

Originally Processed With FOIA(s):
2005-0336-F

FOIA Number:
2005-0336-F

FOIA MARKER

**This is not a textual record. This is used as an
administrative marker by the George Bush Presidential
Library Staff.**

Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files

OA/ID Number: 62043
Folder ID Number: 62043-005

Folder Title:
Physical Science: Energy [2 of 2] [1991]

Stack:

Row:

Section:

Shelf:

Position:

0

0

0

0

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION DOCUMENT NUMBER: 9121692
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: WATKINS, James D.: THE SECRETARY OF ENERGY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 06/07/91

SUBJECT: A RESPONSE TO DR. BROMLEY'S LETTER OF 05/09/91 WHICH
FORWARDED A COPY OF MR. JAMES MCKENZIE'S LETTER OF
04/08/91 REGARDING MOX FUEL.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
PHYSICAL SCIENCES

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

OSTP RECEIVED: 06/11/91
DEPT RECEIVED:

P-Physical Sciences -
FILE: CABINET MEMBER*ENERGY



The Secretary of Energy
Washington, DC 20585

June 7, 1991

9121692
RECEIVED

SI JUN 11 AIO: 29

OFFICE OF THE
DIRECTOR

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
The White House
Washington, D.C. 20500

Dear Allan:

This is in response to your letter of May 9, 1991, which forwarded a copy of Mr. James M. McKenzie's letter of April 8, 1991, concerning his development of a technique to check the seals of mixed oxide (MOX) fuel for light water reactors (LWRs). Since that development has been very successful, he raises the question of whether the United States should reverse its "no MOX fuel decision."

Early in 1981, the Reagan Administration reversed the "no MOX fuel decision," originally made during the Carter Administration, and concluded that the industry could reprocess spent fuel and utilize MOX in the United States as determined by market forces. Subsequent to this change in policy, neither the nuclear industry nor its customers have been willing to proceed with the use of MOX fuel in LWRs.

In a comprehensive 1985 study and assessment of the economics of the fuel cycle, the Nuclear Energy Agency of the Organization for Economic Cooperation and Development concluded that the use of MOX was not economically competitive with ordinary uranium dioxide fuel. Countries such as France and the United Kingdom that are reprocessing can claim reasonable economics for these facilities because the sunk costs, paid for in advance by other countries, are excluded for the most part, leaving only operation, maintenance, and decommissioning as the principal cost elements. Aside from the issue of economics, some countries are reprocessing or purchasing these services because of government policy or national legislation requiring a closing of the fuel cycle.

Because of the complexity and unfavorable costs of aqueous reprocessing, many countries, including the United States, are exploring alternatives, such as pyroprocessing, which hold promise to be simpler and more economic and provide potential for improved nuclear waste management and proliferation resistance.

In summary, our policy is to permit the use of MOX fuel in the United States and allow free market forces to determine the extent to which such fuel is used commercially while we investigate research and development approaches that could improve the benefits of spent fuel reprocessing.

Sincerely,



James D. Watkins
Admiral, U.S. Navy (Retired)

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121405

FROM: WATKINS, James D.: SECRETARY OF ENERGY

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 05/08/91

SUBJECT: MEMORANDUM FOR DR. BROMLEY REGARDING INFORMATION ON
CONGRESSIONALLY DIRECTED PROJECTS ("PORK") AT THE
DEPARTMENT OF ENERGY.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Thomas Ratchford
Dr. Wong
Dr. Henderson

Dr. Phillips
Ken Yale

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 5/14

P-

FILE: PHYSICAL SCIENCES- ENERGY *
INTERNATIONAL - POLICY



The Secretary of Energy

Washington, DC 20585

RECEIVED

May 8, 1991

91 MAY 14 PM 2:31

OFFICE OF THE
DIRECTOR

MEMORANDUM FOR THE HONORABLE D. ALLAN BROMLEY
ASSISTANT TO THE PRESIDENT FOR
SCIENCE AND TECHNOLOGY

SUBJECT: INFORMATION ON CONGRESSIONALLY
DIRECTED PROJECTS ("PORK") AT THE
DEPARTMENT OF ENERGY

Allan,

At our last FCCSET meeting, I promised to send you a list of the congressionally directed projects in DOE's FY 1991 budget. I have attached two papers that delineate the pork that was put in our budget.

Attachment I shows the pork that was added and the cuts in the legitimate science projects that we requested in the President's FY 1991 budget proposal. You will see that we lost a total of \$143.7 million in good science and gained \$141.6 million in pork. Attachment II shows how the congressionally directed funds are to be spent. As you will see, the vast majority are used for "bricks and mortar" projects.

As a first step toward a coordinated effort against "pork", I think it would be worthwhile to collect this type of data from all science agencies.


James D. Watkins
Admiral, U.S. Navy (Retired)

Attachments

p. s. "Directed Projects" = "Pork"

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONALLY DIRECTED PROJECTS ANALYSIS
(Dollars in millions)

	<u>FY 1991 REQUEST</u>	<u>FY 1991 APPROPRIATION</u>	<u>CHANGE</u>
Biological and Environmental Research			
R&D	\$338.8	\$321.7	-17.1
Directed Projects	--	<u>72.2</u>	<u>+72.2</u>
TOTAL:	<u>\$338.8</u>	<u>\$393.9</u>	<u>+55.1</u>
Basic Energy Sciences			
R&D	\$648.7	\$652.6	+3.9
Directed Projects	--	<u>59.2</u>	<u>+59.2</u>
TOTAL:	<u>\$648.7</u>	<u>\$711.8</u>	<u>+63.1</u>
University and Science Education			
DOE Program	\$34.7	\$36.4	+1.7
Directed Projects	--	<u>10.2</u>	<u>+10.2</u>
TOTAL:	<u>\$34.7</u>	<u>\$46.6</u>	<u>+11.9</u>
Fusion Energy	\$325.2	\$273.6 *	-51.6
Superconducting Super Collider	\$317.9	\$242.9	-75.0
* Excludes \$16 million reprogramming			
Summary:			
Cuts to R&D			-143.7
Adds for Directed Projects			+141.6

DEPARTMENT OF ENERGY
1991 Congressionally Directed Projects

UNIVERSITY AND SCIENCE EDUCATION

EPSCoR Planning Grants *	\$2,000,000
EPSCoR Graduate Traineeships *	2,000,000
Nuclear Engineering; University Nuclear Engineering Programs	5,000,000
Upgrading of University Reactors	1,000,000
Rural Enterprises, Inc.	200,000
Clark Atlanta University; Research Center for Science & Tech.	a/..

Total University and Science Education	\$10,200,000
---	---------------------

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Alabama, University of; Biomedical Research Facility	\$9,942,000
Case Western Reserve University; Biomedical Research Facility	9,942,000
Childrens Hospital, Detroit, MI; Equip to support demo on Position Electron Tomography	7,953,600
Laser Medical Applications Centers; Est. Cntrs. of Excellence	1,472,659
Louisiana State University; Biomedical Research Institute	12,427,500
Misericordia Hospital, Phila, PA; 6-MEV linear Accl. for Cancer	2,087,820
Oregon Health Sciences University; Neurosurgery Research Institute	12,427,500
South Carolina, Medical University of; Cardiac Research Institute	5,965,200
West Virginia University; Center for Nuclear Medicine in Alzheimers	9,942,000

Total-Biological and Environmental Research	\$72,160,279
--	---------------------

BASIC ENERGY SCIENCE**Material Sciences**

Fort Hayes State University; Physical Science Center	\$1,988,400
Oklahoma State Univ.; Advance Technology Research Center	4,971,000
Indiana State Univ.; Advanced Technology Center	4,814,414
Univ. Of New Orleans,; Center for Energy Resources Management	9,942,000
Boston College; Energy Sciences Research Facility	9,942,000
Purdue; Hqs. of Midwest Superconductivity Consortium	2,982,600
N. Iowa, University of; Center for Energy & Environmental Educ. Center of Excellence	4,971,000
Ames: Technical and Admin. Services Facility	2,982,600
West Virginia University; planning of proposed Research Center	248,550

ENGINEERING AND GEOSCIENCES

Fort Hayes State University; Physical Science Center	\$1,988,400
--	-------------

ADVANCED ENERGY PROJECTS

Louisiana Tech. University; Manufacturing Systems Engineering Research Center	\$745,650
Nebraska Univ. of; Nebraska Center for Science & Tech.	5,666,940
Diag. Instr. Anal. Lab., Miss. St. Univ.; Tech Transfer	3,976,800

Total-Basic Energy Science	\$59,197,154
-----------------------------------	---------------------

TOTAL CONGRESSIONALLY DIRECTED PROJECTS:	\$141,557,433
---	----------------------

a/ No amount specified, just language encouraging support

* EPSCoR, Experimental Program to Stimulate Competitive Research Programs

THE WHITE HOUSE
WASHINGTON

July 9, 1991

Dear Jim:

Many thanks for sending me the detailed breakdown of the "pork" in your Department. I agree totally that it will be important to get equivalent numbers for as many other departments as possible. Only by making very evident what is taking place can we hope to in fact force a more rational distribution of Federal funding.

I much appreciate your help in getting this documentation and I am looking forward to meeting with you in the very near future because there are a number of rather important topics that we should discuss.

With warmest best wishes,

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

The Honorable James D. Watkins
Secretary
Department of Energy
Washington, D.C. 20585

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121281

FROM: RITTNER, Edmund S.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/24/91

SUBJECT: LETTER TO PRESIDENT BUSH CONCERNING AN AUTOMOTIVE
ENERGY PLAN.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/30/91

FILE: P- PHYSICAL SCIENCES-ENERGY

Dr. Edmund S. Rittner
Consulting Scientist
700 New Hampshire Ave, NW, #116
Washington, DC 20037
202-965-0650

01 APR 30 AM: 03

April 29, 1991

President George Bush
The White House
Washington, DC 20500

OFFICE OF THE
DIRECTOR

Dear Mr. President,

I am attaching herewith a brief automotive energy plan which is capable of eliminating the need for oil imports as well as automobile exhaust air pollution and the accompanying contribution to global warming. The plan calls for the introduction of a well-known non-polluting engine of much higher efficiency and for the replacement of gasoline by a fuel derived from solar energy. The plan does not require any additional monies and it builds upon DOE accomplishments in the biomass area and upon a successful demonstration of the new engine in an automotive application. It also endorses the recent emphasis of the National Academy of Sciences on conservation except for the requirement of a 30% increase in auto fuel efficiency, which would be unnecessary in view of the much higher efficiency of the new engine.

In short, the plan appears to be just what the nation needs!

Sincerely yours,

Edmund S. Rittner

cc: Vice President
Secretary DOE
Secretary DOT
Science Advisor
National Academy of Sciences
Chairman, Senate Energy & Natural Resources Committee
Chairman, House Energy & Commerce Committee
Chairman, House Energy Subcommittee
Senate Majority Leader
Senate Minority Leader
Speaker of the House
House Majority Leader
House Minority Leader

Proposed Automotive Energy Plan

Edmund S. Rittner

The goal of the present plan is to eliminate the need for petroleum imports with their deleterious economic, environmental and potential military impacts; and to eliminate air pollution from automotive exhaust as well as the accompanying contribution to global warming.

The plan calls for the replacement of the gasoline powered internal combustion engine by an external combustion engine employing a Stirling cycle and powered by a fuel derived from photosynthesis and fermentation of agricultural products.

The external combustion engine, the thermodynamic basis for which dates back to the early nineteenth century, has a huge advantage with respect to pollution because the burning of the fuel is completely separated from the internal working. This permits complete oxidation to carbon dioxide and water and avoids formation of oxides of nitrogen because of the absence of high temperature sparking. Extensive development work has been carried out over a twenty five year period by the N.V. Philips Co. and a published account¹ in 1959 describes a 40 HP experimental engine with an efficiency of 38% at an engine speed of 1500 rpm and exhibiting very low noise and vibration. The weight required was 11 lb/HP. Since the efficiency of the internal combustion engine is only 25%, the Stirling cycle engine represents a 50% improvement. A technology transfer to General Motors Corporation took place about twenty years ago but did not result in adoption of the engine. Over the past decade DOE has carried out application research on this engine with the specific aim of incorporation into automobiles. The project was a complete success technically but was discontinued because of lack of interest on the part of the automotive industry.

The advantages of a fuel derived from solar energy are domestic availability, renewability, energy storage, sufficient energy content (for fuels yet to be discussed) for automotive use when employed with the Stirling cycle engine, and avoidance of contributions to global warming. The last advantage results because in the photosynthesis step carbon dioxide is absorbed from the atmosphere in an amount which compensates exactly for that released later in the fermentation and burning steps.

The two most widely practiced industrial processes to produce materials employable as fuels employ grain stocks high in starch content which is converted to glucose. In one of the processes ethanol (ethyl alcohol) is produced by use of one of a variety of fermentation agents (eg, yeast enzymes), a process which has its antecedents in antiquity. In the other process a different class

of fermentation agents is used (eg, *Bacillus butylicus*) and leads to the formation of butyl alcohol and acetone as the principal products in a volumetric ratio of 2:1. This process, which was introduced by Weizmann,³⁾ has been in wide industrial practice since World War I for the production of acetone. The butyl alcohol is more useful as a fuel than acetone and the latter may be converted by hydrogenation to isopropyl alcohol. The latter is also a better fuel than acetone and can be blended with the butyl alcohol to improve the overall fuel yield. A major improvement in energy content can then be achieved by conversion of these alcohols to ethers by means of dehydration (eg, by the use of concentrated sulfuric acid).

The quantities of greatest importance for fuel use in external combustion engines are the heat of combustion/cc and the boiling point which is a rough indication of volatility. These quantities are listed in Table 1 for a number of alcohols and ethers as well as acetone. Also included are octane, which is the quintessential component of gasoline, and the caloric data for several commercially employed mixed blends.

Table 1

Substance	No. C atoms in chain	Heat of Combustion, ³⁾ kcal/cc	Boiling Point, °C
methyl alcohol	1	6.8	64.5
ethyl alcohol	2	9.0	78.5
propyl alcohol	3	10.0	82.0
butyl alcohol	4	10.6	117
amyl alcohol	5	11.0	138
acetone	3	9.3	56.5
ethyl ether	4	12.3	34.6
propyl ether	6	12.8	67.5
butyl ether	8	13.0	142
amyl ether	10	13.1	190
octane	8	16.3	126
gasoline	-	15.6	-
kerosene	-	13.4	-
furnace oil	-	11.8	-
fuel oil	-	10.4-12.1	-

Note that the heat of combustion/cc increases with the number of carbon atoms in the chain of the molecule, that the ethers are substantially more energetic than the corresponding alcohols, and that propyl and butyl ethers are the best choices amongst the listed alcohols and ethers when combustion heat and boiling point are jointly considered. The blend of ethers resulting from the Weizmann fermentation followed by hydrogenation and dehydration would have a heat of combustion of 12.9 kcal/cc. This mixture of ethers will henceforth

be referred to as "ether blend". The combustion heat of ether blend exceeds that of ethanol by 43%, that of furnace oil by 9.3%, and is 83% that of gasoline. It is also of interest to note that butyl ether has a molecular structure identical to that of octane with the addition of an oxygen bridge in the center.

However, consideration of the yields of the two fermentation processes indicates that production of ethanol would permit better utilization of the agricultural resources. Yield data for the ethanol case are available in a recent publication⁴⁾ for wood and corn. The yield expressed as mass of ethanol produced per mass of dry feedstock is 0.33 for wood and 0.35 for corn. This yield includes the possible conversion losses of cellulose or starch to glucose. The corresponding yield for the Weizmann process as reported²⁾ in 1920 is 0.15 - 0.20 for rice, maize or other grains. It turns out that relative to the available resources the ethanol process will produce more total energy than the Weizmann process followed by conversion to the ethers by at least a factor of 1.5. Thus, the opposing tendencies of higher energy content/cc for the ether blend and higher total energy availability from ethanol will call for trade-offs.

Reference (4), which represents an important milestone in the DOE Ethanol from Biomass Program (where the fuel is intended for use in conventional engines), provides data on the annual U.S. energy consumption in quad (1 quad = 10^{15} BTU) during 1989: transportation, 22 quad; total petroleum, 34 quad; total energy, 81 quad. Use of the more efficient external combustion engine would reduce the transportation requirement to 14.5 quad. Reference (4) also concludes that wood is much cheaper than corn at high ethanol production levels where the market for corn coproducts would be saturated. It then estimates the ethanol production potential for cellulosic feedstocks including agricultural-, forestry- and municipal solid wastes; woody or herbaceous high productivity energy crops (HPEC); and trees produced by conventional forestry. Account is taken of available land including forest land not suitable for growing crops, existing cropland available because of excess agricultural capacity, and potential cropland that could become available. Of particular interest is the significant potential of the readily available waste materials which could contribute a total of 3.8 quad, one quarter of the modified transportation requirement. The full 14.5 quad will not be required until complete conversion of all automobiles to the new engine, which could take as long as a decade. The total ethanol production potential is expressed in Table 3 of Ref (4) as 12.4 - 26.5 quad. The lower value is based upon current HPEC productivity and 1988 existing cropland, whereas the higher value refers to anticipated HPEC productivity and projected available cropland in the year 2012. Reference (4) concludes that cellulosic materials potentially available from energy crops, wastes and conventional forestry could provide enough ethanol to meet the current transportation requirement and projects a wholesale selling price of \$0.60 per gallon (mid-1980 basis) by the year 2000, provided that aggressive R&D is continued.

Identical considerations apply to the production of the ether blend as the only changes are substitution of a different agent for fermenting glucose and the addition of the hydrogenation and dehydration steps. The price of the ether blend will be higher than that of ethanol because of the additional processing, but more importantly, because of the lower fermentation yield. R&D with a goal of increasing the latter quantity could prove very valuable because an increased yield would result in both a lower price and an increased energy availability.

Table 2 presents a comparison of ethanol and the ether blend as well as two interesting mixtures of the two with respect to heat of combustion/cc, the total energy production potential (with the lower and higher values defined earlier), and the multiplying factor to obtain expected miles/gallon performance with the Stirling cycle engine.

Table 2

Composition of Fuel	Heat of Combustion, kcal/cc	Energy Potential, quad	Miles/gal Factor
ethanol	9.0	12.4 - 26.5	0.88
$\frac{2}{3}$ ethanol + $\frac{1}{3}$ ether blend	10.3	11.4 - 24.3	1.00
$\frac{1}{3}$ ethanol + $\frac{2}{3}$ ether blend	11.6	10.4 - 22.2	1.13
ether blend	12.9	9.4 - 20.0	1.26

Ethanol has the advantages of lowest price and highest total energy production, but would result in a 12% lowering in miles/gal. (Use of pure ethanol in the conventional engine would result in a 25% lowering in miles/gal.)⁴ The ether blend would produce a 26% increase in miles/gal but a diminution in total energy production relative to ethanol by a factor of 1.32 and would have the highest price of the fuels considered. The fuel consisting of a mixture of $\frac{2}{3}$ ethanol and $\frac{1}{3}$ ether blend is of particular interest as it offers the prospect of no loss in miles/gal while causing relatively little reduction in total energy production and little increase in cost. The mixture of $\frac{1}{3}$ ethanol and $\frac{2}{3}$ ether blend has a caloric content/cc nearly identical with that of furnace oil.

Fuel in excess of that required to serve the automotive requirement could be employed advantageously to replace the high sulfur oil employed in electric utilities, thus reducing the sulfur dioxide emissions leading to acid rain. Such fuel could be stretched considerably further by use of conservation measures such as those recently proposed by the National Academy of Sciences.

The plan has not yet dealt with the problems associated with use

of Diesel engines, which are internal combustion engines particularly useful for large power requirements. Although the exhaust emissions are not being subjected to municipal restriction and inspection, presumably because in the aggregate they are small compared to automobile emissions, this rationale will gradually disappear if the present plan is adopted. Diesel emissions not only offend the senses but contain fine carbon particulates saturated with unburned Diesel fuel which are probably hazardous to respiratory function. Elimination of , or at least major reductions in, such emissions by use of filters and/or catalytic converters should be possible. Legislation requiring a low level cap on particulate emissions is highly desirable. Replacement of Diesel by Stirling cycle engines in automobiles will solve that facet of the overall problem. R&D to replace Diesel fuel by an alternative derived from solar energy is also desirable and the candidates listed in Table 2 should be tried.

A few words are in order to respond in advance to the expected reluctance of the automotive and oil industries to make the necessary adjustments to adoption of the plan. The automotive industry would be relieved of the CAFE standards or equivalent conservation measures presently under consideration, because the desired efficiency improvements in the engine have been exceeded in the Stirling cycle engine. Moreover, the happy prospect of being able to offer an environmentally clean vehicle powered by fuel derived domestically from solar energy should permit recapture of market share lost previously to foreign competitors. On the other hand, failure to offer such a product in advance of foreign competitors would be courting financial disaster. The oil companies face both a challenge and an opportunity. Because they control the fuel distribution network and are highly skilled in handling fuels and in carrying out chemical and physical processing thereon, they are in a premium position to diversify and to continue to serve the present domestic market. Failure to rise to the challenge will result in debilitating loss of market share. Moreover, freedom from criticism and expenses associated with environmentally damaging tanker oil spills should be a welcome advantage.

In summary, the goals of the plan, energy independence and elimination of automotive exhaust pollution and accompanying global warming, may indeed be met by use of a combination of the two mature technologies discussed here. Reductions in fuel cost by the DOE Biomass Program can be expected before they are needed on a large scale because of the long life span of modern automobiles. Any shortfall could be made up by temporary use of fuel oil since the Stirling cycle engine can be operated on any combustible fuel. With respect to cost, it should be kept in mind that achievement of fuel costs competitive with gasoline really implies a large price reduction because of the greatly added value of the environmentally compatible fuel.

Finally, the new plan does not require any new money from the Federal treasury. The added costs, possibly increased engine cost and somewhat higher fuel prices to early users, will be borne by the users and not by the taxpayers. In view of the plethora of advantages surrounding use of the "new" automobile, such price increases will be well tolerated in view of value added.

References

- 1) R.J. Meijer, Philips Technical Review, 20, 245-262, (1958/1959)
- 2) C. Weizmann, British Patent 4845, (March 1915)
C. Weizmann and G.A. Hamlyn, US Patent 1,329,214, (January 1920)
- 3) Combustion values for pure organic substances taken from:
M.S. Kharasch, Bureau of Standards Journal of Research, 2, 359 (1929).
Final products of combustion are $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$.
Corresponding values for the blends from:
Handbook of Chemistry and Physics, 25 Edition, Chemical Rubber
Publishing Co., Cleveland, OH, (1941), p. 1422.
- 4) L.R. Lynd, J.H. Cushman, R.J. Nichols, and C.E. Wyman
Science, 251, 1318-1323 (1991).

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121105

FROM: LEE, T.D.: COLUMBIA UNIVERSITY

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/12/91

SUBJECT: THE TERAFL0P PROJECT PROPOSAL

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS: Enclosure to DAB.

DATE RECEIVED: 04/15/91

FILE: ENERGY

P-Physical Sciences-

9121105

RECEIVED
Columbia University in the City of New York | New York, N.Y. 10027

DEPARTMENT OF PHYSICS

538 West 120th Street

APR 15 11:44
OFFICE OF THE
DIRECTOR

April 12, 1991

The Honorable D. Allan Bromley
Assistant to the President for Science and Technology
Old Executive Office Building
17th and Pennsylvania, NW
Washington, D.C. 20506

Dear Allan,

It was good to talk with you today. RHIC is very much your baby, and it warms one to see everything going well (even though I was nearly frozen).

Enclosed is the Teraflop Project proposal. I greatly appreciate your very strong support and I am looking forward to seeing its fruition under your guidance.

Warmest regards,

T. D.

T. D. Lee

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121123

FROM: GILLELAND, John R.: BECHTEL

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/12/91

SUBJECT: THE ITER CONCEPTUAL DESIGN ACTIVITIES FINAL REPORT.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley

Dr. Wong

Dr Rotchford

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/15/91

FILE: ENERGY

P-Physical Sciences

Bechtel

50 Beale Street
San Francisco, CA 94105-1895
Mailing address: P.O. Box 193965
San Francisco, CA 94119-3965

9121123
RECEIVED

91 APR 15 P 5: 12

OFFICE OF THE
DIRECTOR April 12, 1991

Hon. D. Allan Bromley
Assistant to the President for
Science & Technology
Old Executive Office Building
17th Street & Pennsylvania Avenue, NW
Washington, DC 20506

Dear Allan,

Enclosed is the "ITER Conceptual Design Activities Final Report". The report is a very short summary endorsed by all four parties. Pages 14 through 19 are therefore worth reading. I will be happy to answer any questions.



John R. Gilleland
Vice President, R&D

JRG:za

Enclosure



Overseas Bechtel, Incorporated

THE WHITE HOUSE

WASHINGTON

April 25, 1991

Dear John:

Many thanks for sending me the copy of the "ITER Conceptual Design Activities Final Report". This is an impressive document and one of which you can be justly proud.

I remain convinced that this is one of our most successful international research and development activities to date and look forward to the succeeding phases.

Again, my thanks and with all best wishes,

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. John R. Gilleland
Vice President for Research and Development
Bechtel
Overseas Incorporated
P.O. Box 193965
50 Beale Street
San Francisco, California 94105-1895



INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR

ITER CONCEPTUAL DESIGN ACTIVITIES FINAL REPORT



ITER CONCEPTUAL DESIGN ACTIVITIES:
FINAL REPORT

ITER DOCUMENTATION SERIES, No. 16

ITER CONCEPTUAL DESIGN ACTIVITIES FINAL REPORT

PREPARED BY THE
ITER COUNCIL

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 1991

ITER CONCEPTUAL DESIGN ACTIVITIES:
FINAL REPORT
IAEA, VIENNA, 1991
IAEA/ITER/DS/16

Printed by the IAEA in Austria
February 1991

FOREWORD

Development of nuclear fusion as a practical energy source could provide great benefits. This fact has been widely recognized and fusion research has enjoyed a level of international co-operation unusual in other scientific areas. From its inception, the International Atomic Energy Agency has actively promoted the international exchange of fusion information.

In this context, the IAEA responded in 1986 to calls for expansion of international co-operation in fusion energy development expressed at summit meetings of governmental leaders. At the invitation of the Director General there was a series of meetings in Vienna during 1987, at which representatives of the world's four major fusion programmes developed a detailed proposal for a joint venture called International Thermonuclear Experimental Reactor (ITER) Conceptual Design Activities (CDA). The Director General then invited each interested party to co-operate in the CDA in accordance with the Terms of Reference that had been worked out. All four Parties accepted this invitation.

The ITER CDA, under the auspices of the IAEA, began in April 1988 and were successfully completed in December 1990. This work included two phases, the definition phase and the design phase. In 1988 the first phase produced a concept with a consistent set of technical characteristics and preliminary plans for co-ordinated R&D in support of ITER. The design phase produced a conceptual design, a description of site requirements, and preliminary construction schedule and cost estimate, as well as an ITER R&D plan.

The information produced within the CDA has been made available for the ITER Parties to use either in their own programme or as part of an international collaboration.

As part of its support of ITER, the IAEA is pleased to publish the documents that summarize the results of the Conceptual Design Activities.

CONTENTS

PREFACE	9
1. INTRODUCTION	9
2. ITER OBJECTIVE	10
3. SUBJECT MATTER OF THE CDA	10
4. ORGANIZATION OF THE CDA	10
5. CONCEPT DESCRIPTION	11
6. DESIGN AND R&D ACTIVITIES	14
7. FUTURE R&D NEEDS	14
8. FUTURE ITER PROJECT ACTIVITIES	15
9. SAFETY AND ENVIRONMENTAL ANALYSIS AND TECHNICAL REQUIREMENTS FOR A CONSTRUCTION SITE	18
10. ADDITIONAL POTENTIAL BENEFITS OF ITER	18
11. CONCLUSIONS	19
REFERENCES	19

PREFACE

This is the Final Report by the International Thermonuclear Experimental Reactor (ITER) Council on the ITER Conceptual Design Activities (CDA) which were carried out in 1988-90 jointly by four Parties - the European Atomic Energy Community, Japan, the Union of Soviet Socialist Republics and the United States of America - under the auspices of the International Atomic Energy Agency (IAEA).

1. INTRODUCTION

Thermonuclear fusion is one of the very few options, potentially acceptable from the environmental, safety and economic points of view, to provide energy for a growing world population. The bulk of the research effort takes place in four large fusion programmes which are broadly similar in content, accomplishment and direction and comparable in levels of efforts: in the European Community, in Japan, in the Soviet Union and in the United States. Fusion has now achieved a level of knowledge such that the scientific and technological feasibility of fusion power can be addressed in the next step, the International Thermonuclear Experimental Reactor (ITER).

The history of co-operation on ITER began in 1985 when government leaders in summit meetings called for more substantial international co-operation in order to increase the efficiency and minimize the cost of fusion power development. In response to the summit initiatives, experts from the European Community, Japan, the Soviet Union and the United States, were invited by the Director-General of the IAEA develop a guiding document called the "Terms of Reference Concerning Conceptual Design Activities for an International Thermonuclear Experimental Reactor". The Conceptual Design Activities (CDA) began in April 1988 after the four Parties formally accepted the invitation of the Director-General to participate, in accordance with the Terms of Reference, under the auspices of the IAEA [1].

The Terms of Reference of the CDA allowed for the involvement in the contributions of the Parties of other countries which possess specific fusion capabilities. Canada was involved in the CDA through the contribution of the European Community (plus Sweden and Switzerland), while Czechoslovakia took some part in the contribution of the Soviet Union.

The CDA were directed and managed by (1) the ITER Council (IC), responsible for the overall direction of the CDA and exercising overall supervision of their execution, and (2) the ITER Management Committee (IMC), responsible for the execution of the CDA. The ITER Scientific and Technical Advisory Committee (ISTAC) advised the IC on scientific and technical matters.

2. ITER OBJECTIVE

The overall programmatic objective of ITER is to demonstrate the scientific and technological feasibility of fusion power.

ITER would accomplish this objective by demonstrating controlled ignition and extended burn of deuterium-tritium plasmas, with steady-state as an ultimate goal, by demonstrating technologies essential to a reactor in an integrated system, and by performing integrated testing of the high-heat-flux and nuclear components required to utilize fusion power for practical purposes.

The heart of the ITER facility would be a tokamak device, a concept first demonstrated in the Soviet Union and since then brought to a high level of development in the major fusion programmes of the world.

3. SUBJECT MATTER OF THE CDA

The Terms of Reference of the CDA called for a quadripartite co-operation aiming at:

- (a) defining a set of technical characteristics of an ITER and subsequently carrying out the design work necessary to establish its conceptual design;
- (b) carrying out in a co-ordinated manner specific validating research and development work supportive of the design activities;
- (c) defining future research and development needs and drawing up schedule, manpower and cost estimates for the realization of such a device;
- (d) performing a safety and environmental analysis and defining the technical requirements for a construction site of ITER.

with the objective of providing, by the end of 1990, a design that is then available for all Parties to use either in their own programme or in an international collaborative programme.

Each of these aims was met, as described in the following Sections.

4. ORGANIZATION OF THE CDA

In compliance with point (a) of Section 3., the CDA were carried out in two phases: a definition phase performed from April to October 1988 and, subsequently, a design phase, completed in December 1990.

As part of the definition phase, a single set of ITER technical characteristics was developed and reported on by the IMC in the two-volume

document "ITER Concept Definition" [2]. The report also contained a plan for ITER supporting R&D activities, which were subsequently carried out.

As part of the design phase, a conceptual design of the ITER device was developed. All the design work carried out for the implementation of CDA was documented; it was summarized by the IMC in the document "ITER Conceptual Design Report" [3].

Furthermore the Terms of Reference of the CDA state that the ITER Council "will make suggestions on how the Parties may explore ways and means to comply with the objective of the co-operation...". Accordingly and believing that it would be highly desirable to avoid any unnecessary hiatus in the technical work after completion of the CDA at the end of 1990, the ITER Council in 1989 chartered a Working Party to explore these ways and means and to propose those supporting elements needed for the possible conduct of future ITER collaboration. The ITER Council members came to the view that these findings could be helpful in exploratory discussions among the Parties to prepare consolidated common elements for future negotiations. As a result, a summary of the material produced by the Working Party was incorporated into the Council's Status Report [4] and made available to the Parties in April 1990.

5. CONCEPT DEFINITION

The ITER design is based on scientific knowledge and extrapolations derived from the operation of dozens of tokamaks over the past decade, and on the technical know-how flowing from the extensive technology R&D programmes of the four Parties. The ITER tokamak is shown in Fig. 1. Its principal parameters are listed in Table 1.

The main characteristics and parameters of the ITER tokamak follow from its technical objectives which in turn are in line with the programmatic objective. The detailed technical objectives and the main characteristics of ITER are given in Annex I to the Terms of Reference. Ignition requirements set the value of plasma current. Extended burn favours superconducting coil systems. The design targets for the first wall fluxes and fluence both dictate approximately the same minimum shield thickness in the device. When these are combined with considerations of plasma stability, impurity control and current drive, the general features and approximate size of the ITER reactor are determined. Nevertheless, within the freedom allowed by the technical objectives, the design philosophy has been to control size and minimize cost. Moreover, safety considerations have been an integral part of the design activities.

The design was carried out to comply with the technical objectives of ITER laid down in the Terms of Reference and its Annex I. Design policy,

TABLE 1. ITER PRINCIPAL PARAMETERS

Plasma major radius, R (m)	6.0
Plasma half-width at midplane, a (m)	2.15
Elongation, 95% flux surface	1.98
Toroidal field on axis, B ₀ (T)	4.85
Nominal maximum plasma current, I _p (MA)	22
Nominal fusion power, P _f (GW)	1
Pulse length, (s)	>200

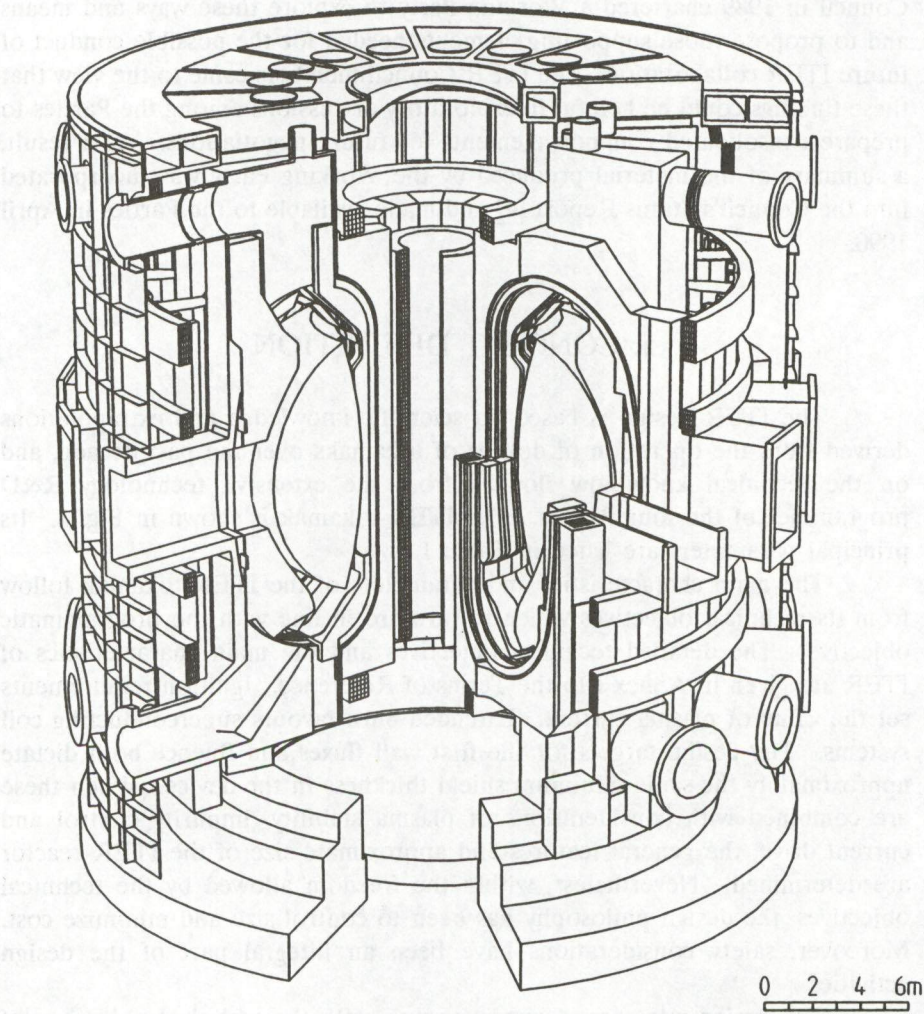


Fig. 1. Principal Elements of ITER Tokamak

J F M A M J J A S O N D

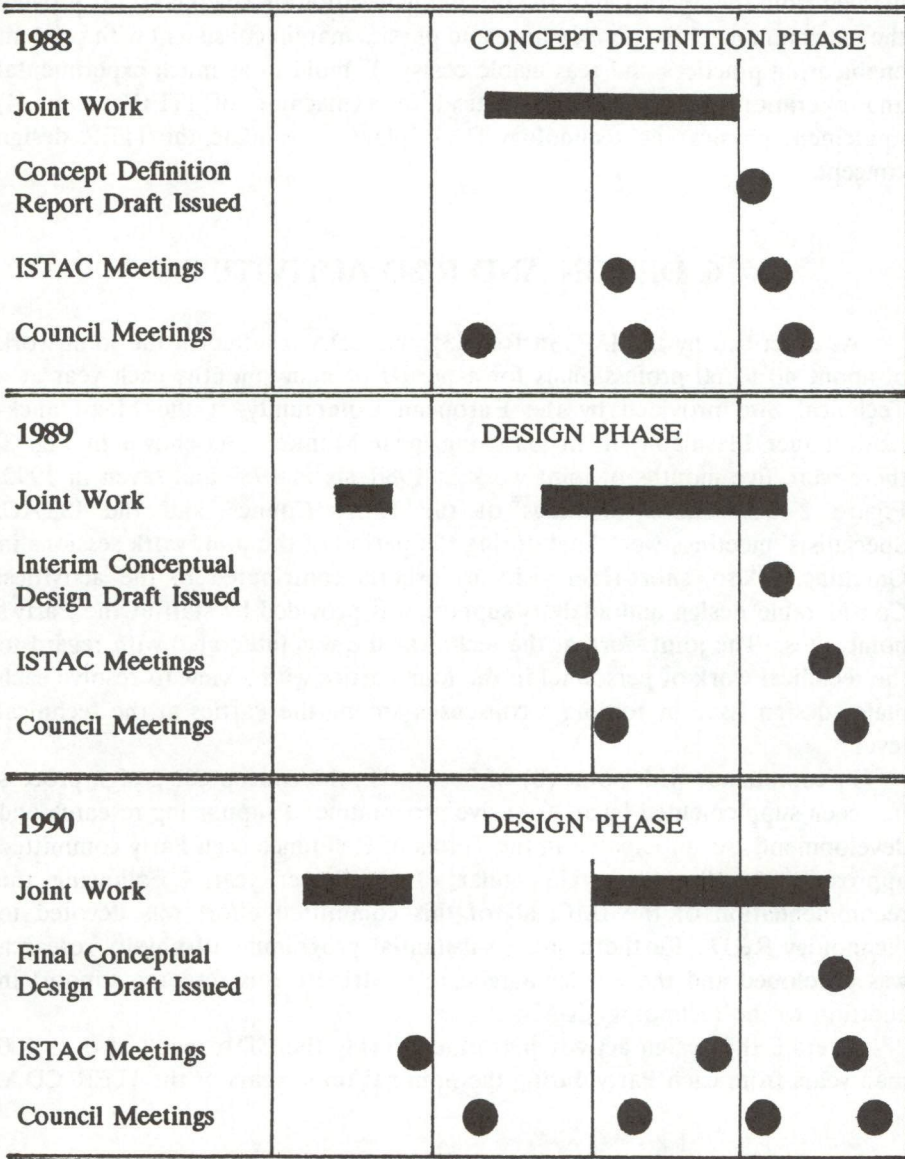


Fig. 2. Schedule of ITER Conceptual Design Activities

aimed at risk reduction, has been to: (1) proceed essentially from the data base derived from the operation of the present generation of Tokamaks; (2) provide the maximum machine performance and physics margin consistent with prudent engineering practices and reasonable costs; (3) build in as much experimental and operational flexibility as practical in a machine of ITER's size; (4) implement physics and technology R&D plans to validate the ITER design concept.

6. DESIGN AND R&D ACTIVITIES

As described by the IMC in Ref. [3], the CDA resulted in the joint work of about 40 to 60 professionals for a period of many months each year at a Technical Site provided by the European Community at the Max-Planck-Institut fuer Plasmaphysik in Garching, near Munich. As shown in Fig. 2, there were five months of joint work in 1988, six in 1989 and seven in 1990. Figure 2 also shows meetings of the ITER Council and the ISTAC. Specialists' meetings were held during the period of the joint work sessions in Garching. Also, short-term visits by experts contributed to the activities. Considerable design and analysis support was provided by staff at the Party's home sites. The joint work at the technical site was integrated with regard to the technical work of personnel in the four Parties with a view to resolve each major design issue by forging a consensus among the Parties at the technical level.

In compliance with point (b) of Section 3., the conceptual design process has been supplemented by an extensive programme of supporting research and development. As anticipated in the Terms of Reference each Party committed approximately 10 million US dollar of R&D per year. Following the recommendation of the IMC, all of this committed effort was devoted to technology R&D. Furthermore, a substantial programme of physics research was developed and the Parties agreed to contribute this research support in addition to the technology R&D.

Overall, the design activity performed during the CDA involved over 100 man years from each Party during the nominal three years of the ITER CDA.

7. FUTURE R&D NEEDS

In compliance with point (c) of Section 3., the CDA has defined the R&D work to be conducted in both physics and technology in the various laboratories of the Parties to validate the scientific and technical basis and assumptions for the ITER design. As described by the IMC [3], the physics R&D plan puts particular emphasis on reducing uncertainties in the divertor

performance and energy confinement, extending the burn duration with non-inductive current drive and avoiding disruptions. The main categories of the technology R&D activities are a superconducting magnet, plasma-facing components, nuclear blankets and shields, remote maintenance, fuelling systems, and heating and current drive systems.

The ITER Council concludes that continued focus on physics R&D, using existing facilities, would minimize uncertainties and increase confidence in the ITER design assumptions. With appropriate additions to the existing technology R&D efforts by the Parties, sufficient prototype and proof-of-principle demonstration and other necessary developments could be carried out to provide a sound basis for decisions to proceed with the construction of ITER, according to the schedule estimates described in the next Section.

8. FUTURE ITER PROJECT ACTIVITIES

The ITER Council has concluded that, from a technical point of view, Engineering Design Activities (EDA) preparing the ground for a possible later decision on construction would be the appropriate next stage in ITER activities [4].

Organizational Assumptions

In order to develop estimates in compliance with point (c) of Section 3., various organizational assumptions were made in addition to the technical assumptions underlying the design: that the Parties would agree to continue their co-operation through all future ITER project activities, that there would be a Central Team, and that there would be Home Support organizations run by each of the Parties to conduct specific design and R&D, assigned by the Central Team, in home research institutions and industry.

All costs have been estimated in January 1989 US\$ and are given in round figures. The costs have been derived with the assumption that the Engineering Design Activities start at the beginning of 1991 and would have to be reassessed should there be a significant delay.

The following estimates are sensitive to the assumptions and would have to be updated as the technical and organizational issues are further resolved.

Project Schedules

A possible project schedule for such EDA, as developed on a purely technical basis by the IMC, is given in Fig. 3. Taking practical considerations into account, the ITER Council believes that after a decision to proceed with the EDA, 6 years would be needed to carry out the design and complete the

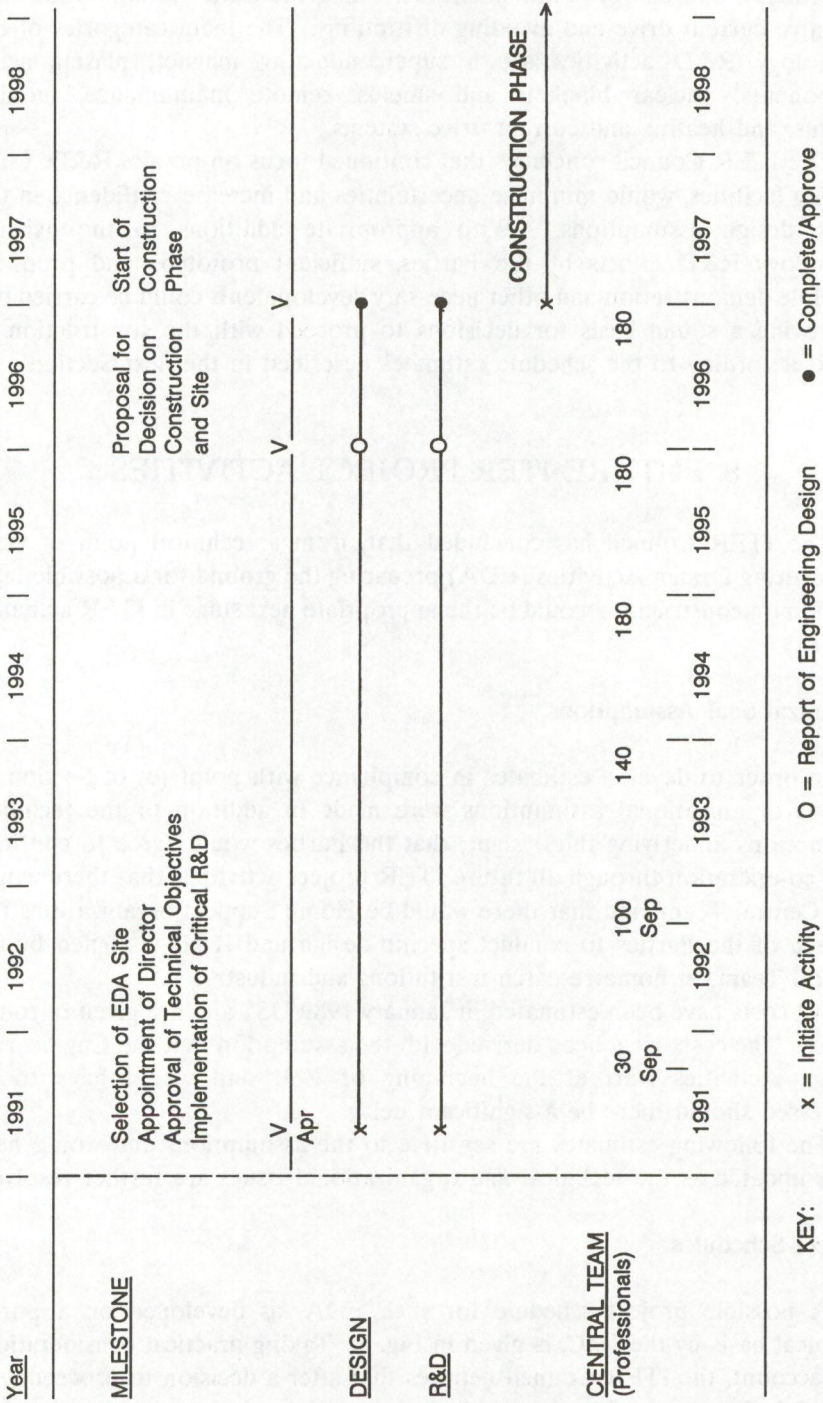


Fig. 3. Possible Schedule for ITER Engineering Design Activities (developed on purely technical basis)

necessary R&D to provide the Parties with well-documented and technically convincing information for making a decision on construction and siting. Following these decisions it has been anticipated that there would be a construction period (about 8 years) and operation in two phases, physics and technology (together lasting about 18 years), concluding with decommissioning.

Manpower and Costs During Engineering Design Activities

The professional manpower needed to carry out the design activities during the EDA amounts to about 1200 professional man years (pmy). This work would be conducted at a central site by a team whose strength would rise to about 180 professionals, and by the home teams. The cost of this design work including full overhead and support personnel, is estimated to be about \$250 million.

The R&D in support of the design includes Physics R&D, Basic Technology R&D which constitutes engineering database validation, and Specific Engineering R&D which consists of scalable models and related test facilities.

Costs of the physics R&D are not included in ITER costs since they are integral to the world fusion programmes and cannot be separately estimated.

The Basic Technology R&D is estimated to cost about \$400 million including R&D to provide alternatives or backup options to the primary choices. The Specific Engineering R&D cost is estimated to be about \$350 million. The cost of developing DEMO-relevant blanket modules, to be tested on ITER, is not included since this work is assumed to be part of the long-term home R&D programmes.

Estimated Manpower and Cost Requirements During Construction, Operation and Decommissioning Activities

The professional manpower that would be needed during the Construction Activities has been estimated to be about 2900 pmy, provided primarily at the construction site.

The construction cost of ITER has been estimated to be about \$4.9 billion.

During the construction phase there would be the need for technology R&D (estimated to cost about \$300 million). As in the EDA, the cost of physics R&D directly attributable to ITER cannot be separated from the world fusion programmes expenditure.

A Central Team of 300 professionals would be needed during the Operation Activities, including physicists and engineers, to operate the machine and supervise the testing programme.

The resulting preliminary operating cost estimates amount to about \$270 million/year. The cost of the experimental programme which will be carried out on ITER will be in addition to this basic operational cost.

Decommissioning costs have not been estimated.

9. SAFETY AND ENVIRONMENTAL ANALYSIS AND TECHNICAL REQUIREMENTS FOR A CONSTRUCTION SITE

As described by the IMC in Ref. [3], in compliance with point (d) of Section 3. of the present report, a safety and environmental analysis has been conducted and construction site requirements for ITER have been under study during the CDA.

The safety and environmental analysis shows that the conceptual design of ITER is consistent with anticipated regulatory dose limits for routine as well as accidental exposure of the public. There remain issues to be addressed by further design and future safety research so as to benefit fully from the potential safety advantages of fusion reactors.

Apart from the requirements deriving from safety and environmental considerations, other key requirements for the site of ITER construction would be sufficient electric grid capability, potential for on-site cooling, land area and appropriate access. The ITER construction site would have to be equipped for handling radioactive components and materials. In general, the range of acceptable conditions for the construction site is sufficiently large that all of the Parties appear to have sites available for detailed consideration at the appropriate time.

10. ADDITIONAL POTENTIAL BENEFITS OF ITER

In addition to its direct benefits, ITER would produce industrial and technical knowledge for participants. Moreover, full implementation of the ITER project could provide valuable experience for international collaboration in other large high-technology projects for solving some of the world problems, for which the scales are such that solutions must be found through multinational efforts. Some of the problems of large-scale global collaboration, particularly those that involve human factors, have already been met and solved during the ITER Conceptual Design Activities.

11. CONCLUSIONS

The ITER Council's final conclusions are the following:

1. The Conceptual Design Activities of ITER represent a significant advance in international technical collaboration by the four Parties.
2. The ITER activity has resulted in a self-consistent conceptual design which meets the programmatic and technical objectives formulated in the ITER CDA Terms of Reference.
3. The ITER conceptual design, along with the long-term physics and technology R&D programmes which have been developed, is technically sufficient to proceed to the engineering design, which is the appropriate next stage in ITER collaboration.
4. The critical issues to be addressed during the engineering design have been identified along with approaches for their resolution which would take into account continuing advances in technical knowledge.
5. The ITER collaboration has served to focus the fusion research efforts of the various Parties toward a common goal.
6. ITER will be judged by public opinion not only as a demonstration of the technical feasibility of fusion power, but also as a demonstration of its safety and environmental advantages. It is important that safety and environmental considerations should continue to be a guiding principle in the engineering design.
7. A significant quantity of R&D has already been carried out during the Conceptual Design Activities, and this has been useful in optimizing the conceptual design. It is important to take the necessary steps to maintain the momentum of this unique international co-operation.

REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Establishment of ITER: Relevant Documents, ITER Documentation Series, No. 1, IAEA, Vienna (1988)

- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, ITER Concept Definition, Vols. 1 and 2, ITER Documentation Series, No. 3, IAEA, Vienna (1989)
- [3] INTERNATIONAL ATOMIC ENERGY AGENCY, ITER Conceptual Design Report, ITER Documentation Series, No. 18, IAEA, Vienna (1991)
- [4] INTERNATIONAL ATOMIC ENERGY AGENCY, ITER Activities Status Report: April 1990, ITER Documentation Series, No. 12, IAEA, Vienna (1990)

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA, 1991

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121036

FROM: LEDERMAN, Leon M.: FERMILAB

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/04/91

SUBJECT: INFORMATION ON FERMILAB, ITS STATUS AND ITS FUTURE.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

KE has seen

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/08/91

FILE: ~~ENERGY~~

P-Physical Sciences - Energy



Fermilab

RECEIVED

91 APR 8 P 3: 08

OFFICE OF THE
DIRECTOR

9121036
Fermi National Accelerator Laboratory
P.O.Box 500 • Batavia, Illinois • 60510
708-840-3211 FTS 370-3211

Director's Office

April 4, 1991

The Honorable D. Allan Bromley
Assistant to the President for Science & Technology
Old Executive Office Building
17th Street and Pennsylvania Avenue, N.W.
Suite 358
Washington, D.C. 20506

Dear Dr. Bromley:

I am taking the liberty of enclosing a few items related to Fermilab, its status and its future. I hope you enjoy them.

Sincerely,

Leon M. Lederman

Enclosures

1. Brief for Fermilab
2. The Tevatron (Sci American)
3. Physicists Close in....(N.Y. Times 3-19-91)

A BRIEF FOR FERMILAB

Leon M. Lederman

March 13, 1991

Fermilab is now the highest energy accelerator in the world and it will remain at this frontier until the supercolliders, the SSC in Texas and the LHC in Europe's CERN laboratory, come on the air by about the year 2000. Since proton machines traditionally take several years to begin to produce useful data, the hegemony of Fermilab will extend well into the next century.

The 25 year history of Fermilab is characterized by exuberance and success. The first phase (1972-82) achieved twice the energy specified in the design with twice the number of beam lines, on schedule and at a cost of \$10M less than appropriated.

The second phase yielded the successful operation of the world's first superconducting synchrotron, raising the energy from 400 Billion-volts to 900 Billion-volts while reducing energy consumption from 60 megawatts to less than 20 MW. This phase saw the initiation of proton-antiproton colliding beams and the operation of the "CDF" particle detector, probably the most sophisticated system of accelerator and detector art ever achieved. Some 1400 experimenters from 100 U.S. universities and laboratories and institutions in 17 foreign countries have chosen Fermilab for their research facility.

The third phase, begun in 1989, involves a dramatic upgrading of the collision rates in order to fully exploit the Laboratory's leading role for the next decade (1991-2001). It is motivated by crises in the progress of our understanding of the nature of fundamental particles (e.g. the top quark) as well as the need to solidify the knowledge base. It is reasonable to expect that the scientific results, the technological advances and the experience of the Fermilab users will all be crucial to the successful exploitation of the SSC.

The third phase has the concomitant goal of providing the Laboratory with an important facility for addressing crucial issues in particle physics away from the high energy frontier which will pass to SSC and LHC. In particular, the Main Injector, designed to

provide unequalled collision rates for the Fermilab collider, will also provide beams of superb properties for addressing two general categories of problems which are very unlikely to be addressed by SSC. One has to do with intense beams of neutral kaons which will enable studies of the enigma of "CP" symmetry-violating processes (addressed by cosmologists as the "origin of matter" problem) at a level of a hundred times greater sensitivity than is now possible. The other facility is super intense beams of neutrinos to elucidate both the long-standing puzzle of the behavior of neutrinos from the sun and the nature of the gravitational "dark matter" that permeates the universe.

Thus, one can easily foresee, a fifteen year period of leadership and productivity for a Laboratory that has achieved a spectacular scientific and technological track record. The history of machines is replete with surprises which could well provide Fermilab with additional scientific missions.

The advances to which Fermilab contributes is part of the investment in basic research, the human knowledge resource from which, if history is any guide, the nation will draw upon for decades to come. Fermilab's technology in such diverse areas as superconducting systems, medical accelerators and instrumentation has already paid back a significant part of the investment made here by the Federal Government. The Laboratory has advanced its science while, at the same time, setting new standards in its attention to educational outreach, to ecological concerns with its created wetlands and massive prairie restoration, to unique medical applications, to its world famous architecture and its concern for the blending of science with the visual and performing arts. Surely this absolutely unique institution is a place of pride for the nation.

Physicists Close In on World's Fastest Supercomputer

Facing daunting calculations on subatomic particles, scientists build their own system.

By JOHN MARKOFF

ON a workbench here at the Fermi National Accelerator Laboratory physicists are running final tests on a notebook-sized module that will soon become the basic building block of the world's fastest supercomputer. This fall it will begin aiding theorists in refining their understanding of the subatomic structure of matter.

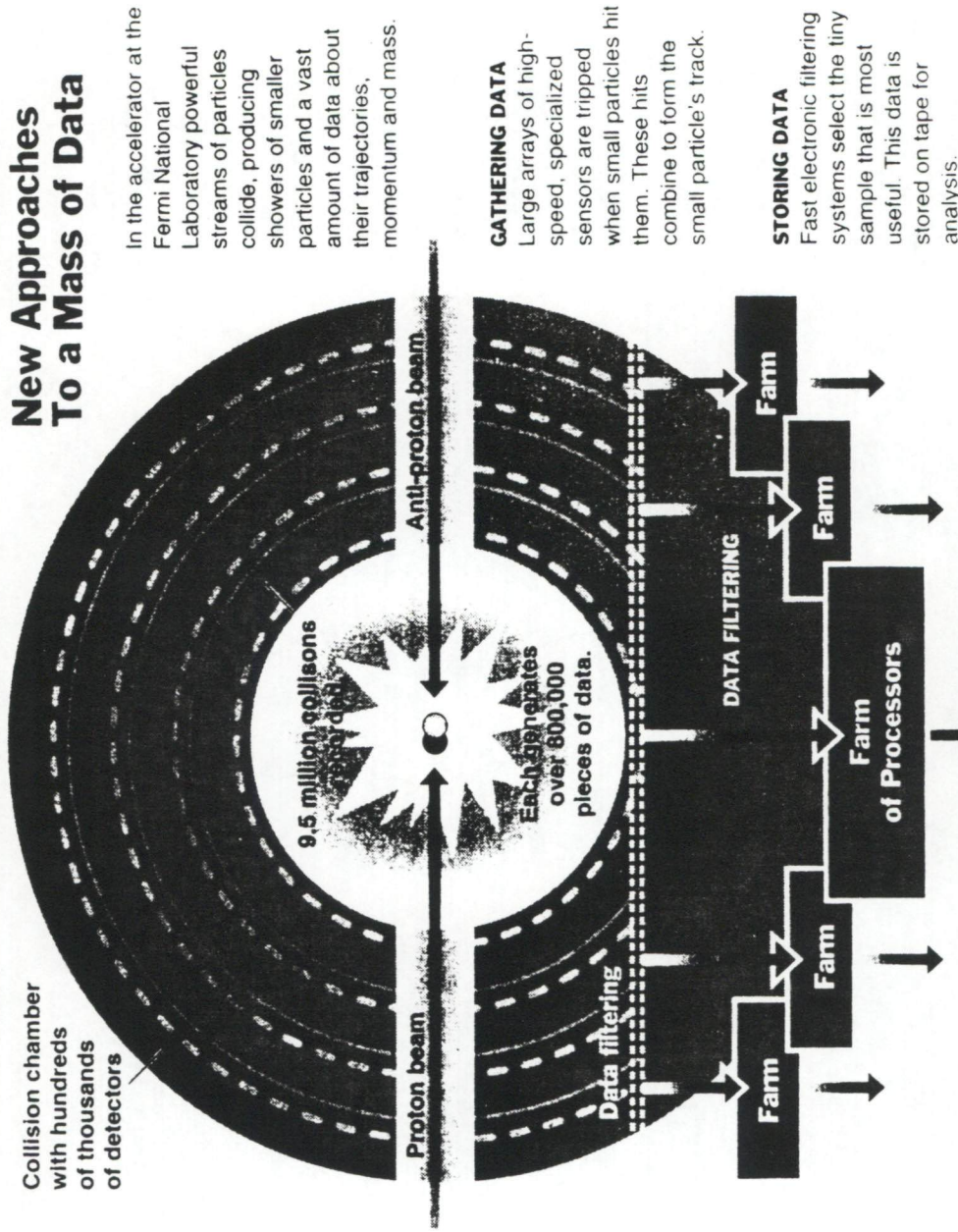
Known as the Advanced Computer Program Multiple Array Processor System, or MAPS, the machine will be composed of an array of 600 thumb-nail-sized microprocessor chips, each capable of computing hundreds of times faster than a standard desktop computer.

Physicists now say they will need to rely on supercomputers like MAPS that are dozens of times more powerful than any now in existence to test a theory that predicts the behavior of fundamental particles known as quarks. At least five groups of scientists in the United States, Italy and Japan are now racing to complete such machines. When the first of these machines, called massively parallel computers, begin to compute answers, perhaps before the end of the year, scientists hope they will provide the strongest evidence yet to confirm — or possibly even debunk — the underlying assumptions of modern physics.

"Our field of research is now pushing the most extreme limits in computing," said Dr. John Peoples, the director of Fermilab.

Because today's commercial supercomputers lack the speed necessary to perform these immense calculations, physicists have increasingly begun designing their own special-purpose machines. By wiring together inexpensive off-the-shelf components, they can create powerful parallel computers that excel at scientific problems by assigning a different processor to each separate component of the model.

These machines work by breaking problems up into hundreds of small parts to speed computing. In contrast, conventional business and scientific computers work sequentially on data. The amount of computing power that will be required is daunting. In fact, theoretical physicists here acknowledge that they do not yet completely know how much will be needed to prove — or



New Approaches To a Mass of Data

In the accelerator at the Fermi National Laboratory powerful streams of particles collide, producing showers of smaller particles and a vast amount of data about their trajectories, momentum and mass.

GATHERING DATA

Large arrays of high-speed, specialized sensors are tripped when small particles hit them. These hits combine to form the small particle's track.

STORING DATA

Fast electronic filtering systems select the tiny sample that is most useful. This data is stored on tape for analysis.

RECONSTRUCTION AND ANALYSIS

Collisions are reconstructed with the aid of computer modeling techniques to gain a clearer view of the particles that were produced. In the next round of experiments, physicists hope to find evidence of a particle known as the top quark, which would confirm key theories about the subatomic structure of matter.

Physicists Close In On Fastest Computer

Continued From Page C1

disprove — their theories. But estimates of the computing power required for accurate testing of elementary particle theories at the necessary level of precision run as high as 10,000 Cray hours — more than a year of computing on the world's fastest supercomputers.

"It's become something of a standard joke in the physics community," said Dr. Thomas Nash, a physicist who heads computation at the national research laboratory. "These problems are already soaking up all the free computing cycles on supercomputers around the country."

Today there are five major projects around the world that have built specialized supercomputers to solve basic theoretical physics problems. In addition to the Fermilab machine, Columbia University and researchers at I.B.M.'s Yorktown Research Laboratory, as well as scientists in Italy and Japan, have working systems.

"We're actually all friends," said Dr. Donald Weingarten, an I.B.M.

As particle accelerators improve, computations must keep pace.

physicist who is in charge of the computer maker's GF-11 supercomputer at Yorktown, which began working on real data earlier this year. "But we all keep close tabs on each other's projects."

Fermilab is now completing work on an upgraded system that will be 10 times more powerful than its first generation system, and will likely be the world's fastest computer when it is complete. But it may be the world leader for only a short period. A consortium of 15 universities is now working with Thinking Machines Inc., a Cambridge, Mass., supercomputer maker to make use of the first so-called teraflop supercomputer.

The machine will be capable of performing one trillion floating point operations — mathematical calculations — per second. By comparison, the fastest supercomputers today reach peak speeds of three billion to five billion floating point operations per second. The teraflop machine is scheduled to be completed in 1993.

"What we're aiming for is a qualitative improvement in accuracy," said Dr. Norman H. Christ, a Columbia University theoretical physicist. "Right now we know we're not in the regime to achieve sufficient theoretical accuracy, but with a machine that is two orders of magnitude faster that should change."

Moreover, what is true for theoretical physicists is also true for their experimental physics colleagues. Here at Fermilab, researchers now measure the results from the subatomic proton-antiproton collisions that take place in the Tevatron accelerator in terms of terabytes of data. A byte is the unit of information that represents one letter or number in a computer's memory and a terabyte is equivalent to one trillion letters or numbers — roughly equivalent to the information contained in 2,000 multi-volume encyclopedias.

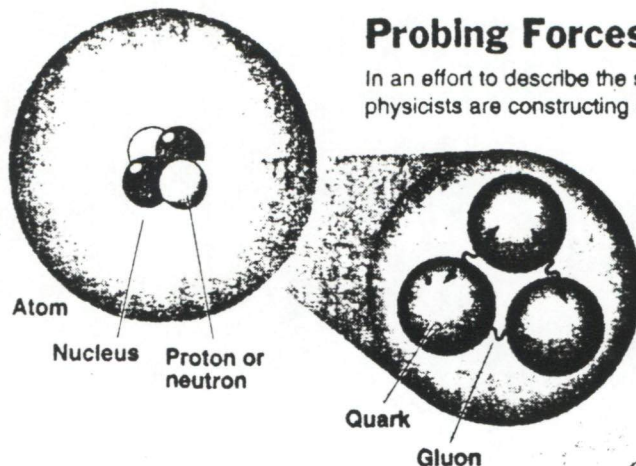
Experimental physicists here require tremendous computing power to conduct their search for an elementary particle known as the top quark. Although it remains elusive, evidence of the particle's existence is necessary to confirm the validity of the leading theory of the basic structure of matter, known as "the standard model." The big accelerator ring at Fermilab, called the Tevatron, is now being refurbished to reach energy levels necessary to yield evidence of the heaviest quark's existence.

"I'm confident we'll find it during the next run," said Dr. Alvin Tollesstrup, a Fermilab physicist who has overseen the design and construction of the experimental apparatus used to capture the streams of high energy particles created by proton-antiproton collisions.

Known as the Collider Detector Facility, the four-story instrument sits at the collision point of the Tevatron ring. Of the hundreds of thousands of collisions that take place each second, data from only about 10 are saved, each generating 100,000 bytes of in-

Probing Forces at Heart of Atom

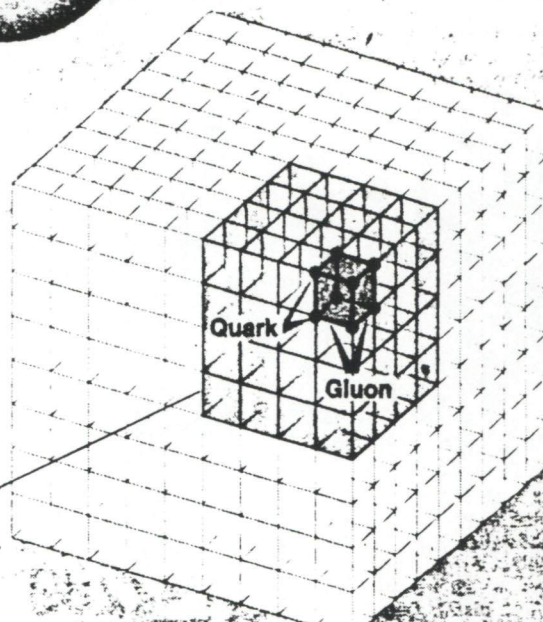
In an effort to describe the strong force that binds the atomic nucleus, physicists are constructing supercomputers to study quarks, the subatomic particles that form the protons and neutrons in the atomic nucleus, and the gluons that hold them together. But the relationships of quarks and gluons are constantly changing and extremely complex. There are believed to be six varieties of quark; gluons are believed to exert eight different kinds of force.



3-DIMENSIONAL MATRIX FOR STUDYING INTERACTIONS

Scientists have constructed a theoretical model of the nucleus in which quarks are represented by "marbles" connected by "sticks" representing gluons. Small sections of the model correspond to processors in a supercomputer under construction at Fermilab. These processors perform the calculations representing changes in the quark-gluon relationship.

Portion of model conforming to processor



Source: Fermilab

The New York Times

formation. Even though the ring runs only part of the time it generates two to three terabytes of data each year.

To capture the huge flows of data physicists at Fermilab will use what they call "farms" of fast reduced instruction set computer, or RISC, processors that gather the output from hundreds of thousands of detectors. The experiments conducted at the laboratory's Collider Detector Facility rely on a hierarchical set of ultrafast triggers, detector electronics, computers and tape storage systems. After they acquire the data from each experiment it is necessary to "reconstruct" each event in order to recognize the events that look most promising.

Even after the reduction this still yields about 230 billion bytes of data that must be available for later anal-

ysis.

Scientists here, who are participating in the design of the computing systems to be used in the future Superconducting Supercollider, or SSC, to be built in Texas later this decade, say that the data collection problems for the new particle accelerator will be several orders of magnitude greater.

The SSC will generate more than 100 "events" each second or about one million events a year. Each event will be monitored by a far larger number of sensors and triggers and will generate a million bytes of data. Annually physicists expect the SSC to yield 1,000 terabytes a year that will then be reduced by a factor of between 100 and 1,000.

To meet these challenges, researchers at Fermilab and other advanced high energy research centers around the world have been forced to go beyond commercially available supercomputers and attempt to develop specialized machines to compute basic physics problems.

Fermilab is now in the final stages of acquiring a new processor farm equivalent to the power of 1,800 Digital Equipment Corporation VAX minicomputers. These systems also function as parallel computers, but less tightly coupled than the MAPS system.

MAPS is also being used to test the theory of quantum chromodynamics, or QCD, a theory that attempts to explain the interaction of quarks, which are thought to bind together as the basic constituents of protons, neutrons and related particles. The term "chromodynamics" is a reference to

Progress in several disciplines changes the market for computers.

the whimsical practice by physicists of labeling different states, or charges, of quarks by three colors: red, purple and green, and those of antiquarks by cyan, yellow and magenta.

A Cornell University physicist, Dr. Kenneth G. Wilson, proposed in 1974 that QCD theory be formulated as a three-dimensional lattice, an array that divides space and time into discrete points. Such a lattice, physicists say, only approximates actual space-time, but it permits them to make calculations that would not be possible otherwise.

Using a mathematical technique known as the Monte Carlo method it is possible to explore QCD theory by making the lattice mesh progressively finer until in principle the physical quantities found on the lattice converge on the values that QCD theory predicts. The Monte Carlo method is a mathematical technique that uses sequences of random numbers to solve problems that might otherwise prove unsolvable.

The Monte Carlo technique is also appropriate to massively parallel computers, making it an ideal approach for the specialized supercomputers that are now being designed to

explore particle physics. Dr. Nash argues that researchers in high energy physics have long taken the lead in exploiting problems which exhibit what he calls "explicit parallelism."

Designing computers to tackle these and similar scientific problems is radically changing the market for ultrafast computers. Until recently the fastest computers have incorporated little or no parallelism. Machines such as those made by Cray Research Corporation have instead been designed around a single or a small cluster of extremely fast processors that line up long "vectors" of calculations and then process them as quickly as possible.

But for a problem that models the flow of air over an airplane wing, the behavior of the atmosphere or a lattice of elementary particles, computers that are composed of hundreds of simple processors are increasingly viewed as more powerful.

"It doesn't take long for a scientist to recognize that a lattice problem obviously corresponds to a grid of processors," said Dr. Nash.

The newest MAPS supercomputer is a second-generation machine based on development work that Fermilab researchers have done in the past three years. Running since 1989, the machine is capable of reaching peak speeds of five billion mathematical operations per second, or gigaflops, roughly equivalent to the power of today's fastest commercial supercomputers. MAPS, built at the cost of \$1 million, is now being upgraded with a new processor board based on two Intel i860 microprocessor chips. When it is finished it will be expanded to 300 nodes and be able to reach peak speeds of 50 gigaflops.

MAPS differs from some of the other special-purpose QCD machines in that it is actually a general-purpose supercomputer that could be programmed to perform other scientific calculations. Fermilab physicists have designed their own parallel programming language, known as Canopy, that could be used for a variety of scientific calculations. But Dr. Nash said that so far MAPS work has focused only on theoretical physics problems.

Brute force number-crunching, with computers capable of ever greater number of cycles per second, is the key to testing QCD, one of the intellectual triumphs of modern physics. "QCD is a very simple theory," said Dr. Christ. "The system is very simple, it's just a question of getting the cycles."

TECHNOLOGY

Digital Equipment Says It Will Enter Market for Massively Parallel Computers

By JOHN R. WILKE

Staff Reporter of THE WALL STREET JOURNAL

A Digital Equipment Corp. executive said Digital would enter the fast-growing market for massively parallel computers within a year.

Robert M. Glorioso, vice president, said "Digital is working on massively parallel computer architectures" that would probably be aimed initially at scientific and technical markets. He said Digital engineers have conducted extensive research over the years in massively parallel computer design, in which scores or even hundreds of smaller processors are tied together to function as one computer.

"It's time to test this technology to see where it can really play," he said in an interview. Despite a slow start in commercial markets, "the whole industry is looking at it more closely now."

Indeed, massively parallel designs are increasingly overtaking conventional machines in raw power. In a closely watched independent test disclosed yesterday by University of Tennessee researcher Jack Dongarra, a parallel computer by **Thinking Machines Corp.** was declared the world's fastest. In a widely accepted benchmark, the machine hit 5.2 gigaflops, or billion floating-point operations per second. A Japanese-built computer by Fujitsu Ltd. took second place.

Mr. Glorioso wouldn't be more specific about the Maynard, Mass.-based company's intentions, suggesting only that it would involve what he called a "systems approach" rather than a single product. He added that software has long been a barrier preventing massively parallel ma-

chines from broad commercial use and that Digital would concentrate more on solving those problems than on any particular machine design. "The hardware actually is the easy part," he said.

None of the major computer makers has a significant presence yet in the massively parallel field. Smaller companies, however, have found it an increasingly hot field, led by closely held **Thinking Machines**. Sales of the Cambridge, Mass., company doubled to an estimated \$60 million last year.

After a late start, Japanese companies also are investing heavily in massively parallel technologies. And while commercial applications have been slow to develop, some companies—including **Dow Jones & Co.**, publisher of *The Wall Street Journal*—have used it to perform fast searches of huge electronic text libraries, or of consumer marketing databases. Scientific and engineering uses also are proliferating.

Mr. Glorioso's comments left the door open for a number of differing approaches to the emerging market, including the possibility of a joint venture. Indeed, Digital insiders hint the company's first move could be a joint effort with **MasPar Computer Corp.** The Sunnyvale, Calif., company is headed by a former Digital engineer who worked on massively parallel de-

signs within Digital before departing for California in 1987. Digital also has done some joint marketing with **Thinking Machines**, mostly in research markets.

Jeffrey Kalb, the former Digital engineer who is now MasPar's president, wouldn't discuss what form any expanded relationship with Digital might take except to say that "we continue to talk about ways to work more closely together." A **Thinking Machines** spokesman said the company continues to work with Digital on some joint sales.

Digital also unveiled as expected a line of "fault-tolerant" computers—machines designed to keep crunching numbers even if a part fails. They are used in banking and other applications where a computer failure would be seriously disruptive.

While some of the details of the announcement had been reported, Digital still managed to surprise some analysts with the aggressive pricing of an entry-level model at just \$46,000. Larger models range in price to as high as \$1 million fully configured.

please
return for
files thanks

91210316

an Article from | **SCIENTIFIC
AMERICAN**

MARCH, 1991 VOL. 264 NO. 3



WE'VE ARRANGED A SMALL CELEBRATION IN HONOR OF YOUR VISIT.



Throughout India in 1991, the traditional "lamp of welcome" will be lighting India's gateway to the '90s and welcoming a new decade of tourism. The 12-month celebration will be taking place all across India—

in festivals ablaze with color, pageantry, ritual and custom. With one-of-a-kind cultural fairs and events, music, dance and sumptuous native cuisines. See India in all its splendor and feel the special spirit of welcome that burns brightly in every home and every heart within India. See India this year.

YES! I'm interested in planning a visit to India. Please send me the FREE "Visit India Year" Kit.

Name

Address

City

State

Zip

Mail To: Government of India Tourist Office
c/o Drawer S
Bellport, NY 11713-0519

Or call: In New York, (212) 586-4901.
In Los Angeles, (213) 380-8855.

India
AIR-INDIA

SA391

The Tevatron

Because it produces antiprotons, accelerates them in a ring using superconducting magnets and smashes them into protons, it is now the world's most powerful source of data on elementary particles

by Leon M. Lederman

On July 3, 1983, my colleagues and I at Fermi National Accelerator Laboratory (Fermilab) near Chicago started the countdown for the inaugural run of the world's first superconducting synchrotron, the Tevatron. It would send a trillion protons on a speed-of-light journey, ending in a collision unlike any that has occurred since very shortly after the birth of the universe. The Tevatron would also launch physicists on an unrivaled adventure in understanding the nature of matter and the discipline of building and operating colossal accelerators.

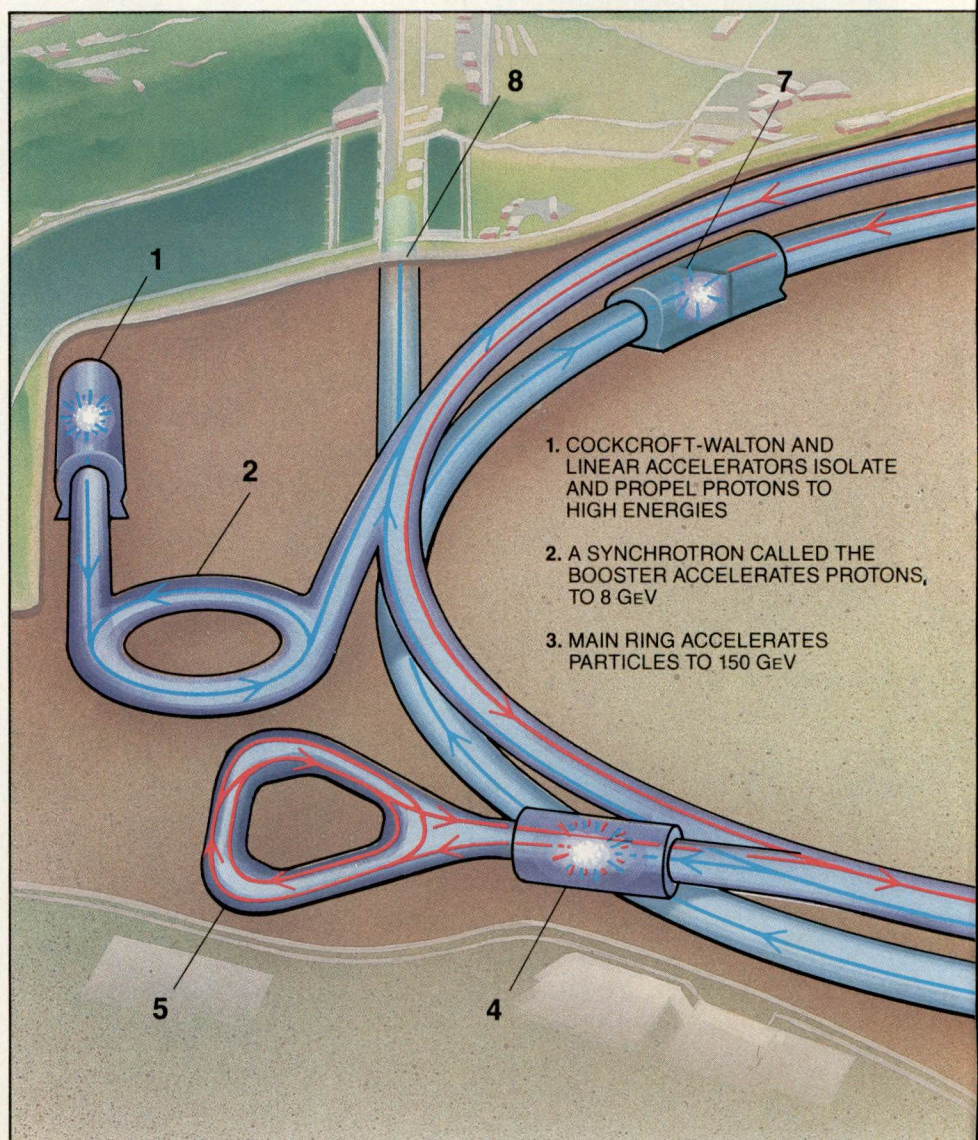
To begin the test, we activated the Main Ring, Fermilab's older synchrotron, to energize the positively charged protons to a mere 120 billion electron volts (GeV). In a nerve-racking instant the protons were injected into the Tevatron, where more than 1,000 superconducting magnets literally took charge. The magnets efficiently produced a powerful field to guide the protons around a 6.3-kilometer circular path no more than a few millimeters wide. In the control room, technicians supervised the computer program that ramped the magnets up in precise synchrony with the increasing energy of the protons: 200, 300, 400 GeV... When the magnetic field reached test-level strength, the protons were smashed into a target at a world record 512 GeV.

The feat capped a 10-year effort to

master the technology of superconducting magnets in accelerators, and it marked the beginning of an era in the physics of matter, energy, space and time. The new "atom smasher" was heralded in newspapers across the U.S. and was praised in messages that

poured in from many institutions, including, in particular, the U.S. Department of Energy (DOE), which had allocated the funding.

During the past eight years, Fermilab has taken many steps to ensure that the Tevatron will remain a preminent fa-



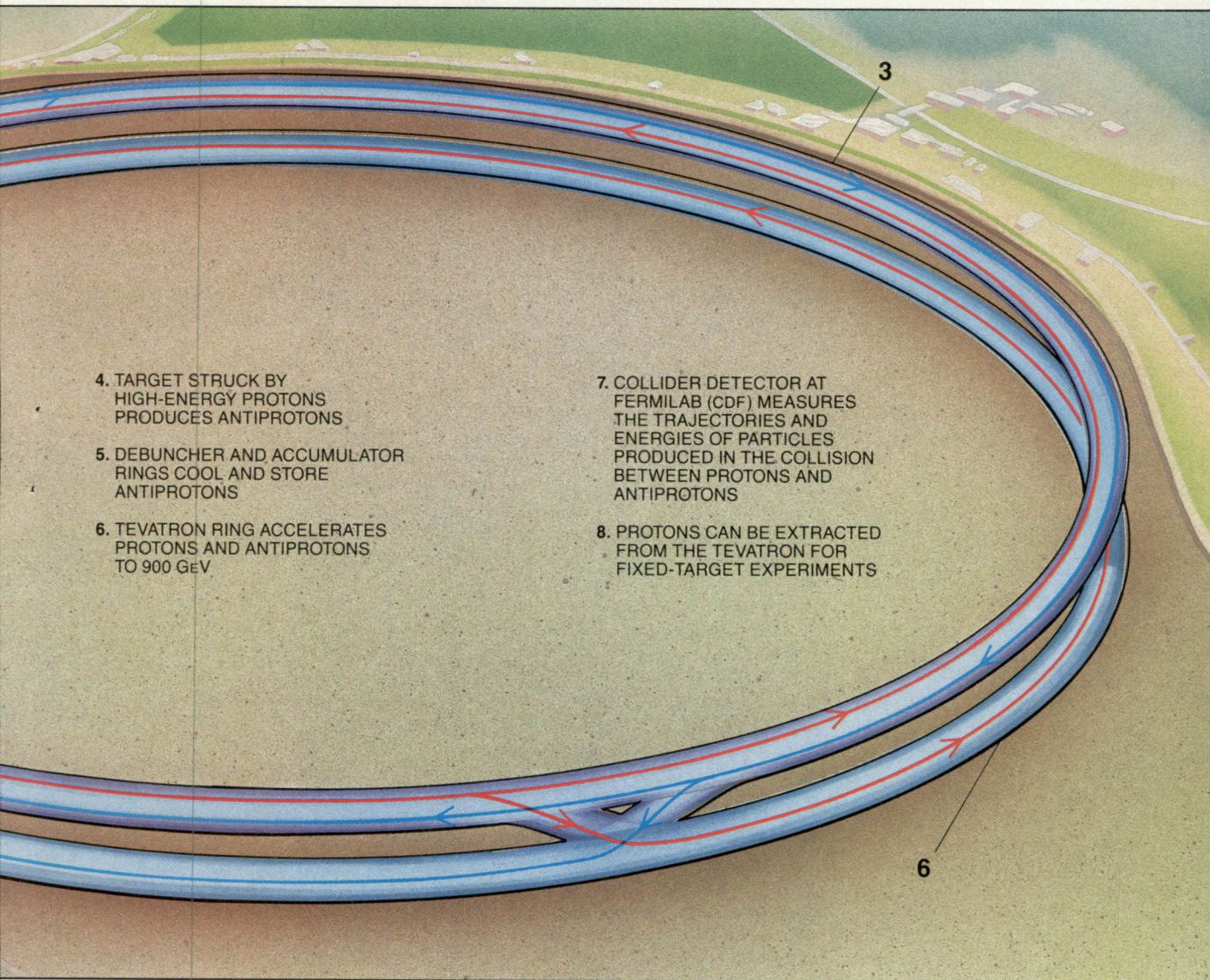
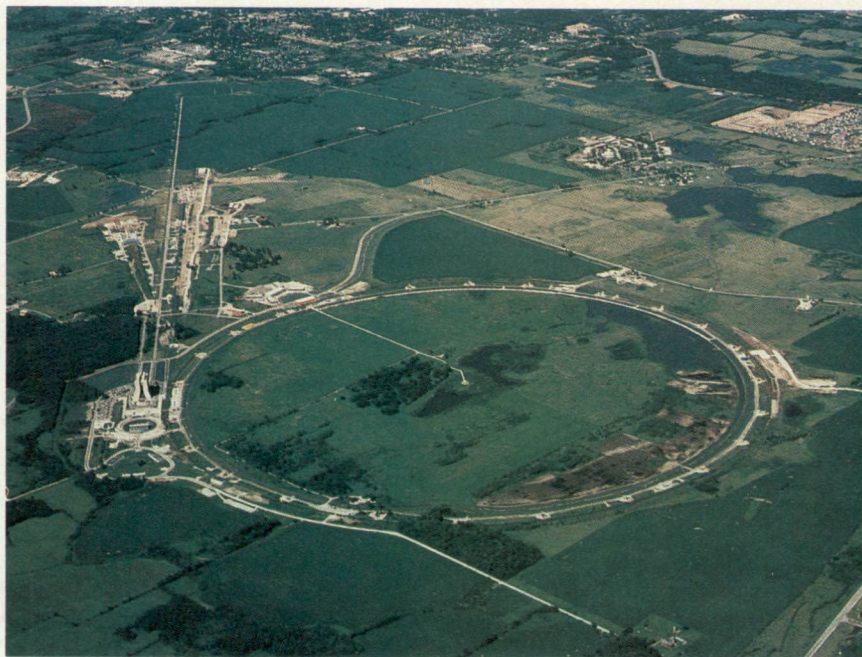
LEON M. LEDERMAN is former director of the Fermi National Accelerator Laboratory (Fermilab) and holds the Frank E. Sulzberger Professorship at the University of Chicago. In 1951 he received his Ph.D. from Columbia University. He managed Columbia's Nevis Laboratories from 1962 until 1979, when he took up his post at Fermilab. He shared the 1988 Nobel Prize in Physics for the discovery of the muon neutrino. He is one of the founders of the Academy for Mathematics and Science Teachers, an institution for improving education in kindergarten through 12th grade.

TEVATRON, the world's most powerful particle accelerator, propels protons (blue arrows) and antiprotons (red arrows) to 900 billion electron volts (GeV) and col-

cility for particle physics. Fermilab has improved the superconducting magnet system, developed an antiproton source and constructed a particle detector. The Tevatron can now collide 900-GeV protons with 900-GeV antiprotons to generate an unmatched 1.8 trillion electron volts (TeV).

With each burst of energy, the Tevatron creates a host of exotic particles, producing data of unprecedented quality. The Tevatron has confirmed many predictions of the Standard Model, the central theory of elementary particles. It has also allowed investigators to explore a domain where "no human eyeball has ever set foot," according to a student with a penchant for mixing metaphors.

The Standard Model proposes that matter is composed of six kinds of quarks and six leptons, and so far all these particles have appeared in ex-



lides them at an energy of 1,800 GeV. The resulting debris has been analyzed to help secure the foundations of phys-

ics. Lessons learned from building the machine will help guide the development of the Superconducting Supercollider.

periments except for the sixth quark, known as top. As the Tevatron evolves during the next five years, it will generate, by most physicists' reckoning, enough collisions to produce the top quark. If it does not emerge, the Standard Model will face a major crisis.

The elusiveness of the top quark is connected to the most seminal issues confronting particle physics. Why do all quarks and leptons have different masses? Does an undiscovered force of nature bestow mass on a particle? Are quarks and leptons composed of even smaller particles? What do the interactions between quarks and leptons suggest about the high-energy environment of the early universe? Theorists have devised many explanations, which have exotic names such as supersymmetry, technicolor, constituent models and superstrings. The Tevatron seeks to illuminate the speculative jungle.

The Tevatron program began more than 15 years ago in anticipation of the needs of the particle physicist today. During the 1970s, elementary particle physics progressed as two kinds of accelerators propelled particles to ever higher energies. Synchrotrons at Fermilab and the European laboratory for particle physics (CERN) near Geneva smashed protons into fixed targets, and accelerators at Stanford University, Cornell University and the Deutsches Elektronen-Synchrotron (DESY) in Hamburg collided electrons with their antimatter twins, positrons.

Although the proton synchrotrons could accelerate particles to much higher energies than the electron-positron colliders, they were in the final analysis no more powerful than the colliders. When a proton boosted to, say, 1,000 GeV is smashed into a target, most of its energy is expended to accelerate the particles produced in the collisions. Only 42 GeV is available to produce new particles. Here the colliders have an advantage. When particles collide head-on, their combined energy is available for creating particles or exploring a new energy regime. Hence, a 1,000-GeV proton that smashes head-on with a 1,000-GeV antiproton releases 2,000 GeV.

The power of an accelerator is not measured by its energy alone, however. An accelerator must generate enough high-energy collisions to produce statistically significant results. Collision rates are generally lower for colliders than for fixed-target machines because particles in a diffuse beam are much more likely to collide with a dense, fixed target than with particles from another diffuse beam. Overall, the col-

liders sacrifice a high collision rate for greater energies.

During the 1970s, the two proton synchrotrons—the Super Proton Synchrotron at CERN and the Main Ring at Fermilab—were competing fiercely. Both laboratories were pushed to improve their machines to study the Standard Model and the fundamental interactions of nature—the weak, electromagnetic and strong forces.

In 1977 CERN went all out to convert its machine from a proton synchrotron to a proton-antiproton collider because it sought to confirm or refute the existence of the so-called intermediate vector bosons (the W^+ , W^- and Z^0). These massive particles are responsible for the weak force. From 1977 to 1981 CERN developed a device that collected and stored antiprotons. The device then squeezed the antiprotons into small bunches using a technique called stochastic cooling. The antiprotons were then injected into the CERN Super Proton Synchrotron, where they eventually smashed head-on into protons.

In 1983 and 1984 CERN discovered the W and Z particles. For this accomplishment, Carlo Rubbia, the leader of one of the experimental groups, and Simon van der Meer, the inventor of stochastic cooling, won the 1984 Nobel Prize [see "The Search for Intermediate Vector Bosons," by David B. Cline, Carlo Rubbia and Simon van der Meer; *SCIENTIFIC AMERICAN*, March 1982].

Fermilab chose a different route to advance the field of high-energy physics. The increasing power of the Super Proton Synchrotron was a major concern to Robert R. Wilson, Fermilab's visionary first director. He realized that if Fermilab could develop a superconducting magnet system, it could ultimately build an accelerator more powerful than CERN's. The proposed Fermilab machine could boost charged particles to higher energies because superconducting magnets can produce a much stronger field than can conventional systems. In 1973, therefore, Wilson started a program to develop superconducting magnets for a new accelerator. Later Alvin V. Tollestrup, who came to Fermilab in 1975 from the California Institute of Technology, became the intellectual leader in developing these magnets.

As director-designate of Fermilab in the fall of 1978, I reviewed various proposals to build an accelerator that would use superconducting magnets. We concluded that such magnets not only could sustain a more powerful accelerator but could also reduce consumption of electricity. (From 1972 to 1978 Fermilab had nearly doubled its

power consumption, while its electricity costs increased sixfold.) Because superconducting components do not resist the flow of electricity at all, a superconducting magnet system would consume considerably less power than a conventional one would. How best to use the new technology was not at all clear. I therefore consulted with an outside group of accelerator geniuses dubbed the three wise men: Boyce D. McDaniel of Cornell University, Burton Richter of Stanford University and Matthew Sands of the University of California at Santa Cruz.

On November 11, 1978, I held a staff meeting to discuss the long-range plans of the laboratory. It was Armistice Day, an appropriate time to call a truce among several groups who had opposing ideas about how to use the superconductor technology. After 18 continuous hours of passionate debate, a clear consensus emerged—at least it seemed clear to me and my advisers. We came up with two major initiatives. First, we would build an accelerator based on a superconducting magnet system and install it in the 6.3-kilometer tunnel occupied by the Main Ring. This machine would smash protons into fixed targets as before but at an energy level more than two times higher. Second, like CERN, we would construct an intense source of antiprotons, inject them into the accelerator and collide them with protons. The goal was to accelerate protons and antiprotons to 1 TeV and produce about 50,000 collisions per second at a total energy of 2 TeV.

From 1979 to 1987 the program was implemented as envisioned in the 1978 plan, at a cost of about \$250 million. The DOE supervised and funded the program, but not without Sturm und Drang. The saving grace was Andrew E. Mravca, a DOE official who believed in the program and knew how to negotiate skillfully with a bureaucracy.

The story of the Tevatron is a very human one, dominated by a collection of heroic figures. Physicists, professional engineers and a corps of gifted amateurs devoted themselves to making the Tevatron the world's most powerful accelerator. If a single factor accounts for the success of this enterprise, it was the happy juxtaposition of physicists and engineers.

When Fermilab set out to design the Tevatron in 1979, we knew it would be significantly more complex than any previous accelerator. The Tevatron would require a huge cryogenic system to cool the magnets below the temperature at which they become supercon-

ductors. It would need an intricate vacuum system to provide both thermal insulation and a clear space in which to accelerate particles. It would demand an elaborate safety network to protect the apparatus and workers from the energy stored in the particle beams and the magnet system. It would involve high-speed computers to monitor and control such parameters as the temperature, pressure, field strength, radiation level and beam position. Finally, the Tevatron would entail sophisticated particle detectors to measure the energies and trajectories of particles formed in collisions between protons and antiprotons. Each of these systems took years to design and build.

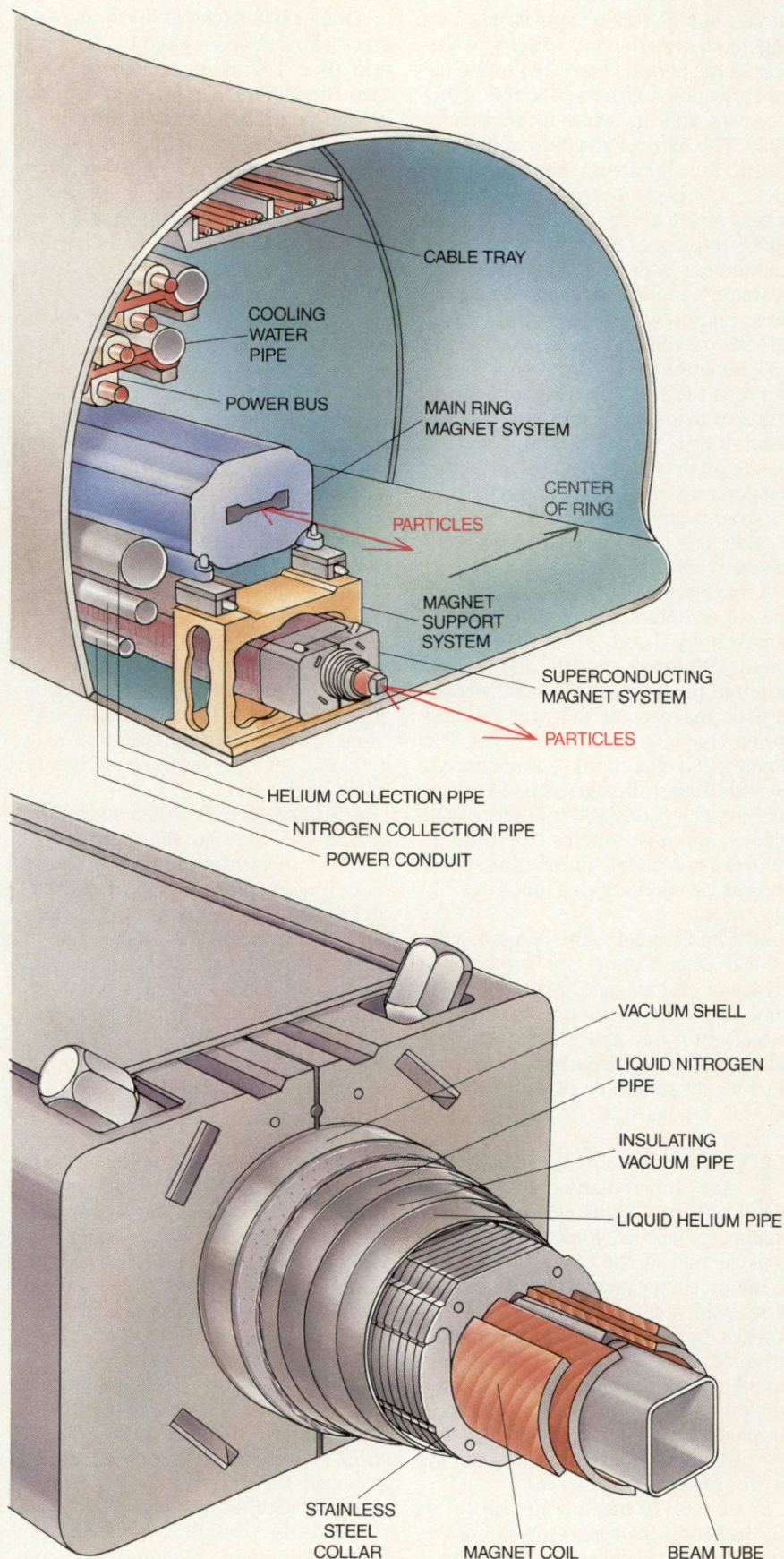
J. Richie Orr was in charge of the Tevatron project. Helen T. Edwards became Orr's deputy and technical manager. Machine guru Thomas L. Collins was principal designer of the accelerator system. Tollestrup and Wilson, with help from Richard A. Lundy, were responsible for the assembly line to produce, test and modify magnets.

The superconducting accelerator magnets posed major technical challenges. The magnets must confine particles within a one-centimeter region in the center of the vacuum tube as they steer the particles around a 6.3-kilometer orbit, 50,000 times a second. The accelerator magnets generate a field as electric currents flow through superconducting wires. The quality of the field depends on the precision with which the superconducting wires are placed around the vacuum tube.

To guide particles, the magnets have to generate a nearly perfect dipole field—one described by a north pole above the orbit and a south pole below. Because it is practically impossible to do so, such magnets as quadrupoles and octupoles were needed to correct for errors in the dipole field.

Accomplishing this task presents several formidable engineering problems. Huge forces push on the wires when they carry the electric currents that create the required magnetic field. The stainless steel clamps that hold the wires must withstand tons of force without yielding more than a thousandth of a centimeter over the 6.4-meter length of each dipole magnet.

Perhaps the most obstinate problem occurs during the acceleration of particles, when the currents change rapidly and increase to 4,000 amperes in about 30 seconds. Changing fields tend to shake and twist wires, creating friction and heat, which are anathema to the superconducting state. The solution to these problems evolved over a decade of research in laboratories around the



FERMILAB TUNNEL (top) houses the Main Ring and the superconducting magnet system that makes up the Tevatron. The tunnel is 3.0 meters wide and 2.4 meters high. In 1982 the Tevatron was installed underneath the Main Ring. One of the Tevatron's dipole magnets appears in the cross section at the bottom. Liquid helium and nitrogen cool the magnet system. They are then collected as gases and recycled.

world, but Fermilab's physicists and engineers were the first to achieve success in the period from 1973 to 1979.

Fabrication of the superconducting wire was still an exotic technology in 1979. The alloy of niobium and titanium, after elaborate metallurgical treatment, was packed into hollow copper tubes. A set of 2,000 rods was then bundled together in a copper shell 250 millimeters wide. The assembly was heated in an oven, extruded through a press and drawn through dies to make strands 0.6 millimeter in diameter and 50 kilometers long. The niobium-titanium rods became fine filaments 10 microns in diameter separated from one another by a sheath of copper, which acts as an insulator at superconducting temperatures (below five kelvins). When 23 strands are woven together to form a cable, they can carry 5,000 amperes at superconducting temperatures.

A mass-production assembly line for the superconducting magnets was supervised by Lundy. His group built about 100 small models and several hundred prototypes before they could get the magnets to perform satisfactorily. They then fabricated about 900 dipoles, 250 quadrupoles and hundreds of other types of magnets used to correct imperfections in the fields of the dipoles and quadrupoles. The total included a reasonable number of spares to replace magnets that might fail in operation.

In 1980 Fermilab built a large facility to test each magnet for mechanical, cryogenic and magnetic properties. The vital statistics of each magnet were logged into a computer program that later served to advise where in the ring the magnet should be placed to cancel residual field errors.

To provide enough coolant for all the superconducting magnets, physicist William B. Fowler and engineer Claus H. Rode directed the construction of the cryogenic system. A major component was a liquid-helium plant that for a time was the world's largest. The facility can now produce simultaneously 4,500 liters of liquid helium per hour and a comparable amount of liquid nitrogen. Liquid nitrogen had previously been delivered by commercial trailers, one arriving every four hours.

In addition to meeting the specifications of the Tevatron, designers of the magnet and cryogenic systems devised safety measures to manage three awesome sources of stored energy that could destroy the machine. First, the Tevatron's magnets store as much as 400 million joules of energy, equivalent

to about 1,000 sticks of dynamite. Second, the beam accelerated by the Tevatron to 1 TeV is equivalent to more than 10 million joules, enough to drill a hole through the surrounding magnet. Third, the magnets require 25,000 liters of liquid helium, which could rapidly expand to 50 million liters of gas, enough to fill a blimp as long as a football field and five stories high. Each of these energy sources raises a host of terrifying engineering problems.

For instance, if a tiny fraction of the particle beam hit several superconducting wires, the particles could heat the wires enough to cause them to cease superconducting, a process known as quenching. The wires would then resist the flow of electricity, dissipate power and consequently heat themselves and adjacent wires to even higher temperatures. Hence, the enormous energy stored in the magnetic field could be released, heating the helium and expanding it in pipes at explosive rates. To protect against such a disaster, Fermilab designed an automatic shutdown procedure, which would in rapid sequence extract the beam from the machine, drain the currents from the magnets and vent the evaporating helium into a large pipe.

In June of 1982 Fermilab suspended operation of the Main Ring, and Peter J. Limon, C. Thornton Murphy and Laurence D. Sauer began supervising the orchestrated chaos involved in assembling the Tevatron. At the peak of activity, some 200 technicians, welders, electricians, engineers and physicists occupied the tunnel. All the resources of Fermilab were focused on fabricating the 1,200 superconducting devices as well as the associated power supplies, utility components, refrigerators and cryogenic connections.

After workers assembled all the parts, made all the connections and sealed all the leaks, they cooled the magnets to an operating temperature of 4.7 kelvins. In June of 1983 Fermilab injected the first bunch of protons from the Main Ring into the Tevatron.

As the Tevatron began demonstrating its power, Fermilab focused its attention on the antiproton source and the detector for the proton-antiproton collider. John Peoples, Jr., managed the antiproton source project along with his systems chiefs, John D. McCarthy, Gerald Dugan, Stephen Holmes and Ernest Malamud. Their ambitious goal was to build a facility that would produce, collect and store at least 10 billion antiprotons per hour so that the antiprotons could be injected into the accelerator in a series of bunches.

Tollestrup and Roy F. Schwitters of Harvard University supervised the development of the Collider Detector at Fermilab (CDF) until 1988, when Schwitters left to direct the Superconducting Supercollider Laboratory in Dallas and was replaced by Melvyn J. Shochet of the University of Chicago. More than 200 scientists—including workers from 10 universities, national laboratories and institutions in Japan and Italy—helped to build the detector.

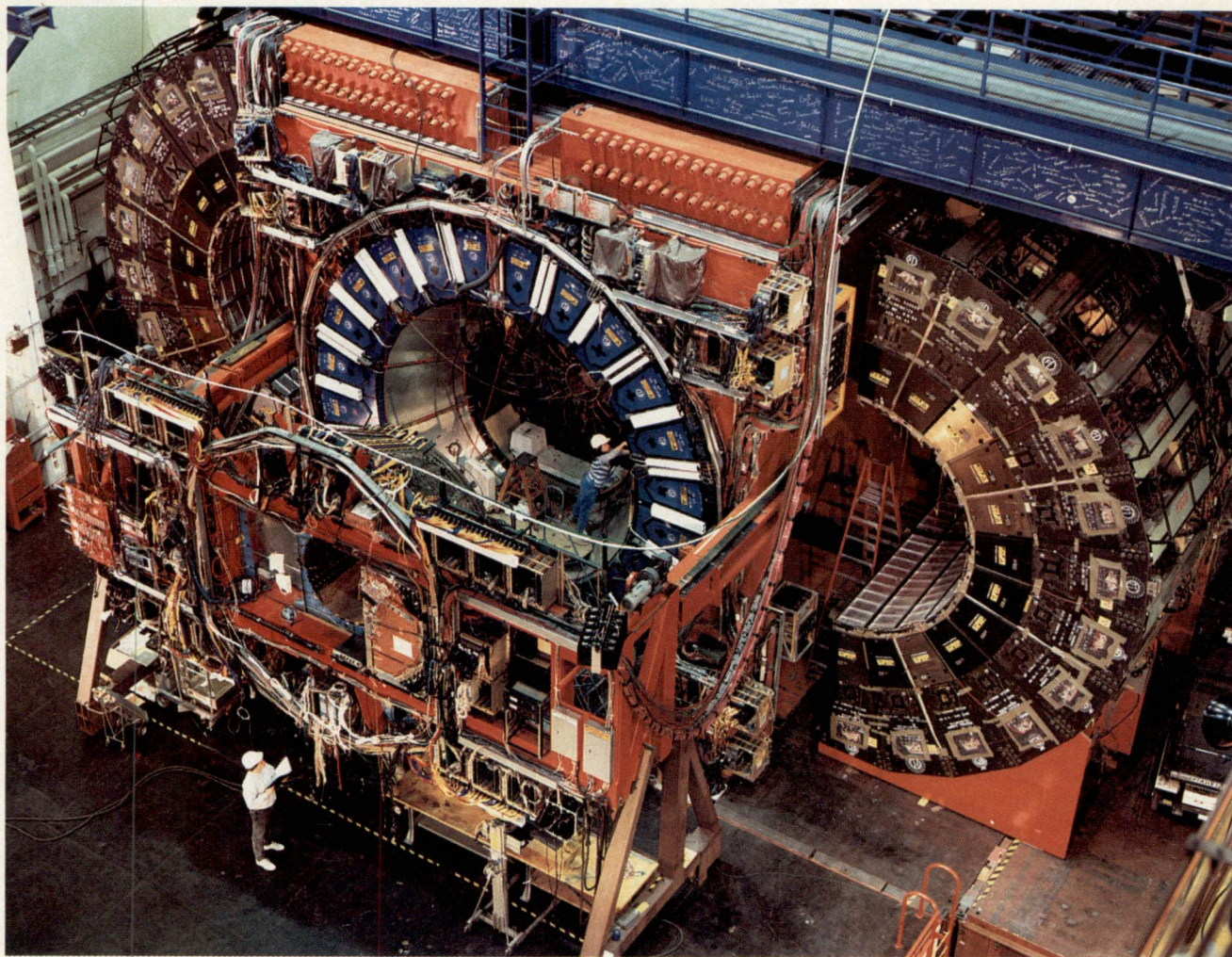
CDF could be characterized as a 5,000-ton Swiss watch. It represents a state-of-the-art device for examining more than 100,000 collisions per second. The energies of the resulting particles are measured by numerous heat sensors; the particles' trajectories are recorded by a wire mesh that carries the electric pulses produced when charged particles pass nearby. For each of the 30 or more particles produced in a typical collision, CDF produces more than 10,000 bits of information about its trajectory and energy. In more than 100 billion collisions it examined, CDF selected for detailed analysis about five million events that were of "more than routine interest."

The Tevatron, the antiproton source and CDF were baptized in a series of experiments that began in January of 1987. These systems required the most sophisticated choreography of accelerator rings ever attempted. The procedure for accelerating particles in the Tevatron is reminiscent of a NASA launch. Control room technicians review an elaborate checklist before they initiate the process that ends in proton-antiproton collisions.

In the first step, negative hydrogen ions composed of two electrons and one proton are released in a device called a Cockcroft-Walton accelerator, which produces an electromagnetic field to propel the ions to an energy of 750,000 electron volts. The ions then enter a 150-meter-long linear accelerator. By inducing an oscillating electric field between a series of electrodes, the linear accelerator boosts ions to an energy of 200 million electron volts. The ions then pass through a carbon foil, extracting the protons from the ions.

In the second step, the protons are guided into the Booster, a synchrotron 500 meters in circumference, where the energy is raised to 8 GeV. The protons are then injected into the Main Ring. Here more than 1,000 conventional, copper-coiled magnets continuously guide and accelerate protons.

In the third step, protons are focused into short bunches at 120 GeV. They are then extracted from the Main Ring and strike a copper target, producing



COLLIDER DETECTOR AT FERMILAB records more than 100,000 proton-antiproton collisions per second. The 5,000-ton apparatus slides into alignment with the Tevatron's parti-

cle beams so that collisions take place in the detector's center. The arches pushed to the side for maintenance are part of the calorimeter, which measures the energies of particles.

antiprotons. About 20 million antiprotons can be collected from each pulse. The antiprotons are then focused by a lithium lens—a cylinder of liquid lithium that transforms a current pulse of 600,000 amperes into a focusing magnetic field.

In the fourth step, the lithium lens directs the antiprotons to the first antiproton storage ring, known as the Debuncher, which is about 520 meters in circumference. The Debuncher is designed to squeeze the antiprotons into as compact a "space" as possible. One can begin to understand how the Debuncher works if one can imagine sitting on an antiproton in the middle of a bunch. From this interesting but precarious vantage point, one can see other antiprotons—some racing faster, some moving slower and some oscillating from side to side. All in all, the antiprotons take up a great deal of space, making it difficult to manipulate the assembly and add more antiprotons.

To increase the density of antipro-

tons, the Debuncher uses two cooling processes. The first, called debunching, is a Fermilab innovation. As a bunch of antiprotons circulates around the ring, a complex, computer-coded radiofrequency voltage speeds up slower particles and slows down faster ones, thereby decreasing the energy distribution of the stored beam. The other process, stochastic cooling, decreases the sideways motion of antiprotons. In this method, particles whose orbits are far from ideal are identified by sensors, which then send correction signals to kicker electrodes that adjust the paths of the errant particles.

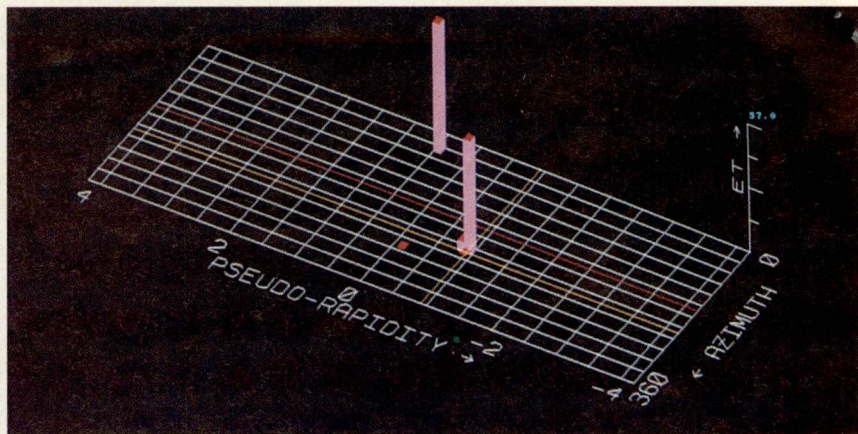
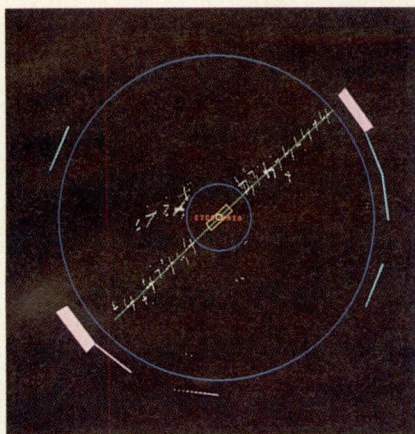
After the Debuncher squeezes the beam in energy and size, the fifth step begins: it sends about 20 billion antiprotons per hour to a concentric ring called the Accumulator. Several independent systems in the Accumulator cool the beam of antiprotons further, ultimately increasing the density of antiprotons by a factor of one million. After four hours, the accumulator ring

contains some 200 billion antiprotons, enough for a "shot" to the Main Ring.

Meanwhile, during the fourth and fifth steps, the Main Ring accelerates 500 billion protons to 150 GeV. The protons are then transferred to the Tevatron ring where they await the antiprotons.

In the sixth step, a portion of the stored antiproton beam is transferred to the Main Ring. The antiprotons are boosted to 150 GeV in the Main Ring and then injected into the Tevatron ring where protons have patiently been circulating. Because the protons are positively charged and the antiprotons are negatively charged, the protons circulate in a direction counter to that of the antiprotons. The antiproton bunches pass through the proton bunches many times, but at this stage the bunches are much too diffuse for significant collisions to take place.

During the first 60 seconds of the final step, both bunches of particles are



COMPUTER DISPLAYS represent particles forged by the collisions between protons and antiprotons in the Tevatron. The diagrams at the left indicate the trajectories of the particles.

The "Lego plots" at the right show where the particles hit the Collider Detector and indicate how much energy the particles released. The pair of displays (above) show a Z^0 particle de-

accelerated to full energy. Strong quadrupole magnets in the Tevatron's ring then squeeze the particles together. During this stage the delicate stability of the circulating bunches can easily be disrupted, scattering particles everywhere. If all goes well, the beams are focused down to a diameter of about 0.1 millimeter, comparable to the diameter of a human hair. The focusing greatly increases the density of each bunch. Each time the bunches cross, there is now a 50 percent chance that a single proton will collide with a single antiproton. According to the original design, more than 50,000 collisions per second should take place in the center of the particle detector.

The first series of collider experiments ended in May 1987, and a second series was started in July 1988 and ran for 11 months. During that period the Tevatron achieved a collision energy of 1.8 TeV. The collision rate improved from a few hundred per second to 120,000 per second, more than twice the design rate. The Tevatron produced a total of about 100 billion collisions between protons and antiprotons. Furthermore, it could sustain a beam of circulating particles for as long as 20 hours, but over time the beams would slowly decrease in size and density as they were scattered by residual gases in the vacuum tube and by other effects that are not yet understood. The Tevatron accomplished these feats using only 20 megawatts of power (as compared with Fermilab's consumption of 60 megawatts in 1979).

One of the most satisfying aspects of these first experiments was to confirm the hypothesis that proton-antiproton collisions can be analyzed in a straightforward manner. This hypothesis is not obvious when one considers that the proton is a mess: it is composed of

three quarks and many force-carrying particles called gluons. The antiproton is, similarly, an antimess. It seemed plausible that a collision between a proton and an antiproton could have produced an indecipherable hodgepodge in which most particles would mask the interesting behavior of others. It turned out, however, that most particles produced in the collision were so low in energy as to be mere spectators of the main events. Only a few high-energy particles emerged, indicating a clean collision between one quark in a proton and another quark in an antiproton.

A variety of high-energy particles can be resolved by CDF. Electrons, muons and photons are easily identified by their trajectories and energies. The quarks appear as jets, that is, bundles of pions, protons, neutrons and kaons. Short-lived particles such as W and Z also decay into a recognizable spray. In many cases, neutrinos, which are not recorded by CDF, can be located by noting "missing" momentum.

By the end of 1990, Fermilab investigators had published some 25 papers. These detailed such new insights as the size of quarks, the nature of the weak and electromagnetic forces, the properties of "bottom" quarks and the lower limit of the mass of the top quark.

The Standard Model assumes that quarks are truly fundamental: they have neither structure nor spatial dimension; they are point particles with no radius. If so, quarks should scatter off one another in different ways than they would if they have a finite radius or any type of structure. Investigators may be able to determine whether quarks have structure, therefore, by studying the distribution of jets produced in collisions between quarks. So

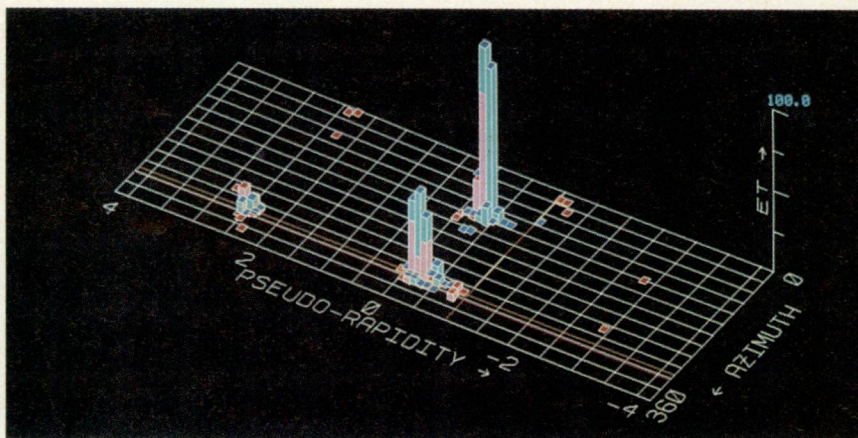
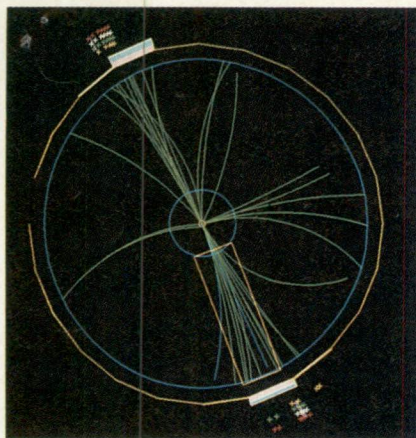
far the results from CDF agree with the Standard Model. If quarks do have a finite radius, it is less than 2×10^{-19} meters (that is, at least 4,000 times smaller than the radius of a proton).

To determine crucial parameters of electromagnetic and weak forces, Fermilab has studied the masses and decay properties of the W^+ , W^- and Z^0 particles. Although the 1987 results from CDF gave the most precise value for the Z^0 mass, this was very soon superseded by the "Z" factories, Stanford's and CERN's electron-positron colliders. On the other hand, CDF supplemented by results from the CERN proton-antiproton collider provides the primary data on W properties.

In the past two decades, physicists have come to recognize that the weak and electromagnetic forces are expressions of a more profound interaction now designated the electroweak force. Fermilab has precisely measured a crucial parameter of the electroweak force, the so-called weak mixing angle. This parameter essentially describes the relative strengths of the electromagnetic and the weak forces in their electroweak alliance.

Fermilab has recently reported exciting evidence for the production of B mesons (particles made of a bottom quark and an antidown or antistrange quark). The run in 1989 recorded about as many B meson events as those observed in all the electron-positron colliders combined. The 1991 run should increase the yield by 100 times in the CDF detector.

Physicists generally believe that a detailed study of the decay of B mesons will lead to a better understanding of the origin of matter. In recent years we have learned that the origin of matter in the early universe was derived from a tiny violation of a deep symmetry of



caying into an electron and a positron. In the other pair, a quark degenerates into two jets containing protons, neutrons, mesons and other baryons. The grid in the Lego plots

represents the interior of the detector as though the cylindrical device were cut across the top and flattened. The energy scale (labeled "ET") is given in billions of electron volts.

matter and antimatter, known as the charge-parity symmetry. Hence, the study of this symmetry violation in B mesons will be a major focus of Tevatron during the next decade.

One of Fermilab's highest priorities has been to search for events that would suggest the production and decay of a top quark. So far CDF has observed only one dubious event. Applying theoretical predictions for the number of events that should have been observed in the CDF data for any assumed mass of the top quark, CDF concluded that the mass of the top quark is greater than 90 GeV.

Why is the top quark so much heavier than its closest relative, the 5-GeV bottom quark? The answer is connected to the most interesting issue in particle physics—the nature of mass and the mechanisms by which the particles of matter acquire mass. The most elegant theories predict that the quarks should have small or vanishing mass. Is the top quark just an anomalously heavy spectator, or is it the key to the internal structure of the Standard Model? The Tevatron is now the only accelerator in the world that can address this issue. In the next decade CDF is planning to increase its sensitivity gradually to find the top quark.

During the past six years, while Fermilab developed and used the Tevatron collider, it continued to produce important results with the fixed-target program. Here the power of the Tevatron was used to create beams of muons, neutrinos, pions and other particles. The Tevatron's high energy and superior time structure have yielded data of unequalled precision for more than 20 experiments.

One of the most interesting examples is the research on the proper-

ties of particles carrying the "charm" quark. In a 1987 run, this experiment amassed more fully analyzed charm events than had previously been collected by all the world's facilities since the charm quark was discovered in 1975. The result was a bonanza of data on lifetimes, new states and modes of decay.

The Tevatron entered final phase of its program in July 1989, when I retired as director of Fermilab and was succeeded by John Peoples, Jr. The program, called Fermi III, includes, notably, a more powerful linear accelerator and a new Main Ring to inject particles into the Tevatron. Fermi III should improve the collision rate of the Tevatron from 120,000 per second to more than six million per second. Because of these improvements, by 1996 the Tevatron should be sensitive to a top quark with a mass as high as 250 GeV.

Fermi III also plans to complete a second detector called DZERO for experiments to begin in 1992. DZERO incorporates a great deal of the experience acquired by CERN in its pioneering proton-antiproton research. Paul D. Grannis of the State University of New York at Stony Brook and H. Eugene Fisk of Fermilab led the DZERO project and enjoyed assistance from some 17 U.S. and foreign institutions. As the detectors are gradually improved to match the machine's performance, the Tevatron will seek again to peer inside the quark and the electron, and it will subject the Standard Model to tests of great precision.

Fermilab's pioneering efforts in superconducting magnet technology will strongly influence the future of accelerators. Several machines will soon use superconducting magnet technologies, including, this year, the 800-GeV proton ring at the DESY laboratory and, in

1995, a 3-TeV proton accelerator at the Soviet accelerator laboratory at Serpukhov. The most dramatic occurrence, however—certainly from the perspective of the U.S.—is the decision to build the Superconducting Supercollider. It will use 10,000 superconducting magnets in a pair of 20-TeV proton rings.

As the Tevatron program enters its second decade, it maintains an approach consistent with Fermilab's founding philosophy: the laboratory exists to serve the university science community. It is important to point out that the typical university group that collaborates at Fermilab is about the same size as those that do experimental science anywhere in the university. Fermilab and other "big science" projects should be judged on the scientific value of their work and the opportunities they provide to both experienced professors and young investigators. Oceanographers, astronomers, genome biologists and particle physicists have been wrestling with the problem of managing large, shared facilities for some time. We must learn to cope with the human problems, particularly the preservation of creativity and initiative, if we are to continue to probe nature's deepest secrets.

FURTHER READING

SUPERCONDUCTING MAGNET TECHNOLOGY FOR ACCELERATORS. R. Palmer and A. V. Tollestrup in *Annual Review of Nuclear and Particle Science*, Vol. 34, pages 247-284; 1984.

WORLDS WITHIN THE ATOM. John Boslough in *National Geographic*, Vol. 167, No. 5, pages 634-663; May 1985.

FROM QUARKS TO THE COSMOS: TOOLS OF DISCOVERY. Leon M. Lederman and David N. Schramm. Scientific American Library, 1989.

What Controls the Cell Cycle

Although the recursive events leading to the birth of new cells are well known, biologists are only now learning how those events are regulated. One protein is the major regulator in virtually all organisms

by Andrew W. Murray and Marc W. Kirschner

By 1900 scientists had already identified the basic events of the cell cycle—the growth and division of a single cell into daughter cells. Yet until recently, little was known about what regulated that cycle, which in humans is vital not only to reproduction but also to growth, tissue repair, immunity and countless other processes.

In the past five years, two separate experimental approaches to the problem have converged on an astonishing finding. The regulation of the cycle in eukaryotes (all living organisms except bacteria and viruses) seems to depend to a great extent on changes in the activity of a single molecule, called the *cdc2* protein.

The discovery is exciting not only because it illuminates a problem that has puzzled cell biologists for decades but also because a deepened understanding of cell-cycle regulation could have profound implications for medicine. On one hand, the work could lead to new ways to induce proliferation of cells needed to reconstruct damaged organs or tissues—perhaps including mature neurons, which do not divide. On the other hand, improved understanding of the cycle may help yield ways to halt the promiscuous reproduction of cancer cells.

In a way, the recent history of cell-cycle research is reminiscent of the build-

ing of the first transcontinental railroad in the U.S., during which two separate groups labored in splendid isolation before uniting their tracks with a golden spike at Promontory Point, Utah, in 1869. In the case of the cell, biochemists and physiologists (studying eggs) and geneticists (studying unicellular yeast) have finally achieved a satisfying intellectual union some 20 years after they began separate lines of investigation.

When the two scientific groups began their work on the cell cycle, they had a common foundation of knowledge. For instance, 19th-century microscopists and other researchers had established that the cycle has two main phases: interphase and mitosis [see *illustration on opposite page*].

In interphase the cell nucleus remains intact. A cell grows continuously, stockpiling material enough for two cells. It also replicates its chromosomes, shortly before mitosis. The chromosomes, which are made of DNA and are stored in the nucleus, contain the genes.

In mitosis, two nuclei are formed from one. First the envelope encasing the nucleus breaks down, and the now duplicated chromosomes become attached to a structure called the mitotic spindle. Then the spindle segregates the chromosomes, ensuring that each daughter nucleus will have one copy of every chromosome. Next a nuclear envelope re-forms around each set of chromosomes, after which the rest of the cell, including the cytoplasm, divides to form two complete daughter cells that are genetically identical to the parent [see "The Mitotic Spindle," by J. Richard McIntosh and Kent L. McDonald; *SCIENTIFIC AMERICAN*, October 1989].

Sometimes a process called meiosis substitutes for mitosis. During sexual reproduction, new individuals are formed by the fusion of an egg with a

sperm. Hence, if the cells of successive generations of an organism are to contain the same number of chromosomes as the cells of the parents, the egg and sperm must each carry only half that number. This halving of chromosome number is accomplished by meiosis, in which precursors of eggs and sperm undergo two rounds of chromosomal segregation in rapid succession without an intervening period of replication. In males the precursors divide symmetrically, producing four sperm. In females the precursors divide asymmetrically, producing one large egg and, usually, three very small cells that are discarded.

By 20 years ago it was also clear that the cell cycle is exquisitely regulated. One type of regulation concerns the control of cell size. At the end of mitosis, newly formed somatic (nonreproductive) cells are the same size the parent cell was at its birth, which means the parent somehow paces its division to occur precisely when its mass has been doubled.

Cells also have to coordinate various events in the cycle. For instance, they must avoid entering mitosis or meiosis until their chromosomes have been replicated; failure to wait can yield cells that lack a particular chromosome—an aberration that can kill a cell or, at times, promote cancer. What remained unclear was just how cells managed to coordinate the segregation of chromosomes with their replication and also to coordinate those processes with cell growth.

Yoshio Masui, then at Yale University, and L. Dennis Smith, then at Argonne National Laboratory, took a giant step toward answering that question in 1971. They independently identified a substance in frog eggs that seemed to control when mitosis and meiosis began.

The basic development of those eggs must be sketched briefly if Masui and Smith's findings are to be understood [see *illustration on page 58*]. The pre-

ANDREW W. MURRAY and MARC W. KIRSCHNER are colleagues at the University of California, San Francisco. Murray, who is assistant professor of physiology, obtained his Ph.D. from Harvard University in 1984. He worked in Kirschner's laboratory before taking his current post. Kirschner, who holds a 1971 doctorate from the University of California, Berkeley, has been professor of biochemistry and biophysics at the San Francisco campus since 1978. He moved to San Francisco from Princeton University.

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121081

FROM: PEWITT, Douglas

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 04/03/91

SUBJECT: SUPERCONDUCTING SUPER COLLIDER

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/08/91

FILE: P- PHYSICAL SCIENCES-ENERGY

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01. Letter	To: Allan Bromley From: Douglas Pewitt Re: Superconducting Super Collider (3 pp.)	4/3/91	(b)(2)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files
WHORM Cat.:
File Location: Physical Science: Energy [2 of 2] [1991]

Date Closed:	3/29/2010	OA/ID Number:	62043-005
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P-6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Removed as a personal record misfile.

Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
(b)(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
(b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
(b)(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
(b)(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
(b)(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

FAX TRANSMISSION

TO:

Name : Prof. D. Allan Bromley		Date: 3 Mar 91
Company :		
Fax Number: (202) 395-3261	Phone : (202) 456-7116	

FROM:

N. D. Pewitt	
Fax Number: (214) 780-0733	Phone : (214) 780-7052

SUBJECT:

Superconducting Super Collider

MESSAGE:

Comments I hope are useful.

PAGE: 1 OF: 4

MS
As guessed, this
was not in the system.
Show in system w/ DAB
& cc to Wong. I gave
Karl a copy so no need
to do any copies

dlh
4/8

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120962

FROM: DAVIS, Edward M.: AMERICAN NUCLEAR ENERGY COUNCIL

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 03/28/91

SUBJECT: DR. BROMLEY'S SUPPORTIVE EFFORTS IN ENSURING THAT
NUCLEAR ENERGY'S POTENTIAL CONTRIBUTIONS WERE
RECOGNIZED IN THE ADMINISTRATION'S NATIONAL ENERGY
STRATEGY.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 04/01/91

FILE: ENERGY

P-Physical Sciences

912 0961

AMERICAN NUCLEAR ENERGY COUNCIL

RECEIVED

Edward M. Davis
President

March 28, 1991

91 APR 1 P2:48

OFFICE OF THE
DIRECTOR

The Honorable Allan Bromley
Assistant to the President
for Science and Technology
The White House
Washington, DC 20500

Dear Dr. Bromley:

On behalf of the American Nuclear Energy Council (ANEC), I would like to thank you for your supportive efforts in ensuring that nuclear energy's potential contribution to meeting our nation's future energy and environmental needs were recognized in the Administration's National Energy Strategy (NES).

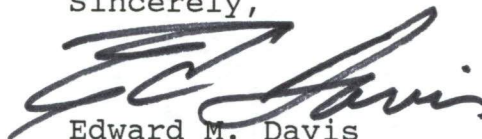
We believe that the recent events in the Persian Gulf and the congressional enactment of the Clean Air Act Amendments compel the nation to increase its reliance on nuclear energy in the future. We are prepared to assist the Administration and Congress in efforts to fashion a bipartisan national energy strategy that promotes economic growth, energy security and environmental progress.

We also applaud the Administration's position on the various provisions that address the central impediments to revitalizing the nuclear energy option, specifically nuclear licensing reform for advanced, standardized plants and nuclear waste management initiatives to resolve the impasse at Yucca Mountain site. We urge your continued support of these provisions as part of a comprehensive energy bill.

For your information, I have taken the liberty of enclosing a recent speech that I gave on the implications of global warming for the U.S. nuclear energy industry which discusses how nuclear energy contributes to curbing the buildup of greenhouse gases.

We look forward to the opportunity of working with you and your staff on energy policy. Please have your staff contact me if I can be of assistance.

Sincerely,



Edward M. Davis

"IMPLICATIONS OF GLOBAL WARMING
FOR THE U.S. NUCLEAR ENERGY INDUSTRY"

Edward M. Davis
President
American Nuclear Energy Council

Presented
to
The Third U.S. Energy Association
Global Climate Change Forum

Tuesday, March 5, 1991

I WANT TO THANK THE U.S. ENERGY ASSOCIATION FOR THE KIND INVITATION TO SPEAK HERE TODAY BEFORE SUCH AN IMPRESSIVE AUDIENCE.

I ESPECIALLY WANT TO THANK JOHN GREY, JOHN LANDIS AND ROGER GALE FOR WHOM I'VE HAD THE PRIVILEGE TO KNOW AND FOR WHOM I HAVE THE HIGHEST RESPECT WHEN IT COMES TO ENERGY AND ENVIRONMENTAL POLICY MATTERS.

I AM DELIGHTED TO SPEAK ON THE IMPLICATIONS OF GLOBAL WARMING FOR THE FUTURE OF NUCLEAR ENERGY OPTION. THERE IS NO QUESTION THAT THIS IS A TIMELY MEETING AND TOPIC. THIS DECADE IS SHAPING UP AS AN EXTRAORDINARILY PIVOTAL ONE FOR THE ENVIRONMENT, FOR ENERGY SECURITY AND – NOT COINCIDENTALLY – FOR NUCLEAR ENERGY. WHAT WE DO – OR DON'T DO – IN THE NINETIES WILL VERY LIKELY DEFINE THE ENVIRONMENTAL QUALITY, THE ENERGY BLUEPRINT AND VERY FUTURE OF NUCLEAR ENERGY IN THE NEXT CENTURY. SO THE QUESTIONS WE ARE ATTEMPTING TO ANSWER TODAY ARE EXTREMELY IMPORTANT ONES.

IF I WERE TO ASSESS THE IMPLICATIONS OF GLOBAL WARMING ON THE FUTURE OF NUCLEAR ENERGY IN ONE WORD, MY SPEECH WOULD BE VERY SHORT AND SIMPLE. THE ANSWER IS SIGNIFICANT. BUT TO APPRECIATE THE FULL RAMIFICATIONS OF CONCERNS ABOUT GLOBAL CLIMATE CHANGE ON NUCLEAR ENERGY -- AND ALL OTHER ENERGY RESOURCES FOR THAT MATTER -- I THINK WE HAVE TO PUT THEM IN THE CONTEXT OF THE MANY OTHER RELATED CONSIDERATIONS THAT ARE AT WORK TODAY. FOR TODAY, THERE IS A CONFLUENCE OF EVENTS, INCLUDING THE PERSIAN GULF WAR AND THE BUSH ADMINISTRATION'S SUBMITTAL OF ITS NATIONAL ENERGY STRATEGY, THAT IS CREATING A WINDOW OF OPPORTUNITY FOR EFFECTIVE ACTION.

AS THEY SAY IN THE ADVERTISING BUSINESS, "THE MEDIUM IS THE MESSAGE." IT IS MY BELIEF THAT IN THE ENERGY BUSINESS, THE CONTEXT IS THE MESSAGE AND, AS I WILL EXPLAIN LATER, THE GLOBAL WARMING ISSUE HAS FUNDAMENTALLY AND SIGNIFICANTLY ALTERED THE WAY WE VIEW ENERGY AND ENVIRONMENTAL POLICY ISSUES. THIS IS THE INSIGHT I HOPE I CAN SHARE WITH YOU TODAY. BECAUSE, AS I SAT DOWN TO PREPARE MY REMARKS, IT BECAME APPARENT TO ME THAT I WOULD HAVE TO FOCUS ON SOMETHING BESIDES THE OBVIOUS.

IF YOU ACCEPT THE FACT THAT NUCLEAR ENERGY EMITS NO GREENHOUSE GASES AND THE FACT THAT, ACCORDING TO THE NATIONAL ENERGY STRATEGY (NES) REPORT, IF NO ACTION IS TAKEN, THE USE OF FOSSIL FUELS TO MEET U.S. ENERGY DEMAND WILL RESULT IN AN 80 PERCENT INCREASE IN ENERGY-RELATED CO2 EMISSIONS BY THE YEAR 2030, THEN YOU READILY UNDERSTAND WHY THE DEBATE OVER NUCLEAR ENERGY IS BEING RESHAPED BY THE OMNIPRESENT CONCERN FOR GLOBAL CLIMATE, AND THE ENVIRONMENT IN GENERAL.

SO TODAY I WOULD LIKE TO FOCUS MY REMARKS NOT ON THE TECHNICAL ASPECTS OF HOW NUCLEAR ENERGY MIGHT CONTRIBUTE TO EFFORTS TO CURB THE BUILD-UP OF GREENHOUSE GASES, BUT RATHER HOW THE POLITICAL CONCERN FOR GLOBAL WARMING AND THE ENVIRONMENT IS INFLUENCING THE DEBATE ON NUCLEAR ENERGY AND ENERGY IN GENERAL.

IN MY VIEW, GLOBAL WARMING HAS OPENED THE DOOR FOR THE REVITALIZATION OF NUCLEAR ENERGY BECAUSE THE ISSUE FORCES ONE TO TAKE AN INTEGRATED LOOK AT BOTH OUR ENERGY AND ENVIRONMENTAL NEEDS. IT IS THIS INTEGRATION OF ENERGY AND ENVIRONMENTAL POLICYMAKING THAT IS CHANGING THE POLITICAL LANDSCAPE WHEN IT COMES TO NUCLEAR ENERGY.

AS AN INDICATION OF THE NEED FOR THIS INTEGRATED EXAMINATION OF OUR NATION'S ENERGY AND ENVIRONMENTAL CHALLENGES AND ITS IMPACT ON THE FORTHCOMING DEBATE ON ENERGY POLICY, I WOULD CALL YOUR ATTENTION TO THE RECENT SPEECH OF HOUSE ENERGY COMMITTEE CHAIRMAN JOHN DINGELL, IN WHICH HE STATED IN PART WHAT I'M NOW PARAPHRASING:

"WE ARE NOW CURSED BY THE TRADITIONAL CONFLICT BETWEEN ENERGY AND ENVIRONMENTAL POLICY...MUCH OF OUR LAW AND PRACTICE IS BASED ON THAT CONFLICT...

"INSTEAD OF SWINGING BACK-AND-FORTH BETWEEN OUR CONCERN FOR ENERGY AND THE ENVIRONMENT, STRENGTHENING OR WEAKENING OF LAWS WE HAD PASSED JUST A FEW YEARS EARLIER, WE NEED TO INTEGRATE THE TWO AND FASHION ENERGY POLICIES WHICH TAKE INTO ACCOUNT THE NEED TO PROTECT OUR ENVIRONMENT...

"WITH SERIOUS ENVIRONMENTAL ISSUES SUCH AS GLOBAL WARMING, WE NEED TO FIND SOLUTIONS TO OUR ENERGY PROBLEMS CONSISTENT WITH ENVIRONMENTAL PROTECTION...

"A CLASSIC EXAMPLE OF A TOUGH ENERGY ISSUE IS NUCLEAR POWER. THERE IS NO MIDDLE GROUND ON NUCLEAR POWER. BUT EVENTS IN THE PERSIAN GULF, AND THE PASSAGE OF THE CLEAN AIR ACT LAST YEAR, BOTH MAKE NUCLEAR POWER MORE IMPORTANT."

THE CHAIRMAN CONCLUDED HIS REMARKS BY SAYING, "THERE IS NO HOPE FOR ENERGY INDEPENDENCE IN THIS COUNTRY UNLESS WE MOVE STRONGLY TOWARD NUCLEAR POWER." WHILE CHAIRMAN DINGELL WAS REFERRING TO THE IMPLICATIONS OF THE PASSAGE OF THE CLEAN AIR ACT AMENDMENTS, THE

IMPLICATIONS OF EFFORTS TO CURE GLOBAL WARMING YIELD SIMILAR OBSERVATIONS BY MOST OBJECTIVE ENERGY POLICY ANALYSTS.

I'M NOT HERE TO TELL YOU THAT NUCLEAR ENERGY IS A PANACEA – CLEARLY IT IS NOT. THE NATION REQUIRES A COMPREHENSIVE AND BALANCED NATIONAL ENERGY POLICY – ONE THAT RELIES ON CONSERVATION AND DEMAND-SIDE MANAGEMENT, AS WELL AS ENHANCED PRODUCTION OF DOMESTIC ENERGY SOURCES, INCLUDING NUCLEAR ENERGY. BUT, IN MANY RESPECTS, NUCLEAR ENERGY BEATS WHATEVER IS IN SECOND PLACE, WHEN YOU CONSIDER BOTH ENERGY AND ENVIRONMENTAL NEEDS, PARTICULARLY IN THE UTILITY AND TRANSPORTATION SECTORS.

BY THE WAY, THOSE TWO SECTORS ACCOUNT FOR ABOUT 63 PERCENT OF OUR TOTAL ENERGY CONSUMPTION.

SO IF YOU DEFINE OUR ENERGY AND ENVIRONMENTAL PROBLEM IN AN INTEGRATIVE WAY, ONE OF PROVIDING FUTURE ENERGY DEMAND AND SIMULTANEOUSLY:

- REDUCING OIL CONSUMPTION
- REDUCING OR STABILIZING CO₂ EMISSIONS

THEN NUCLEAR ENERGY BECOMES AN ATTRACTIVE OPTION, PARTICULARLY WHEN USED WITH ELECTRIC TRANSPORTATION. BECAUSE IT IS SUCH AN OBVIOUS CHOICE, PEOPLE AND POLITICIANS OF ALL POLITICAL PERSUASIONS ARE BEGINNING TO TAKE AN OBJECTIVE LOOK AT NUCLEAR ENERGY.

AND SO THE OLD POLITICAL CALCULUS IS GIVING WAY TO A NEW POLITICAL EQUATION OR DYNAMIC. MOREOVER, AS A CONSEQUENCE, MANY MEMBERS OF CONGRESS ARE BECOMING

LESS TOLERANT AND LESS PATIENT WITH THOSE WHO ARE IDEOLOGICALLY OPPOSED TO NUCLEAR ENERGY.

ONE CANNOT DISMISS NUCLEAR ENERGY OUTRIGHT AS AN OPTION AND STILL BE INTELLECTUALLY HONEST. ENVIRONMENTAL GROUPS LOSE CREDIBILITY WITH CONGRESS WHEN THEY ARGUE ON THE ONE HAND THAT THE GLOBAL CLIMATE ISSUE REQUIRES URGENT AND SIGNIFICANT ACTION, AND ON THE OTHER HAND, SAY THAT, DESPITE THE SERIOUSNESS OF THE GLOBAL CLIMATE ISSUES, NUCLEAR ENERGY MUST NOT BE CONSIDERED AS AN OPTION.

I CAN'T EVEN BEGIN TO COUNT THE MEMBERS OF CONGRESS WHO HAVE TOLD ME THE STORY OF HOW THE ENVIRONMENTAL GROUPS LOBBIED FOR STRINGENT CLEAN AIR STANDARDS, ONLY TO MUMBLE AN ANSWER WHEN ASKED ABOUT THEIR POSITION ON NUCLEAR ENERGY. AS A CONSEQUENCE, MODERATE ENVIRONMENTAL GROUPS HAVE ACKNOWLEDGED, ALBEIT GRUDGINGLY, NUCLEAR ENERGY'S POTENTIAL ROLE IN CURBING GREENHOUSE GASES.

FOR EXAMPLE, THE UNION OF CONCERNED SCIENTISTS (UCS) IN A JANUARY 1990 LETTER TO PRESIDENT BUSH SIGNED BY A SUBSTANTIAL NUMBER OF THE NATION'S MOST PROMINENT SCIENTISTS, INCLUDING 49 NOBEL LAUREATES AND 700 MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES, CALLED FOR STRONG LEADERSHIP BY THE U.S. IN THE DEVELOPMENT AND IMPLEMENTATION OF GLOBAL WARMING POLICY.

A UCS STATEMENT STATES THAT:

"GLOBAL WARMING HAS EMERGED AS THE MOST SERIOUS ENVIRONMENTAL THREAT OF THE 21ST CENTURY...ONLY BY TAKING ACTION NOW CAN WE ENSURE THAT FUTURE GENERATIONS WILL NOT BE PUT AT RISK ... THE UNITED STATES SHOULD DEVELOP AND IMPLEMENT A NEW NATIONAL ENERGY

POLICY, BASED ON THE NEED TO SUBSTANTIALLY REDUCE THE EMISSION OF CARBON DIOXIDE, WHILE SUSTAINING ECONOMIC GROWTH. THE CORNERSTONES OF THIS POLICY SHOULD BE ENERGY EFFICIENCY AND THE EXPANSION OF CLEAN ENERGY SOURCES."

THESE SCIENTISTS PROPOSE A FIVE-POINT PLAN THAT INCLUDES:

- A STEADY INCREASE IN MOTOR VEHICLE FUEL ECONOMY STANDARDS, WHILE THE SEARCH CONTINUES FOR FUELS AND OTHER TECHNOLOGIES THAT MITIGATE CARBON DIOXIDE IMPACT;
- A SUBSTANTIAL INCREASE IN FEDERAL FUNDING FOR RESEARCH ON ENERGY EFFICIENCY TECHNOLOGIES, AS WELL AS FEDERAL ACTIVITIES TO ENHANCE THE ADOPTION OF MORE EFFICIENT ENERGY USE;
- DEVELOPMENT, DEMONSTRATION AND COMMERCIALIZATION OF RENEWABLE ENERGY TECHNOLOGIES ON A MASSIVE SCALE;
- A NUCLEAR ENERGY PROGRAM THAT EMPHASIZES PROTECTION OF PUBLIC HEALTH AND SAFETY, RESOLUTION OF THE PROBLEM OF RADIOACTIVE WASTE DISPOSAL, AND STRINGENT SAFEGUARDS AGAINST THE PROLIFERATION OF NUCLEAR MATERIALS AND TECHNOLOGY THAT CAN BE APPLIED TO WEAPONS CONSTRUCTION, AND
- FULL CONSIDERATION OF ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACTS IN THE ESTABLISHMENT OF FEDERAL SUBSIDIES AND REGULATORY STANDARDS FOR DEVELOPMENT OF ENERGY SOURCES.

IN A NUTSHELL, THE GLOBAL CLIMATE ISSUE HAS RESHAPED THE WAY WE CONSIDER ENERGY AND ENVIRONMENTAL POLICY ISSUES AND HAS LED TO AN INTEGRATED LOOK AT ENERGY ALTERNATIVES AND THEIR RESPECTIVE TRADEOFFS.

NATIONAL ENERGY STRATEGY

THE RECENTLY RELEASED NES IS A LANDMARK INTEGRATED STUDY ON ENERGY AND ENVIRONMENTAL POLICY. ITS AUTHORS SHOULD BE COMMENDED FOR PROVIDING AN INVALUABLE SERVICE TO THE NATION, INCLUDING: MARK KERRIGAN, LINDA STUNTZ, ASSISTANT SECRETARY BILL YOUNG, DEPUTY SECRETARY HENSON MOORE AND SECRETARY WATKINS.

IT IS MY HOPE THAT THE NES WILL SERVE AS AN INTEGRATED FRAMEWORK UPON WHICH TO EVALUATE OUR ENERGY ALTERNATIVES.

THE NES, IN ADDITION TO PROPOSING AN ENERGY STRATEGY, ALSO LAYS OUT A STRATEGY FOR ENVIRONMENTAL PROGRESS, AND SPECIFICALLY FOR CURBING THE BUILD-UP OF TOTAL GREENHOUSE GASES.

THE NES PROVIDES A SERIES OF ACTIONS THAT WILL REDUCE GREENHOUSE GASES FROM FUTURE ENERGY PRODUCTION AND USE.

THE NES STRATEGY REFLECTS MEASURES THAT, IF IMPLEMENTED, WOULD RESULT IN U.S. CO₂ LEVELS INCREASING BY APPROXIMATELY 25 PERCENT THROUGH THE YEAR 2015 AND THEN MAINTAINING ANNUAL CO₂ EMISSIONS AT OR BELOW THAT LEVEL THROUGH THE YEAR 2030.

WHEN ADDED WITH ACTIONS PLANNED AND BEING TAKEN TO CURB OTHER GREENHOUSE GASES, THE NES STRATEGY WILL HOLD

GLOBAL WARMING POTENTIAL (GWP) EMISSIONS AT OR BELOW THE 1990 LEVEL.

THE NES STRATEGY IS BASED ON TWO BASIC APPROACHES:

- IMPROVING ENERGY EFFICIENCY, AND
- SHIFTING TO ENERGY SOURCES AND TECHNOLOGIES THAT EMIT FEWER GREENHOUSE GASES.

ENERGY EFFICIENCY INITIATIVES IN THE NES INCLUDE:

- INCREASED TRANSPORTATION FUEL EFFICIENCY;
- IMPROVED BUILDING EFFICIENCY, INCLUDING ENHANCED RESEARCH AND DEVELOPMENT IN IMPROVING INDUSTRIAL ENERGY EFFICIENCY;
- ENHANCED TRANSPORTATION RESEARCH AND DEVELOPMENT, INCLUDING THE DEVELOPMENT OF ELECTRIC VEHICLES, AND
- FEDERAL SUPPORT FOR INTEGRATED RESOURCE PLANNING IN ELECTRICITY MARKETS.

FOR NEW AND EXISTING TECHNOLOGIES ASSOCIATED WITH LOW OR MINIMAL NET GREENHOUSE GAS EMISSIONS, THESE ACTIONS WILL:

- REMOVE REGULATORY CONSTRAINTS TO NATURAL GAS PRODUCTION, TRANSMISSION AND USE;
- REDUCE CONSTRAINTS TO OBTAINING ADDITIONAL HYDROELECTRIC POWER FROM EXISTING DAMS;

- FACILITATE NUCLEAR POWER DEVELOPMENT THROUGH LICENSING REFORM;
- DEVELOP ACCELERATED RESEARCH AND DEVELOPMENT ON BIOMASS-BASED ALCOHOL AND ALTERNATIVE FUELS;
- CONTINUE RESEARCH AND DEVELOPMENT EFFORTS TO DEVELOP PHOTOVOLTAIC, WIND, SOLAR THERMAL, BIOMASS, AND GEOTHERMAL TECHNOLOGIES, AND
- PROVIDE INCENTIVES FOR THE DEVELOPMENT OF CLEAN COAL TECHNOLOGY

BY THE YEAR 2000, NES ACTIONS THAT WILL BE THE LARGEST CONTRIBUTORS TO CURBING GREENHOUSE GAS EMISSIONS INCLUDE:

- INTEGRATED RESOURCE PLANNING EFFORTS, COUPLED WITH ENERGY EFFICIENCY ACTIONS, THAT REDUCE ELECTRICITY DEMAND (25 PERCENT OF TOTAL REDUCTION);
- NATURAL GAS REFORMS (23 PERCENT);
- GREATER USE OF ALTERNATIVE FUELED VEHICLES (23 PERCENT), AND
- EXPANDED USE OF WASTE-TO-ENERGY TECHNOLOGY (15%)

THE LARGEST CONTRIBUTORS TO REDUCING GREENHOUSE GASES IN 2030 WOULD BE:

- EXPANDED USE OF NUCLEAR ENERGY (36 PERCENT);
- INCREASED TRANSPORTATION FUEL EFFICIENCY AND EXPANDED USE OF ALTERNATIVE FUELS AND ALTERNATIVE VEHICLES (25 PERCENT)

- ENERGY EFFICIENCY AND INTEGRATED RESOURCE PLANNING EFFORTS (15 PERCENT), AND
- INDUSTRIAL ENERGY EFFICIENCY IMPROVEMENTS (11 PERCENT).

IN THE LONG RUN, NUCLEAR ENERGY IS THE SINGLE LARGEST CONTRIBUTOR TO CURBING GREENHOUSE GASES.

TODAY, THE 111 U.S. COMMERCIALY OPERATING PLANTS, TOTALLING A COMBINED GENERATING CAPACITY OF 100,774 MEGAWATTS, REDUCE CO2 EMISSIONS BY APPROXIMATELY 128 MILLION TONS ANNUALLY.

AS FAR AS THE FUTURE IS CONCERNED, THE ADMINISTRATION'S STRATEGY OF RELYING ON NUCLEAR ENERGY COULD PROVE TO BE AN EFFECTIVE ONE AS DEMONSTRATED BY THE FRENCH EXPERIENCE. SINCE THE 1970S, NUCLEAR GENERATION INCREASED IN FRANCE FROM 10 PERCENT TO MORE THAN 75 PERCENT TODAY. AS A RESULT, FROM 1979-1987:

- SULFUR DIOXIDE EMISSIONS DECLINED 92 PERCENT, FROM 978,000 TO 83,000 TONS ANNUALLY;
- NITROGEN OXIDE EMISSIONS DECLINED 84 PERCENT, FROM 208,000 TONS TO 34,000 TONS ANNUALLY , AND
- CARBON DIOXIDE EMISSIONS DECLINED 84 PERCENT, FROM 82 MILLION TONS TO 13 MILLION TONS ANNUALLY.

THESE REDUCTIONS IN AIRBORNE EMISSIONS CLEARLY PROVE THAT NUCLEAR ENERGY WORKS FOR A CLEAN ENVIRONMENT.

THIS FACT IS ALSO DEMONSTRATED IN THE INTEGRATED NES ANALYSIS THAT WITHOUT RELIANCE ON NUCLEAR ENERGY, IT

BECOMES NEARLY IMPOSSIBLE TO CURB THE BUILDUP OF GREENHOUSE GASES AND MAINTAIN ECONOMIC GROWTH. THIS CONCLUSION HAS BEEN REACHED BY MANY OTHERS INVOLVED IN THE DEBATE OVER GLOBAL WARMING.

FOR EXAMPLE, SENATOR TIM WIRTH EARLY ON MUST HAVE ARRIVED AT THIS CONCLUSION, AND HAS NOT BEEN SWAYED BY ATTACKS ON HIM FOR THINKING OR SPEAKING THE UNTHINKABLE – THAT NUCLEAR ENERGY RATHER THAN BEING AN ENVIRONMENTAL CURSE MIGHT PROVE TO BE THE ENVIRONMENT'S BEST HOPE FOR CURBING GREENHOUSE GASES.

NES AND THE NUCLEAR ENERGY OPTION

THE NES INCLUDES FOUR KEY GOALS FOR THE NUCLEAR ENERGY OPTION WITH AN OVERRIDING THEME TO REMOVE UNDUE REGULATORY AND INSTITUTIONAL BARRIERS:

- MAINTAINING EXACTING SAFETY AND DESIGN STANDARDS;
- REDUCING ECONOMIC RISK;
- REDUCING REGULATORY RISK, AND
- ESTABLISHING PROGRESS ON HIGH-LEVEL WASTE DISPOSAL;

FOUR INITIATIVES IN THE NES TO REVIVE THE NUCLEAR ENERGY INDUSTRY INCLUDE:

- ACCELERATE INTRODUCTION OF ADVANCED NUCLEAR ENERGY PLANT DESIGNS;
- ACCELERATE CERTIFICATION OF STANDARD PLANT DESIGNS;
- REFORM THE LICENSING PROCESS, AND

- ENCOURAGE PROGRESS ON HIGH-LEVEL WASTE DISPOSAL.

THE DOE'S NUCLEAR PROGRAM IS SUPPORTED BY BOTH ITS FY 92 BUDGET REQUEST AND NES LEGISLATIVE INITIATIVES IN THE SENATE AND HOUSE.

THE MAJOR GOAL OF DOE'S PROGRAM IS TO MAKE COMMERCIALY STANDARDIZED ADVANCED LIGHT-WATER REACTOR DESIGNS AVAILABLE FOR ORDER BY 1995; TO ASSIST IN SECURING AN ORDER BY 1995 AND TO PROVIDE FOR NEW NUCLEAR CAPACITY GENERATION BY 2000. THUS, THE NES PAVES THE WAY FOR A PROJECTED 195 TO 290 GIGAWATTS OF NUCLEAR CAPACITY TO BE ON LINE BY 2030 IF THE NATION CAN OVERCOME THE BARRIERS TO INVESTING IN NEW NUCLEAR POWERPLANTS, EXTENDING THE LIFETIME OF EXISTING PLANTS AND DISPOSING OF NUCLEAR WASTE.

THIS GOAL AND PROGRAM IS CONSISTENT WITH THE INDUSTRY'S STRATEGIC PLAN FOR ORDERING THE NEXT NUCLEAR ENERGY PLANT BY 1995, WHICH WAS RELEASED IN NOVEMBER LAST YEAR. THE NUCLEAR POWER OVERSIGHT COMMITTEE (NPOC) STRATEGIC PLAN:

- IDENTIFIES ALL THE SIGNIFICANT ENABLING CONDITIONS WHICH MUST BE MET TO ACHIEVE THIS GOAL;
- ASSIGNS LEAD AND SUPPORTING RESPONSIBILITIES TO THE APPROPRIATE EXISTING ORGANIZATIONS OR STANDING COMMITTEES IN THE INDUSTRY TO DETAIL AND IMPLEMENT AND ACTION PLAN FOR ACHIEVING EACH CONDITION, AND
- FOSTERS JOINT AND COORDINATED EFFORTS BETWEEN GOVERNMENT AND INDUSTRY, WHICH WOULD ENHANCE IMPLEMENTATION OF THE STRATEGIES AND PROVIDE FOR SHARING RESOURCE REQUIREMENTS.

THE DOE BUDGET REQUEST SUPPORTS THE GOAL OF A NEW ORDER BY 1995 BY PROVIDING FUNDING TO ACCELERATE DESIGN, CERTIFICATION AND FIRST OF KIND ENGINEERING (\$62.5 MILLION).

AS FAR AS LICENSING REFORM AND NUCLEAR WASTE IS CONCERNED, THE NES PROPOSES LEGISLATION IN THESE AREAS, AND I AM PLEASED TO REPORT THAT BOTH LEGISLATIVE INITIATIVES ARE CONTAINED IN THE NES LEGISLATIVE PACKAGE TRANSMITTED TO CAPITOL HILL YESTERDAY, S. 570 AND H.R. 1301.

I AM ALSO PLEASED TO REPORT THAT YESTERDAY THE SUPREME COURT DENIED NEVADA'S REQUEST TO REVIEW A 9TH CIRCUIT COURT DECISION, WHICH FOUND IN FAVOR OF DOE AND UPHELD THE CONSTITUTIONALITY OF THE NUCLEAR WASTE POLICY ACT; THUS, BRINGING THE SOLUTION TO THE IMPASSE IN NEVADA OVER THE YUCCA MOUNTAIN PROGRAM ONE STEP CLOSER. I SUPPOSE THE ACTION NOW SHIFTS TO THE HILL IN ITS DELIBERATIONS ON NATIONAL ENERGY LEGISLATION.

YOU MIGHT ASK WHAT SUPPORT THE INDUSTRY CAN EXPECT TO RECEIVE FOR THE NUCLEAR INITIATIVES CONTAINED IN THE NES. AS AN INDICATION OF SUPPORT FOR NUCLEAR, I HAVE BROUGHT WITH ME THE RESULTS OF A RECENT CONGRESSIONAL POLL COMMISSIONED BY ANEC AND CONDUCTED BY REICHMAN-KARTEN-SWORD, INC. THE POLL SHOWS BROAD SUPPORT FOR NUCLEAR ENERGY AS PART OF THE NES:

- SEVENTY-SEVEN PERCENT OF THE 300 CONGRESSIONAL OFFICES SURVEYED FAVOR NUCLEAR ENERGY AND 85 PERCENT SAY NUCLEAR ENERGY SHOULD BE AN IMPORTANT PART OF AMERICA'S ENERGY FUTURE. BY MORE THAN A 2-TO-1 MARGIN, CONGRESSIONAL SUPPORT EXISTS FOR THE NATIONAL ENERGY STRATEGY'S GOAL OF ORDERING AN ADVANCED LIGHT-WATER REACTOR BY 1995. FIFTY-FIVE PERCENT FAVOR THIS GOAL

- THE TOP THREE FACTORS INFLUENCING CONGRESSIONAL OPINION ON NUCLEAR ENERGY, ACCORDING TO CONGRESSIONAL STAFF ARE:

- SAFE OPERATIONS, 92 PERCENT;
- WASTE DISPOSAL, 86 PERCENT, AND
- PUBLIC ACCEPTANCE OF NUCLEAR ENERGY, 63 PERCENT.

- ON THE ISSUE OF SAFETY, 85 PERCENT BELIEVE NUCLEAR ENERGY PLANTS ARE SAFE, AND 67 PERCENT SAY PLANT SAFETY IS IMPROVING.

- EIGHTY PERCENT RANK WASTE DISPOSAL AS A "VERY URGENT" LEGISLATIVE ISSUE.

THERE ARE OTHER FACTORS, BESIDES CONCERN OVER GLOBAL WARMING, THAT ARE ALSO SHAPING THE WAY POLICYMAKERS VIEW THE NUCLEAR OPTION, INCLUDING:

- NUCLEAR ENERGY'S IMPROVED SAFETY RECORD;
- NEED FOR BASELOAD CAPABILITY;
- POTENTIAL FOR ELECTRIC VEHICLES TO BACK OUT OIL FROM THE TRANSPORTATION SECTOR, AND
- PASSAGE OF THE CLEAN AIR ACT.

AS A RESULT OF THESE MANY FACTORS, THE STAGE IS SET FOR MAKING THE 1990S A DECADE OF EXTRAORDINARY PROGRESS FOR NUCLEAR ENERGY. WE HAVE AN OPPORTUNITY TO LAUNCH THE NEXT GENERATION OF NUCLEAR ENERGY PLANTS IN THIS DECADE BY COMPLETING THE CRITICAL REFORMS WHICH WE STARTED 10 YEARS AGO AND BY RESTORING THE CONFIDENCE THAT WILL ALLOW NEW ORDERS FOR NUCLEAR PLANTS TO BEGIN.

THE IMPACT OF GLOBAL WARMING AND ENVIRONMENTAL CONSIDERATIONS WILL BE SIGNIFICANT. AND WHEN MIXED WITH THE OTHER FACTORS I HAVE IDENTIFIED, WE SEE A POWERFUL ELIXIR FOR THE RENEWAL OF NUCLEAR ENERGY AND THE LAUNCHING OF A NEW GENERATION OF ADVANCED NUCLEAR ENERGY PLANTS.

IN SHORT, THE STAGE IS SET FOR THE 102ND CONGRESS TO DRAW AN ENERGY BLUEPRINT FOR OUR NATION THAT WILL STAND THE TEST OF TIME. I BELIEVE THIS WILL BE AN HISTORIC CONGRESS WITH RESPECT TO ENERGY LEGISLATION. I AM EQUALLY CONVINCED THAT NUCLEAR ENERGY WILL PLAY A SIGNIFICANT ROLE IN THE FINAL ENERGY STRATEGY TO EMERGE FROM CONGRESS. NUCLEAR ENERGY TRULY WORKS FOR A CLEAN ENVIRONMENT AND PROVIDES AMERICA THE POWER OF INDEPENDENCE.

THE QUESTION IN THIS DECADE IS NOT WHETHER ANOTHER NUCLEAR PLANT WILL BE BUILT, BUT WHEN, WHERE AND BY WHOM. THIS DOES NOT COME A MOMENT TOO EARLY FOR THE NATION. THE FACT IS THAT OUR NATION IS AT A CROSSROADS WITH RESPECT TO ENERGY POLICY. WE TRULY FACE A WATERSHED IN PROVIDING RELIABLE, SAFE AND CLEAN ENERGY FOR THE UNITED STATES -- AND NUCLEAR ENERGY IS PREPARED TO RESPOND TO MEET THIS CHALLENGE.

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120850

FROM: HEFNER, Robert A.: NATURAL GAS EXPLORATION & PRODUCTION CO.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 03/20/91

SUBJECT: R&D FUNDS FOR NATURAL GAS VEHICLE TANK TECHNOLOGY

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong
Dr. Phillips

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 03/25/91

FILE: ENERGY

P-Physical Sciences -

9120850



A NATURAL GAS EXPLORATION & PRODUCTION COMPANY

March 20, 1991

ROBERT A. HEFNER III, CHAIRMAN

91 MAR 25 12:21

TO: Mike Baly, President, American Gas Association
Nicholas Bush, President, Natural Gas Supply Association
Robert Catell, President, Brooklyn Union Gas Company
Richard Clarke, Chairman, Pacific Gas & Electric
Daniel A. Dreyfus, Strategic Planning, GRI
Richard D. Fairman, Chairman, Southern California Gas Co.
Jerold V. Halvorsen, President, INGAA
The Honorable Walter Hickel, Governor of Alaska
Kenneth Lay, Chairman, Enron Oil & Gas
Garry Mauro, Commissioner of Texas General Land Office
Susan Pilcher, CEO, Natural Fuels Corporation
The Honorable Charles Robb, U.S. Senate
Chuck Roy, Fossil Fuels, US Department of Energy
Alan Schwartz, Esquire
J.D. Scott, Chairman, ONEOK
Jeffrey Seisler, Executive Director, Natural Gas Vehicle Coalition
The Honorable David Walters, Governor of Oklahoma
The Honorable James D. Watkins, Secretary of Energy
The Honorable Timothy Wirth, U.S. Senate
Robert Woody, Esquire

CC: → D. Allen Bromley, Science & Technology Assistant to President Bush

FROM: Robert A. Hefner III

RE: R&D Funds for Natural Gas Vehicle Tank Technology

It seems to me the recent Gulf War should reemphasize our national R&D priorities and that one of the most vital areas for R&D funds should be natural gas vehicles. The total fiscal 1991 appropriation by Congress for natural gas research was \$117.67 million. From that amount only \$5.5 million was appropriated for natural gas vehicle research, and from that no funds were targeted for natural gas vehicle tank technology. The fiscal 1992 appropriation hearings are now in progress and no funds are included for NGV tank technology. I urge each of you to immediately do what you can to obtain allocation of significant R&D funds for NGV tank technology. I believe some of the Stealth carbon fiber and composite technology developed for the military would be applicable for NGV tank technology. When I mentioned this to Allen Bromley last week, he agreed this is an area of R&D that should be "looked into again".

THE GHK COMPANY

3030 NORTHWEST EXPRESSWAY 18TH FLOOR OKLAHOMA CITY, OKLAHOMA 73112-5467 USA
TELEPHONE: 405/948-9800

RECYCLED PAPER

TELEFAX: 405/948-9898



A NATURAL GAS EXPLORATION & PRODUCTION COMPANY

March 20, 1991

ROBERT A. HEFNER III, CHAIRMAN

91 MAR 25 P 4: 24

OFFICE OF THE
DIRECTOR

TO: Mike Baly, President, American Gas Association
Nicholas Bush, President, Natural Gas Supply Association
Robert Catell, President, Brooklyn Union Gas Company
Richard Clarke, Chairman, Pacific Gas & Electric
Daniel A. Dreyfus, Strategic Planning, GRI
Richard D. Fairman, Chairman, Southern California Gas Co.
Jerold V. Halvorsen, President, INGAA
The Honorable Walter Hickel, Governor of Alaska
Kenneth Lay, Chairman, Enron Oil & Gas
Garry Mauro, Commissioner of Texas General Land Office
Susan Pilcher, CEO, Natural Fuels Corporation
The Honorable Charles Robb, U.S. Senate
Chuck Roy, Fossil Fuels, US Department of Energy
Alan Schwartz, Esquire
J.D. Scott, Chairman, ONEOK
Jeffrey Seisler, Executive Director, Natural Gas Vehicle Coalition
The Honorable David Walters, Governor of Oklahoma
The Honorable James D. Watkins, Secretary of Energy
The Honorable Timothy Wirth, U.S. Senate
Robert Woody, Esquire

CC: D. Allen Bromley, Science & Technology Assistant to President Bush

FROM: Robert A. Hefner III

RE: R&D Funds for Natural Gas Vehicle Tank Technology

It seems to me the recent Gulf War should reemphasize our national R&D priorities and that one of the most vital areas for R&D funds should be natural gas vehicles. The total fiscal 1991 appropriation by Congress for natural gas research was \$117.67 million. From that amount only \$5.5 million was appropriated for natural gas vehicle research, and from that *no* funds were targeted for natural gas vehicle tank technology. The fiscal 1992 appropriation hearings are now in progress and *no* funds are included for NGV tank technology. I urge each of you to immediately do what you can to obtain allocation of significant R&D funds for NGV tank technology. I believe some of the Stealth carbon fiber and composite technology developed for the military would be applicable for NGV tank technology. When I mentioned this to Allen Bromley last week, he agreed this is an area of R&D that should be "looked into again".

THE GHK COMPANY

3030 NORTHWEST EXPRESSWAY 18TH FLOOR OKLAHOMA CITY, OKLAHOMA 73112-5467 USA
TELEPHONE: 405/948-9800

RECYCLED PAPER

TELEFAX: 405/948-9898



"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120780

FROM: DAVIS, Edward M.: AMERICAN NUCLEAR ENERGY COUNCIL

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 03/14/91

SUBJECT: THE RESULTS OF AN ANEC-COMMISSIONED POLL ON
CONGRESSIONAL ATTITUDES TOWARD NUCLEAR ENERGY.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Dr. Wong

WHITE HOUSE TRACKING #:

CONTACT PERSON: TED GARRISH

REMARKS:

DATE RECEIVED: 03/18/91

FILE: *P-Physical Sciences -*
~~NUCLEAR~~ ENERGY

9/20780

AMERICAN NUCLEAR ENERGY COUNCIL

March 14, 1991

RECEIVED

MAR 18 4:41

OFFICE OF THE
DIRECTOR

Mr. Allan Bromley
Assistant to the President for
Science & Technology Policy
Executive Office of the President
Old Executive Office Building
17th Street & Pennsylvania Avenue, N.W.
Washington, DC 20506

Dear Mr. Bromley:

On behalf of the American Nuclear Energy Council (ANEC), I am pleased to transmit to you the results of an ANEC-commissioned poll on congressional attitudes toward nuclear energy.

The results indicate that broad support exists in Congress for nuclear energy's vital role in a national energy strategy, including initiatives that pave the way for an advanced nuclear energy plant order by 1995, nuclear energy plant licensing reform and progress on nuclear waste disposal.

Seventy-seven percent of the 300 congressional offices surveyed favor nuclear energy and 85 percent say nuclear energy should be an important part of America's energy future. Fifty-five percent support the National Energy Strategy's goal of ordering an advanced nuclear energy plant reactor by 1995, while only 23 percent oppose the goal.

Nuclear energy must be a principal component of any long-lasting energy blueprint that provides America energy security, economic vitality and environmental progress. I look forward to working with you as Congress develops an energy policy that, like nuclear energy, will give America the power of independence.

For additional information on nuclear energy's vital role in a national energy strategy, please call Ted Garrish, ANEC senior vice president - governmental relations, at (202) 484-2670.

Sincerely,



Edward M. Davis

EMD/pk
Enclosures

410 First Street, S.E. Washington, D.C. 20003 (202) 484-2670



February 19, 1991

MEMORANDUM

TO: Participants in Recent ANEC Survey

FROM: Reichman-Karten-Sword, Inc. (RKS)

SUBJECT: Summarizing Survey Results

Between November 12 and December 14, 1990, RKS conducted 300 telephone interviews among energy legislative assistants assigned to representatives, senators and, energy and environmental committees. The average interview took 21 minutes to conduct and all participants were guaranteed their absolute anonymity.

The purpose of the survey was to learn the mood of Congress in late 1990 regarding nuclear energy. In addition, the survey sought to assess the effectiveness of ANEC'S CONGRESSIONAL INFORMATION PROGRAM (CIP). CIP's goal is to enhance the understanding and confidence of Congress in the safe operation of U.S. nuclear energy plants. Questions in the survey were directed at measuring how well CIP is achieving this goal. This memorandum highlights the key results generated by this survey.

The interview covered the following four major categories:

- Challenges and issues facing nuclear energy from Congress' perspective;
- Regulation of nuclear energy;
- Influences on congressional opinions of nuclear energy; and
- General opinions about nuclear energy.

**CHALLENGES AND ISSUES FACING NUCLEAR ENERGY FROM CONGRESS'
PERSPECTIVE**

- Asked about nuclear energy's importance in the future, 38% of those interviewed say it will be very important, and 47% respond that it will be somewhat important for the future resulting in a total of 85% who expect that it will be important. Only 14% feel it will not be important.
- Asked how they think their constituents would respond, congressional staff perceive a gap between their own views and how they project their constituents' opinions: 9% expect their constituents would call nuclear energy very important in the future, and 45% expect that their constituents would respond that nuclear energy would be somewhat important. Some 40% expect that their constituents would say nuclear energy will not be important.
- In listing the biggest obstacles facing the nuclear energy industry today, the top three mentions by congressional staff are public opinion, waste disposal and safety.
- Asked to volunteer the major legislative issues relating to nuclear energy that congressional staff think Congress should address over the next two years, waste disposal is the top mention, followed by licensing reform, safety, and a national energy policy with a strong nuclear component.

REGULATION OF NUCLEAR ENERGY

- Asked to assess the effectiveness of the NRC as a regulatory agency, 7% call it very effective and 53% respond somewhat effective for a total of 60% calling NRC effective. Some 28% label NRC as not too effective and 5% call it not at all effective for a total of 33% who rate NRC not effective. Thus, by 60% to 33%, congressional staff perceive NRC as effective.
- Questioned about where the regulation of nuclear plant safety authority should reside, by 72% to 21%, congressional energy staff feel it should be Federal rather than State government; regarding environmental aspects, by 57% to 30%, congressional staff also feel that this regulation should reside with the Federal government rather than State government.

INFLUENCES ON CONGRESSIONAL OPINIONS OF NUCLEAR ENERGY

- In response to being read a list of nine items and asked how important each one will be on influencing congressional opinion on the need for nuclear energy in the future, three items are called very important by half or more of those interviewed:
 - Safe operations;
 - Progress on waste disposal; and
 - Public acceptance.

Three items are called very important by about half of those interviewed:

- Demand for electricity;
- Reducing foreign oil dependence; and
- Cost of nuclear energy.

- In asking about contact with the nuclear energy industry, the survey finds two out of three responding that they had such contact over the past year. The most frequent contact was with a utility CEO or senior nuclear energy plant manager, and Washington or trade association reps.
- Asked about the effectiveness of this contact, 31% call it very effective, and 52% describe it as somewhat effective; only 6% say it is not effective and 11% respond they are "not sure".
- Asked to assess the job the nuclear energy industry does in getting information to congressional offices, 9% give the highest rating, excellent, and another 55% call it pretty good; about one in four (28%) call it not so good and 6% describe it as poor. Therefore, by 64% to 34%, congressional staff give the industry positive marks.

- When asked to volunteer how the nuclear energy industry can improve the ways it gets information to Congress, the suggestion garnering the largest mention was "more personal contact". Other major suggestions were:
 - more briefings;
 - provide more information/greater detail;
 - be more credible/accurate with the information provided; and
 - improve public standing of nuclear energy.

GENERAL OPINIONS ABOUT NUCLEAR ENERGY

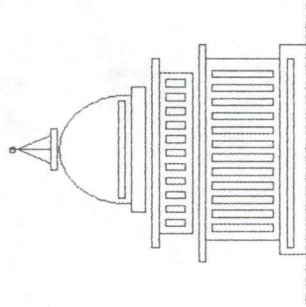
- The survey finds over half saying they are familiar with the nuclear energy plant nearest their constituency; 78% say they are very or somewhat satisfied with the credibility of information provided by that plant; and 56% of those interviewed say that they have visited a nuclear energy plant -- up from 44% responding this way in a previous survey undertaken by ANEC.
- Asked how well informed they feel they are about nuclear energy plant operations, 15% respond very well informed, and 51% answer fairly well informed.

- Asked directly whether they favor or oppose nuclear energy as one of the ways to provide electricity, the survey finds 77% who respond that they favor the use of nuclear energy, versus 15% who oppose it.
- When questioned about their opinions on the safety of nuclear energy plants, the 1990 survey finds 85% who call nuclear plants safe -- up from 72% answering this way in the 1988 survey.
- And when asked directly if they think safety at nuclear energy plants is improving, 67% respond affirmatively versus 18% who answer negatively and 15% who are not sure.
- Finally, congressional staff were asked if they support the nuclear industry's goal of placing an order for a nuclear energy plant by 1995 in time to serve customers by the turn of the century. Over half (55%) answer yes, compared with 23% who respond no, and a similar number (22%) who are not sure.
- And when asked the likelihood that a nuclear energy plant will be built in the U.S. over the next 10 years, 11% call it very likely and 46% say it is somewhat likely for a total of 57% who say it is likely.

A SURVEY OF CONGRESSIONAL STAFF

AMERICAN NUCLEAR ENERGY COUNCIL
CONGRESSIONAL INFORMATION PROGRAM

FEBRUARY 1991



Reichman-Karten-Sword, Inc.
New York - San Francisco

OBJECTIVES

- Update ANEC's 1988 CIP survey by obtaining measurements of effectiveness of CIP
- Expand 1988 CIP survey to understand changes in opinions and the "why's" underlying opinions
- Utilize survey as basis for two-way communication with Congress

SUBJECTS COVERED

- Problems and issues facing nuclear energy from Congress' perspective
- Regulation of nuclear energy
- General opinions about nuclear energy
- Influences on Congressional opinions of nuclear energy including CIP

METHODOLOGY

- Survey aimed at energy legislative aides assigned to representatives, senators and energy and environmental committees
- ANEC provided Congressional Yellow Book as basis for sample selection
- RKS screened listings to locate proper person
 - Chief of Staff
 - Legislative Director
 - Energy Legislative Assistant

METHODOLOGY (cont'd)

- Introductory letter mailed in early November
 - ANEC identified as sponsor
 - Anonymity guaranteed
 - Respondents promised summary
- Telephone interviews between November 12 and December 14, 1990
- Average interview lasted 21 minutes
- Thank you letter and critique form sent to all respondents

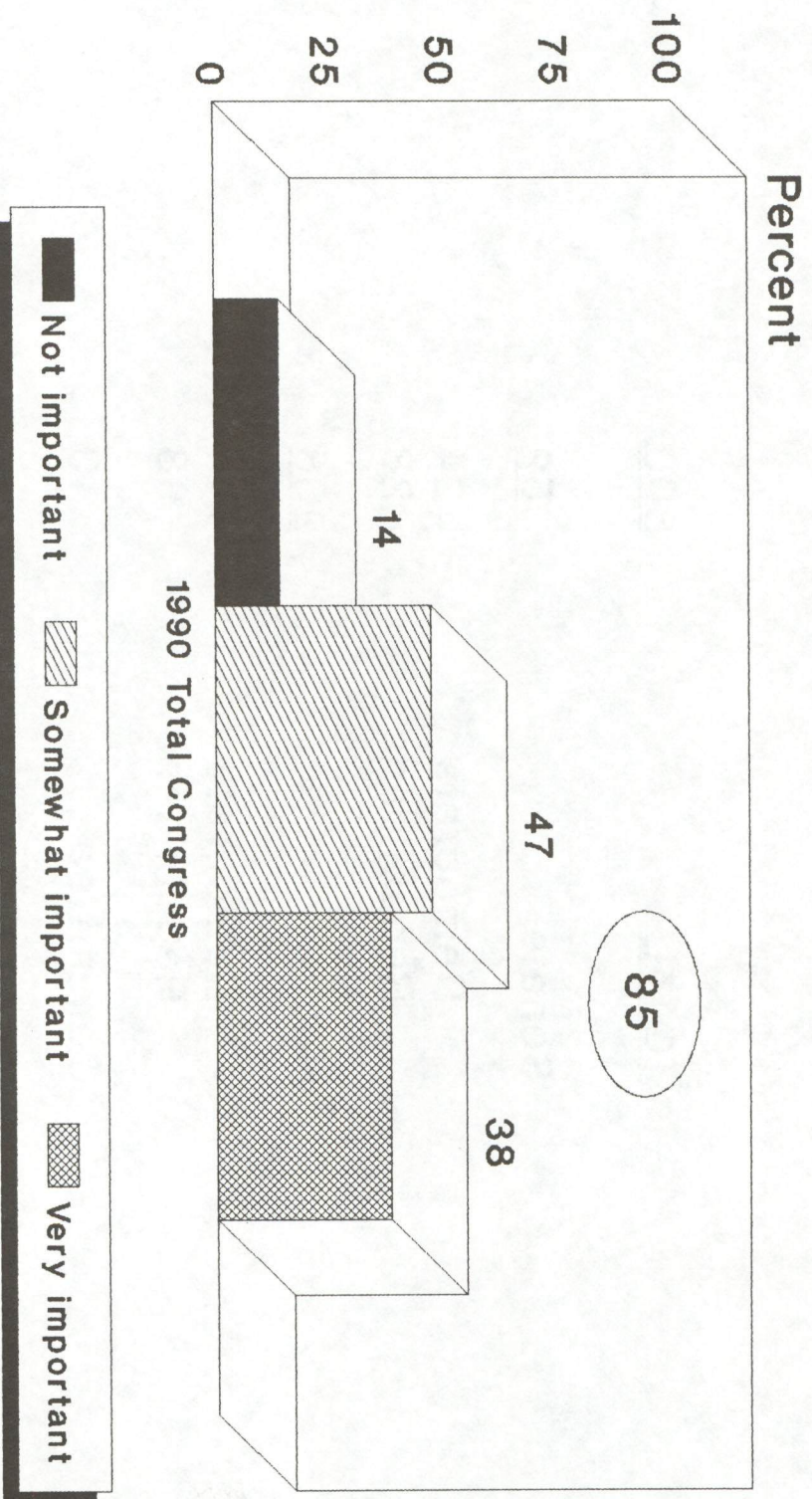
THE FINAL SAMPLE

In total, 300 telephone interviews conducted:

	#
<u>TOTAL</u>	<u>300</u>
Senate	<u>52</u>
Democrats	24
Republicans	28
House	<u>208</u>
Democrats	110
Republicans	98
Committee	40

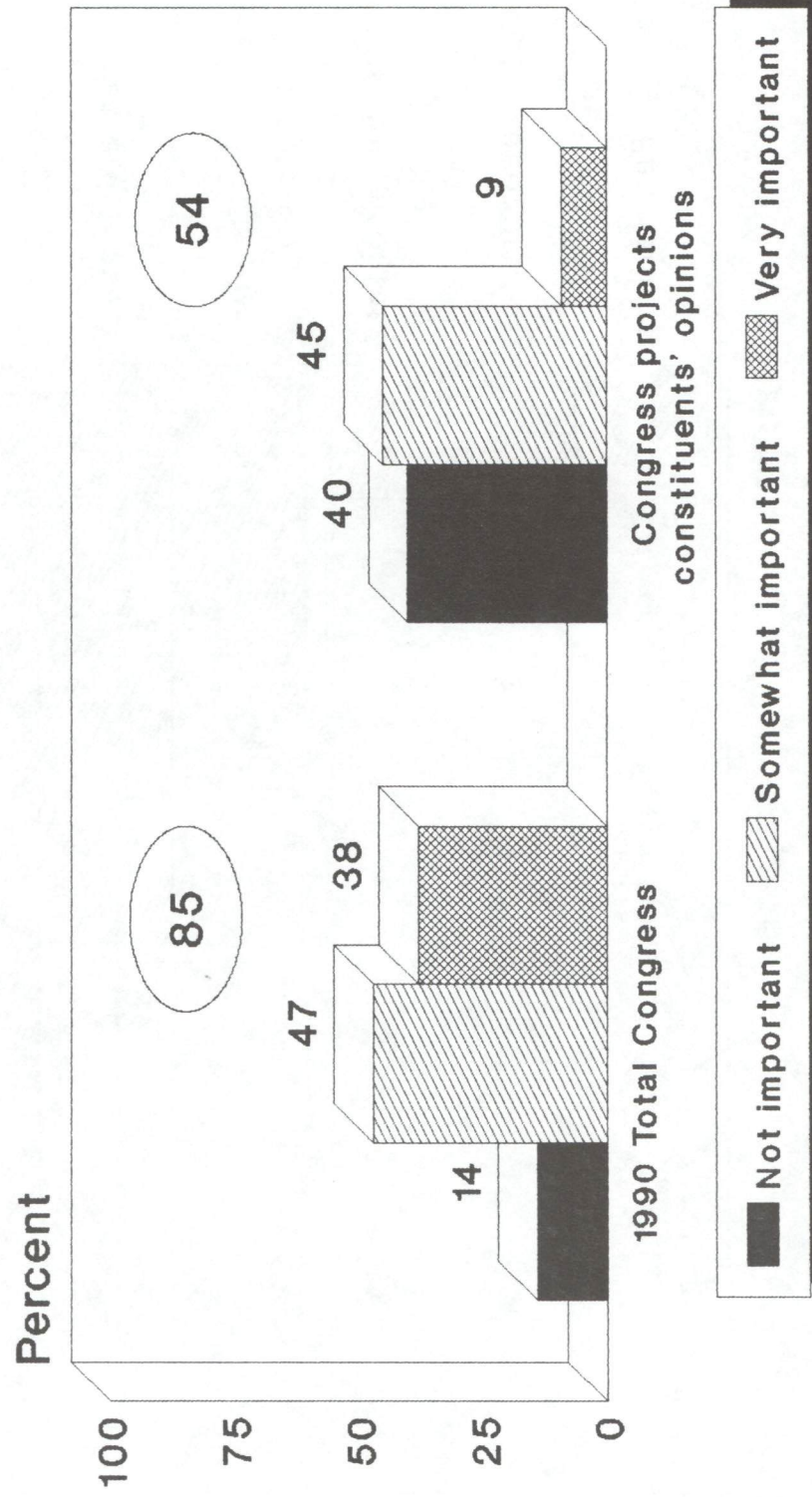
Expected sampling error for Total is ± 4 at 95%

NUCLEAR ENERGY'S IMPORTANCE IN FUTURE



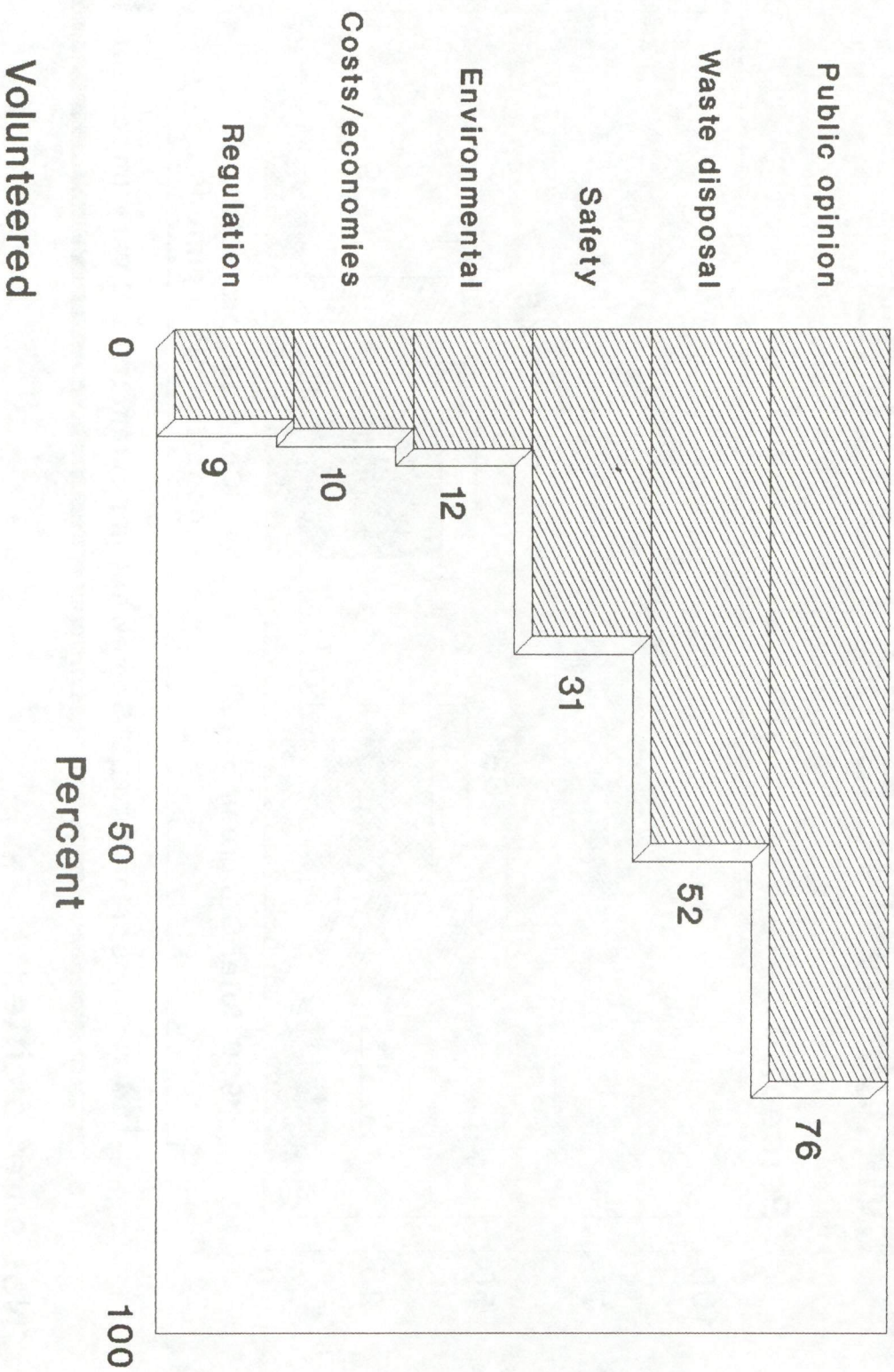
"Not sure" omitted

NUCLEAR ENERGY'S IMPORTANCE IN FUTURE

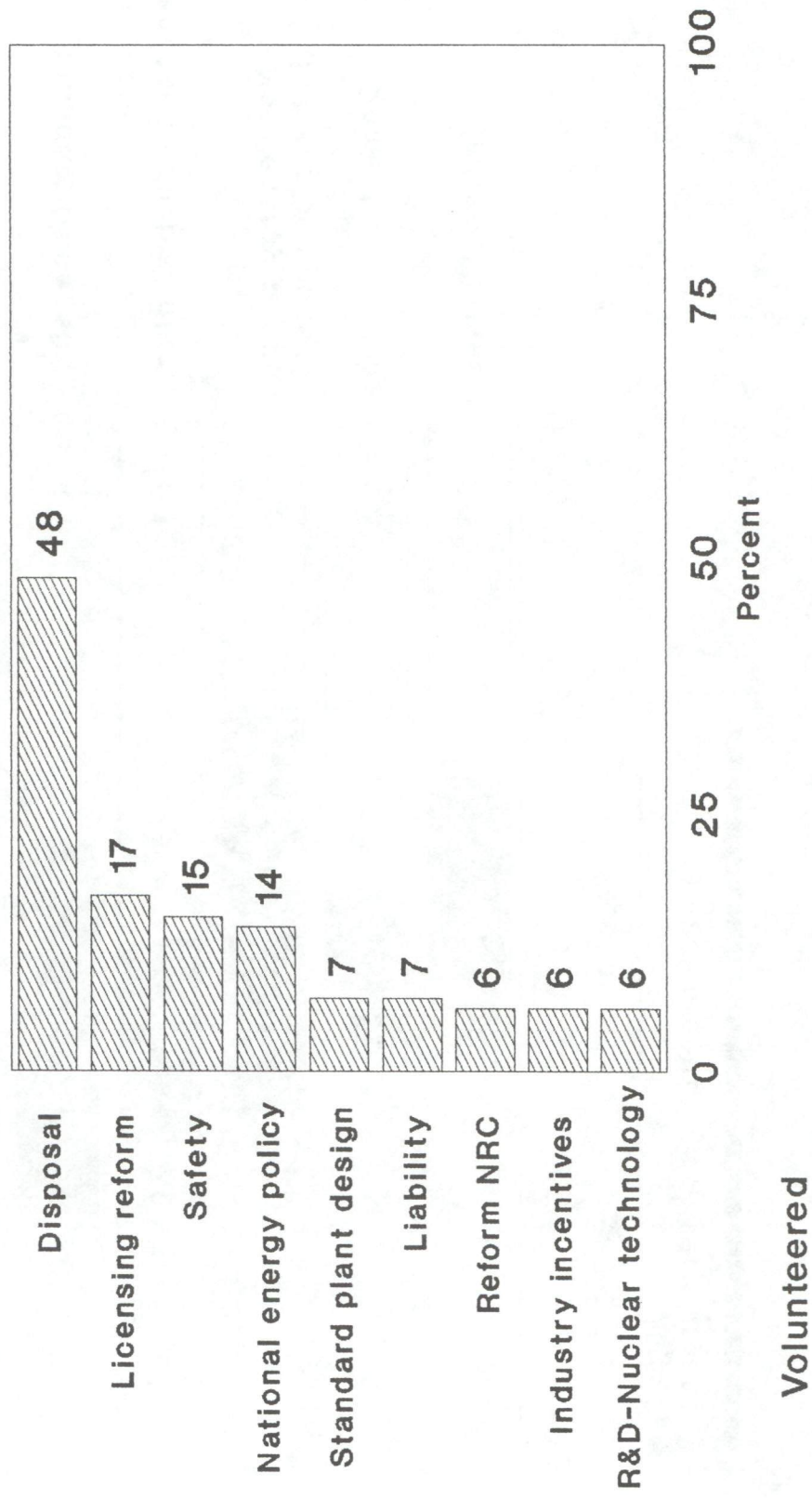


"Not sure" omitted

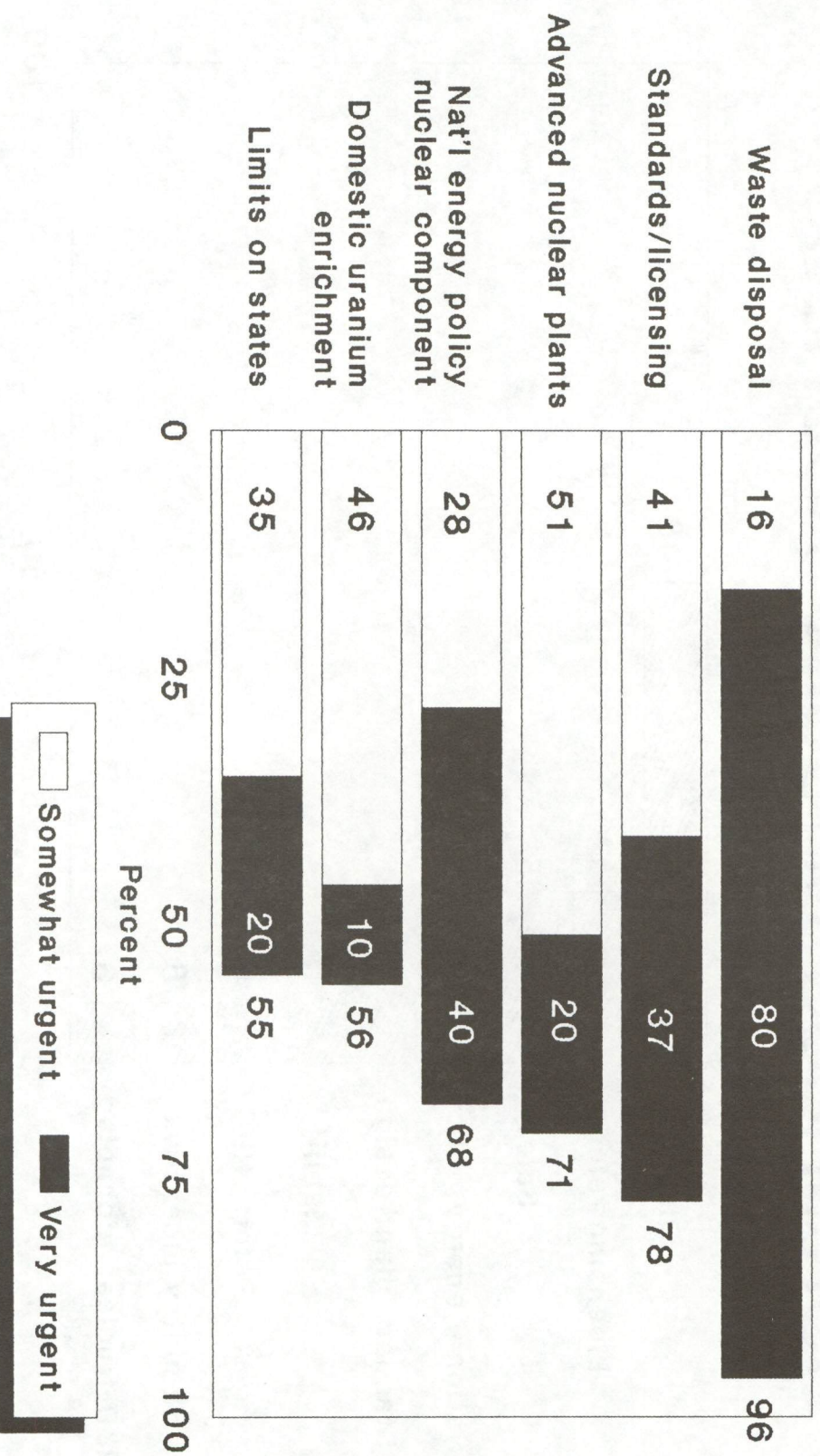
PROBLEMS FACING NUCLEAR INDUSTRY



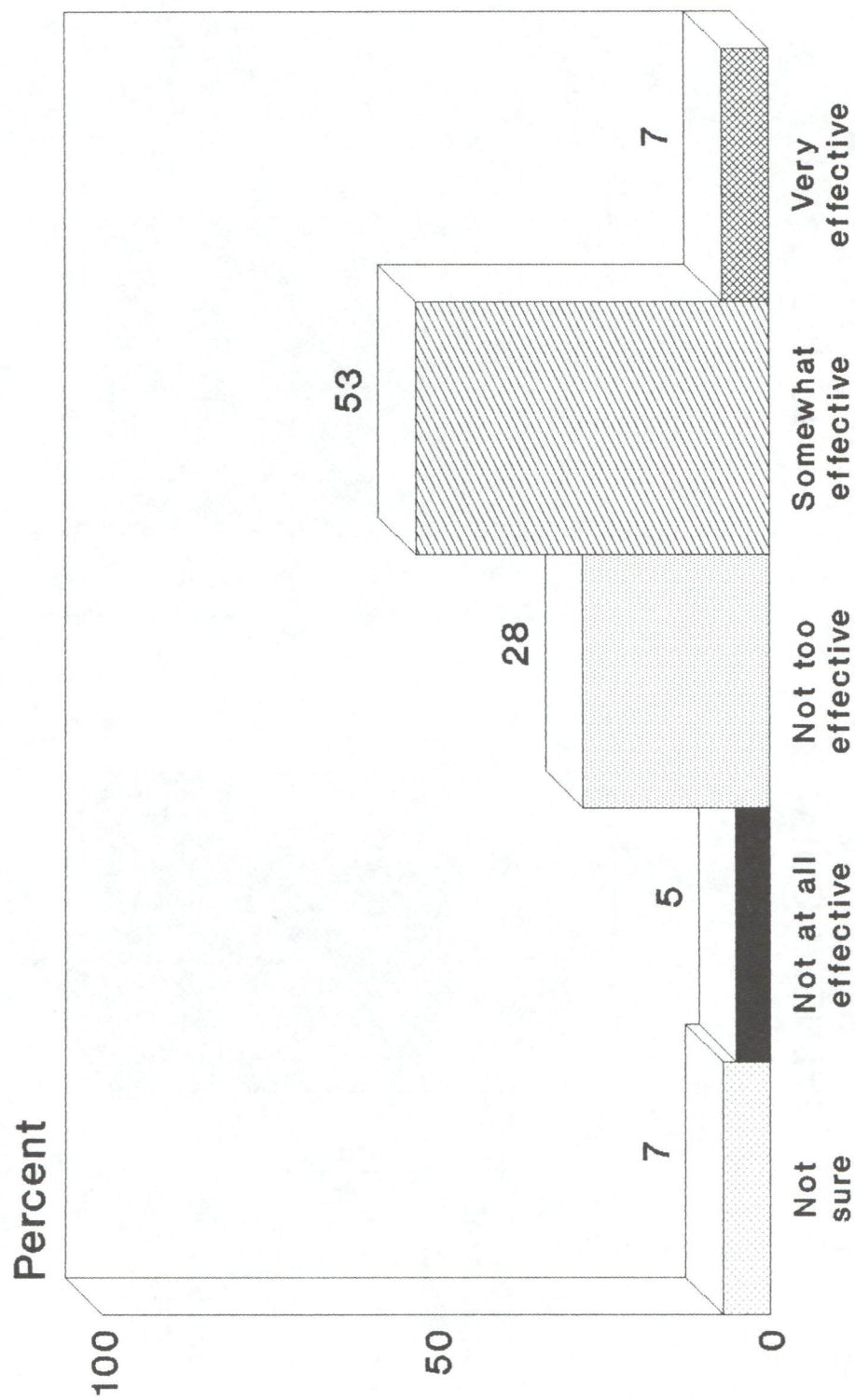
MAJOR LEGISLATIVE ISSUES CONGRESS SHOULD ADDRESS



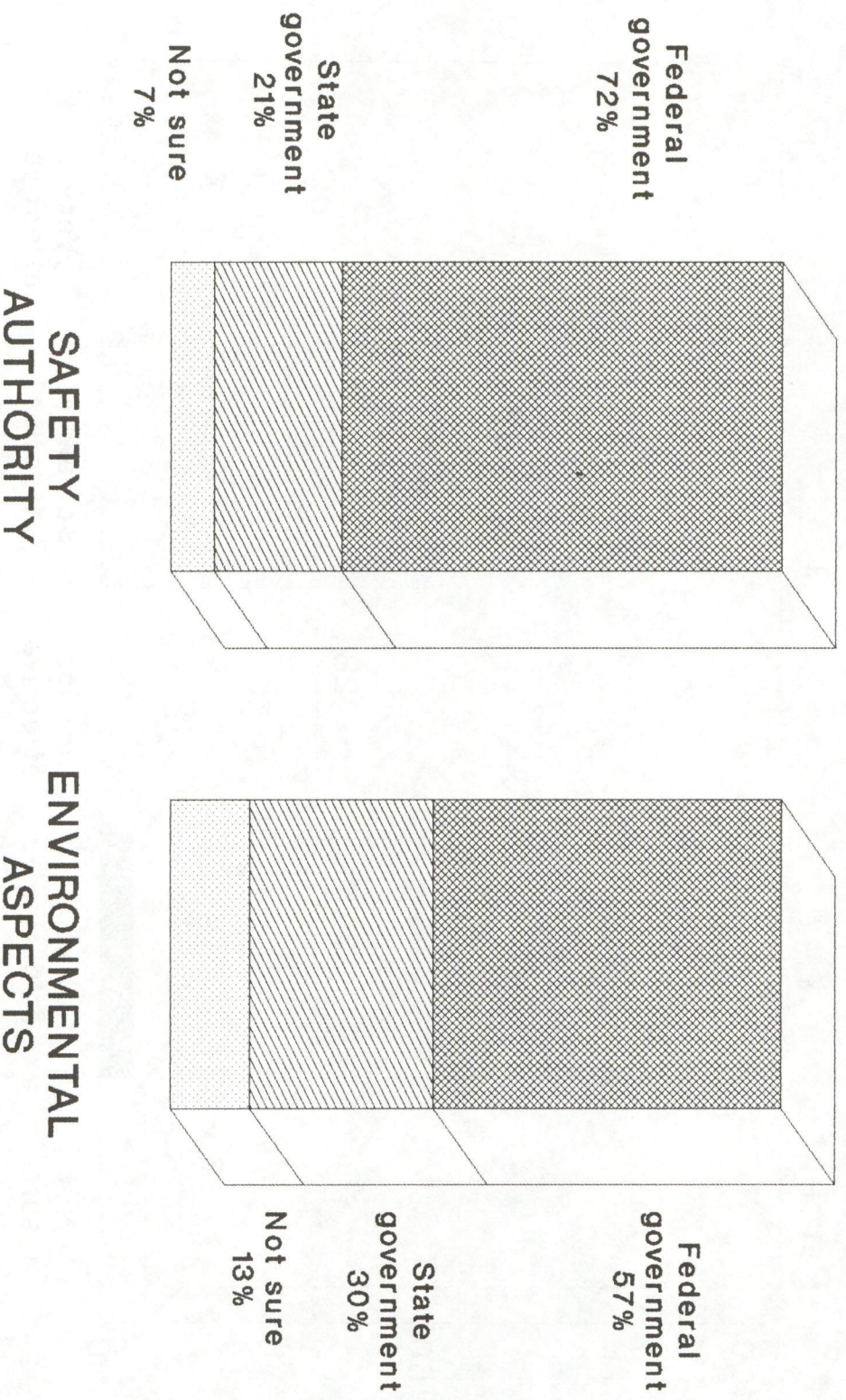
URGENCY OF LEGISLATIVE ISSUES



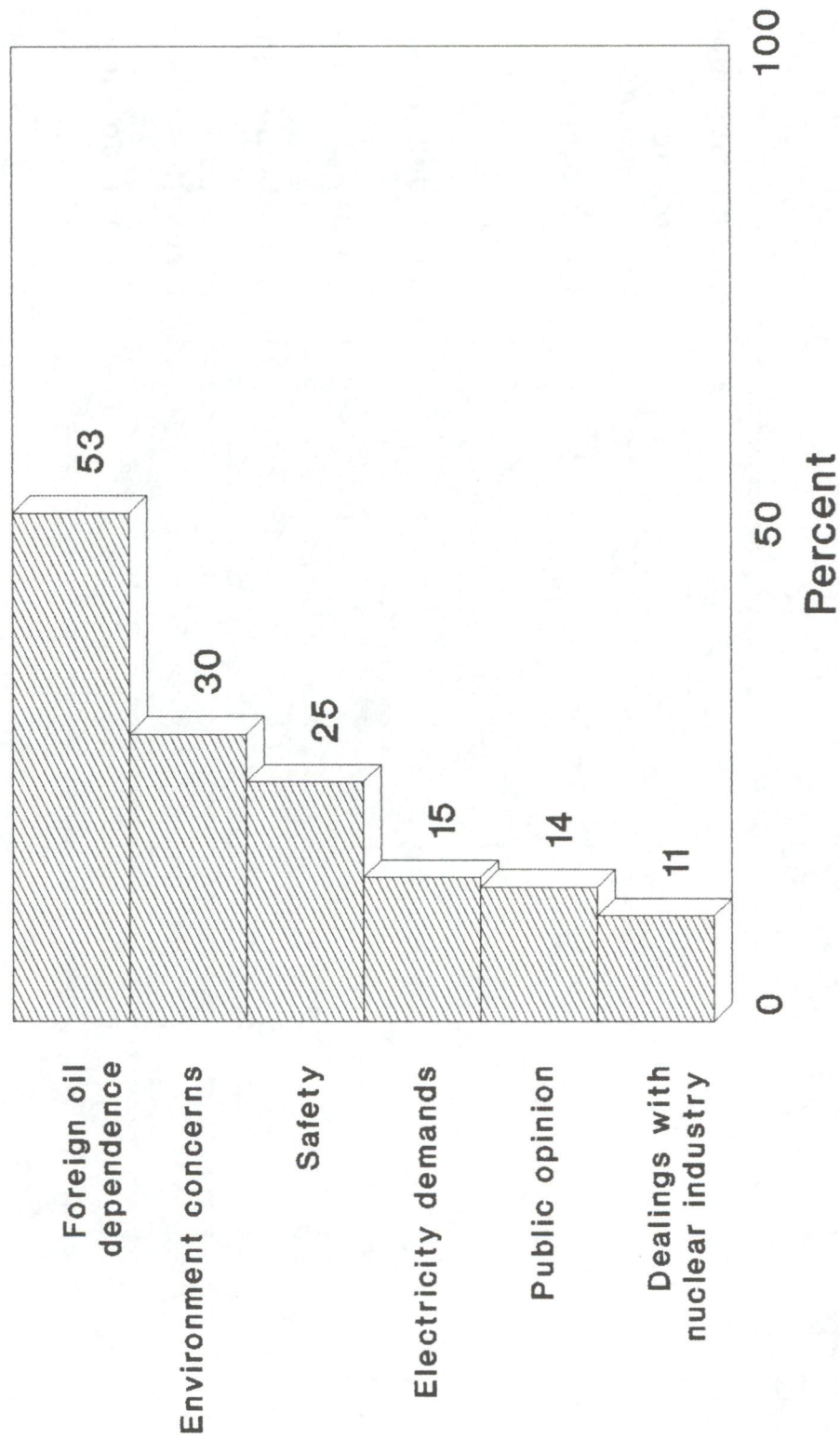
EFFECTIVENESS OF NRC



NUCLEAR ENERGY PLANT REGULATION

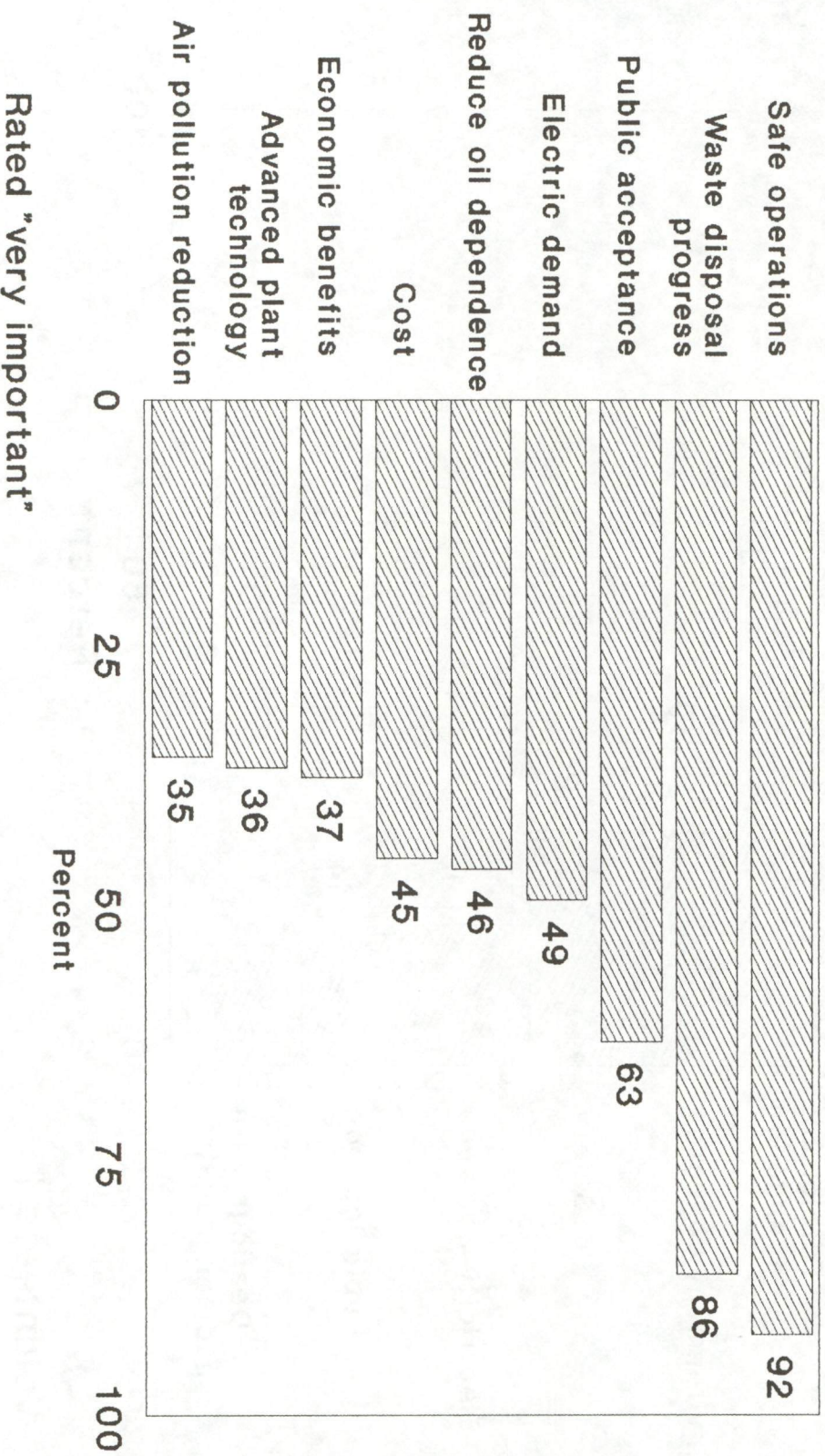


FACTORS MOST INFLUENCING CONGRESSIONAL OPINIONS ON NUCLEAR ENERGY IN PAST

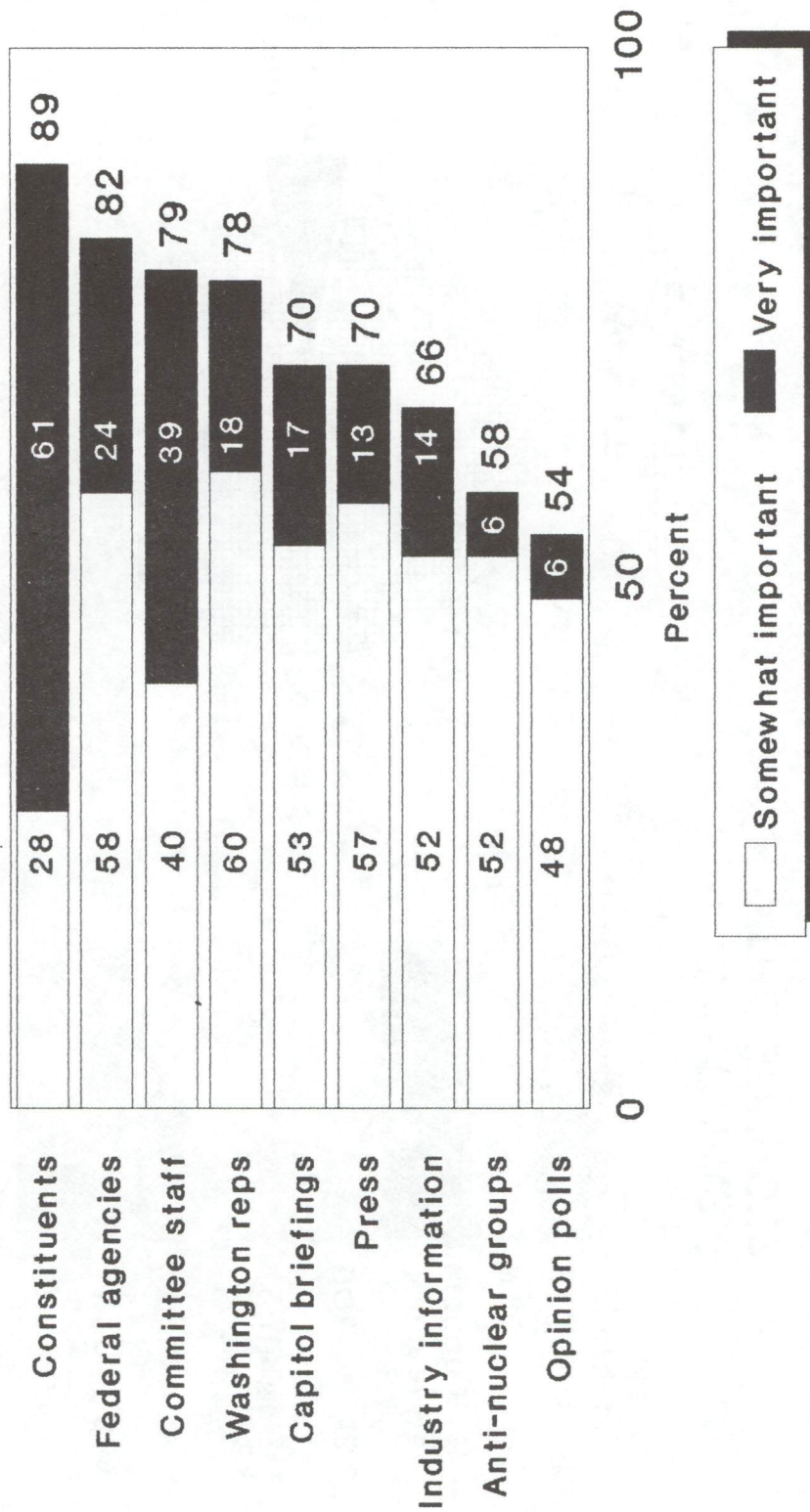


Volunteered

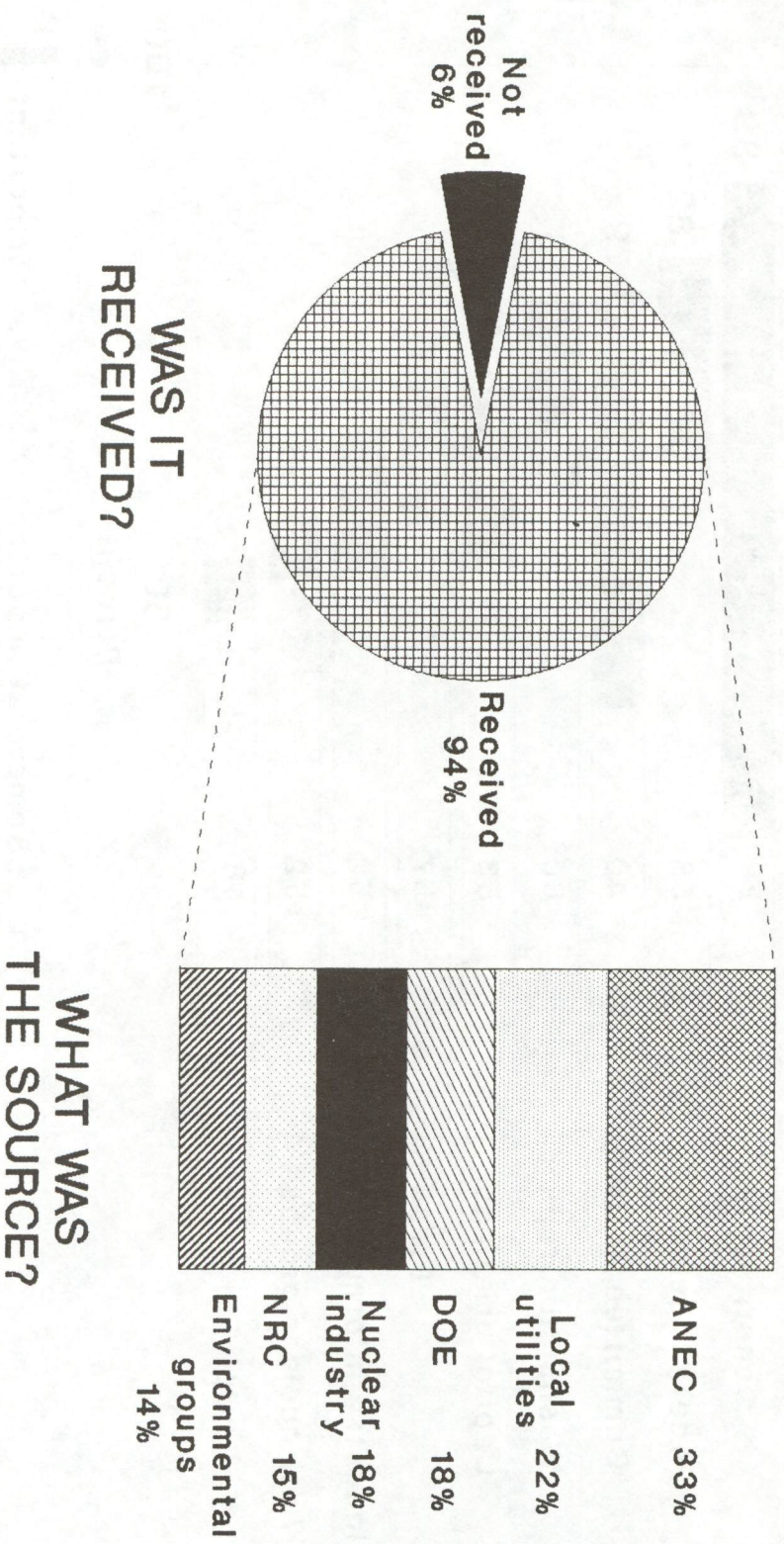
FACTORS' IMPORTANCE IN INFLUENCING CONGRESSIONAL OPINION IN FUTURE



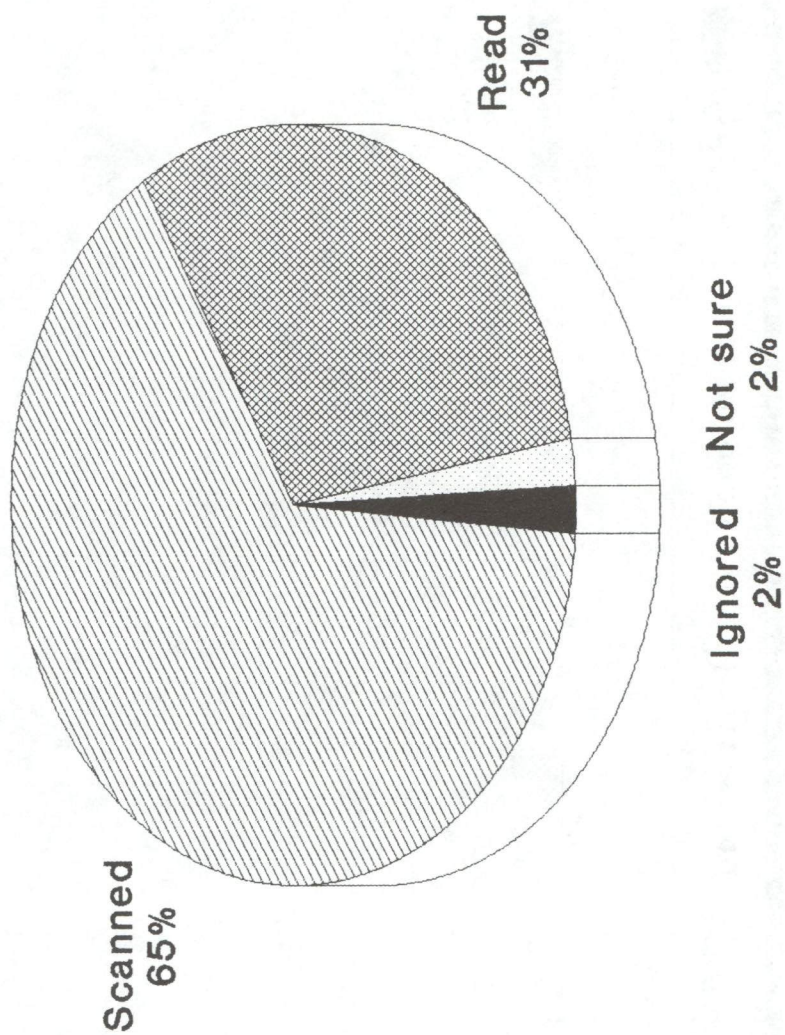
IMPORTANCE OF INFORMATION SOURCES INFLUENCING CONGRESSIONAL OPINIONS



NUCLEAR ENERGY WRITTEN INFORMATION



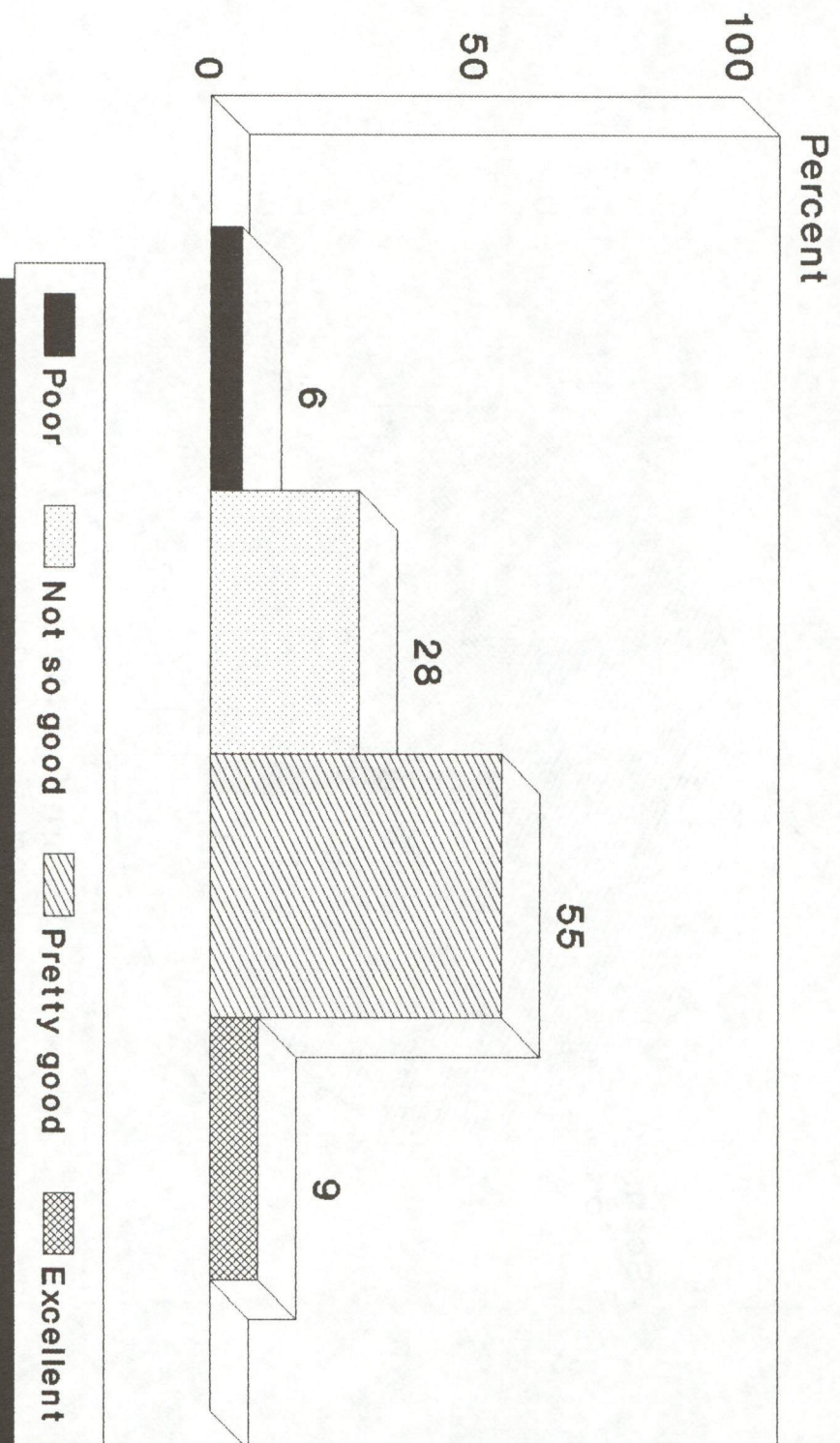
WAS INFORMATION READ?



Base: Received information

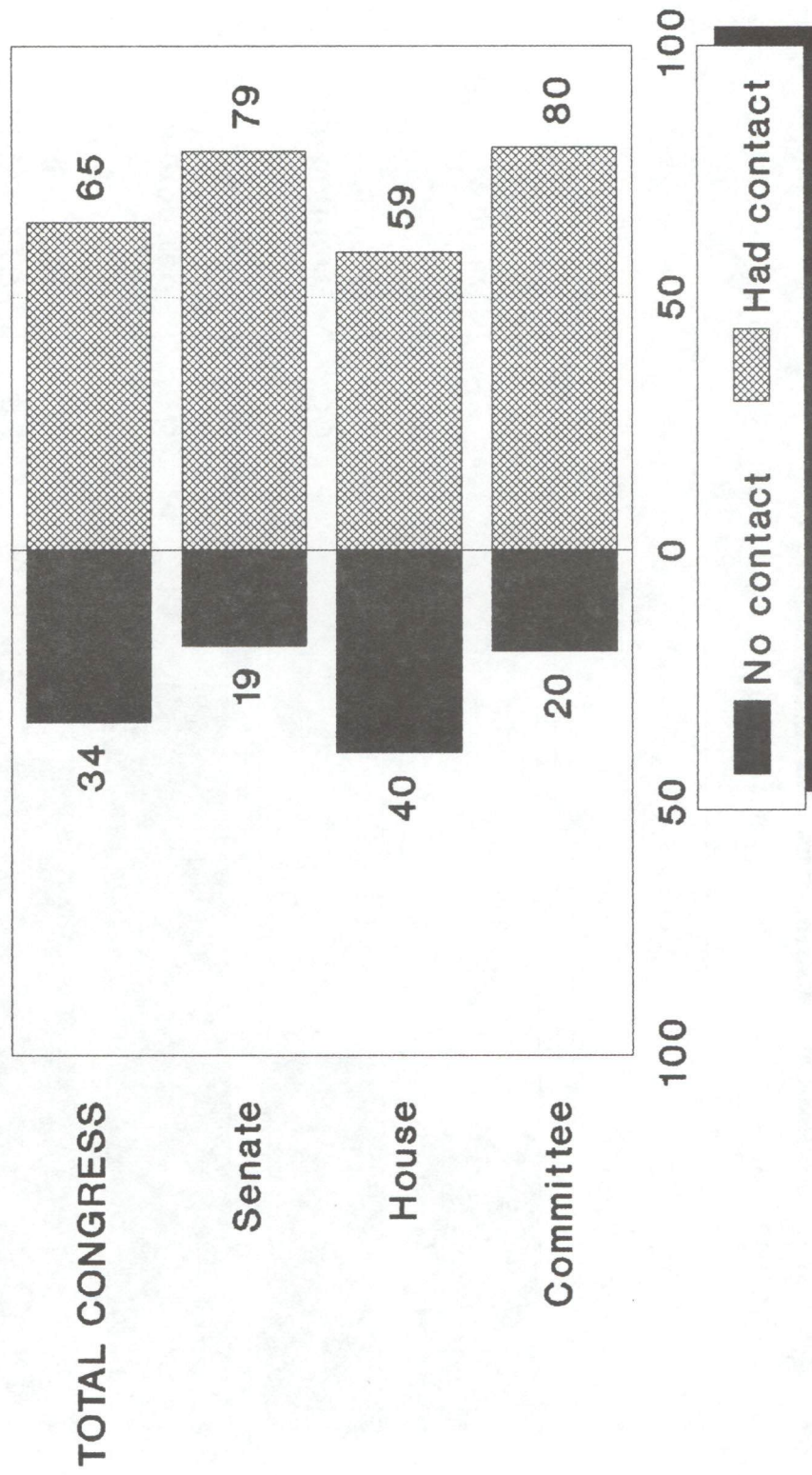
GETTING INFORMATION TO CONGRESS

Rating nuclear energy industry:

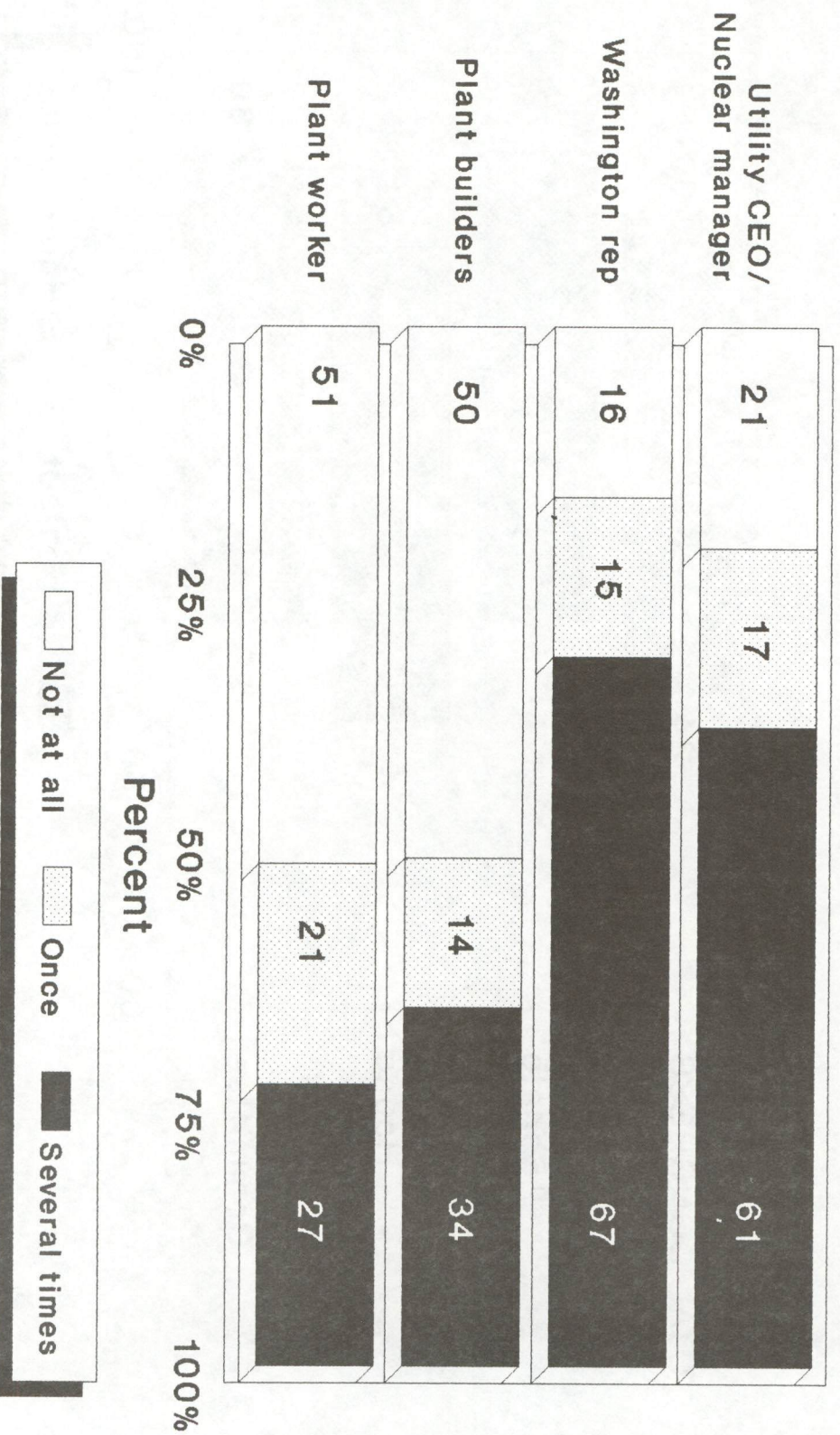


"Not sure" omitted

NUCLEAR ENERGY INDUSTRY CONTACT

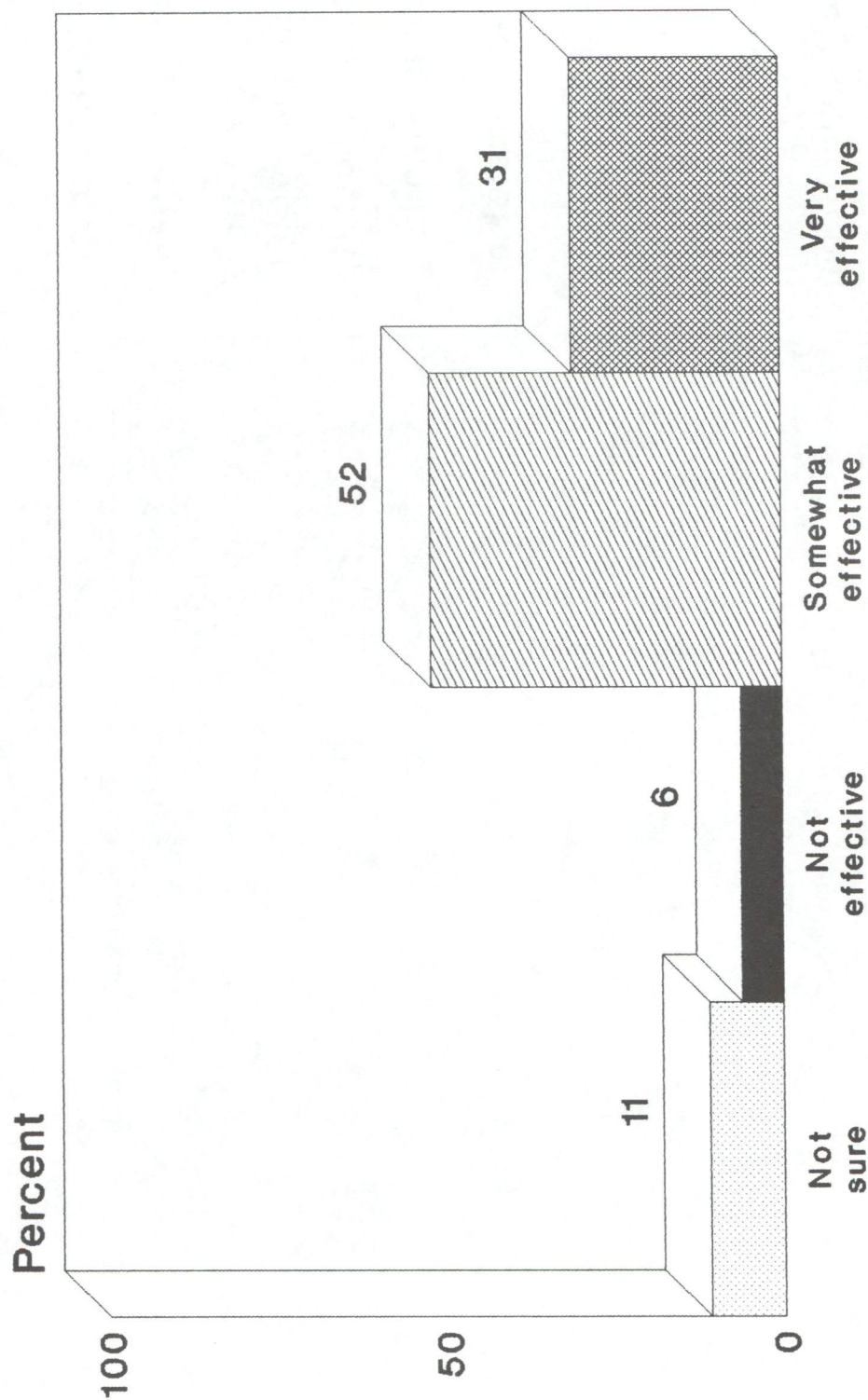


WHO MADE THE CONTACT?



Base: Had contact

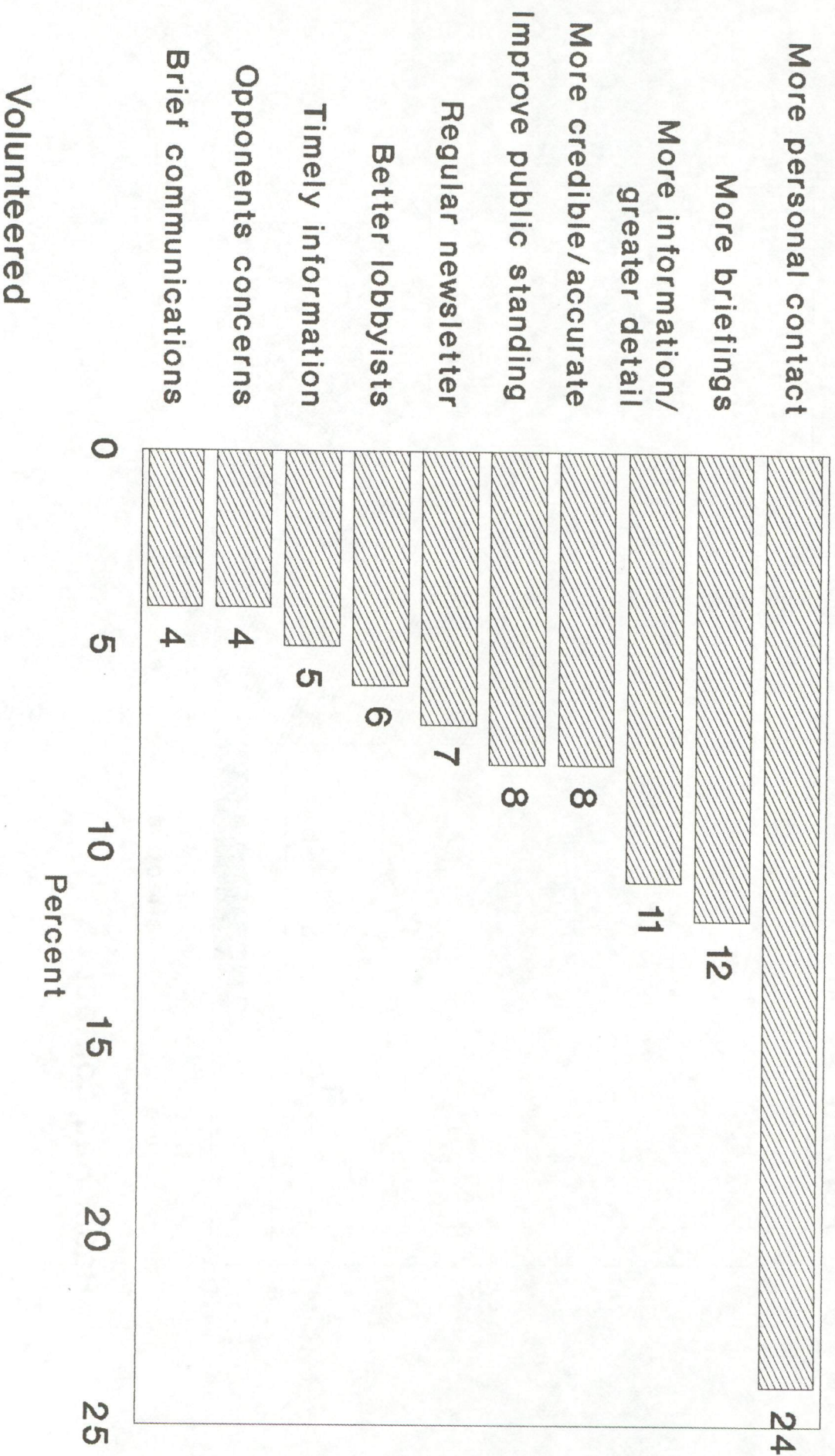
EFFECTIVENESS OF CONTACT



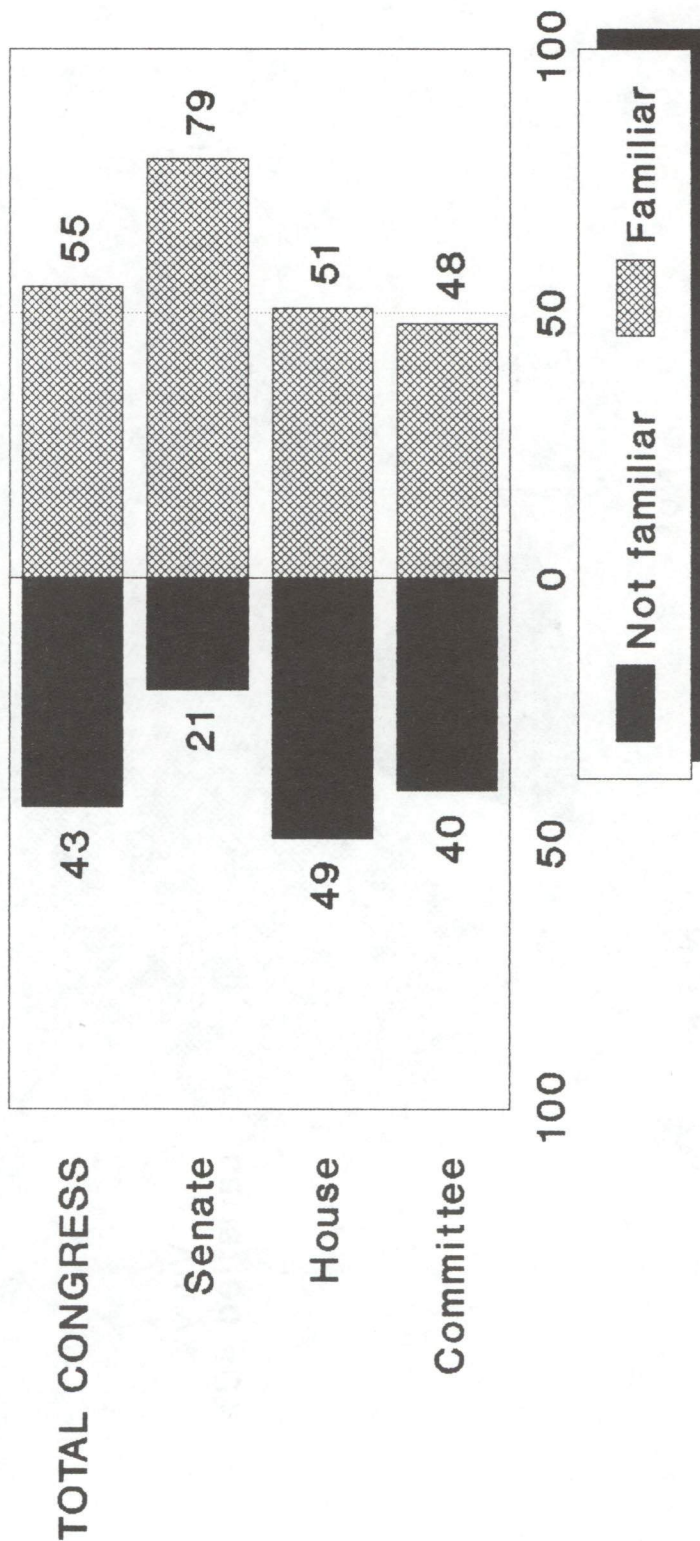
Base: Had contact

GETTING INFORMATION TO CONGRESS

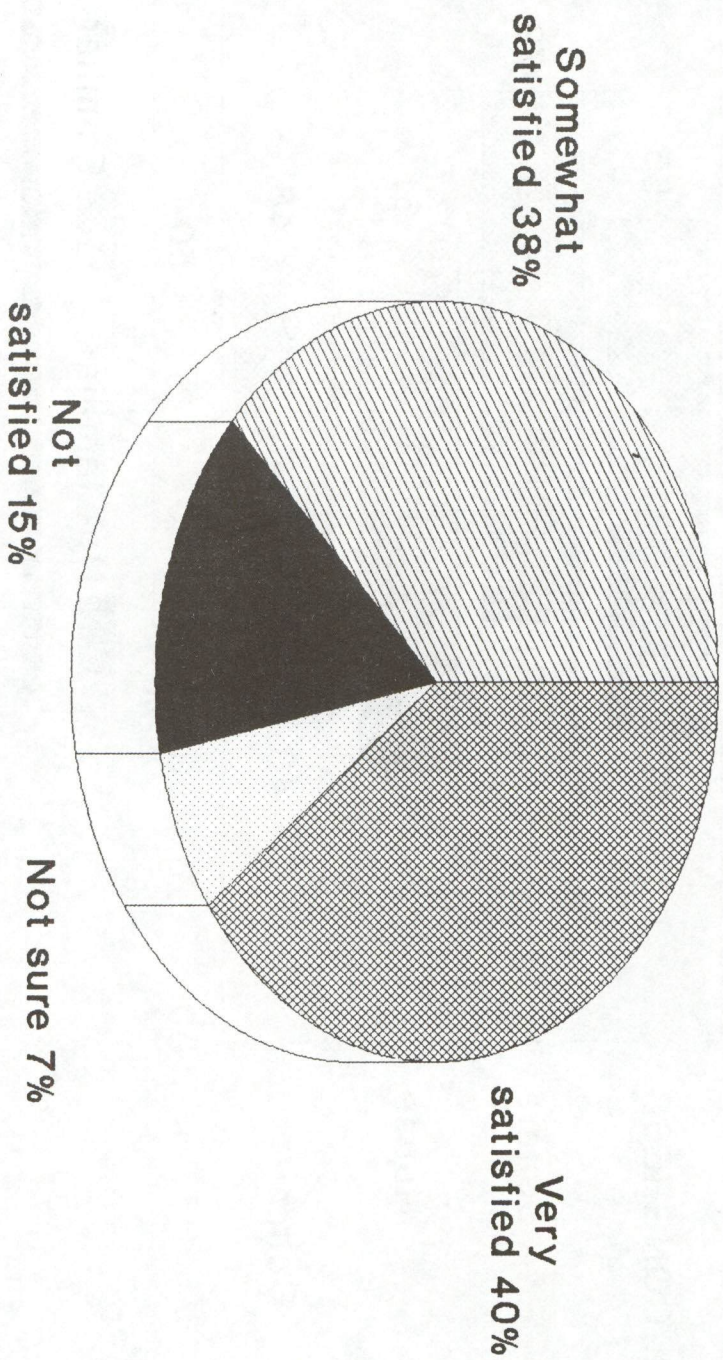
Ways to improve:



FAMILIARITY WITH NEAREST NUCLEAR ENERGY PLANT

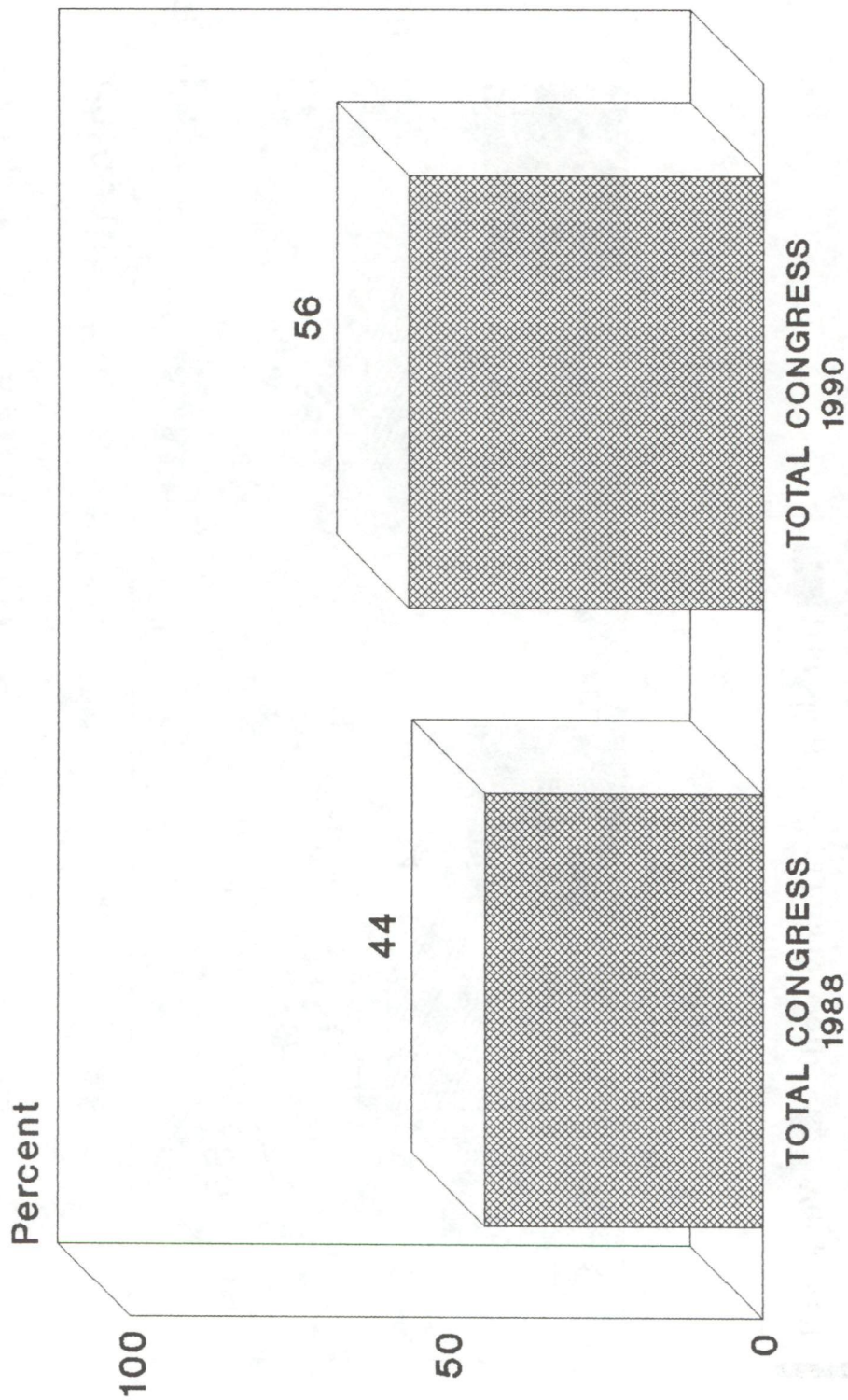


SATISFACTION WITH CREDIBILITY OF PLANT INFORMATION



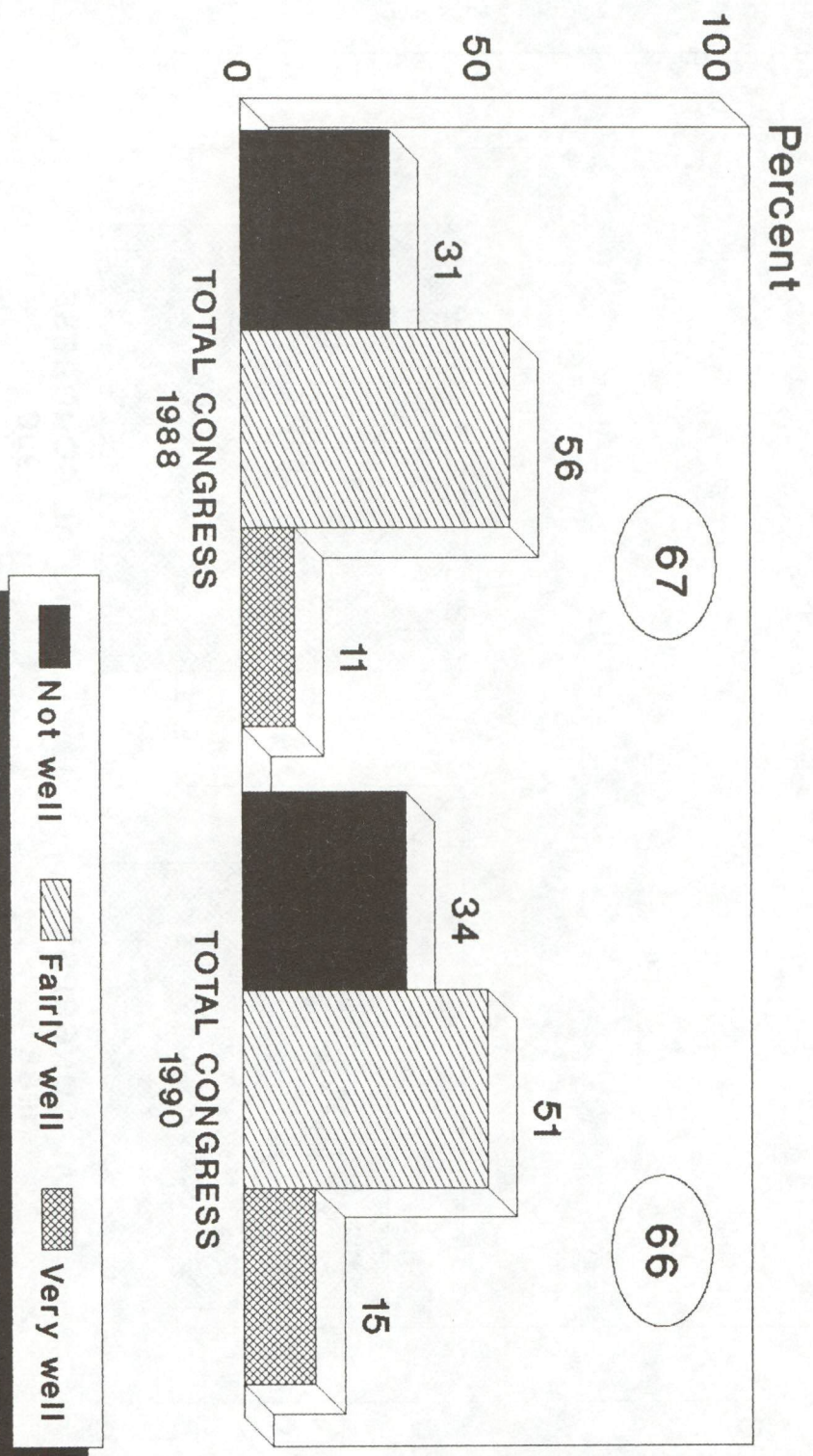
Base: "Very" or "somewhat" familiar

NUCLEAR ENERGY PLANT VISIT



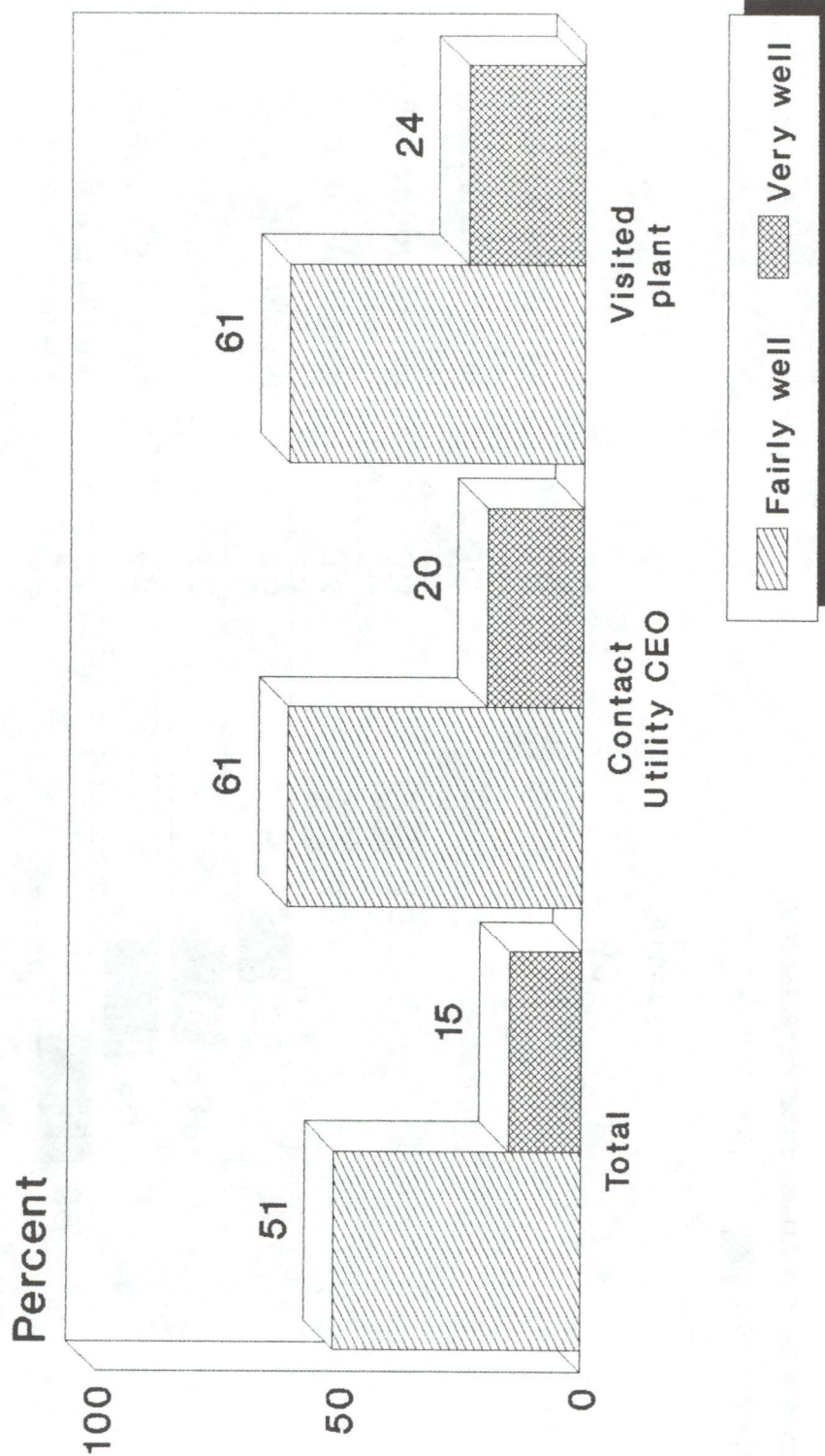
NUCLEAR PLANT OPERATIONS

How well informed?



NUCLEAR PLANT OPERATIONS

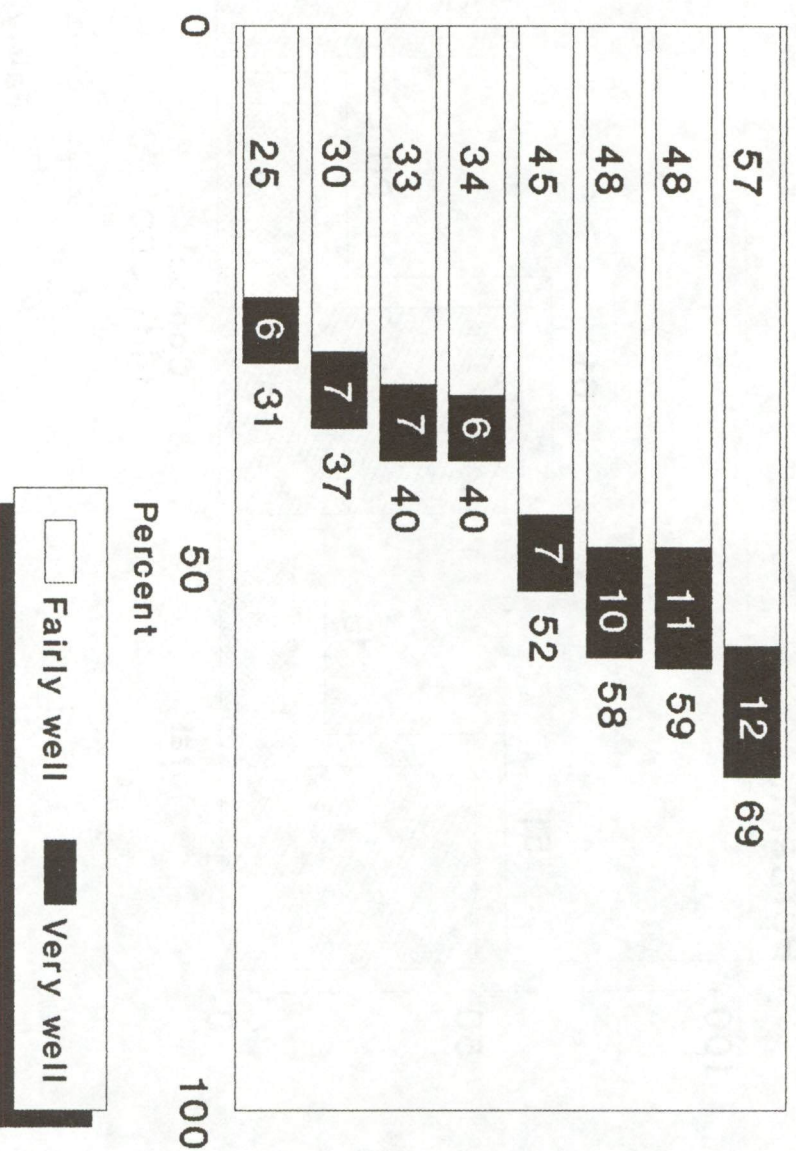
How well informed?



NUCLEAR PLANT OPERATIONS

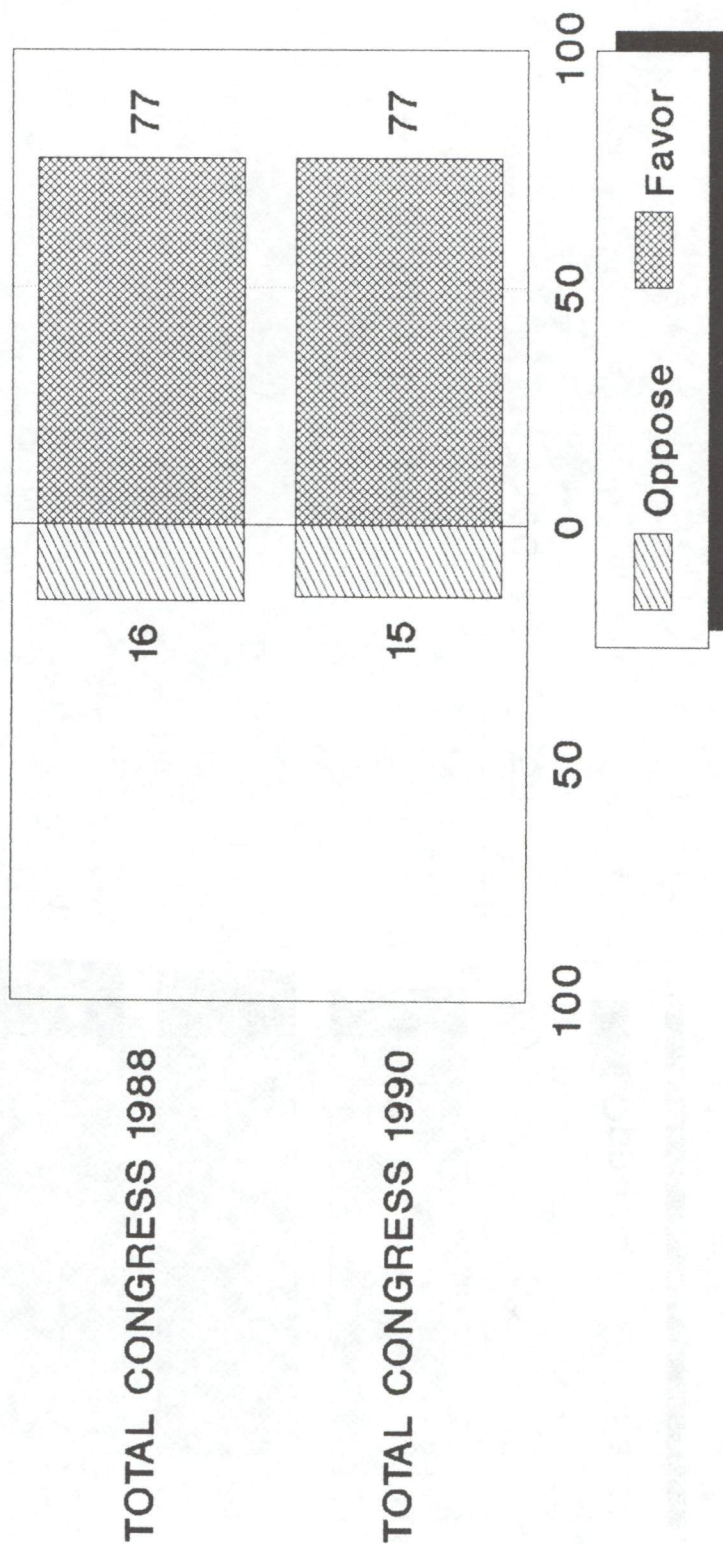
Level of familiarity:

Total informed



NUCLEAR ENERGY

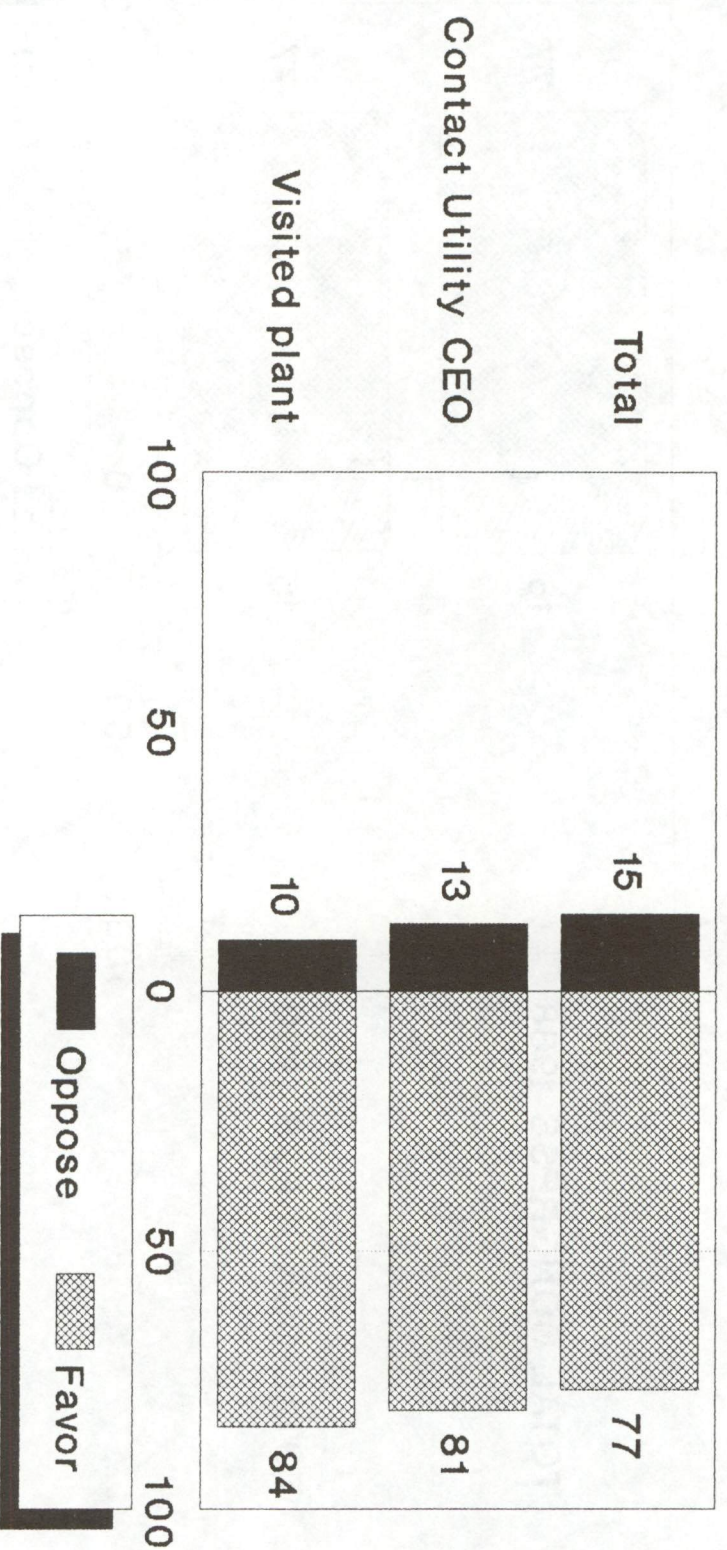
Favor or oppose?



"Not sure" omitted

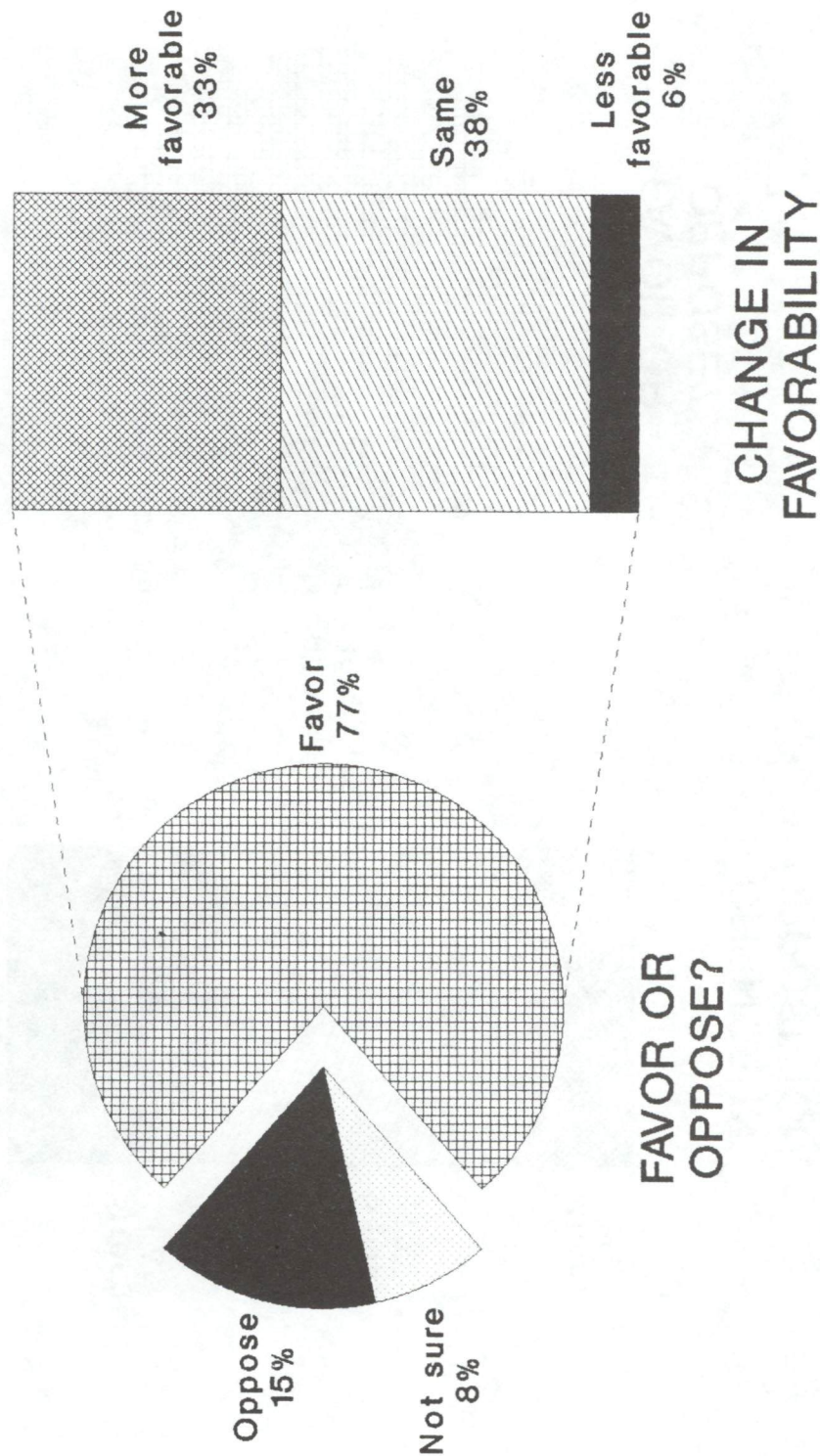
NUCLEAR ENERGY

Favor or oppose?

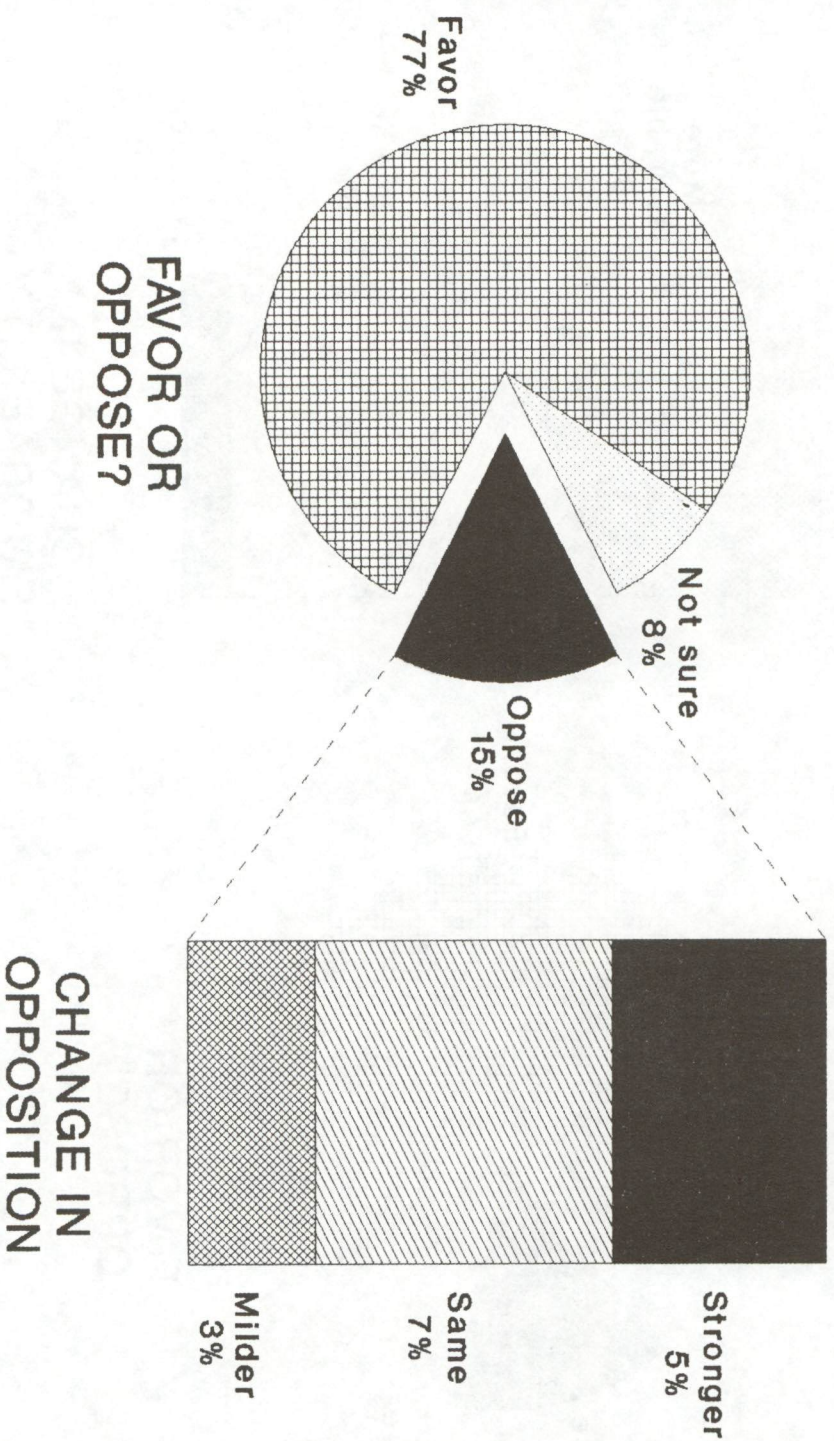


"Not sure" omitted

CHANGE IN FAVORABILITY TOWARD NUCLEAR ENERGY

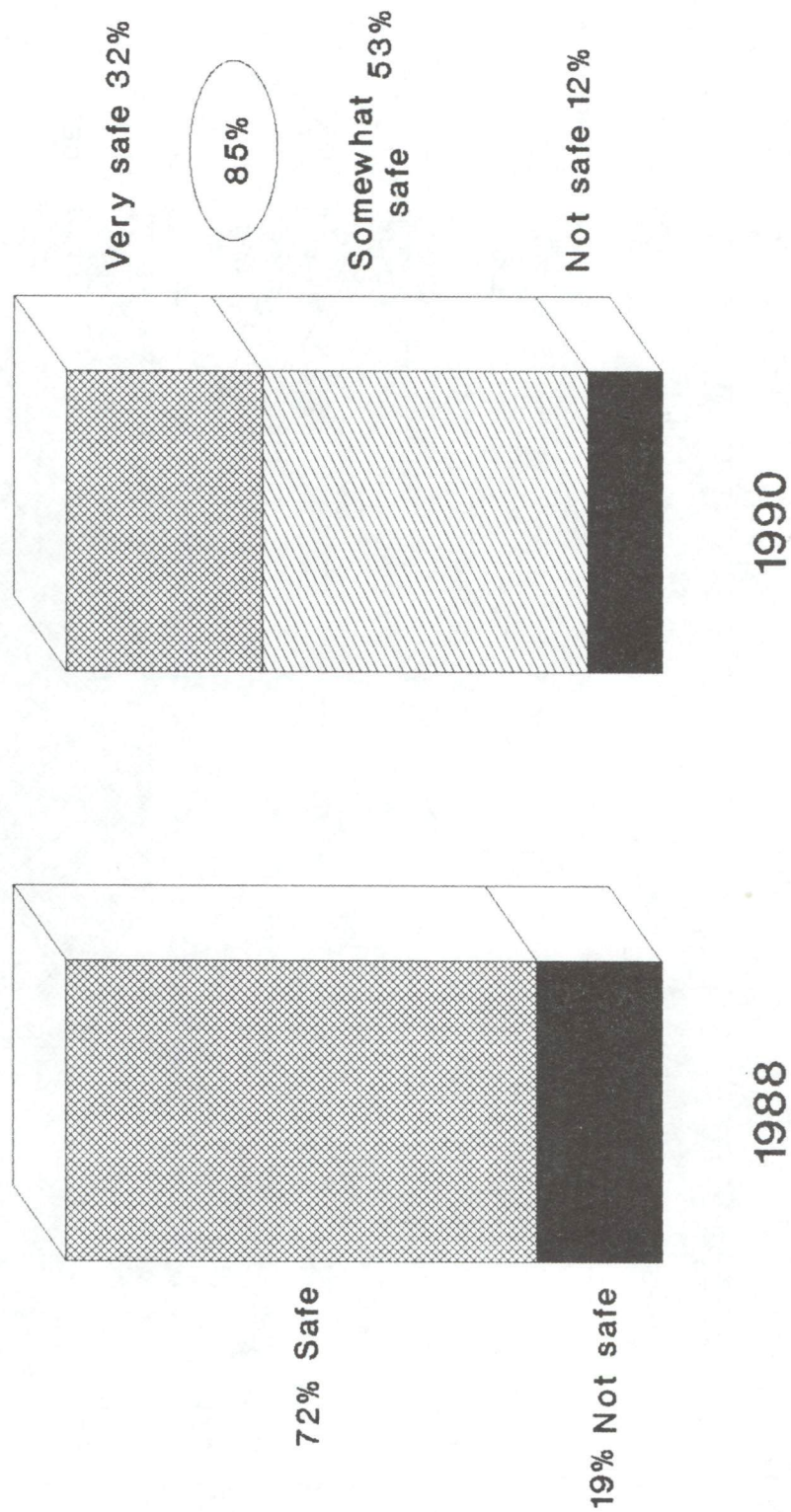


LEVEL OF OPPOSITION TOWARD NUCLEAR ENERGY



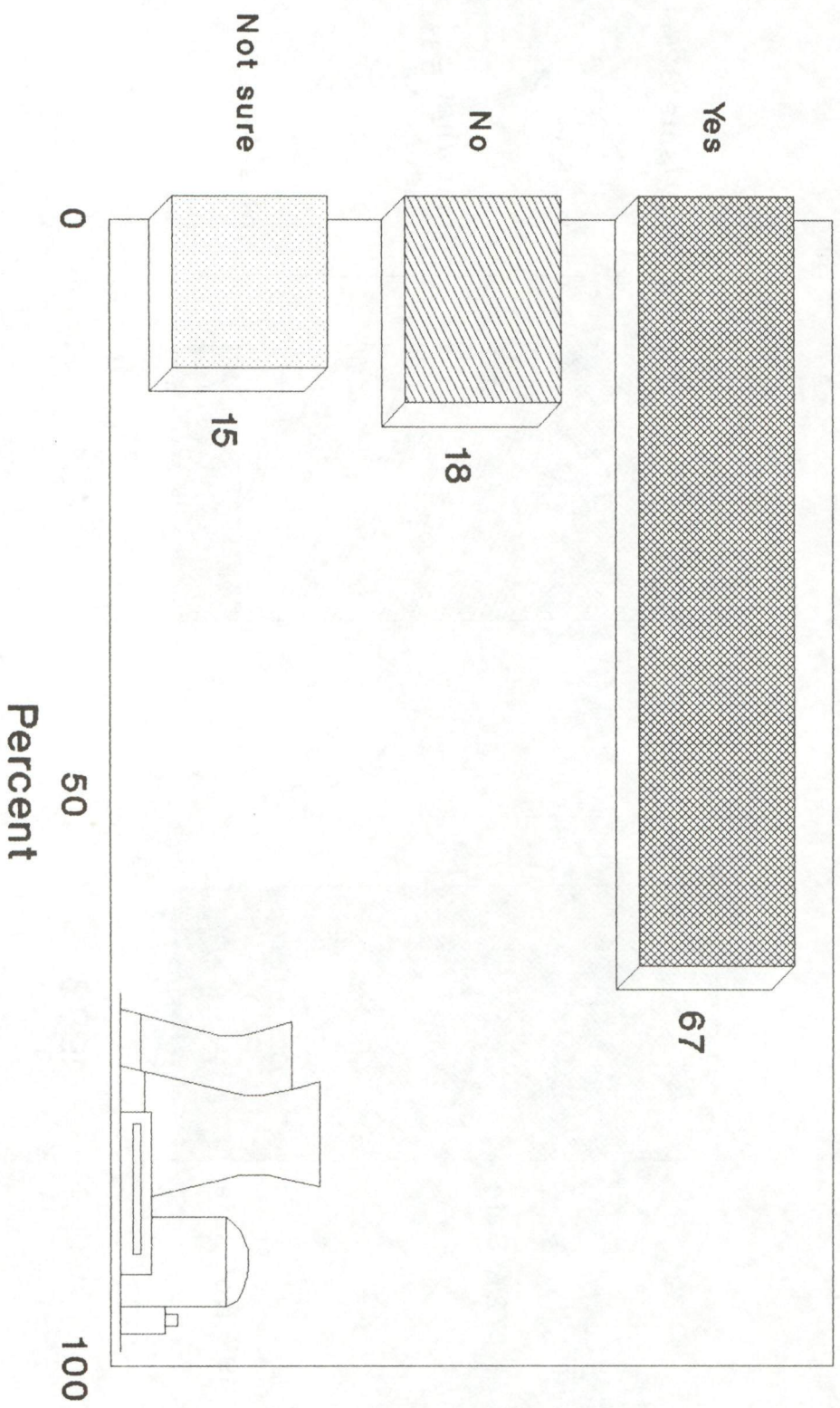
NUCLEAR ENERGY PLANTS

Rating the safety:



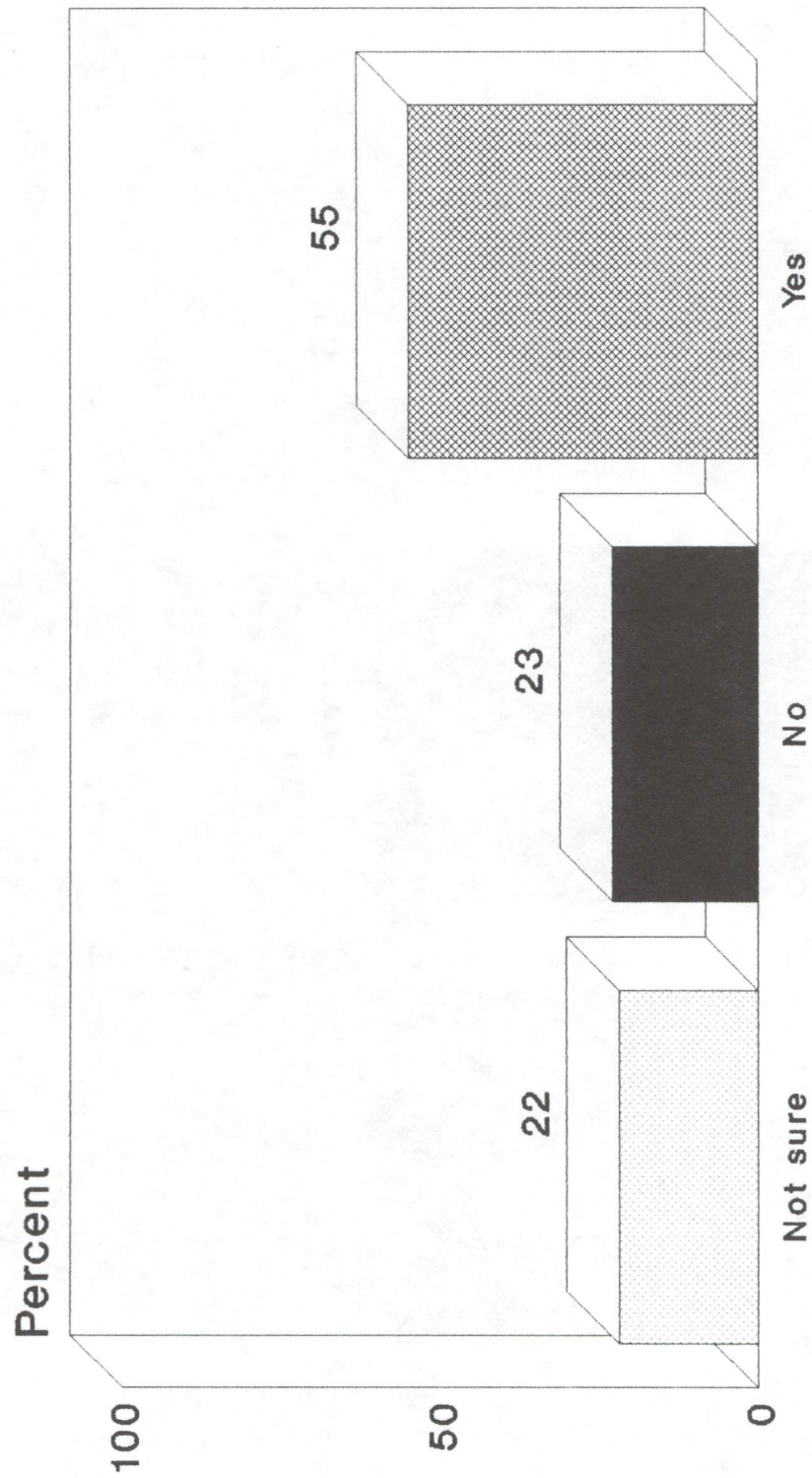
"Not sure" omitted

IS PLANT SAFETY IMPROVING?



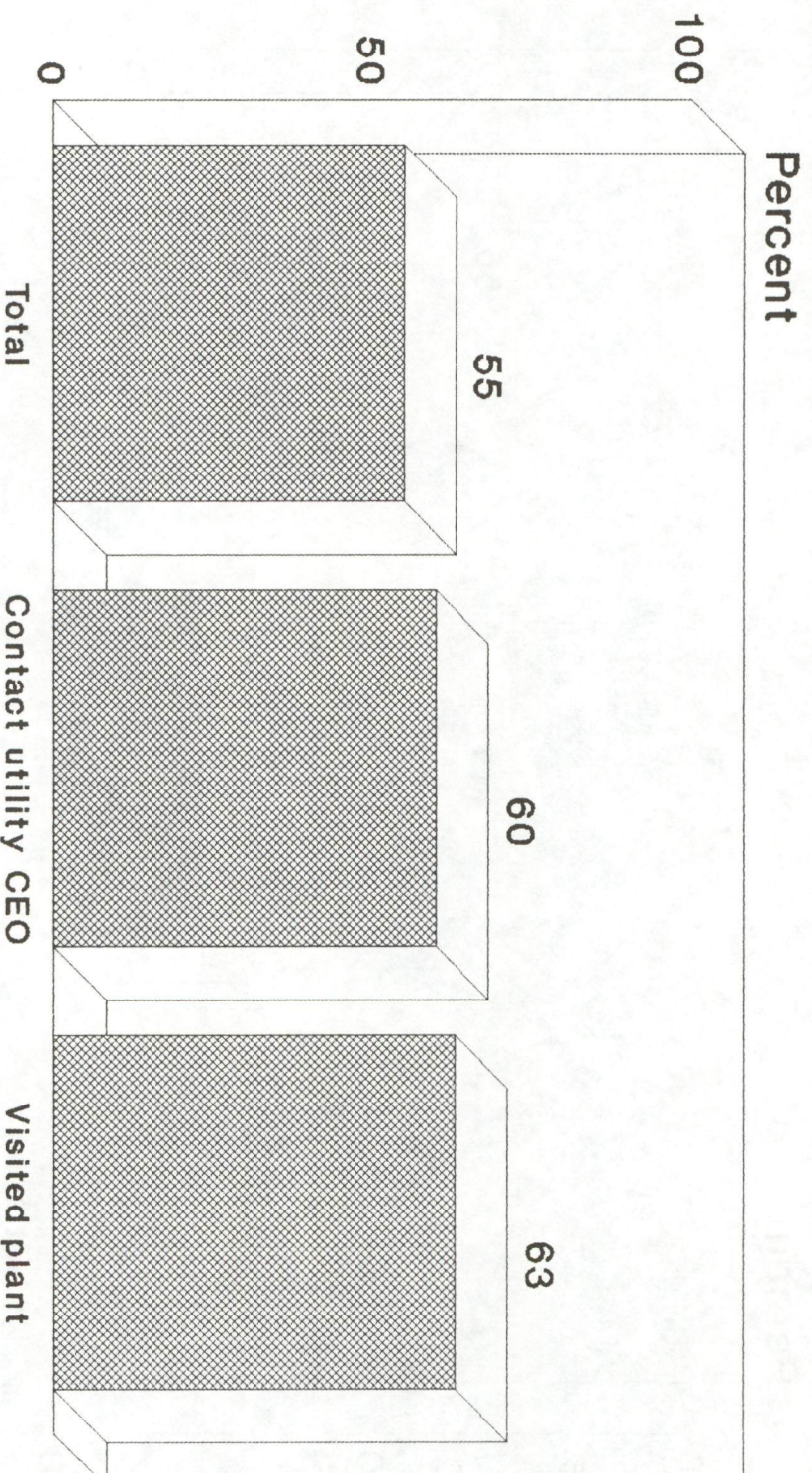
ORDER PLANT BY 1995

Do you support goal?

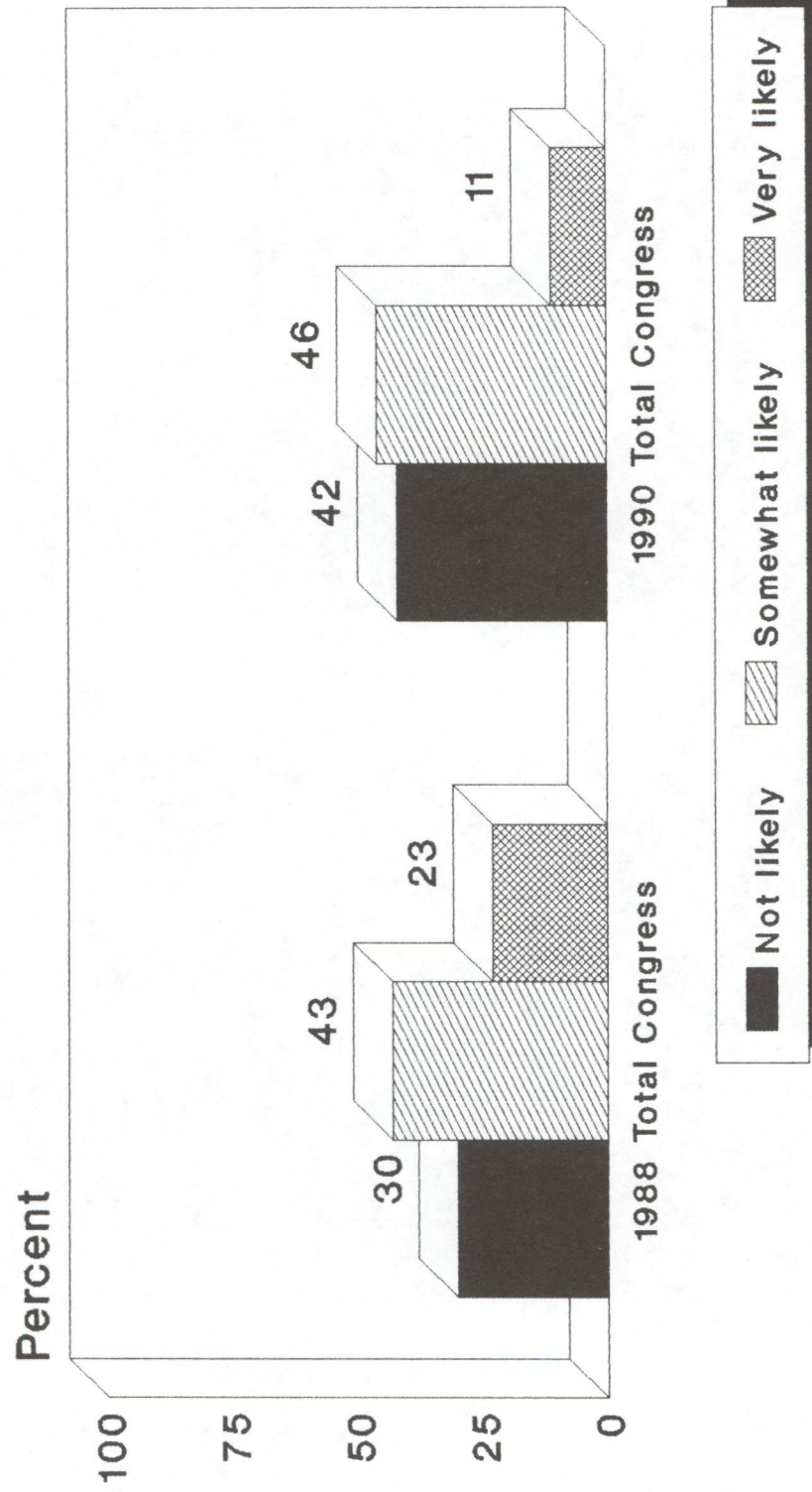


ORDER PLANT BY 1995

Support the goal:



LIKELIHOOD OF BUILDING PLANT IN NEXT 10 YEARS



"Not sure" omitted

Gene

"CORRESPONDENCE TRACKING"

TYPE: REQUEST FOR MEETING DOCUMENT NUMBER: 9120662

FROM: MINGAY, Don: ATOMIC ENERGY CORP. OF SOUTH AFRICA LIMITED

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 02/20/91

SUBJECT: REQUEST TO SCHEDULE A ONE HOUR MEETING TO DISCUSS
THE ISSUES CONFRONTING OSTP AND THE POSSIBILITY OF A
COLLABORATION OF U.S. AND S. AFRICAN INSTITUTIONS.

ASSIGNED TO: D. Allan Bromley

*Try Monday
June 24th
after the argument*

ACTION REQUIRED: AS NECESSARY

SENDER'S DUE DATE: OSTP DUE DATE: 03/20/91

DATE COMPLETED: -----

COPIES TO: Thomas Ratchford
Dr. Wong

WHITE HOUSE TRACKING #: CONTACT PERSON:

REMARKS:

*6/24/91 DAB met!
xx*

DATE RECEIVED: 03/06/91

P-Physical Sciences -
FILE: INTERNATIONAL*ENERGY



RECEIVED

31 MAR 6 P2:51

OFFICE OF THE
DIRECTOR

REFERENCE :
ENQUIRIES : D W MINGAY
TEL. NO. : (012) 316-5853
DATE : 1991-02-20

Prof D A Bromley
Scientific Advisor to the President
White House
Washington, D.C.
USA

Dear Allan,

The bi-annual ICENES Conference (Emerging Nuclear Energy Systems) will be held in Monterey under the aegis of LLNL from 16 to 21 June this year. I have been fortunate enough to have received funding to attend this meeting. As a result, the opportunity arises to detour slightly from the straight and narrow and stop-over in Washington for example. Is there any chance that you might be able to find an odd hour on Friday 14 or Saturday 15 June or else on Sunday 23 or Monday 24 June when I could have a chat with you. I am very aware of the fact that your time is anything but your own these hectic days, but there is no success without trying. It would be fascinating to meet you in your new environment and follow up on discussions which ended last time recognising only a few of the demands on time that such a position would make on you and on your health. Every photograph associated with reporting shows that you seem to have thrived on these demands. I trust that this is the case and that you are indeed keeping well and fit. I recognise also that many overnight shifts on accelerators tends to prepare one better for long hour demands but still, anno domini creeps in as well as avoirdupois!

Allan, this is a long shot that you might (a) be in Washington at this time and (b) might be able to accommodate an hour or so for me. Should the hour be available somewhere else, I would happily try to modify my flight schedule to get there. I am holding thumbs.

My position has changed and I head up four programs under the group title of Energy Systems which include the 20 MW research reactor, the reactor theory group (which inter alia do Koeberg Reload Design and Safety Analysis), Material Technology which includes surface physics and a large hot cell complex for complete destructive and non-destructive testing of reactor fuel elements, surveillance samples etc, the van de Graaff and the tokamak based plasma physics group. It is a challenge, operating on diminishing budget, drastic

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
02. Letter	To: Allan Bromley From: Don Mingay Re: Request for meeting [personal information redacted] (1 pp.)	2/20/91	(b)(6)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: General Science Files
WHORM Cat.:
File Location: Physical Science: Energy [2 of 2] [1991]

Date Closed:	3/29/2010	OA/ID Number:	62043-005
FOIA/SYS Case #:	2005-0336-F	Appeal Case #:	
Re-review Case #:		Appeal Disposition:	
P-2/P-5 Review Case #:		Disposition Date:	
AR Case #:		MR Case #:	
AR Disposition:		MR Disposition:	
AR Disposition Date:		MR Disposition Date:	

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P-6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Removed as a personal record misfile.

Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
(b)(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
(b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
(b)(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
(b)(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
(b)(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

staff reductions and having to earn a growing component of our income from external contracts. There are however excellent challenges and, as such, opportunities, but not without heartache and sadness (we have reduced our personnel by 47% over the past 3 years and the end is not yet in sight).

(b)(6)

I would be fascinated to hear about any of the many issues that have confronted you and in particular your feelings about possible collaboration in future of U.S.A. with South African Institutions, following the final demise of Apartheid which is not far away. There is much to be said.

All best wishes to you,

Sincerely



Don Mingay
SENIOR PROGRAM MANAGER: ENERGY SYSTEMS

Atoomenergiekorporasie van Suid-Afrika E

Atomic Energy Corporation of South Africa

Postbus 582 Pretoria 0001 P O Box 582 Pretoria 0001

Dr. Mingay is on your schedule on June 24 at 2:00pm, and I will call him re details (see Next to last paragraph.

Faksnommer:
Fax number:

(012) 316-5925

Indien al die bladsye nie bevredigend ontvang is nie, skakel asseblief (!
If all the pages are not satisfactorily received, please phone (012)

Verwysingsnommer:
Reference number:

Datum:
Date:

Aan:
To: Prof. D A Bromley

Faksnommer
Fax number:

Vir aandag:
For attention:

Getal bladsye (dekbladsy ingesluit):
Number of pages (including cover page): 1

Van:
From: Dr Don Mingay

Telefoonnommer:
Telephone number: (012) 316-5853

Boodskap:
Message:

Prof D A Bromley,
Scientific Advisor to the President,
Office for Science and Technology Policy
White House Washington D.C.

1991-05-24

Dear Allan,

We have been through a rather busy period of late and my apologies for not having reported back sooner following my cry for help relating to the visa application by Lance Vogel. His trip was a great success and he feeds back to me that we are actually doing well in maintaining a small but viable forefront effort in developing new fast nodal-method calculational skills for 3-D analyses for core and reflector which are now required. The USA appears to be rather stagnant in their general nuclear reactor theory inactivity. I do however recognise, that when the USA revs up its actions, it simply powers past small operators like ourselves. However, in the meantime, it is good to have comments indicating a bit of envy from the USA colleagues that we are progressing in our small way. He had a splendid trip and interacted well at Penn State and Lawrence Berkeley where he gave talks, and came back with a new lease of life. Again, my thanks for your support and action.

My trip rears its head and I have planned to fly in to Washington late on Sunday night. I will therefore be available all of Monday and fly out late on Tuesday afternoon on my way home. I mention this simply since I recognise that your schedule is obviously full and should you find an alternative time to Monday at 2 p.m. as preferable, I will be available to respond to any short term optimisation. On this point however, please ask Marian to let me know exactly where and when I should present myself to gain access to an office which is not just down the WNSL corridor!

As before, I look forward tremendously to this trip and re-establishing contact.

All very best wishes,

Sincerely

Arrange if possible for me to take him to lunch at Army & Navy Club initial

Marian

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120360

FROM: BUCKMAN, FREDERICK W.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 02/05/91

SUBJECT: NATIONAL ENERGY STRATEGY-CONSUMERS POWER'S SUPPORT
FOR THE MODULAR HIGH TEMPERATURE GAS-COLLED REACTOR
BEING A HIGH PRIORITY ELEMENT OF THIS REVIVAL EFFORT

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: Dr. Wong
D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 02/11/91

FILE: *Physical Sciences -*
~~NUCLEAR~~ ENERGY



RECEIVED

91 FEB 11 12:16

9120360
Frederick W. Buckman
President and
Chief Operating Officer

General Offices: 212 West Michigan Avenue, Jackson, MI 49201 • (517) 788-1111

February 5, 1991

OFFICE OF THE
DIRECTOR

Dr. D. Allen Bromley, Director
Science & Technology Policy
White House Office
of Science & Technology
OEOB 360
17th & Pennsylvania Avenue, N.W.
Washington, D.C. 20500

Dear Dr. Bromley:

As the Nation prepares to enter the 21st century, we are increasingly confronted with global competition for energy resources as well as a rising tide of domestic awareness of the environmental, social and economic consequences associated with the available energy supply options. Perhaps at no other time in our history has the need for a National Energy Strategy been so important to our economic health.

The revival of the nuclear option is a most challenging element of our National Energy Strategy. The purpose of my letter is to reiterate our support for the Modular High Temperature Gas-Cooled Reactor (MHTGR) being a high priority element of this revival effort.

We have evaluated the MHTGR as a future option on our system and view it to be most attractive. While generic issues of regulatory reform, waste disposal and broad public support plus our current internal financial limitations prevent us from aggressively pursuing the MHTGR in the near-term, we are hopeful that this technology becomes a realistic alternative in our long-term strategy to provide safe, economic, environmentally responsible energy to our Michigan customers.

February 5, 1991
Dr. D. Allen Bromley

In the interim, we urge that the Government maintain a stable, commercial MHTGR Program and give careful consideration to deploying a close variant of the commercial MHTGR design as a New Production Reactor. With maximum commonality and close cooperation between the two programs, the commercial MHTGR can be deployed for a modest, incremental effort.

If you would like to discuss this matter further, please do not hesitate to call.

Sincerely,

A handwritten signature in dark ink, appearing to read "Frederick W. Bushman", with a long horizontal flourish extending to the right.

FWB/dl

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120382

FROM: MEYER, JAMES

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 02/02/91

SUBJECT: ELECTRICAL POWER FROM SEA-WATER FOR THE WORLD ENERGY
SUPPLY.

ASSIGNED TO: Dr. Wong

ACTION REQUIRED: DIRECT RESPONSE

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED: 2/14/91 by EW

COPIES TO:

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

Kook letter - should not be a sweet
unless singly "thank you for your letter"

DATE RECEIVED: 02/13/91

P-Physical Sciences -
FILE: ENERGY

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

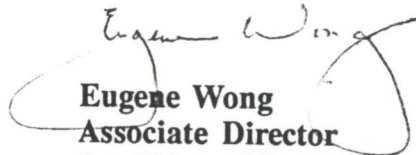
February 14, 1991

Dear Mr. Meyer:

Thank you for your interesting letter to our office.

We are unable to comment on "the merits or stupidity" of your proposal because we have no expertise in this area. Perhaps you should try your idea on an electrochemist to test its feasibility. Good luck!

Sincerely yours,


Eugene Wong
Associate Director
for Physical Sciences and Engineering

Mr. James Meyer
351 Grafton Street
San Francisco, California 94112

NATIONAL SCIENCE ADVISOR
WHITE HOUSE EXECUTIVE OFFICES
WASH, DC 20508

FEB 2, 1991

9120382

DEAR NATIONAL SCIENCE ADVISOR,

I AM WRITING REGARDING WHERE IS BEST TO INVEST SCIENCE ASSETS.

THE PROPOSED SUPERCOLIDER SHOULD NOT BE BUILT BECAUSE NO NEW DATA WILL COME OUT OF IT. HIGHER ENERGY COLLISIONS BETWEEN PARTICLES WILL STILL BE PRODUCING PHOTONS AND PROTONS. TEN BILLION DOLLARS MORE WILL NOT SHOW ANY OTHER RESULT SO WHY NOT SPEND THE MONEY ELSEWHERE?

SUPERFICIAL STUDIES I'VE DONE CONVINCED ME THAT ELECTRONIC CIRCUITS CAN BE DESIGNED TO PRODUCE ELECTRIC POWER FROM SEAWATER. THESE CIRCUITS USE GALVANIC FORCES THAT OCCUR WHENEVER TWO CONDUCTORS OF DIFFERENT MATERIAL SUCH AS IRON AND ALUMINUM CONTACT MOISTURE. I AM CONVINCED IN THE OCEAN THIS PROCESS COULD SUPPLY ALL THE ENERGY THE WORLD COULD EVER USE AND NOT POLLUTION WOULD RESULT.

WHAT IS NEEDED IS A DEVICE TO COLLECT THE FORCE IN USEFUL AMOUNTS. THE VAST NUMBERS INVOLVED NEED TO BE EXPLORED AND UNDERSTOOD. BUT, IT IS NOT TOO DIFFICULT TO SEE HOW A CIRCUIT COULD BE OPERATED USING KNOWN FACTS ABOUT THERMAL ELECTRIC AND ELECTROCHEMICAL PROCESSES. ONE CHARGE AT A TIME WOULD COLLECT TO BE HARVESTED. SINCE WELL OVER FIFTY WATTS OF POWER ARE AVAILABLE PER POUND OF SEAWATER IT IS EASY TO SEE THE POTENTIAL HERE. THIS SOURCE IS IN FACT GREATER THAN FUSION AND EASIER THAN PEDALING A BIKE.

I MAY BE WRONG BUT WHY NOT TAKE A LOOK AT ^{ONE OF} THE ONLY KNOWN FORCES THAT EXISTS; THE CHARGE THAT MAKES RUST, CAUSES CHEMICAL CHANGE, AND IS AVAILABLE EVERYWHERE--SOME SOURCES BEING EASIER TO TAP THAN OTHERS.

THE REMOVAL OF CHARGE FROM SEAWATER CAN BE USED TO FREEZE OUT OF SOLUTION PURE WATER. REMOVING FIFTY WATTS OF CHARGE CAN CAUSE ONE POUND OF WATER TO FREEZE IF THE RIGHT CONDITIONS EXIST. SO, NOT ONLY IS POWER AVAILABLE BUT FRESH WATER, ALSO.

PLEASE COMMENT ON THE MERITS OR STUPIDITY OF THIS PROPOSAL.

THANK YOU,

James Meyer

JAMES MEYER
351 CRAFTON ST
SAN FRANCISCO, CA
94112

DIRECTOR
OFFICE OF THE

91 FEB 13 9 12 AM

RECEIVED

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9120327

FROM: WOLF, JAMES L. AND ALDEN MEYER

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/31/91

SUBJECT: A NATURAL ENERGY STRATEGY POLL.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED: -----

COPIES TO: Dr. Wong
D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 02/04/91

P- PHYSICAL SCIENCES -
FILE: ENERGY

The
ALLIANCE
To Save Energy

1725 K Street, N.W.
Suite 914
Washington, D.C. 20006-1401
202/857-0666
Fax: 202/331-9588



RECEIVED

Board of Directors

Chairman
Senator Timothy E. Wirth

Co-chairman
Senator James M. Jeffords

Founding Chairman
Charles H. Percy

Past Chairmen
Senator John Heinz
Daniel J. Evans

Treasurer
Thomas P. Dickerson
General Partner
Tullis-Dickerson & Co., Inc.

William A. Nitze
President

James L. Wolf
Executive Director

Norman R. Augustine
Chairman and CEO
Martin Marietta Corporation

Joseph A. Califano, Jr.
Managing Partner
Dewey, Ballantine, Bushby,
Palmer and Wood

Edward J. Carlough
General President
Sheet Metal Workers' International
Association

John W. Ellis
Chairman and CEO
Puget Sound Power & Light Company

Robert K. Gray
Chairman and CEO
Hill and Knowlton Public Affairs
Worldwide

Thomas R. Kuhn
President
Edison Electric Institute

George H. Lawrence
President
American Gas Association

Mildred B. McCauley
Member Board of Directors
American Association of Retired Persons

Richard L. McGraw
Vice President of Corporate Affairs
COMSAT Corporation

David O. Maxwell
Chairman and CEO
Fannie Mae

Frank H. Pearl
Chairman
Rappahannock Investment Company

Russell W. Peterson
President Emeritus
National Audubon Society

W. T. Stephens
Chairman and CEO
Manville Corporation

Robert B. Stobaugh
Charles Edward Wilson Professor
of Business Administration
Harvard Business School

W. Roger Strelow
Vice President
Bechtel Environmental, Inc.

Stephen Wiel
Commissioner, State of Nevada
Public Service Commission

January 31, 1991

01 FEB 4 AM 11:01

The Honorable D. Allan Bromley
Assistant to the President for Science & Technology
Old Executive Office Building
17th and Pennsylvania Avenue, N.W.
Washington, DC 20506

OFFICE OF THE
DIRECTOR

Dear Dr. Bromley:

As you consider what policies to include in a national energy strategy, we want you to be aware of the results of a recent national poll sponsored by the Alliance To Save Energy and the Union of Concerned Scientists concerning voters' preference for different strategies. Public support, as Admiral Watkins has stated, will be necessary for any set of policies to be enacted.

The results of the poll are conclusive: the public overwhelmingly favors policies promoting energy efficiency and renewable energy. As detailed in the enclosed poll:

- By a margin of 76 percent to 21 percent, Americans believe that to meet our energy needs we should reduce demand and use energy more efficiently rather than opening oil drilling off our coasts and in wilderness areas.

- 80 percent of Americans favor raising federal fuel efficiency standards for automobiles from the present 27.5 mpg to 40 mpg by the year 2000.

- 69 percent of voters believe that the United States should join other industrialized countries in fighting global warming by committing to limit the amount of carbon dioxide emissions from the U.S.

- 91 percent of Americans favor legislation to require new homes financed by FHA or VA mortgages to meet strict energy efficiency standards

- 75 percent of the people would give renewable energy the largest or next largest share of the Department of Energy's R&D budget, and energy conservation is their second priority.

These findings, and many others in the enclosed poll, form the basis of the principles and policies of a national energy strategy based upon energy efficiency and renewable energy sources. We hope you will endorse such policies. American voters clearly would reject a national energy strategy that does not incorporate these.

If you have any questions concerning the poll, you may call either one of us, or the pollsters who conducted it.

Yours truly,

James L. Wolf
Executive Director
Alliance To Save Energy

Alden Meyer
Director, Energy and
Climate Change Program
Union of Concerned Scientists

"CORRESPONDENCE TRACKING"

9160020



TYPE: ACTION

DOCUMENT NUMBER: 9120120

FROM: WATKINS, JAMES D.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE:

SUBJECT: THE NAT'L CRITICAL TECHNOLOGIES REPORT FOR THE
PRESIDENT TO SEND TO CONGRESS

ASSIGNED TO: D. Allan Bromley

*Bill: Please draft
gentle response!
DAB*

ACTION REQUIRED: AS NECESSARY

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO:

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 01/23/91

P-Physical Sciences -

FILE: ENERGY-~~NOT~~ REPORT

THE WHITE HOUSE
WASHINGTON

January 29, 1991

Dear Jim:

Thank you for your letter of January 23 regarding the National Critical Technologies report. For a variety of reasons, the government/private sector panel enlisted to identify "national critical technologies" got off to a slower start than I had hoped. The study now appears to be on track and I expect to have the report in the hands of the President in February and to the Congress in March. We have had excellent cooperation from a number of agency personnel during the course of this study including, prominently, Everet Beckner and others from the Department of Energy. As a result of this input, we expect the report to have major impact.

Sincerely,



D. Allan Bromley
Assistant to the President
for Science and Technology

Admiral James D. Watkins, U.S. Navy (Retired)
The Secretary of Energy
Department of Energy
Washington, DC 20585



The Secretary of Energy

Washington, DC 20585

RECEIVED

January 23, 1991

91 JAN 24 A 9:49

OFFICE OF THE
DIRECTOR

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
Director, Office of Science
and Technology Policy
The White House
Washington, D.C. 20500

Dear Dr. Bromley: *Allan*

This Department is working with the Office of Science and Technology Policy to produce the National Critical Technologies (NCT) Report for the President to send to Congress, as mandated. At your request, I assigned Under Secretary John Tuck to serve on the NCT Advisory Panel.

I have been following the activities of the Panel and, quite frankly, I am disappointed to find that not only is the Report running very late in its preparation, but it is also suffering from serious technical weakness in many areas of interest to DOE. Mr. Tuck has found it necessary to assign many sections of the Report for rework by experts from the DOE staff and from the Laboratories. Due to the importance of this work, I hope that the other panel members are responding similarly.

Sincerely,


James D. Watkins
Admiral, U.S. Navy (Retired)

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120230

FROM: MAYER, FREDERICK J.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/21/91

SUBJECT: NEW DEVELOPMENT IN THE FIELD OF NUCLEAR ENERGY

ASSIGNED TO: Dr. Wong

ACTION REQUIRED: AS APPROPRIATE

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED: 2/6/91 by KAE

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 01/29/91

FILE: ~~PHYSICAL~~ ENERGY

P-Physical Sciences -

9120230
RECEIVED
January 21, 1991

Dr. Allen D. Bromley, Science Advisor to the President
Executive Office of the President
Office of Science and Technology Policy
Room 360, Old Executive Office Building
Washington, D. C. 20506

91 JAN 29 A 9:24

OFFICE OF THE
DIRECTOR

Dear Dr. Bromley:

Since we have not met, I should mention that I am a plasma physicist and I have been involved for over 20 years in both magnetic and inertial fusion.

I am writing this letter to inform you of a potentially important new development in the field of nuclear energy. As I know that nuclear physics has been one area of interest for you for some time, I wanted to let you know of this development before the "noise-level" increases.

To get to the point, I and a colleague (Dr. John R. Reitz) now believe that we have understood the "strange" and apparently nuclear observations of the now-numerous, but not yet reproducible, experiments called (incorrectly) "cold fusion", and the more recent experiments called (correctly) cluster impact fusion. We describe our results that explains the "cold fusion" observations in a paper (to be published in May) that is entitled "Nuclear Energy Release in Metals"; it also suggests straightforward tests of our theory.

In addition, we have completed a second overarching paper ("On Very-Low Energy Nuclear Reactions") that describes the physics of the cluster impact fusion experiments and its connection to "cold fusion" and other anomalous experiments having nuclear observations that have surfaced recently. I wanted to inform you of these results, because it does now appear to us that a new and significant

source of nuclear energy will become available to us. I hasten to add that we are, of course, quite aware of the physics communities incredulity regarding such observations, and the negative atmosphere surrounding them, however, there is, in our opinion, some exciting new nuclear physics here, which can be both simply understood and very usefully employed.

I am writing to let you know of these results early on, so that, if there are specific people we should talking to (and are not), we would like to know about them. We are presently involved in a collaboration with Naval Research Laboratory in this area.

Finally, I would be happy to brief you or some of your colleagues on these matters if you so wish. Please let me know.

Respectfully yours,

A handwritten signature in cursive script, reading "Frederick J. Mayer".

Frederick J. Mayer, PhD
President

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

February 6, 1991

Dear Dr. Mayer:

Thank you for writing to Dr. Bromley about your paper, "Nuclear Energy Release in Metals." As nuclear physicists, Dr. Bromley and I both have followed the developments in what has been termed "cold fusion" with interest and, perhaps, a touch of incredulity.

I would appreciate your sending me a preprint of your paper so that I can get some idea of the physics, chemistry, or whatever, that you associate with the measurements.

Sincerely,



Karl A. Erb
Assistant Director
for Physical Sciences and Engineering

Dr. Frederick J. Mayer
President
FJM Associates
1417 Dicken Drive
Ann Arbor, Michigan 48103

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120170

FROM: WEST, HENRY S.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/16/91

SUBJECT: CONTROLLING THE VOLTAGE OF LIGHTENING FOR ENERGY

ASSIGNED TO: Dr. Wong → Dan Pryor to respond to Mr West

ACTION REQUIRED: AS NECESSARY

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

3/1/91 by D Pryor

COPIES TO:

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

Don -
would you take
care of this one
(ie, respond) please?
Sally will type your
response & log the
item out of our
queue. Thanks Kal

P-Physical Sciences -

DATE RECEIVED: 01/19/91

FILE: ENERGY-LIGHTENING

9120170

Henry S. West
7819 Reservoir Road
Port Edward, N.Y. 12828

October 18, 1976

Science Advisor to:
The President of the United States
Washington, D.C.

Re: Energy Potential

Dear Sir:

I have a theory, which if proved to be correct, could provide us with an unlimited source of energy.

In the June issue of science Digest on pages 22 and 23 there is an article entitled, "Lightning Demystified." According to this article the National Oceanic and Atmospheric Administration, while flying through 300 electrical storms, have determined cloud formations and conditions and temperature variations necessary to produce electrification. The voltage measured at the start of electrification was 1000 volts per meter, during electrification voltage was measured at 240,000 volts per meter.

Knowing this, would not the next step be to find a substance formed that is better than clouds and placed in a compact, inclosed container. My idea is not to make lightning but to control the voltage between 1000 volts and 240,000 so that there would be a continuous flow of current.

The amperage in lightning, according to the Encyclopaedia Britannica, has been measured at 100,000 amps. by using a nonlinear resistance shunt.

I can visualize where this type of energy would create problems. It would drain off electrons and protons from the immediate area and interrupt radio transmission and stop conventional motors. Therefor any power plant would have to be placed in a remote section. I can also visualize where this same energy could be used for spacecraft in the future.

Please forward this letter to the proper agency for consideration and please acknowledge this letter.

This may seem like a wild scheme, but so was the harnessing of electricity a comparatively short time ago.

Respectfully yours,

Henry S. West
Henry S. West

Bush Library Photocopy
Preservation

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

February 27, 1991

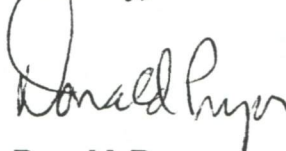
Mr. Henry S. West
7819 Reservoir Road
Fort Edward, N.Y. 12828

Dear Mr. West:

Thank you for your letter to Dr. Bromley which was recently received although it was apparently written several years ago. I trust the delay was not in our mail system.

Harnessing atmospheric phenomena such as the aurora and lightning have been considered as power sources. The energy available, however, is quite limited and unreliable. In addition, there would be considerable engineering challenges to overcome and environmental concerns to address. Nonetheless, as you point out, we do need creative thinking such as yours in order to produce innovative alternative energy sources.

Sincerely,

A handwritten signature in dark ink, appearing to read "Donald Pryor". The signature is fluid and cursive, with a large initial "D" and a stylized "P".

Donald Pryor

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120228

FROM: JACKSON, J. DAVID

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/14/91

SUBJECT: AN ENERGY POLICY FOR THE U.S. IN LIGHT OF THE
PERSIAN GULF CONFLICT.

ASSIGNED TO: Dr. Wong

ACTION REQUIRED: FOR DAB
SIGNATURE

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

3/18/91 by Don Pryor

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT

REMARKS:

P-Physical Sciences

DATE RECEIVED: 01/19/91

FILE: ENERGY-PERSIAN GULF

3/15
Dawson
Don Pryor
drafted this
SAB
Gene W has
cleared
dr
3/18

9120228

430 Vermont Avenue
Berkeley
California 94707-1742

14 January 1991

Dr. D. Allan Bromley
Science & Technology Assistant to the President
Old Executive Office Building
Washington, D.C. 20506

Dear Allan,

I am writing on the eve of armed conflict in the Persian Gulf about the urgent need for a sensible energy policy for the U.S. Whatever the duration or outcome of the crisis over Kuwait, the Gulf region will occupy our attention and demand massive commitment for many years to come. The situation in that part of the world, with its oil resources, its extremes of wealth and poverty, its religious and nationalistic fanaticism, is, and is likely to remain, a powder keg. It may be naive to suggest that the U.S. can have any moderating influence for productive change, but that is why I write.

Our profligate use of energy (a steady-state average per capita consumption of energy of all forms of 11 kW !) has led us to dependence of the Gulf's oil and, in large part, to our military involvement there today. A serious, long-term strategy for energy self-sufficiency by, say, 2005 A.D. could be the linchpin in a policy that would bring positive changes in the Persian Gulf region and the whole Mideast. An announced and implemented campaign with a realistic time-table would have an influence on the thinking of the oil sheikdoms and Iraq and Iran. The prospect of eventual loss of a major market for their oil would, I hope, focus their minds and make them all amenable to suggestion. Foreign policy objectives consonant with such a energy policy are fairly obvious - mutual down-scaling of armaments in the region, settlement of the Palestinian issue, movement away from hereditary or dictatorial rule, and opening of the societies to individual freedoms and some form of participative democracy (These last can be done within the framework of religious mores if the fanaticism is eliminated.).

I am prompted to write to you because of the newspaper reports in the past month of the "gutting by the White House Staff" of the report by Watkins's task force on a new energy policy. The NY Times quoted one White House staffer as saying that, in the long run, free enterprise is the best solution. While I gather that the report may have been more of a laundry list of possible options than a coherent policy, I find it less than reassuring for that long run to read of such a cavalier attitude in the White House. Perhaps you will tell me it is not true. In any event, I urge you to devote your energies to persuading the Administration to put forward a far-reaching strategy for energy self-sufficiency by early in the next century, if not before. Nothing could be more important.

I look forward to seeing you at the end of April when we both sign the Register of new Members of the N. A. S.

With best wishes, I am

Yours sincerely,



J. David Jackson

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

March 18, 1991

Dave
Dear Dr. Jackson:

Thank you for your letter of January 14 on energy policy. Now that the National Energy Strategy has been released, I hope that the public debate can be focused on issues rather than sketchy and misleading stories about the process of its development. Thankfully, prospects are that this discussion will go on much longer than did the war in the Gulf.

As you point out, there is ample opportunity for conservation in this country, and there should be ample incentive. Pointing out that energy use amounts to a steady-state average of 11 kW per capita is a dramatic statement of the room for improvement. Steady progress has been made in reducing energy intensity (energy consumption per dollar of GNP) -- more than 28 percent reduction between 1972 and 1989. Economists insist that the steady pace, despite volatility in costs, indicate that the market is not elastic and that neither energy taxes nor regulations would be very efficient. People need to be educated about energy use and today's options and we need to develop more efficient technology for tomorrow.

The Strategy bears the unmistakable imprint of the approach taken by Admiral Watkins. What it may lack in coherency, it may make up in balance, flexibility and realism. A great deal of useful analysis has been done in the course of this work. The Nation is in a much better position to understand its energy needs. The Strategy does promise to avoid increasing our dependence on imported oil. It promises to protect our environment. It proposes to expand domestic supplies of oil, gas, coal, nuclear and renewable power. It proposes to encourage conservation and increase efficiency. It recognizes the important role of research and development. Reaching consensus on energy policy, implementing it and carrying it out are among my highest priorities.

I, too, look forward to our meeting at the National Academy of Sciences in April.

Sincerely yours,

D. Allan Bromley
D. Allan Bromley
Director

Dr. J. David Jackson
430 Vermont Avenue
Berkeley, California 94707-1742

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120203

FROM: HALL, DARWIN C.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/02/91

SUBJECT: CONTEMPORARY POLICY ISSUES (THE UNCERTAINTY OF COSTS
DUE TO POLICIES TO REDUCE CO2)

ASSIGNED TO: Dr. Wong

ACTION REQUIRED: DIRECT REPLY

SENDER'S DUE DATE:

OSTP DUE DATE:

02/08/91

DATE COMPLETED:

2/6/91 by KFE

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

DATE RECEIVED: 01/19/91

FILE: ENERGY

P-Physical Sciences -

"CORRESPONDENCE TRACKING"

TYPE: ACTION

DOCUMENT NUMBER: 9120203

FROM: HALL, DARWIN C.

TO: DR. BROMLEY

DATE OF
CORRESPONDENCE: 01/02/91

SUBJECT: CONTEMPORARY POLICY ISSUES (THE UNCERTAINTY OF COSTS
DUE TO POLICIES TO REDUCE CO2)

ASSIGNED TO: Nancy Maynard

ACTION REQUIRED: DIRECT REPLY

SENDER'S DUE DATE: OSTP DUE DATE: 02/08/91

DATE COMPLETED: -----

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #:

CONTACT PERSON:

REMARKS:

*No Action req'd. they are
just offering a free copy of
a report WSB 3/26/91*

DATE RECEIVED: 01/19/91

FILE: ENERGY

P-Physical Sciences

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

February 6, 1991

Dear Dr. Hall:

Thank you for sending reprints of two of your recent articles on energy technologies to Dr. Bromley. They were referred to me, and I read them with interest -- especially in view of my current preoccupation with related issues on behalf of OSTP.

I might offer just one or two comments on your relative cost tables. It is our hope and expectation that at least some technologies will make significant gains in relative cost effectiveness in the future, either as a result of R&D or for other reasons. Secondly, I was interested to read in the January issue of Mechanical Engineering that the cost of producing nuclear power in France will fall to 0.22 francs per kilowatt-hour in the 1990s, significantly below the estimate of 0.28 francs per kilowatt-hour produced by a desulfurized coal plant.

Sincerely,



Karl A. Erb
Assistant Director
for Physical Sciences and Engineering

Professor Darwin C. Hall
Editorial Office
Department of Economics
California State University
1250 Bellflower Boulevard
Long Beach, California 90840-4607



9/20203

Contemporary Policy Issues

A journal of
Western Economic Association
International

Editorial Office
Department of Economics
California State University
Long Beach

Editor

Eldon J. Dvorak
CSU, Long Beach

Coeditors

Alejandra C. Edwards
CSU, Long Beach
Darwin C. Hall
CSU, Long Beach
Robert J. Michaels
CSU, Fullerton

January 2, 1991

Dr. D. Allan Bromley
Assistant to the President for Science and Technology
Director, Office of Science and Technology Policy
The White House
Washington D.C. 20503

Dear Dr. Bromley:

I read with interest your essay, "The Making of a Greenhouse Policy," Issues in Science and Technology, V.7, N.1, Fall 1990.

You rightly focused on the uncertainty of costs due to policies to reduce CO₂. My own articles, presented at the 64th Annual Conference of the Western Economic Association International, have something to add on that aspect of CO₂ policy. I enclose reprints:

"Preliminary Estimates of Cumulative Private and External Costs of Energy," Contemporary Policy Issues, V.8, N.3, July 1990, pp. 283-307.

Amy L. Walton and Darwin C. Hall, "Solar Power," Contemporary Policy Issues, V.8, N.3, July 1990, pp. 240-254.

These two articles are part of an entire special edition devoted to the economic issues involved. I enclose a brochure describing this edition. I invite you to request from me a complimentary copy.

Sincerely,

Darwin C. Hall
Coeditor and Professor