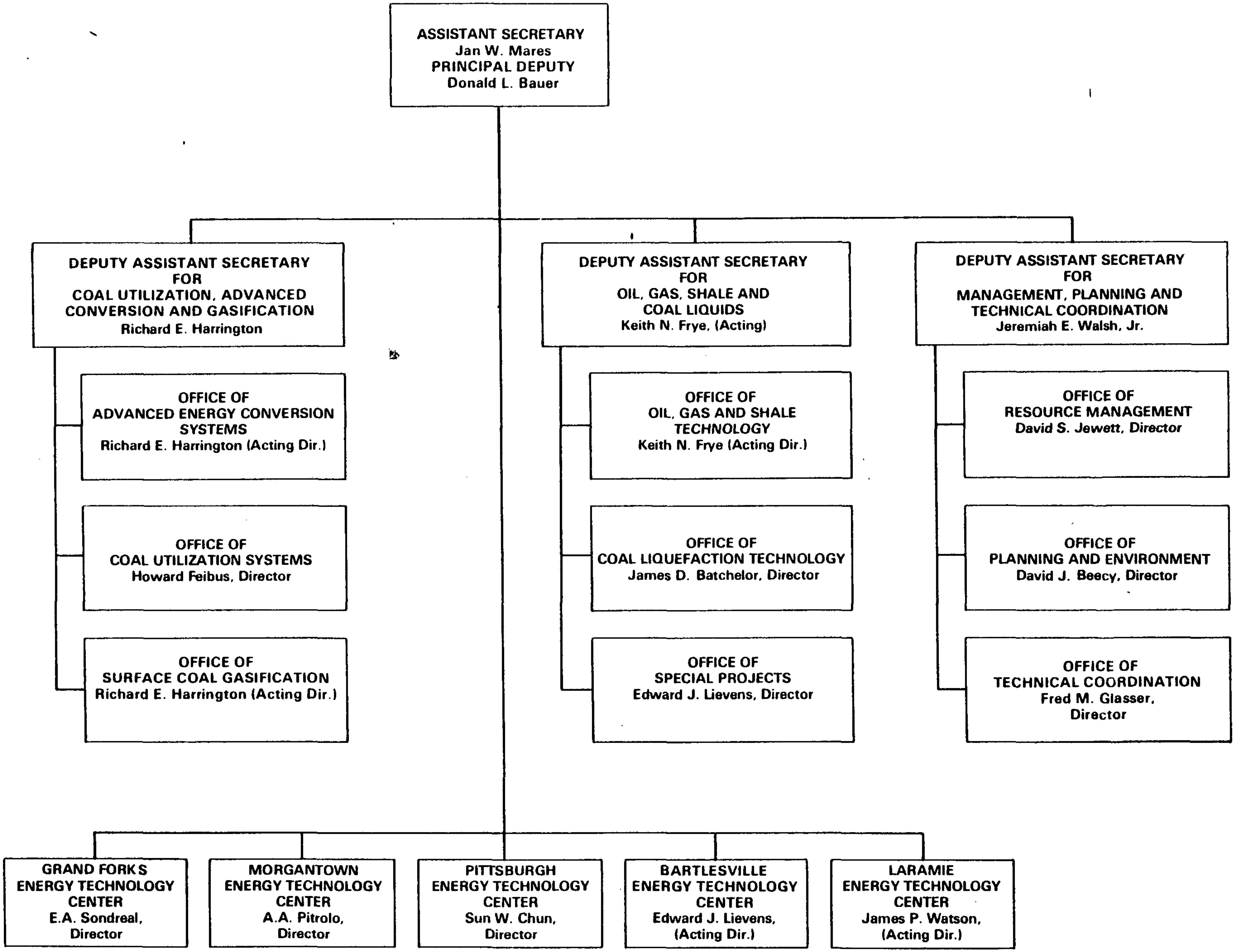
Advanced Energy Conversion-Heat Engine

Contact/Telephone No. - John W. Fairbanks/353-2822

The materials effort emphasizes engineering to improve materials for industrial/utility gas turbine and diesel engine hot-section components to provide efficient, durable, environmentally acceptable operation with coal base fuels. Development of new materials is focused on adherent corrosion resistant oxide ceramic coatings such as zirconia and alumina. Silicon carbide and silicon nitride are also being evaluated. The effect of coating process modifications, such as substantial surface preparation, plasma deposition, and laser heating of the coating, are being examined. Also, to support the water cooled gas turbine engine capability to operate with coal base fuels, materials work on vane and blade materials and fabrication is being conducted to determine the strength of powder metallurgically produced and directionally solidified metallic alloys.

Appendix L provides further details.

Office of the Assistant Secretary for Fossil Energy



October 1982

Office of Technical Coordination -Advanced Research and Technology Development

Contact/Telephone No. - S.J. Dapkunas/353-2784

The objective of this program is to develop a broad, generic technology base in structural materials used in fossil fuel conversion systems such as coal gasification, liquefication and combustion and shale processsing. Major areas include:

1 - High temperature corrosion and erosion of ferrous and non-ferrous alloys;

2 - Corrosion and fracture of structural ceramics such as silicon carbide and silicon nitride;

3 - Deterioration of oxide refractories under gaseous and slagging conditions; and

4 - Reliability of pressure vessel low alloy steels.

Appendix M provides further details.

Office of Surface Coal Gasification

Contact/Telephone No. - James Carr/353-5985

The materials program objectives are to develop and apply appropriate materials to coal gasification plants/components, vessels and piping systems. The overall goal is to improve the operational reliability, system durability and to reduce fabrication as well as operating costs of coal gasification plant constituent elements and/or components operating under high temperature, erosive, corrosive, dirty environment conditions. Materials being evaluated include structural ceramics, coatings and claddings, refractories, high strength metal alloys.

Appendix N provides more details.

Office of the Assistant Secretary for Nuclear Energy

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  - Safety, QA & Safeguards Division
    Neal Goldenberg (Acting Dir.)

May 1982

OFFICE OF NUCLEAR ENERGY

Office of Breeder Technology

Contact/Telephone No. -
D.K. Magnus/353-5004 for the Fuels and Core Materials Division
C. Purdy/353-4486 for the Materials and Structures Program

The applied research and development technology activities, conducted at several national laboratories, industrial organizations, universities and through bilateral and trilateral technology programs and exchanges with foreign nations, relate to current, advanced and alternate reactor systems. The scope of these activities include the following areas: fuel cycles; design and performance of high quality core components for fuels, blanket and control systems; development of the structural materials used in these components and systems; development and demonstration of equipment, processes and procedures for fabricating, processing, handling and producing plutonium bearing fuels, materials and components; sodium technology; standards and quality assurance; assuring a reliable high quality and affordable fuel supply for LMFBR's; destructive and non-destructive testing examination and evaluation of core components and the facilities and capabilities for conducting such examinations; responsibility for engineering and supporting facilities; associated safety, safeguards, and non-proliferation; maintaining competent capabilities in the several contractor organizations that conduct the pertinent R&D activities and programs. These activities are responsive to the administration's policies and goals and, to the DOE programs that support them.

In-reactor and out of reactor property evaluations are being conducted on core materials, clad/ducts, fuels and absorber materials. Through irradiation testing in FFTF and EBR-II, the Fuels and Core Materials Program is developing, qualifying and verifying the use of reference, improved and advanced mixed oxide fuels and boron carbide absorbers, including full size driver and blanket fuel, and absorber element pins and assemblies -- same for carbide fuels. Fabrication development, evaluation, qualification and verification (raw material processing, melting, hot working, cold working and finishing) are conducted on reference, improved and advanced alloys including in-reactor qualification of pins, ducts and assemblies; surveillance assemblies of reference materials now in FFTF Core 1. Improved and advanced materials are being tested for use in future cores.

The objectives of the materials and structures programs are to develop procedures that will assure economic and safe components and systems while providing designers with sufficient flexibility in components and systems design to facilitate optimization. Materials being evaluated are low allay and stainless steels as well as ferrous superalloys. Major areas include materials characterization, radiation effects, mechanical properties, joing methods, non-destructive testing, tubology, corrosion and wear, and materials data documentation.

Appendices O and P provide more details.

High Temperature Reactor Development Division

Contact/Telephone No. - J. E. Fox/353-4162

The objective of the HTGR Program is to facilitate the commercialization of HTGR concepts by developing information and technology needed for important HTGR applications. Major areas are (1) development of metallic alloys with corrosion resistance and thermal stability for use in components such as heat exchangers, hot ducts, thermal barrier cover plates, control rods, seals and support structures, and (2) development of high strength nuclear graphite and other ceramic materials with adequate radiation and oxidation characteristics for use in fuel and reflector blocks, can support posts and blocks, and thermal barrier and structural support pads.

Light Water Reactor Systems Program

Contact/Telephone No. - Peter M. Lang/353-3313

The objective of the extended burnup subprogram of the LWR Systems Program is to develop technology to reduce the volume of spent fuel generated by LWR's in order to reduce the pressure on the back end of the fuel cycle. The major materials-related areas are (1) develop light water reactor fuel with improved pellet-cladding interaction performance allowing extended fuel burnup, (2) develop Gd_2O_3-UO_2 burnable absorbers for extended burnup, and (3) determine fission gas release from high burnup fuels. These development efforts include determination of properties of nuclear fuel materials and of behavior of these materials under severe conditions of temperature, pressure, and neutron irradiation.

Office of Naval Reactors

Contact/Telephone No. - Robert H. Steele/557-5561

The Materials Research and Development Program is in the Reactor Materials Division under the Deputy Assistant Secretary for Naval Reactors. The program supports the development and operation of improved and longer life reactors and pressurized water reactor plants for naval nuclear propulsion. In addition, during FY 1981 and 1982, this program supported the Light Water Breeder Reactor (LWBR) which operated in the Shippingport Atomic Power Station and the Advanced Water Breeder Activity to develop technical information that will assist U.S. industry in evaluating the LWBR for commercial scale applications.

The objective of the materials program is to develop and apply in operating service materials capable of use in the high power density and long life required of naval ship propulsion systems. This work includes irradiation testing of reactor fuel, poison, and cladding materials in the Advanced Test Reactor at the Idaho National Engineering Laboratory. This testing and associated examination and design analysis demonstrates the performance characteristics of existing materials as well as defining the operating limits for new materials.

Corrosion, mechanical property, and wear testing is also conducted on reactor plant structural materials under both primary reactor and secondary steam plant conditions to confirm the acceptability of these materials for the ship life. This testing is conducted primarily at two Government laboratories - Bettis Atomic Power Laboratory in Schenectady, New York.

One result of the work on reactor plant structural material is the issuance of specifications defining the processing and final product requirements for materials used in naval propulsion plants. These specifications also cover the areas of welding and nondestructive testing.

The materials program effort applied to the Water Breeder Reactor program included irradiation testing of the fuel rods utilizing the thorium-uranium-233 fuel cycle, which has the potential for providing appreciably more energy than the current design of water reactors. This testing provides the basis for the development of analytical models for use in calculating the performance of fuel rods in pressurized water reactors.

Funding for this materials program is incorporated in naval projects jointly funded by the Department of Defense and the Department of Energy and the Water Breeder Reactor program funded by the Department of Energy. This funding amounts to approximately $55 million dollars in both FY 1981 and 1982, including slightly over $20 million as the cost for irradiation testing in the Advanced Test Reactor.

Office of Space Nuclear Projects

Contact/Telephone No. - G. Bennett/353-3197

This office provides reactor and radioisotopic thermoelectric power sources for space flight and terrestrial missions. All applied research and development, fabrication, systems integration and safety requirements for power sources are responsibilities of this office.

Appendix Q provides more details.

Division of Waste Repository Deployment

Contact/Telephone No. - C. R. Cooley/353-4285

This program evaluates geologic and engineering materials for the isolation of radioactive wastes within deep-mined geologic formations, or within the subsea bed. This includes determination of properties of geologic and engineering materials (on exchange transport of radioactivity through geohydrologic systems, corrosion of metallic containers in geohydrologic environments, teaching), dissolution of radioactive glasses and ceramics, and expanding concretes and clays.

Appendix R provides more detail.

Appendix A: Office of Building Energy Research and Development

The Office of Building Energy Research and Development works to increase the energy efficiency of the buildings sectors through performance of R&D on building systems, building equipment, and community energy systems. In addition, the Office carries out the statutory requirements of appliance standards and labeling, building energy performance standards, the residential conservation service, and Federal energy management programs. Specific objectives include providing the technology to:

- reduce energy consumption in existing buildings, and in new buildings;
- increase the energy efficiency of oil and gas combustion heating systems and of oil- and gas-fired heat pump systems;
- improve the energy efficiency of advanced electric heat pump and refrigeration systems, and of lighting systems; and
- develop new planning techniques and systems that will decrease the energy consumption of communities.
- funding is given below for FY 1981.

1. Considering Heat Exchanger Systems — $ 80K

DOE Contact - Danny Lim (202) 252-9130
Battelle (Brookhaven Subcontract No. 490885)
Bud Woodworth (516) 345-2123

Investigation of materials feasible for use as heat exchangers for condensing oil- and gas-fired burners. Ceramics, stainless steel, plastics and lead-coatings are among the materials being considered.

Keywords: Corrosion, Materials Characterization, Ceramics

2. Thermal Insulation — $162K

DOE Contact - William Gerken (202) 252-9191
ORNL (Contract No. 3470-0521)
D. L. McElroy (615) 574-5976

Evaluation of the termal resistance of thermal insulation. Use of an instrumented Nichrome screen heater is being analyzed and a simple prototype constructed.

Keywords: Materials Characterization

3. Thermal Resistance of Insulation $100K

DOE Contact - William Gerken (202) 252-9191
NBS - Gaithersburg (ORNL Subcontract No. 3740-5618)
F. Powell (202) 921-3637

Development of equipment to measure thermal resistance of insulating materials at thicknesses of up to six inches. Two prototypical line-heated guarded hot plates are being developed and compared to a heat flow meter technique.

Keywords: Materials Characterization

4. Corrosion in Insulating Materials $ 59K

DOE Contact - William Gerken (202) 252-9191
Stevens Institute (ORNL Subcontract No. 3470-5763)
R. Weil (201) 420-4257

Corrosion testing studies with urea-formaldehyde foams and also with cellulosic insulation and fiberglass insulation.

Keywords: Corrosion

5. Insulating Materials $ 43K

DOE Contact - William Gerken (202) 252-9191
Tennessee Technological U. (ORNL Subcontract No. 3470-5269)
Dave Yarbough (615) 574-5978

Operating temperatures of convectively-cooled, recessed incandescent light fixtures and of insulated flourescent light fixtures are being measured. Effect of vibration on density of loose-fill insulation and effects of thickness change due to compressive loading on insulating batts and loose-fill insulation are also being measured.

Keywords: Materials Characterization

6. Convection Effects, Moisture Transport, and Condensation and Scattering $ 39K

DOE Contact - William Gerken (202) 252-9191
U. of California - Berkeley (ORNL Subcontract No. 3470-5265)
C. Tein (415) 642-6000

Analytical and experimental studies on natural convection effects in insulation cavities, on moisture transport and condensation, and on the absorption and scattering characteristics of insulating materials.

Keywords: Materials Characterization

7. <u>Out-gassing Substances</u> $ 95K

DOE Contact - William Gerken (202) 252-9191
U. of Iowa (ORNL Subcontract No. 3470-5264)
K. Long (319) 353-2121

Identification of out-gassing substances from urea-formaldehyde foams. Attempting to demonstrate multiple-stage releases that depend on temperature and humidity.

Keywords: Materials Characterization

8. <u>Permanency of Cellulosic Insulation</u> $ 73K

DOE Contact - William Gerken (202) 252-9191
NBS - Gaithersburg (Contract No. DE-AI05-78OR06113)
S. Davis (202) 921-3744

Attempting to ensure that certain types of materials, which are suitable for flame-retarding cellulosic insulation, exhibit a degree of permanency. Materials being studied include: one part borax, 2 parts boric acid (25%); two parts borax, one part boric acid (25%); two parts borax, two parts boric acid, one part aluminum sulfate.

Keywords: Materials Characterization

9. <u>Fire Performance of Insulation</u> $ 12K

DOE Contact - William Gerken (202) 252-9191
Underwriters Lab
Wayne Kleinfelder (312) 272-8800

Conducting fire performance tests of insulation used as a cavity fill in residences. Radiant floor panel tests being conducted with different attic configurations. Primarily cellulosic insulating materials are being used.

Keywords: Materials Characterization

Appendix B: Office of Energy Systems Research

This office supports generic research of a long-term, high-risk, high-payoff nature aimed at stimulating innovation in conservation technology. The research is both broadly based and multi-sectoral, providing a technology base for the other conservation programs. The Office consists of three divisions: Energy Storage, Energy Conversion and Utilization Technologies (ECUT), and Electric Energy Systems. Funding is shown below for FY 1981.

Energy Storage Division

The principal function of the Energy Storage Division is to foster more efficient and more economical use of intermittent energy sources. A vital part of this R&D effort is the development, fabrication, characterization and compilation of data bases. Described below are the materials R&D efforts of the five subprograms of the Division.

1. Batteries and Electrochemistry $1,700K

DOE Contact - A. Landgrebe (202) 252-1474
ANL, Case-Western Reserve U., Ceramatec,
Dow Chemical, Diamond-Shamrock, Ford, Gould, MIT, U. of
Pennsylvania, Reynolds Metals, Stanford U., U. of Belgrade

Lithium-iron sulfide and sodium sulfur batteries operate at temperatures of several hundred degrees Celsius. Corrosion of container materials is a concern, as are materials for current collectors, separators, and seals. Of special importance is the development of processing techniques to make beta-alumina parts with reproducible properties for use in sodium sulfur batteries.

Aluminum alloys are being prepared and characterized for use as negative electrodes in aluminum-air batteries. Polymers are being synthesized and prepared as films for use as electrolytes and electrodes in storage batteries; glasses just for use as electrolytes. Catalysts which contain no platinum are being studied for use in the electrochemical reduction and oxidation of oxygen.

Keywords: Alloy Development, Alternate Materials, Coatings and Films, Corrosion, Elastomers and Polymers, Joining Methods

2. Thermal Storage $2,300K

DOE Contact - R. Shivers (202) 252-1488
Rocket Research, Trans Energy, I.G.T., North Carolina U., Babcock and Wilcox, Purdue U., Sandia Livermore, ORNL

Materials development activities include: development of domestic sources for ceramics for electric resistance charged heat storage units, including improved physical (cracking and dusting) characteristics, improved heat transfer performances and reduced costs; development of building materials construction elements which incorporate phase change heat storage material for passive solar buildings; development of high-temperature storage materials and compatible containment materials for advanced industrial process heat storage application; research on the means of stabilizing the latent heat performance of salt hydrates which are useful for thermal storage; research to identify and characterize solid-solid transition phase change materials for thermal storage; and research on heat exchanger materials for fouling problem activities.

Keywords: Alloy Development, Alternate Materials, Transformations

3. Chemical and Hydrogen Storage $900K

DOE Contact - M. Gurevich (202) 252-1488
Brookhaven, U. of Virginia, Teledyne Energy Systems, International Nickel, General Atomics, State U. of New York, Battelle - Columbus, ANL, JPL, Rocket Research, Life Systems, SRI, Ergenics, SoCal, General Electric, LASL, R. J. Teitel Associates

Work on the behavior of hydrogen includes: investigation of glass microspheres for hydrogen storage, H_2 embrittlement effects on pipeline steels; the use of metal hydrides for separation of hydrogen from natural gas and waste gase streams; SPE electrolytes for producing H_2 from water; electrodes and separators for alkaline electrolysis; process/materials for recovery of H_2 from H_2S; and catalysts for electrolytic and thermochemical hydrogen production. In other projects, chemical heat pumps are being developed for thermal energy upgrade and storage using sulfuric acid/water systems and selected pairs of metal hydrides.

Keywords: Alloy Development, Polymers, Catalysts

4. Mechanical Energy Storage $1,000K

DOE Contact - R. Shrivers (202) 252-1488
LLNL, MIT, Johns Hopkins U., RPI, Union Carbide, Rocketdyne, AVCO, Owens Corning, Ewald, Eton Co., ORNL

The primary emphasis is the development of Mechanical Energy Storage Technology (MEST) suitable for automative and fixed-base application through in-house and contractual efforts. Of particular interest is the development of materials and the placing of them in appropriate configurations for flywheel rotors; development of elastomeric materials and configurations for braking energy recovery; and development of transmission systems and control techniques for flywheel-augmented power systems.

Keywords: Alloy Development, Alternate Materials, Elastomers and Polymers

5. Superconducting Magnetic Energy Storage $1,000K

DOE Contact - R. Shivers (202) 252-1488
LASL, U. of Wisconsin

The overall objective is to develop technology for both large-scale (1,000 MWh) diurnal energy storage plants and small-scale (10 kWh) utility system stabilization devices. The major emphases are the development of a low-cost polyester-glass support structure for cryogenic service and the development of a high-purity aluminum stabilizer conductor.

Keywords: Superconductors, Glasses, Alloy Development

Energy Conversion and Utilization Technologies Division

The purpose of the ECUT program is to support longer-term, generic and problem-solving research aimed at developing new technologies for increasing energy productivity. The program was initiated in FY 1981. It consists of seven projects, including a Materials Project. In its first year of operation, the ECUT Materials Project concentrated primarily on a series of research assessments that identified materials research opportunities with significant energy conservation potential. The budget for this work was $350,000. In addition, the ECUT Physical Processes Project carried out research on development of innovative heat exchanger materials at a cost of $82,000, bringing the total FY 1981 ECUT materials expenditure to $432,000. These projects are described below.

1. Anti-Corrosive Coatings for Heat Transfer Surfaces $ 82K

DOE Contact - W. Thielbahr, Idaho Operations Office (208) 526-0682
Garrett Airesearch

Research is being carried out to determine the feasibility of applying, by chemical vapor deposition (CVD) aluminum anti-corrosive coatings to complex heat transfer surfaces in fully fabricated low-cost metallic heat exchangers.

Keywords: Corrosion

2. ECUT Materials Project $ 350K

DOE Contact - J. J. Eberhardt (202) 252-1500
ORNL, Renssalaer, Plastics Institute of America, MIT
ORNL Field Manager: J. Carpenter (615) 574-4571

Work in FY 1981 was principally devoted to identifying fertile research areas for work to begin in FY 1982. Short reviews, emphasizing identification of opportunities for enhancing energy efficiency through improvement of materials properties or production processes, were carried out in the following areas: materials for high-temperature waste heat recovery; buildings insulation; materials for building heat exchangers; advanced electrodes for aluminum reduction cells; materials for the light-duty adiabatic diesel engine; materials for advanced heat engines; lightweight materials for ground transportation; tribological applications to ground transportation; recycle of plastics; and magnesium production. As a result of these studies, it was decided to initiate work in FY 1982 in three research areas: tribology; high-temperature materials; and polymers and plastics. Tribological research is concentrating on studies of the lubricating qualities of the constituents of base stock oils and the friction and wear of dissimilar ceramics at elevated temperatures. High-temperature materials efforts include studies on ordered metallic alloys, ceramic joining, toughening of ceramics, and alternative methods of producing SiC powders. Polymers and plastic work is concentrated on: recycle of plastic scrap from automobile shreds, polypropylene battery cases, and plastic beverage containers (begun in late FY 1981); aging of rigid urethane foam insulation (also begun in late FY 1981); and study of plastic-coated low-temperature heat exchangers. Work on lightweight materials (lower-cost composites and innovative technologies for reducing costs in primary and secondary magnesium reduction and processing) is expected to begin in FY 1983.

Keywords: Alternate Materials, Ceramics, Elastomers and Polymers, Erosion and Wear, Adhesives and Lubricants, Joining Methods, Materials Characterization, Materials Processing

Electric Energy Systems Division

This program conducts R&D designed to expedite the development of higher-risk, long-term payback technologies which have a significant potential for improving the efficiency of the electrical energy system (e.g., increased capacity utilization, loss reduction). Research is also conducted in technologies for shifting fuel use from oil and gas to more abundant resources; on successfully integrating new energy sources (dispersed generation and storage) into the grid; and on investigating safety concerns.

1. Development of a Low-Resistance Magnetic Composite Material $ 350K

DOE Contact - Jit Vora (202) 252-1633
General Electric (Contact No. AC01-78ETZ-9313)
Harley Lake (518) 385-8606

Develop and optimize the process necessary to produce a magnetic material made of amophous metals. The resultant tecnology, when applied to magnetic circuits of electric power equipment, should lead to increased efficiency.

Keywords: Materials Processing

2. <u>Development of Future Electrical Insulating Systems</u> $ 320K

DOE Contact - Jit Vora (202) 252-1633
National Bureau of Standards (Contract No. EX-77-A-01-6010/A053)
Richard Van Brunt (301) 921-3121

Develop advanced diagnostic techniques, test procedures and statistically valid models for monitoring and identifying aging or degradation processes in compressed gas electrical insulating sytems under normal or near-normal operating conditions.

Keywords: Materials Characterization

3. <u>High-Voltage Breakdown Strengths of Insulating Gas</u> $ 650K

DOE Contact - Russel Eaton (202) 252-4844
ORNL (Contract No. W-7405-ENG-0026)
Lucas Christophorou (615) 574-6199

Analyze, from a physiochemical point of view, the factors influencing the breakdown strength of gaseous dielectrics and seek gases with superior performance.

Keywords: Materials Characterization

4. <u>Study of Gas Dielectrics as Cable Insulators</u> $ 100K

DOE Contact - Russell Eaton (202) 252-4884
MIT (Contract No. ET-76-C-01-2295-T019)
Chad Cooke (617) 253-2591

Fundamental study of gas dielectrics for insulation purposes which is covering four areas of applied research: basic gases and mixture studies, particle trap studies, large system performance, and insulating surface studies.

Keywords: Materials Characterization

5. <u>Aging Process in Solid Dielectrics</u> $ 700K

DOE Contact - Russell Eaton (202) 2520-4844
Battelle - Columbus (Contract No. EC-77-C-01-5010)
Mike Epstein (614) 424-6424

Developing an understanding of insulating aging characteristics of solid dielectrics used for underground transmission cable systems. Develop and verify short-term cable test procedures which will accurately predict insulation life for its rated service.

Keywords: Materials Characterization

6. <u>Synthetic Tape Development</u> $ 600K

DOE Contact - Russell Eaton (202) 252-4844
Brookhaven (Contract No. ET-77-C-02-0016)
Bill Harrison (516) 345-2124, ext. 4774

Develop optimized polymeric film tapes for ambient temperature taped cable use.

Keywords: Elastomers and Polymers, Coatings and Films

7. <u>Transient Breakdown Voltages in Solid Dielectric Cables</u> $ 250K

DOE Contact - Russell Eaton (202) 252-4844
Cable Technology Lab (Contract No. ET-78-C-01-3062)
Carlos Catz (201) 846-3220

Develop a physical model of voltage aging for solid dielectrics used for high-voltage underground transmission cable systems. Develop a procedure for a short-term voltage test on solid dielectric cables.

Keywords: Erosion and Wear

8. <u>AC Superconducting Power Transmission Cable Development</u> $3,100K

DOE Contact - Russell Eaton (202) 252-4844
Brookhaven (Contract No. ET-76-C-02-0016)
E. Forsyth (516) 345-2123

Develop a flexible AC superconducting cable system based on NB_3Sn conductor and a tape dielectric. The project includes management of all supporting research on materials and refrigeration.

Keywords: Superconductors

Appendix C: Office of Vehicle and Engine R&D

The Office of Vehicle and Engine R&D has established a number of broad programs aimed at reducing highway vehicle fuel consumption. One, the Heat Engine Highway Vehicle Systems Program, is underway to develop advanced gas turbine, adiabatic diesel, and Stirling engines and to confirm their potential to achieve significant improvements in fuel consumption over the conventional spark-ignition engine. Project management responsibility for this program has been delegated to the NASA Lewis Research Center. Program management is the responsibility of the Office of Vehicle and Engine R&D. A related effort, the Heat Engine Highway Systems Materials and Components Technology Program, is being conducted for DOE by the Army Material and Mechanics Research Center (AMMRC).

The success of these advanced propulsion systems depends strongly on the development of new or improved materials. Ceramic materials are needed for the hot-flow-path components of the advanced gas turbine and the adiabatic diesel engines, to meet operating temperatures and manufacturing cost requirements. The Stirling engine requires low-cost iron-based alloys capable of operating at high temperatures while exposed to high-pressure hydrogen. Material technology development programs are underway for each of these propulsion systems. Key elements of each program are described briefly in the following. As indicated, most of the material development activities are being conducted by industry under contract. Further information can be obtained by contacting R. B. Schulz, Technology Development and Analysis Division, (202) 252-8064. Funding for FY 1981 and FY 1982 is indicated below by (81) and (82) respectively.

1. Ceramic Applications in Turbine Engines (CATE) $3,534K (81) $1,370K (82)

NASA Contact: P. T. Kerwin (216) 433-4000, extension 6770
Detroit Diesel Allison (NASA Subcontract DEN 3-17)
J. A. Byrd - (317) 242-5340

This program applies ceramic components to the Detroit Diesel Allison GT 404/505 gas turbine engines. Replacing existing metal parts allows increased operating temperatures, and thereby improves engine efficiency. Efforts include ceramic material characterization, ceramic process development, and ceramic design technologies.

Key Words: Ceramics and Glasses, turbine engines, silicon carbide, silicon nitride

2. Advanced Gas Turbine Powertrain Development (AGT-100) $1,860K (81) $2,251K (82)

NASA Contact: P. T. Kerwin (216) 433-4000, extension 6770
Detroit Diesel Allison/Pontiac (NASA Subcontract DEN 3-168)
H. E. Helms - (317) 242-5335

The AGT-100 project objective is to develop an advanced gas turbine engine capable of demonstrating, by September 1985, the DOE/NASA goals of improved fuel economy, reduced emissions, and alternative fuel capability. This will require the use of ceramic materials for most or all of the hot-section components. Efforts include material characterizations, process development, and component design and test.

Keywords: Ceramics and Glasses, turbine engines, silicon carbide, silicon nitride

3. Advanced Gas Turbine Powertrain Development (AGT-101) $3,747K (81) $3,820K (82)

NASA Contact: R. S. Palmer (216) 433-4000, extension 6653
Garrett/Ford (NASA Subcontract DEN 3-167)
E. E. Strain - (602) 267-2797

The AGT-101 project objective is to develop an advanced gas turbine engine capable of demonstrating, by September 1985, the DOE/NASA goals of improved fuel economy, reduced emissions, and alternative fuel capability. This will require the use of ceramic materials for most or all of the hot-section components. Efforts include material characterizations, process development, and component design and test.

Keywords: Ceramics and Glasses, turbine engines, silicon carbide, silicon nitride

4. Ceramic Durability Evaluation $ 100K (81) $ 120K (82)

NASA Contract: W. A. Sanders (216) 433-4000, extension 6153
Garrett Turbine Engine Company (NASA Subcontract DEN 3-27)
K. W. Benn - (602) 267-4373

The aim of this project is to assess the capability of materials to perform satisfactorily at the temperatures and exposure times required for automotive turbine engines. Commercially available ceramic materials (silicon carbide and silicon nitride) are being evaluated under extended thermal exposures of up to 2500°F for 3500 hours.

Keywords: Ceramics and Glasses, silicon carbide, silicon nitride

5. Ceramic Component Technology $ 266K (81) $ 381K (82)

NASA Contact: T. J. Miller (216) 433-4000, extension 6153

Development and evaluation of advanced techniques for fabricating and evaluating ceramic components are the targets of this project. Ceramic fabrication by hot isostatic pressing (HIP), and non-destructive evaluation (NDE) by techniques such as acoustic microscopy will be investigated.

Keywords: Ceramics and Glasses, HIP, NDE

6. <u>Ceramic Stator Evaluation</u> $0 ($400K obligated in 80)

NASA Contact: G. K. Watson (216) 433-4000, extension 6905
Ford Motor Company (NASA Subcontract DEN 3-19)
E. A. Fisher - (313) 337-5485

The goals of this project are integral-stator fabrication development by four ceramic component suppliers, and property characterization of silicon nitride and silicon carbide. Durability testing of the stators in a simulated engine environment is being conducted to assess the overall potential of these ceramic materials.

Keywords: Ceramics and Glasses, turbine engines, silicon nitride, silicon carbide

7. <u>High-Density Reaction-Bonded Silicon Nitride (RBSN)</u> $0 (Effort Complete)

NASA Contact: S. Dutta (216) 433-4000, Extension 6111
Ford Motor Company (NASA Subcontract DEN 3-20)
E. A. Fisher - (313) 337-5485

Process parameters were developed to optimize silicon powder preparation and nitriding schedules to achieve high density RBSN (> 2.8 g/cm^3) for injection-molded components. Improvements in strength and oxidation resistance were demonstrated.

Keywords: Ceramics and Glasses, silicon nitride, reaction sintering

8. Materials - Adiabatic Diesel $ 0 (81) $ 880K (82)

NASA Contact: H. W. Davison (216) 433-4000, extension 8142

This is a new program. Planned effort includes development and evaluation of high-temperature low-thermal-conductivity materials for adiabatic diesel engines. A variety of materials are being considered, including zirconia, silicon nitride, silicon carbide, and various composites. The particular materials selected will depend upon factors such as component application, component design concept, material cost, and availability.

Keywords: Ceramics and Glasses, zirconia, silicon carbide, silicon nitride, adiabatic diesel engines

9. <u>Material Characterizations - Stirling Simulation Rig Test</u> $160K (81), $140K (82)

NASA Contact: J. A. Misencik (216) 433-4000, extension 6676

Candidate Stirling engine alloys are being subjected to a simulated engine environment to assess the combined effects on material properties of high-pressure hydrogen, high temperature, and combustion products. Both commercial alloys and new experimental alloys will be evaluated, with emphasis on relatively low-cost iron-based alloys.

10. <u>Material Characterizations - High-Temperature Creep Evaluation</u> — $155K (81), $70K (82)

NASA Contact: R. H. Titran (216) 433-4000, extension 398

Creep properites of both commercial alloys and new experimental alloys will be characterized over a temperature range spanning the proposed operating temperatures of the Stirling engine. The effects of long-term (3500 hours) thermal aging at engine operating temperatures while exposed to hydrogen or argon at one atmosphere pressure will be assessed. Subsequent creep-rupture properties will be evaluated to determine mechanical property degradation due to aging, atmosphere, and time.

Keywords: Alloy Development and Alternative Materials, creep rupture, hydrogen embrittlement, material properties.

11. <u>Material Characterizations - Hydrogen Permeability of Alloys</u> — $50K (810, $30K (82)

NASA Contact: S. R. Schuon (216) 433-4000, extension 6826
ITT Research Institute (NASA Subcontract DEN 3-6)
S. Bhattacharyya - (312) 567-4192

Hydrogen permeability data are being obtained at Stirling engine operating temperatures and pressures for both commercial alloys and new experimental alloys, in high-purity hydrogen and in "doped" hydrogen.

Keywords: Alloy Development and Alternative Materials, hydrogen permeability, material properties

12. <u>Material Characterizations - Alloy Properties in High-Pressure Hydrogen</u> — $181K (81), $130K (82)

NASA Contact: R. H. Titran (216) 433-4000, extension 398
ITT Research Institute (NASA Subcontract DEN 3-217)
S. Bhattacharyya - (312) 567-4192

Creep properties of candiate Stirling engine alloys will be measured in high-pressure hydrogen at engine operating temperatures using a specially designed creep test apparatus. The results obtained in hydrogen will be compared to results obtained in air to assess the effects of high-pressure hydrogen on material properties.

Keywords: Alloy Development and Alternative Materials, creep rupture, hydrogen embrittlement, material properties

13. <u>Material Development - Improved Cast Cylinder Alloys</u> $0 ($491K obligated FY 80)

NASA Contact: J. R. Stephens (216) 433-4000, extension 6826
AiResearch Casting Company (NASA Subcontract DEN 3-234)
M. Woulds - (213) 323-9500, extension 6905

The objective of this work is to develop and evaluate castable iron-based alloys for Stirling engine application which will meet performance requirements and reduce both cost and strategic material usage. Modifications to existing commercial or experimental castable alloys will be explored in order to develop materials which will allow heater head operating temperatures as high as 820°C.

Keywords: Alloy Development and Alternative Materials, iron-based alloys, material properties

14. <u>Material Development - Cast Iron Alloy Containing Nonstrategic Elements</u> $151K (81), $175K (82)

NASA Contact: Coulson Scheurmann (216) 433-4000, extension 267
United Technologies Research Center (NASA Subcontract DEN 3-282)
F. D. Lemkey - (203) 727-7318

The objective of this program is to identify a ferrous alloy, for the automotive Stirling enginer cylinder and regenerator housings, which contains only nonstrategic materials. Alloy selection is based on the multi-component Fe-Cr-Mn(Mo)-Al-C(N) system which contains austenitic iron solid solution (8) matrices reinforced by finely dispersed carbide (carbo-nitride) phases.

Keywords: Alloy Development and Alternative Materials, iron-based alloys, material properties

15. <u>Material Development - Evaluation of Improved Alloys</u> $49K (81), $0K (82)

NASA Contact: S. R. Schuon (216) 433,4000, extension 6826

Mechanical properties and hydrogen permeabilities of improved heater tube alloys will be evaluated. The 19-9DL alloy, which is attractive except for permeability properties, is being modified by addition of strong oxide-forming elements such as aluminum. Tensile and creep properties of these modified alloys are being evaluated in-house, while hydrogen permeabilities will be measured under contract. A limited study is also being conducted on modification of low chromium (12 percent Cr) alloys.

Keywords: Alloy Development and Alternative Materials, iron-based alloys, hydrogen permeability, material properties

19. <u>Stepped Stress-Rupture Studies</u> $0K (81), $45K (82)

AMMRC Contact: G. D. Quinn (617) 923-5258

The objective of this program is to perform quick preliminary screening tests on new ceramic materials. The following tests will be employed: (1) room-temperature strength, as measured by flexural modulus of rupture (2) room-temperature fracture toughness, as measured by Vickers indentation (3) stress rupture at 1200^{o} (4) stepped-temperature stress-rupture (STSR) testing. In addition, characterization via chemical analysis, X-ray diffraction metallography and fractography will be used, and creep behavior will be studied via the STSR test. Materials to be tested include: Carborundum's latest sintered alpha silicon carbide, and the latest versions of AiResearch ceramics.

Keywords: Ceramics and Glasses

20. <u>Advanced Transformation-Toughened Ceramics</u> $0 (81), $95K (82)

AMMRC Contact: R. N. Katz (617) 923-5754
University of Michigan
T. Y. Tien - (313) 764-9449

This effort is directed at the characterization of existing and the development of improved transformation-toughened ceramics for abiabatic engine applications. New (non-zirconia) systems offering enhanced strength, toughness, and lower cost potential will be explored, including alumina/chromia matrix, zirconia/hafnia, and precipitate composites. Work on the development of materials will take place via funding of an unsolicited proposal from the University of Michigan.

Keywords: Ceramics and Glasses, adiabatic engines, transformation-toughened ceramics

21. <u>Toughened Ceramics for Advanced Heat Engines</u> $0 (81), $210K (82)

ORNL Contact: A. C. Schaffhauser (615) 624-4826

This program involves the development of ceramics with improved resistance to brittle fracture. The first phase of this work includes exploratory development at Oak Ridge National Laboratory (ORNL) on dispersion-toughened SiC and Al_2O_3 using ductile metal or intermetallic particles, and processing development on Si_3N_4 fiber composites by a qualified subcontractor. Characterization of the structure and toughness of these materials is also included. The second phase will include optimization of processing parameters, dispersion and/or fiber and matrix characteristics, and evaluation of the high-termperature properties after long-term exposure.

Appendix D: Office of Industrial Programs

This office conducts cost-shared R&D on selected energy conservation technologies. The primary foci are processes with wide-ranging industrial applications and processes which are specific to the most energy-intensive industries. Research attempts to develop the technology needed for improving the energy productivity of industrial processes for reducing the amount of waste energy. Funding given below is for FY 1981.

1. Low-Energy Lime and Cement $75K

DOE Contact - Jerome Collins (202) 252-2366
Southwest Research Institute (Contract No. DE-AC03-79C40250)
William Mallow (512) 684-5111, extension 2341

The aim of this project is to develop a low-energy method for the conversion of limestone to lime for use in the manufacture of hydraulic cements. Laboratory process development and feasibility studies are focused on the catalytic decarboxylation of fine-ground limestone to produce a slaked lime slurry. Approximately 3.5 million barrels of oil equivalent are expected to be saved annually if this process is proven effective and reaches its commercial potential.

Keywords: Cements and Conrete, Catalysts, Lime

2. High-Temperature Heat Pump $700K

DOE Contact - John Eustis (202) 252-2084
Westinghouse Electric (Contract No. EC-77-01-5026)

The objective of this project is to develop and demonstrate a reverse Rankine cycle heat pump system that could provide steam at higher delivery temperatures (-320°F) than commercially available heat pumps (-210°F). The project consists of the full-scale design and development of a system to be constructed at a Westinghouse facility in Pennsylvania.

Keywords: Materials Characterizaiton, Alternate Materials

3. Fluid Degradation $49.8K

DOE Contact - John Eustis (202) 252-2084
Sundstrand
R. Gaudet (815) 226-6000

Establishing the volume and location of noncondensible gases and other undesirable compounds in an Organic Rankine Cycle system. Determining the rate of build-up of benzoic acid and iron benzoate. Project is to be completed in FY 1982.

Keywords: Corrosion, Materials Characterization

4. Ceramics for a High-Temperature Heat Exchanger $550K

DOE Contact - James Osborne (202) 252-2084
ORNL
Anthony Schaffhauser (615) 574-4826

Characterizing silicon carbide ceramics for use in high-temperature industrial recuperators. Also, testing effects of fuel impurity on ceramics and metals. In tandem with this effort, high-temperature recuperators will be demonstrated in industrial settings (e.g., aluminum remelting furnace, glass melting furnace).

Keywords: Ceramics, Corrosion, Materials Characterization

Appendix E: Office of Solar Electric Technologies

The overall goal of this office is to accelerate the development and widespread use of solar energy in the production of electricity through performance of R&D on high-risk, high-payoff tehcnologies. The Office contains three divisions: Photovoltaic Energy Technology, Wind Energy Technology, and Ocean Energy Technology.

Photovoltaic Energy Technology Division

This program supports R&D activities whose aim is both to advance the scientific understanding and to establish the technology base needed in order for the private sector to develop and utilize advanced photovoltaic energy systems.

Materials R&D work in the photovoltaics program investigates concepts, materials and structures which will lead to low-cost solar cells, and it seeks both collector and balance-of-system development. Due to space limitations, general categories of research, rather than individual projects, are presented below. Further detail on the material R&D of the Program can be found in the Photovoltaic Energy Systems Program Summary (January, 1982, DOE/CS Dist. Category UC-63).

1. Polycrystalline Thin Film Materials — $2,200K (81), $2,400K (82)

DOE Contact - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Solar Energy Research Institute
Allen Herman (303) 231-1311 (FTS 327-1311)

This project has discovered certain degradation modes present in copper sulphide thin films and will now place primary emphasis on the more stable copper indium diselenide material. Other photovoltaic materials to be explored are: zinc phosphide, cadmium telluride, zine silicon arsenide, indium phosphide, copper selenide and tungsten diselenide. The goal of this effort is to demonstrate the technical feasiblity of at least two polycrystalline thin film materials by the mid 1980's.

Keywords: Coatings and Films, Solar Cells

2. Polycrystalline Silicon Cells — $20K (81), $16K (82)

DOE Contact - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Solar Energy Research Institute
Jack Stone (303) 231-1370 (FTS 327-1730)

This project seeks to obtain large-grain films with photovoltaic array efficiencies greater than 10%; the fabrication of these devices on low-cost substrates is emphasized. Exploratory development activites have been initiated, with a goal of demonstrating technical feasibility in FY 1983.

Keywords: Coatings and Films, Solar Cells

3. <u>Amorphous Thin-Film Materials</u> $2,800K (81), $3,200K (82)

DOE Contract - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Solar Energy Research Instute
Jack Stone (303) 231-1370 (FTS 327-1370)

Advanced hydrogenated amorphous silicon is being studied to obtain an understanding of the fundamentals of the defect-state passivation process which has led to efficiencies greater than 6.5% for solar cells with areas over $1cm^2$. Amorphous materials other than amorphous silicon:hydrogen, such as amorphous silicon carbide, amorphus boron, and amorphous silicon:hydrogen: floruine, are also being investigated.

Keywords: Coatings and Films, Solar Cells

4. <u>Advanced Concentrator Concepts</u> $1,150K (81), $1,250K (82)

DOE Contract - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Solar Energy Research Institute
John Benner (303) 231-1396 (FTS 327-1396)

Study of concepts, such as multi-junction concentrator cells, which offer projected efficiencies approaching 30%, and luminescent converter concentrators.

Keywords: Materials Processing, Solar Cells

5. <u>Electrochemical Photovoltaic Cell</u> $1,150K (81), $1,250K (82)

DOE Contract - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Solar Energy Research Institute
William Wallace (303) 231-1380 (FTS 327-1380)

Centers on fundamental studies of the semiconductor/electrolyte interface and its uses for low-cost, stable, high conversion efficiency devices for in-situ storage. The near-terms goals of this effort are to develop a stable cell conversion efficiency of 10% in FY 1984 using amorphous or poly-crystaline electrodes.

Keywords: Materials Processing, Solar Cells

6. <u>Low-Cost Solar Array</u> $12,000K (81), $11,000K (82)

DOE Contract - Alan Postlethwaite (202) 252-1723 (FTS 252-1723)
Jet Propulsion Lab
Kris Kolliwad (213) 577-5197 (FTS 792-5197)

Flat-plate silicon arrays are being developed. The project addresses all steps in the array production process, including purification of raw polysilicon, growth of silicon sheets, creation of an individual solar cell, encapsulation and high-volume automatic array assembly. Emphasis is placed in improving quality while reducing cost during each phase.

Keywords: Materials Processing, Solar Cells

Wind Energy Technology Division

The R&D work of the wind program emphasizes the attainment of reductions in the cost of energy from WECS (wind energy conversion systems) through testing of blades and other advanced components, as well as the basic study of systems, components, and materials for wind machines.

1. Fiberglass/Resin Composite Material Fatigue $28K (81), $0 (82)

DOE Contact - Peter Goldman (202) 252-1776 (FTS 252-1776)
IIT Research Institute (Contract No. DEN 3182)
NASA Project Manager: R. Lark (216) 433-5103 (FTS 252-5103)

The objective of this research was to characterize and compare the static and ultra-high cyclic fatigue properties of fiberglass/polyester resin composite laminates and fiberglass/epoxy resin composite laminates. Fiberglass/polyester resin composites offer the potential for improving wind turbine rotor blade fabrication processes when compared to processes using fiberglass/epoxy materials. Laminates of fiberglass/epoxy and fiberglass/epoxy and fiberglass/polyester resin were fabricated and subjected to static and ultra-high (approaching 4×10^8) cyclic fatigue tests. As a result, a data base characterizing design allowable stress levels as a function of the number of anticipated bending cycles for these materials was developed. The final report of this research project is complete and should be published in June 1982.

Keywords: Materials Characterization

2. Corrosion Resistant Steel Spot Welded Joint Fatigue Life Characterization for Wind Turbine Rotor Blades $20K (81), $16K (82)

DOE Contact - Peter Goldman (202) 252-1776 (FTS 252-1776)
Budd Company
NASA Project Manager - R. Lark (216) 433-5103 (FTS 294-5103)

The objective of this research is to characterize the static and ultra-high (4×10^8) cyclic fatigue properties of stainless steel type 301 spot welded sheet joints. Corrosion resistant materials offer the potential for long life, and low maintenance wind turbine rotor blade performance, in salt air environments. A variety of spot welded joints were fabricated utilizing laminated spot welded construction. A report on this research will be published in FY 1982. Fatigue testing of the blade spar was initiated in May 1982 and will be completed in FY 1982.

Keywords: Materials Characterization

3. Wood Composite Material Fatigue $0 (81), $75K (82)

DOE Contact - Peter Goldman (202) 252-1776 (FTS 252-1776)
University of Dayton Research Institute (Contract No. DEN 3-286)
NASA Project Manager - R. Lark (216) 433-5103 (FTS 294-5103)

The objective of this research is to characterize the static and fatigue properties of laminated wood composite materials with applications to more efficient structure design of rotor blades. Laminated wood composite test specimens have been fabricated and will be subjected to ultra-high (approaching 4×10^8) cyclic fatigue loads. Completion of tests is planned in early FY 1983 and test results will be reported in late FY 1983.

Keywords: Materials Characterization

Appendix F: Office of Renewable Technology

The Office of Renewable Technology consists of three divisions: the Geothermal and Hydropower Division, the Energy From Municipal Waste Division, and the Biomass Energy Technology Division. In FY 1981, only the first two divisions conducted materials R&D programs; accordingly the Biomass Energy Technology Division is not discussed below. Funding is given for FY 1981.

Geothermal and Hydropower Division

This division support high-risk, high-payoff R&D aimed at developing the basic technology needed for the private sector to more fully utilize geothermal energy resources for both electric power generation and direct heat applications. Materials R&D is being conducted within six subprograms: Geothermal Materials, Geochemical Engineering, Hot Dry Rock, Drilling and Completion, Geothermal Logging Instrumentation, and the Raft River 5 MWe Binary Plant.

(A) Geothermal Matrials

The Geothermal Materials Program is coordinated by the Brookhaven National Laboratory; Brookhaven Contact Larry Kukacka (516) 282-2123.
DOE Contact - Leon Lehr (202) 252-8076

1. Development of Geothermal Well Completion Systems $7K

Dowell Division of Dow Chemical (Contract No. DE-AC02-77ET283324)
E. Nelson (918) 250-4271

Develop and evaluate a suitable geothermal well cementing material through stability, placement, and chemical measurements.

Keywords: Cements and Concrete, Eleastomers and Polymers

2. Alternate Materials of Construction $300K

Brookhaven (Contract No. DE-AC02-76CH00016)
L. Kukacka (516) 282-2123

Evaluating and developing alternate materials of construction. The work includes determination of engineering design requirements, testing of prototype equipment, economic evaluations, and plant demonstrations. Program makes use of subcontracts and industrial participation.

Keywords: Alternate Materials, Elastomers and Polymers

3. Cementing of Geothermal Wells $50K

Brookhaven (Contract No. DE-AC02-76CH00016)
L. Kukacka (516) 282-2123

Developing improved cements which are specifically designed for geothermal well applications. The task includes preparation of a technical plan, testing and practical demonstration of new cements, and transfer of the technology to the private sector.

Keywords: Cements and Concrete, Materials Characterization

4. Pitting-Resistant Alloys $250K

Brookhaven (Contract No. DE-AC02-76H00016)
D. Van Rooyen (516) 282-4050

Developing metallic alloys and steels that possess improved properties and are cost-effective. The project makes use of subcontracts with industry, laboratories, and universities.

Keywords: Alloy Development

5. Materials Needs for the Utilization of Geothermal Energy $50K

National Academy of Sciences, National Material Advisory Board (Brookhaven Subcontract No. 494818)
D. Groves (202) 389-6526

Identified materials problems that limit the design and operation of cost-effective geothermal energy systems, and recommended appropriate actions. The final report was issued in March, 1981.

Keywords: Materials Characterization

6. Economic Impact of Using Non-Metallic Materials $55K

National Water Well Association (Brookhaven Subcontract No. 485874)
T. Gass (614) 846-9355

Evaluating the potential economic impact of the use of plastic materials in low-temperature (150^{o}C) geothermal well construction. Data from the project are currently being compiled.

Keywords: Elastomers and Polymers

7. <u>Elastomer Materials Technology Transfer</u> $100K

L'Grade, Inc. (Brookhaven Subcontract No. 490316)
A. Hirasuna (714) 645-4880

Transferring to industry the elastomer technology developed under an earlier contact, and continuing the developing of high-temperature sealing materials.

Keywords: Elastomers and Polymers, Seals and Bearings

8. <u>New Fluorocarbon Elastomers for Seals</u> $155K

Exfluor Research (Brookhaven Subcontract No. 486106)
E. Dumitru (512) 454-3812, or (512) 471-5679

Attempting to increase the operating capabilities of elastomers in geothermal environment to 300°C by cross-linking and subsequent fluorination of elastomeric materials.

Keywords: Elastomers and Polymers, Seals and Bearings

9. <u>Design and Fabrication of Polymer Concrete Pipe</u> $20K

Lindsey Industries (Brookhaven Subcontract No. 486337)
J. Schroeder (213) 969-3471

Designing and fabricating a full-scale section of polymer concrete pipe and investigating appropriate joining methods for direct utilization of geothermal processes.

Keywords: Cements and Concrete

10. <u>Improved Drill Bit Material</u> $70K

Terra Tek (Brookhaven Subcontract No. 492267)
R. Hendrikson (801) 582-2220

Attempting to ensure longer life of drill bits and reamers through optimization of alloys and heat treatment of candidate alloys. Liaison is being maintained with interested bit manufacturers.

Keywords: Alloy Development, Materials Characterization

11. <u>Pump Bearing Materials Development</u> $50K

Solar Turbines International (Brookhaven Subcontract No. 490656)
D. Huey (714) 238-5609

Developing durable materials that will resist wear and deterioration when used as bearings in pumps. The goal is to improve pump lifetimes and to increase the efficiency of heat extraction from geothermal wells.

Keywords: Seals and Bearings, Erosion and Wear

12. <u>Well Casing Materials</u> $80K

Lawrence Livermore National Lab (Contract No. W-7405-Eng-480
R. D. McCright, W. P. Frey, R. Kuan (415) 422-7051

Evaluating the corrosion performance of carbon and alloy steel (up to 9 Cr-1 Mo) tubing string materials exposed for six months in a producing well at the Salton Sea geothermal field. Some API steels were heat treated. All materials were exposed to brine in the well at three different depths.

Keywords: Alloy Development, Alternate Materials, Corrosion, Materials Processing

13. <u>Shape Memory Alloy Seals</u> $100K

Rockwell International (Brookhaven Subcontract No. 509927)
W. Firske (213) 341-1000

Developing durable high-temperature metallic seals for downhole pump applications. The sealing technique utilizes the unique properties of nickel-titanium (Nitinol) "memory alloy" to provide the seals.

Keywords: Alloy Development, Seals and Bearings

14. <u>Hydrogen Embrittlement and Localized Corrosion of Steels</u> $115K

Case Western Reserve U. (Brookhaven Subcontract No. 510034)
A. Troiano (216) 368-4234

Using the NACE tensile test to evaluate in a sour environment a series of new alloys now being developed and prepared for service in geothermal downhole applications.

Keywords: Alloy Development, Corrosion

15. Cathodic Protection of Well Casings $2K

San Diego State U.
Brookhaven Contact: Larry Kukacka (516) 282-2123

This project, started in FY 1981, is determining the feasibility of use of cathodic protection for high-temperture applications of well casings and above-ground components. The first phase is to be completed in FY 1982.

Keywords: Corrosion

16. Geothermal Materials Compatibility and Failure Analysis $17K

Radian Corporation
P. Ellis (512) 454-4797

Providing corrosion engineering support services and component failure analysis. Also, preparing geothermal well materials reference book.

Keywords: Corrosion

(B) Geochemical Engineering

The Geochemical Engineering Program is coordinated by the Battelle Pacific Northwest Laboratory; PNL Contact - Donald Shannon (509) 376-3139. DOE Contact: Leon Lehr (202) 252-8076.

1. Sampling and Analysis of Geothermal Fluids $100K

Pacific Northwest Lab
C. H. Kindle (509) 376-5904

Developing standardized, accurate fluid and gas sampling/analysis methods through industry/government/university cooperative efforts. Standardization and acceptance is being accomplished through the American Society for Testing and Materials. Isobutane sampling is being emphasized.

Keywords: Corrosion

2. High-Temperature Chemical Sensors for Geothermal Fluids $630K

Leeds and Northrup, U. of Pennsylvania, Owens Illinois, General Electric, Pacific Northwest Lab
George Jenson (5090 376-9124

Developing electrical and electrochemical probes that can measure the chemical environment of geothermal water and steam under the high-pressure, high-temperatuere conditions of a geothermal well and associated piping. Such data will permit the prediction and control of corrosion, scaling, and pollution in geothermal systems. Subprojects are: high-temperature glass pH electrode development, geothermal CO_2 sensor, chemically sensitive semiconductor devices, zirconia-based pH electrode development, redox electrode development, and improved corrosion ratemeter.

Keywords: Corrosion, Semiconductors

3. <u>Binary Cycles Fluid Case Study</u> $155K

Pacific Northwest Lab
Donald Shannon (509) 376-3139

Developing and demonstrating to industry advanced methods for monitoring geothermal power plants. Methods are being tested in the Magma Electric Company's 10MWe cycle plant. Technical assistance is also being provided for materials and chemical monitoring of the Heber Geothermal Binary 15 MWe Demonstration Plant. In addition, corrosion samples and NDE of heat exchanger are included in this effort. Total funding for this study (including non-materials research) is $460K.

Keywords: Corrosion,NDE

(C) Hot Dry Rock

The Hot Dry Rock (HDR) Energy Extraction Demonstration Program is coordinated by Los Alamos National Lab; LANL Contact - John Rowley (505) 667-1378. DOE Contact: A. Jelacic (202) 252-8020.

The objective of this effort is to determine the technical and economic feasibility of hot dry rock concepts. A major element of the program is the Phase II Energy Extraction System at the Fenton Hill Test Site, which consists of two well bores drilled to a maximum depth of 15,000 feet and connected by a series of hydraulic-induced fracture.

1. <u>Cablehead</u> $10K

LASL In-House Project
Bert Dennis (505) 667-5697

Developing cablehead for borehole logging and fracture mapping for the Phase II System at the Fenton Hill site. Bottom-hole temperature in the EE-2 wellbore is 317°C. Cablehead is designed for field assembly and for durability in the geothermal environment. It has been deployed in the borehead for temperature and caliper logs with no failures to date.

Keywords: Elastomers and Polymers, Adhesives and Lubricants

2. <u>High-Temperature Armor Cable</u> $50K

Southwest Research Institute (LASL Subcontract No. 4-L40-4069M-1)
Roy S. Marlow (512) 684-5111

Testing samples of high-temperature well logging around instrument cable for use in geothermal boreholds. Also testing electrical integrity of insulation materials and cable performance at 275°C and 8,000 psi fluid pressure. Electrical insulation materials primarily being used are PFA and TFE teflon.

Keywords: Elastomers and Polymers, Materials Characterization

1. Metal-Sheathed Logging Cable Development $175K

Halpen Engineering (Scandia Contract No. 13-5163)
A. Halpenny (716) 855-0116

Commercial development of a metal-sheathed, mineral-insulated, single-conductor, electrochemical logging cable for continuous operation in geothermal wells at temperatures of up to 350°C.

Keywords: Materials Processing, Logging Cables

2. Diamond Compact Wear Mechanisms $100K

General Electric (Sandia Contract No. 13-9406)
L. E. Hibbs, Jr. (518) 385-8330

The objective of this project is to provide technical support in regard to the effects of drilling fluids on the required cutting force, wear mechanisms, and wear rates of polycrystalline diamond compacts.

Keywords: Erosion and Wear, Ceramics, Materials Characterization

3. Geothermal Drill Bit Seals and Lubricant Development $120K

Terra Tek (Sandia Contract No. 46-3053)
J. Finger (505) 844-8089

This project seeks to develop a 200-hour life bearing and seal package adaptable to most types of downhole motors that operate at a 121°C (250°FO) circulation temperture.

Keywords: Seals and Bearings, Adhesives and Lubricants

4. Chemical and Elevated Temperature Effects on Clay-Based Drilling Fluids $100K

Texas Tech U.
M. Guven (806) 742-3110

This project seeks to develop a fundamental understanding of clay particle morphology under the influence of both various chemical species and elevated temperatures similar to the conditions encountered during geothermal drilling activities.

Keywords: Adhesives and Lubricants

5. High Temperature Elastomers $100K

Sandia Project
C. Arnold (505) 844-8728

Investigating Elastomeric materials and material design considerations for high-temperature elastomers. Such elastomers are needed in both geothermal drilling system bearings and seals and in downhole tools used in geothermal drilling and completions and borehold logging.

Keywords: Elastomers and Polymers

6. Investigation of Inert Geothermal Drilling Fluids/Gases $300K

Sandia Project
B. C. Caskey (505) 844-8835

Experimentally evaluating the field performance of alternate drilling fluids and gases, such as nitrogen. The aim is to inhibit the chemical corrosion of geothermal drill pipe while minimizing erosion and wear on the drilling components.

Keywords: Corrosion, Erosion and Wear

7. Drillstem Corrosion Testing $150K

Sandia Project
R. J. Salzbrenner (505) 844-5041

Investigating the effects of corrosion fatigue and stress corrosion cracking on candidate geothermal drillstem materials.

Keywords: Corrosion, Erosion and Wear, Materials Characterization

8. High-Temperature Particulate Plugging Agents $300K

Sandia Project
J. Kelsey (505) 844-6968

Developing materials to help improve circulation in geothermal wells. Research centered on high-temperature particulate agents for plugging large fractures.

Keywords: Materials Characterization

9. Carbide Development $80K

SRI, International
Sandia Contact: J. Finger (505) 84408089

Developing non-stoichiometric carbides to increase both the toughness and hardness of materials used where abrasions can occur. Investigation is focused on the study of tantalum carbides and niobium carbides.

Keywords: Ceramics

10. <u>Aqueous Foams</u>

Sandia Project
Chuck Carson (505) 844-6477

Developing aqueous foam for use as a geothermal drilling fluid. Evaluating properties at high temperatures in the presence of geothermal brines.

Keywords: Materials Characterizations

(E) Geothermal Logging Instrumentation

The Geothermal Logging Instrumentation Materials Support Program is coordinated by the Sandia National Lab; Sandia Contact James Kelsey (505) 844-6968.
DOE Contact: Ray La Sala (202) 252-8077

1. <u>High-Temperature Thick Film Development</u> $ 60K

Purdue U. (Sandia Subcontract No. 42-5815)
R. W. West (317) 749-6244

Developing a family of ceramic thick film materials (conductive, resistive, dielectric, and semiconductive) which retain useful electrical and mechanical characteristics for both extended periods (10^5 hours) at 300°C and short periods (1,000 hours) at 500°C.

Keywords: Coatings and Films, Ceramics, Semiconductors, Glasses

2. <u>Gallium Phosphide Semiconductor Fabrication</u> $200K

Sandi Project
T. Zipperian (595) 844-6407

Developing a materials processing technique and electric contacts for gallium phosphide semiconductors that must operate at 275°C for at least 1,000 hours.

Keywords: Materials Processing, Coatings and Films, Semiconductors

3. <u>High-Temperature Gallium Phosphide and Gallium Arsenide Seminconductors</u> $50K

Texas A&M U. (Sandi Subcontract No. 42-7271)
O. Eknoyan (713) 845-7030

Investigating metallization, passivation and doping techniques to establish a technological basis for the fabrication of high-temperature (GaP, GaAs) diodes, controlled rectifiers, and the eventual design of transistors.

Keywords: Coatings and Films, Materials Processing, Semiconductors

4. High Temperature Magnetic Materials Reserach $ 30K

Texas A&M U. (Sandia Subcontract No. 42-5820)
R. K. Pandey (713) 845-7030

Measuring magnetic properties of commercially available soft and hard materials at temperatures ranging from 20°V yo 400°C.

5. Amorphous Metallization for Semiconductor Circuits $ 40K

U. of Wisconsin (Sandia Subcontract No. 49-1664)
J. D. Wiley (608) 262-3736

Investigating the related phenomena of diffusion and electromigration in amorphous metals. Obtaining experimental data needed to assess feasiblity of using amorphous metal films for metallization on high-temperature semiconductor integrated circuits in order to improve reliability.

Keywords: Coatings and Films, Semiconductors, Materials Characterization

(F) Raft River 5 W Binary Plant $100K

DOE Contact - Denis Feck (202) 252-5778
EG&G, Idaho
Judd Whitbeck (208) 526-1879

Providing corrosion and scale inhibitor support for the Raft River Project.

Keywords: Corrosion

Energy from Municipal Waste Division

This division conducts long-range, generic research on processes and systems that use municipal wastes. Its aim is to develop the technological base for enhancing energy recovery, particularly in key municipal applications, such as water and wastewater treatment facilities.

1. Material Corrosion in Municipal Waste-to-Energy Incinerator Systems $100K

DOE Contact - Donald Walter (202) 252-6104
NBS - Chemical Thermodynamics Division (Contract No. 20528)
Joseph Berke (301) 921-2343

Examining corrosion problems at several municipal waste burning sites. The aim is to determine the possibility of developing a short-term test for the corrosive property of candidate materials in the harsh environment of municipal waste energy recovery systems.

Keywords: Erosion and Wear

Appendix G: Office of Solar Heat Technologies

The Office of Solare Heat Technologies conducts R&D aimed at providing a technological base from which low-cost, reliable solar energy source systems can be generated. The Office contains three divisions: Active Heating and Cooling, Passive and Hybrid Solar Energy, and Solar Thermal Technology. Funding is given for FY 1981.

Active Heating and Cooling Division

This program funds F&D projects with industry and academic institutions directed towards the development of cost-effective, reliable and publicly acceptable active solar heating and cooling systems. A major emphasis of the program is to ensure that the information derived from these projects is made available to all of the members of the solar community who will benefit from it.

1. Development of Selective Surfaces — $ 25K

DOE Contact - Carl Conner (202) 252-8156
The Berry Group (DOE Contract No. DE-AS04-78CS34293)
John Cotsworth (291) 549-3800

Developing improved techniques for producing selective surfaces on stainless steel, aluminum, and copper. Testing several of these surfaces under conditions of ultraviolet radiation, heat and humidity and investigating the feasibility of large-scale production of the selective surfaces.

Keywords: Coatings and Films, Materials Processing, Materials Characterization, Radiation Effects

2. Selective Paint Scale-Up Development — $127K

DOE Contact - Carl Conner (202) 252-8156
Honeywell, Avionics Division (DOE Contract No. DE-AC04-78CS14287)
Paul Zimmer (615) 378-5718

Investigating various manufacturing techniques for the large-scale production of a low-cost, durable, thickness-sensitive selective paint coating for flat-plate solar collector panels. Also, optimizing the optical properties of the thickness-insensitive selective paint coating.

Keywords: Coatings and Films, Materials Processing, Materials Characterization

3. <u>Evaluation of Selective Solar Absorber Surfaces</u> $ 40K

DOE Contact - Carl Conner (202) 252-8156
Lockheed - Palo Alto Research Lab (DOE Contract No. DE-ACo4-78CS15361)
Stanley Greenberg (415) 493-4411

Phase I consisted of the sampling and limited environmental exposure of a large number of slective absorber surface finishes. In Phase II, degraded (environmentally exposed) and non-degraded finishes are being analyzed in an effort to determine the degradation mechanisms operative in the coating.

Keywords: Coatings and Films, Erosion and Wear

4. <u>Corrosion Resistance of Metallic Solar Absorber Materials</u> $100K

DOE Contact - Carl Conner (202) 252-8156
Olin-Metals (DOE Contract No. DE-AC04-81?AL16222)
Edward Smith (203) 789-5293

Generating long-term corrosion data applicable specifically to solar collectors. Testing commercially-available heat transfer liquids with a variety of alloys currently used in solar absorbers. Establishing the susceptibility of these metals to various forms of corrosive attack in each of the liquids. Establishing a correlation between laboratory corrosion data and the corrosive attack found in actual solar collectors.

Keywords: Corrosion

5. <u>Reliability and Maintainability Program</u> $740K

DOE Contact - Carl Conner (202) 252-8156
SERI (Contract No. EG-77-C-01-4042)
Tom Hafferty (3030 231-1000

Providing the latest information from R&D to groups with reliability and maintainability (R&M) concerns. Assisting in the design, manufacture, installation, and maintenance of reliable and durable systems. As part of this work, develping a laboratory method for analyzing R&M data, performing fluid corrosion and atmospheric corrosion research, determining the characteristics of typical solar collector parameters during system failure, and developing a corrosion sensor for collector systems.

Keywords: Corrosion, Materials Characterization

6. <u>Solar Collector Studies for Solar Heating and Cooling Applications</u> $ 41K

DOE Contact - Carl Conner (202) 252-8156
Springborn Labs (DOE Contract No. DE-AC04-78CS35359)
Bernard Baum (203) 749-8371

Evaluating weather-resistant, low-cost glazing and housing materials that will have a lifetime of up to twenty (20) years under varying stress and high (300°F) temperature conditions. Screening surface etching processes and anti-reflective coatings to reduce reflection losses and increase transmission of plastic glazing. Developing coatings and fils for UV protection of plastics.

Keywords: Coatings and Films, Radiation Effects

7. <u>Develpment of Selective Surfaces</u> $ 90K

DOE Contact - Carl Conner (202) 252-8156
Telic Corp. (DOE Contract No. DE-AC04-80AL13116)
John Thorton (213) 828-7449

Developing the materials and technology needed for producing inexpensive and durable solar selective coatings in a continuous or semicontinuous mode on plates or metal strips. Planar magnetron sputtering is the process being used. An important task of this project is the preparation of continuously-coated strips which are to be provided to interested manufacturers for the fabrication of collectors, and to be tested in the field by firms working in the solar industry.

Keywords: Coatings and Films, Materials Processing

8. <u>Improved Solar Collector Sealants</u> $141K

DOE Contact - Carl Conner (202) 252-8156
Westinghouse (DOE Contract No. DE-AC04-78CS15362)
Morris Mendelsohn (412) 256-3397

Studying the properties of several possible solar collector sealants, and choosing the best candidates. Studying the effects of breathing in flate-plate thermal collectors. Improving the long-term performance of the best candidates by chemical modifications and by reformulation.

Keywords: Seals and Bearings, Materials Characterization, Elastomers and Polymers

Passive and Hybrid Solar Energy Division

This program has two principal thrust: (1) development of new materials, products and systems for buildings and community systems; and (2) transfer of technology developed within the program to the builing industry. Within the Division, the Pasive Solar Materials & Components Program funds R&D and testing of commong and advanced materials, components and assemblies that can improve the performance, reduce the cost, or simplify the design of passive solar heating, cooling, and daylighting systems. Much of this effort consists of financial support of prototype systems presently being developed by industry.

1. Phase-Change Storage/Insullation — $29K

DOE Contact- David Pellish (202) 252-8110
HITEK, Inc. (DOE Contract No. DE-FC02-80CS30523)
Mrs. Charles Bliege (503) 367-6005

Developing a passive thermal batery module which uses phase change maerials and whose module size is being optimized for installation, shipping and handling.

Keywords: Transformations

2. Water Storage — $17K

DOE Contact- David Pellish (202) 252-8110
Solar Concept Development Co. (DOE Contract No. DE-FC02-80CS30529)
Richard Bourne (916) 753-1100

Developing a passive waterwall unit for use in new construction. The unit contains a water storage module, acrylic or polycarbonate glazing, night insulation, an insulation controller, and a window actuator.

Keywords: Coatings and Films

3. Interior Window Insullation — $59K

DOE Contact- David Pellish (202) 252-8110
Solar Systems Deisgn Inc. (DOE Contract No. DE-FC02-80CS30531)
Robert Mitchell (518) 767-3100

Developing a lightweight, movable interior thermal window shutter. Contains a honeycomb insulating core with external shin to withstand impact and abrasion.

Keywords: Alternate Materials

4. Multi-Layer Insulation — $78K

DOE Contact- David Pellish (202) 252-8110
Star Technology Corp. (DOE Contract No. DE-FC02-80CS30532)
Doug Davis (303) 963-1969

Developing an insulating curtain system which utilizes multiple layers of fabric including reflective layers for insulation enhancement.

Keywords: Alternate Materials

Solar Thermal Technology Division

The objective of this program is to establish the technical feasiblity and cost readiness of mid- and high-temperature solar concentrating systems. Research is focused upon three classes of systems: (1) linear-focusing distributed receivers (parabolic troughs and hemispherical bowls), (2) point-focusing distributed receivers (parabolic dishes), and (3) central receiver systems.

1. Graded Cermet Selective Absorbers $107K

DOE Contact- Frank (Tex) Wilkins (202) 252-1684
Telic Corporation (SERI Subcontract No. XH-9-8260-A)
John Thornton (201) 828-7449

Graded composition platinum/alumina cermets have demonstrated as high-performance selective absorbers. By modifying the graded compostion, Telic has produced a cermet of equally high performance at a savings of 70% of the precious metal. Current research is attempting to establish commerical process feasiblility.

Keywords: Materials Processing, Alloy Development, Alternate Materials

2. Natural Weathering Exposure $25K

DOE Contact- Frank (Tex) Wilkins (202) 252-1684
DSET (SERI Subcontract No. XJ-9-8215)
Tom Anderson (602) 456-7356

Conducting tests on the effect of natural weathering exposure on reflectors, glazings and absorbers. Included are commercially-produced materials foric baseline data, and laboratory materials which are the result of R&D efforts. Exposure include 45°south-facing racks and EMMAQUA (equatorial-mounted, mirror-augmented, water sprayed) 8X concentrators.

Keywords: Erosion and Wear.

3. Kinetic Corrosion Mechanisms $25K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
University of Utah (SERI Subcontract No. XP-0-8046-1)
Charles H. Pitts (801) 581-5157

Determination of a parametric model describing passivation and corrosion kinetics of a typical austenitic, Type-316 stainless steel, and a typical ferritic steel (Fe-9 Cr-1Mo) is the primary task of this contract. This model includes the effects of cyclic temperatures and variable electrolyte composition, and will allow prediction of corrosion rates.

Keywords: Corrosion

4. Polymer Metalization $90K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
SRI International (SERI Subcontract No. XP-9-8127-1)
Sharon Brauman (415) 859-2737

Investigating the interactions between polymeers and metallized reflective films. Metallizaton is by electrolytic deposition. Environmental stress includes increased tempearture, humidity and cyclic thermal conditions. Testing includes optical and mechanical examination.

Keywords: Elastomers and Polymers, Materials Characterization, Materials Processing

5. Polymer Protective Laminates $68K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
Springborn Laboratories (DOE Subcontract No. DE-AC01-79)
Bernard Baum 749-8371

Polymers typically are deficient in one or more optical/physical properties. By lamination of polymers, a composite material with higher performance can be prepared. This contract is investigating laminated composites for use as reflectors or transmitters.

Keywords: Elastomers and Polymers, Materials Characterization

6. Mirror Environmental Stress Matrix $190K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
SERI, Battele Pacific Northwest labs, Sandia National Labs - Livermore, Jet Propulsion Labs, Sandia National Labs - Albuquerque
Pat Call (303) 231-1931

A testing matrix has been devised to compare mirrors developed in various laboratories to those commercailly available. Detailed characterization will allow insight into the degradation processes. In addition, developing alternate mirrors using such metal backings as aluminum, tantalum, titanium, nickel and chromium.

Keywords: Materials Characterization, Erosion and Wear, Alloy Development

7. Molten Salt Corrosion $520K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
Sandia National Labs - Livermore
Dan Dawson (415) 422-2953

Molten nitrate salts are a prime candidate for heat transfer and storage media for central receiver systems. Present research is attempting to qualify Incoloy 800 for this purpose. Slow strain rate, isothermal fatigue, and inducing cyclic thermal strains are among the experimental testing techniques.

Keywords: Corrosion

8. Silver/Glass Mirror Degradation $200K

DOE Contact - Frank (Tex) Wilkins (202) 252-1684
Sandia National Labs - Livermore
John Vitko (415) 422-2820

This cotract is investigating mechanisms of silver/glass reflector degradation. Identification of the aggressive species and modification of mirror consturction are being pursued in order to minimize reflected energy loss from the element.

Keywords: Erosion and Wear

Appendix H: Office of Alcohol Fuels

This office is sponsoring R&D aimed at providing the technology base needed for production of economically-competitive alcohol fuels. The current focus of the program is on long-term improvements in process technologies for the production of alcohol from wood, for cellulose fermentation processes, and for multifuel and hybrid engines. Funding is given for FY 1981

1. Membrane Development for Low-Energy Separations — $ 325K

DOE Contact - Richard Moorer (202) 252-1277
SERI
Paul Schissel (303) 231-1000

Studying the mechanisms of membrane fouling and degradation, and development of new membrane systems specifically tailored for use in alcohol production.

Keywords: Elastomers and Polymers

2. Removal of Alcohol by Selective Absorption — $ 35K

DOE Contact - Richard Moorer (202) 252-1277
Whittaker Corp., Shock Hydrodynamics Division (Contract No. B-9189-4)
Emil Lawton (213) 985-6940

Developing an imbibitive polymer which will efficiently remove alcohol from water by absorption.

Keywords: Elastomers and Polymers

3. Development of Ethanol-Selective Membranes — $ 50K

DOE Contact - Richard Moorer (202) 252-1277
Southern Research Institute (Contract No. B-9189-3)
Robert Lacey (205) 323-6592

Developing ethanol-selective membranes that combine high selectivities for ethanol over water with low resistances to the transfer of the permeating species, ethanol or water. The approach involved the formation of a thin ethanol-selective layer on the surface of a low-resistance substrate either by a method involving direct chemical treatment of the low-resistance substrates or by a method involving ultrafiltration of ethanol-selective polymers in and onto substrates, followed by cross-linking to effect firm attachment.

Keywords: Elastomers and Polymers, Coatings and Films

Appendix I: Office of Military Application

The Office of Military Application, under the Assistant Secretary for Defense Programs, directs the research and development, testing, and production of nuclear weapons. Weapon research and development is conducted primarily at the Department of Energy's three nuclear weapon laboratories: Lawrence Livermore National Laboratory (LLNL), Livermore, California; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Sandia National Laboratories at Albuquerque, New Mexico (SNLA) and Livermore, California (SNLL). Weapons production is conducted at seven government-owned, contractor operated plants.

The objectives of the materials research sponsored by the program are to develop materials and materials technology for national security uses. The research is directed toward basic material science, the understanding and development of advanced materials and fabrication technology, and the development of materials and processes required to produce nuclear and non-nuclear parts.

Materials and process development activities emphasize the balance between research and development necessary to provide materials compatible with the extreme environments and performance requirements associated with nuclear ordnance. Detailed knowledge of materials and their behavior often provides the only way to eliminate problems associated with their use and achieves the objectives of functionability, reliability, and longevity. The ability to investigate, characterize, recognize, and develop materials has enabled the weapons program to meet development scheduled for warheads that have remained in the Nation's stockpile with minimum maintenance, maximum safety, and high reliability.

		FY 1981	FY-1982
Lawrence Livermore National Laboratory			
1.	Dynamic Compaction of AlN	$ 200K	$ 450K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
William H. Gourdin (415) 422-8093; FTS 532-8093

Investigating methods of producing ceramic objects by explosive compaction of aluminum nitride powders as an alternative to fabrication by conventional sintering. The HE compacted samples are characterized by TEM and SEM in situ to provide input for 2-d hydrocode simulations of the HE compaction process.

Keywords: Ceramics, Alternate Materials, Materials Processing

		FY 1981	FY-1982
2.	Weld Modeling	$ 25K	$ 350K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
Kim W. Mahin, M. Kassner, D. Duncan (415) 423-0740; FTS 533-0740

A study to improve our understanding and prediction of residual stress and distortion by characterizing the structure/property changes occurring in a material during fusion welding, translating this information into a mathematical model, then using the model to upgrade existent computer programs.

Keywords: Joining Development, Modeling

		FY 1981	FY-1982
3.	Liquid Pu Corrosion of Refractories	$ 150K	$ 150K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
William W. Hrubesh (415) 423-1691; FTS 533-1691

A study of the relative corrosion resistance of W, Ta, Nb, V, Mo, and Ti to attack by molten plutonium in the temperature range of 800°-1200°C.

Keywords: Corrosion, Materials Characterization

		FY 1981	FY-1982
4.	Structure-Property Relations of Polymers and Composites	$ 200K	$ 450K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
Jay K. Lepper (415) 422-6372; FTS 532-6372

A study to be able to predict durabilities of Kevlar-epoxy and graphite-epoxy composites from a basic understanding of the structure, failure process, and mechanical property relations of the Kevlar fibers and epoxy glasses. The critical structural properties relations of Kevlar have been reported and the chemical degradation of this structure (aging) is being investigated.

Keywords: Polymers, Materials Processing, Alternate Meterials, Composites, Kevlar, Graphite, Epoxy

5.	Directed Energy Surface Modification	$ 0K	$ 400K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
Elton N. Kaufmann; R. G. Musket (415) 423-2640; FTS 533-2640

The utility of surface treatments employing laser, electron beam and ion beam irradiation, either separately or in combination, is being studied for improved materials compatibility in the areas of high temperature oxidation, liquid metal corrosion, and hydrogen interactions. Various surface sensitive analysis techniques will help determine the efficacy of this processing alternative.

Keywords: Ion Implantation, Laser Surface Treatment, e-Beam Surface Treatment

6.	Liquid Pu Corrosion of Refractories	$ 150K	$ 150K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Lawrence Livermore National Laboratory (Contract No. W-7405-Eng-48)
Dave H. Wood/R. Logan (415) 422-7169; FTS 532-7169

This is a general study in two areas: (1) to understand the synergistic effects of texture and fracture direction on the fracture transition curves of U and (2) to elucidate the mechanism(s) of elevated temperature creep behavior of U as influenced by chemical impurities and thermomechanical processing.

Keywords: Uranium Texture, Elevated Temperature Creep Properties.

	FY 1981	FY-1982
Sandia National Laboratories-Livermore		
7. Hydrogen Compatibility of Materials	$1200K	$1200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Livermore (Contract No. DE-AC04-76DP00789)
David M. Schuster (415) 422-2166; FTS 532-2166

This is an interdisciplinary study to: (1) identify and understand the mechanisms of hydrogen embrittlement; (2) characterize the hydrogen compatibility of several austenitic stainless steels; (3) develop techniques to produce structures for hydrogen service, i.e., barrier technology and near net-shape processing.

Keywords: Hydrogen Effects on Materials, Hydrogen Embrittlement, Hydrogen Permeation, Net-Shape Processing.

8. Electrochemical Fabrication	$ 250K	$ 250K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Livermore (Contract No. DE-AC04-76DP00789)
David M. Schuster (415) 422-2166; FTS 532-2166

Electrodeposition from aqueous solutions of Au, Cu, and Ni is being studied with a focus on the relationship between critical process variables and the mechanical and physical properties of the deposit. Another activity is the development and implementation of a high-speed electrodeposition process which would preserve the properties of coatings deposited at lower rates.

Keywords: Coatings and Films, Materials Processing, Electrodeposition, Gold Copper, Nickel

9. Interdisciplinary Study of Weldments (WELDWOG)	$ 500K	$ 500K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Livermore (Contract No. DE-AC04-76DP00789)
David M. Schuster (415) 422-2166; FTS 532-2166

Welds consist of modified microstructures and heterogeneous regions. Therefore, no matter how thoroughly we characterize the base metal, the process of joining subsections into assemblies produces behavior that cannot be predicted reliably by any means presently available. We have initiated an interdisciplinary program whose goal is to develop means to predict metallurgical and mechanical behavior of weldments. This goal requires state-of-the-art computational capability. The objectives for WELDWOG are:

1. Predict and control residual, stress and distortion.
2. Predict metallurgical state and associated behavior.
3. Predict and control mechanical flaws.
4. Predict weldability from base metal properties.

Keywords: Weldments, Modified Microstructures, Interdisciplinary Program, Weldability.

	FY 1981	FY-1982
10. Coatings and Films	$ 250K	$ 250K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
D. M. Mattox (505) 844-8333; A. W. Mullendore (505) 844-5353;
J. K. G. Panita (505) 844-8604

Engineering applications, deposition technology development, and basic scientific studies are being pursued in the areas of sputter deposition, ion plating, vacuum deposition, chemical vapor deposition, and plasma spraying. Coatings as hydrogen barriers, electrical contacts, insulators, bonding agents, corrosion inhibitors, wear surfaces, and monolythic structures are being developed and studied. Emphasis is on materials preparation and characterization.

Keywords: Coatings and Films, Materials Development, Materials Characterization, Materials Application

11. Erosion and Wear in Mechanical Components	$ 200K	$ 200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
R. E. Cuthrell (505) 844-7195; L. E. Pope (505) 844-5041; F. G. Yost (505) 844-8358; M. F. Smith (505) 844-8333

The mechanisms of erosion and wear in mechanical and electromechanical components are being studied. Techniques and materials for reducing erosion and wear are being evaluated. Techniques include coatings, ion implantation, lubrication, and materials selection. Studies of chemical and contamination effects on surface deformation and fracture are assisting in defining the mechanisms of erosion and wear.

Keywords: Erosion and Wear, Surface Deformation, Surface Fracture Copper, Nickel

12. Cleaning Procedures and Residual Contamination	$ 100K	$ 100K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
N. E. Brown (505) 844-2747; S. L. Erickson (505) 844-2631; R. Sowell (505) 844-1038

The efficiencies of various types of cleaning procedures are being determined by measuring residual contaminations following use of the procedures. The procedures include detergent cleaning, solvent cleaning, ultrasonic cleaning, and vapor degreasing. New methods for the analysis of residual contamination are being developed.

Keywords: Materials Processing, Contamination, Cleaning, Detergent, Solvent, Ultrasonic, Vapor Degreasing

		FY 1981	FY-1982
13.	Physical and Chemical Aging Mechanisms in Polymers	$ 250K	$ 250K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
J. G. Curro (505) 844-3963; J. A. Sayre (505) 844-6631; K. T. Gillen (505) 844-7494; R. L. Clough (505) 844-0324

The mechanisms of physical and chemical aging in polymers are being studied to provide a basis for predicting long-term reliability of weapons. The relationship between structure and properties of rubber modified epoxies are being studied to develop process controls. Rubber modified epoxies are used extensively as a tough encapsulant in weapons.

Keywords: Elastomers and Polymers, Encapsulants, Aging, Process Controls, Epoxies, Reliability

14.	High Strength Uranium Alloys	$ 50K	$ 50K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
K. H. Eckelmeyer (505) 844-7775; A. D. Romig (505) 844-8358

Thermal mechanical treatments are being investigated to provide high strength uranium allows with good ductility and corrosion resistance. Candidate alloys are U-3/4%Ti, U-2%Mo, and U-2 1/4Nb, a substantial increase in the strengths of uranium alloys plus increased flexibility in processing should result from these studies.

Keywords: Alloy Development, Uranium, Corrosion, Strengthening Mechanisms

15.	Welding Processes	$ 200K	$ 200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
J. L. Jellison (505) 844-2747; G. A. Knorovsky (505) 844-1109

The pulsed laser and pulsed tungsten inert gas arc processes are being studied for the production of miniature fusion welds for component envelope closure. Weld processes are tailored to provide joints with optimal mechanical properties. Solid phase bonding is being developed for production of joints between dissimilar metals and where fusion welding is impractical.

Keywords: Joining Methods, Solid Phase Welding, Pulsed Laser Welding, Pulsed Tungsten Inert Gas Welding, Dissimilar Metal Joints, Miniature Welds

	FY 1981	FY-1982
16. Improved Methods of Materials Characterization	$1500K	$1500K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
R. E. Whan (505) 844-8904; K. E. Eckelmeyer (505) 844-7775; J. A. Borders (505) 844-8855

New and improved methods of materials characterization are being developed and implemented. Automated data acquisition and instrument control are being added to existing instrumentation in order to give higher accuracy and reliability and to improve productivity by out-of-hours data acquisition and processing. New facilities include a high resolution transmission electron microscope, scanning Auger microprobe, Fourier transform infrared spectrometer, and a laser Raman microprobe. Improved capabilities inclde automated electron microprobe, x-ray diffraction, and emission spectroscopy equipment and automated in situ electron diffraction data analysis.

Keywords:

17. Ceramics and Glasses	$1200K	$ 1500

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
R. J. Eagan (505) 844-4069; C. J. Brinker (505) 844-3552; J. J. Mecholsky (505) 844-0787; J. A. Wilder (505) 844-1332

A family of glass ceramics is being developed to match the expansion coefficients of most materials of technical interest. Processing schedules provide hermetic seals to metal. Fracture analyses and structural studies point toward tougher materials for severe environments. The sol-tel processing promises unique applications of glass as a coating in critical electrical components.

Keywords: Ceramics, Glass, Glass Ceramics, Seals, Sol-Gel, Fracture Toughness

18. Uranium Corrosion	$ 250K	$ 250K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
L. J. Weirick (505) 844-1016; B. C. Bunder (505) 844-8940

The mechanism of uranium corrosion in moist air is being investigated using weight loss measurements and mass spectroscopy. Chemical and electrochemical and surface techniques are used to evaluate and understand corrosion of glasses used in sealing applications to aluminum and battery contact pins. Variables such as glass composition, pH, and solution chemistry are under study.

Keywords: Corrosion, Uranium, Actuators, Glass Corrosion

		FY 1981	FY-1982
19.	Organic Adhesives and Lubricants	$ 200K	$ 200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
L. A. Harrah (505) 844-6847; J. A. Kelber (505) 844-3408; L. E. Pope (505) 844-5041

Model polymers are being studied to determine the actual bonding between organic adhesive and metal substrate through the use of detailed analysis of Auger line shapes. Factorial experiments are designed to evaluate the relative importance of several parameters influencing moving friction such as contact force, material hardness, temperature, environment, etc.

Keywords: Adhesives, Bonding, Auger Line Shapes, Friction, Wear

20.	Real-Time Radiography Development	$ 60K	$ 100

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
F. A. Hasenkamp (505) 844-5334

Real-time video recordings of radiography of various weapons materials/environmental tests are required. A complete real-time radiograph image processing facility is being established and is used on all weapon systems tests.

Keywords: Nondestructive Evaluation (NDE), Materials Processing and Characterization, Weapons Environmental Test Diagnostics

21.	Ultrasonic Phased Array Test and Data Processing System	$ 100K	$ 150K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Sandia National Laboratories-Albuquerque (Contract No. DE-AC04-76DP00789)
J. H. Gieske (505) 844-6346

Development of digital scanning and focusing of ultrasonic wave to enhance testing. Development of acoustic imaging to better define size and shape of flaws.

Keywords: Nondestructive Evaluation (NDE), Materials Characterization

Los Alamos National Laboratory	FY 1981	FY-1982
22. Adhesives Development	$ 120K	$ 130K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Lamination-bonding of Kapton/Aluminum to stainless steel grids for electron beam windows. Electron gun accelerator columns in laser amplifiers consisting of alternating aluminum and cast epoxy rings.

Keywords: Adhesives

23. Polymers and Adhesives	$ 750K	$ 795K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
W. A. May, Jr. (505) 667-6362; FTS 843-6362

Development of fabrication processes and evaluation and testing of commercial materials for weapons programs. Development of plastic-bonded composites, cushioning materials, compatible adhesives.

Keywords: Adhesives, Polymers

24. Plutonium Alloy Development	$1060K	$1250K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
D. R. Harbur. (505) 667-2556; FTS 843-2556

Development of new alloys of plutonium for weapons applications; includes casting, mechanical working, and stability studies. Measurements of resistivity, thermal expansion, and differential thermal analysis are made to assess fabrication processing and stability.

Keywords: Alloy Development, Plutonium Phase Stability

25. Mechanical Properties and Alloy Development	$ 200K	$ 215K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Thermomechanical processing of plutonium allows to optimize mechanical properties. Study of complex microstructures, grain refinement, and deformation-induced transformations.

Keywords: Alloy Development, Mechanical Properties, Plutonium

	FY 1981	FY-1982
26. Amorphous Actinides	$ 90K	$ 0K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Intermetallic compounds like U_6Fe and Pu_5GA_3 have been produced in the amorphous state by fission fragment bombardment from neutron irradiation. Physical properties have been measured using differential scanning calorimetry.

Keywords: Alternate Materials, Amorphous, Irradiation

27. Inorganic Materials Synthesis	$ 60K	$ 0K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. J. Bard (505) 667-4691; FTS 843-4691

Develop synthetic materials using scull-melting techniques for encapsulation of nuclear waste.

Keywords: Waste Management, Nuclear Waste

28. Metallic Glasses	$ 90K	$ 75K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. J. Bard (505) 667-4691; FTS 843-4691

Surface modification of U alloys by laser and electron-beam treatments. Also experimental and calculational modeling studies of atomic-mobility phenomena and irradiation effects in metallic glasses ($Fe_{40}Ni_{40} P_{14} B_6$ and $Pd_{80} Ge_{20}$).

Keywords: Metallic Glasses, Surface Modification, Rapid-Solidification Technology, Irradiation Effects.

29. Superhard Materials	$ 56K	$ 50K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

B_4C has been added to conventional W-Ni-Fe alloys to improve hardness, wear resistance, and resistance to deformation. These alloys have been developed to eliminate the use of critical materials such as Co in high hardness materials.

Keywords: Alternate Materials, Boron Carbide, Hot Processing

		FY 1981	FY-1982
30.	Surface Studies	$ 420K	$ 290K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
W. P. Ellis (505) 667-4043; FTS 843-4043

Studies of surface structures, gas-solid reactions and catalysis. Surface analytical tools used to characterize surface structure, detect and identify impurities, and obtain information about valence band electrons.

Keywords: Catalysts, Surface Science, Gas-Solid Reactions

31. Gas-Solid Reactions in Actinides — $ 90K — $ 115K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Reaction chemistry of actinide metal and allow surfaces, attack by hydrogen, nature of catalytic processes.

Keywords: Catalysts, Actinides

32. Bulk Glass Fabriction Technology — $ 150K — $ 50K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickenson (505) 667-4365; FTS 843-4365

Casting and hot forming into hemispheres, disks, plates, sheets, and rods. Composition is controlled to yield good strength, hardness, nuclear requirements, or chemical durability.

Keywords: Glass, Hot Forming

33. Slip Casting of Ceramics — $ 100K — $ 120K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Slip casting of many ceramics including alumina and magnesia. Technology uses colloidal chemistry and powder characterization theory along with materials engineering.

Keywords: Ceramics, Slip Casting, Alumina

	FY 1981	FY-1982
34. Ceramics Technology	$ 150K	$ 100K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Castable ceramics for molds, crucibles, liners, and electrical insulators. Moldable ceramics of alumina with silica and plastic binders. Ceramic heat pipes. Design and properties of brittle materials.

Keywords: Ceramics, Castable Ceramics, Heat Pipes, Brittle Materials

35. Glass and Ceramic Sealing Technology	$ 90K	$ 100K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Ceramic-to-ceramic and ceramic-to-metal seals. Custom alumina combustion tubes, plug closures for alumina and silicon carbide heat pipes, high-voltage feed-throughs, beryllia klystron window.

Keywords: Glass, Ceramics, Seals

36. Bulk Glass Fabriction Technology	$ 150K	$ 50K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickenson (505) 667-4365; FTS 843-4365

Development of ceramic materials with improved strength and fracture toughness using SiC or Si_3N_4 whiskers in a glass or ceramic matrix.

Keywords: Ceramics, Glass, Whiskers, Composites

37. New Hot Pressing Technology	$ 150K	$ 200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Hot pressing of ceramic components for laboratory use. Typical materials are carbon-carbon composites, B_4C composites and metal filters.

Keywords: Ceramics, Hot Pressing, Composites, Metal Filters

	FY 1981	FY-1982
38. Glass and Ceramic Coatings	\$ 70K	\$ 80K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Develop vitreous enamels and general ceramic coatings to provide radiation-hardened electrically-insulating components for accelerator technology.

Keywords: Enamels, Ceramics Coatings

39. Plasma-Flame Sprayng Technology	\$ 75K	\$ 140K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Metallic and/or ceramic coatings or free-standing shapes. Coatings for radiation hardening, radiochemical detectors, temperature resistance, oxidation and corrosion resistance, light absorbence, and electrical conductance. Microstructure, uniformity, and density of coatings.

Keywords: Coatings, Metals, Ceramics, Plasma-Flame Spraying

40. Physical Vapor Deposition and Surface Analysis	\$ 150K	\$ 165K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickenson (505) 667-4365; FTS 843-4365

Physical vapor deposition and sputtering to produce materials for structural applications. Doped in situ laminates of aluminum and Al_kO_y and composites of Ta - TaC_x for high strength and smooth surface finish.

Keywords: Coatings, Physical Vapor Deposition, Sputtering, Aluminum, Tantalum

41. Target Coatings	\$ 300K	\$ 350K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Single and multilayer metallic coatings, smooth and uniform in thickness. Substrates are hollow or solid small spheres of metal glass, or plastic. Electrolytic and autocatalytic processes being investigated.

Keywords: Coatings, Thin Films

		FY 1981	FY-1982
42.	Chemical Vapor Deposition Coatings	$ 200K	$ 230K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Low-temperature coatings on hollow, spherical substrates. Low pressure conditions for deposition in fluidized bed. Coatings of tungsten, molybdenum, rhenium, nickel, and Mo_2C.

Keywords: Coatings, Chemical Vapor Deposition, Fluidized Bed

43.	Radiochemistry Detector Coatings	$ 150K	$ 160K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Physical vapor deposition of coating for radiochemical detectors. Metallic and nonmetallic coatings.

Keywords: Coatings, Radiochemical Detectors, Physical Vapor Deposition

44.	Parylene Coating Development	$ 75K	$ 110K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickenson (505) 667-4365; FTS 843-4365

Vacuum vaporization of p-xylene dimer and thermal pyrolysis with in situ polymerization on a substrate. Coatings produce good physical and chemical resistance and forms strong vapor barrier.

Keywords: Coatings, Parylene, Polmers

45.	Structural Polmer Castings	$ 300K	$ 350K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Large complex castings of polymers for a variety of structural applications. Require electrical and structural properties. Polyurethanes with additives for special mechanical and physical properties.

Keywords: Polymers, Polyurethane, Castings

		FY 1981	FY-1982
46.	Mechanical Properties of Uranium	$ 125K	$ 150K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. Mulford (505) 667-4665; FTS 843-4665

Mechanical properties of U-6%Nb at high strain rates. Hydrogen at ppm levels causes drastic reduction in biaxial ductility with very little effect on uniaxial ductility.

Keywords: Hydrogen, Mechanical Propertis, Uranium, Biaxial, Uniaxial, Ductility

		FY 1981	FY-1982
47.	Moldable Ceramics	$ 50K	$ 60K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Develop injection and compression molding techniques for Al_2O_3 ceramic shapes with about 25 vol % wax or epoxy binder. Complex ceramic shapes may be molded to final dimensions or near final dimensions and fired to full density.

Keywords: Moldable Ceramics, Injection Molding, Compression Molding, Near-net-shape Molding.

		FY 1981	FY-1982
48.	Joining Process Development	$ 100K	$ 110K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickenson (505) 667-4365; FTS 843-4365

Microcomputer technology for process control. Multiaxes programmable control high-voltage electron beam wedler. Fusion welding process includes lasers, electron beam, and gas tungsten arc.

Keywords: Joining, Welding, Electron Beam, Lasers, Microcomputers

		FY 1981	FY-1982
49.	Explosion Welding	$ 25K	$ 30K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Develop transition joints between 1100, 3000, and 5000 series Al alloys and 304 stainless steel. Develop computer program to model explosion welding parameters for various material combinations.

Keywords: Joining, Welding, Explosion Welding

	FY 1981	FY-1982
50. Solid State Bonding	$ 25K	$ 30K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
J. M. Dickinson (505) 667-4365; FTS 843-4365

Develop bonding techniques for seamless ICF targets. Clean surfaces and apply thin interlayers of bonding materials using sputtering techniques. Investigating Al, Ti, and Be with various bonding materials.

Keywords: Joining, Solid State Bonding, Sputtering

51. Materials Characterization Studies	$ 150K	$ 50K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. J. Bard (505) 667-4691; FTS 843-4691

Optical metallography, scanning electron microscopy, transmission electron microscopy, x-ray diffraction of metals, alloys, ceramics, graphites, and polymers.

Keywords: Materials Characteriation, Electron Microscopy, X-Rays, Metallography.

52. Nondestructive Evaluation	$ 840K	$ 900K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. Morris (505) 667-6216; FTS 843-6216

Betatron radiography, nuclear fluorescence, acoustic emission and scattering, tomographic techniques for nondestructive evaluation. Image enhancement techniques for better resolution and definition.

Keywords: Nondestructive Evaluation, Radiography, Acoustic Emission

53. Low Temperature Electronic Properties	$ 200K	$ 200K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Understand electronic properties of materials through their superconducting and magnetic behaviors. Emphasis on actinide elements and their alloys.

Keywords: Superconductivity, Magnetism, Actinides, Electronic Properties

FY 1981 FY-1982

54. Solid State Bonding $ 25K $ 30K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
T. C. Wallace (505) 667-6074; FTS 843-6074

Investigations to develop new superconducting materials with high transition temperatures and critical fields. Materials with itinerant magnetic properties are also of interest.

Keywords: Superconductivity, Magnetism

55. Phase Transformations in Pu and Pu Allows $ 225K $ 260K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Mechanisms, crystallography, and kinetics of transformations in Pu and alloys. Studies use pressure and temperature dilatometry, optical metallography, and x-ray diffraction.

Keywords: Transformations, Plutonium

56. X-Ray Diffraction of Actinides at High Pressure $ 150K $ 210K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

X-ray diffraction status of plutonium and americium at pressure using a diamond anvil cell. Compressibility and phase transformations in plutonium and americium are determined. Data relates to f-electron bonding in actinides

Keywords: Transformations, Actinides, X-Rays, Diamond Anvil Cell

57. Neutron Diffraction of Pu and Pu Alloys $ 25K $ 35K

DOE Contact - W. G. Collins (301) 353-5494; FTS 233-5494
Los Alamos National Laboratory (Contract No. W-7405-eng-36)
R. N. R. Mulford (505) 667-4665; FTS 843-4665

Neutron diffraction studies on plutonium and its alloys conducted at the Los Alamos WNR pulsed neutron source. Time-of-flight technique used to do diffraction at elevated temperatures and pressures.

Keywords: Transformations, Plutonium, Neutron Diffraction, Pulsed Neutron Source

APPENDIX J: OFFICE OF DEFENSE WASTE AND BYPRODUCTS MANAGEMENT

Alternative Waste Forms, Canisters and Related Processes Are Being Developed for Defense High-Level and Transitanic Wastes

FY 1982 $11 million, Organizationally under NE Prior to FY 1982

HLW FORMS — $5 million

Alternative Waste Forms and Compositions Developed and characterized

SRL, INEL, PNL, RHO, LLL

HLW PROCESSES — $6 million

Lab scale, Radioactive Process Development Engineering Scale,

Glasses and Polycrystalline Ceramic Forms

SRL, PNL, LLL, ANL, ORNL, RES

Ray Walton
DP 123
353-3388

Appendix K: *Office of Basic Energy Sciences*

Materials Sciences Division

The Materials Sciences Division reports to the Director of the Office of Energy Research through the Associate Director for Basic Energy Sciences. The objective of the Materials Sciences program is to conduct fundamental research aimed at increasing the understanding of materials and materials related phenomena of interest to the Department of Energy. Research is conducted primarily at DOE laboratories, universities and to a lesser extent in industry.

This program is basic or long range in nature and is intended to provide the necessary base of materials knowledge ultimately needed to advance our energy technologies. Emphasis is placed on areas where problems are known to exist or are anticipated and on generic areas of fundamental importance. Another aspect of the program is the development and utilization of unique facilities used not only by DOE contractors but also by other laboratory, university, and industry scientists. Among these facilities are several which began operation recently. The Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory started operation in early FY 1982 and is being used for both neutron scattering and neutron irradiation effects research. The National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory began experimentation in FY 1982. The NSLS provides intense beams of x-radiation and vacuum ultraviolet radiation for research. The nation's highest voltage electron microscope (1.5 MeV) began operation at Lawrence Berkeley Laboratory in FY 1982. An atomic resolution (1.7A) microscope wil be delivered to LBL in FY 1982 and begin operation in FY 1983. Other major facilities used in the Materials Sciences program which are also used by other programs include: The High Flux Beam Reactor (BNL), High Flux Isotope Reactor (ORNL), 1.0 MeV High Voltage Electron Microscope (ORNL), 1.2 MeV High Voltage Electron Microscope/Tandem Accelerator (ANL) and the Microanalysis Center (U. of Illinois). These facilities and others are described in detail in the Materials Sciences Programs annual listing of projects report.

Some of the research is directed at a single energy technology (e.g., photovoltaic materials for direct conversion of solar energy into electricity), whereas other research is applicable to many technologies simultaneously (e.g., the embrittlement of structural materials due to the presence of hydrogen) and still other has more fundamental implications underpinning all materials research (e.g., mechanisms of atomic transport in solids).

At the DOE laboratories, technology and information transfer occurs quickly between the basic and applied programs when they are co-sited at the same laboratory. The Materials Sciences subprogram also supports research at universities and to a lesser extent industrial laboratories, taking advantage of the unique expertise of researchers at each of the different types of institutions. Coordination of DOE's applied materials development efforts with the Materials Sciences program takes place primarily through the DOE

Energy Materials Coordinating Committee (EMaCC), but also through Materials Sciences Research Assistance Task Forces, technology meetings, and less formal contacts among staff members. The program utilizes workshops and reports of its Council on Materials Science (a non-governmental body with representatives from academia, industry, and DOE laboratories) to help focus on critical issues. In FY 1981, the Council reviewed research needs and opportunities in the areas of radiation effects and theory of condensed matter/role of computation. For FY 1982, two areas: nuclear waste and materials research at high pressure will be reviewed. Reports of these Panel meetings are available from the Materials Sciences office. Many of the past reports have been published in the open literature.

The Materials Sciences Division has three major categories which represent the disciplines involved and the administrative units in the program: A) Metallurgy and Ceramics, B) Solid State Physics, and C) Materials Chemistry. The following description of the program is separated into those three categories. Further information can be obtained by contacting Dr. L. C. Ianniello, Director, Division of Materials Sciences (301-353-3427) or other staff members:

Dr. M. C. Wittels, Branch Chief for Solid State Physics and Materials Chemistry

Dr. T. A. Kitchens, Solid State Physicist

Dr. S. M. Wolf, Metallurgist

Dr. R. J. Gottschall, Ceramist

A description of all of the Division's projects is given in an annual summary report--the most recent is Materials Sciences Programs, FY 1982, DOE/ER-0143. The overall funding for the Division in FY 1981 and FY 1982 is given in Table I:

Table I - Materials Sciences Budget ($M)

	FY 1981	FY 1982
Operating	87.5	94.5
Equipment	7.1	7.9
Construction	0.3	0.6
Total Materials Sciences	94.9	103.0

Tables II, III, and IV provide information on contractor allocation (II), selected areas of research (III), and economic sector (IV) for the last complete fiscal year FY 1982 for the operating funds.

Table II - Operating Funds by Contractor

	FY 1982 Total Program (%)
Ames Laboratory	7.18
Argonne National Laboratory	19.66
Brookhaven National Laboratory	14.90
Idaho National Engineering Laboratory	0.39
Illinois, University of (Materials Research Laboratory)	2.87
Lawrence Berkeley Laboratory	6.89
Lawrence Livermore National Laboratory	1.35
Los Alamos National Laboratory	3.30
Oak Ridge National Laboratory	20.11
Pacific Northwest Laboratory	2.02
Sandia National Laboratories	3.06
Solar Energy Research Institute	0.29
Contract Research (Unsolicited Proposals)	17.98
	100.00

Table III - Operating Funds by Selected Areas of Research (FY 1982)

	Number of Projects (Total=4000) (%)	Total Program $ (%)
(a) Materials		
Polymers	6.1	2.3
Ceramics	47.3	25.0
Semiconductors	16.4	10.1
Hydrides	9.7	6.2
Ferrous Metals	23.7	13.9
(b) Technique		
Neutron Scattering	11.8	20.0
Theory	21.7	10.4
(c) Phenomena		
Catalysis	10.2	6.9
Corrosion	13.3	10.8
Diffusion	22.0	9.1
Superconductivity	9.7	6.1
Strength	20.5	9.9
(d) Environment		
Radiation	22.5	21.6
Sulphur-Containing	6.1	4.0
High Temperature	22.2	15.0

Table IV - Funding by Economic Sector (FY 1981)

	Percent
Universities (including those DOE university laboratories where graduate students are involved in a large extent, e.g., LBL and AMES	34.8
DOE Laboratories	64.7
Industry and other	0.5
	100.0

A. Metallurgy and Ceramics FY 1981 ($35.5M) FY 1982 ($40.5M)

The objective of research conducted under the metallurgy and ceramics category is primarily to better understand how metallic and ceramic materials behavior/properties are related and controlled by structure and processing conditions. By processing is meant the methods and techniques used to prepare, form or fabricate materials. Important properties of materials such as fracture, plastic flow, superconductivity, corrosion resistance, radiation resistance, and transport phenomena all depend on structure. As a consequence of this improved understanding, better materials and a greater ability to predict behavior of materials in energy systems will eventually be possible. Although basic in nature, the program is centered around research areas deemed to be of greatest interest for energy systems. For example, there is within the metallurgy and ceramics category a strong emphasis on hydrogen effects, radiation effects, corrosion, creep and high temperature deformation, high temperature ceramics, and superconductivity. Research is carried out at INEL, Ames, ANL, LANL, LBL, LLNL, ORNL, PNL, Sandia, SERI, and universities.

There are five budget areas under the Metallurgy and Ceramics category: structure of materials, mechanical properties, physical properties, radiation effects and engineering materials.

The structure of materials area supports research designed to enhance our understanding of the atomic, electronic, defect and microstructure of materials, how they are affected by chemical composition and processing, and how they relate to material properties.

The budget area of mechanical properties is concerned with material behavior related structural integrity requirements of all energy systems. Research addresses the understanding of strength at high and low temperatures creep, fatigue, elastic constants, micro- and macrostrain, fracture, and mechanical-chemical effects in hostile environments.

Research under the physical properties area is directed toward understanding the fundamental phenomena controlling thermal, optical, mass transport, and electrical properties of materials, how they can be altered by various heat treatments or other processing steps, and how they are affected by external variables such as temperature and pressure.

The radiation effects area encompasses research delineating radiation induced changes of materials properties important to fusion and fission energy concepts. The effect of irradiation, both neutron and ion, on mechanical properties, structure and electrical properties is studied in this area.

In the engineering materials area, research is aimed at understanding more fully the complex materials and phenomena generally associated with real world materials problems. Some of the topics under study include: erosion, friction and wear, engineering corrosion and fracture, welding and joining, non-destructive evaluation, and the forming and processing of materials.

B. Solid State Physics FY 1981 ($37.6M) FY 1982 ($42.3M)

The solid state physics category is directed toward fundamental research on matter in the condensed state, wherein the interactions of electrons, atoms, and defects are tracked with the purpose of determining the critical properties of solids. These interactions are the ultimate source of all materials properties. Research under this category includes a broad spectrum of experimental and theoretical efforts, which contribute basic solid state knowledge important to all energy technologies. Accelerated progress is made in this field through the rapid advancements in unique experimental tools and their coupling with high-speed computer systems. Through these efforts, fundamental understanding of matter in the condensed state contributes broadly to characterizing material properties and processes important for all energy technologies. Research is carried out at Ames, ANL, BNL, LANL, LBL, LLNL, ORNL, PNL, Sandia, and universities.

There are five budget areas within the solid state physics category: neutron scattering, experimental research, theoretical research, particle-solid interactions, and engineering physics.

The neutron scattering area supports research of a unique kind, namely the use of the neutron as an analytical probe of the properties of solids and liquids. With this probe, fundamental parameters of superconductors, magnets, hydrides, and solid imperfections are determined in a manner that cannot be accomplished by any other technique. The exploitation of this probe is being advanced by recent development of more efficient monochromators and wider use of longer wavelength probes. Increased efforts are conducted with neutrons from pulsed spallation sources at ANL and LANL. The bulk of the Nation's efforts in this important area has historically been supported at DOE laboratories, where the advanced research reactors are in operation.

The experimental research area is very broad and includes all fundamental investigations, experimental in concept, on liquids and solids of metals, alloys, semiconductors, insulators, and compounds. The area of high-temperature energy systems is being pursued. Ion implantation and backscattering research is being used to learn how to improve superconductor and photovoltaic performance. Hydrogen and hydrides are under study through ultrahigh-pressure and spectroscopic techniques. Synchrotron radiation is utilized in characterizing surfaces with particular relation to catalytic response.

With nearly all these experimental areas, a highly advanced theoretical research program is closely coupled. A large part of the theoretical effort is directed towards dynamic processes in solids and liquids and requires extensive use of DOE's most advanced computer complexes.

Under particle-solid interactions, a major effort is under way to correlate the complex effects of particles of different mass, energy, and charge not only on surfaces but in bulk materials as well.

The engineering physics area supports research to fulfill the much needed goal of utilizing solid state physics expertise in engineering research for which it has a unique capability. Typical of the work initiated are research laboratory investigations of novel processing techniques with mass spectrometer-computer control for complex material preparation, such as solar materials and superconducting alloys. Another area is the extension of cryogenic and refrigeration techniques to new fluid systems that hold promise for the utilization of low-grade heat.

C. Materials Chemistry FY 1981 ($11.4M) FY 1982 ($11.7M)

The materials chemistry category provides support for research directed toward developing our understanding of the chemical properties of materials as determined by their composition, structure, and environment (pressure, temperature, etc.) and to show how the laws of chemistry may be used to understand physical as well as chemical properties and phenomena. Included, for example, are studies of energy changes accompanying transformations, the influence of varying physical conditions on rates of transformations, and the manner in which the structure of atomic groupings influences both properties and reactivity.

Chemical concepts coupled with physical experimental techniques are used to study the kinetics of reactions of solids and liquids, the interaction and/or penetration of species in adjacent media, corrosion phenomena and the stability of high-temperature materials of interest to fossil and geothermal technologies. The program also includes research on the chemical thermodynamics of fission products and their interactions with fuels and cladding materials. Electrochemistry is an important aspect of research supported under this category. Research involving elastomers and polymers is also being pursued. Research is carried out at Ames, ANL, LANL, LBL, LLNL, ORNL, and universities.

There are three budget areas in the materials chemistry category: structural chemistry, engineering chemistry, and high-temperature and surface chemistry.

Structural chemistry involves studies of a wide variety of problems where a knowledge of the relationship between the atomic structures of materials and their reactivity is required. Important examples of these effects include the influence of different chemical environments on the catalytic properties of metals. Changes in both the crystal and magnetic structures of compounds are correlated with their specific roles in fuel synthesis, for example.

The methods of engineering chemistry are applied to problems that are currently limiting the efficiency of energy conversion systems. Examples of research underway include: structural and morphological changes that arise during the charge-discharge cycles of the high-temperature battery and studies of thermodynamics of advanced nuclear fuels.

The high temperature and surface chemistry area includes programs on fundamental studies of the influence of surface properties on reactivity. The correlation of mass transport and thermodynamic properties of molten salts in high-temperature battery systens and chemical studies of the influence of micro-inclusions such as sulfides on the formation of pits and crevices to determin whether these inclusions play a significant role in the initiation of stress-corrosion cracking are examples of research underway.

Appendix L: Division of Advanced Energy Conversion

SiC Impregnation of Diesel Engine Components

DOE Contact:	J. W. Fairbanks, (301) 353-2822, FTS 233-2822 Division of Advanced Conversion Technology
DOE/PNL Contract:	B-B0193, Laystall Engineering Ltd. Wolverhampton, UK - J.E. Tanner, (011) 44-902-51789 B-B0195, Transamerica/Delaval, Oakland, CA - A.R. Fleisher, (415) 577-7400 FY 82 Funds: $52.3 K

Investigate the potential increased erosion resistance of diesel engine cylinder liners and piston rings impregnated with SiC particles by Laystall Engineering. Components to be engine tested by Transamerica/Delaval using oil-water emulsions and/or heavy petroleum fuels.

Controlled Nucleation Thermochemical Deposition of SiC on Thermal Barrier Coatings

DOE Contact:	J.W. Fairbanks, (301) 353-2822, FTS 233-2822 San Fernando Laboratories, Pacoima, CA - J.J. Stiglich, (213) 899-7484
DOE/PNL Contract:	FY 81: B-A0759 ($96.4 K) FY 82: B-B0198 ($82.5 K)

SiC overlayers have the potential to (1) act as sealing layers to prevent penetration of condensates from dirty combustion environments into ceramic coatings and (2) provide erosion resistance to the underlying thermal barrier coating.

The FY 81 program will evaluate the potential of the Controlled Nucleation Thermochemical Deposition (CNTD) process developed at San Fernando Laboratory for producing SiC overlayers on segmented or porous thermal barrier coatings.

Based on the results of the FY 81 work, piston caps and valve inserts with thermal barrier coatings will be SiC overcoated for diesel engine testing in FY 82.

In a separate task, a tungsten/tungsten carbide coating will be applied to fuel injector components of a diesel engine. The resistance of the coated injector to wear by coal derived liquids and/or coal-slurries will be measured.

Insulative/Wear Resistance Materials for the Adiabatic Diesel Engine

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822

DOE/PNL Contract: FY 82: B-D8533 ($90 K)
Cummins Engine Company, Columbus, IN - Roy Kamo, (812) 379-5591

Investigate the use of ZrO_2 densified with Cr or other oxides for application in the adiabatic diesel engine. This class of materials has the potential for providing erosion/corrosion resistance to engines operated on alternate fuels. Cylinder liners, heads, ports, and piston crowns will be fabricated from the densified ZrO_2 and will be engine tested.

Electron Beam Reactive Physical Vapor Deposition of Thermal Barrier Coatings

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Airco-Temescal, Berkeley, CA - E.R. Demeray, (415) 841-5720, Ext 380

DOE/PNL Contract: FY 81: B-A0760, B-B0449, ($131 K)
FY 82: B-B0199 ($125 K)

This program is divided into two tasks:

(1) Develop a computer controlled EB-PVD coater to provide highly reproducible coating parameters over a wide dynamic range of deposition conditions. Twenty-one (21) samples submitted for testing at NASA-Lewis.

(2) Systematically investigate the variables affecting the adherence of substoichiometric thermal barrier layers on -alumina forming metallic coatings. Samples will be sent to NASA-Lewis for thermal cyclic testing and to the David Taylor Laboratory, Annapolis, for low temperature hot corrosion testing.

Investigation of the Effect of Alternate Fuels on 2-Stroke Diesel Engine Operation

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822

DOE/PNL Contract: FY 81: B-A0764 ($15 K)
FY 82: B-B0196 ($42.6 K)
Norwegian Institute of Technology, Trondheim, Norway - Arthur Sarsten, (075) 95511

Investigation of methods to improve large industrial/utility medium speed diesel engine efficiency and durability through use of ceramic coatings on combustion zone components. This study shall use data developed on both residual petroleum fuels, shale oil refined to Marine Fuel Diesel and SRC-II middle distillate coal-derived liquid fuel and coal slurries, with emphasis on the latter. The erosion of the slurries on injectors, pumps, and combustion zone components will also be measured. This program is to provide analysis of advantages and directions to pursue with thermally insulated combustion zone components (the adiabatic concept) coupled with Norwegian thermal insulating coating experience, digitally controlled fuel injection, and computer models.

Investigate Vanadium and Hot-Corrosion Resistance of Cr-Si Base Coating System

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Pratt and Whitney, West Palm Beach, FL - R.H. Barkalow

DOE/PNL Contract: B-A0766
FY 81: $80.0 K
FY 82: $50.4 K

Develop an improved metallic coating using the silicon base system for industrial/utility gas turbine hot-sections operating on high vanadium sulfur and sodium base petroleum fuels, minimally processed coal-derived fuels, and petroleum/shale oil fuels. This program will also provide a reduced use of strategic materials.

Development of Advanced Plasma Sprayed Ceramic Coatings for Industrial Gas Turbines

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Pratt and Whitney, East Hartford, CT -
D.S. Duvall, (203) 565-7775

DOE/PNL Contract: B-A0747
FY 81: $138 K
FY 82: $ 69 K

Develop durable ceramic coatings for near-term industrial/utility gas turbine hot-section components, primarily airfoils, to substantially improve hot-corrosion/erosion resistance and achieve advantages of thermal insulation.

Thermal stress resistance shall be achieved with the plasma spray deposited ceramic coatings by reducing the coatings susceptibility to thermal stain induced spallating during engine operation. The increased spalling resistance is achieved by use of ceramic compositions and process techniques which produce microcrack "toughening" and/or segmentation of the ceramic layer. Early cooled metal bars have gone 10,000 cycles in 1805°F without spallation. These samples lasted 4000 cycles at 1950°F and are currently being tested at 2050°F and have gone 7000 - 13,000 cycles before spallation occurs.

Materials Characterization and Test Co-ordination for Combustion Zone Durability Program

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Lawrence Berkeley Laboratory, University of California, Berkeley, CA - D.H. Boone, (415) 486-4914

DOE/PNL Contract: FY 81: B-B0189 ($46 K)
FY 82: B-B0197 ($150 K)

Analyze samples produced in laboratory furnace/crucible tests and samples obtained from supporting combustion test programs (burner rig, engine, etc.) to determine materials degradation mechanisms for selected combinations of combustion parameters, fuel chemistry, and test material (chemistry and structure) in an attempt to build a sound base for predicting combustion zone durability of a wide range of materials exposed at anticipated advanced alternate fuels.

Modified Diesel Engine Combustion Systems for Coal Derived Liquid Fuel Operation

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822

DOE/PNL Contract: FY 81: B-A0763 ($73 K)
Cummins Engine Company, Columbus, OH - Roy Kamo (812) 379-5591

Two different combustion techniques (the spark assisted diesel and the pre-combustion chamber) will be investigated for medium speed diesel engines operating on coal-derived liquid fuel.

Advanced Physical Vapor Deposited Ceramic Coatings for Industrial Gas Turbines

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822

DOE/PNL Contract: B-A0762
FY 81: $63.6 K
FY 82: $150.0 K
Pratt and Whitney, East Hartford, CT - D.S. Duvall

Ceramic coatings produced by electron-beam physical vapor deposition at Pratt and Whitney have exhibited 20 times greater resistance to thermal cycling induced spalling than the best plasma sprayed ceramic coatings being developed for turbine airfoils. However, it has not been possible to consistently achieve these large improvements due to apparent problems in reproducibly creating the proper ceramic structure. This program will identify the optimum process and ceramic structure characteristics which will allow fabrication of EB-PVD ceramic coatings with reproducibly good spall resistance.

Development and Engine Testing of Ceramic Coatings on Diesel Engine Components

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Central Institute for Industrial Research, Oslo, Norway - Ingard Kvernes, (011) 472-6955880

DOE/PNL Contract: FY 81: B-B0190 ($25 K)

The objective of this work is to develop ceramic coatings for heat loaded diesel engine components. The diesel engine components are primarily exhaust valves, but include also piston crowns, piston grooves, cylinder liners, and cylinder covers. This program consists of two tasks: (1) test and evaluate ceramic or thermal barrier coatings developed and tested in Norwegian diesel propelled ships operated on residual petroleum fuels, and (2) provide U.S. coatings for Norwegian lab test and evaluation.

Diesel Engine Applications of Glass Matrix Composites

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822

DOE/PNL Contract: FY 82: B-B0194 ($101.4 K)
United Technologies Research Center, East Hartford, CT - K.M. Prewo, (203) 727-7237

Investigate the feasibility of using fiber reinforced glass matrix composites for cylinder liners and combustion chamber components of diesel engines operated on CDLF and/or coal slurries. In addition to the possible increased erosion resistance these composites could provide, they may also provide greater stress distribution than traditional monolithic ceramic components or ceramic coatings used in the adiabatic diesel engine.

Combustion Zone Durability Program

DOE Contact: J.W. Fairbanks, (301) 353-2822, FTS 233-2822
Battelle Pacific Northwest Laboratory, Richland, WA - D.D. Hays, (509) 373-2829, FTS 440-2829 (Program Management)
J.T. Prater, (509) 373-3012, FTS 440-3012 (Research Programs)

Contract: PNL-001-001 FY 81: $1066 K Total Program Funds
PNL-002-001 FY 82: $1300 K Total Program Funds

The objective of the Combustion Zone Durability Program is to identify potential factors limiting materials durability in combustion zone hot components of heat engines operated on advanced alternate fuels and to develop materials and materials system (coatings/substrates) to assure durable operation with these fuels with minimum modifications to existing equipment designs.

PNL manages the Combustion Zone Durability Program using industrial, academic, and other government laboratories to address critical materials problems that are likely to restrict usage of alternate fuels in optionally fuel heat engines. Program definition, priority assignment, and program reviews are supported by a Steering Committee composed of individuals with proven expertise in coating development from inception through the engine use who are now working in National Labs or other government agencies.

PNL manages the CZD program as well as conducting in-house research programs in support of it. Program costs at PNL (including program management, steering panel expenses, and in-house research) were:

FY 81: $218 K
FY 82: $320 K

In-house research programs include:

1. The development and use of high rate triode sputtering techniques. Triode sputtering provides much greater flexibility for variation and control of coating composition and structure. Both high rate triode d.c. and r.f. sputtering shall be used to deposit hybrid coatings of MCrAlY with stabilized ZrO_2 or Al_2O_3 that are adherent to metal substrates and impermeable to combustion product condensates. The durability of graded metal to ceramic layers will be evaluated with respect to the selection, distribution, and coarsening of metal and ceramic phases. Coatings with dense outer layers of pure ceramic and mixed metal-ceramic outer layers will be prepared for hot corrosion and erosion testing.

2. The development and use of plasma spraying for the application of erosion resistant/insulative coatings. Coatings with SiC particles and fibers incorporated in metallic and ceramic matrices are being prepared.

3. Independent examination and test facilities to support DOE funded programs. This includes providing burner rig testing of ceramic and metallic coatings with doped petroleum fuels or coal-derived liquids.

<u>Applications of Composite Gas Turbine Components</u> $300 K

DOE Contract: J.W. Fairbanks, (301) 353-2816, FTS 233-2816
General Electric Gas Turbine Division, Schenectady, New York
(Contract No. DE-AC01-80ET17005) - Gene Kunkel, (518) 383-7206

Objectives: Maximize the potential for durability, reliability, and performance of large gas turbine hot-stage parts by evaluating a hybrid bucket composed of airfoil vanes of optimized creep rupture and low cycle fatigue properties, dovetails of high tensile strength and ductility; and corrosion resistant overlays.

Status: The technology development evaluates a hybrid bucket composed of a directionally solidified airfoil section, which is diffusion bonded using hot isostatic pressing to a dovetail section of powdered metal.

Three directionally solidified airfoil alloys (MAR-M200+Hf, René 80H and 441) and two powdered metal alloys (AP-1 and PA-101) are being evaluated with primary emphasis on assessing bondline strength, heat treat effects, stress rupture, low cycle fatigue and tensile strength, over a range of operating temperatures.

The results to date indicate the possibility of a significant increase in allowable bucket metal temperatures leading to increased gas turbine output and/or efficiency. Low cycle fatigue tests of DS airfoil specimens demonstrate significant improvements over conventional cast alloys, ranging 10x to 80x. Similarly, the tensile tests of PM dovetail specimens demonstrate significant improvements in strength and ductility over conventionally cast alloys, ranging 20% to 200% respectively.

Keywords: Directionally Solidified, Consolidated Powers, Materials Characterization

Appendix M: Office of Technical Coordination (Advanced Research and Technology Development)

The objectives of the Advanced Research and Technology Development program are to assess and identify long-range advanced research needs in coal processing, fossil fuels utilization and extraction, materials, components, and instrumentation; to provide oversight of ongoing advanced research in fossil energy so as to ensure balance and proper priorities; to initiate and fund projects involving new, exploratory concepts or goal-oriented basic research; to manage the Materials Research and University Coal Research programs; and to provide policies for, and overview of, Fossil Energy-supported university activities. The Advanced Research and Technology Development program also is designed to provide an effective communications channel between the Fossil Energy program and academic institutions; to encourage these institutions to become involved in programs related to the DOE Fossil Energy mission; and to manage programs concerned with providing an adequate technical base for development of commercial construction materials and instrumentation for Fossil Energy pilot plants and demonstration plants.

It should be noted that a few contracts that were sponsored by this Office and active in FY 1981 and FY 1982 were negotiated and funded from prior years' appropriations. In this context, the exact funding level for these activities are not easily determined, and thus are indicated in the text as PYA, prior years' appropriation.

1. Management of the AR&TD Fossil Energy Materials Program

FY 1981 $225 K
FY 1982 $300 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R.A. Bradley, P.T. Carlson, (615) 574-6094, FTS 624-6094

The overall objective of the Advanced Research and Technology Development (AR&TD) Fossil Energy Materials Program is to conduct a fundamental long-range research and development program that addresses, in a generic way, the materials needs of fossil energy systems and ensures the development of advanced materials and processing techniques. The purpose of this task is to manage the AR&TD Fossil Energy Materials Program in accordance with procedures described in the Program Management Plan approved by DOE.

This task is responsible for preparing the technical program plan; preparing budget proposals for the Program; assigning work to be accomplished by subcontractors and by ORNL; placing and managing subcontracts for fossil energy materials development at industrial research centers, universities, and other government laboratories; and for reporting the progress of the Program.

Keywords: Management; Materials Program

2. <u>Critical Materials Requirements for Synthetic Fuel Facilities</u>

FY 1981 $50 K
FY 1982 $42 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
D.L. Lennon, (615) 574-9535, FTS 624-9535

The purpose of this task is to identify and quantify the critical materials requirements for designated synthetic fuel facilities. The initial effort is directed to a generic direct coal liquefaction facility. The basic approach is similar for all materials and energy facilities investigated. It is performed as an engineering estimate of material requirements based on engineering and technical data for the type of synthetic fuel facility being investigated and is supplemented with commodity/economic data where the latter approach is more effective (such as in indirect materials requirements). This method may be characterized as a microanalysis approach (i.e., building the whole from its parts), as opposed to the macroanalysis approach using national economic input/output data that forms the basis of some investigations reported in the literature to date.

Keywords: Critical Materials; Synthetic Fuel Facilities

3. <u>Technical Monitoring of Coal Gasification Subcontracted Materials Projects for the AR&TD Fossil Energy Materials Program</u>

FY 1981 0
FY 1982 $50 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W.A. Ellingson, (312) 972-5068, FTS 972-5068

The purpose of this technical management activity is to assist DOE Headquarters, DOE Oak Ridge Operations, and Oak Ridge National Laboratory with technical monitoring of the subcontracts of the AR&TD Fossil Energy Materials Program which are related to high-temperature gaseous corrosion, corrosion of refractories and ceramics, and nondestructive evaluation methods.

Keywords: Technical Monitoring; Coal Gasification

4. <u>Microstructural Effects in Abrasive Wear</u>

FY 1981 $15 K
FY 1982 0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of Notre Dame, Department of Metallurgical Engineering and Materials Science (Contract No. DE-AS05-77ET10460, A004)
T.H. Kosel, N.F. Fiore, (219) 283-4516

This research was aimed at establishing quantitative relations between microstructure and wear resistance for highly alloyed white irons and cobalt-base powder metallurgy alloys that are commonly used in coal mining, handling, and conversion processes. The project involved mechanical testing, metallographic analysis, and wear testing. The mechanical testing was to establish the correlation between wear and other mechanical behavior such as plastic deformation. The metallographic analysis was to establish quantitative relationships between wear mechanisms and microstructural parameters. The wear testing included characterization of wear scars produced in laboratory systems by computer-aided microtopographical examination, scanning, and transmission electron microscopy, and quantitative microanalysis of phases. This project was completed in FY 1981.

Keywords: Abrasion; Wear; Materials Characterization

5. <u>Wear-Resistant Alloys for Coal Handling Equipment</u>	FY 1981	PYA
	FY 1982	0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of California, Department of Materials Science and Mineral Engineering (Contract No. DE-AS05-79ET10698, A002)
V.F. Zackay, E.R. Parker, (415) 642-3811

The goal of this project is the development of wear-resistant alloys for coal transportation and fragmentation equipment. The project involves the establishment of alloy design criteria, the development of evaluation tests, development and characterization of alloy steels of greater hardness and toughness, and the production and evaluation of components through laboratory and in-service tests.

Keywords: Abrasion; Wear; Materials Characterization

6. <u>Alloy Evaluations for Fossil Fuel Process Plants (Liquefaction)</u>	FY 1981	$65 K
	FY 1982	0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Ames Laboratory (Contract No. W-7405-eng-82)
T.E. Scott, (515) 294-4446, FTS 865-4446

Since petroleum refinery pressure vessels are constructed of 2 1/4 Cr-1 Mo steel (A387-74A-Gr.22-Cl.2) with a stainless steel weld overlay liner, it is anticipated that coal liquefaction "dissolver" vessels will be fabricated similarly. In the event the stainless steel liner is breached, the ferritic 2-1/4 Cr-1 Mo steel shell will be exposed to the coal liquefaction environment. Consequently, the objective of this investigation is to evaluate the mechanical property integrity of dissolver vessel materials.

Keywords: Corrosion; Materials Characterization

7.	A New Class of Steels for Thick Wall Pressure Vessels	FY 1981 FY 1982	PYA $325

DOE Contact: S.J. Dapkunas, (301) 353-2784 FTS 233-2784
University of California, Department of Materials Science
(Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7843)
E.R. Parker, P.N. Spencer, J.A. Todd, (415) 642-0863

The objective of this work is to develop a new class of pressure vessel steels. Precipitation-hardened alloys should in principle have properties much less sensitive to section thickness than conventional bainitic or martensitic steels. Ni-V-C steels appear capable of giving good mechanical properties with very slow cooling rates. The program will optimize compositions with respect to toughness, weldability, and other operationally important characteristics.

Keywords: Alloy Development; Coatings and Films

8.	Alloy Development for Thick Walled Pressure Vessels	FY 1981 FY 1982	PYA 0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of California, Department of Materials Science
(Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7843)
E.R. Parker, R.O. Ritchie, J.A. Todd, (415) 642-0863

The current objectives are primarily aimed at producing a modification of 2-1/4 Cr-1 Mo steel (Ni and mischmetal additions) to improve hardenability, toughness, and resistance to temper embrittlement. Good progress has been made in this direction but there has not been a great deal of industrial interest in the compositions currently being examined. Rather, concerns with respect to reaction vessel materials has produced interest in higher chromium materials that have good strength. Alternatively, 2 1/4 Cr-1 Mo steel could remain of interest providing that stable microstructures can be developed that are strong, tough, and resistant to hydrogen attack. The UCB Project will lead the AR&TD effort to produce a modified alloy that can be used in reaction pressure vessels at temperatures as high as 540^{o}C. Alloys that have been produced and characterized through the UCB Program on design of low alloy steels will be examined in some detail to evaluate their adequacy with respect to strength, toughness, and resistance to hydrogen attack under dynamic loading.

Keywords: Alloy Development; Alternative Materials

9.	Microstructure and Micro-mechanical Response in Austenitic Stainless Steel Overlays on Low Alloy Steel Plate	FY 1981 FY 1982	0 $48 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of Cincinnati, Department of Materials Science and Metallurgical Engineering (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-22279C)
J. Moteff, (513) 475-3096

This research is expected to provide sufficient information to establish correlations between the weld overlay process, postweld heat treatment, microstructure, micro-mechanical response and macroscopic mechanical behavior. Microhardness is being used to establish the material micro-mechanical behavior at various temperatures. This project will, in addition to furnishing an understanding of the reasons for existing weldment microcracking problems, help optimize the welding process and postweld heat treatment variables.

Keywords: Materials Processing; Materials Characterization

10. <u>Metallurgical Response and Behavior of the Weld Fusion and Heat Affected Zone in Cr-Mo Steels for Fossil Energy Applications</u>	FY 1981 FY 1982	0 $58 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of Tennessee, Department of Chemical, Metallurgical, and Polymer Engineering (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7685X77)
C.D. Lundin, (615) 974-5170

The objective of this research is to develop fundamental information on the metallurgical behavior of the heat affected zone of welds in chromium-molybdenum alloys. This is being accomplished by: (1) documenting transformation behavior under the welding conditions that involve rapid heating and cooling, (2) determining the metallurgical transformation products in the heat affected zone and fusion zone, (3) determining the sensitivity of the materials to heat affected zone cracking, (4) determining the sensitivity of the materials to phenomena such as reheat cracking and/or hot cracking, and (5) determining the influence of the various heat affected zone regions on the creep rupture behavior.

Keywords: Materials Processing; Materials Characterization

11. <u>Characterizing and Improving the Toughness of Thick-Sectioned Electroslag Weldments</u>	FY 1981 FY 1982	$80 K $92 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Colorado School of Mines, Department of Metallurgical Engineering (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-07219C)
G.R. Edwards, R.H. Frost, (303) 273-3773

The objective of this program is to characterize the effects of process variables, including potential, electrode composition and velocity, and flux composition, that are important to the optimization of the electroslag welding process. Early work focused on electroslag weldments in 100 mm plates of 2-1/4 Cr-1 Mo steel. Emphasis was placed on process control and flux development rather than microstructural and mechanical properties characterization. Welding of thicker plates is not envisioned since to some extent commercially produced electroslag weldments in 2 1/4 Cr-1 Mo steel are currently available. In contrast, the CSM Program is aimed at a more fundamental understanding of the electroslag welding process.

Keywords: Materials Processing; Joining Methods; Materials Characterization

12. <u>Characterization of Heavy Section Weldments of 2-1/4 Cr-1 Mo Steet</u>	FY 1981	$90 K
	FY 1982	0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
G.M. Goodwin, D. P. Edmonds - (615)574-4809, FTS 624-4809

Submerged-arc, electron-beam, and narrow gap gas tungsten arc weldments were characterized under this program. Characterization included microstructural analyses, mechanical properties testing, and investigations of postweld heat treatment time and temperature effects on toughness and strength.

Keywords: Materials Processing; Material Characterization

13. <u>An X-Ray Study of Residual Stresses in Narrow Groove TIG Weldments</u>	FY 1981	$104 K
	FY 1982	0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Pennsylvania State University Materials Research Laboratory
(Contract No. DE-AC05-79OR13591)
C.O. Ruud - (814) 863-2843

X-ray diffraction techniques are being used to measure residual stresses adjacent to welds of various types. The first activity is an X-ray stress analysis of the NG-GTA weld produced by Westinghouse-Tampa. This will be followed by a detailed analysis of a SAW weld and a NG-GTA weld in the 300 mm plate of 2 1/4 Cr-1 Mo steel obtained by ORNL. Efforts will be made to procure and analyze an electron beam (EB) weldment in the same plate. An examination of residual stress distribution in cladding will be made. Experimental data obtained on weldments will be correlated with predictions based on a finite element model, experimental mechanical properties data produced elsewhere in the AR&TD Program.

Keywords: Materials Processing; Materials Characterization

14. Development of Automated Welding Processes of 2-1/4 Cr-1 Mo Steet

FY 1981 $277 K
FY 1982 0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Westinghouse Electric Corporation, Tampa Division
(Contract No. DE-AC05-780R13511)
U. A. Schneider - (904) 477-0535

A variation of the gas tungsten-arc welding process was investigated. This process uses AC-heated filler wire and a narrow joint preparation to increase the rate at which filler metal is deposited and reduce the amount of filler necessary for a given application. Welding characteristics of the system and properties of the weld were investigated. A field demonstration of the process, including all necessary fixturing and positioning equipment, was made after laboratory research was completed.

Keyword: Materials Processing

15. Hydrogen Attack in Cr-Mo Steels at Elevated Temperatures

FY 1981 $129 K
FY 1982 $152 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Cornell University, Materials Science and Engineering Department
(Contract No. W-7405-eng-26, Union Carbide Corporation
Subcontract No. 7963)
Che-Yu Li - (607) 256-4349

The objective of this program is to determine the kinetics of nucleation and growth of methane bubbles or cavities in 2 1/4 Cr-1 Mo steels (primarily ASTM 387) at elevated temperatures under the influence of high pressure hydrogen and applied stress and to develop kinetic equations for estimating the number density and size distribution of grain boundary cavities as a function of time under conditions of interest to coal conversion plant operations. Currently, this is the only in-situ hydrogen attack work supported by the AR&TD Program. All other programs that address hydrogen attack involve autoclave exposure followed by some sort of evaluation. The work on the effect of constant stress and pressure on the nucleation and growth of methane bubbles in low alloy steels will be continued. Models will be developed, based on experimental observations, to describe hydrogen attach in 2 1/4 Cr-1 Mo steel and the important metallurgical parameters will be identified. Work on 3 Cr-1 Mo steel along with tests on a Japanese version of modified 2 1/4 Cr-1 Mo steel will be performed.

Keyword: Hydrogen Effects

16. Evaluation of Fracture Toughness of Pressure Vessel Steels

FY 1981 $185 K
FY 1982 0

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R. K. Nanstad - (615) 574-4471, FTS 624-4471

The goal of this task is the characterization of the fracture toughness of steels and their weldments that are candidates for the construction of large coal conversion pressure vessels. Included in this study is the influence of service environment on the stability of mechanical properties.

Keyword: Materials Characterization

17. Effect of Heat Treatment on Microstructure and Mechanical Properties of Modified Low Alloy Steels

FY 1981 0
FY 1982 $200 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R. K. Nanstad, R. W. Swindeman - (615) 574-4471, FTS 624-4471

The objective of this research is to determine the effects of heat treatment on the microstructure and mechanical properties of modified low-alloy steels and their weldments that are candidates for the construction of large coal conversion pressure vessels. The Cr-Mo steels, including modifications to standard 2-1/4 Cr-1 Mo and 3 Cr-1 Mo specifications, are under development to increase strength at elevated temperatures. This work is concerned with the influence of processing heat treatments, postweld heat treatments, and in-service thermal aging of the microstructures of these modified alloys.

Keyword: Materials Characterization

18. Analysis of Hydrogen Attack on Pressure Vessel Steels

FY 1981 $146 K
FY 1982 $105 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of California at Santa Barbara, Department of Chemical and Nuclear Engineering (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-22276C)
G. R. Odette - (805) 961-3525

The initial objectives of the program have been achieved and physical models have been developed that describe the initiation and development of methane damage in carbon steel and 2-1/4 Cr-1 Mo steel. Nelson diagrams have been predicted and appear to be reasonably consistent with available data. Additional work is needed to refine the analyses and confirm the adequacy of the basic thermodynamic information available in the literature. The model has been particularly useful in establishing the relative importance of microconstituents, deformation mechanisms, and fracture mechanisms to the hydrogen attack process. In this sense it will guide the development of modified low alloy steels for optimum resistance to hydrogen attack. The role that stress steels and plastic strain transients play in the hydrogen attack phenomena is being examined. Such information is vital because the current design rules for hydrogen service restrict the use of the Nelson curves to situations where the stresses do not exceed the primary stress intensities provided in the ASME Boiler and Pressure Vessel Code.

Keyword: Hydrogen Effects

19. The Fatigue Bahavior of Chromium Containing Ferritic Steels at Elevated Temperature

FY 1981 0
FY 1982 $ 67 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of Connecticut, Metallurgy Department
(Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19K-22278C)
A. J. McEvily - (203) 486-2941

The objective of this research is to obtain a detailed understanding of the fatigue behavior of these alloys in terms of metallurgical and environmental effects. This understanding should provide a basis for the quantitative analysis of service lifetimes as well as for the optimization of the microstructure for fatigue resistance. Areas of research include fatigue crack initiation and propagation at elevated temperatures in chromium steels and their weldments with particular emphasis on the influence of oxidation.

Keyword: Materials Characterization

20. Deformation and Fracture of Low Alloy Steels at High Temperatures

FY 1981 0
FY 1982 $159 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
University of Illinois, Department of Mechanical and Industrial Engineering (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 19X-22239C)
D. L. Marriott - (217) 222-7237

The objective of this work is to investigate the microstructural changes and the mechanisms of damage accumulation that accompany, or arise from, high temperature deformation of a range of 2-1/4 Cr-1 Mo steels. The tests conducted under this program will provide a description of the microstructural changes in the chosen test materials under steady and cyclic loading. Progress toward understanding mechanisms of damage accumulation in the test materials for a spectrum of loading conditions should also result from this work. The results of the program will also provide a basis for the development of constitutive relations for correlation of damage and failure.

Keyword: Materials Characterization

21. Study to Optimize Cr-Mo Steels to Resist Hydrogen and Temper Embrittlement

FY 1981 $ 81 K
Fy 1981 $ 90 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Westinghouse Electric Corporation Research and Development Center
(Contract No. DE-AC05-78OR13513)
B. J. Shaw - (412) 256-3255

This program developed from earlier work sponsored by the American Petroleum Institute and has as its objective the establishment of the effects of composition and strength level on the tendency of Fe-Cr-Mo steels to undergo temper or hydrogen embrittlement (KISCC). Although these correlations will be developed from knowledge of the composition and heat treatment, the resulting model is expected to be largely empirical and lack a sound metallurgical basis. To rectify this situation Westinghouse initiated a new program to fully characterize the microstructures and constituents in the alloys prepared for the embrittlement work. The characterization data will be of considerable value to the hydrogen attack studies.

Keyword: Hydrogen Effects

22. Program on Corrosion of Metals in Coal Liquefaction Processes — FY 1981 $284 K, FY 1982 $146 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
The Metal Properties Council, Inc. (Contract No. DE-AC05-79OR13546)
Martin Prager, F. F. Lyle, Jr., L. M. Adams - (212) 644-7693

The objectives of this program are to (1) determine the general susceptability of carbon steels, and nickel-base alloys to corrosion in coal liquids; (2) identify and measure concentrations of suspected corrosive species in coal liquids before and after corrosion tests; (3) determine the effect of temperature on corrosion of metals and on the stability of corrosive species in coal liquids; (4) relate extent, type of corrosion, and corrosion mechanism(s) to corrosive species present in coal liquids; and (5) provide background data for the interpretation of results of in-situ corrosion tests and failures in liquefaction plants.

Keyword: Corrosion

23. Corrosion in Coal Derived Liquids — FY 1981 $350 K, FY 1982 $450 K

DOE Contact: S.J. Dapkunas, (301) 353-2784, FTS 233-2784
Oak Ridge Laboratory (Contract No. W-7405-eng-26)
J. R. Keiser, R. R. Judkins, V. B. Baylor - (615) 574-4453, FTS 624-4453

The purpose of this research is to study the modes of corrosive attack occuring in coal liquefaction processes. Such corrosion modes include general attach by organic and inorganic acids and stress-corrosion cracking. Basic corrosion studies are conducted to understand the reaction between the oxidants and engineering materials. In addition, this task includes pilot plant testing of alloys for resistance to corrosion and stress-corrosion cracking in various coal liquefaction process stream environments. The results of this work should provide an understanding of the various corrosion modes observed as on corrosion of metals and on the stability of corrosive species in coal ure liquids; (4) relate extent, type of corrosion, and corrosion mechanism(s) to corrosive species present in coal liquids; and (5) provide background data for the interpretation of results of in-situ corrosion tests and failures in liquefaction plants.

Keyword: Corrosion

24. Evaluation of Advanced Materials for Use in Coal Liquefaction Letdown Valves

FY 1981 #248 K
FY 1982 $267 K

DOE Contact: S. J. Dapkunas, (301) 353-2784, FTS 233-2784
Battelle-Columbus Laboratories (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 85X-69611C)
I. G. Wright, A. H. Clauer - (614) 424-4377

The original aim of this project was to obtain erosion data on several candidate valve trim materials under a range of slurry erosion conditions that would be useful to valve and process engineers involved in materials selection and valve design. Reconstituted coal-derived slurries were used to erode candidate materials under a range of slurry velocity and impingement angle conditions. Characterization of the erosive slurries, ranking of the erosive resistance of cemented tungsten carbides and various ceramics, and service trails of an experimental carbide valve stem were completed.

The project continues to obtain erosion data on candidate valve trim materials under varied wear conditions, investigate several approaches to the development of new erosion-resistant materials, and characterize the erosion behavior of new materials. In addition, a suitable substitute erodent and liquid carrier combination is being developed for use in standardized laboratory materials evaluation and screening tests, which preferably will reduce levels of health risks and handling problems. This project will help to develop an understanding of materials behavior in slurry erosion.

Keywords: Erosion; Materials Characterization

25. Studies of Materials Erosion in Coal Conversion Systems

FY 1981 $160K
FY 1982 $297K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Lawrence Berkeley Laboratory (Contract No. "-7405-eng-26, Union Carbide Corporation Memorandum Purchase Order No. 19X-22247V)
A. V. Levy - (415) 486-5822; FTS - 451-5822

The objective of this program is to determine the erosion-corrosion behavior of materials used in the flow passages of liquid slurries under conditions representative of those in coal liquefaction systems. From the understanding gained from testing different materials over a range of controlled operating conditions within and beyond those of currently acceptable practice, slurry flow operating parameter criteria will be developed. The information that will be gained from this program will be structured in a manner that will make it directly usable by coal liquefaction system designers.

Keywords: Corrosion; Erosion and Wear

26. Develop Model Alloys with Refractory-Metal Additions and Oxide-Disperson-Strengthened Alloys — FY 1981 0; FY 1982 $30K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, K. Natesan - (312) 972-5068; FTS - 972-5068

This project emphasizes the development of Fe-Cr-Ni alloys with refractory metal (Nb, Zr, etc.) additions and development of FE-base ODS alloys with cerium oxide and yttrium oxide additions. Detailed evaluation of promising alloys will be continued in subsequent years. Once suitable compositions for corrosion resistance are established, the developed alloys may be used as cladding, coating, or coextruded tubes in gasification systems.

Keywords: Oxide-Dispersion; Alloys

27. Creep Rupture Properties of High-Chromium Alloys in Simulated Coal Gasification Atmospheres (CGA) — FY 1981 0; FY 1982 $80K

DOE Contact - S. J. Dapkunas, (301)353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingston, K. Natesan - (312)972-5068; FTS - 972-5068

The purposes of this project are to (1) experimentally evaluate the uniaxial creep rupture behavior of selected high-chromium alloys (e.g., Incoloy 800H, Type 310 stainless steel) and weldments exposed to complex gas mixtures typical of coal-conversion process environments, and (2) correlate the creep properties such as rupture life, rupture strain, and minimum creep rate with the chemistry of exposure environment, temperature, and alloy chemistry.

Keywords: Creep Rupture; High-Chromium Alloys

28. The Effect of Coal Gasification Atmospheres on Biaxial Creep of Alloys — FY 1981 $135K; FY 1982 $200K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
EG&G Idaho, Inc., Idaho National Engineering Laboratory
(Contract No. DE-AC07-76ID01570)
G. R. Smolik - (208) 526-8317; FTS - 583-8317

The purpose of this program is to measure the biaxial stress-rupture strength and ductility of type 310 stainless steel, alloy 800H, Haynes alloy 188, and Inconel 657. Test temperatures range from 649 to 982 °C, and time of the tests is to 500 h. Data from this continuing program will be used to supplement existing data on these alloys for coal gasification environments because little information exists on the structure of these alloys after exposure to coal gasification environments.

Keywords: Creep; Gasification

29. <u>Evaluate Corrosion Mechanisms for Potential Candidate Materials in Low- and Intermediate-Btu Gasification Atmospheres</u> — FY 1981 $ 60K; FY 1982 $295K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, K. Natesan - (312) 972-5068; FTS - 972-5068

The work being conducted under this project provides a basic understanding of the corrosion behavior or commercial and model alloys after exposure to multicomponent gas mixtures. The information generated also provides a rational basis for the extrapolation of corrosion rates as a function of temperature, alloy composition, and chemistry of the gas environments. The corrosion experiments (conducted by using a thermogravimetric technique in mixed gas atmospheres) on selected commercial high-chromium alloys and on model alloys fabricated with compositional variations will establish the role of different alloying elements on the mechanisms of scale development and on the breakaway phenomena leading to scale failure.

Keywords: Corrosion; Gasification

30. <u>Exposure of Candidate Metals and Refractories in Selected Coal Gasification Pilot Plants</u> — FY 1981 $100K; FY 1982 0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
The Metal Properties Council, Inc. (Contract No. W-7405-eng-26,
Union Carbide Corporation Subcontract No. 40X-40455C)
A. O. Schaefer, R. Yurkewycz - (212) 705-7693

The purpose of this program is to evaluate candidate materials of construction through a field testing program, which consists of coupon exposure tests in almost all of the coal gasification pilot plants. Tests of one, three, and six months duration at plant operating conditions are used. Correlation between these field tests and laboratory research will yield a strong design data base upon which materials selections can be made.

Keywords: Corrosion; Materials Characterization

31. <u>Screening and Study of Behavior of Materials Subjected to Combined Erosion and Corrosion</u> — FY 1981 $200K; FY 1982 $287K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
The Metal Properties Council, Inc. (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 40X-40455C)
A. O. Schaefer, E. J. Vesley - (212) 705-7693

The purpose of this program is to obtain experimental information on the synergistic effects of corrosion and erosion. Complex laboratory experiments are carried out to evaluate the effects of corrosive environments on erosion behavior. These tests are carried out at high temperature (to 900 ^{o}C) and high pressure (to 0.7 MPa). Particle velocities of 60 m/s in a corrosive environment are studied. The results from this work will establish the critical erosion parameters for increased materials degradation in an erosion-corrosion environment at elevated temperatures.

Keywords: Erosion; Corrosion; Materials Characterization

32.	<u>Development of Nondestructive High-Temperature Erosion Monitoring System</u>	FY 1981 $158K FY 1982 $140K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, K. J. Reimann - (312) 972-5068; FTS - 972-5068

The purpose of this continuing program is to develop reliable real-time on-line high-temperature systems that will measure erosive wear. An active program involving laboratory and field tests over the past six years has developed a first-generation field-implementable system for real-time monitoring of erosive wear. The program involves development of nondestructive testing methods and evaluation of the reliability of the test methods for the measurement of erosive wear.

Keywords: Nondestructive Testing; Erosion

33.	<u>Wear-Resistant Materials for Coal Conversion Components</u>	FY 1981 $150K FY 1982 0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Albany Research Center Bureau of Mines U.S. Department of the Interior (Contract No. De-A105-800R206987)
J. E. Kelley, H. W. Leavenworth, Jr. - (503) 967-5896; FTS - 420-5896

The objective of this work is to improve the performance of coal conversion systems by developing and identifying improved wear-resistant materials for valves, nozzles, and other wear-prone components. The need for these improved materials has been amply demonstrated by frequent failures in gasification and liquefaction plants.

34.	<u>Failure Analysis of Components in Coal Gasification Systems</u>	FY 1981 $133K FY 1982 0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, D. R. Diercks - (312) 972-5068; FTS - 972-5068

The purpose of this program is to evaluate the performance of coal conversion plant components that have failed in service and to interact with plant personnel to select alternative materials, design options, and process conditions that may improve component performance. This program has resulted in an active materials information exchange between plant operators and laboratory researchers. Analysis of a failure is typically followed by a recommendation to change the material of construction for better component performance, or to modify operating procedures to avoid failure in the future.

Keywords: Failure Analysis

35. <u>Development of an On-Line Acoustic Valve Leak Detection System</u>	FY 1981	$48K
	FY 1982	0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingston, C. A. Youngdahl - (312) 972-5068; FTS - 972-5068

The purpose of this program is to develop a nondestructive acoustic system to detect internal leakage past valves for lock-hopper and dry ash letdown service as well as block valves for coal gasification and liquefaction process plants. A passive acoustic system is being developed and initial field tests have been conducted on large (>6-in.) ball valves for lock-hopper service.

Keywords: Acoustic Detection

36. <u>Development of Acoustic Emission Nondestructive Testing to Detect Fracture of Concrete Linings</u>	FY 1981	$48K
	FY 1982	0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No., W-31-109-eng-38)
W. A. Ellingson, C. A. Youngdahl - (312) 972-5068; FTS - 972-5068

The purpose of this program is to develop techniques for the application of acoustic emission sensing to detect crack formation (or other mechanical degradation) of thick refractory concrete linings of the type envisioned for full-scale gasification processes.

Keywords: Acoustic Emission

37. <u>Development of Thermal Shock Resistant Refractories</u>	FY 1981	0
	FY 1982	$100K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, D. R. Diercks - (312) 972-5068; FTS - 972-5068

The purpose of this program is to develop thermal-shock resistant refractories for use in slagging gasifiers. The proposed improvements will be accomplished by the addition of selected secondary phases in the refractory compositions so that the thermal and microstructural characteristics of the refractories are suitably modified. The basic principles of thermal shock improvement through such secondary phase additions will be established in the laboratory- and engineering-scale experiments.

Keyword: Refractories

38. <u>Improvement of the Mechanical Reliability of Monolithic Refractory Linings for Coal Gasification Process Vessels</u>

FY 1981	$43K
FY 1982	0

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Babcock & Wilcox Company Research and Development Division
(Contract No. "-7405-eng-26, Union Carbide Corporation
Subcontract No. 40X-92353V)
R. A. Potter - (804) 384-5111; FTS - 671-1060

Monolithic refractory designs based on practices in the petrochemical industry have been used in many of the non-slagging coal gasification processes being developed or partially sponsored by the Department of Energy. These linings are easy to install and relatively inexpensive and generally insulate vessel shells more effectively than brick linings. They are very prone to cracking, however, and it is this characteristic that concerns those involved with the operation and overall performance of coal conversion process. It is generally thought that the cracking and associated thermomechanical degradation of monolithic refractory linings is most significantly affected by their performance during the initial dry-out and heat-up. It was the objective of this work to improve the thermomechanical reliability, i.e., reduce or eliminate the cracking, of monolithic refractory linings of coal gasification process vessels operating to 2000°F during the initial dry-out and heat-up.

Keywords: Corrosion; Ceramics; Glasses; Materials Characterization

39. <u>Creep Behavior of Monolithic Refractory Materials</u>

FY 1981	$82K
FY 1982	$170K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Iowa State University, Engineering Research Institute, Department
of Materials Science and Engineering (Contract No. W-7405-eng-26,
Union Carbide Corporation Subcontract No. 7940)
T. D. McGee - (515) 294-9619; FTS - 865-9619

Refractory concretes appear to be prime candidate materials for the linings of dry ash coal gasification pressure vessels. Due to extreme conditions in the gasification process (temperatures to 1200°C, stresses to 2000 psi, corrosive atmosphere) it is important to have available high-temperature high stress creep data for these materials. Not only is data important but also information on the mechanisms of creep is desirable. This information is needed for ongoing research at other institutions into elimination of cracking in the refractory linings which causes failure.

Keywords: Ceramics; Glasses; Materials Characterization

40. <u>A Model to Predict Thermal Stress and Strain in Refractory Linings or Brick Linings</u> FY 1981 $36K
FY 1982 $176K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Massachusetts Institute of Technology (Contract No. W-7405-eng-26, Union Carbide Corporation Subcontract No. 7682)
Oral Buyukozturk - (617) 253-7186

The objective of this continuing program is to modify the existing model for prediction of thermal stress and strain in monolithic linings so that it can be used to predict (and improve) the performance of brick linings.

Keywords: Refractory Liners

41. Investigation of CO Disintegration of Refractories in Coal Gasifiers FY 1981 $53K
FY 1982 $68K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Virginia Polytechnic Institute and State University, Department of Materials Engineering (Contract No. DE-AC01-80ET13702)
J. J. Brown, Jr. - (703) 961-6777

The objectives of this investigation are to determine (1) whether or not Co disintegration is likely to occur in the refractories used in coal gasifiers, and (2) to identify the conditions under which CO disintegration of the refractories can be expected to be a serious problem. It is also a goal of this investigation to develop information that will assist in the identification of refractory deterioration or failure that is caused by CO disintegration.

Keywords: Corrosion; Ceramics; Glasses

42. Corrosion of Refractories in Slagging Gasifiers FY 1981 $121K
FY 1982 $235K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, S. Greenberg - (312) 972-5068; FTS - 972-5068

The purpose of this program is to investigate the parameters that affect the corrosion of refractories in slagging gasifiers so that lining lifetimes can be optmized through proper choice of refractory materials, coal selection or modification, and/or changes in process variables.

Keywords: Gasifiers; Corrosion

43. Testing and Development of Materials for Catalytic Coal Gasification Process Equipment FY 1981 $160K
FY 1982 $80K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
U.S. Department of the Interior Bureau of Mines (Contract No. DE-A105-82OR20992)
H. Heystek - (205) 758-0491

The objectives of this research are to: (1) determine the effect of catalytic coal gasification (CCG) environments on metal and refractory materials of construction by exposure to CCG reactor conditions in a laboratory simulator and (2) identify the attach mechanisms of CCG environments on metals and refractories so that materials offering improved performance at lower cost can be identified.

Keyword: Corrosion

44. ' <u>Design, Engineering, and Evaluation of Refractory Liners for Slagging Gasifiers</u> — FY 1981 $1,019K; FY 1982 $10K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
IIT Research Institute (Contract No. DE-AC05-78OR13410)
S.A. Bortz - (312) 567-4400

The purpose of this program is to determine the rate of wear of refractory lining systems under slagging conditions at sufficient scale and under prototype conditions to permit refractory lifetime determination. A 1.5-m-diam by 8.5-m-high test facility has been constructed, and the integrated checkout and shakedown of the system has been completed.

Keywords: Corrosion; Ceramics

45. <u>Phase Relations Relevant to Coal Slag</u> — FY 1981 $83K; FY 1982 $150K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Pennsylvania State University (Contract NO. W-7405-eng-26, Union Carbide Corporation Subcontract No. 9006)
Arnulf Muan - (814) 865-7659

The purpose of this program is to determine the chemical contraints affecting the performance of refractory materials under experimental conditions corresponding to those prevailing in slagging gasifiers.

In particular, this program concentrates on systems containing chromic oxide because refractories containing significant amounts of this component have demonstrated excellent resistence to corrosion. This program interfaces with the ANL and IITRI programs to provide information on chemical stability of reaction products.

Keywords: Corrosion; Ceramics

46. <u>Engineering Evaluation and Review of IIT Research Institute Refractory Test Facility</u> — FY 1981 $41K; FY 1982 $15K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
R. A. Bradley - (615) 574-6094; FTS - 624-6094

The objectives of this task are to provide project engineering overivew services and to perform evaluations and reviews of the IITRI Refractory Test Facility. The aim is to ensure the timely completion of facility construction and subsequent checkout and shakedown of the unit.

Keywords: Corrosion, Ceramics

47. <u>Silicon Carbide Powder Synthesis</u> FY 1981 0
FY 1982 $50K

DEO Contact - J. S. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
G. C. Wei - (615) 574-5129; FTS - 624-5129

The purpose of this work is to develop processes for synthesis of improved, highly pure, uniformly sinterable powders. The developmental and some selected commercial SiC powders will be characterized and evaluated.

Keywords: Powder Synthesis; Silicon Carbide

48. <u>Short Fiber Reinforced Structural</u> FY 1982 0
FY 1982 $200K

DEO Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
F. C. Gac - (505) 667-5126; FTS - 843-5126

The purpose of this study is to investigate the utility of whisker reinforcement technology for producing structural ceramic composites of improved strength and facture toughness. The program consists of two technical tasks. The first is to optimize an existing Los Alamos whisker growth process to produce alpha-phase silicon nitride (-Si_3N_4) whiskers and beta-phase silicon carbide (-SiC) whiskers of uniform size, optimum strength, and in quantities suitble for composite use. The second task will involve evaluating the contribution of the whiskers in selected ceramic-matrix composites.

Keywords: Ceramics

49. <u>Ceramic Fabrication and Microstructure Development</u> FY 1981 0
FY 1982 $200K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
G. C. Wei - (615) 574-5129; FTS - 624-5129

The purpose of this work is to develop improved structural ceramics by developing techniques for fabrication powders into dense monolithic ceramics and ceramic-matrix composites with controlled microstructure. The task includes correlation of the properties of structural ceramics with their microstructure, crystal structure, microchemistry, and fabrication history.

Keywords: Fabrication, Microstructure; Ceramics

50. <u>Mechanical Behavior and Strength of Structural Ceramics</u> FY 9181 $125K
FY 1982 $150K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
P. F. Becher - (615) 574-5157; FTS - 624-5157

The purpose of this work is to develop improved structural ceramics by correlating the mechanical properties of structural ceramics with their microstructure, crystal structure, microchemistry, and fabrication history. Changes in such key properties as flexural strength, fracture toughness, and subcritical crack growth as a function of exposure time to combustion products of fossil fuels at high temperatures are also determined. This correlation is accomplished by determining changes in mechanical properties of the structural ceramics after long-term exposures and comparing with properties of as-maunufactured specimens. Another purpose is to identify the degradation mechanisms for these materials and to determine the fundamental role of intrinsic and extrinsic defects, impurities, and second phases in limiting the high-temperature performance of structural ceramics in order to aid in the development of new materials or improvements in existing materials for fossil energy components such as heat exchangers and high-temperature gas turbines.

Keywords: Structural Ceramics

51.	High Temperature Applications of Structural Ceramics	FY 1981 $260K FY 1982 $263K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
National Bureau of Standards, Center for Material Science
(Contract No. DE-A105-800R20679)
S. J. Schneider - (301) 921-2845

The objective of this study is to characterize the high temperature failure mechanisms and factors that influence their operation with an aim toward improving the properties of structural ceramics, especially silicon carbide and silicon nitride based materials, for use in coal conversion applications.

Keywords: Ceramics; Glasses; Material Characterization

52.	Corrosion of Alloys in FBC Systems	FY 1981 $132K FY 9182 $165K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Argonne National Laboratory (Contract No. W-31-109-eng-38)
W. A. Ellingson, K. Natesan - (312) 972-5068; FTS - 972-5068

The purposes of this project are to (1) experimentally evaluate the high-temperature corrosion behavior of iron- and nickel-base alloys in gas environments with a wide range of oxygen, sulfur, and carbon potentials, (2) develop corrosion information in the temperature range 400 to 750^{o}C in mixed-gas atmospheres using internally cooled tube specimens of selected commercial materials, (3) evaluate deposit-induced corrosion behavior of heat-exchanger and gas-tubing materials after exposure to multicomponent gas environments, and (4) develop corrosion rate expressions, based upon experimental data, for long-term extrapolation to component design lives.

Keywords: Corrosion; Fluidized Bed Combustion

53. Materials Testing in an Atmospheric Fluidized Bed Combustor — FY 1981 $72K; FY 9182 0

DOE Contact -¯S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
General Atomic Company (Union Carbide Corporation Subcontract No. 41B28916C)
W. S. Rickman - (714) 455-3860

The purpose of this project is to test materials in an operating atmospheric fluidized bed combustor (AFBC) to determine the mechanism of calcium sulfate film formation on cooled and uncooled heat transfer surfaces.

Keywords: Corrosion

54. Investigation of Gas-Metal Reactions in Cyclic Oxidizing and Reducing Atmospheres and the Effect of Sulfate Deposits on Corrosion — FY 1981 $125K; FY 1982 $200K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
J. H. DeVan, P. J. Ficalora - (615) 574-4451; FTS - 624-4451

The purpose of this task is to determine the corrosion properties of heat exchanger and uncooled internal structural materials under normal and off-normal heating conditions in coal-fired fluidized-bed combustors (FBCs).

The materials are exposed to simulated FBC environments under a variety of well-defined operating conditions in order to systematically evaluate corrosion-erosion mechanisms as they apply to heat exchanger surfaces in coal-fired, limestone-scavenged fluidized beds. This task is intended to guide the selection of materials of construction for utility and industrial AFBCs intended for the mid 1980s.

Keywords: Gas-Metal Reactions; Fluidized-Bed Combustors

55. Hot Corrosivity of Coal Conversion Products on High-Temperature Alloys — FY 1981 0; FY 1982 $90K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
University of Pittsburgh (Contract No. DE-AC01-79ET13547)
G. H. Meier, R. A. Stoehr, E. A. Gulbransen - (412) 624-5316

The object of this program is to develop information about the hot corrosion of high-temperature alloys in the environment likely to be found when a gas turbine is operated on low Btu gas produced from coal in a fluidized bed gasifier. The program is designed to determine the mechanisms of attack and the major factors which influence the kinetics of hot corrosion in these environments.

Keywords: Corrosion

56. Investigation of the Mechanisms of Molter Salt Corrosion of Candidate Materials for Molten Carbonate Fuel Cells

FY 1981 0
FY 1982 $50K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Oak Ridge National Laboratory (Contract No. W-7405-eng-26)
J. H. DeVan - (615) 574-4451; FTS - 624-4451

This program focuses on the corrosion mechanisms associated with the anode and cathode current collectors in molten carbonate fuel cells. DTA/TGA studies of structural metals in Li_2CO_3-K_2CO_3 salts will be conducted to establish the sequence of oxidation reactions that occur between the elements Fe, Ni, Cr, and Co and the salt in an oxidizing gas typical of the cathode region. The resistance of Ni_3Al to a thin coating of Li_2CO_3-K_2CO_3 will be evaluated under reducing (anodic) and oxidizing (cathodic) conditions. Lastly, salt purification techniques and analytical procedures will be developed to permit determinations of the solubilities of structural metal oxides (Fe_3O_4, Cr_2O_3, and Al_2O_3) in molten carbonate salt under anodic and cathodic conditions.

Keywords: Fuel Cells, Current Collectors

57. Oxide Electrodes for High Temperature Fuel Cells

FY 1981 0
FY 1982 $103K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Pacific Northwest Laboratory (Contract No. W-7405-eng-26 Union)
J. L. Bates - (509) 375-2579; FTS - 444-2579

This project is a research effort to find and develop highly electronically conducting oxides with resistance to corrosion in molten alkali metal carbonates. The oxides are to be used as cathodes in molten carbonate fuel cells. Specifically, the work will determine the effects of rare earth (RE) and indium oxide additions on the electrical transport properties and on the corrosion resistance of HfO_2 (ZrO_2)-RE_xO_y-In_2O_3. In addition, the study will develop an understanding of the crystallographic, microstructural, and phase equilibrium factors which influence the above properties. Materials will be fabricated for testing under molten carbonate fuel cell conditions.

Keywords: Fuel Cells

58. Materials and Components Newsletter

FY 1981 $110K
FY 1982 $133K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
Battelle-Columbus Laboratories (Contract No. DE-AC05-80ET10609)
E. E. Hoffman (DOE/ORO) - (615) 576-0735; FTS - 626-0735
I. G. Wright (BCL) - (614) 424-4377

The purpose of this task is to publish a newsletter to address recent developments in materials and components in fossil energy applications.

Keywords: Materials; Components

59. Materials Research for the Clean Utilization of Coal; Task 2: Materials Performance and Properties Data

FY 1981 $275K
FY 1982 $267K

DOE Contact - S. J. Dapkunas, (301) 353-2784; FTS - 233-2784
National Bureau of Standards, (Contract No. EA-77-A-01-6010)
S. J. Schneider, H. M. Ondik, R. C. Dobbyn - (301) 921-2892

The goal of this project is to assist the coal conversion industry in extending the userful life and reliability of plant components by maintaining a central source of information on the performance, especially failures, of materials and components used in coal conversion environments.

It will provide an integrated materials properties data base for materials of construction to aid the coal conversion industry in the design, construction, and operation of plants converting coal to alternate energy forms, including MHD power generation.

The project will collect and evaluate the appropriate information, maintain suitable computer files for ready retrieval, and disseminate the data in convenient form to the users.

Keywords: Materials Characterization

Appendix N: Division of Surface Coal Gasification

PROJECT TITLE: PLANTS MATERIALS SURVEILLANCE TESTS $0 (81) $460K (82)

DOE Contact - J. Carr (301) 353-5985, FTS 233-5985
Oak Ridge National Laboratory, Oak Ridge, Tennessee
R. A. Bradley - (615) 574-6094, FTS 624-6094
Metal Properties Council, Inc., New York, New York
O. A. Schaefer (212) 644-7694

OBJECTIVE:

To develop a data base to assist in selection of materials for economical construction and reliable operation of commercial coal gasification (CG) plants through the evaluation of metals and refractories in CG pilot plants; to provide a means to correlate laboratory tests, establish materials corrosion/erosion mechanisms and identify effects of plant and process variables on material corrosion.

STATUS:

The selection of construction materials for future coal gasification plants requires that a materials performance data base be developed. Since 1973, The Metal Properties Council, Inc. has conducted a multiphase program to evaluate the resistance of construction materials to coal gasification environments. This MPC program has included the exposure of alloys and refractories in operating coal gasification pilot plants.

For each pilot plant, MPC will perform in-plant exposure tests based on a test plan developed jointly by the MPC subcontractor and the industrial developer of the gasifier. Metals and refractories will be exposed in appropriate test locations in the pilot plants and process conditions will be monitored for each test location. The plants to be included in the test program are Peat-Gas (HYGAS), U-Gas, BiGas, Westinghouse, and Mountain Fuel Resources. Other plants, such as GE-GAS and Exxon, may be included in subsequent tests.

Surveillance testing in the Synthane and CONOCO Coal pilot plants was completed as part of the AR&TD Fossil Energy Materials Program. Two text exposures each were completed in the U-Gas and BiGas plants, and four test exposures were completed in the HYGAS plant.

Topical reports on materials performance in the Synthane and CONOCO Coal pilot plants were prepared. Results of tests completed on metals were published.

This is a new coal gasification project initiated in FY 82 which is essentially a continuation of an earlier ARTD project.

PROTECTIVE COATINGS AND CLADDINGS - APPLICATION/EVALUATION $0 (81) $550K (82)

DOE Contact J. Carr (301) 353-5985, FTS 233-5985
Argonne National Laboratory, Argonne, Illinois
Dr. W. A. Ellingson (312) 972-5068, FTS 972-5068
Lockheed Palo Alto Research Laboratory
Dr. Roger Perkins (415) 493-4411

OBJECTIVE:

To develop reliable application methods and materials for coating and/or cladding gasification constituent elements/components for temperature, corrosion and erosion protection and thereby enhance economic and reliable construction and operation of coal gasification plants.

STATUS:

A number of coating and cladding materials have been identified through laboratory experiments for possible application to gasification pilot plant components, such as cyclones, dip legs, heat exchangers, pipes, valves, and instrumentation probe plants. Several coating, cladding and weld overlay development programs were sponsored by the AR&TD Fossil Energy Materials program. Lockheed Palo Alto Research Laboratory developed FE/CoCrAlY(Hf) coatings and FECrAlHf claddings that showed excellent corrosion resistance in low- to medium-Btu simulated coal gasification environments for up to 2000 h at 1600-1800 degrees F. Interdiffusion, however, limits the lifetime beyond 2000 h. Further work will be required to extend the useful lifetime to at least 10,000 h. International Nickel Corp. (INCO) developed higher chromium nickel-based alloys for use as weld overlays. These compositions have shown good corrosion resistance for up to 1000 h in a high-Btu environment at 1800 degrees C, but their performance in low- to medium-Btu environments have not been evaluated.

Laboratory and field testing through methods and materials introduced under AR&TD programs will be developed so that they can be readily used on a commercial basis. Bonding, mechanical integrity, and microstructural characteristics will be extensively examined before and after tests. As the coatings/claddings and weld overlay techniques exhibit satisfactory performance in a gasifier environment, they will be identified and the technology will be transferred to appropriate industries for commercial applications. Furnace-fused coating compositions and the substrate types will be tested in order to establish requirements for elimination of void formation and interface separation. Laser surface-fused CoCrAlHf(Y) coatings will be prepared to establish requirements for crack-free deposits. Test samples will be prepared with a two-layer, laser-fused coating. Weld overlay tests using FeCrAlHf clad Alloy 800 will be used to establish practices for weld deposition on cut edges and over base metal weld overlay will be developed. Alternative coatings (e.g., ceramic coatings) and coating procedures will be examined for possible application in gasifier components.

New coal gasification project initiated in FY 82 based on earlier ARTD project.

CERAMIC FABRICATION/APPLICATION TECHNOLOGY - SUBTASK A LOCKHOPPER VALVES — $0 (81) $200K (82)

DOE Contact, J. Carr (301) 353-5985, FTS 233-5985
Los Almos National Laboratory, Los Alamos, New Mexico
Frank D. Gac, (505) 667-5126, FTS 843-5126

OBJECTIVE:

To develop and apply ceramic technology to coal gasification plant components to achieve higher reliability, durability, and lower cost under very high temperature and extreme erosive, corrosive conditions by developing special brittle materials (ceramic) design methodology and fabrication methods and integrally effecting exploratory development of critical components, such as lockhopper valves.

STATUS:

One area that is key to the successful commercialization of coal gasification is valving, in particular, the type III lockhopper valve. The erosive/corrosive conditions, coupled with elevated temperature, suggest ceramics should be utilized for this application. Attempts by other researchers to address this problem met with poor success due to a basic unfamiliarity of designing with ceramics. The investigators in this program intend to mesh extensive materials fabrication expertise with state-of-the-art brittle materials design knowledge to address the type III lockhopper valve problem.

This is a new coal gasification project initiated in FY 82.

CERAMIC FABRICATION/APPLICATION TECHNOLOGY - TASK B - HEAT EXCHANGER — $0 (81) $300K (82)

DOE Contact, J. Carr (301) 353-5985, FTS 233-5985
Argonne National Laboratory, Argonne, Illinois
Dr. W. A. Ellingson, (312) 972-5032, FTS 472-5068
Solar Turbine International, San Diego, California
Mike Ward, (714) 238-5572

OBJECTIVES:

To develop and apply ceramic technology to coal gasification plant components to achieve higher reliability, durability, and lower cost under very high temperature and extreme erosive, corrosive conditions by developing special brittle materials (ceramic) design methodology and fabrication methods and integrally effecting exploratory development of critical components such as heat exchangers.

STATUS:

Design methodology for structural components made from brittle material requires a different approach than when ductile materials are used. Although the design methodology required for ceramics is relatively new, developments in design methodology for brittle materials over the past 10 years for other components appear to be applicable to heat-exchanger design. Recent approaches to brittle materials design have evolved from the high-temperature ceramic gas turbine work which began under ARPA funding in the early 1970's and continues today with DOE Conservation Funding under the program "Brittle Materials Design, High-Temperature Gas Turbine." The approach taken in the program has been to apply finite element computer codes to the heat transfer and stress analysis of a prospective component. In conjunction with computer analysis, materials properties of candidate materials are carefully measured. Because strength data on brittle ceramics vary widely due to the distribution of flaws in the ceramics, a statistical approach is taken to the correlation of measured strength data with the probability of existence of critical flaws in the material.

Feasibility was demonstrated (under an earlier ARTD project) for constructing large SiC heat-exchanger modules which possess capabilities required for heat exchangers, namely minimum cross leakage and gas permeability, resistance to shock by thermal transients, and ability to withstand 100 psig internal pressure at operating temperatures of 2500 degrees F.

This is a new coal gasification project initiated in FY 82 based on the earlier ARTD effort. The silicon carbide heat exchangers built by Solar Turbines, Inc. will be retubed with finned ceramic tubes and tested to obtain material performance data relative to heat transfer, leakage (pressure drops), effectiveness, and structural integrity. Mechanical tests will be conducted on various components (headers, finned and smooth tubings, joints and header transitions pieces) to validate the design methodology. The structural, thermal, and hydraulic analyses used in the design of the ceramic heat exchanger will provide the basis for a design methodology. Materials design data in a gasifier environment will be obtained.

SLAGGING REFRACTORIES $0 (81) $400K (82)

DOE Contact, J. P. Carr, (301) 353-5983, FTS 233-5985
Argonne National Laboratory, Argonne, Illinois
Dr. W. A. Ellingson, (312) 972-5068, FTS 972-5068

OBJECTIVES:

To develop the technology to attain an adequate life (minimum of 1 year) for refractories to line the main pressure vessels of slagging coal conversion systems with minimum cost and use of critical materials and thereby realize the greater efficiencies and economics achievable in slagging gasification systems.

STATUS:

Refractories used in main process vessels of slagging coal gasifiers are subjected to extremely hostile environments. Temperatures of 1400-1750 degrees C, highly corrosive coal slags, and highly reducing multicomponent gas atmospheres pose difficult challanges for any material. Of all the potential refractory failure mechanisms, corrosion by coal slags and thermal shock appear to be the most serious and most difficult to solve effectively.

Tests to date have not been able to separate performances of these six best refractories despite significant differences in their microstructures and bonding. More aggressive accelerated testing methods are being developed. These tests emphasize the synergism between the corrosion and erosion aspects of degradation. Further, qualitative observations made after corrosion tests indicate that high chromia refractories possess very poor thermal shock characteristics. Data are currently available to rank the sensitivity of the candidate refractories to thermal shock damage.

New Coal Gasification project initiated in FY 82 based on earlier ARTD project/work.

PROCESS PLANT MATERIALS REVIEW, EVALUATION, AND SUPPORT $0 (81) $225K (82)

DOE Contact, J. Carr, (301) 353-5985, FTS 233-5985
Argonne National Laboratory, Argonne, Illinois
Dr. W. A. Ellingson, (312) 972-5068, FTS 972-5068
Oak Ridge National Laboratory, Oak Ridge, Tennessee
R. A. Bradley, (615) 574-6094, FTS 624-6094

OBJECTIVE:

To review and evaluate the performance of pilot plants to establish the data base to define materials requirements and guide respective development efforts for the ultimate construction of more reliable, economic, efficient, and safe coal gasification plants.

STATUS

Selection of materials, components, and instrumentation for operating coal gasification pilot plants was based on experience gained in the fossil-fueled power and petrochemical industries. In many instances, these selections are inadequate for commercial plants. Assessment and documentation of performance in operating plants is needed for a data base to design subsequent commercial plants as well as to provide guidance in establishing needed R&D programs.

The first step in this task will be a thorough baseline audit of each coal gasification process selected to identify the significant materials requirements and likely materials problem areas. These areas will then be analyzed to define the anticipated service conditions and potential failure modes and to determine whether additional materials development is required. After the process audit is completed, the materials requirements of the corresponding pilot or demonstration plant will be reviewed. Materials testing and problem areas will be defined, and technology gaps identified. Materials testing and surveillance activities in the plants will be initiated where appropriate, and gaps in plant operating data needed to better define materials service conditions in critical components will be determined. Ongoing follow-up activities will then be carried out to ensure that the necessary operating data are collected and that any materials performance and surveillance tests initiated are properly conducted and analyzed. Reviews, testing, and analysis activities will be documented in a series of reports for each coal gasification process.

New Coal Gasification project initiated in FY 82.

ADVANCED PRESSURE VESSEL MATERIALS FABRICATION TECHNOLOGY $0 (81) $100K (82)

DOE Contact, J. P. Carr, (301) 353-5985, FTS 233-5985
Oak Ridge National Laboratory, Oak Ridge, Tennessee
R. A. Bradley, (615) 574-6094, FTS 624-6094

OBJECTIVE:

To advance pressure vessel forming technology to attain more economic and readily fabricated full scale coal gasification system vessels through the use of higher strength materials and alternate fabrication techniques.

STATUS:

The current candidate material for gasification pressure vessels is a 2-1/4 Cr-1 Mo steel (SA-387 grade 22 class 2). The A542 specification for 2-1/4 Cr-1 Mo steel describes higher strength versions of this steel, and the use of this A542 material would allow increases in design stress intensities above the SA-387 material. The higher strength versions of 2-1/4 Cr-1 Mo steel are not currently approved for pressure vessel construction in the ASME Code, primarily because of an insufficient data base.

This task will provide the materials data base that is necessary to obtain ASME Code approval of a high-strength pressure vessel steel (A542). This stronger grade of steel will result in thinner wall vessels, thus reducing the cost of materials and fabrication.

This new Coal Gasification project was initiated during FY 82.

APPENDIX O: Office of Breeder Reactor Technology: Fuels and Core Materials Division

The Fuels and Core Materials Division materials program described in the following FY 1981 and 1982 Budget Summary are directed at providing technical support on materials required for the design of reliable, safe and economical fast breeder reactor plants and their operation. The funding for core component materials, such as reactor fuels, absorbers, cladding and ducts, at various contractors, national laboratories and government laboratories is as follows:

1. Advanced Fuels - Transients $ 600 (81); $ 200 (82)

   DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
   Argonne National Laboratory (Contract No. W-31-109-ENG-38)
   L. Neimark, S. M. Gehl - (312) 972-5199; FTS 972-5199

   Keywords: Ceramics, Glasses; Radiation Effects

2. Advanced Fuels - Transients $ 150K (81); $ 180K (82)

   DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
   Atomics International (Contract No. DE-AT03-76SF76026)
   W. Wolfe, E. Specht, B. Ostermeir - (213) 341-1120; FTS 791-1120

   Fabricate advanced fuel blanket pellets for carbide blanket fuel assembly testing. Perform pin evaluation and pin code development.

   Keywords: Ceramics, Glasses; Fuel Development, Uranium Carbide, Pin Evaluation, Code Development

3. Advanced Fuels - Steady State $ 300K (81); $ 200K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Combustion Engineering Company (Contract No. DE-AT02-76-CH91001)
S. A. Caspersson - (203) 688-1911

Assess an extended lifetime advanced oxide fuel system.

Keywords: Ceramics, Materials Characterization

4. Alloy Development $ 364K (81); $ 300K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
General Electric Company (Contract No. DE-AT03-76SF1031)
E. A. Aitken - (408) 738-4238; FTS 738-7238

Perform examinations and analysis of creep-in-bending test, and assess post-irradiation ductility of advanced alloys for core components.

Keywords: Radiation Effects, Materials Characterization

5. Advanced Fuels Development $1,390K (81); $2,250K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
General Electric Company (Contract No. DE-AT03-76SF1031)
E. A. Aitken - (408) 738-4238; FTS 738-7238

Design, irradiate and evaluate advanced oxide fuels, and blankets under specific conditions of neutron irradiation. Tests are focused on providing data for design and licensing in the areas of thermal performance, mechanical performance, chemical effects and run-beyond-cladding breach.

Keywords: Ceramics, Fuel Development, Radiation Effects

6. Alloy Development $3,814K (81); $3,500K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
J. L. Straalsund - (509) 376-3306; FTS 444-3306

Characterize the in-reactor deformation behavior of breeder reactor cladding and duct materials. Work emphasizes measurement of in-reactor swelling, creep, and post-irradiation mechanical properties such as tensile behavior and fracture toughness. Irradiation resistance of tailored commercial and development alloys is investigated.

Keywords: Radiation Effects, Materials Characterization

7. Reference Fuels $3,139K (81); $4,080K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Design, fabricate, irradiate, examine and evaluate standard FFTF driver fuel. Conduct special tests such as high power, power-to-melt and Fuel Open Test Assembly experiments. These experiments cover both steady-state and transient conditions.

Keywords: Ceramics, Materials Characterization

8. Advanced Fuels $3,175K (81); $3,090K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Design, fabricate, irradiate, and examine advanced driver fuel. Perform post-irradiation examination of advanced breached fuel pins.

Keywords: Ceramics, Radiation Effects

9. Absorbers $1,256K (81); $ 910K (82)

DOE Contact: A. VanEcho, (301) 353-3930; FTS 233-3930
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
M. Parker - (509) 376-3238; FTS 444-3238

Design, fabricate, irradiate absorber pellets, pins and assembly experiments for reference and advanced breeder reactor control rod concepts. This experimental work includes physical and mechanical property evaluation of boron carbide and related materials.

Keywords: Ceramics, Radiation Effects, Materials Characterization

10. Fuel Support Technology $2,145K (81); $1,020K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Obtain by laboratory measurements, properties data required for design, performance analysis and fabrication of fuel and blanket materials. Develop analytical relationships to describe experimental data compatible with performance codes and models. Review, evaluate and recommend properties data for non-metallic fuel/blanket materials.

Keywords: Materials Characterization

11. Fuel Fabrication $1-,240K (81); $13,250K (82)

DOE Contact: W. M. Hartman, (301) 353-5198; FTS 233-5198
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
L. Rice - (509) 376-1911; FTS 444-1911

Design, develop and build an automated fuel pin fabrication facility. The facility will incorporate advanced equipment and techniques designed to reduce personnel exposure and maximize special nuclear materials safeguards.

Keywords: Materials Processing

12. Program Management $1,424K (81); $ 800K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
D. E. Mahagin - (509) 376-0384; FTS 444-0384

Draft and implement multi-year program and test plan.

Keywords: Program Plan

13. Post Irradiation Examination, Deactivation and Storage of Carbide Fuel $2,145K (81); $1,020K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Los Alamos National Laboratory (Contract No. W-7405-ENG 36)
J. L. Green, W. T. Wood - (505) 667-2610; FTS 843-2610

Conduct hot cell operations. Deactivate carbide fuel/blanket fabrication facilities.

Keywords: Ceramics, Materials Processing, Materials Fabrication

14. Reference Fuels $2,145K (81); $1,020K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Hanford Engineering Development Laboratory (Contract No. DE-AC14-76FF02170)
C. M. Cox - (509) 376-0384; FTS 444-0384

Obtain by laboratory measurements, properties data required for design, performance analysis and fabrication of fuel and blanket materials. Develop analytical relationships to describe experimental data compatible with performance codes and models. Review, evaluate and recommend properties data for non-metallic fuel/blanket materials.

Keywords: Materials Characterization

15. <u>Fuel/Blanket Assembly Development</u> $2,615K (81); $2,590K (82)

DOE Contact: R. J. Neuhold, (301) 353-4471; FTS 233-4471
Westinghouse Advanced Reactors Division (Contract No. EY-76-C-02-3045-M)
A. Boltax - (412) 722-5363; FTS 726-5363

Design, fabricate and test performance of oxide fuel subassemblies in support of the national effort on advanced fuels development. Perform design, thermal-hydraulic analysis, and fabrication of blanket fuel assemblies. Develop and verify pin life codes.

Keywords: Ceramics, Materials Processing, Materials Characterization

Appendix P: Office of Breeder Technology Projects: Materials and Structure Program

The Breeder Mechanical Component Development Division, under the Office of Breeder Reactor Technology Projects is responsible for overall program management of the Materials and Structures Program. The objectives of the Program are to (1) provide technologies to assure LMFBR components and systems will be safe and reliable during their design lifetime: (2) provide LMFBR designers and manufacturers with materials, methods, procedures, tools and criteria that are consistent with good economics, are not overly conservative, and provide for broad component design flexibility; and (3) provide an improved technological basis for licensing. R&D programs for FY 1981 and FY 1982 in the material area are described below.

1. Mechanical Properties Design Data $2894K (81), $2570K (82)

DOE Contact: C. Beals, (391) 353-4329, FTS 233-4329
Argonne National Laboratory, Chicago, IL, Tom Kassner, FTS 972-5191
GE/ARSD, Sunnyvale, CA, Peter Ring, (408)-925-2330
Hanford Engineering Development Laboratory, Richland, WA, L. Blackburn, FTS 444-3335
Idaho National Engineering Laboratory, Idaho Falls, ID, G. Korth, FTS 583-0345
Naval Research Laboratory, Washington, DC, D. Michel, (202) 767-2621
Oak Ridge National Laboratory, Oak Ridge, TN, C. Brinkman, FTS 624-5106
Westinghouse-Advanced Reactors Division, Madison, PA, W. Ray, (412) 722-5512

OBJECTIVES: Generate materials properties data to support the development and implementation of high temperature structural design methods and criteria. Characterization of the deformation and failure characteristics of reference structural materials. Environments considered include irradiation, steam, sodium and elevated temperature.

STATUS: The materials properties which are being measured are physical properties, yield strength, tensile strength, fatique, creep rupture, creep-fatique, impact strength, and fracture mechanics properties. The materials under consideration are Type 304 stainless steel, Type 316 stainless steel, ferritic 2-1/4 Cr-1 Mo steel, ferritic 9 Cr-1 Mo (modified) steel, A-286 steel, Alloy 800 steel and Alloy 718 steel. Also, Type 308 stainless steel, Type 16-8-2 stainless steel, and INCO 82 steel and their weldments. In addition, transition weld joints between ferritic steel and austenitic stainless steel are being characterized.

Keywords: Materials Characterization, Radiation Effects, Mechanical Properties.

2. Fabrication Technology $735K (81), $480K (82)

DOE Contact: C. Beals, (301)-353-4329, FTS 233-4329
GE/ARSD, Sunnyvale, CA, Peter Ring, (408)-925-2330
Idaho National Engineering Laboratory, Idaho Falls, ID, H. Smartt, FTS 583-8333
Oak Ridge National Laboratory, Oak Ridge, TN, G. Goodwin, FTS 624-4809

OBJECTIVE: Develop improved methods and procedures for fabricating LMFBR piping systems. Develop designs and fabricating methods for transition joints between piping sections of ferritic and austenitic materials. Develop materials for welding austenitic stainless steels which have improved properties at LMFBR operating temperatures.

STATUS: The products from several commercial methods of fabricating austenitic stainless steel pipe have been evaluated and characterized. Fabrication methods have been developed for making ferritic 2 1/4 Cr-1 Mo/Alloy/800/Type 316 stainless steel transition joints and thermal transient testing of prototypical size joints has been conducted. Materials properties of several Controlled Residual Element (CRE) austenitic stainless steel weld materials have been determined.

Keywords: Joining Methods, Fabrication, Welding.

3. Nondestructive Testing Technology $935K (81), $695K (82)

DOE Contact: C. Beals, (301) 353-4329, FTS 233-4329
Argonne National Laboratory, Chicago, IL, Karl Reimann, FTS 972-5066
Hanford Engineering Development Laboratory, Richland, WA, S. Mech, FTS 444-0506
Oak Ridge National Laboratory, Oak Ridge, TN, R. McClung, FTS 624-4466

OBJECTIVE: Develop methods, techniques and equipment for inspection of LMFBR components during manufacture and for periodic in-service inspection after plant construction.

STATUS: Emphasis is on development of rod-anode radiographic techniques for tube-to-tubesheet welds for heat exchangers in the radiography area.

Emphasis in the eddy-current area is on the development of flaw detection capability for steam generator single and double wall tubes made from ferritic 2-1/4 Cr-1 Mo material.

Emphasis in the ultrasonic testing area is in the development of both wall thickness and flaw detection capability for ferritic steam generator tubing and flaw detection capability for stainless steel pipe.

Keywords: Nondestructive Evaluation, Inspection.

4. Tribology Technology $285K (81), $170K (82)

DOE Contact: C. Beals, (301) 353-4329, FTS 233-4329
Hanford Engineering Development Laboratory, Richland, WA, R. Johnson, FTS 444-5188
Westinghouse-Advanced Reactors Division, Madison, PA, S. Shiels, (412) 722-5377

OBJECTIVE: To qualify wear-resistant materials and processes for LMFBR applications.

STATUS: Testing has been conducted on aluminized ferritic 2-1/4 Cr-1 Mo material to be used for steam generator tube support plates and on spark deposited coatings for valve applications.

Keywords: Erosion and Wear, Tribology.

5. <u>Coolant/Technology</u> $165K (81), $205K (82)

DOE Contact: C. Bigelow, (301) 353-4299, FTS 233-4299
GE/ARSD, Sunnyvale, CA, P. Roy, (408) 925-5181

OBJECTIVES: (1) To develop appropriate water chemistry specifications, analytical instrumentation, and operating procedures to ensure the integrity and reliability of LMFBR steam generators; and (2) to determine carbon transport behavior in bimetallic LMFBR hot sodium systems and effects of decarburization on 2-1/4 Cr-1 Mo steel steam generator material.

STATUS: Testing has been conducted on ferritic 2-1/4 Cr-1 Mo tubing for steam generators in caustic environment and on an LMFBR intermediate sodium system mockup loop.

Keywords: Corrosion.

6. <u>Advanced Alloy Technology</u> $794K (81), $590K (82)

DOE Contact: C. Beals, (301)-353-4239, FTS 233-4329
Oak Ridge National Laboratory, Oak Ridge, TN, V. Sikka, FTS 624-5112

OBJECTIVE: Develop a modified 9 CR-1 Mo alloy steel as a structural material for LMFBR plant systems, and as an alternative to the current reference materials, i.e. austenitic stainless steels and 2 1/4 Cr-1 Mo alloy steel.

STATUS: The development effort on this alloy was initiated in 1977 and is concentrated in five major areas. These development areas are preparation/fabrication, mechanical/physical properties, design methods, joining behavior and corrosion behavior. Application has been made to the ASTM for a specification for the material and the data packages for application to the ASME Code Sections I, III and VIII for code acceptance of the material will be completed in FY 1982.

Keywords: Alloy Development, Alternate Materials, Materials Character ization.

7. <u>Documentation</u> $355K (81), $320K (82)

DOE Contact: C. Beals, (301)-353-4329, FTS 233-4329
Hanford Engineering Development Laboratory, Richland, WA, T. Bierlein, FTS 444-3447
Oak Ridge National Laboratory, Oak Ridge, TN, M. K. Booker, FTS 624-5113

OBJECTIVE: To coordinate and maintain a system for documenting materials data to provide an authoritative data source for use in the design and construction of nuclear power plant system.

STATUS: The documentation process is ongoing and continues to furnish updated data for use in the design and construction of nuclear power plant systems.

Keywords: Materials Characterization, Materials Data Documentation.

APPENDIX Q: Office of Space Nuclear Projects

This Office is responsible for both Space and Terrestrial system power sources based on radioisotopic thermoelectric heat convertors or advanced space power reactors. Funding is shown below for FY 1982.

1. Iridium Alloy Processing and Fabrication - $1610

   DOE Contact: G. Bennett (301) 353-3197; FTS 233-3197

   Contractor: Oak Ridge National Laboratory
   R. H. Cooper (615) 574-4470; FTS 624-4470

   Contract: W-7405-eng-26

   Iridium alloys doped with Th and Al are processed from purchased high purity iridium powder. Product is sheet processed via electron beam plus arc-cast melting. Production is under Processing Configuration Control in accord with Processing and Quality Assurance Specifications assuring nuclear/aerospace quality in the product. This effort is closely scheduled and integrated with system projects.

   Keywords: Material Processing, Quality Assurance

2. Carbon Bonded Carbon Fiber Insulation (CBCF-3) - $375

   DOE Contact: G. Bennett (301) 353-3197; FTS 233-3197

   Contractor: Oak Ridge National Laboratory
   R. H. Cooper (615) 574-4470; FTS 624-4470

   Contract: W-7405-eng-26

   CBC-3 carbon fiber insulation in the 0.02-0.24 gm/cm^3 density range is produced for assembly in space flight system radioisotopic thermoelectric power generators (RTG's). All processing is under Production Configuration Control in accord with Processing and Quality Specifications assuring nuclear/aerospace quality in the product.

   Keywords: Material Processing, Quality Assurance

3. General Purpose Heat Source - $2,000

   DOE Contact: G. Bennett (301) 353-3197; FTS 233-3197

   Contractor: Los Alamos National Scientific Laboratory
   S. Bronisz (505) 667-4782; FTS 843-4782

   Contract: AL-7405-eng-36

Assembly and testing of $^{238}PuO_2$ fuel bodies encapsulated in iridium alloy clad vent sets and inserted into fine weave pierced fabric graphites was conducted using developmental heat source components. Testing included system compatibility, high temperature - high strain rate impact studies. Launch incident evaluations have included and will include launch pad abort fire, reentry impact, blast overpressure, sequential testing and component qualifications tests.

Keywords: Ceramics, Materials Characterization

4. <u>Space Nuclear Reactor Power System Technology Program</u> (SP-1000 - $2000

DOE Contact: Lt. Col. R. E. Smith, Jr. (USAF) (301) 353-4021; FTS 233-4021

Contractor: Los Alamos National Scientific Laboratory
D. Buden (505) 677-5540; FTS 843-5540

Contract: AL-7405-eng-36

Lithium-Mo and Li Mo+13 RE heat pipes containing wire wicks are under development for the SP-100 reactor core. These heat pipes are essential components of the SP-100 design targeted for future Space Shuttle launch. Wire mesh artery heat pipe performance testing will continue during the fiscal year.

Keywords: Materials Characterization

APPENDIX R: Division of Waste Respository Deployment

The National Waste Terminal Storage (NWTS) Program provides the technology and facilities necessary to meet all applicable safety and environmental requirements for the long-term managment of nuclear waste. The wastes include these from both the commerical and the defense nuclear activities of this nation. In broad scope the materials activities support: waste packaging, interim storage, and disposal; and evaluates existing structural materials and geologic formation.

The major objectives for waste disposal are: (1) to select suitable geohydrologic regions to minimize the release of radioactivity in the event of failure of the containment systems; (2) to select suitable geologic formations within satisfactory geohydrologic regions to contain the waste; (3) to design the repository to minimize the effect of mining and waste emplacement of the integrity of the geologic formation; and (4) to provide an engineered system as a backup to the geologic formation to contain the waste within the package for sufficient time to allow for decay of major radioactive nuclides.

1. Waste Isolation

DOE Contract - C. R. Cooley (301) 353-4285; FTS 233-4285
Division of Waste Repository Deployment

The materials activities related to Waste Isolation include:

- o Migration of radioactive waste through geohydrologic systems
- o Thermomechanical response of geologic formations
- o Engineered barriers for waste containment within the repository
- o Waste packaging materials and fabrication processes for spent nuclear fuel and for the containerized high-level and transuranic wastes for emplacement in geologic environment

Details, Contracts, and Funding for the Elements in Waste Isolation Follow:

1A. Waste Migration Rates

Waste Transport

Waste Migration: PNL, SL, LLL, LASL, RHO, ORNL, University of New Mexico, Battelle Memorial Institute

The materials characteristics of the geohydrology and geologic formation are evaluated using geophysical measurements and drilling operations. The measurements of the ion exchange capability of the geologic media delays the rate of migration of radioactivity sufficiently that all but the very long lived radioactivity would decay below natural levels before release to the biosphere. The rock formation of interest include basalt, salt, and tuff.

Keywords: Ceramics, Materials Characterization, Radiation Effects, Corrosion

1B. Thermomechanic Response of Rocks 82 $5,900

DOE Contract - W. Eister (301) 353-3188; FTS 233-3188
RE/SPEC, LLL, RHO, LBL, USGS, Colorado School of Mines

The effect of mining and waste emplacement is of concern as it relates: (1) to the stability of the mined openings in the rock, and (2) to the suitability of the rock and its associated hydraulic conductivity. Since there is considerable experience as related to mining effects, the primary attention is directed to the thermomechanics response of the rocks. The heat will result from the decay of radioactive waste. The thermomechanic property and the effect on the related hydraulic conductivity are being studied in the laboratory and in deep geologic formations.

Keywords: Materials Characterizations, Ceramics

1C. Waste Package 81 $1,500
Engineered Barriers 82 $7,800

DOE Contract - W. Eister (301) 353-3188; FTS 233-3188
HELD, SL, PNL, RHO, Penn State University, Westinghouse, ANL

The objective of this activity is to seal the spent fuel in an overpack container campatible with the geologic environment. The property of principal interest is corrosion resistance of the overpack container, however, there are also significant efforts on the other components of the package and the engineered barriers, steel and titanium, alloys are the principal candidates at this time. These studies include:

- Leach rate of the UO_2 in the spent fuel
- The characteristics of the zirconium clad
- Backfill materials between the overpack and rock to limit the access of groundwater to the overpack and/or retard the transport of radioactivity from a failed package; a bentonite-sand mixture is a typical candidate.

In addition, materials are being evaluated to seal the repository. Concrete is the principal material being used in these studies.

Keywords: Cements and Concrete, Corrosion, Hydrogen Effects, Joining Methods, Materials Characterization, Materials Processing, Non-Destructive Evaluation, Radiation Effects