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**DETERMINATION OF TECHNOLOGY TRANSFER
REQUIREMENTS FOR ENHANCED OIL RECOVERY**

**A Study of the Data Needs of the Oil Industry
and Other Users of EOR Technical Information**

Final Report

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ABSTRACT

Spears and Associates, Inc. conducted a detailed field study to determine the technical information needs of current and potential users of enhanced oil recovery data. Under the direction of the Bartlesville Energy Technology Center (BETC), the study (1) identifies groups which have a need for EOR-related information, (2) delineates the specific information needs of each user-group, and (3) outlines methods for improved transfer of appropriate information to the end users. This study also assesses attitudes toward the EOR-related efforts of the U.S. Department of Energy (DOE) and the BETC, and the role each should play in facilitating the commercialization of EOR processes. Spears and Associates surveyed more than 300 users and potential users of EOR information. Included in the survey sample were representatives of major oil companies, independent oil companies, engineering consulting firms, university and private research organizations, financial institutions and federal, state, and local policy-making bodies. In-depth questionnaires were specifically designed for each group. This study analyzes each group's position pertaining to (1) current level of EOR activity or interest, (2) current and projected EOR information needs, (3) assessments of the BETC's current information services and suggestions for improvement, (4) delineation of technical and economic constraints to increased EOR activity, and (5) steps the DOE might take to enhance the attractiveness of commercial EOR operations.

PREFACE

This report has been prepared for the U.S. Department of Energy's Bartlesville Energy Technology Center under contract No. DE-AC19-78BC00050. Information contained in this report fulfills the scope of work defined in Tasks I and II of the subject contract:

Task I: Identify user targets for DOE developed EOR technology and determine data requirements of divergent groups having interest in EOR.

Task II: Using case models developed in Task I, identify possible non-process constraints and determine the DOE's role in interfacing responsibility in Technology Transfer. Determine the feasibility of a DOE Technology Transfer Center to control and coordinate EOR technology/information dissemination related to achieving EOR goals.

Responsibility for the interpretation and opinions expressed herein rests with Spears and Associates, Inc., as contractor to the U.S. Department of Energy.

Valuable assistance was provided by numerous experts from the petroleum industry, government agencies and the other groups which are likely to have a significant impact upon the commercial application of enhanced oil recovery techniques.

The principal authors thank all those who supported and assisted in the collection of data and in the shaping of this report. The authors, of course, retain responsibility for any errors in interpretation or fact.



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INTRODUCTION

Under the direction of the Bartlesville Energy Technology Center (BETC), Spears and Associates has completed this study of the technology transfer process as it relates to enhanced oil recovery (EOR). The primary tasks involved were as follows:

1. Identify target user groups of technical EOR information.
2. Determine the specific information requirements of each group.
3. Recommend methods for improving the technology transfer process.

As a second and closely allied task, this study was also designed to uncover attitudes within each potential user group toward the role of the Federal Government in facilitating the commercialization of EOR.

A third major task also undertaken as part of this contract was to develop a handbook of environmental regulations affecting enhanced oil recovery projects. This handbrok, compiled in a language and format which make it a useful tool for personnel involved in on-site EOR field operations, has been completed and delivered to BETC's Environmental Compliance Division.

This report will discuss the results of Tasks 1 and 2 (as outlined in the Preface).

BACKGROUND AND METHODOLOGY

To obtain the data necessary for this analysis, Spears and Associates conducted a multi-segmented survey of more than 300 users, and potential users, of EOR information.

To assure data quality and access to EOR decision-making respondents, the data-gathering effort was conducted by Spears and Associates' market research interviewing team composed of experienced field consultants (geographically located in key oil producing regions) and analysts and executive consultants from Spears and Associates' Tulsa staff. The number of personal interviews with EOR information users (by category) is as follows:

<u>CATEGORY</u>	<u>INTERVIEWS</u>
Major oil producing companies	41
Independent oil producing companies	93
Oil field service and supply companies	21
Engineering consulting firms	24
Chemical suppliers	19
Financial institutions	32
Federal, state and local policy making bodies	52
Universities involved in EOR research	20
Environmental and consumer organizations	<u>8</u>
TOTAL	310

In-depth interview discussion guides were prepared for each group. Included in each survey instrument were questions designed to meet the following data-gathering objectives:

- Determine the respondent's current level of EOR activity or interest.
- Identify both current and future EOR-related information needs.
- Assess BETC's current information services in relation to the respondent's data requirements.
- Identify technical, economic and institutional constraints to increasing activity or acceptance of EOR processes.
- Recommend steps or courses of action DOE might take to accelerate commercial EOR operations.

Interview candidates were selected on the basis of their known interest in EOR or their companies' estimated resources with EOR potential. Independent oil producers are the most difficult group to pre-qualify and were selected at random from areas expected to have high EOR potential. Whenever possible, interviews were conducted with only those companies believed to have reserves or resources adequate enough to warrant an enhanced recovery project. Within each user segment, we have examined four key elements required to make a commitment to EOR:

- What considerations or concerns must be addressed?
- What types of information are required to address these concerns?
- What or who is the source of this information?
- Who makes the decision?

Throughout the data gathering phase, discussions were held with senior management officials who were knowledgeable of EOR technology and are, or might be, instrumental in establishing or implementing their companies' EOR goals and programs. Interviews with these decision makers were quite productive, lasting an average of 60 to 90 minutes. Special accommodations were made in many instances to provide thoughtful input to our inquiry. Many interview sessions involved three to five participants.

A pretest was conducted in March and April, 1979, to determine the validity of the survey instruments. Work on the full survey began in May, 1979, and was completed in early September. Tabulation and preliminary analysis of data was initiated in June and was completed in September. The graphs and user group profiles in the Statistical Analysis section give full details of the results of the survey.

EXECUTIVE SUMMARY

OIL PRODUCERS

- o The level of EOR activity is greatest in major oil companies, which have substantially more technical and financial resources than independents and can better afford to undertake EOR pilot research programs. Over 90 percent of the major and integrated oil producers are actively exploring EOR potential, while over half of the independents are still only generally aware of the state-of-the-art.
- o Most independent oil companies do not have the technical or financial resources to undertake EOR projects. Of those which have started such projects, the majority have been able to do so only because of DOE cost-sharing programs. Less than 10 percent of the overall independents (and only 15 percent of the larger independents) are involved in EOR projects. Nearly all of these involve thermal processes. Most of the remainder are several years away from commercial operation. Less than half have screened their properties.
- o Interest and involvement among both major and independents knowledgeable of EOR is increasing rapidly (particularly in the more mature processes, such as thermal and CO₂).
- o Information constraints to commercialization include:
 - There is no central source for EOR data
 - The data are too voluminous
 - Production histories of commercial application are not available.
 - Cost factors are seldom addressed in the literature.
 - Many critical decision makers are unaware of state-of-the-art technology.

- o Other constraints to commercial EOR projects are:
 - High front-end capitalization costs
 - Competing uses for corporate funds
 - Capital formation problems for independents
 - Uncertainties of materials cost and supply when required
 - Field unitization problems (multiple ownership complicates incentives)
 - Lack of technical expertise among smaller companies
 - Inadequate incentives to offset the high risks involved
 - Uncertain time frame for return on investment (too long for independent involvement)
 - Lack of clear federal policies regarding price, tax, etc.
 - Environmental regulatory restrictions

- o Overcoming these restraints will require that one or more of the following actions be taken:
 - Special tax incentives
 - More EOR R&D
 - Incentives to "pioneer commercialization"
 - Loan guarantees
 - Price assurance or margin guarantees
 - Easing of regulatory restrictions

- o Independents don't own large fields or blocks of wells. Most have only working interests in geographically dispersed areas. Rather than one company controlling the reservoir, several blocks of multiple ownership leases may exist. Since commercial EOR operations will require full-field application, this could become a major impediment.

- o Majors are primarily concerned with the economic restraints imposed by uncertain price, cost of materials and operation and environmental control. They are on the verge of commercial application but lack only the right incentives.

Independents are further behind on the scale of involvement. Many are unaware of the technical aspects of EOR. The primary constraints to independents appear to be 1) lack of technical expertise and manpower, 2) lack of suitable properties, 3) inability to meet capital formation requirements.

- o EOR information requirements do not appear to have uniformity, at least between major and independent. This is perhaps due in part to the many hats which employees of independent oil companies must wear. Nearly 30 percent of the major/integrated group have EOR specialists, while independents rely upon their regular production engineer to keep abreast of EOR developments.
- o Final decision to undertake an EOR project is rarely made at a technical level. In all producer categories, this decision is made at the highest levels of managerial authority. Often, this level was also the one that decided to initiate the exploratory phase of EOR.
- o By and large, decision level determines data needs:
 - Researchers and engineers want more technical data.
 - Operations managers want feasibility inputs.
 - Top management want bottom-line assessments.
 - To meet these varied data needs, specialized publications may be necessary.
- o Most producers expressed a need for more lithological data on reservoirs being tested for EOR. Special reports containing this information would be well received among the technical community.
- o Technology transfer has traditionally been accomplished through technical journals which (among all producers) are the most highly regarded source for technical information.

- o However, technical journals are the least preferred source for other critical types of EOR information, such as:
 - Economic considerations
 - Environmental requirements and costs
- o Those producers involved in pilot projects want information related to cost and availability of materials and overall economics (price, tax exemptions, return on investment, etc.).
- o Producers not currently involved (most of which are independents) want to know what the capital investment and operating costs will be.
- o Environmental protection costs do not appear to significantly affect the economic feasibility decisions of major and integrated producers. They do appear to restrict the independents, however.
- o Eighty-eight percent of the major and integrated producers currently receive BETC data, usually at the engineering or research level. The opposite is true of small independents where 84 percent do not receive BETC information. Sixty percent of the large independents do not receive BETC information.
- o Although few independents receive EOR information disseminated by BETC, after they were shown copies of the quarterly Progress Review, many independents requested to be placed on the BETC mailing list.
- o Information on EOR currently distributed by BETC is highly regarded by oil industry users. Eighty-one percent feel the Progress Review is a good technical reference source for concise state-of-the-art information.
- o Many respondents indicate the material is useful and the most timely information available on a regular basis. Some respondents (primarily technical people employed by companies with extensive EOR experience) say they would like technical and economic information on pilot projects to be given in greater detail.

- o Respondents from independent oil companies, many of whom have nothing but an academic interest in EOR, say they would like information in a more capsulized form. Special publications may be necessary to satisfy this information need.
- o Oil producers and other knowledgeable EOR information users (consultants and university reseachers) give BETC high marks for responding quickly to individual information requests.
- o Generally, BETC information assessments were related to the quarterly Progress Review (often spoken of colloquially as "the quarterly report"), which has far greater circulation than special or annual reports.
 - Survey respondents believe the quarterly Progress Review's greatest strengths are its:
 1. Usefulness as a technical reference source
 2. Concise state-of-the-art updates
 3. Timeliness
 - Respondents believe the quarterly Progress Review's greatest weaknesses are:
 1. Lack of detail (for technical users)
 2. Lack of interpretative results
- o However, EOR data is beginning to snowball. Given the complexities of EOR, a clearing house for EOR technology transfer is needed. Many oil producers expressed a desire for this center to be headquartered in Bartlesville (where they have received excellent service and felt a good rapport existed between industry and government).
- o Most oil producers (of all sizes) and other EOR information users indicate only limited utilization of external, computerized data base sources. As a result, information in hard copy (printed) form is most desired.

- o A special technical information center for EOR would receive favorable response among most oil producers:
 - Fourteen percent said that an EOR technical information center would fill a major void in the technology transfer process
 - Another 56 percent would utilize on an occasional to regular basis.
- o Over 80 percent were unfamiliar with RECON. Nearly all of those who are familiar with RECON do not utilize it. Overall, only 2 percent of the oil producers surveyed said that they use RECON.
- o Nearly three-fourths of all oil producers interviewed indicated an increase in future EOR information needs:
 - Most expressed a need for state-of-the-art and economic information related to process application.
 - Independents expressed a desire for technical interpretation or other assistance.

ENGINEERING CONSULTANTS

- o Nearly 80 percent of the engineering consultants interviewed are actively involved in EOR. One-third are acting in some consulting role to operators of the cost-share demonstration projects. Overall, consultants are well informed about the EOR cost-share program. Only 9 percent expressed no interest.
- o Because independents lack personnel with EOR technical expertise, the engineering consultant becomes pivotal to their involvement. Seventy percent said they were involved in the final decision of client producers.
- o Consultants tend to "specialize" in technical expertise. A small group of EOR "experts" appears to be emerging.
- o The consultant often is the link between the producer and the financial community.

- o Technical consultants have high technical requirements. No other segment consistently requested more detailed engineering and cost data. Many consultants are on the leading edge of EOR knowledge. While consultants consider technical journals (like JPT and SPEJ) the most reliable sources for technical data, BETC was mentioned as a primary source. Nearly 60 percent considered this source as "good" or "excellent." Many had specific praise for BETC's cooperation. Economic uncertainties are viewed by most as the biggest constraint to the commercialization of EOR.
- o Nearly half (45%) feel their future information needs will increase. Another 25 percent think that the status of EOR will determine their interest and needs. When the producers get involved, they will also.
- o Consultants knowledgeable in EOR feel that a number of reservoirs will reach the economic limits for secondary production in the next year. Evaluation of what to do with these reservoirs will escalate consulting activity in EOR over the next three years.
- o Consultants believe that commercializing EOR now will require:
 - Creative cost incentives (52 percent said special cost incentives for independents will be required).
 - Assurance of a market price sufficient to provide an acceptable return-on-investment.
 - A special technical data base (While only 10 percent now utilize a computerized data base, 80 percent said they would be regular users of a technical information center specific to EOR).

FINANCIAL INSTITUTIONS

- o There seems to be no shortage of funds to be invested in oil activity, but such funds are generally loaned only to finance proven production. Banks currently consider EOR too risky to lend money on the basis of projected production.

- o Banks indicate that they are willing to finance EOR projects through "balance sheet" loans (based on a company repayment guarantee or pledge of assets), but such terms are generally unacceptable to major oil companies and beyond the resource capabilities of most independent producers.
- o Given the uncertainties of EOR, normal banking channels will not be available to oil producers for EOR projects without some sort of loan guarantee. The only possible exceptions are thermal projects in areas of proven potential.
- o Many bankers say oil producers' best source of EOR funding is likely to be equity participation by other oil companies or refiners.
- o Seventy-four percent said that EOR loan requirements would be more strict than other petroleum loans.
- o Other than thermal, the only way banks seem willing to fund EOR projects through the commercial development phase is through some sort of government guarantee. Currently, however, strict loan requirements prohibit the funding of most EOR projects. Several bankers put it rather bluntly: "We aren't in the venture capital business."
- o Although banks new to petroleum lending have received some criticism from conservative bankers for their "loose" loan requirements, the loan practices in question have pertained to exploratory and new development ventures -- not EOR. If anything, these banks have more restrictive policies on EOR loans than traditional petroleum banks.
- o In general, bankers are familiar with the economic and technical aspects of oil production, but their understanding of EOR lags. In all cases, the traditional petroleum banks have a higher level of awareness than banks new to petroleum lending.

- o Of all banks interviewed, 67 percent have petroleum engineers on staff. Most have only one or two engineers on staff, but two banks had 8 to 10 on staff.
- o Among the 22 traditional petroleum banks, nearly 90 percent have petroleum engineers on staff. Thus, among these banks, there is a high understanding of current production methods.
- o Bankers rely heavily on trade journals (primarily the Oil & Gas Journal) for information on EOR. Other banking and technical journals are also important sources. In contrast, only 7 percent of the banks interviewed receive information from BETC.
- o Most banks requested some sort of summary state-of-the-art data since they relied upon engineering reports supplied by either the customer or a consultant when analyzing a specific development project.
- o Banks new to petroleum project financing have an even more basic knowledge of EOR. These banks have no petroleum engineers on staff. They rely on consultants to fulfill their technical review requirements. As a result, state-of-the-art summaries of EOR technology would be even more useful to these banks.
- o Since the customer provides production and reservoir data, most bankers felt they might need more detail on how a process reacts under certain reservoir conditions.
- o While most bankers indicated they were generally unfamiliar with DOE programs, over three-fourths indicated they wanted to learn more.
- o Although only 11 percent of the banks interviewed had made loans on EOR projects (all thermal), more than half anticipated making EOR project loans in the future.

- o When the time comes for banks to participate in EOR funding, traditional petroleum banks anticipate a need for detailed engineering and cost data. Many felt they would need a source for impartial data to compare to customer expectations. Some indicated DOE could fulfill this need.
- o Seventy-five percent (75%) said they would utilize an EOR technical information center for such a purpose.

OIL FIELD SERVICES

- o Most oil service and supply companies are aware of state-of-the-art technology but have not undertaken their own research into technical application of EOR techniques. Only 14 percent are conducting research which includes EOR application.
- o Service companies strongly indicate that EOR does not involve processes or equipment which they do not currently utilize. The difference is that EOR operations require greater precision.
- o While only 14 percent are involved in specific EOR research, 70 percent have provided a service to a customer's EOR project. Over half of this experience was in miscible gas.
- o Service companies are very protective of proprietary data, yet over 80 percent indicated they would be willing to work with DOE if the question could be resolved. Eighty-eight percent did not view this as a constraint.
- o Over 90 percent of those interviewed perceive their products or services to be adequate to meet the demands of EOR. One-half would not anticipate altering their techniques. Most of the others would anticipate only a more critical processing of data. The exception to this would be among reservoir or well analysis services, where special tooling may be necessary.

- o Major oil producers are the current source of EOR expertise for service companies.
- o While over two-thirds are familiar with the DOE cost-share program, only 29 percent receive information on a regular basis. Most do not view themselves as principal beneficiaries of technology transfer now.
- o However, 75 percent do see their information needs increasing significantly when commercial EOR projects are started. Of these, nearly three-fourths would utilize the EOR technical information center regularly. (None had heard of RECON.) Service companies see no constraints in their operations which are specific to EOR.

CHEMICAL SUPPLIERS

- o Nearly 80 percent of the chemical companies expresses a "very high" awareness of EOR technology. The remainder felt they had a "high" understanding, indicating that chemical companies are keenly interested in the technical progress being made in chemical processes.
- o Seventy-four percent receive BETC publications regularly.
- o Most chemical suppliers have viewed the progress in chemical EOR with active interest, but have not chosen to undertake their own research in EOR. Instead, they prefer to respond to demand from oil companies.
- o Most chemical suppliers are taking a "wait and see" stance with regard to EOR. Perhaps, this is because oil field chemicals represent only 1 percent of total chemical industry sales -- and EOR specialties only about 1 percent of that.
- o With technology for chemical EOR processes lagging behind expectations and current sales of EOR chemical specialties virtually non-existent, large scale capital commitments generally have not been made for increasing capacities to accommodate future demand for EOR chemicals.

- o Because two to three years is required for expansion of present capacity or the construction of new plants, bottlenecks in the supply of chemicals could develop if activity in chemical flooding were to increase suddenly.
- o All the findings reflect the near-term uncertainty most chemical suppliers associate with EOR.

UNIVERSITIES

- o Virtually all university researchers interviewed:
 - Have an active interest in EOR technology (95%).
 - Concentrate their work in basic laboratory research (95%).
 - Indicate that their work is limited by lab space, time, manpower and funding constraints (67%).
 - Need technically detailed information (100%).
- o The types of additional technical information most frequently mentioned were:
 - Technical reports specific to both reservoir and process.
 - More maps, charts and other graphic displays.
 - Detailed cost factors.
- o The vast majority (84%) of those surveyed use BETC as a primary source of EOR data.
- o Most want easier access to bibliographic sources.
- o Eighty-four percent also saw need for a specialized EOR information center.

- o Over half felt it would fill a major void in the technology transfer process or be a regular source of EOR information.
- o Like other user segments, university researchers also want data from non-DOE projects (primarily lab data).
- o While over 70 percent felt their information needs would remain unchanged during the next year, nearly two-thirds felt they would increase over the next three years.

STATE POLICY GROUPS

- o Officials of state regulatory agencies are more familiar with the oil industry than state legislators.
- o Officials in "oil states" rank highest in terms of technical expertise.
- o Even in "oil states," EOR awareness lags.
- o Nearly all expressed a desire to learn more.
- o State legislators obtain information regarding oil production primarily from non-technical data sources, such as:
 - Oil companies
 - Special interest groups
 - Public hearings
 - Constitutents
 - Government reports
 - Trade journals

- o Few receive BETC data regularly.
- o Nine-five percent of the legislative members contacted did not receive data now being disseminated, but 90 percent asked to be added to quarterly Progress Review distribution.
- o Forty-two percent of the administrative officials were not currently receiving DOE data but 84 percent asked to be added to the mailing list).
- o Ninety percent of the administrative officials and 100% of the legislators would utilize an EOR technical information center. The overwhelming majority felt they needed only summary-type information which could keep them abreast of the developing state-of-the-art.
- o The majority of the state officials indicated that they were concerned with environmental aspects of EOR.
- o The most frequently mentioned solution to oil production constraints was more consistent federal policy.

FEDERAL POLICY GROUPS

- o Federal policy groups are the most important information user group outside the oil industry. Federal policy makers represent a pivotal force in the commercialization of EOR.
- o In Washington, technical understanding of oil production is low.
- o All federal policy makers (or their staff members) expressed a desire for more information about EOR.
- o Federal policy-makers do not want -- nor could they use -- mountains of technical data.

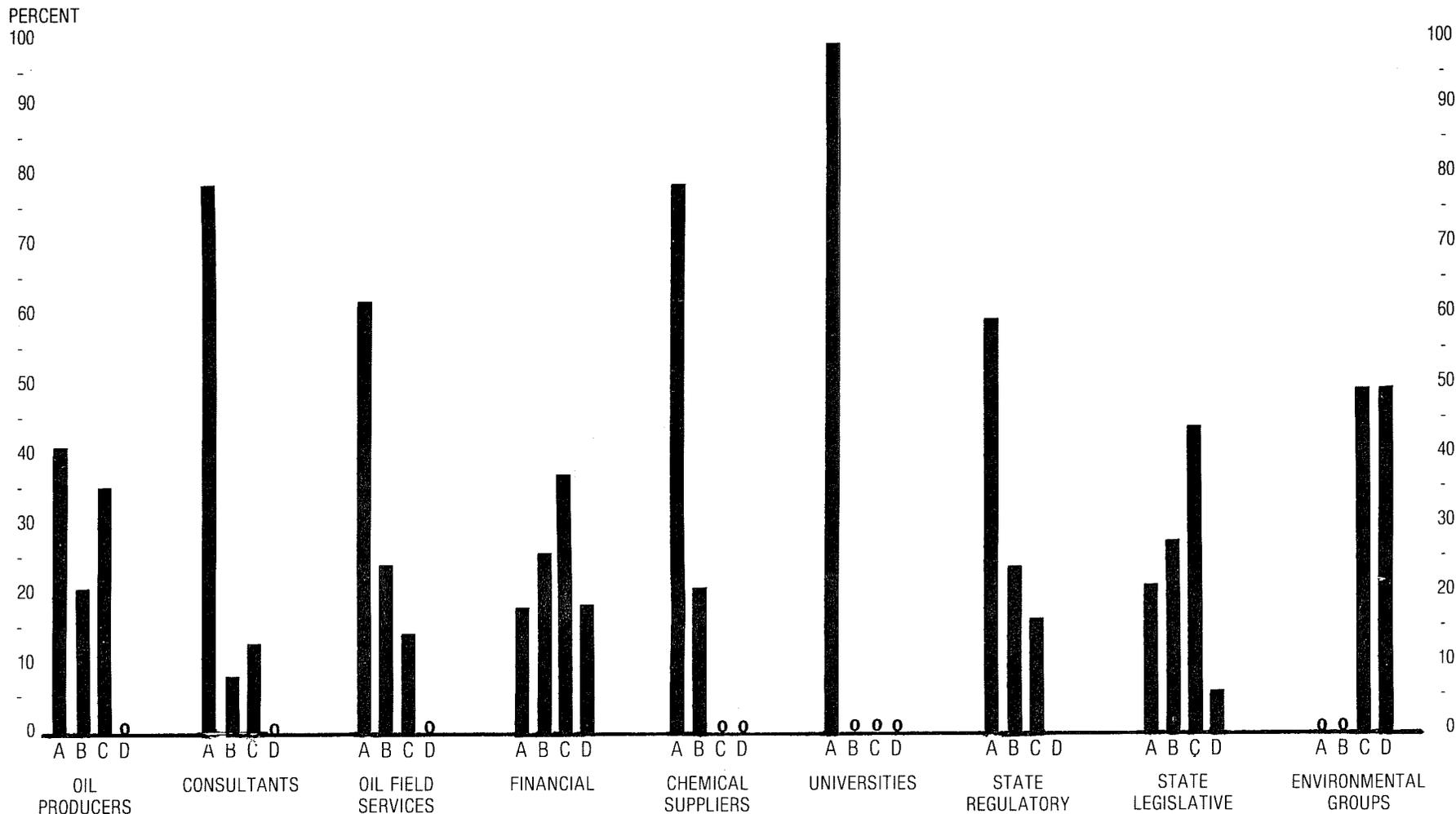
- o They need bottom-line assessments that can be applied to policy decisions.
- o As a minimum, members of Congress need information concerning:
 - Complete descriptions of the process being developed, its advantages and disadvantages (as they relate to national needs).
 - The practical limits of the process and its risks, either in terms of technical uncertainty or special problems associated with its applications. Environmental concerns are an example.
 - The cost of assuming these risks, both monetary costs and the cost to the general welfare (such as trade-offs with environmental protection and energy produced).
 - The expected effect the process will have on incremental production of fossil energy and its relation to other potential energy sources. This is a necessary assessment in determining the cost effectiveness of one program against another or the overall cost of total energy produced.
- o Federal policymakers identified four major types of constraints, which can be categorized as follows:
 1. Lack of Understanding: As a whole, members of Congress have very little knowledge of the technical or economic aspects of petroleum production (especially with regard to tertiary techniques). However, this should not be confused with a lack of desire to know. During the course of our inquiry, we received excellent cooperation from members of Congress and their staffs. Many times special arrangements were made to accommodate our interviewers.
 2. Too Much Conflicting Data: There is no lack of information. If anything, there is too much. The varied special interest groups -- from all points of the political spectrum -- provide abundant quantities of data which often conflict and must be evaluated before making decisions on public policy.

3. Satisfying Constituents: Success or failure of much of the program requires the support of the federal government through economic incentives or financial guarantees. Economic incentives directed at accelerating domestic oil production could be offset by other measures aimed at reducing excess profits or concern for environment. Constituent pressure is being placed on federal policy makers to effect policies which will produce more energy, yet because the public, as a whole, does not understand the problems involved, they support restrictive measures aimed at controlling the above concerns.
 4. Political Realities: Congress seldom moves in concert. Therefore, getting legislation favorable to accelerated commercialization may be beyond the realm of political reality.
- o The federal government could have major effect on the commercialization of EOR for the following reasons:
- Any enhanced oil recovery project involves large capital expenditures combined with high risk and uncertain return. Incentives are required to offset these negative influences before near-term commercialization can be expected. These incentives may be in form of tax credit, loan guarantees, decontrolled prices or other measures which would assure acceptable return on investments.
 - Environmental policy must address the health and welfare of the nation in terms of contamination control and energy production.
 - Budget allocations must continue to support field demonstration and commercialization efforts (including the technology transfer system) in order to accelerate the acceptance of new technologies which will enable DOE to reach its incremental production goals.
 - Large amounts of historical field data are still required before wide-spread acceptance and application of EOR will occur. These data must be generated, collected, assembled, and disseminated through various media.
 - The Federal Government (through the Executive, Legislative, and Judicial branches) can directly affect the national mood. This can, in turn, provide either incentive or disincentive for the commercial development of EOR processes.

ALL SURVEY RESPONDENTS

Exhibit 1

Level of EOR Activity or Awareness of EOR State-of-the-Art*



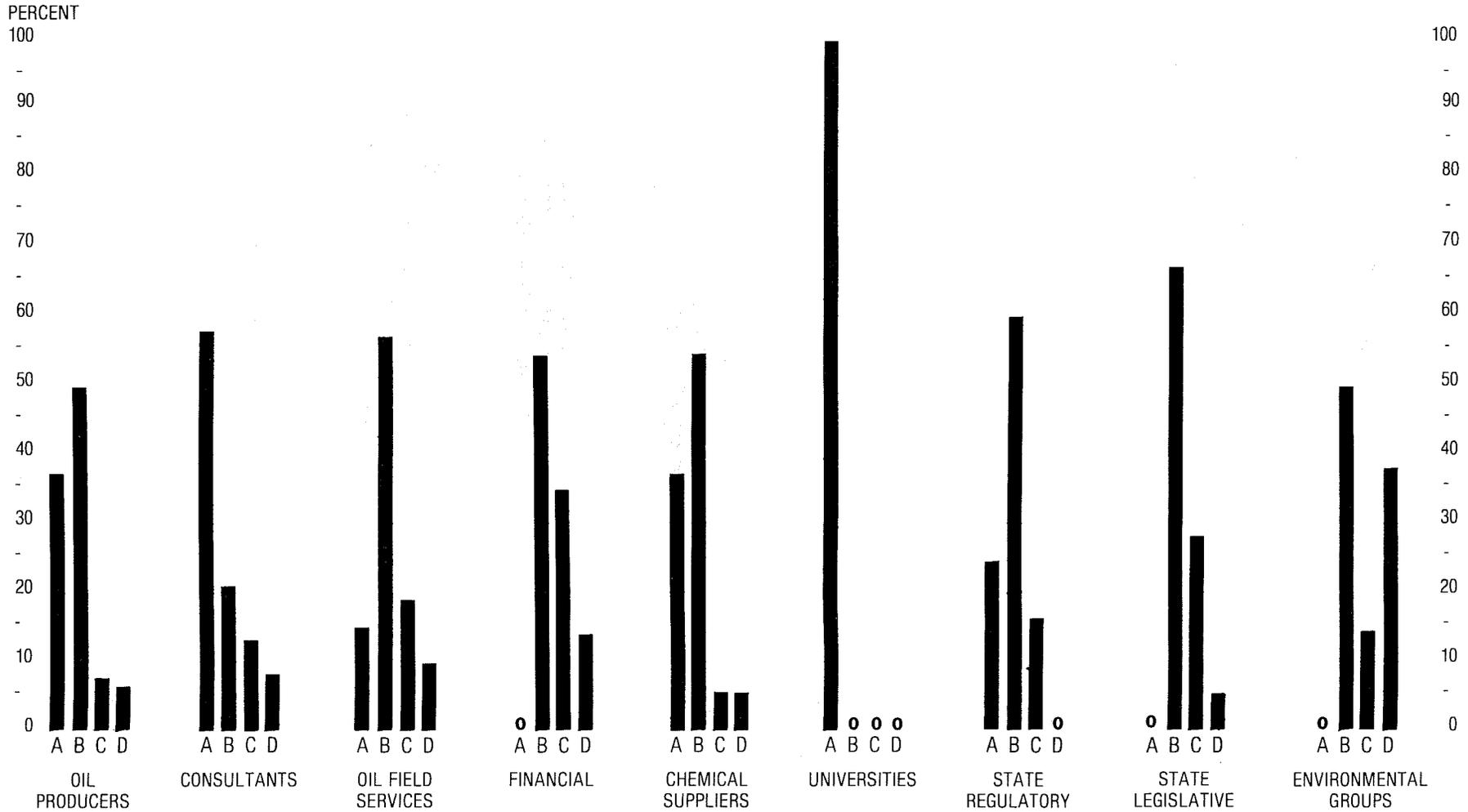
*Respondents were asked to rate their own level of EOR involvement. Producers rated their level of EOR activity. All other groups rated their level of awareness of EOR technology.

A = Highly Involved or Aware
 B = Actively Interested
 C = Generally Aware
 D = Not Interested or Aware

ALL SURVEY RESPONDENTS

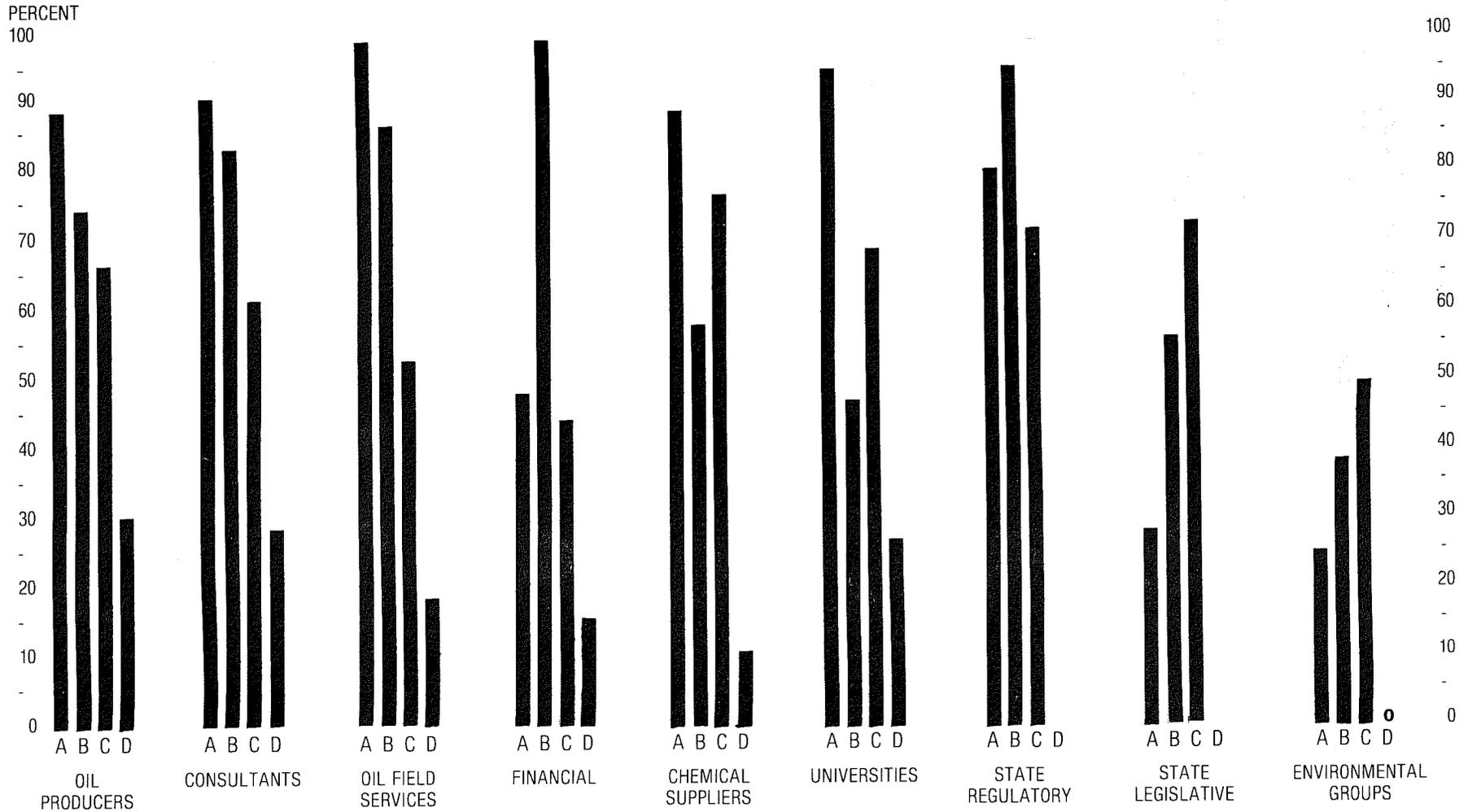
Exhibit 2

Familiarity with DOE Cost-Share Program



A = Well Informed
 B = Some Familiarity
 C = Not Familiar, But Want To Be
 D = Not Familiar, Have No Interest

ALL SURVEY RESPONDENTS
Exhibit 3
Sources of Technical EOR Information



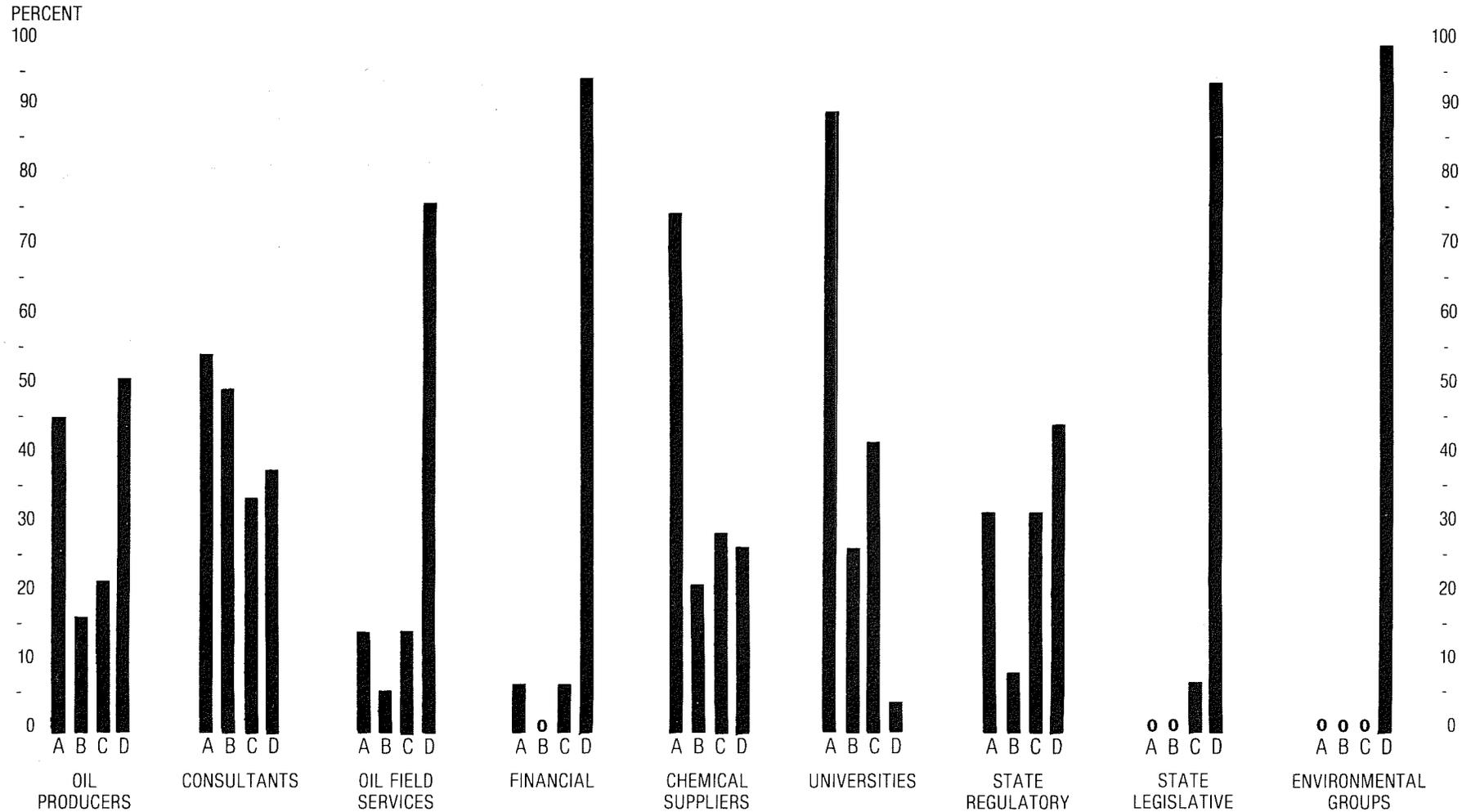
*Respondents not asked about their use of computer data bases.

A = Technical Journals
B = Trade Journals
C = Seminars and Conferences
D = Computer Data Bases

ALL SURVEY RESPONDENTS

Exhibit 4

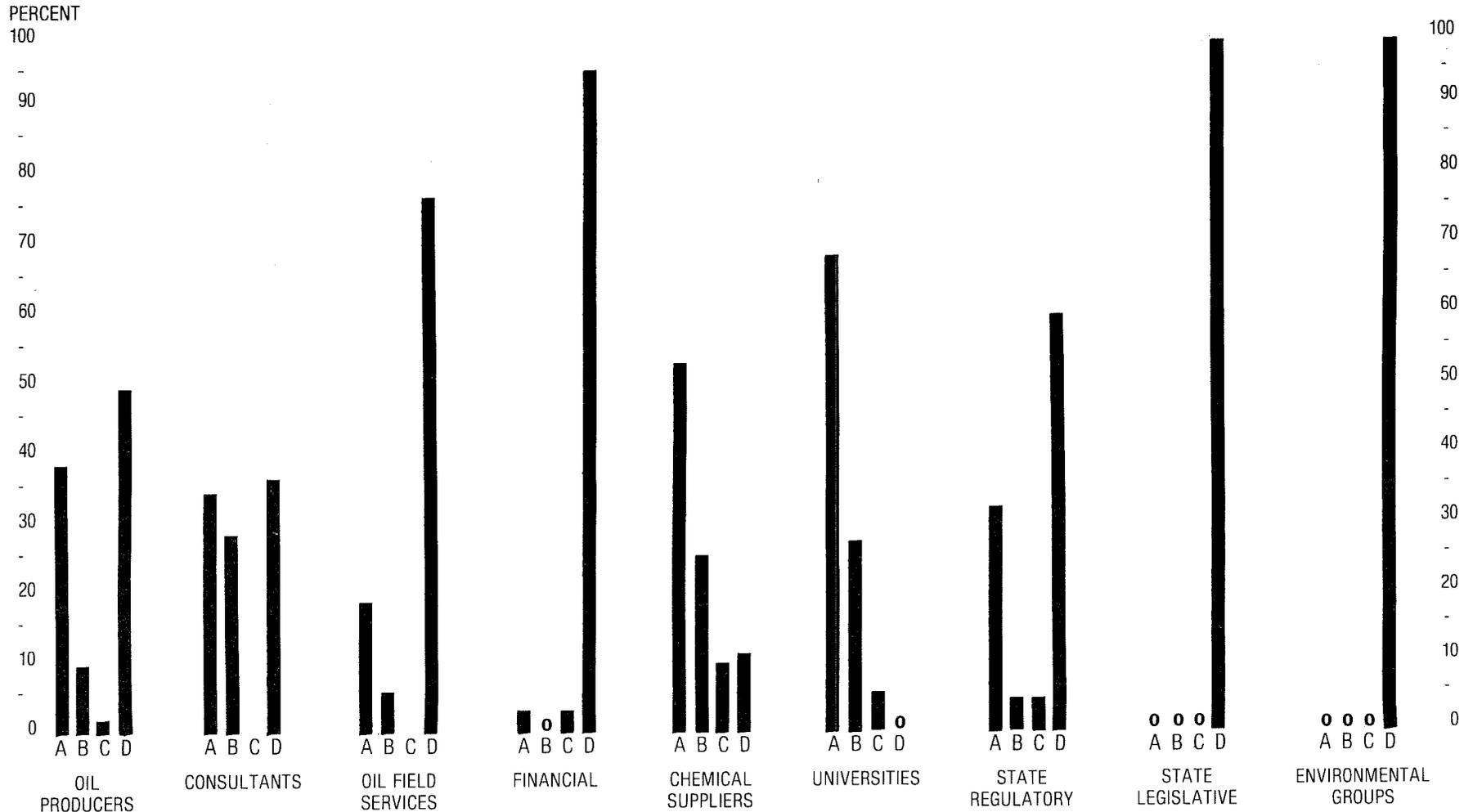
Types of EOR Information Received from DOE



*Includes monthly reports, special reports, regulation information, and newsletters.

A = Quarterly Report
 B = Annual Reports
 C = Other Information*
 D = None

ALL SURVEY RESPONDENTS
 Exhibit 5
Assessment of EOR Information from BETC

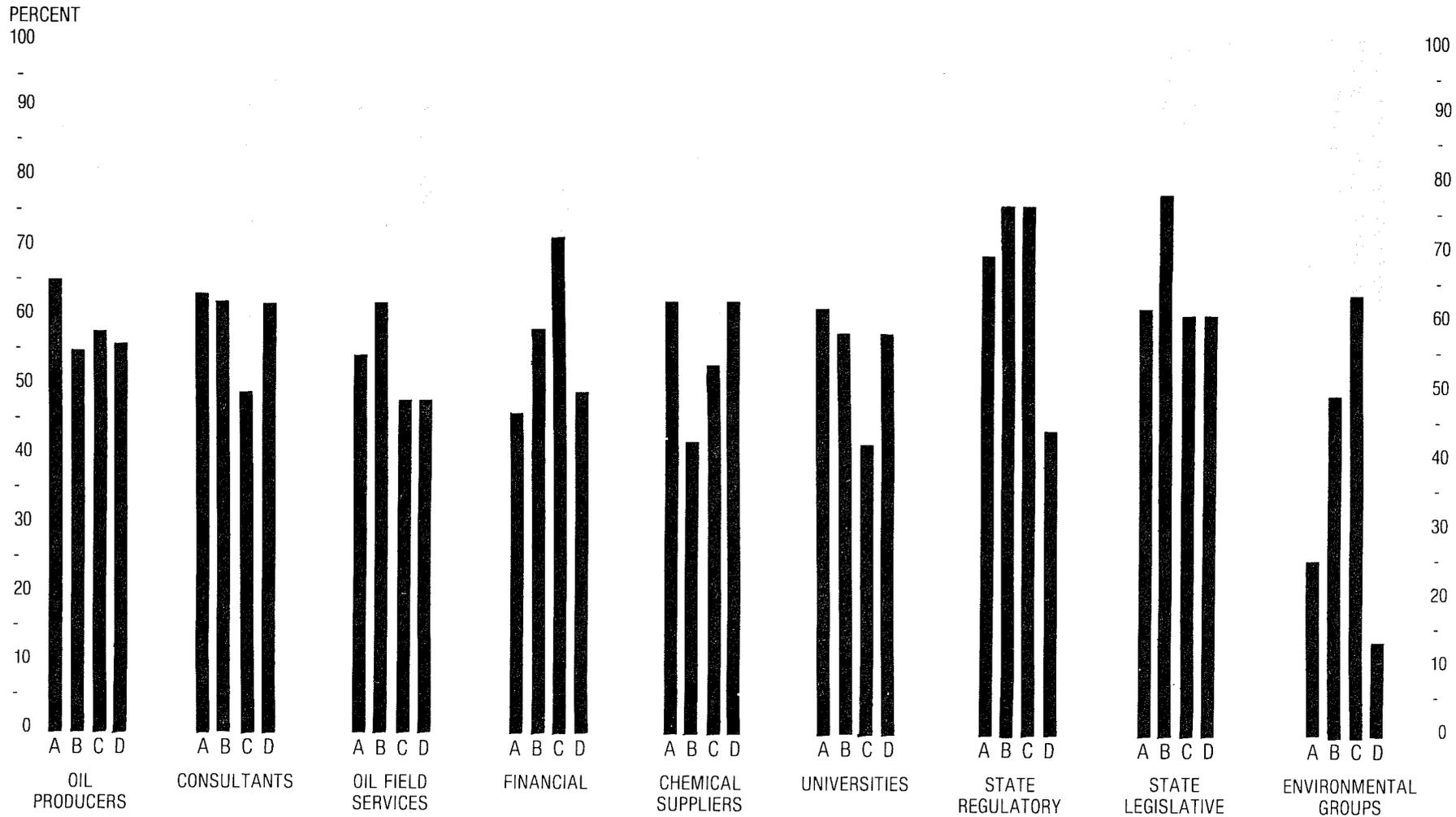


A = Excellent/Good
 B = Fair
 C = Poor/Of No Use
 D = Not Familiar

ALL SURVEY RESPONDENTS

Exhibit 6

Types of EOR Information Desired from BETC

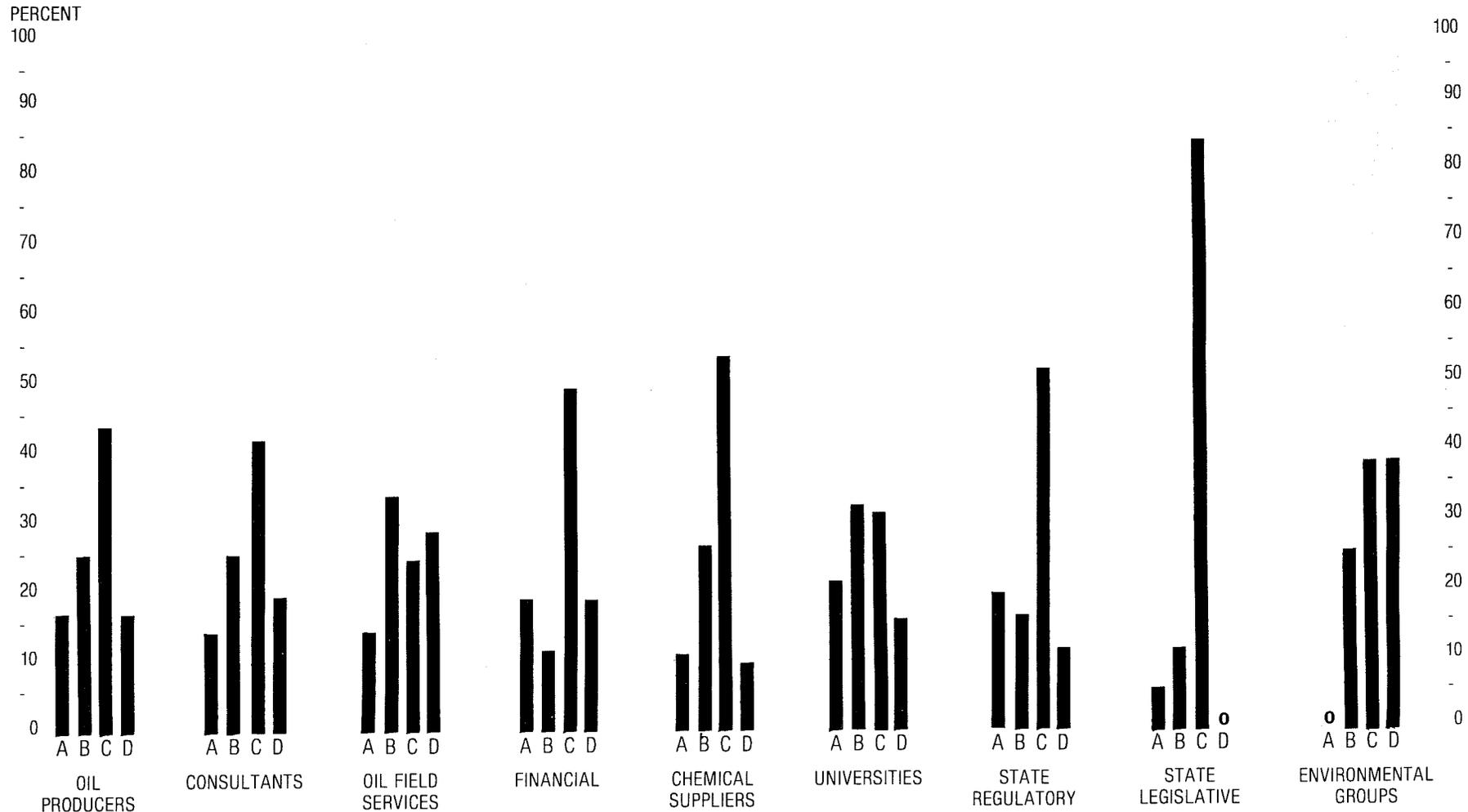


A = Detailed Technical Reports
 B = Quarterly Reports
 C = State-of-the-Art Summaries
 D = Detailed Cost Factor Analyses

ALL SURVEY RESPONDENTS

Exhibit 7

Usefulness of EOR Technical Information Center



A = Would Fill Major Void
 B = Would Be Regular Source
 C = Would Be Occasional Source
 D = Would Not Use

THE CURRENT STATUS OF EOR

Making a commitment to begin an enhanced oil recovery project involves many decisions and organizational levels within a given company. Since EOR is a developing technology, an oil company's EOR status can be easily determined by identifying the level of its current involvement. For the purpose of this study, Spears and Associates has identified six levels of involvement ranging from a limited awareness of the state-of-the-art (Pre-Involvement) to operating a commercial-scale EOR project.

Within each phase, critical decisions are made at various organizational levels which affect the movement of the project through the various phases. By identifying the type of decision which must be made, and who will make that decision, information needs can be categorized and a more effective transfer of technology accomplished.

We have divided the progression from "unaware of EOR" to "full-scale commercial operation" into six distinct phases, as follows:

<u>PHASE</u>	<u>ACTIVITY</u>
Pre-Involvement	Develop Awareness of EOR
Phase I	Property Screening
Phase II	Pre-Pilot Evaluation
Phase III	Pilot Testing
Phase IV	Commercial Development
Phase V	Continuing Commercial Operation

These phase breakdowns are the result of an analysis of more than 130 interviews with engineering and management personnel in more than 100 oil companies. Although each producer company performs these separate tasks in its own particular manner, all companies must go through these six stages before they will be prepared to undertake an EOR project on a commercial basis.

As a result, the technical and economic considerations involved in each phase of EOR are common to all oil producing companies, regardless of size. The process of analyzing the technology transfer requirements of EOR and the role DOE should assume in the commercialization of EOR becomes significantly easier when viewed in this manner.

The Oil Producers Critical Decision Model outlines each step in the commercialization process. In addition, it outlines:

- o The primary recipients of EOR information
- o Their specific information needs
- o The interaction with ancillary groups (such as banks and oil field service companies)
- o The major constraints involved in each phase
- o The optimum role DOE could assume for technology transfer, research and development, and regulatory interaction.

The EOR Decision Flow Chart traces an EOR project through the various phases. This chart depicts a typical organization of a large or major producer. While small independents may not have the same organizational structure, the decisions identified in each phase will be applicable to any size producer.

Because EOR is so capital intensive and requires extraordinary risk consideration, any EOR project becomes a "boardroom decision" involving top-level management support from initiation to exploratory investigation to commercial operation.

By analyzing the responses from our indepth interviews, we have categorized, by level of involvement, the companies that were a part of our survey. The Current Status of EOR Involvement table shows our assessment of the distribution of the major, integrated and independent oil companies in the six phases of EOR involvement. Although these percentages were derived only from the oil companies in our survey, we believe they can be applied to the entire domestic oil industry. This is particularly true of the Majors and Integrated category, in which our sample of 25 companies covers virtually the statistical universe of this category. Percentages for Large Independents and Small Independents are statistically less significant. However, our company's 15 years of experience in oil industry-related research leads us to believe that the percentages for those two categories would be essentially accurate if expanded to include all independent oil producers.

By comparing the results of this table with the major constraints to EOR involvement expressed by oil producers, it seems likely that those companies which are currently in Phase I or the Pre-Involvement Phase will not undertake greater EOR involvement in the near future -- if ever.

For a small percentage in those two categories, technological breakthroughs or added economic incentives (such as decontrolled oil prices, tax incentives, or loan guarantees) may provide sufficient encouragement for them to progress along the path of EOR involvement. However, because many have properties which are not suitable for EOR, they will never become involved in EOR.

In addition, the essentially short-term, high payoff orientation of American independent oil producers must be recognized.

"Independents" are collectively a wide assortment of organizations -- from one man firms operated out of an automobile and a motel room -- to a structured, well staffed, smooth-running organization.

Generally, larger independents are not very interested in EOR except perhaps the more mature technologies -- CO₂ and thermal. While the history of waterflood shows that larger independents were among the first to get involved, one must remember that waterflood was a comparatively simple process and payback began within a period of months.

If the independent is to get deeply involved in EOR, several things must happen and he must feel good about them:

1. He wants to know what the price of oil and gas will be. He is against government control and doesn't trust his long-term welfare to the political process.
2. He first needs help understanding the economics of EOR. This is a boardroom decision where the technician will have little voice. Management will act first on "favorable" economic evaluations.
3. DOE should provide supporting data and one-on-one personal explanations of EOR, explaining the economics and technology at the same time to the same person. In addition to the independent producer himself, his banker and his consultant also should be included in such meetings. This effort should focus on the mature technologies (CO₂ and thermal) with shortest payback. Target companies should be chosen carefully.
4. Immediate involvement should not be expected.

With few exceptions, independents are "drilling" oriented. They drill, hopefully find oil or gas, and -- again with exceptions -- prefer to sell proven production to larger companies equipped with the organizational structure to operate the properties.

Long-term payout (over 5 years) is very foreign to the kind of business propositions most independents want to consider. They prefer high risk, quick payback ventures (like wildcatting) that payoff quickly and profitably. Sophisticated discounted cash flow calculations (which are so important in the operations of major oil companies and other large corporations) have little place in the decision-making process of independent oil producers. From our experience, independents seldom purchase equipment that will not pay for itself in approximately 24 months. For development projects, the payout period may be longer, but would still be substantially less than that required for EOR.

Drilling funds, which account for approximately one-third of the wells drilled by independents, attract investments from doctors, lawyers, etc., who are likewise looking for early results -- or an opportunity for a quick tax write off. This orientation toward drilling can be seen in the table below.

U.S. DOMESTIC DRILLING AND PRODUCTION
(All percentages are approximations)

	<u>Largest 25 Companies</u>	<u>Next 75 Largest Companies</u>	<u>All Other Companies</u>
Percent of wells drilled	15%	22%	63%
Oil production	65%	5%	30%
Expenditure for all production equipment	46%	25%	29%
Expenditure for EOR	90%	7%	3%
Percent of recoverable reserve (30 billion barrels)	83%	5%	11%

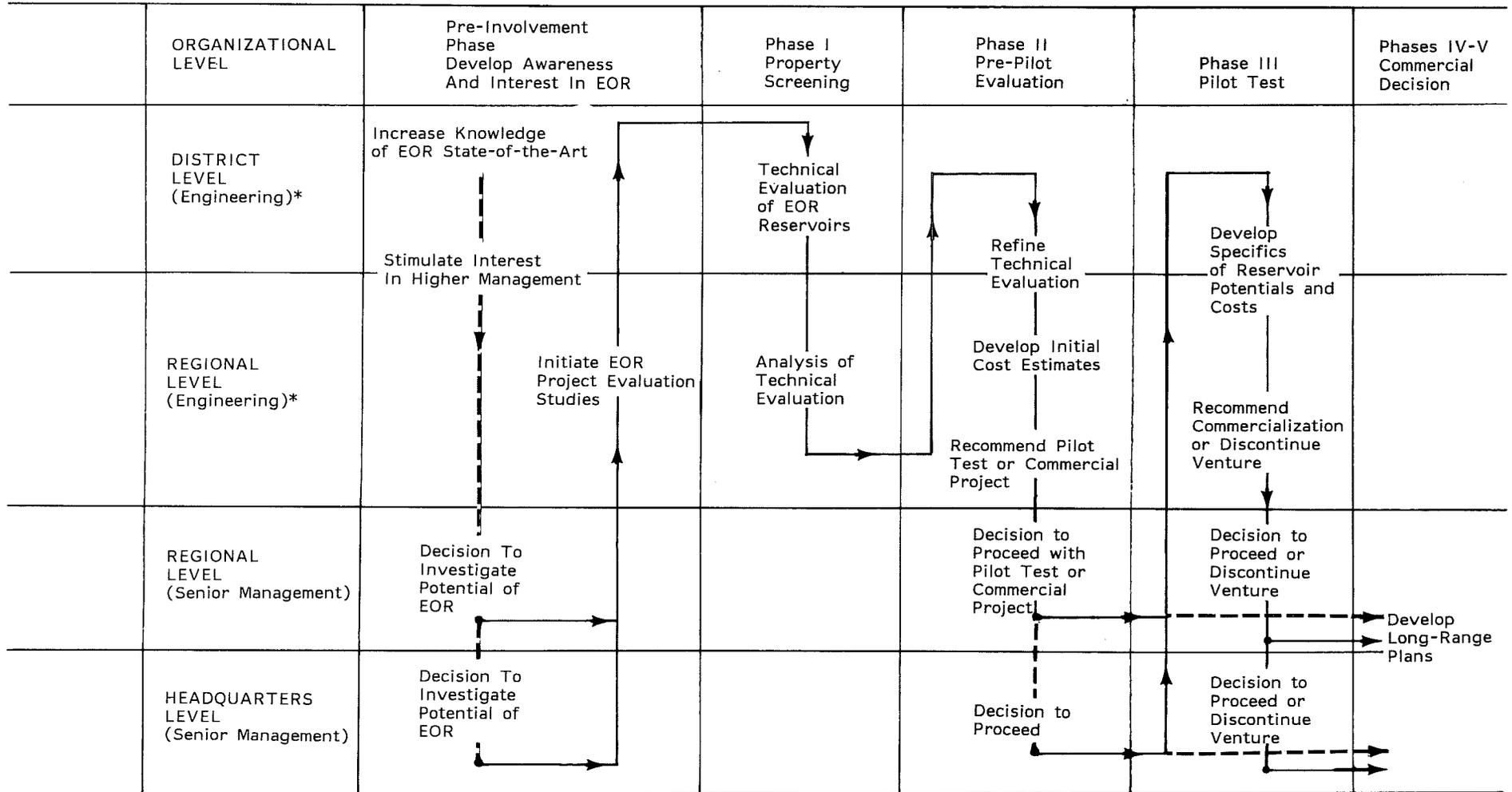
Sources: Summary of Energy Companies' Operations (Harcourt Brace Jovanovich, Inc.); U.S. Department of Commerce.

Exhibit 8

CURRENT STATUS OF EOR INVOLVEMENT
(By producer category, all processes)

	Pre- Involvement	Phase I Property Screening	Phase II Pre-Pilot Evaluation	Phase III Pilot Test Evaluation	Phase IV Commercial Development	CATEGORY TOTAL
SMALL INDEPENDENTS	52%	36%	3%	6%	3%	100%
LARGE INDEPENDENTS	51%	22%	12%	10%	5%	100%
MAJORS AND INTEGRATED	4%	4%	8%	48%	36%	100%
<u>Years to Complete Each Phase:</u>						<u>Total Years To Reach Phase V</u>
Thermal	Indefinite	1 - 3	1 - 2	1 - 2	0 - 3	3 - 10
CO ₂		1 - 3	1 - 2	2 - 5	1 - 3	5 - 13
Chemical		1 - 3	1 - 2	5 - 10	5 - 10	12 - 25

Exhibit 9
EOR DECISION FLOW CHART



*In some companies (notably majors, integrated producers and large independents), this function may be performed by a corporate EOR staff or R&D personnel.

EXAMINING THE DOE ROLE

In 1976, under authority and funding of Congress, DOE and its predecessors were charged with the responsibility for encouraging and conducting R&D and field demonstrations of commercial feasibility for application of improved or enhanced methods for the extraction of oil from this nation's rapidly depleting petroleum reserves.

A major goal of this program was to accelerate transfer of the technology developed in enhanced oil recovery processes to those sectors of private industry that need access to data in order to utilize the new process technologies, reduce their risk, and thereby accomplish the program's incremental production goals.

Technology transfer, then, is a cornerstone of the development phase of the EOR program. But will technology transfer accomplish the goal of commercialization and incremental production? We foresee only limited near-term commercial application without additional involvement by the Federal government which minimize the non-process constraints which still restrict the private sector.

DOE support and technology transfer has effectively brought virtually all the major oil producers to the verge of commercial scale EOR projects. But, as of this writing, commercial scale projects, excepting thermal processes, are non-existent. Technology transfer efforts have, to date, accelerated the learning process but have had limited effect upon commercial application. In examining the DOE role in accelerating commercial development, we feel that efforts that go beyond technology transfer will be required.

The timing of commercial EOR activities within the private sector must be analyzed in terms of risk and rate of return. Constraining commercial application of the new technologies are the high degree of risk involved and a low or unpredictable return on the investment. These concerns place unacceptable financial exposure upon the private corporation. Even where national interests are concerned, private corporations believe the risks of EOR are too great and are generally unwilling to jeopardize income statements through large-scale commitment to

EOR. On the other hand, the public sector (DOE) must place different values on the outcome of an EOR venture than does the oil producer.

To determine the extent of additional involvement, the public benefit and risk must be considered.

What must be done is analyze the public rate-of-return. If private returns are too low and public returns are high (as in the case of EOR), then more government involvement can be justified. The appropriate type of involvement in this question is for the federal government to assume a portion of the risk. If the private sector is expected to accelerate its commercialization of developing EOR technology, special incentives, guarantees or other forms of policy actions (which reduce the risk exposure of the private sector) may be necessary to assure the public rate of return from increased oil production.

TECHNOLOGY TRANSFER OVERVIEW

The major thrust of Spears and Associates' approach to this study was to examine the role of technology transfer as it relates to commercialization of EOR. This determination was needed in order to identify prime users of EOR technology and their impact upon the commercialization process. During normal diffusion of technological innovations, a finite period of time exists between innovation and commercial development. During this time, information on experience with the innovation is disseminated throughout the industry until sufficient experience in successful application reduces the risk to an acceptable level. Then, and only then, will wide-spread commercialization begin.

In a free enterprise economy, business firms (and consumers) are free to use new technology as slowly or as rapidly as they please (subject to the constraints imposed by the marketplace). Diffusion of new technology is essentially a learning process. However, during the period between innovation and widespread commercial application, the learning process moves from the research laboratories and/or a few innovative firms to a considerable number of users and producers.

Technology transfer in the free marketplace is normally accomplished by the firm developing the innovation through the efforts of salesmen, advertising, etc. Through those channels, information regarding the existence of the process, characteristics of its application, its availability, and its cost are disseminated. Information regarding the reaction of users to the innovation tends to be circulated more informally through word-of-mouth and the trade press.

Certain conditions will affect the rate of application of new technologies and the rapidity with which the innovation will spread throughout an industry:

1. The number of firms using the innovation will directly affect the probability of non-users utilizing it in the near future. Specifically, as the number of firms adopting a process increases, the probability of

its adoption by non-users also increase. This is due primarily to the reduction of associated risks. As uncertainties grow smaller, profits can be more accurately forecast, and information on experience with the innovation spreads among the non-users.

2. Another aspect affecting probability of application is the potential for profit. The more profitable an investment the innovation promises to be, the greater the probability that a firm will assume the investment risk. When profit is uncertain, for whatever reasons, acceptance of the new technology will be viewed with great caution. This is especially true of the smaller, less capitalized companies.
3. A similar aspect is the size of the investment. On innovations which require only small investments, probability increases. The opposite is, of course, true of new technologies which require large, expensive project financing (such as EOR). Not only will the project find itself in competition with other, less risky investment alternatives, but the firm will also have more difficulty in obtaining outside financing.
4. The effect of an industry's market structure can affect how rapidly a new process will be utilized commercially. If, as in the case of EOR, large amounts of capital are required, utilization of the technology is likely to be restricted to a few large firms. Smaller firms, regardless of the resources they might collectively control, will react to the new technology at a much slower rate than the large firms.

Calling upon previous studies and Spears and Associates' experience in the petroleum industry, we looked at technology transfer as the essential element which could successfully cut the time normally required for the spread of technical innovation to commercial development.

Despite this nation's need for increased domestic energy production, the EOR research and development program is weighted with constraints which would, under normal technology diffusion, delay any wide-spread acceptance and commercial application until well beyond the years of critical need. Some of the most important of these constraints are:

- High risk associated with technical uncertainty (applicability to a given field)
- Uncertain recovery potential
- Large capital investments
- Long time frame between investment and incremental production
- Financing problems
- Uncertain market price and return on investment
- Legal issues (field unitization)
- Environmental issues
- Tax uncertainties
- Policy uncertainties

Any one of these problems could delay the commercial development of a promising innovation to the oil recovery process. Adding them together and trying to develop a system which can transcend their negative influence is an almost imponderable task.

But if even minimum goals are to be reached, these constraining forces must be analyzed both independently and collectively. Information which could be effectively disseminated to users which influence the commercialization process must be identified and transmitted through the most timely and useful means.

The most obvious and important user of the data being developed is the oil producer. Whether large or small, the producer ultimately dictates whether commercial development of a process is achieved.

Therefore, we have identified the various decisions that must be made within a producing company in order to commit either resource or financial reserves to an enhanced recovery project. We have also looked at other groups, both within and outside the oil industry, which influence that commitment.

- o Technology transfer can assist in bringing producers and other EOR participants from pre-involvement through pilot testing and field demonstration.
- o But at the point of commercial scale expansion, technology transfer becomes secondary to institutional constraints reflected in the economics (such as price uncertainties, cost of materials, availability of materials, unknown returns, and changing regulatory framework).
- o Technology transfer options (for users in each phase of involvement are included on the following page).

TECHNOLOGY TRANSFER REQUIREMENTS

TARGET GROUPS	TECH TRANSFER EMPHASIS		
	Major	Moderate	Minor
PRODUCERS:			
Majors/Integrated	X		
Large Independents	X		
Small Independents		X	
CONSULTANTS	X		
OIL FIELD SERVICES		X	
CHEMICAL SUPPLIERS			X
BANKS		X	
STATE LEGISLATURE			X
STATE REGULATORY		X	
FEDERAL POLICY	X		
UNIVERSITY		X	
ENVIRONMENTAL			X

TYPE OF EFFORT REQUIRED		
Broader Coverage Needed	Greater Detail Needed	Specialized Publications Needed
	X	
X	X	
X		X
X	X	
X		X
X		X
X		X
X	X	X
X		X
X		X

Exhibit 11
TECHNOLOGY TRANSFER OPTIONS

<u>PRE-INVOLVEMENT PHASE</u>		<u>PHASE I</u>	<u>PHASE II</u>	<u>PHASE III</u>	<u>BEYOND</u>	
<ul style="list-style-type: none"> o DOE Executive EOR Report (Newsletter to top decision makers in EOR Universe) o Awareness brochure (explaining problems, economics and benefits to nation from EOR) o News releases o Feature articles (in trade journals) o DOE EOR R&D update (Newsletter) o Special publications <ul style="list-style-type: none"> -- Specific to process -- Maps of geographic areas with potential -- Incentives/explained -- "How To" guide for obtaining EOR information from DOE o Speakers bureau (briefings) 	<ul style="list-style-type: none"> o Slide programs o Video tapes for industry o Video features for public TV o Did you know? cartoon series for any interested publication -- mass distribution telling the "Story of EOR" o Tailored information <ul style="list-style-type: none"> -- Articles in banking journals -- Brochures for special interests -- Investor benefits 	<ul style="list-style-type: none"> o Information packages (Technical Information kits). <ul style="list-style-type: none"> -- Tailored to size of company -- Tailored to process -- "Tell is like it is" booklet explaining risks involved with EOR for industry and policy makers. Explain all technical and economic risks, then explain the REAL risk (not producing enough oil) -- Unitization information o Technical reservoir screening guide o Lists of who is doing what o DOE executive EOR report 	<ul style="list-style-type: none"> o Provide technical hotline o Special publications <ul style="list-style-type: none"> -- "How To" guides -- Histories of process -- Bibliographic references and technical search assistance o State-of-the-art summaries (process performance) o Awareness brochure o Booklet on importance of accurate reservoir data o Lists of candidate fields o EOR environmental guide o Newsletters o Progress reviews o Technical clinics (at BETC) o Tailored information (to suppliers): <ul style="list-style-type: none"> -- List of capital equipment required -- Geographic operating costs by process -- Material requirements/cost -- Environmental equipment 	<ul style="list-style-type: none"> o Executive Report o Other information as required o Incentives explained <ul style="list-style-type: none"> -- Guarantees -- Tax incentives o "How To" packages <ul style="list-style-type: none"> -- Finance -- Testing & evaluating -- Permitting -- Unitizing o List of finance sources o Technical assistance o Historical data o equipment requirements o operating requirements o Environmental guide o Newsletters o Seminar meetings o Ancillary target updates 	<ul style="list-style-type: none"> o Executive Report o Technical assistance o Historical data <ul style="list-style-type: none"> -- Progress updates -- Experience, etc. -- Trade-offs o Unitization information 	<ul style="list-style-type: none"> o Technical information as required

OIL PRODUCERS CRITICAL DECISION MODEL

LEVEL OF OIL PRODUCER INVOLVEMENT IN EOR	PRE-INVOLVEMENT PHASE INCREASING AWARENESS OF EOR	PHASE I PROPERTY SCREENING	PHASE II PRE-PILOT EVALUATION	PHASE III PILOT TEST AND EVALUATION	PHASE IV COMMERCIAL DEVELOPMENT	PHASE V COMMERCIAL OPERATION			
PRIMARY INFORMATION RECIPIENTS	<ul style="list-style-type: none"> Operational headquarters management Engineering staff and management Production research (where applicable) Auxiliary groups 	<p>Majors/Integrated:</p> <ul style="list-style-type: none"> Field operations personnel Specialized EOR personnel Engineering staff Production research personnel <p>Large Independents:</p> <ul style="list-style-type: none"> Engineering staff Owner/President/CEG Production research and technical specialists <p>Small Independents:</p> <ul style="list-style-type: none"> Engineering staff Owner/President Field engineer 	<p>Technical Feasibility</p> <p>Majors/Integrated:</p> <ul style="list-style-type: none"> Field operations personnel Specialized EOR personnel Engineering staff Production research personnel <p>Large Independents:</p> <ul style="list-style-type: none"> Engineering staff Senior engineer Senior management Specialized EOR personnel <p>Small Independents:</p> <ul style="list-style-type: none"> Engineering staff Owner/President <p>Economic Feasibility</p> <p>Majors/Integrated:</p> <ul style="list-style-type: none"> Engineering Staff Specialized EOR personnel Senior management Senior engineering personnel <p>Large Independents:</p> <ul style="list-style-type: none"> Senior management Engineering staff Specialized EOR personnel Owner/President <p>Small Independents:</p> <ul style="list-style-type: none"> Senior management Engineering staff Owner/President 	<p>Environmental Responsibilities</p> <p>Majors/Integrated:</p> <ul style="list-style-type: none"> Specialized environmental personnel Manager, production/operations Engineering staff <p>Large Independents:</p> <ul style="list-style-type: none"> Engineering staff Manager of production/operations Specialized environmental personnel <p>Small Independents:</p> <ul style="list-style-type: none"> Engineering staff Manager of production/operations Owner/President Environmental personnel 	<p>Final Decision</p> <p>Majors/Integrated:</p> <ul style="list-style-type: none"> Senior management committee Senior vice president President/CEO <p>Large Independents:</p> <ul style="list-style-type: none"> Owner/President Senior vice president Board of directors Senior management committee <p>Small Independents:</p> <ul style="list-style-type: none"> Owner/President Board of directors 	<ul style="list-style-type: none"> Engineering and operations staff 			
SPECIFIC INFORMATION NEEDS	<ul style="list-style-type: none"> Explanation of program and goals Summary state-of-the-art 	<ul style="list-style-type: none"> Targeted information (regarding a specific process, geographic region, incentive, etc.) which would motivate a particular type of producer, property owner or investor 	<ul style="list-style-type: none"> Specific steps or guides which can be applied to specific type reservoirs or conditions Historical data specific to both process and reservoir Bibliographic references and search assistance Independent evaluation services 	<ul style="list-style-type: none"> "How To" instructions (clear and concise) on obtaining data through DOE Technology Transfer system Most current state-of-the-art summaries of processes to be considered (cross-referenced to most likely candidate reservoirs) Information package appropriate for process and size of company 	<ul style="list-style-type: none"> Lab analysis Compare to other projects (those underway and those considered but rejected) Latest cost estimates and projections Full disclosure of economic factors Environmental handbook and special assistance in meeting requirements Explanation and assistance for utilizing incentives 	<ul style="list-style-type: none"> Listings of "most likely" finance sources "How To" package for finance proposals Provide data (as required) to financial sources Detailed explanation of incentives 	<ul style="list-style-type: none"> Information and reports on similar projects Production histories on similar geologic formations Updates of successes/failures and "trade-offs" involved Detailed technical data (as required) On-line data base access 	<ul style="list-style-type: none"> Detailed technical data (as required) On-line data base access 	<ul style="list-style-type: none"> Detailed technical data Data base access
ANCILLARY INTERACTION	<ul style="list-style-type: none"> Consultants Other oil companies Industry associations EOE Technical Information Center Industry trade and technical publications 	<ul style="list-style-type: none"> Consultants Other oil companies Industry associations EOE Technical Information Center Industry trade and technical publications 	<ul style="list-style-type: none"> Oil field services (logging, drilling, etc.) EOE Technical services Consultants EOE Technical Information Center Other oil companies University research 	<ul style="list-style-type: none"> EOE Technical Information Center Industry technical community Engineering consultants EOE Technical Information Center Chemical suppliers (if applicable) Technical labs 	<p>Technical</p> <ul style="list-style-type: none"> Engineering consultants Technical labs EOE Technical Information Center Service companies <p>Economic</p> <ul style="list-style-type: none"> Engineering consultants EOE Technical Information Center EPA State regulatory agencies Suppliers Service companies Financial institutions Industry associations <p>Capital Formation</p> <ul style="list-style-type: none"> Financial institutions Private investors Other companies (participants) Royalty owners Insurance companies Refineries (purchaser of feedstock) Other financial sources 	<ul style="list-style-type: none"> Service companies Engineering consultants Suppliers Technical labs EOE Technical Information Center University labs Other oil companies 	<ul style="list-style-type: none"> Financial institutions Engineering consultants EOE Technical Information Center Industry technical community 	<ul style="list-style-type: none"> EOE Technical Information Center Other companies Service companies Financial institutions Downstream markets 	<ul style="list-style-type: none"> Industry services and suppliers Financial institutions Industry downstream markets
CONSTRAINTS	<p>Majors</p> <ul style="list-style-type: none"> Virtually all have advanced beyond this stage <p>Independents</p> <ul style="list-style-type: none"> Lack of awareness Fear of uncertainties High risks Alternate investment/budget considerations Lack of clear policy re: tax, price, technology, etc. No history of application with success High costs versus ROI Informational inconsistencies 	<p>Majors</p> <ul style="list-style-type: none"> Virtually all have advanced beyond this stage <p>Independents</p> <ul style="list-style-type: none"> Technical expertise, manpower Lack of properties suitable to EOR Multiple field ownership No concerted effort Residual oil saturation and other reservoir parameters not definite (re: degree of certainty required) Lack of experience Lack of information High risks High costs Technical and economic uncertainties 	<p>Majors</p> <ul style="list-style-type: none"> Virtually all have advanced beyond this stage <p>Independents</p> <ul style="list-style-type: none"> Technology/costs too exotic for small companies (who possess properties) Not enough performance data to assure normal business risk Fields not utilized Injection materials not available Specialized surface equipment requirements unknown Economics (price/tax, etc) unknown Technical uncertainties Crude oil price unknown Unfavorable ROI and inability to forecast with certainty Environmental constraints Political climate Time requirements unknown National economy Cost of money Alternative investment opportunities with less risk, higher ROI 	<p>Majors</p> <ul style="list-style-type: none"> Most have advanced beyond this phase. For those that have not, constraints are: Technical uncertainties Properties are unsuitable for immediate application Crude oil price unknown Unfavorable ROI and inability to forecast with certainty Environmental constraints Political climate Time requirements unknown National economy Cost of money Alternative investment opportunities with less risk, higher ROI <p>Independents</p> <ul style="list-style-type: none"> Technology/costs too exotic for small companies (who possess properties) Not enough performance data to assure normal business risk Fields not utilized Injection materials not available Specialized surface equipment requirements unknown Economics (price/tax, etc) unknown Technical uncertainties Crude oil price unknown Unfavorable ROI and inability to forecast with certainty Environmental constraints Political climate Time requirements unknown 	<p>Majors</p> <ul style="list-style-type: none"> National economy Cost of money Alternative investment opportunities with less risk, higher ROI Traditional project financing infrastructure unwilling to assume high/uncertain risks Small producers lack ability to obtain non-recourse financing High front-end costs Costs of injected materials Uncertain operating costs Regulatory unknowns Competitive budget requirements Time versus DC/ROI <p>Independents</p> <ul style="list-style-type: none"> Lack of lab facilities Lack of expertise (both producer and traditional service contractors) Technical uncertainties Time re: ROI versus risks Alternate uses of corporate funds and manpower Lack of technical facilities, expertise, manpower Lack of comparison field tests 	<p>All Producers</p> <ul style="list-style-type: none"> No successful commercial projects to serve as benchmark Overall, risks too great to assume on major (or even minor) scale within critical time frame Environmental costs and restrictions Alternate uses of corporate funds for projects offering greater long-term benefit 	<p>All Producers</p> <ul style="list-style-type: none"> World economy National economy Political climate Development of other energy sources Resource depletion 		
DOE ROLE	<p>Technology Transfer</p> <ul style="list-style-type: none"> Executive Report Newsletters Features in trade journals Seminars Brochures Personal contact Industry liaison Establish tracking system Stimulate ancillary group interaction <p>Research & Development</p> <ul style="list-style-type: none"> Continuing areas of research Reservoir analysis Fluid flow Pollution control (esp. thermal) CO₂ application and logistics Surfact flooding Improved waterflood methods High temperature tooling Corrosion resistance Improved curing methods Bottom-hole pressure measurement Technical "Hotline" <p>Regulatory</p> <ul style="list-style-type: none"> State and federal government liaison Industry liaison 1. Clarification of regulations 2. "Sounding Board" for producers' problems Broaden definition of heavy oil 	<p>Technology Transfer</p> <ul style="list-style-type: none"> Provide technical data for reservoir analysis List of companies doing similar work Computer services for data search (PDS, GURC, etc.) Executive Report More detailed information re: geology and process Technical updates Information "package" for high potential EOR candidates 1. A "How To" guide 2. Financing guidance 3. Testing, evaluating guides 4. Special incentives 5. Summaries of what can be expected (no surprises, etc.) <p>Research & Development</p> <ul style="list-style-type: none"> Provide technical screening assistance DOE Tech Evaluation Team Provide lab assistance <p>Regulatory</p> <ul style="list-style-type: none"> Continued liaison with industry and government 	<p>Technology Transfer</p> <ul style="list-style-type: none"> Provide technical assistance, computer modeling service, cross-screening, etc. Bibliographic assistance Logistics and "flexible" requirements Executive Report Provide full economic data Equipment requirements Environmental requirements Explanation of incentives Identify likely sources of financing Provide assistance in developing a finance package for banks, venture capital firms, and other lending institutions <p>Research & Development</p> <ul style="list-style-type: none"> Technical assistance Lab services <p>Regulatory</p> <ul style="list-style-type: none"> Continued liaison with industry and government Pricing policies Tax incentives Loan guarantees Environmental reqs. Utilization (with states) Permit requirements 	<p>Technology Transfer</p> <ul style="list-style-type: none"> Provide full information for cross evaluation Provide histories of similar tests, etc. Provide special incentives for evaluation phase Explanation of incentives Updates on other projects <p>Research & Development</p> <ul style="list-style-type: none"> Technical assistance on alternate process applications Lab services <p>Regulatory</p> <ul style="list-style-type: none"> Continued liaison with industry and government Special incentives for test projects 	<p>Technology Transfer</p> <ul style="list-style-type: none"> Provide technical and economic information as required Require reports (on progress/problems, etc.) for on-going data base Begin to reduce involvement as risks become more in line with normal business acceptance level <p>Research & Development</p> <ul style="list-style-type: none"> Technical advice <p>Regulatory</p> <ul style="list-style-type: none"> Incentives for commercial pioneering Reports on commercial experience 	<ul style="list-style-type: none"> DOE role confined to Technology Transfer 			

STATISTICAL ANALYSIS

OIL PRODUCERS

Majors and Integrated

Number in survey: 42

Respondent level: Manager, technical operations

Current level of EOR expertise: High (96% are actively involved)

Direct experience with EOR: High level of experience in all types EOR processes. Most experimental research is being conducted by this group. Virtually all companies (92%) have undertaken some form of pilot testing.

Impact on EOR: Most significant of all groups. Only group currently capable of generating capital required to undertake commercial EOR project. Majors possess the assets, reserves, and technical expertise required for EOR involvement. Lack of economic incentive is the primary constraint.

Attitude toward EOR: Most majors feel that, except for chemical processes, the technology for EOR is sufficient to assume the risks involved. Only economics and uncertain federal energy policies restrict application on a commercial scale.

Perceived constraints:

1. Unfavorable economics
2. Technological uncertainties
3. Crude oil price
4. High risks versus return-on-investment

Opinion of DOE role:

1. Decontrol all prices
2. Provide tax credits for EOR
3. Improve transfer of technology
4. Relax regulatory restrictions
5. Support intensified EOR research

Familiarity with DOE programs: Well informed. Most are involved in cost-share programs. All others have studied the programs.

Familiarity with BETC: High (88 percent receive BETC information).

Information sources:

1. Technical journals
2. Technical reports (DOE)
3. Trade journals
4. Technical seminars
5. Oil industry sources
6. Computer data base

Information needs:

1. Technical reports (specific to process) and discussions of engineering trade-offs.
2. Details on costs
3. Experience with different type reservoirs
4. State-of-the-art summary data

Information levels:

1. Top management
2. Production research
3. Production engineering

Information format:

1. Hard copy
2. Bibliographic references
3. Computer data base access

Future EOR information needs: Already sophisticated users of EOR data, majors will require the bulk of all data being distributed.

Usefulness of EOR Technical Information Center: Moderate to high (46 percent would utilize it occasionally, 34 percent would use it as regular source).

OIL PRODUCERS

Large Independents

Number in survey: 57

Respondent level: Engineering management or staff

Current level of EOR expertise: Moderately high. Nearly one-fourth are actively involved in actual EOR activities. Another one-fourth are screening properties for possible application.

Impact on EOR: Perhaps the only "independents" who can be expected to undertake EOR projects during critical time frame (1980-1990) own or control large amounts of old domestic reserves. Nearly one-half of this category can be expected to have an impact on EOR.

Attitude toward EOR: Excepting those currently involved (approximately one-fourth), large independents do not express more than "academic" interest in EOR. Lacking capital, expertise, and suitable properties, they look to the majors as principal innovators for EOR technology.

Perceived constraints:

1. Lack of suitable properties (most have not yet evaluated for possible EOR application)
2. Unfavorable economics
3. Lack of technical expertise
4. Crude oil price uncertainty
5. Lack of capital
6. Multiple ownership of candidate reservoirs

- Opinion of DOE role:
1. Decontrol oil prices
 2. Relax regulatory restrictions
 3. Provide EOR tax credits
 4. Improve general business climate

Familiarity with DOE programs: Most are familiar but not involved.

Familiarity with BETC: Moderate to low. Nearly 60 percent are unfamiliar with BETC information.

- Information sources:
1. Technical journals
 2. Technical reports (DOE)
 3. Seminar presentations
 4. Colleagues
 5. Trade journals

- Information needs:
1. Summary state-of-the-art data
 2. Technical reports on process with detailed cost analysis
 3. Reservoir information
 4. Technical results of all experiments (including failures)

- Information levels:
1. Top management
 2. Engineering staff
 3. Field operations management

- Information format:
1. Hard copy
 2. Bibliographic materials

Future EOR information needs: Will increase as more experience is gained in process application. Not involved in more than limited research involved in EOR.

Usefulness of EOR Technical Information Center: Moderate. Only one-third would utilize more than "occasionally."

OIL PRODUCERS

Small Independents

Number in survey: 33

Respondent level: Top management

Current level of EOR expertise: Low, most are only "generally aware" of current state-of-the-art. Less than 10 percent have pilot projects underway.

Direct experience with EOR: Except for some thermal experience (principally in California), small independents have virtually no direct experience with EOR.

Impact on EOR: Least impact of oil producers during the critical time frame of EOR program. While small independents collectively control large deposits of old oil production, they lack the capital and other resources to engage in EOR until risks are substantially reduced.

Attitude toward EOR: Too risky for small independents. Costs are too high for small operator. Without a major participating (as the operator) and/or the government supplying financial incentives and technical assistance, small independents do not expect to be involved with EOR.

Perceived constraints:

1. Lack of technical expertise and/or manpower
2. Lack of capital
3. No suitable properties
4. Unfavorable economics
5. Multiple ownership of candidate reservoirs

Opinion of DOE role:

1. Provide EOR tax credits or incentives
2. Improve technology and awareness of expertise
3. Provide technical and financial assistance

Familiarity with DOE programs: Only a small (12%) segment is well informed. The major portion remaining have some familiarity or want to be.

Familiarity with BETC: Very low; 78 percent were not familiar with data being disseminated.

Information sources:

1. Technical journals
2. Technical reports
3. Trade journals
4. Colleagues
5. Consultants
6. Grapevine

Information needs:

1. Summary state-of-the-art data
2. Histories of process application by reservoir type
3. Technical screening information
4. Details on economics involved
5. Financial incentive information
6. Technical assistance

Information levels:

1. Top management
2. Chief engineer

Information format: . . . 1. Hard copy (printed materials)

Future EOR information needs: Will increase as EOR activity increases overall. Will require general information initially with increasing amounts of technical detail and assistance.

Usefulness of EOR Technical Information Center: Moderately high; over two-thirds felt it would be used regularly or on occasions where specific EOR data was needed.

OIL PRODUCERS
 Exhibit 1
Respondent Job Categories

ALL PRODUCERS

<u>TITLE</u>	<u>Number</u>	<u>Percent</u>
President	10	8%
Vice President	22	17
Manager of Production/Engineering/Operations	35	26
Regional Manager/Division Manager	7	5
District Manager/Area Manager	5	4
EOR Managers/Specialists	19	14
Chief Engineer (Production, Reservoir, Research)	14	11
Engineering Staff	18	13
Assistant to Vice President	<u>2</u>	<u>2</u>
TOTAL	132	100%

OIL PRODUCERS
 Exhibit 2
Respondent Organization Level

ALL PRODUCERS

<u>LEVEL</u>	<u>Number</u>	<u>Percent</u>
Headquarters - Top Management	11	8%
Headquarters - Vice President	15	11
Headquarters - Operations Personnel	25	19
Headquarters - Technical and Research Personnel	26	20
Region/Division - Vice President or Manager	23	17
Region/Division/District - Supervisor	2	2
Region/Division/District - Operations Personnel	<u>30</u>	<u>23</u>
TOTAL	132	100%

OIL PRODUCERS
 Exhibit 3
Interview Distribution by Geographic Area

ALL PRODUCERS

<u>AREA</u>	<u>Number</u>	<u>Percent</u>
South Texas (including Houston)	32	24%
Mid-Continent (Oklahoma and Kansas)	26	20
Rocky Mountains	20	15
West Coast	18	14
East Texas and Louisiana	16	12
West Texas	7	5
Appalachia (Kentucky, West Virginia, Pennsylvania, Indiana)	7	5
Midwest (Illinois, Ohio)	<u>6</u>	<u>5</u>
TOTAL	132	100%

OIL PRODUCERS

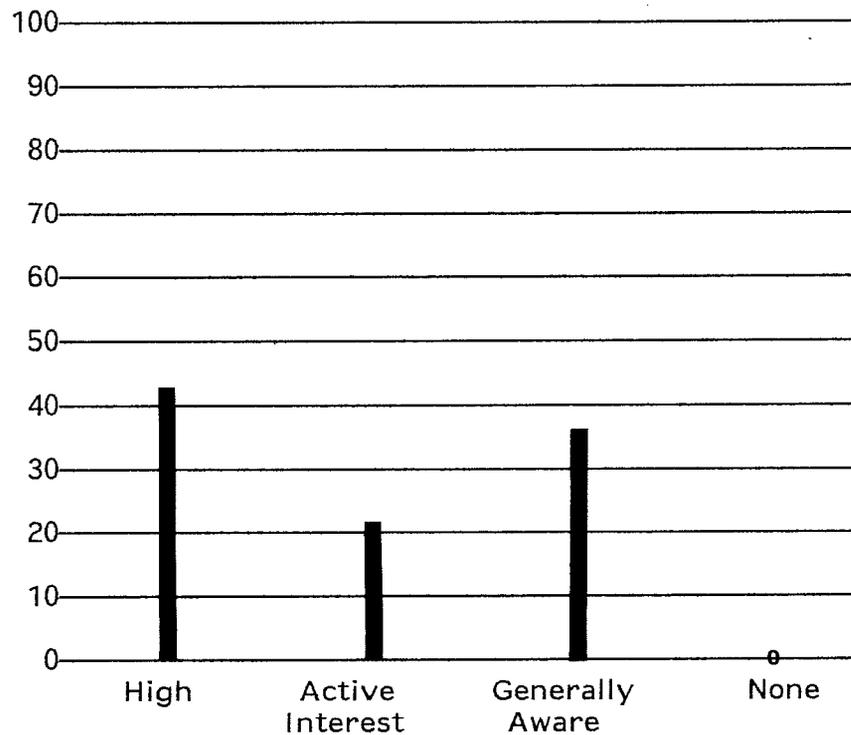
Exhibit 4

Level of EOR Activity

ALL PRODUCERS

(Base 132)

PERCENT



LEVEL OF ACTIVITY

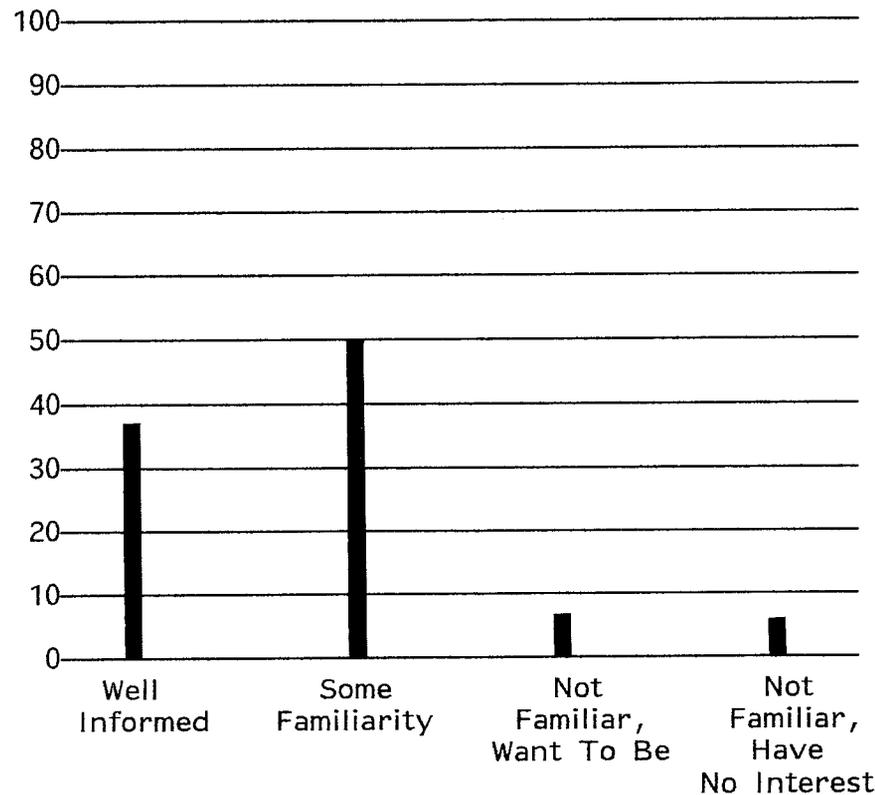
OIL PRODUCERS

Exhibit 5

Familiarity with DOE Cost-Share Program

ALL PRODUCERS

(Base 132)



DEGREE OF FAMILIARITY

OIL PRODUCERS
Exhibit 6
Level of EOR Activity

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
High [Experienced in EOR]	42%	84%	28%	15%
Active Interest	22	14	25	27
Generally Aware	36	2	47	58
No Interest	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

- o Interest (experience) is highest among major/integrated producers. Most companies (84%) in this group are conducting pilot research tests on EOR or involved in a commercial project (thermal only).
- o Three-fourths of the large independents and 85 percent of the smaller independents are several years away from commercial production since they are generally unaware of the current technology.
- o Those independents who expressed an active interest appear to have properties which might be EOR candidates. However, most companies have not evaluated the reservoirs.

OIL PRODUCERS

Exhibit 7

Familiarity with DOE Cost-Share Program

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Well Informed	37%	71%	26%	12%
Some Familiarity	50	29	60	61
Not Familiar, But Want To Be	7	--	5	18
Not Familiar, Have No Interest	6	--	9	9
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

- o This table again demonstrates the involvement of the major oil producer. Virtually 100 percent are familiar with the EOR cost-share program.
- o It is significant that only less than 10 percent of the independents have no interest in EOR. While independents are not currently involved, they indicate a receptive interest in becoming better informed.

OIL PRODUCERS
Exhibit 8
EOR Critical Decision Responsibilities
(Responsible for initial evaluation of reservoirs)

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Specialized EOR Personnel	12%	29%	7%	--
Production Research/R&D Personnel	7	12	7	--
Senior Engineering Personnel	3	7	*	*
Engineering Staff	48	19	65	57%
Field Operations Personnel	14	33	4	10
Owner/President	14	--	16	30
Consultant	<u>2</u>	<u>--</u>	<u>1</u>	<u>3</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

*Combined with engineering staff.

- o Size of company dictates who wears the decision hat. The larger companies have technical specialists while smaller companies rely upon generalists.
- o Technical expertise in EOR is generally lacking among the small independents. Less than half of the small independents have screened their properties for EOR candidate reservoirs.
- o Reservoir evaluation among small independents is shared between the owner and engineering staff, which often is limited.

OIL PRODUCERS

Exhibit 9

EOR Critical Decision Responsibilities

(Responsible for determining technical feasibility)

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Specialized EOR Personnel	14%	29%	11%	--
Production Research/R&D Personnel	4	12	1	--
Senior Engineering Personnel	8	7	14	*
Engineering Staff	34	19	32	57%
Field Operations Personnel	19	33	14	10
Senior Management (includes Regional Vice Presidents, General Managers, etc.)	6	--	14	--
Owner/President	8	--	--	30
Consultant	<u>7</u>	<u>--</u>	<u>14</u>	<u>3</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

*Combined with engineering staff

- o Determination of a project's technical feasibility is delegated to the same levels as the initial evaluation of properties among majors and small independents (See Exhibit 8).
- o Large independents appear to rely more upon outside help (consultants) and senior engineers when attempting to assess the technical feasibility of a potential project.

OIL PRODUCERS

Exhibit 10

EOR Critical Decision Responsibilities

(Responsible for determining economic feasibility)

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Specialized EOR Personnel	12%	26%	9%	--
Senior Management (includes Regional Vice Presidents, General Managers, etc.)	36	17	45	45%
Senior Engineering Personnel	8	12	9	*
Engineering Staff	30	45	23	25
Owner/President	8	--	5	20
Consultant	<u>6</u>	<u>--</u>	<u>9</u>	<u>10</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

*Combined with engineering staff.

- o Economic assessments involve a higher percentage of "non-technical" personnel.
- o Over half of the independents charge senior management personnel with economic decisions relating to EOR.
- o Special economic information should be targeted to upper management levels in all producer categories.

OIL PRODUCERS

Exhibit 11

EOR Critical Decision Responsibilities

(Responsible for environmental considerations)

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Specialized Environmental Personnel	29%	71%	11%	6%
Manager, Production/Operations	16	12	19	16
Engineering Staff	28	10	40	29
Legal Staff	1	2	--	--
Government Sources	14	5	16	23
Consultant	9	--	14	13
Owner/President	<u>3</u>	<u>--</u>	<u>--</u>	<u>13</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

- o Nearly three-fourths (71%) of the major or integrated producers have full-time environmental coordinators on staff.
- o Only a limited number of independents have specialized environmental personnel. One-third rely upon outside sources for assistance in these matters, indicating a need for assistance.

OIL PRODUCERS

Exhibit 12

EOR Critical Decision Responsibilities

(Responsible for final decision)

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Board of Directors	13%	7%	16%	14%
Owner/President*	36	12	41	58
Senior Vice President	27	38	27	14
Senior Management Committee	<u>24</u>	<u>43</u>	<u>16</u>	<u>14</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

*"Owner" pertains to small independent companies only. At this level a single owner or partner may serve as President. In larger companies (Major, Integrated, and Large independent), the President is an officer named by the Board of Directors. Ownership is, of course, a different matter. This category reflects those companies in which the final EOR decision is made by the chief operating officer, no matter what his title.

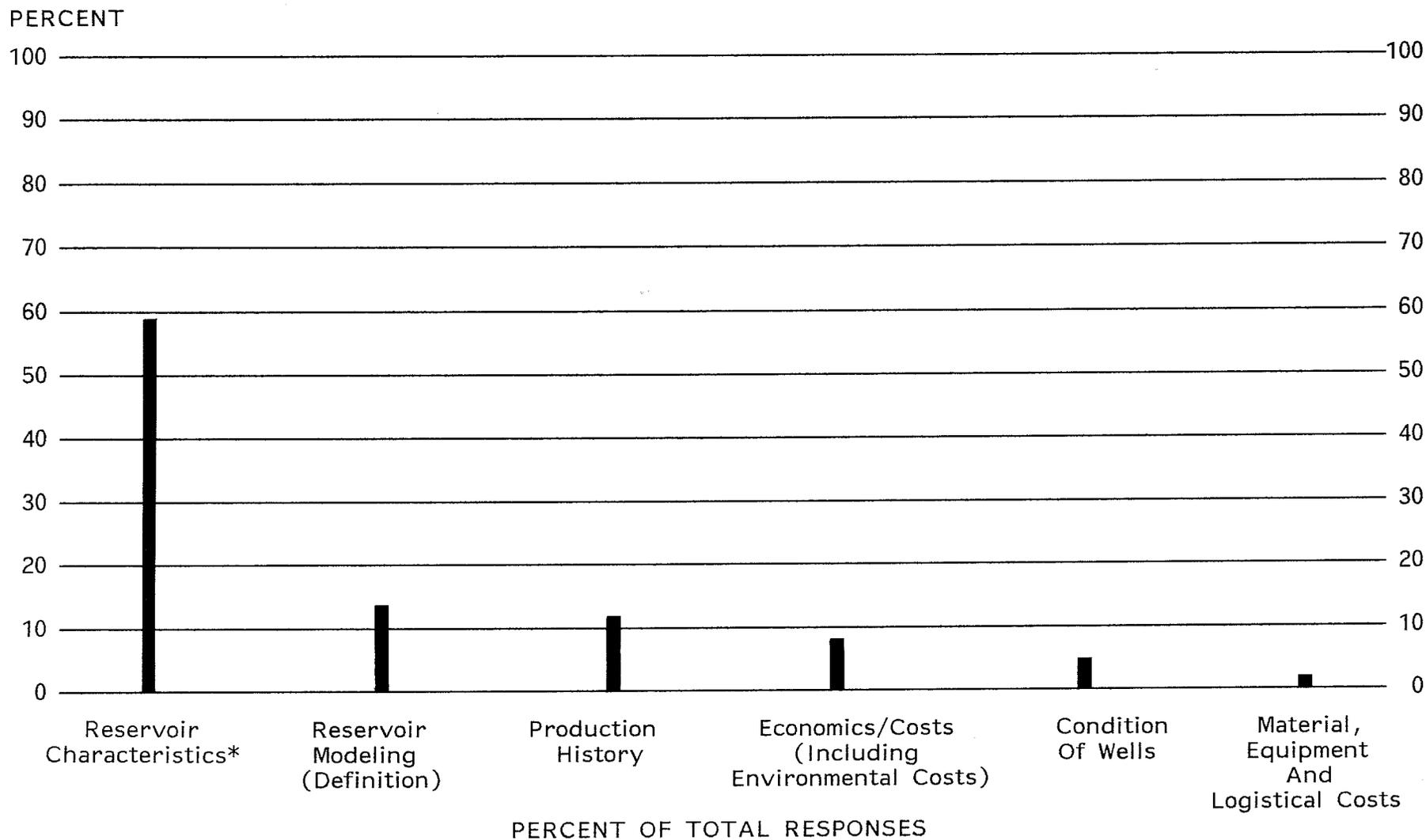
- o The final decision to undertake an EOR project is rarely made at a technical level. In all producer categories, this determination was made at the highest levels of managerial authority.
- o Our observations indicate that even the exploratory phases of EOR involvement (property screening, feasibility determination, etc.) must at least have the support of this level of authority. This would indicate a critical need to keep top management informed of the program and state-of-the-art developments.

Explanation of Exhibits 13-14

All producers were asked to identify specific types of technical data they would require in order to assess the feasibility of an EOR project. Exhibits 13-14 reflect the statistical tabulation of all responses.

- o Fifty-eight percent indicated they needed reservoir lithological data to assess the potential of an EOR process. (Exhibit 14 reflects the individual reservoir characteristics most frequently mentioned.)
- o It should be noted that this (lithological) information was desired for those reservoirs which have had EOR processes applied. Comparisons could then be made to in-house models of reservoirs owned or controlled by the operator and screening guidelines could be developed.
- o Because of the complex heterogeneity of hydrocarbon reservoirs, these screening guides can be utilized only for preliminary evaluations of the properties. Costly and complex testing and analysis must still be performed on the individual reservoir before accurate projections can be made.
- o These factors tend to emphasize a major constraint imposed upon independent operators, who lack the technical expertise or manpower required.

OIL PRODUCERS
 Exhibit 13
Types of EOR Technical Data Required
 (Of 474 total responses)



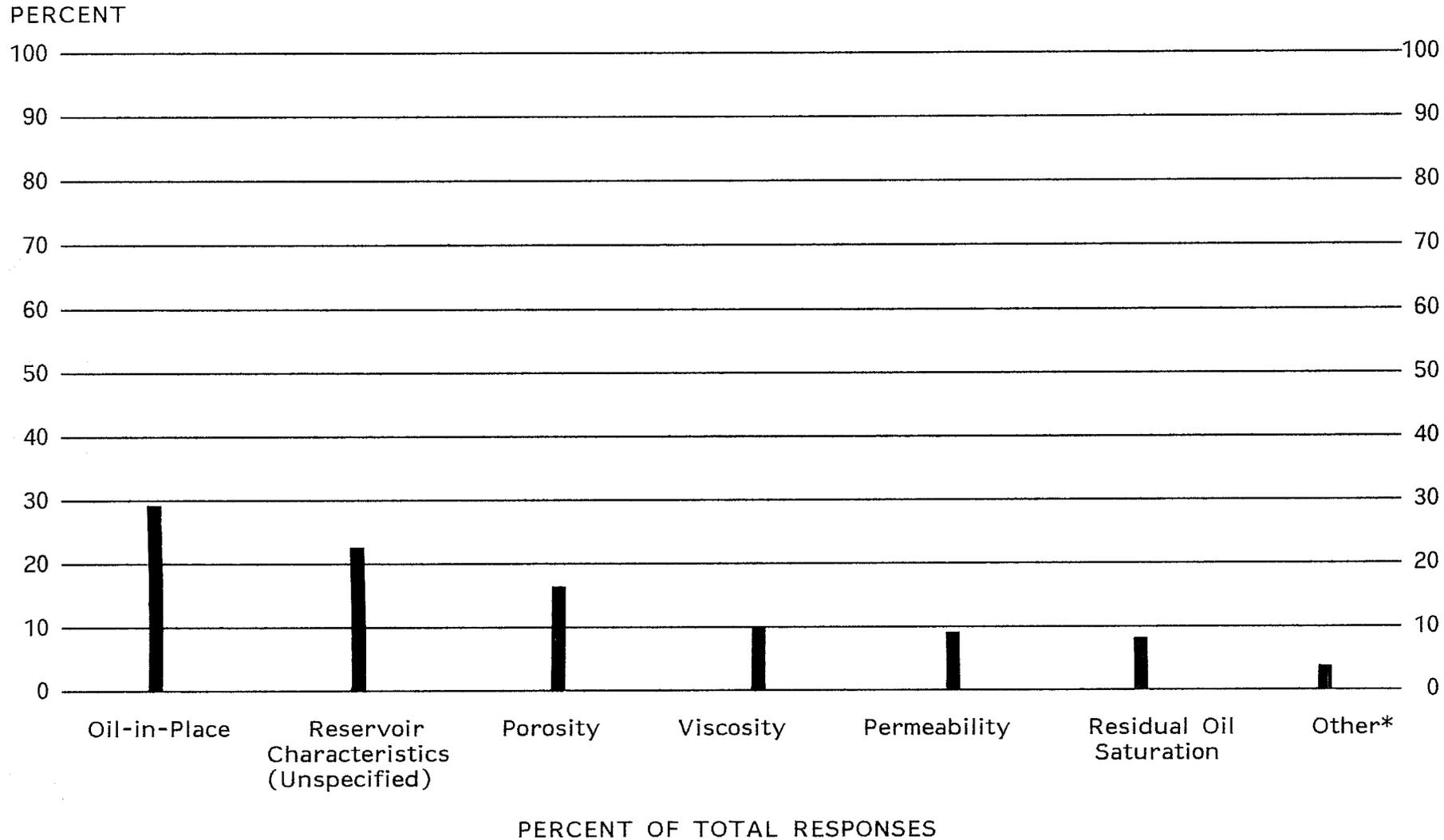
*Includes rock and fluid properties of the reservoir.

OIL PRODUCERS

Exhibit 14

Reservoir Characteristics Needed for EOR Analysis

(Of 274 total responses)



*Includes depth, temperature, pressure.

Explanation of Exhibits 15-23

All producers were asked to rank nine frequently used sources of technical information on a scale of one (lowest) to nine (highest). Exhibits 15-23 reflect the statistical tabulation of this ranking.

Exhibit 15 graphically reflects the overall ranking of technical sources among all producers surveyed.

Exhibit 16 shows the frequency each source was mentioned and the average rating received:

- o Technical journals received the highest ranking and most mentions.
- o Technical reports were the second highest ranked although trade journals and seminar presentations received more mentions. ("Technical Reports" includes DOE publications.)

Exhibits 17-19 are a breakdown of the above information by producer size category.

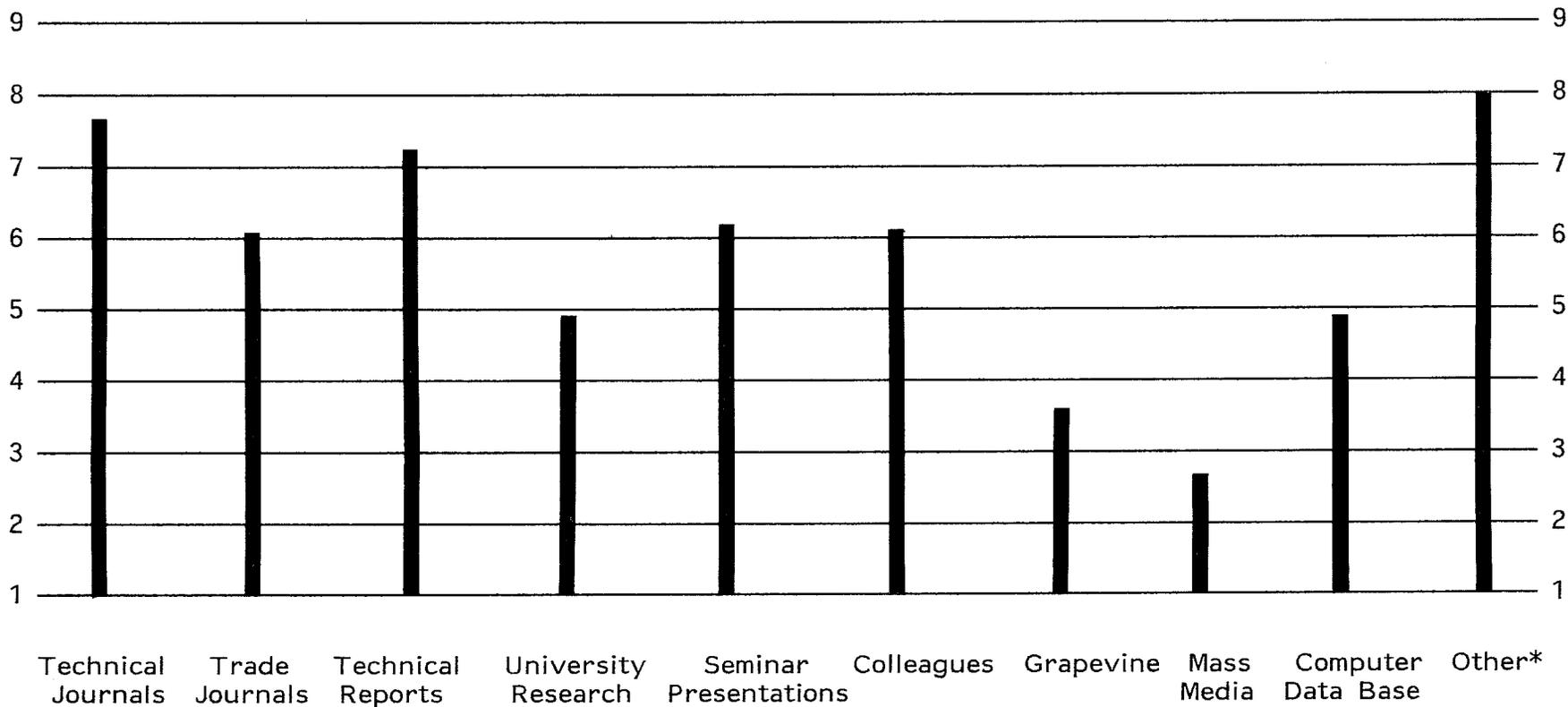
Exhibit 20 compares the ratings in a linear scale by producer size category. The similarity of the trend line indicates that all oil producers rely upon the same sources for technical information.

Exhibits 21-23 compare those highly regarded sources which received an 8 or 9 ranking.

OIL PRODUCERS
 Exhibit 15
Ratings of EOR Technical Information Sources

ALL PRODUCERS
 (Base 126)

RATING SCALE



*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, consultants).

OIL PRODUCERS
Exhibit 16
Ratings of EOR Technical Information Sources

ALL PRODUCERS
(Base 126)

	<u>Average Rating</u>	<u>Frequency Of Mention</u>
Technical Journals	7.70	99%
Technical Reports	7.31	79%
Trade Journals	6.06	98%
Seminar Presentations	6.22	84%
Colleagues	6.10	79%
University Research	4.91	76%
Computer Data Base	4.90	58%
Grapevine	3.58	56%
Mass Media	2.69	52%
Other*	8.00	17%

Note: "Average rating" is the arithmetic mean of all ratings mentioned (on a 1 to 9 scale). "Frequency of mention" represents the percent of respondents who indicated that they use the category in question as a source of technical information. Both numbers are needed to assess information sources fully. For instance, technical reports receive a higher rating than trade journals, but trade journals have more widespread usage.

*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

OIL PRODUCERS
Exhibit 17
Ratings of EOR Technical Information Sources

MAJORS AND INTEGRATED
(Base 40)

	<u>Average Rating</u>	<u>Frequency Of Mention</u>
Technical Journals	7.75	100%
Technical Reports	7.66	88%
Colleagues	6.19	68%
Trade Journals	5.90	98%
Seminar Presentations	5.83	88%
Computer Data Base	5.19	68%
University Research	5.10	78%
Grapevine	3.09	55%
Mass Media	2.91	55%
Other*	8.40	25%

Note: "Average rating" is the arithmetic mean of all ratings mentioned (on a 1 to 9 scale). "Frequency of mention" represents the percent of respondents who indicated that they use the category in question as a source of technical information. Both numbers are needed to assess information sources fully. For instance, technical reports receive a higher rating than trade journals, but trade journals have more widespread usage.

*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

OIL PRODUCERS
Exhibit 18
Ratings of EOR Technical Information Sources

LARGE INDEPENDENTS
(Base 55)

	<u>Average Rating</u>	<u>Frequency Of Mention</u>
Technical Journals	7.58	100%
Technical Reports	7.29	75%
Seminar Presentations	6.43	82%
Trade Journals	6.06	98%
Colleagues	5.99	85%
Computer Data Base	4.65	58%
University Research	4.51	67%
Grapevine	3.00	51%
Mass Media	2.46	47%
Other*	7.55	20%

Note: "Average rating" is the arithmetic mean of all ratings mentioned (on a 1 to 9 scale). "Frequency of mention" represents the percent of respondents who indicated that they use the category in question as a source of technical information. Both numbers are needed to assess information sources fully. For instance, technical reports receive a higher rating than trade journals, but trade journals have more widespread usage.

*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

OIL PRODUCERS
Exhibit 19
Ratings of EOR Technical Information Sources

SMALL INDEPENDENTS
(Base 31)

	<u>Average Rating</u>	<u>Frequency Of Mention</u>
Technical Journals	7.87	97%
Technical Reports	6.83	74%
Seminar Presentations	6.37	81%
Trade Journals	6.29	100%
Colleagues	6.23	81%
University Research	5.39	58%
Computer Data Base	4.93	45%
Grapevine	4.86	68%
Mass Media	2.72	58%
Other*	9.00	3%

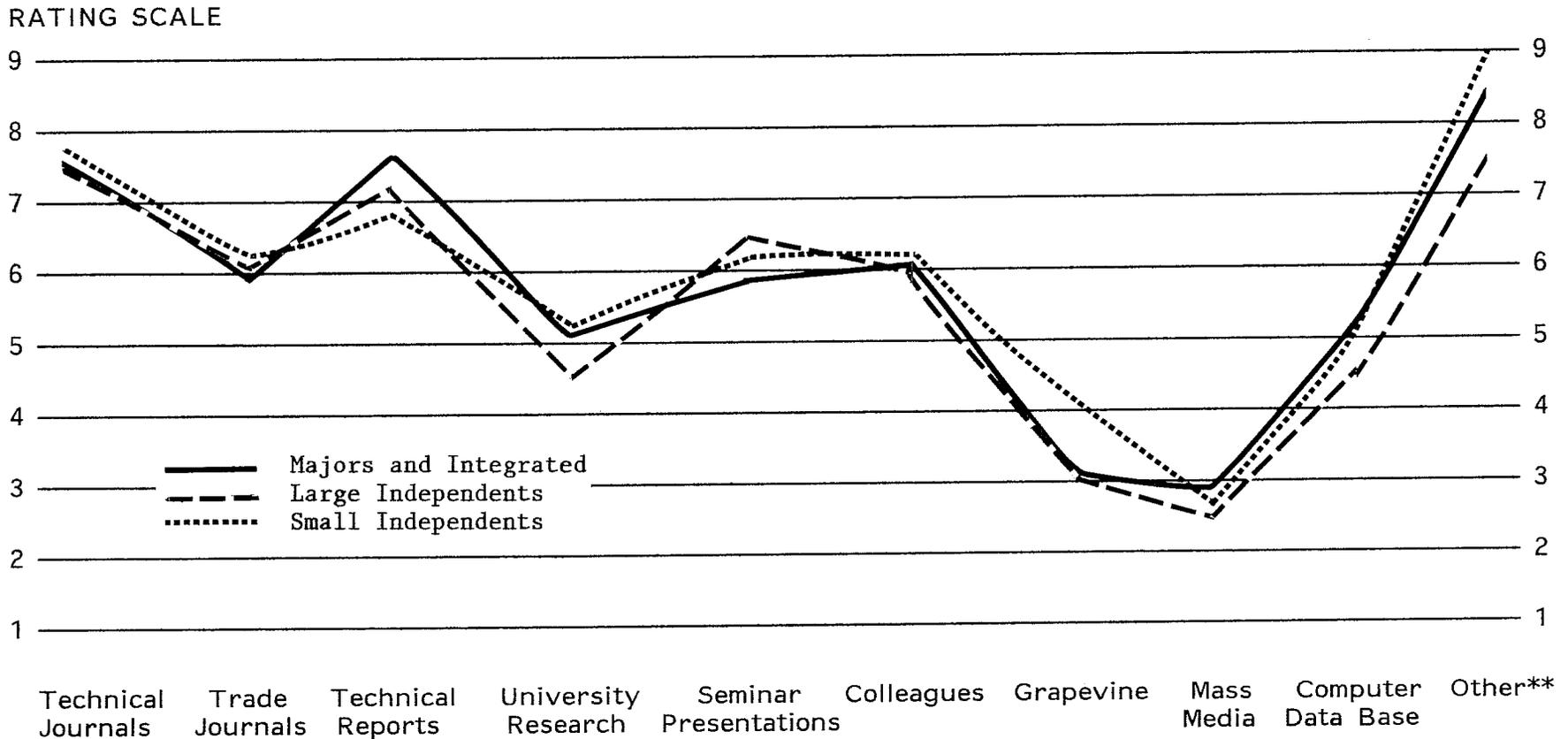
Note: "Average rating" is the arithmetic mean of all ratings mentioned (on a 1 to 9 scale). "Frequency of mention" represents the percent of respondents who indicated that they use the category in question as a source of technical information. Both numbers are needed to assess information sources fully. For instance, technical reports receive a higher rating than trade journals, but trade journals have more widespread usage.

*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

OIL PRODUCERS

Exhibit 20

Comparative Ratings of EOR Technical Information Sources*



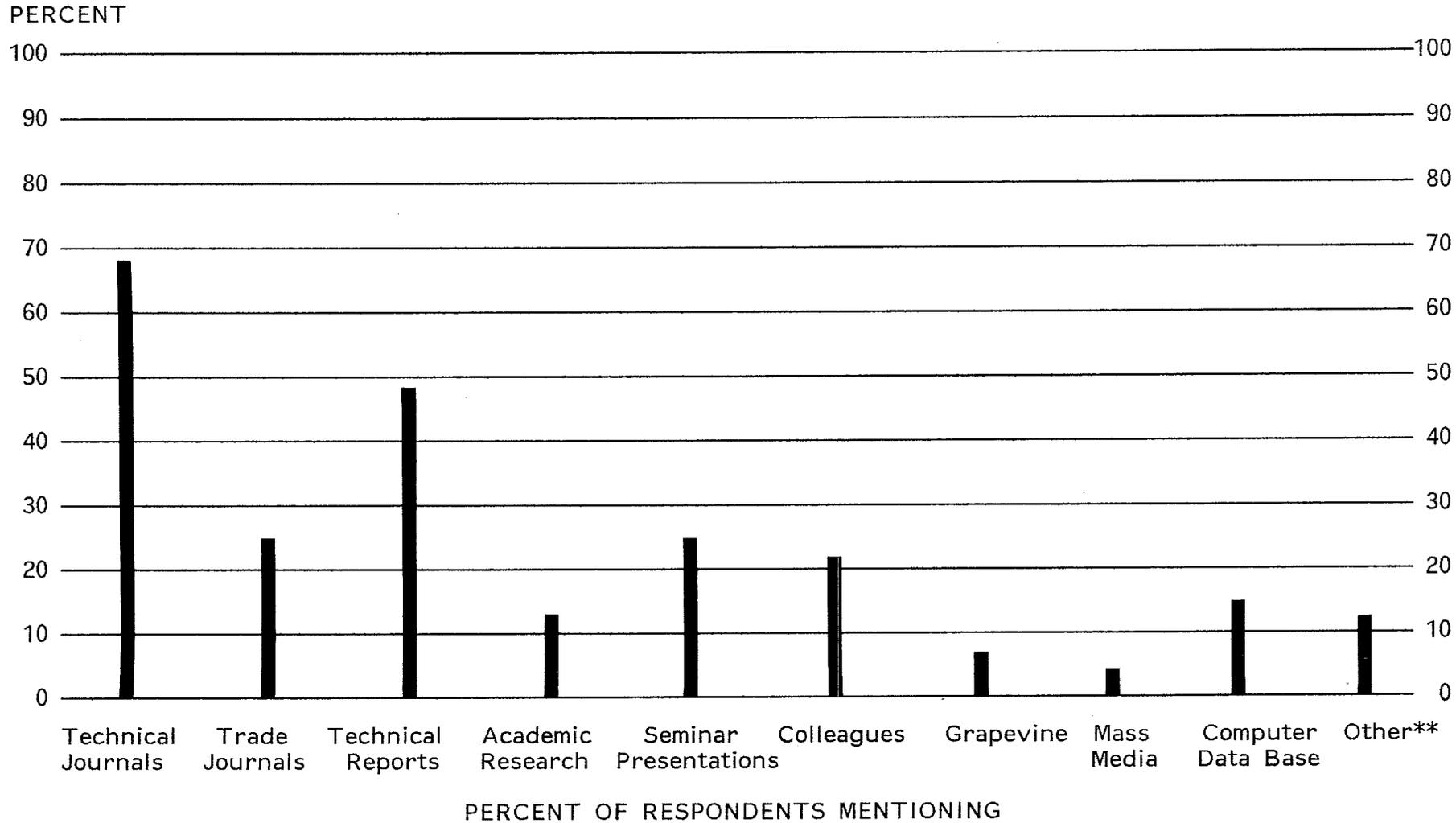
*Respondents were asked to rate various information sources according to their usefulness in supplying technical EOR information. Respondents rated the sources on a 1 to 9 scale (with 9 being the highest rating). Sources were rated independently (rather than placed in rank order) so that it was theoretically possible for all to have equal ratings.

**Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

Highly Regarded Sources of EOR Technical Information*

ALL PRODUCERS

(Base 126)



*Information sources receiving an 8 or 9 rating from respondents.
 **Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants). Of 22 respondents mentioning "other" sources, 16 rated them 8 or 9.

OIL PRODUCERS

Exhibit 22

Highly Regarded Sources of EOR Technical Information

(Sources rated 8 or 9 by respondents)

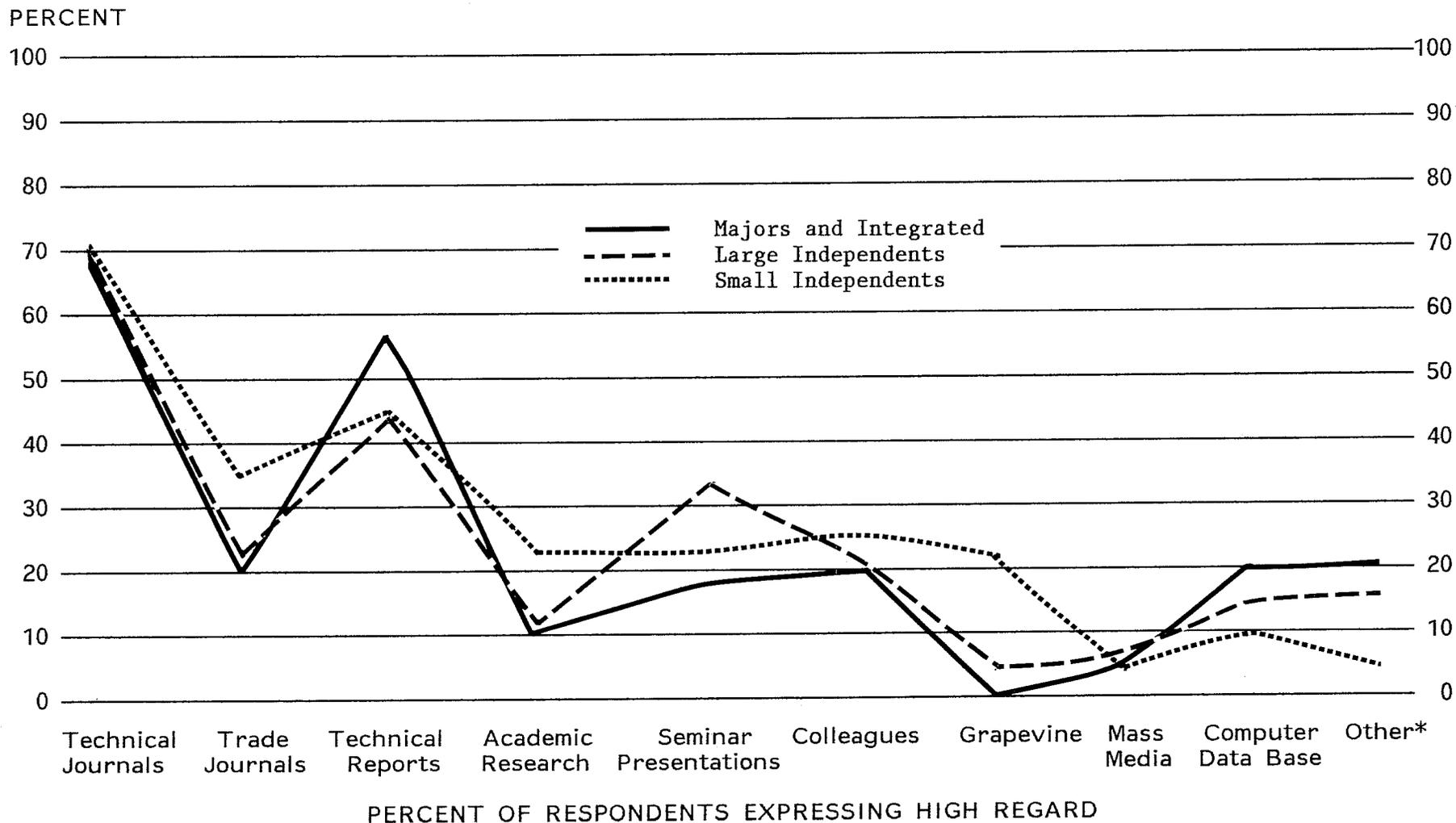
	<u>ALL PRODUCERS</u>		<u>MAJORS AND INTEGRATED</u>		<u>LARGE INDEPENDENTS</u>		<u>SMALL INDEPENDENTS</u>	
	<u># of Mentions</u>	<u>Percent</u>	<u># of Mentions</u>	<u>Percent</u>	<u># of Mentions</u>	<u>Percent</u>	<u># of Mentions</u>	<u>Percent</u>
Technical Journals	86	68%	27	68%	37	67%	22	71%
Trade Journals	31	25%	8	20%	12	22%	11	35%
Technical Reports	61	48%	23	58%	24	44%	14	45%
Academic Research	16	13%	3	8%	6	11%	7	23%
Seminar Presentations	32	25%	7	18%	18	33%	7	23%
Colleagues	28	22%	8	20%	12	22%	8	26%
Grapevine	9	7%	--	--	2	4%	7	23%
Mass Media	5	4%	2	5%	2	4%	1	3%
Computer Data Base	19	15%	8	20%	8	15%	3	10%
Other*	16	13%	8	20%	7	13%	1	3%
	(Base 126)		(Base 40)		(Base 55)		(Base 31)	

*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

OIL PRODUCERS

Exhibit 23

Highly Regarded Sources of EOR Technical Information (Those sources receiving 8 or 9 rating from respondents)



*Includes in-house sources and other oil industry sources (API, AAPG, NPC, IPAA, Consultants).

Exhibit 24

- o There appears to be a direct correlation between active involvement in EOR and being "plugged in" to the current dissemination of DOE information (see Current Status of EOR Involvement, Page 32). Those companies most heavily involved (majors and integrated) receive DOE information (88%), while almost equal percent (84%) of small independents do not receive it.
- o Since the overwhelming majority of those familiar with BETC information rated it as "good" to "excellent," it can be concluded that BETC has filled an information void (at least among oil producers actively involved in EOR).
- o Many of those interviewed have continued to "track" the progress of certain projects which closely resemble the type projects they are contemplating.

OIL PRODUCERS

Exhibit 24

EOR Information Received from DOE

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
No, Don't Receive	51%	12%	60%	84%
Yes, Do Receive	49%	88%	40%	16%

TYPES OF INFORMATION RECEIVED

(Multiple Responses)

Quarterly Reports	45%	86%	35%	12%
Annual Reports	17%	40%	11%	--
Other Information*	22%	43%	16%	6%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

*Includes monthly and special reports, newsletters, regulations information, and EOR Symposium Proceedings.

OIL PRODUCERS

Exhibit 25

Assessment of EOR Information from BETC

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Excellent	7%	7%	9%	3%
Good	31	52	24	16
Fair	10	19	7	3
Poor	2	5	2	--
Not Familiar	<u>50</u>	<u>17</u>	<u>58</u>	<u>78</u>
TOTAL	100%	100%	100%	100%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

- o Among those currently receiving BETC information (notably majors), most have a high regard for its usefulness.
- o This assessment indicates that BETC is fulfilling a major role in technology transfer among the technical community currently involved in EOR.

OIL PRODUCERS
 Exhibit 26
Content of BETC Quarterly Report
 (Of 41 total responses)

		A M O U N T O F I N F O R M A T I O N			
		Not Enough	About Right	Too Much	TOTAL PERCENT
T E C H N I C A L D E T A I L	Not Enough	10%	15%	2%	27%
	About Right	2%	61%	6%	69%
	Too Much	2%	0%	2%	4%
TOTAL PERCENT		14%	76%	10%	↓ → 100%

- o Overall, the Quarterly Progress Reviews were considered "about right" in both the amount of information and technical detail, although over one-fourth (27%) felt that more technical detail should be included.

OIL PRODUCERS

Exhibit 27

Quarterly Progress Report's Greatest Strength

ALL PRODUCERS

(Base 42)*

<u>STRENGTH</u>	<u>PERCENT</u>
Good technical reference source providing concise state-of-the- art information	81%
The most timely update of state- of-the-art available	5
Most detailed technical reference available	14
TOTAL	100%

*Representing 71% of those who receive the Quarterly Progress Review, the distribution of comments by sub-
catagory is:

Major/Integrated	29
Large Independent	12
Small Independent	<u>1</u>
	42

OIL PRODUCERS
 Exhibit 28
Quarterly Progress Report's Greatest Weakness

ALL PRODUCERS
 (Base 47)*

<u>WEAKNESS</u>	<u>PERCENT</u>
Information is not sufficient enough	47%
No interpretations of results stated	22
No cost data	7
Too much information, needs to be more concise	15
No weakness	<u>9</u>
TOTAL	100%

*Representing 76% of those who receive Quarterly Progress Review, the distribution of comments by sub-catagory is:

Major/Integrated	29
Large Independent	15
Small Independent	<u>3</u>
	47

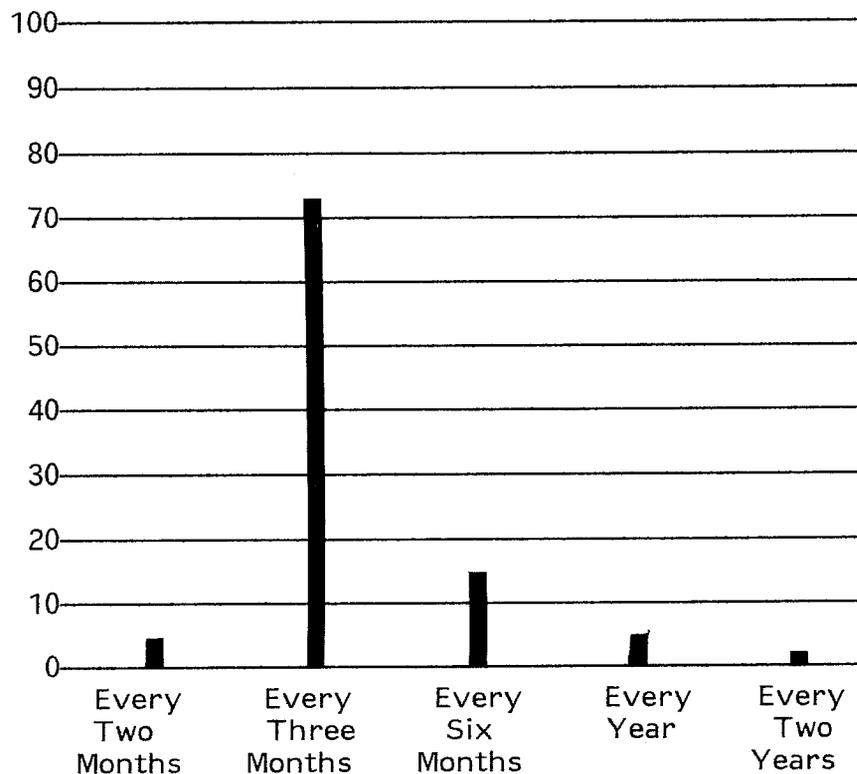
OIL PRODUCERS

Exhibit 29

Preferred Frequency of BETC Progress Review

(Of 41 total responses)

PERCENT



PREFERRED FREQUENCY

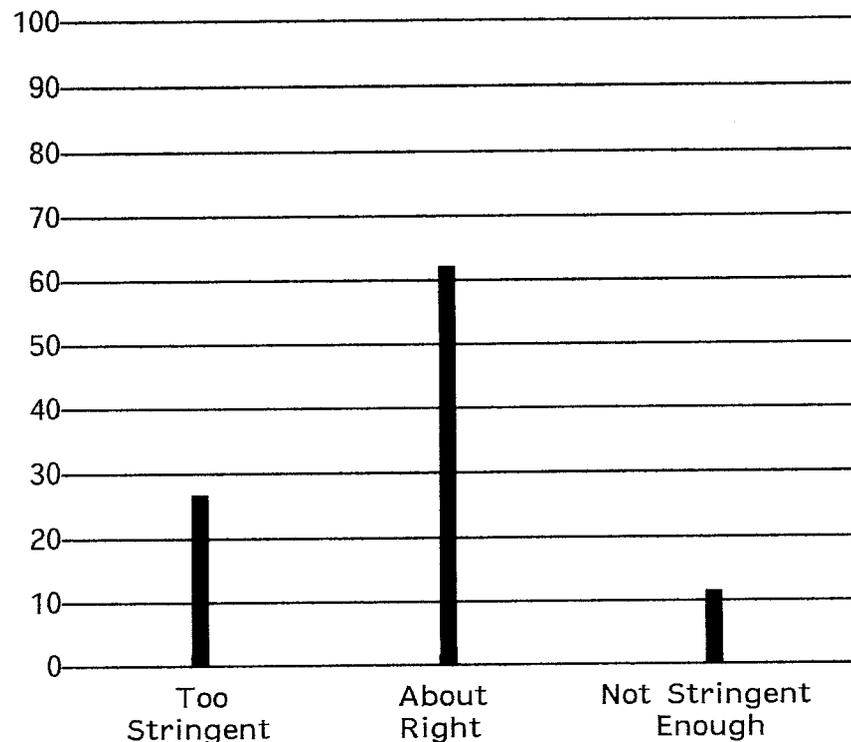
OIL PRODUCERS

Exhibit 30

Assessment of Cost-Share Program

Reporting Requirements

(Of 26 total responses)

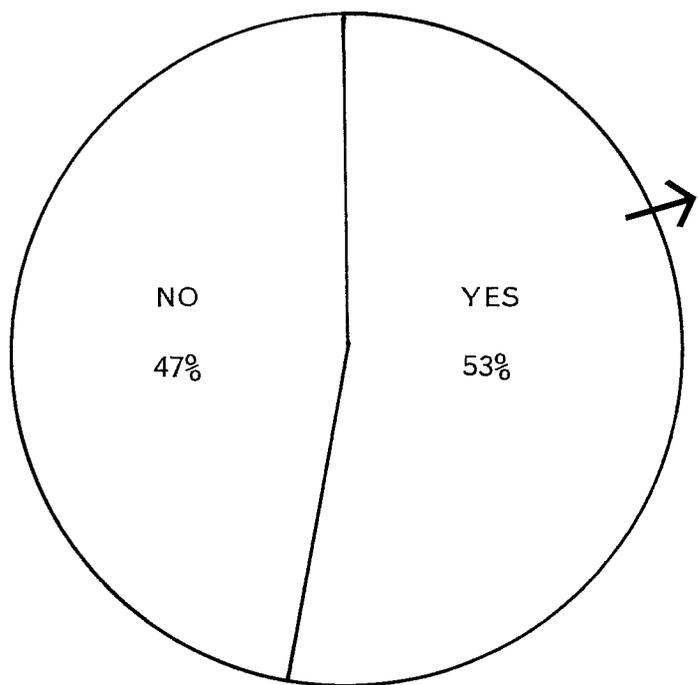


ASSESSMENT OF REQUIREMENTS

OIL PRODUCERS
 Exhibit 31
In-House Technical Data Base Usage

ALL PRODUCERS
 (Base 132)

Do you have an internal data base for technical information?



USEFULNESS OF THIS DATA BASE FOR EOR

	<u>Percent</u>
EOR is included	4%
EOR being included	14
EOR is limited	7
EOR not included	42
EOR use is unknown	<u>33</u>
TOTAL	100%

- o While over half of the producers surveyed have an in-house technical data base, three-fourths of this group indicated that EOR information is not included.
- o The significant lack of in-house EOR data sources corresponds directly with the strong support indicated for an EOR Technical Information Center (Exhibit 33).

OIL PRODUCERS

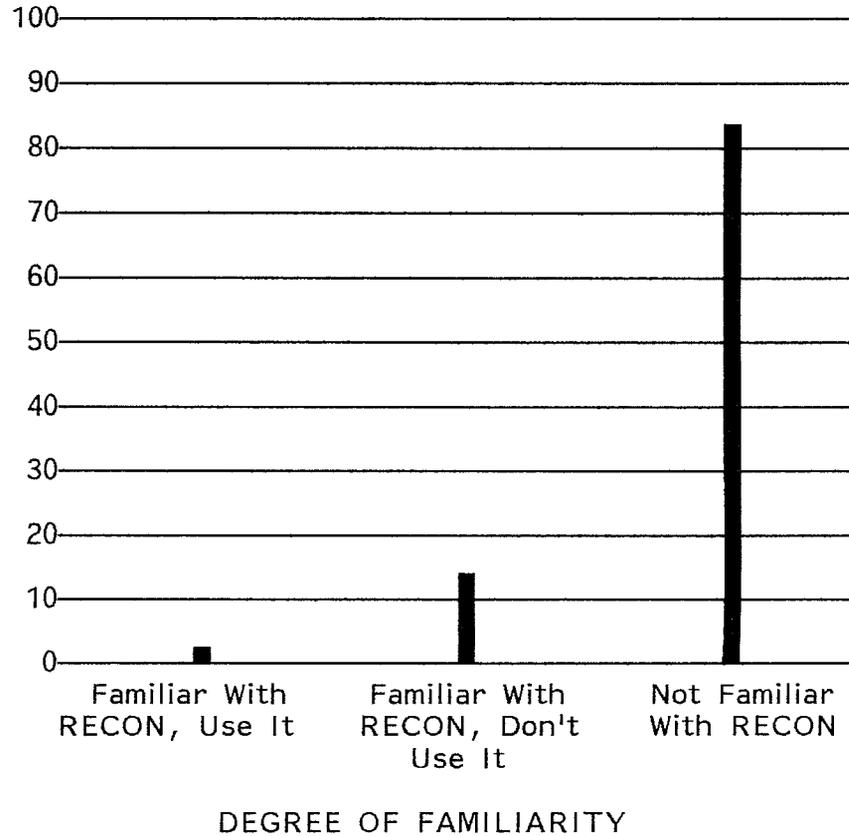
Exhibit 32

Familiarity with RECON System

ALL PRODUCERS

(Base 132)

PERCENT



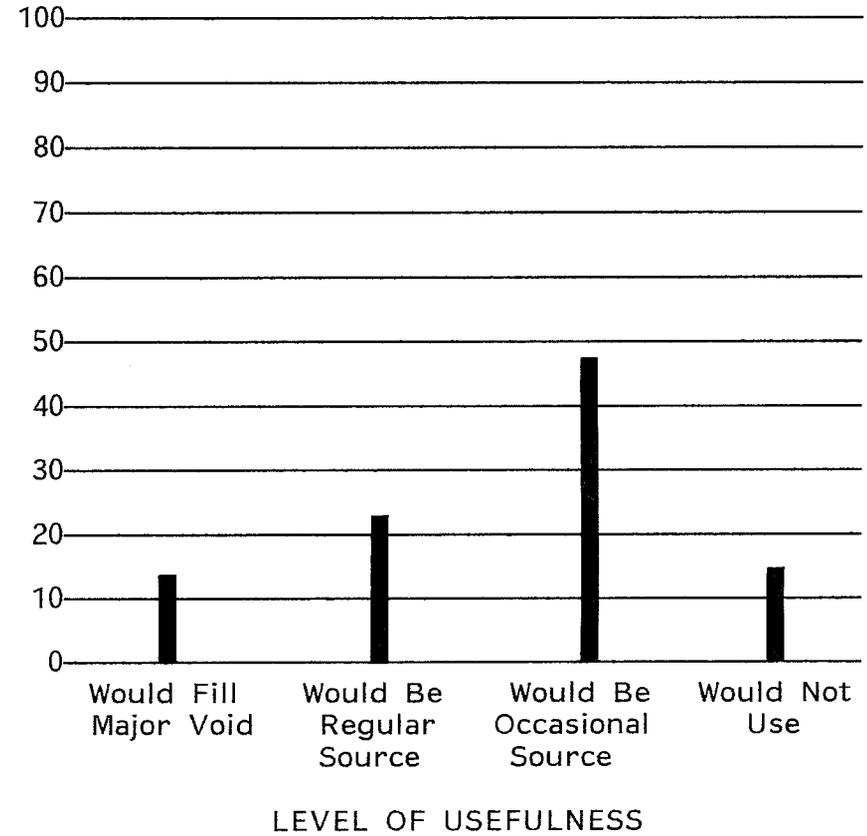
OIL PRODUCERS

Exhibit 33

Usefulness of EOR Technical Information Center

ALL PRODUCERS

(Base 129)



- o DOE's RECON System has very little support among oil producers as a reliable information source.
- o On the other hand, 85 percent of those surveyed indicated they would utilize a special EOR information center if it were available. Many expressed a desire for such a center to be located at BETC.

OIL PRODUCERS
Exhibit 34
Familiarity with RECON System

	<u>ALL PRODUCERS</u>		<u>MAJORS AND INTEGRATED</u>		<u>LARGE INDEPENDENTS</u>		<u>SMALL INDEPENDENTS</u>	
	<u>Total Mentions</u>	<u>Percent</u>	<u>Total Mentions</u>	<u>Percent</u>	<u>Total Mentions</u>	<u>Percent</u>	<u>Total Mentions</u>	<u>Percent</u>
Familiar with RECON, Use It	3	2%	3	7%	--	--	--	--
Familiar with RECON, Don't Use It	19	14%	12	29%	4	7%	3	9%
Not Familiar with RECON	110	84%	27	64%	53	93%	30	91%
	(Base 132)		(Base 42)		(Base 57)		(Base 33)	

OIL PRODUCERS

Exhibit 35

Expected Usefulness of a Special EOR Technical Information Center

	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
It would fill a major void as EOR technology source	14%	7%	14%	22%
It would become a regular source of information	23	27	23	19
It would be useful to us occasionally	33	46	25	28
Might be useful in a few instances	15	5	20	19
Can't foresee our using it at all	<u>15</u>	<u>15</u>	<u>18</u>	<u>12</u>
TOTAL	100%	100%	100%	100%
	(Base 129)	(Base 41)	(Base 56)	(Base 32)

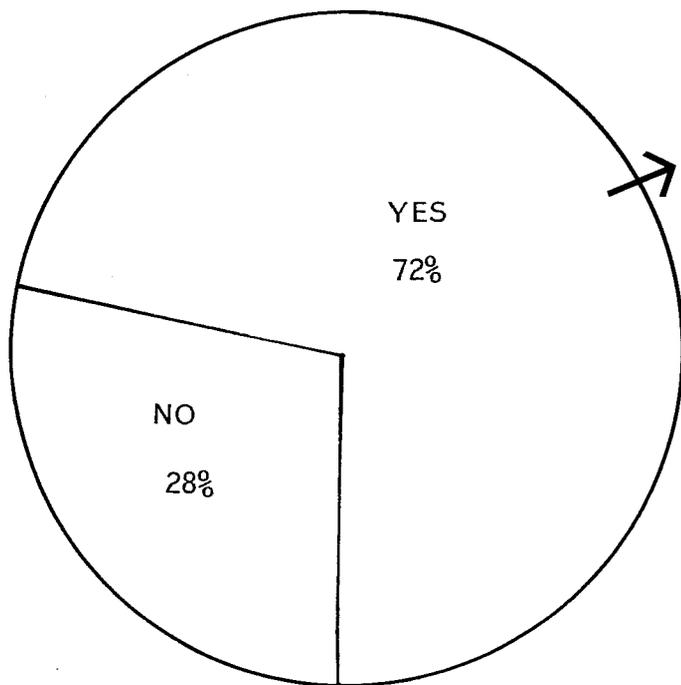
OIL PRODUCERS

Exhibit 36

Will Information Needs Change in the Future?

ALL PRODUCERS

(Base 132)



TYPES OF INFORMATION NEEDS THAT WILL INCREASE

	<u>Percent</u>
General state-of-the-art information	64%
Detailed economic information	13
Technical assistance or advice	10
Reservoir and/or production histories specific to EOR process successes and failures	<u>13</u>
TOTAL	100%

OIL PRODUCERS

Exhibit 37

Types of EOR Information Desired from BETC

(Percent of repondents mentioning)

[Multiple Responses]

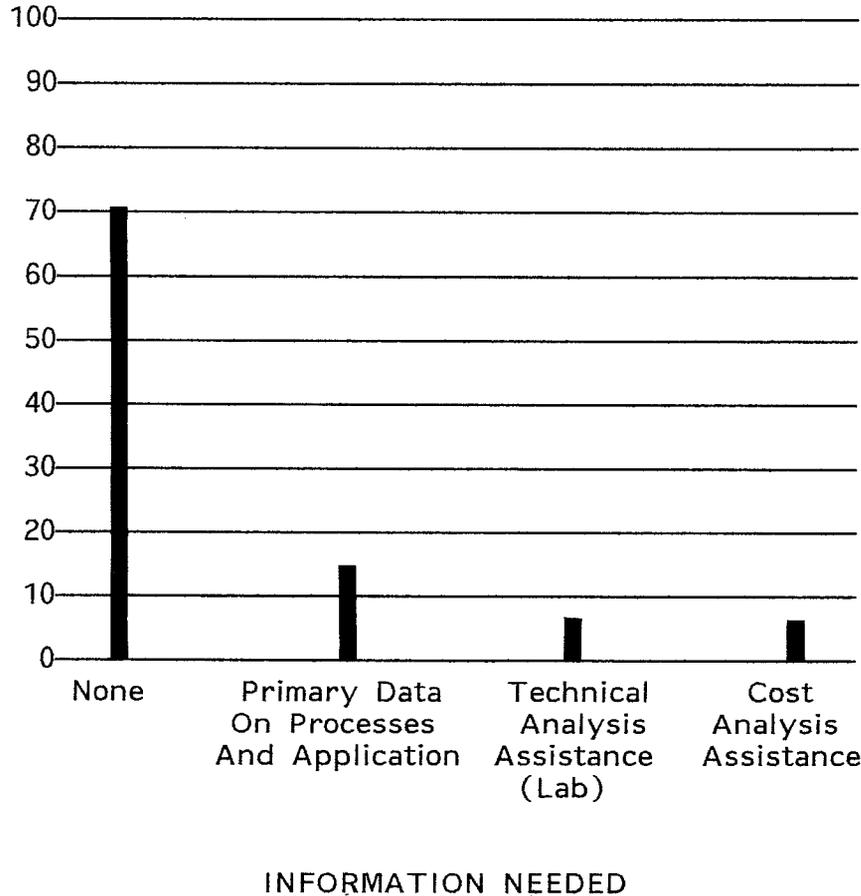
	<u>All Producers</u>	<u>Majors and Integrated</u>	<u>Large Independents</u>	<u>Small Independents</u>
Technical reports (specific to a reservoir)	60%	62%	60%	55%
Technical reports (specific to a process)	67%	69%	65%	67%
Quarterly reports	55%	50%	51%	67%
Graphic material (maps and charts, etc.)	30%	29%	30%	33%
Summary data on EOR state-of-the-art	58%	52%	60%	61%
Detailed discussion of cost factors	56%	69%	49%	52%
Detailed discussions of engineering alternatives, trade-offs (specific to a reservoir)	56%	64%	54%	48%
Detailed discussions of engineering alternatives, trade-offs (specific to a process)	57%	67%	54%	48%
	(Base 132)	(Base 42)	(Base 57)	(Base 33)

LARGE INDEPENDENTS

Exhibit 38

Specific Information Needs Unique to Independents
(Of 41 total responses)

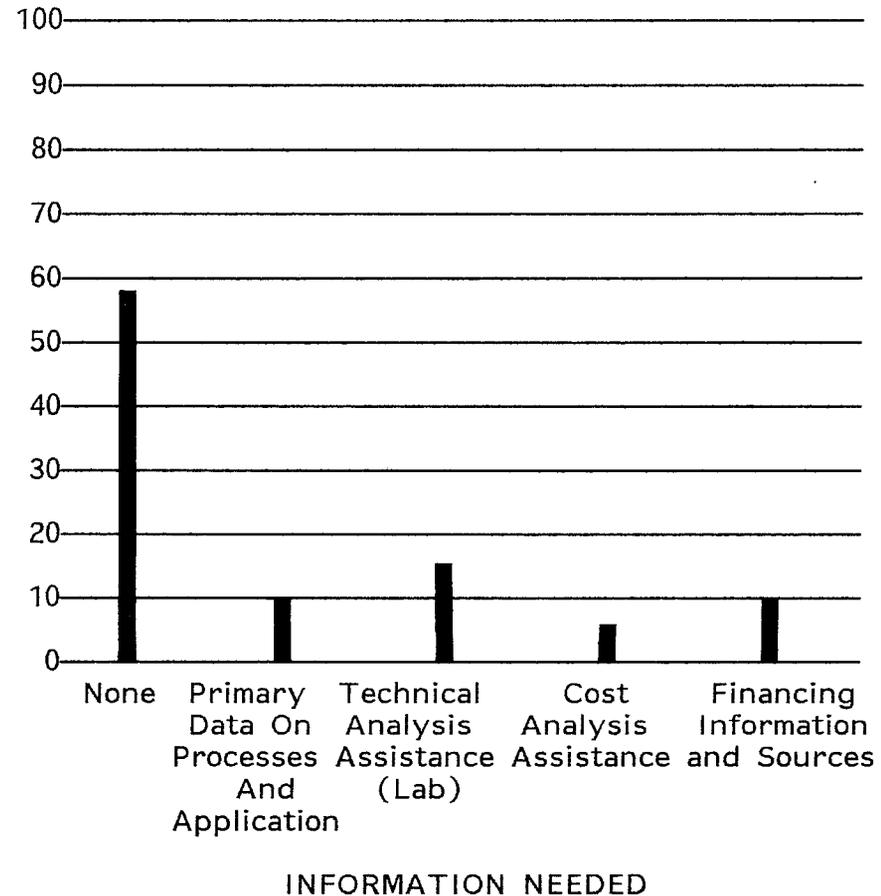
PERCENT



SMALL INDEPENDENTS

Exhibit 39

Specific Information Needs Unique to Independents
(Of 31 total responses)



o While most independents did not perceive any unique information needs, it should be kept in mind that over half of the independents surveyed are only generally aware of EOR technology.

Explanation of Exhibit 40

Commitment to an EOR project involves many levels of decision makers who rely upon both technical (process) and non-technical data to evaluate potential EOR projects and formulate their decisions.

Exhibit 40 reflects the sources oil producers rely upon for both economic and environmental protection information relating to EOR.

- o Note that technical journals, which were the most preferred and most highly regarded source for technical information, are the least preferred source for other critical types of EOR information.
- o Since external sources are relied upon so heavily for these types of data, a special information newsletter should be considered for distribution to decision makers involved in economic and environmental decisions.

OIL PRODUCERS

Exhibit 40

Other EOR Information Sources (By Data Type)

ALL PRODUCERS

(Multiple Responses)

	Economic Information Concerning <u>EOR</u>	Environmental Information Concerning Oil <u>Production</u>
Technical Journals (JPT-SPEJ)	3%	--
Trade Journals	9	4%
Government Sources	10	63
In-House Sources	41	16
Oil Industry Sources*	30	15
Meetings and Seminars	4	--
Others	<u>3</u>	<u>2</u>
TOTAL	100%	100%
	(Of 112 total responses)	(Of 99 total responses)

*Includes oil field service companies, Consultants, API, IPAA, other oil companies.

Explanation of Exhibits 41-44

Producers were asked to identify specific types of cost data required to determine the economic feasibility of an EOR project. Each respondent was asked to list the items in order of their importance.

Exhibit 41 reflects the overall response of all producers surveyed.

Exhibits 42-44 reflect the same information by producer size category.

- o While slight differences do exist in the importance most producers place on these type data, the statistical correlations indicate a uniform need for the same types of data.
- o Efforts should be made to obtain these types of information from the demonstration projects since no other sources are available.

OIL PRODUCERS

Exhibit 41

Cost Data Needed to Determine Economic Feasibility

(Ranked in order by first mention)

ALL PRODUCERS

(Base 132)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>FOURTH MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Material Costs	45	40%	14	14%	5	7%	4	9%	68	21%
Capital Investment	33	29	31	32	14	20	3	7	81	25
Overall Economics	25	22	19	19	16	23	13	30	73	23
Operating Costs	9	8	30	31	17	25	16	36	72	22
Environmental Costs	<u>1</u>	<u>1</u>	<u>4</u>	<u>4</u>	<u>17</u>	<u>25</u>	<u>8</u>	<u>18</u>	<u>30</u>	<u>9</u>
TOTAL	113	100%	98	100%	69	100%	44	100%	324	100%

- o Material costs (chemicals, CO₂, water, etc.) were the most frequent "first mention" but rank fourth in overall importance (indicating an initial preoccupation with such costs).
- o Of respondents who specified types of costs, 93 percent mentioned the cost of chemicals. Only 7 percent mentioned the cost of CO₂.
- o Initial capital investment requirements appear to be the most important cost item needed.
- o Once capital expense has been determined and overall economics considered (i.e., price, ROI, etc.), cost of operation becomes increasingly important.

OIL PRODUCERS

Exhibit 42

Cost Data Needed to Determine Economic Feasibility

(Ranked in order by first mention)

MAJORS AND INTEGRATED

(Base 42)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>FOURTH MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Material Costs	14	37%	5	15%	3	14%	2	12%	24	22%
Overall Economics	10	26	6	18	6	29	4	23	26	24
Capital Investment	7	18	10	30	6	29	2	12	25	23
Operating Costs	6	16	11	33	5	24	7	41	29	27
Environmental Costs	<u>1</u>	<u>3</u>	<u>1</u>	<u>3</u>	<u>1</u>	<u>4</u>	<u>2</u>	<u>12</u>	<u>5</u>	<u>4</u>
TOTAL	38	100%	33	100%	21	100%	17	100%	109	100%

- o Since most majors have already determined capital investment costs, they appear more concerned with how material and operating costs affect the overall economics of a project.
- o Environmental costs do not appear to significantly affect the economic decisions of the major/integrated producer group.

OIL PRODUCERS

Exhibit 43

Cost Data Needed to Determine Economic Feasibility

(Ranked in order by first mention)

LARGE INDEPENDENTS

(Base 57)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>FOURTH MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Material Costs	19	41%	6	15%	--	--	--	--	25	20%
Capital Investment	16	35	14	36	4	16%	--	--	34	27
Overall Economics	8	17	9	23	7	28	8	53	32	26
Operating Costs	3	7	7	18	7	28	6	40%	23	18
Environmental Costs	--	--	<u>3</u>	<u>8</u>	<u>7</u>	<u>28</u>	<u>1</u>	<u>7</u>	<u>11</u>	<u>9</u>
TOTAL	46	100%	39	100%	25	100%	15	100%	125	100%

OIL PRODUCERS

Exhibit 44

Cost Data Needed to Determine Economic Feasibility

(Ranked in order by first mention)

SMALL INDEPENDENTS

(Base 33)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>FOURTH MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Material Costs	12	41%	3	12%	2	9%	2	17%	19	21%
Capital Investment	10	35	7	27	4	17	1	8	22	24
Overall Economics	7	24	4	15	3	13	1	8	15	17
Operating Costs	--	--	12	46	5	22	3	25	20	22
Environmental Costs	--	--	--	--	<u>9</u>	<u>39</u>	<u>5</u>	<u>42</u>	<u>14</u>	<u>16</u>
TOTAL	29	100%	26	100%	23	100%	12	100%	90	100%

- o Among small independents (where EOR awareness is lowest), the greatest concerns are material costs and capital investment. Operating cost did not receive a single first mention.
- o Material costs received more first mentions but ranked third overall. Most of these responses were directed toward cost of chemical materials. Since chemical processes are the least likely type process for an independent to be in, one can easily see the need for "awareness of the state-of-the-art information."

Explanation of Exhibits 45-48

Producers were asked to identify the major constraints restricting their company from becoming involved in commercial scale EOR projects in the immediate future. Each respondent was asked to list the constraints in order of their importance.

Exhibit 45 shows the response of all producers.

Exhibit 46-48 reflect the same response broken out by producer size category.

- o Significant percentages of independents indicate that lack of suitable properties is the major constraint prohibiting commercial involvement in EOR.
- o Ten percent of major and integrated companies, 38 percent of large independents and 33 percent of small independents list "Lack of Suitable Properties" as their major constraint. These figures correspond highly to those companies we currently place in Phases I and II. If our estimates are accurate, these companies cannot be expected to move any further toward commercialization in the near future.
- o Most producers viewed economic constraints to be the most restrictive to commercial development of EOR.
- o Technical uncertainties ranked relatively low in all producer categories. This may be due to the level most respondents occupy in the corporate structure. Since most were upper level management, they are, perhaps, more concerned with the economics than the technical aspects of EOR.

OIL PRODUCERS

Exhibit 45

Constraints Restricting Involvement in EOR on Commercial Scale

(Ranked in order by first mention)

ALL PRODUCERS

(Base 132)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Unfavorable Economics	47	36%	31	36%	6	14%	84	32%
Lack of Suitable Properties	37	28	2	3	4	10	43	16
Crude Oil Prices	20	15	8	9	3	7	31	12
Technological Uncertainties	11	8	9	10	5	12	25	10
Lack of EOR Expertise	6	5	18	21	10	24	34	13
Government Policies	5	4	3	3	7	17	15	6
Environmental Restraints	3	2	6	7	1	2	10	4
Risk Involved	1	1	10	11	6	14	17	6
No Constraints	<u>2</u>	<u>1</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>2</u>	<u>1</u>
TOTAL	132	100%	87	100%	42	100%	261	100%

OIL PRODUCERS

Exhibit 46

Constraints Restricting Involvement in EOR on Commercial Scale

(Ranked in order by first mention)

MAJORS AND INTEGRATED

(Base 42)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Unfavorable Economics	21	50%	6	25%	2	20%	29	38%
Crude Oil Prices	7	17	3	13	--	--	10	13
Technological Uncertainties	4	10	6	25	3	30	13	17
Lack of Suitable Properties	4	10	--	--	1	10	5	7
Government Policies	2	5	1	3	1	10	4	5
Risk Involved	1	2	5	21	1	10	7	9
Environmental Restraints	1	2	3	13	--	--	4	6
Lack of EOR Expertise	1	2	--	--	2	20	3	4
No Constraints	<u>1</u>	<u>2</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>1</u>	<u>1</u>
TOTAL	42	100%	24	100%	10	100%	76	100%

OIL PRODUCERS

Exhibit 47

Constraints Restricting Involvement in EOR on Commercial Scale

(Ranked in order by first mention)

LARGE INDEPENDENTS

(Base 57)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Lack of Suitable Properties	22	38%	2	5%	1	6%	25	21%
Unfavorable Economics	17	30	16	40	3	17%	36	31
Crude Oil Prices	9	16	5	12	--	--	14	12
Lack of EOR Expertise	3	5	11	27	6	33	20	17
Technological Uncertainties	3	5	1	3	2	11	6	5
Government Policies	2	4	1	3	3	16	7	6
Risk Involved	--	--	4	10	2	11	7	6
Environmental Restraints	--	--	--	--	1	6	1	1
No Constraints	<u>1</u>	<u>2</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>1</u>	<u>1</u>
TOTAL	57	100%	40	100%	18	100%	115	100%

OIL PRODUCERS

Exhibit 48

Constraints Restricting Involvement in EOR on Commercial Scale

(Ranked in order by first mention)

SMALL INDEPENDENTS

(Base 33)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>THIRD MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Lack of Suitable Properties	11	33%	--	--	2	15%	13	19%
Unfavorable Economics	9	28	9	39%	1	8	19	27
Crude Oil Prices	4	12	--	--	3	23	7	10
Technological Uncertainties	4	12	2	9	--	--	6	9
Lack of EOR Expertise	2	6	7	31	2	15	11	16
Environmental Restraints	2	6	3	13	--	--	5	7
Government Policies	1	3	1	4	2	15	4	6
Risk Involved	--	--	1	4	3	23	4	6
No Constraints	--	--	--	--	--	--	--	--
TOTAL	33	100%	23	100%	13	100%	69	100%

LARGE INDEPENDENTS

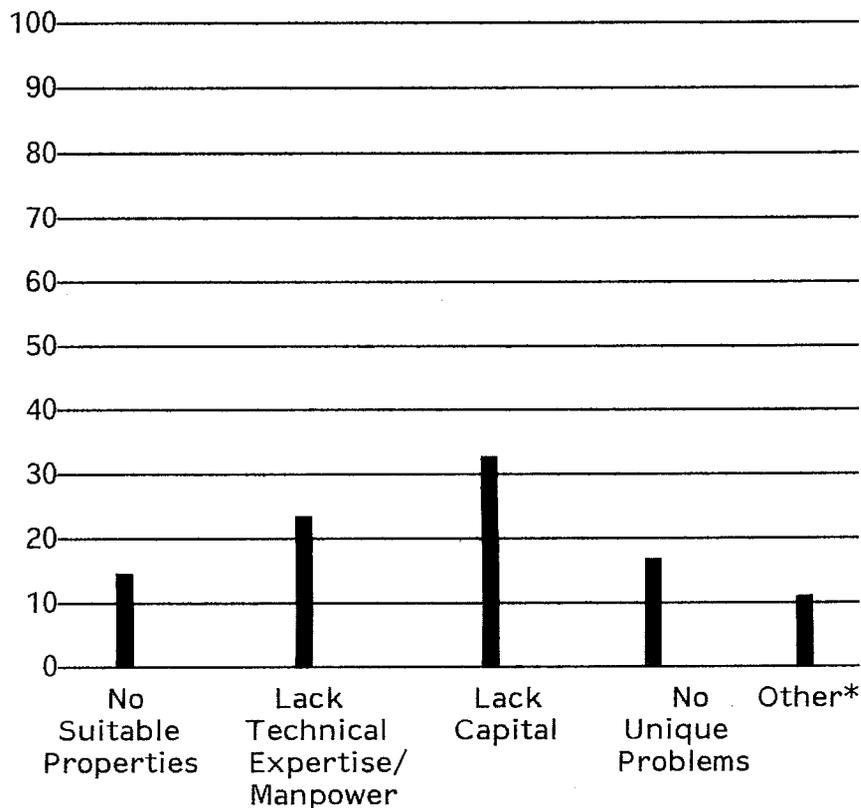
Exhibit 49

Problems Unique to Independents

Affecting Involvement in EOR

(Of 66 total responses)

PERCENT



UNIQUE PROBLEMS

*Other includes: government regulation, uncertain government policy, materials, availability, lack of tax incentive, and don't know.

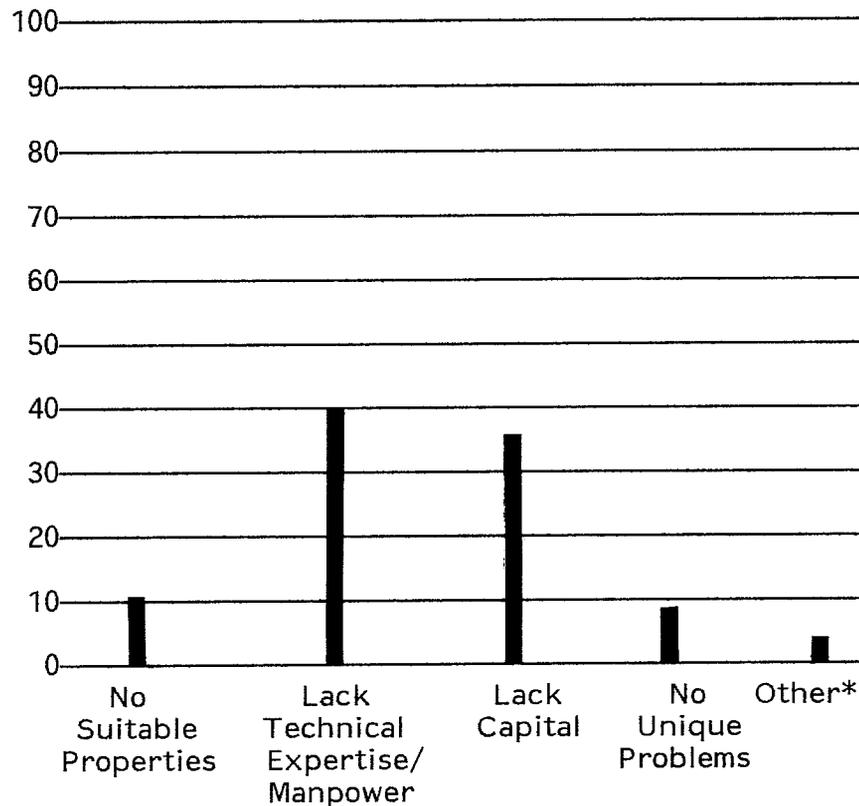
SMALL INDEPENDENTS

Exhibit 50

Problems Unique to Independents

Affecting Involvement in EOR

(Of 47 total responses)



UNIQUE PROBLEMS

*Other includes: environmental controls and government uncertainty.

Explanation of Exhibits 51-54

All producers were asked to comment on actions that might allow them to overcome the current constraints to their involvement in a commercial EOR project.

Exhibit 51 reflects the overall response of all producers.

Exhibits 52-54 reflect the breakout by producer size category. It should be noted that over half of the producers surveyed chose decontrol of oil prices as the most important action required. Since this is an emotional issue that was being heatedly discussed at the time of this study, these answers must be weighed accordingly. It is interesting how few times decontrol occurred as second mention (5% overall).

- o Tax credits for EOR projects also appears to be an incentive that many producers would like to see (22% overall).
- o Intensifying EOR research ranked highest among major and integrated producers. This is significant since this group is the most knowledgeable of the level of current technology.

OIL PRODUCERS

Exhibit 51

Actions Needed to Overcome Current EOR Constraints

ALL PRODUCERS

(Base 132)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Decontrol Oil Prices	53	51%	3	5%	56	35%
Provide Tax Credits	16	15	18	32	34	22
Revise Regulations	10	10	11	20	21	13
Improve Business Climate	8	8	7	13	15	9
Improve Technology Transfer	7	7	8	14	15	9
Intensify EOR Research	5	5	7	13	12	8
Company Must Grow	<u>4</u>	<u>4</u>	<u>2</u>	<u>3</u>	<u>6</u>	<u>4</u>
TOTAL	103	100%	56	100%	159	100%

OIL PRODUCERS

Exhibit 52

Actions Needed to Overcome Current EOR Constraints

MAJORS AND INTEGRATED

(Base 42)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Decontrol Oil Prices	22	58%	1	5%	23	39%
Intensify EOR Research	5	13	4	19	9	15
Revise Regulations	4	10	4	19	8	13
Provide Tax Credits	3	8	6	28	9	15
Improve Business Climate	2	5	--	--	2	4
Improve Technology Transfer	1	3	5	24	6	10
Company Must Grow	<u>1</u>	<u>3</u>	<u>1</u>	<u>5</u>	<u>2</u>	<u>4</u>
TOTAL	38	100%	21	100%	59	100%

OIL PRODUCERS

Exhibit 53

Actions Needed to Overcome Current EOR Constraints

LARGE INDEPENDENTS

(Base 57)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Decontrol Oil Prices	21	54%	2	9%	23	37%
Provide Tax Credits	6	15	5	23	11	18
Revise Regulations	4	10	5	23	9	15
Improve Business Climate	3	8	6	28	9	15
Improve Technology Transfer	3	8	2	9	5	8
Company Must Grow	2	5	1	4	3	5
Intensify EOR Research	<u>--</u>	<u>--</u>	<u>1</u>	<u>4</u>	<u>1</u>	<u>2</u>
TOTAL	39	100%	22	100%	61	100%

OIL PRODUCERS

Exhibit 54

Actions Needed to Overcome Current EOR Constraints

SMALL INDEPENDENTS

(Base 33)

	<u>FIRST MENTION</u>		<u>SECOND MENTION</u>		<u>TOTAL MENTIONS</u>	<u>OVERALL PERCENT</u>
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>		
Decontrol Oil Prices	10	38%	--	--	10	25%
Provide Tax Credits	7	27	7	54	14	34
Improve Technology Transfer	3	12	1	8	4	10
Improve Business Climate	3	12	1	8	4	10
Revise Regulations	2	7	2	15%	4	10
Intensify EOR Research	--	--	2	15	2	5
Company Must Grow	<u>1</u>	<u>4</u>	<u>--</u>	<u>--</u>	<u>1</u>	<u>3</u>
TOTAL	26	100%	13	100%	39	100%

CONSULTANTS

Number in survey: 23.

Typical level of respondent: President or other partner.

Current level of EOR awareness: Very high. All were familiar with EOR state-of-the-art (through reading, at least).

Direct experience with EOR: 18 consultants had participated in active or proposed EOR projects.

Impact on EOR: Primary technical source for most independent producers and central to the process of bank financing (either in preparing proposal for the producer or evaluating applications for banks).

Attitude toward EOR: Consultants, in general, are a highly sophisticated audience but one with no real stake in EOR. Most have enough business from conventional oil and gas operations and maintain only general interest in EOR. Because many view their prime role as advisors to independents, bottom-line considerations are very important.

Perceived constraints:

1. Overall unfavorable economics
2. Government policies
3. Crude oil price

Opinion of DOE role:

1. Provide incentives/subsidies
2. Decontrol oil price
3. Technology transfer
4. Ease environmental regulations
5. Get out of the oil business

Familiarity with DOE programs: More than 80 percent are familiar with DOE activities but only half had direct experience with a cost-share project.

Familiarity with BETC: 60 percent receive the quarterly Progress Review. Many also receive annual and special reports.

Assessment of Progress Review: Fair to good. Consultants believe the reports are not detailed enough and do not consider non-DOE projects. BETC receives high marks for cooperation.

Recommended changes:

1. Include non-DOE projects
2. Provide interpretation
3. Include more data

Information sources:

1. Technical journals (JPT and SPEJ)
2. Trade journals (Oil & Gas Journal, World Oil Petroleum Engineer)
3. Seminars (SPE and DOE)
4. Technical reports (DOE)

Information needs:

1. Detailed technical reports (reservoirs and processes)
2. Quarterly reports
3. Analysis of cost factors
4. State-of-the-art summaries
5. Graphic illustrations

Information format: Hard copy. Computer data bases are seldom used. Not specific enough to EOR and data is suspect. Primary use is bibliographic from universities.

Future EOR information needs: Will increase, however, some of the profession's leaders say further involvement will depend on progress of EOR.

Usefulness of EOR Technical Information Center: Would be occasional users overall, although some believe it would be a major asset.

Additional Comments:

- o Nearly 70 percent said they were involved in the final decision of client producers. Since independents lack the technical expertise required by EOR, engineering consultants are pivotal to the smaller producer companies.
- o Consultants tend to "specialize" in technical expertise. A small group of EOR "experts" appears to be emerging.
- o Consultants also provide engineering assistance to the financial community. Many banks employ consultants to assist in determining feasibility of large project finance applications.
- o Consultants knowledgeable with EOR feel that a number of reservoirs will reach the economic limits for secondary production in the next year. Evaluation of what to do with these reservoirs will escalate consulting activity in EOR over next three years.

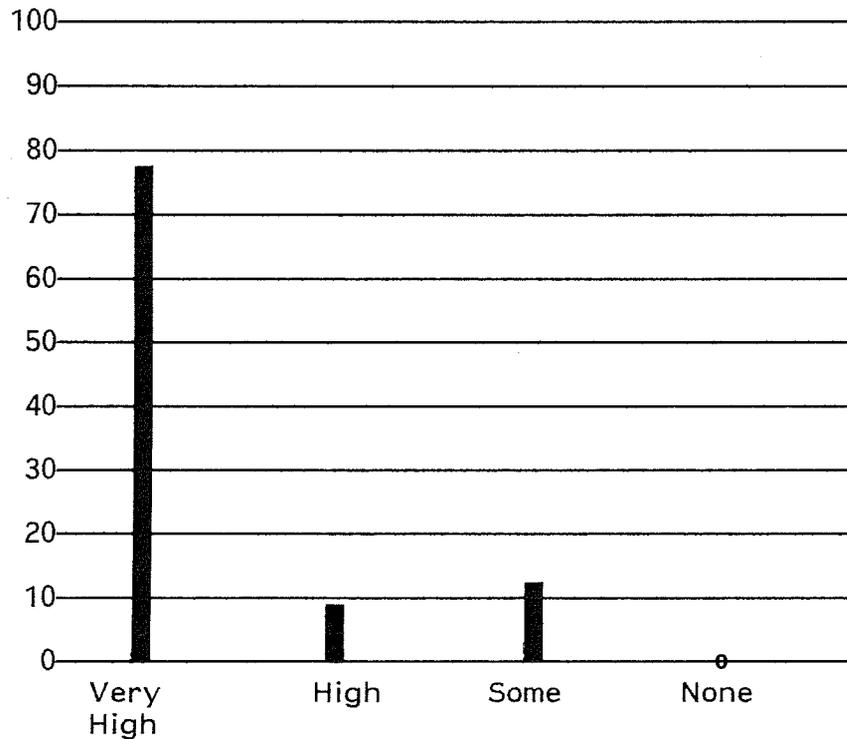
CONSULTANTS

Exhibit 1

Awareness of EOR Technology

(Base 23)

PERCENT



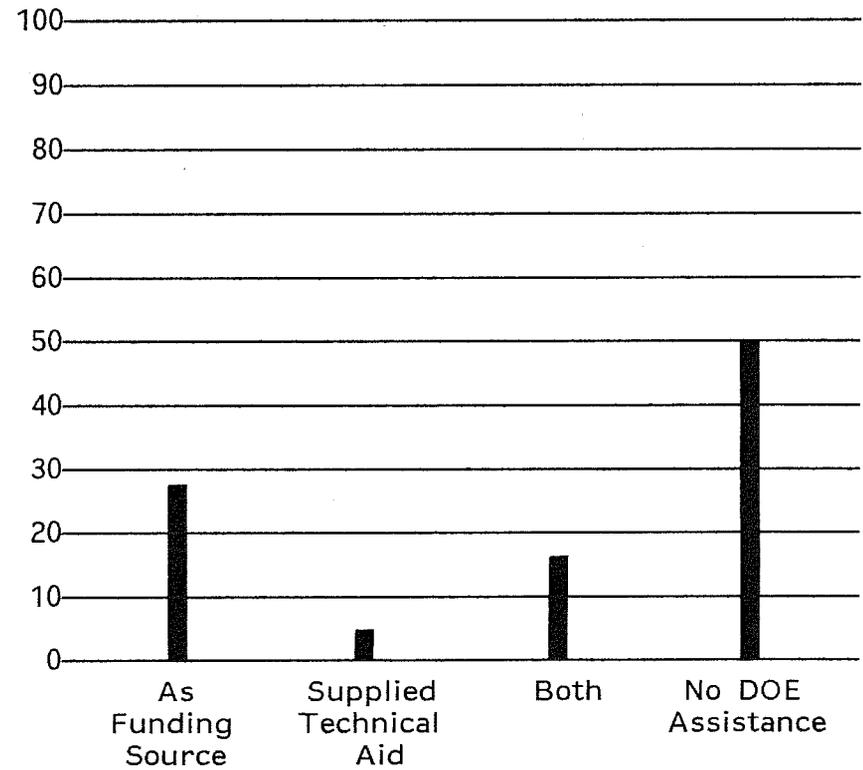
LEVEL OF AWARENESS

CONSULTANTS

Exhibit 2

DOE Involvement in EOR Projects

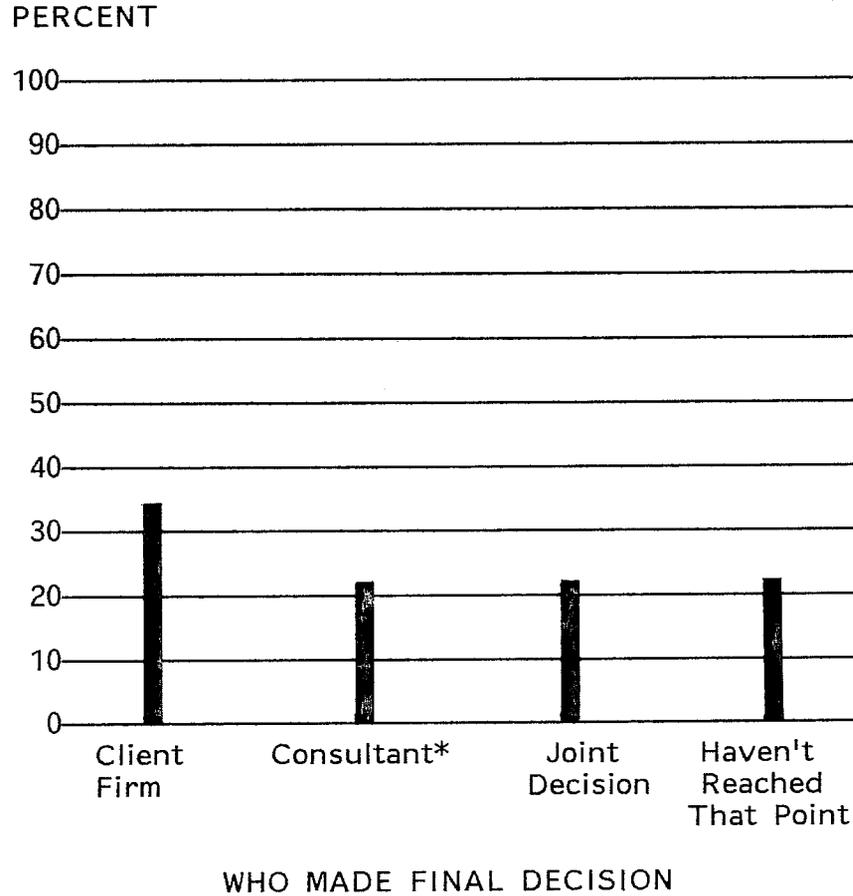
(Base 18)*



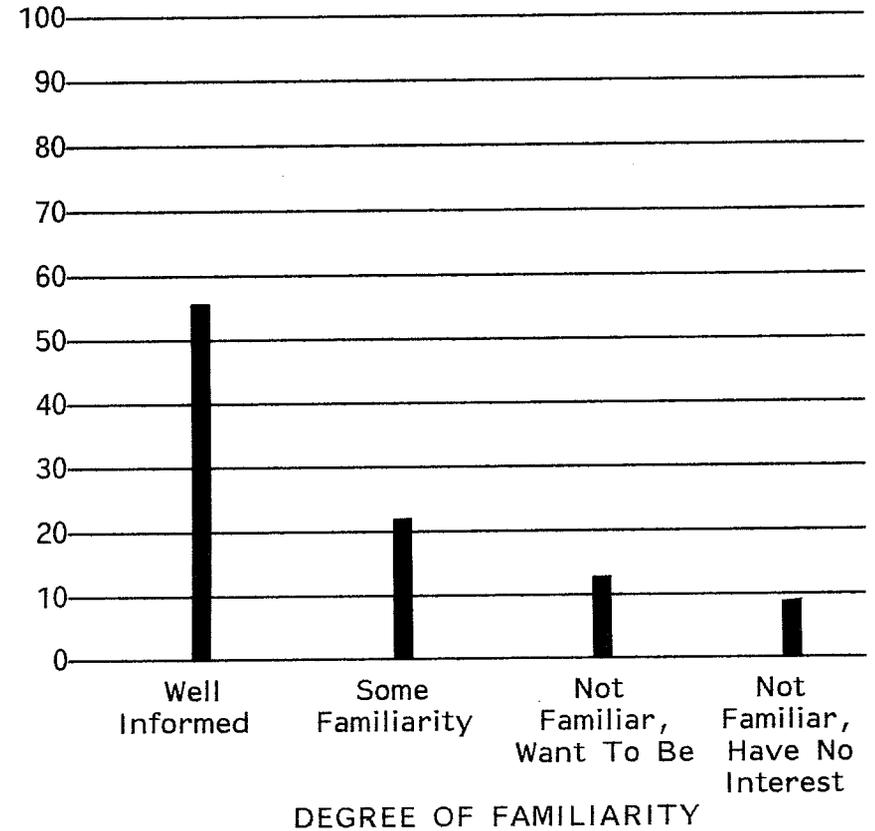
DOE INVOLVEMENT

*Five respondents said they had no practical experience in active or proposed EOR projects.

CONSULTANTS
 Exhibit 3
Responsibility for Final Decision
 (Base 23)



CONSULTANTS
 Exhibit 4
Familiarity with DOE Cost-Share Program
 (Base 23)



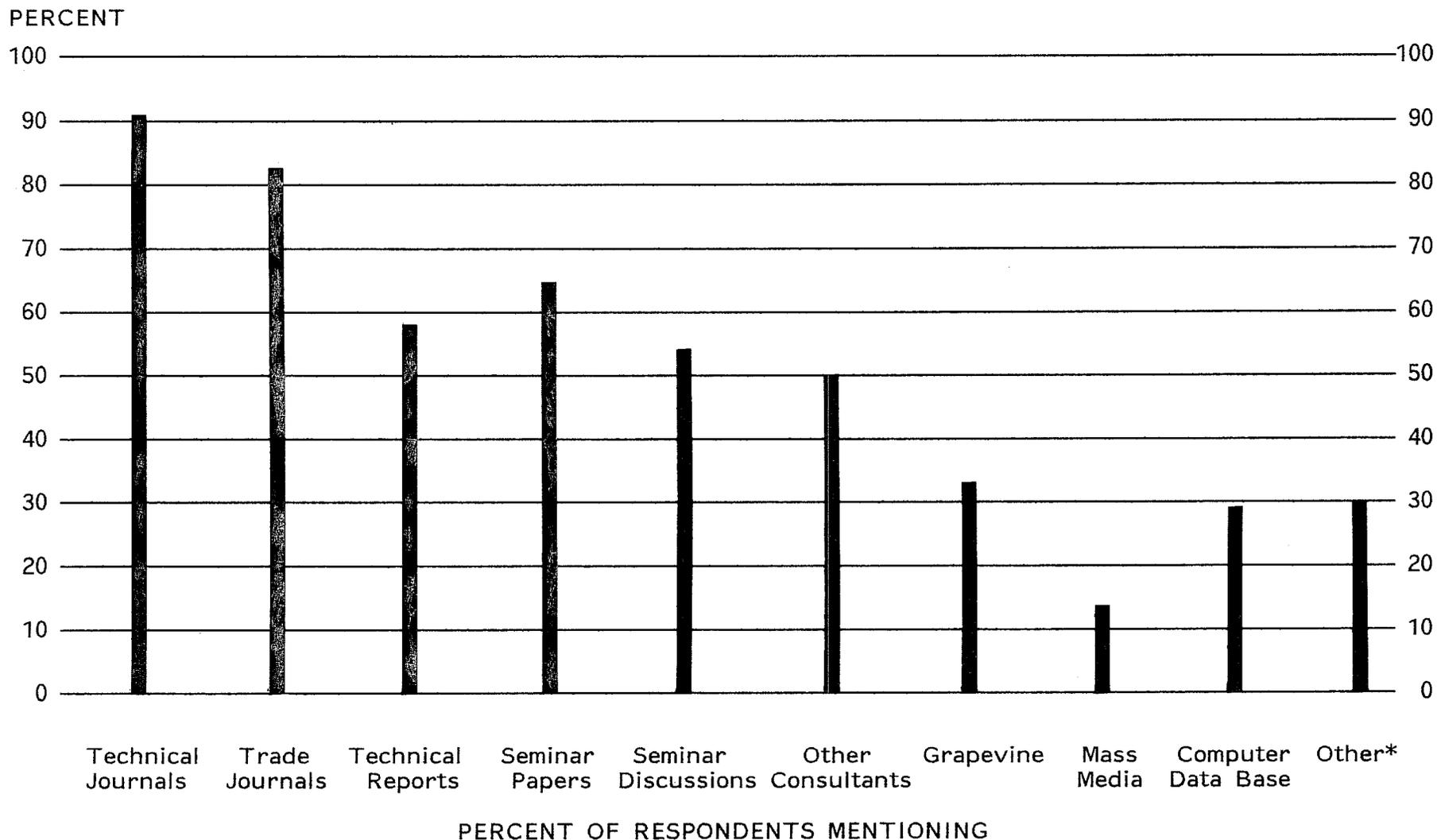
*Clients always made final decision. In some cases, however, producer has no engineering staff and must rely heavily on consultant's technical judgment.

CONSULTANTS

Exhibit 5

Sources of EOR Technical Information

(Base 23, Multiple Responses)



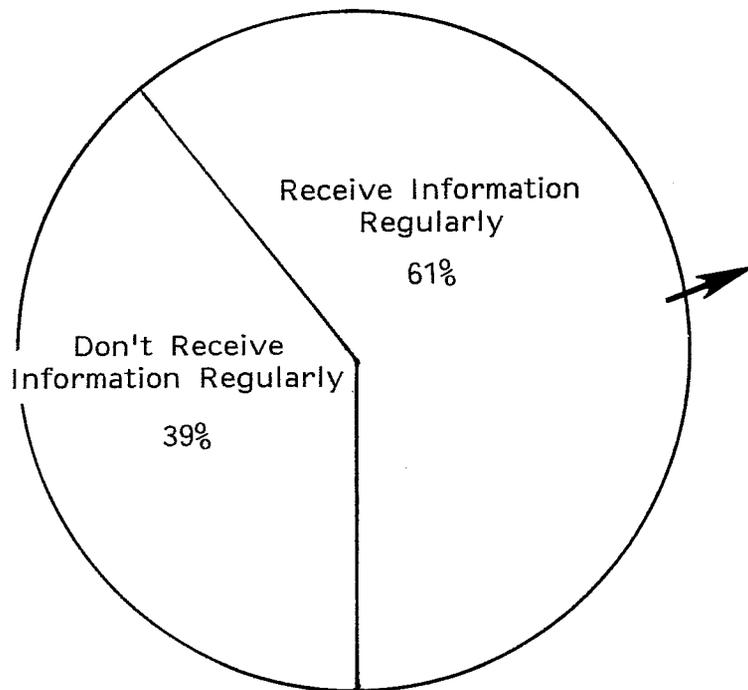
*Includes SPE meetings (3), in-house research (3), patent literature, Bureau of Mines list of fields.

CONSULTANTS

Exhibit 6

EOR Information Received from DOE

(Base 23)

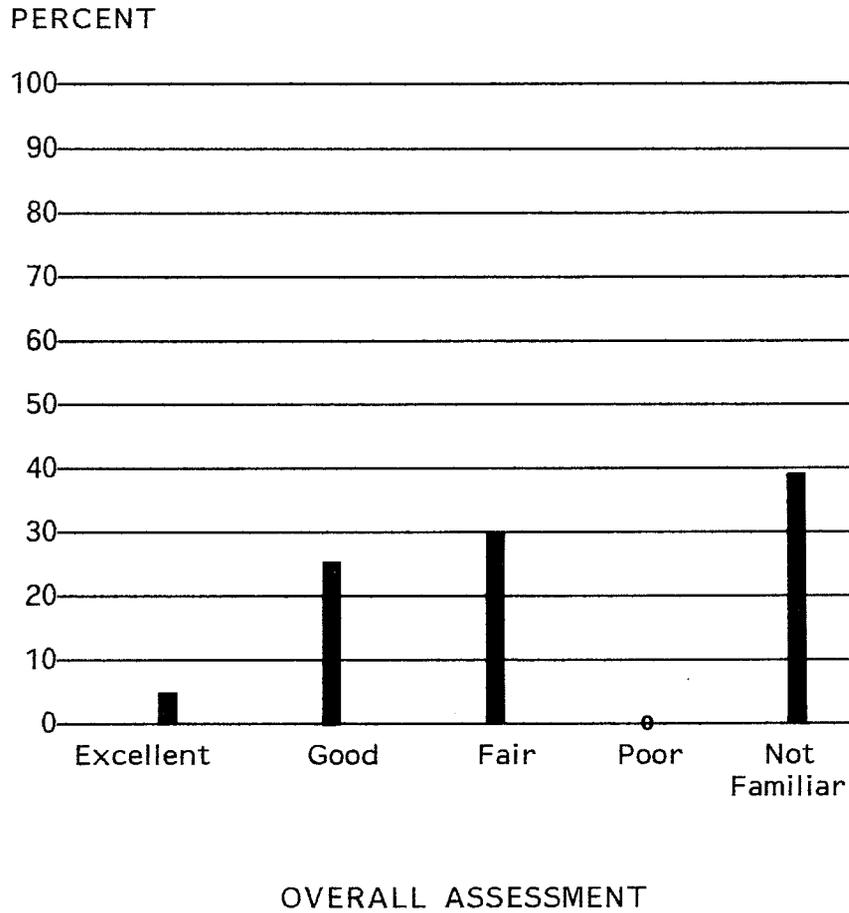


TYPES OF INFORMATION RECEIVED
(Base 14, Multiple Responses)

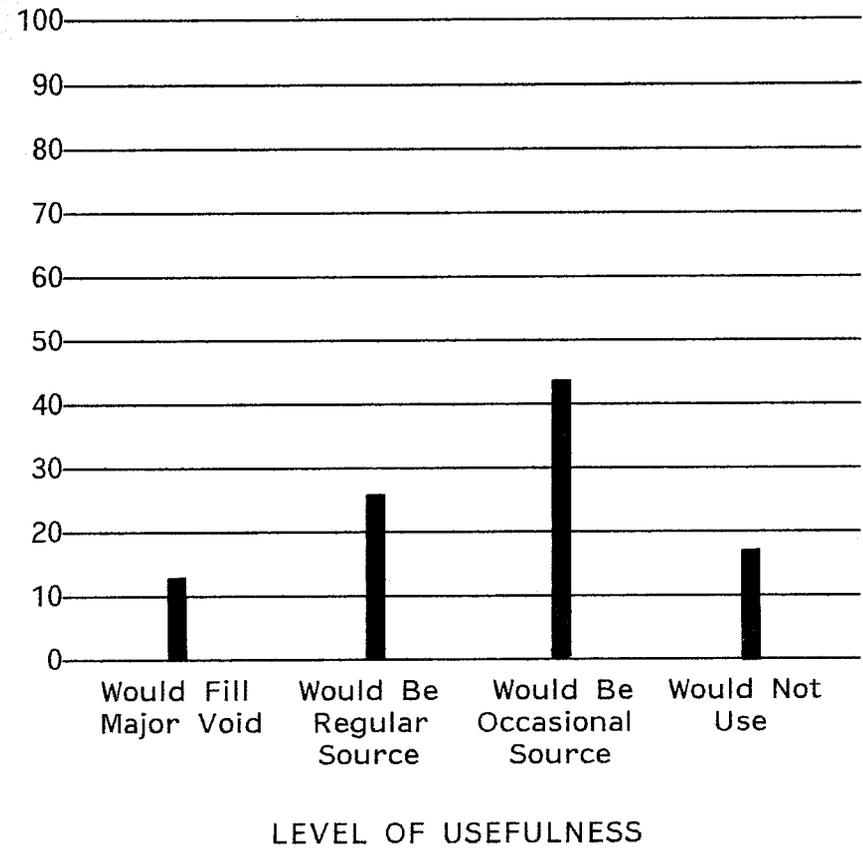
	<u>Total Mentions</u>
Quarterly Report	12
Annual Reports	11
Other Information*	7

*Includes special and monthly reports, bulletins, RFP's and EOR Symposium information.

CONSULTANTS
 Exhibit 7
Assessment of Information from BETC
 (Base 23)



CONSULTANTS
 Exhibit 8
Usefulness of EOR Technical Information Center
 (Base 23)

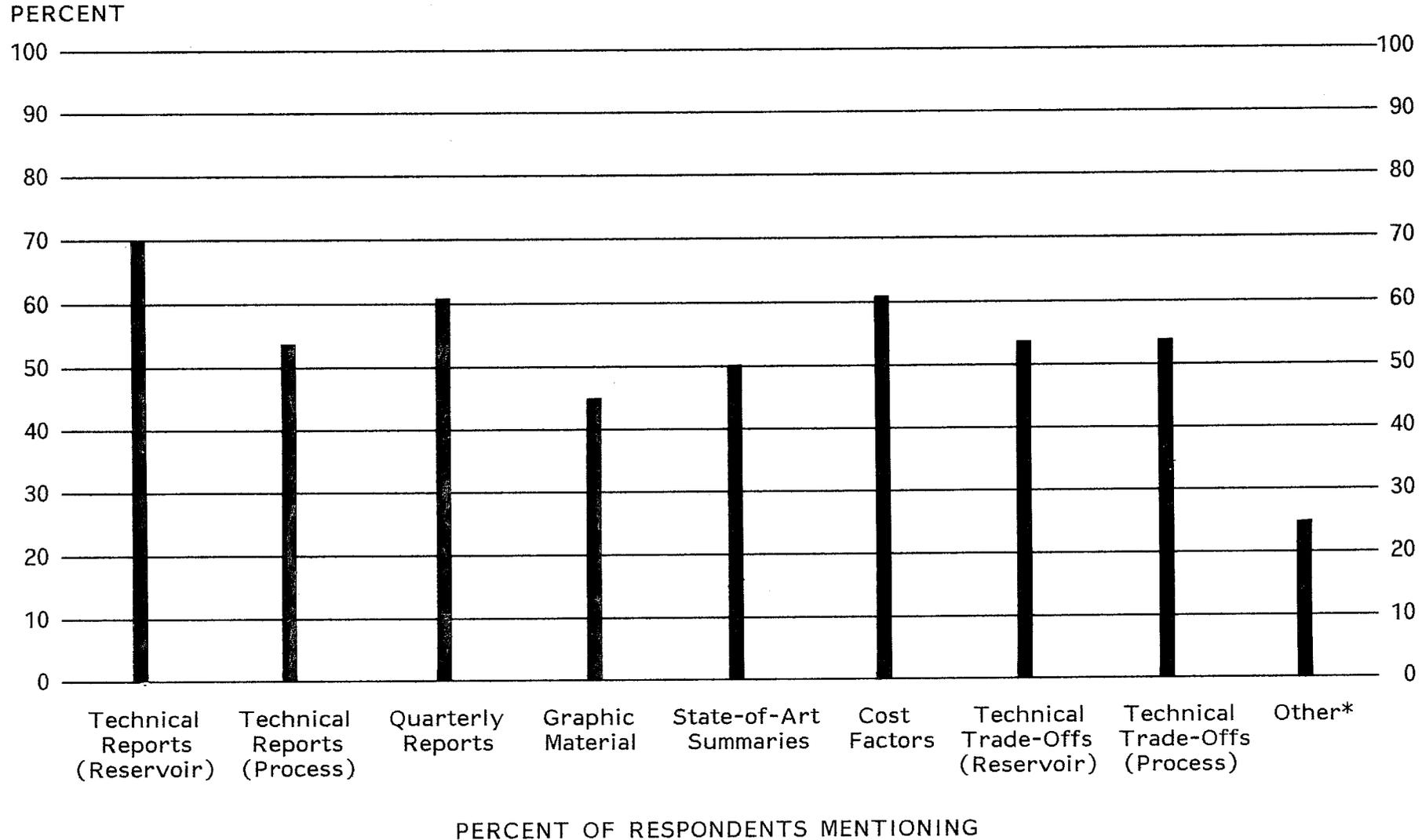


CONSULTANTS

Exhibit 9

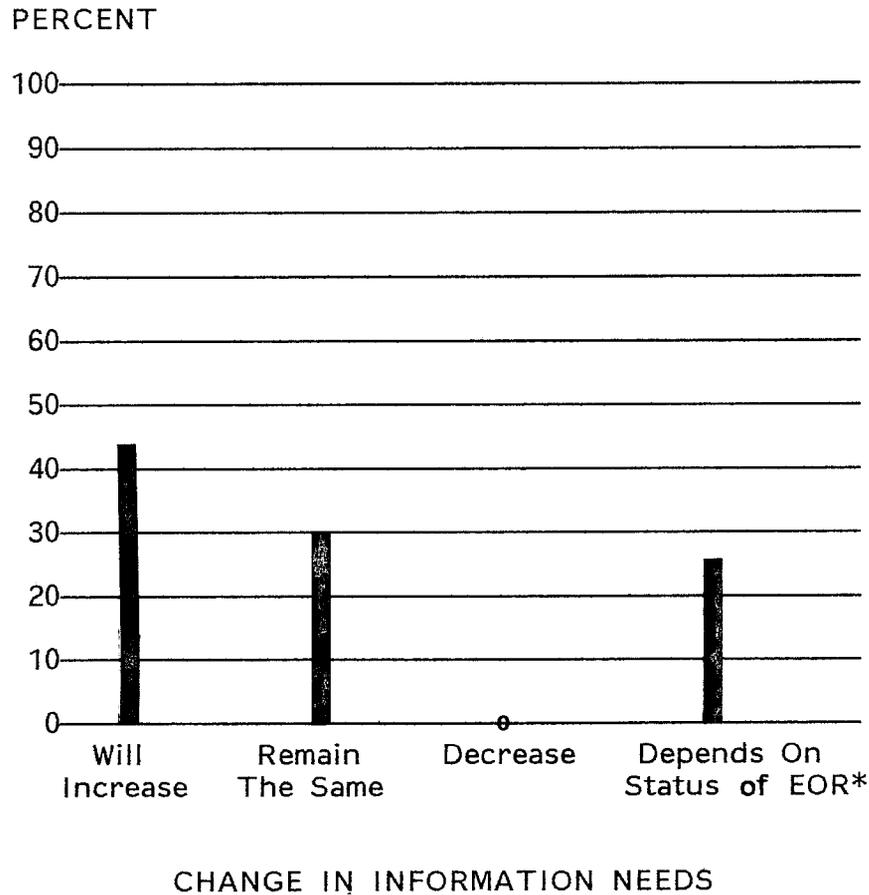
Types of Information Desired from BETC

(Base 23, Multiple Responses)

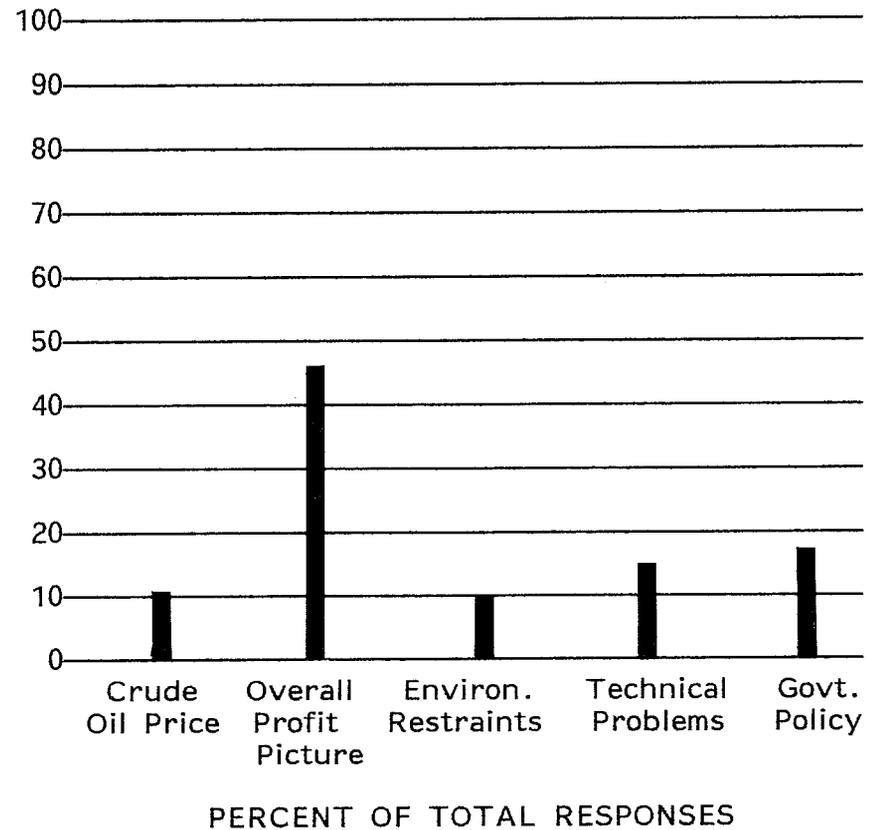


*Includes reports on non-DOE projects, regulations, university research, success-failure evaluations.

CONSULTANTS
 Exhibit 10
Future EOR Information Needs
 (Base 23)



CONSULTANTS
 Exhibit 11
Major Constraints
 (Of 76 Total Responses)



*It is perhaps significant that three of the world's most highly regarded consulting firms gave this response.

OIL FIELD SERVICE COMPANIES

Number in survey: 21.

Respondent level: Manager, technical market development.

Current level of EOR expertise: Highly aware of the principles of EOR and summary assessments of recent development in state-of-the-art technology.

Direct experience with EOR: Highest is miscible gas (55%) followed by thermal (23%) and chemical (20%).

Impact on EOR: Relatively low overall, although some services have greater impact (specifically, those concerned with reservoir analysis). All respond primarily to business demand. When demand for EOR specialization occurs, companies serving major oil companies can be expected to provide technical expertise.

Attitude toward EOR: See it as no real change in their business from primary and secondary services.

Perceived constraints: None foreseen specific to their involvement. Most feel their current products or services adequate to meet needs of EOR.

Opinion of DOE role:

1. Allow oil prices to rise to world market.
2. Simplify environmental regulations
3. Provide exchange of information between oil companies and service companies which protect proprietary data

Familiarity with DOE programs: High. Only 10 percent indicated no interest.

Awareness of BETC: Relatively low. Only 29 percent receive information regularly.

Information sources:

1. Technical journals (JPT, SPEJ)
2. Other service companies
3. Trade journals
4. Seminars

Information needs:

1. Quarterly progress updates
2. Fairly detailed technical report summaries
3. Updates on technological breakthrough
4. Access to more detailed technical and cost data

Information levels:

1. Top management
2. Research and product/service development
3. Sales management

Information format: Hard copy (with bibliographic references).

Future EOR information needs: Expected to increase substantially as process application and number of projects spread. Service companies respond to customer demand.

Usefulness of EOR Technical Information Center: Expressed high usage potential. Nearly half would be frequent to regular users. Another one-fourth would use occasionally.

Additional Considerations:

- o The majority (86%) of oil service company respondents say their companies have direct EOR experience.
- o The bulk of that familiarity has been gained on miscible gas projects (primarily those operated by major oil companies).
- o Only 14 percent of respondents indicated that their companies are currently doing EOR research of their own. Most companies are willing to respond to the expressed needs of oil companies operating EOR projects.
- o Although some respondents say their companies will require special equipment for EOR operations, most indicate that EOR involves "nothing new" of service companies. The difference is in the degree of accuracy required.
- o The exception is in the area of reservoir and well analysis services, where improved accuracy and reliability (e.g., nuclear monitoring devices to track horizontal fluid flow) could have a major impact on lessening the uncertainties associated with EOR.
- o In general, service companies believe their current services are adequate to meet the requirements of EOR. More than 70 percent of the respondents said their companies could meet the demand for EOR-related equipment and services -- even if the demand doubled.
- o Most respondents (81%) indicate that their need for technical information on EOR will remain high or increase in the future.

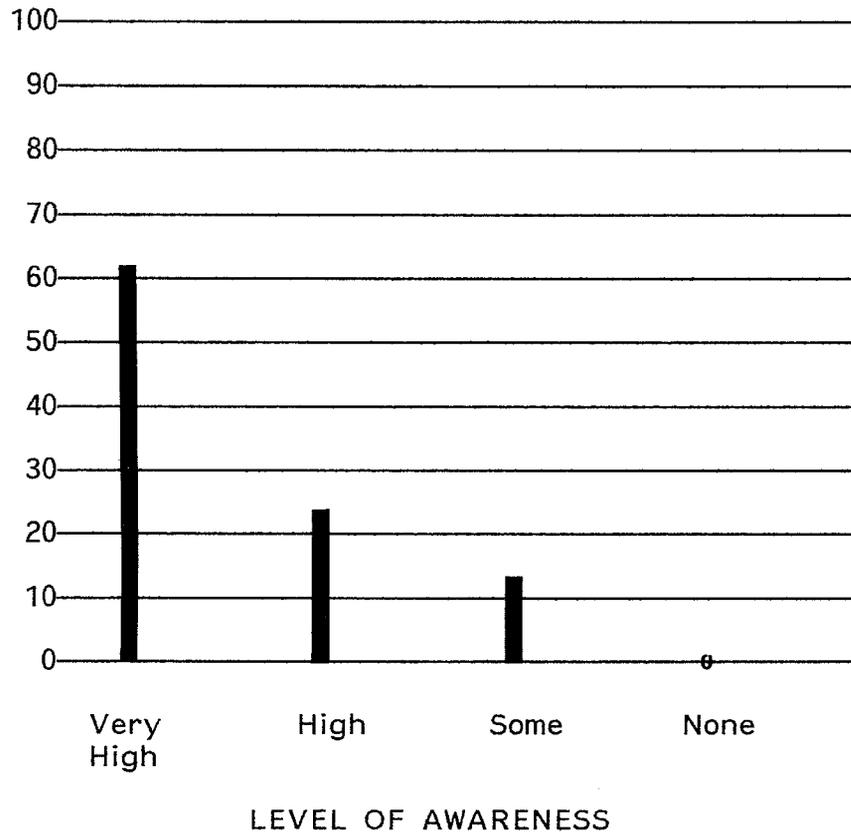
OIL FIELD SERVICE COMPANIES

Exhibit 1

Awareness of EOR Technology

(Base 21)

PERCENT

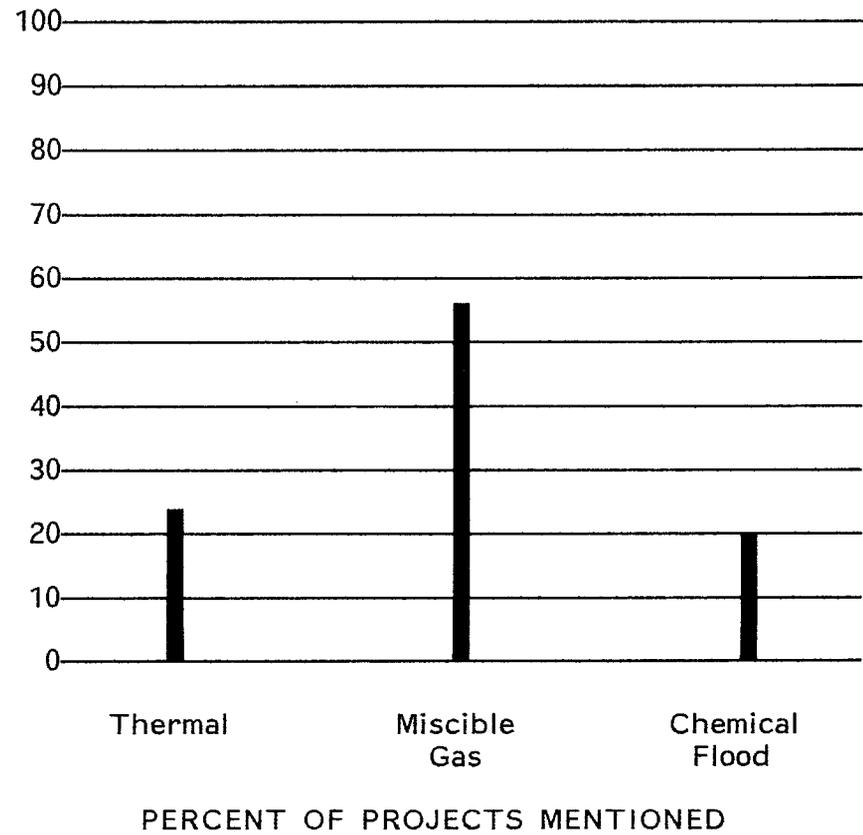


OIL FIELD SERVICE COMPANIES

Exhibit 2

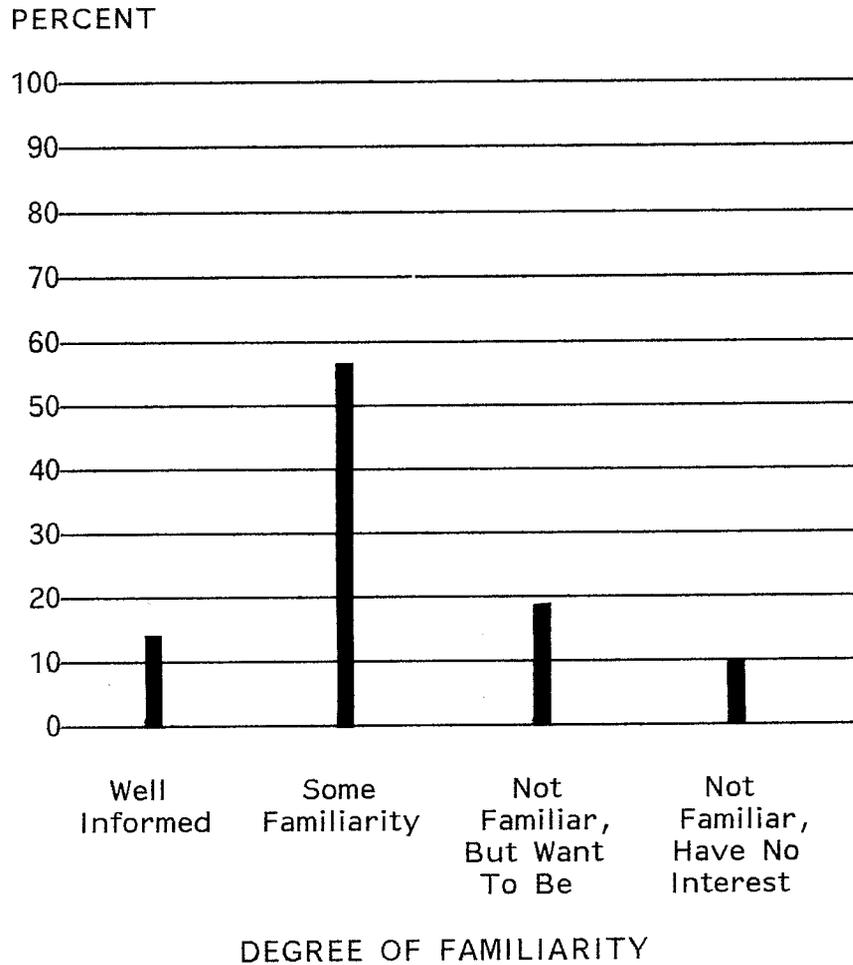
EOR Project Experience (By Process)

(Base 25)*

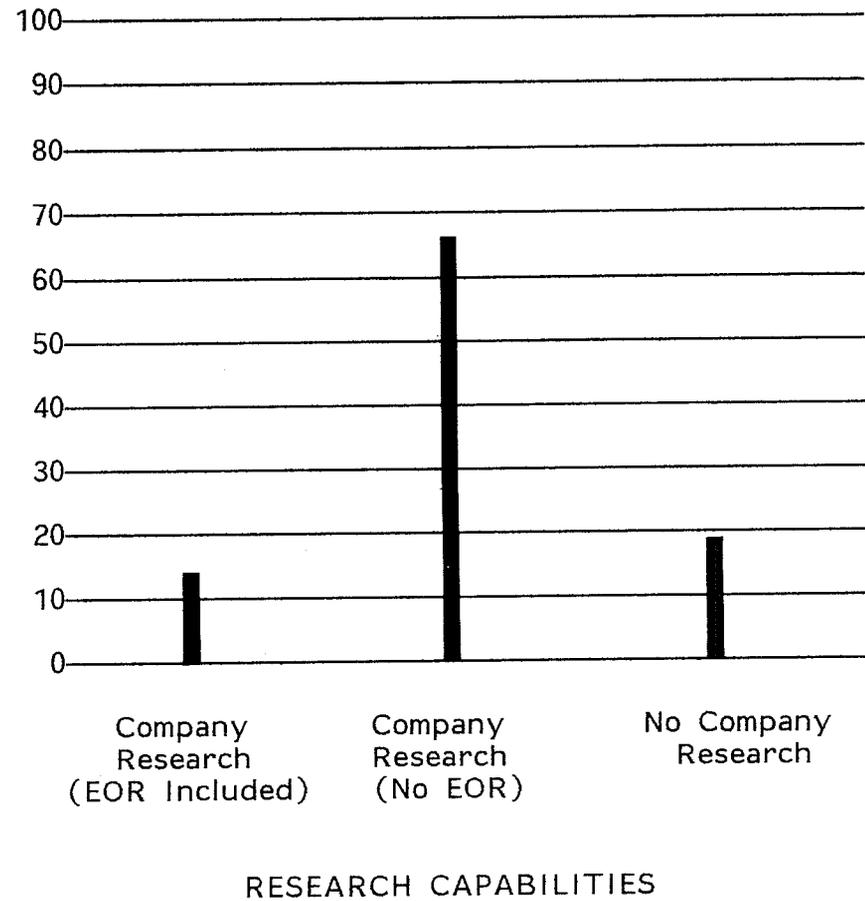


*Of 25 projects mentioned, 19 were operated by major oil companies, 4 by independents and 2 by government agencies.

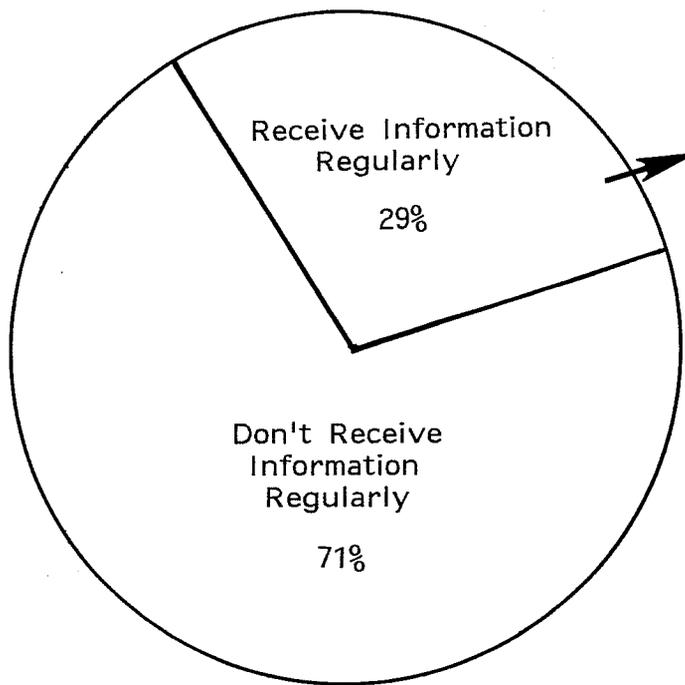
OIL FIELD SERVICE COMPANIES
 Exhibit 3
Familiarity with DOE Cost-Share Program
 (Base 21)



OIL FIELD SERVICE COMPANIES
 Exhibit 4
Internal Research Capabilities
 (Base 21)



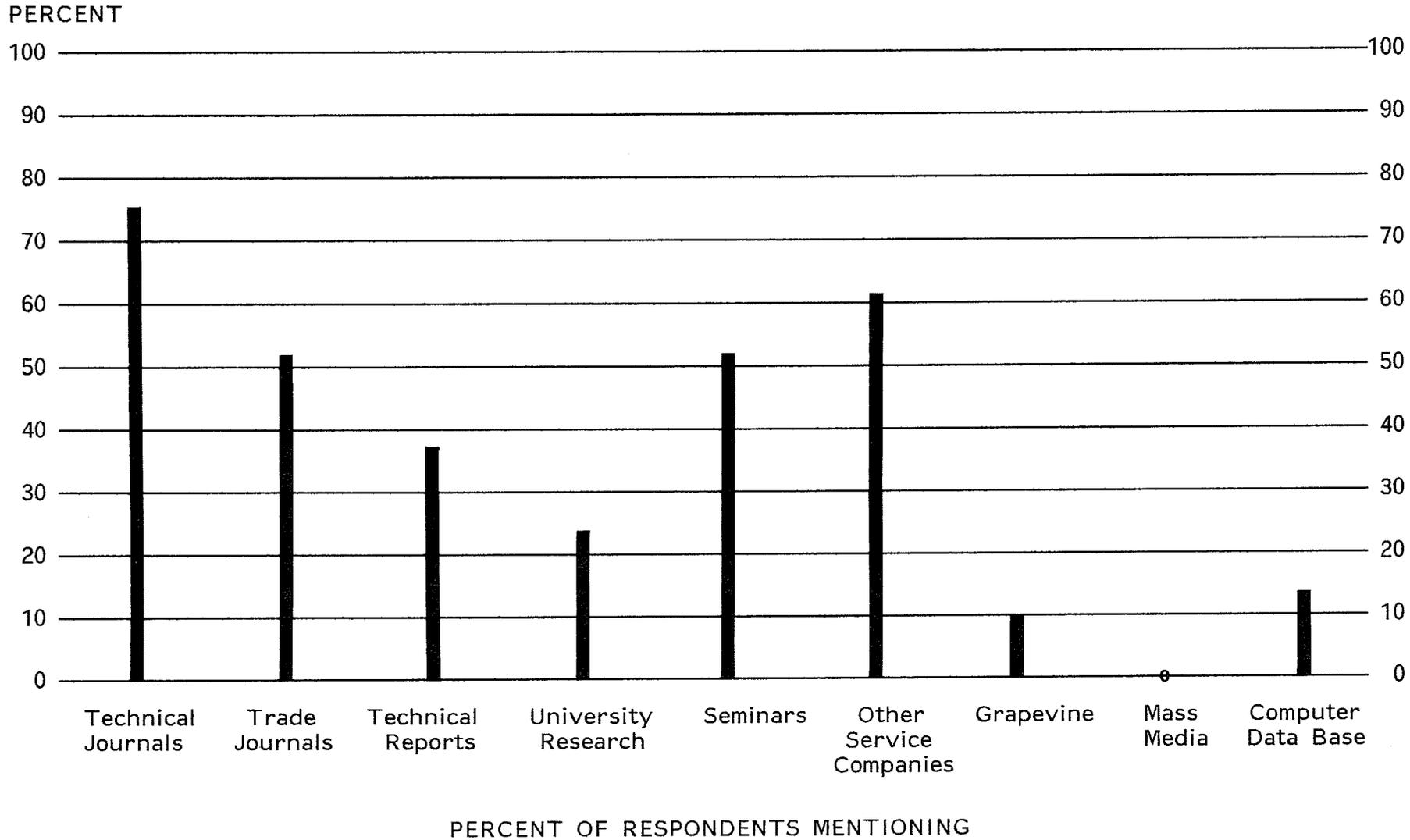
OIL FIELD SERVICE COMPANIES
Exhibit 5
EOR Information Received from DOE
(Base 21)



TYPES OF INFORMATION RECEIVED
(Base 6, Multiple Responses)

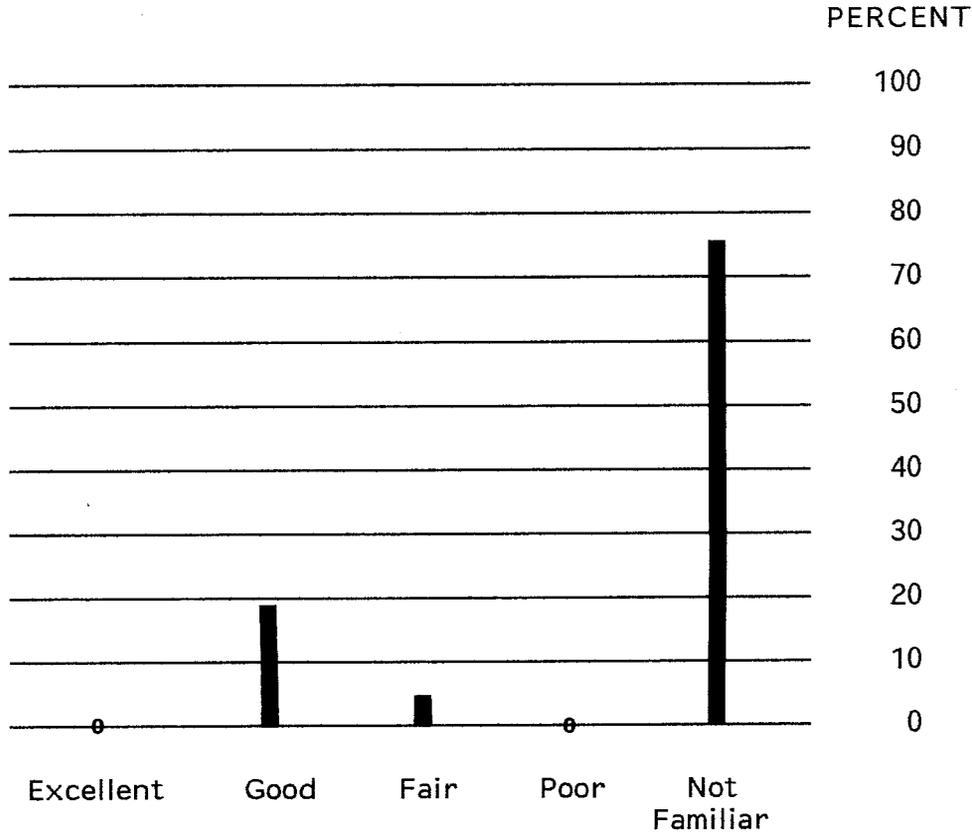
	<u>Total Mentions</u>
Quarterly Report	4
Annual Report	1
Other Information (Special EOR Reports)	3

OIL FIELD SERVICE COMPANIES
 Exhibit 6
Sources of Technical EOR Information
 (Base 21, Multiple Responses)

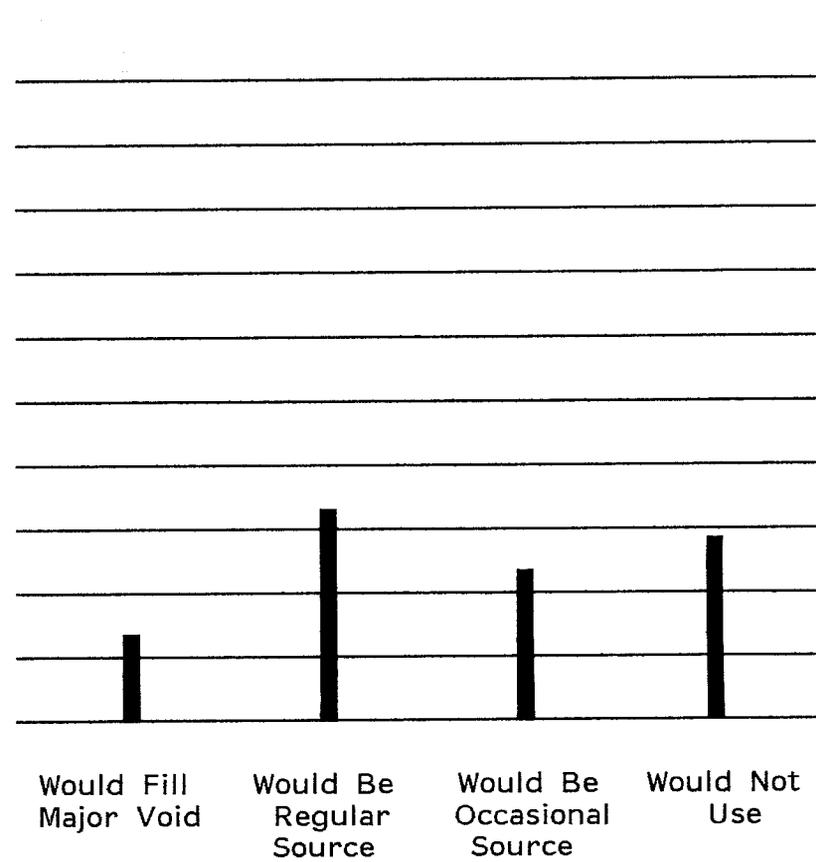


*Includes internal sources (3), consulting firms (3), major oil companies

OIL FIELD SERVICE COMPANIES
 Exhibit 7
Assessment of Information from BETC
 (Base 21)



OIL FIELD SERVICE COMPANIES
 Exhibit 8
Usefulness of EOR Technical Information Center
 (Base 21)

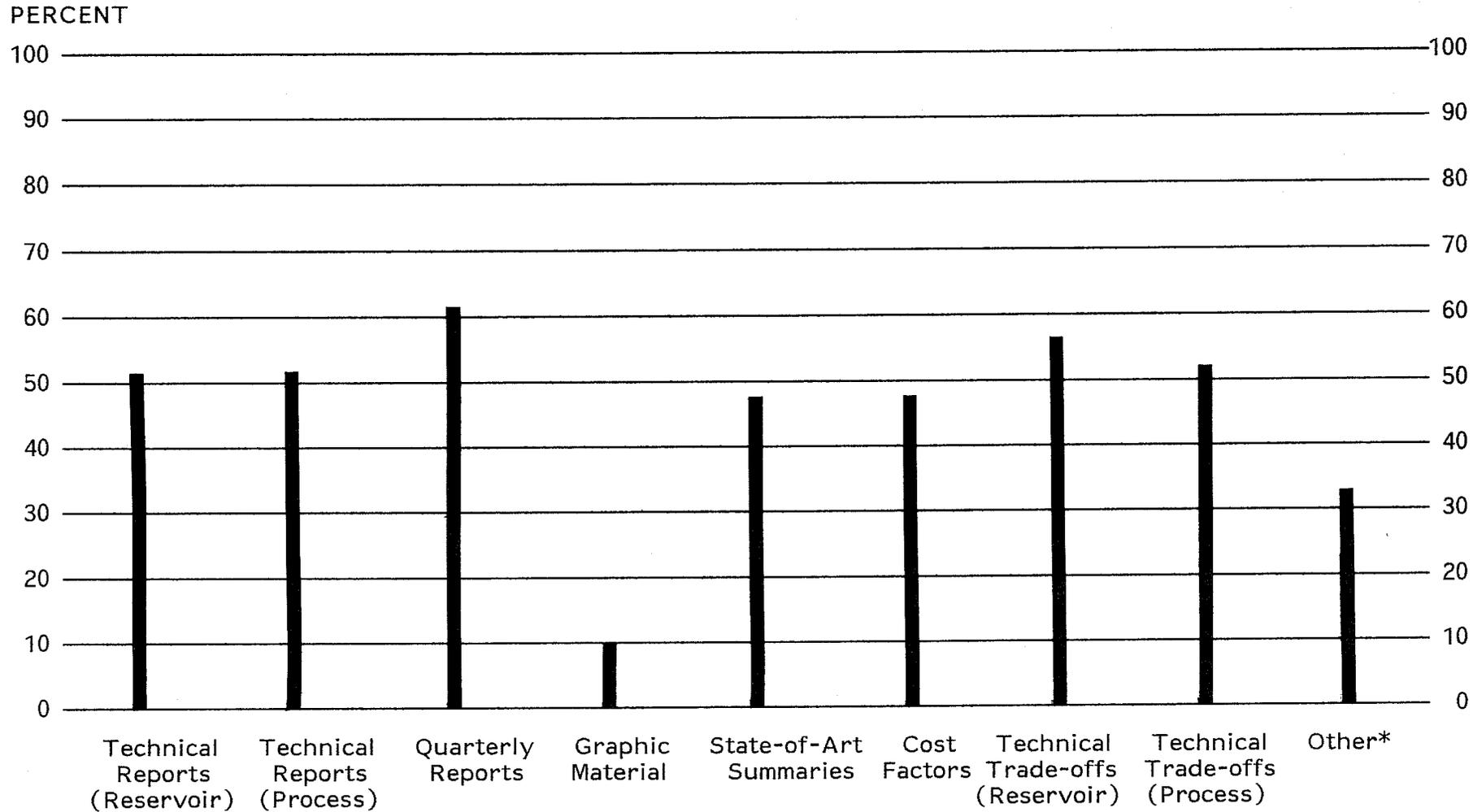


OIL FIELD SERVICE COMPANIES

Exhibit 9

Types of Information Desired from BETC

(Base 21, Multiple Responses)



PERCENT OF RESPONDENTS MENTIONING

*Includes information about equipment and services needed (3), problems (2), fracturing formations, synthetic fuels.

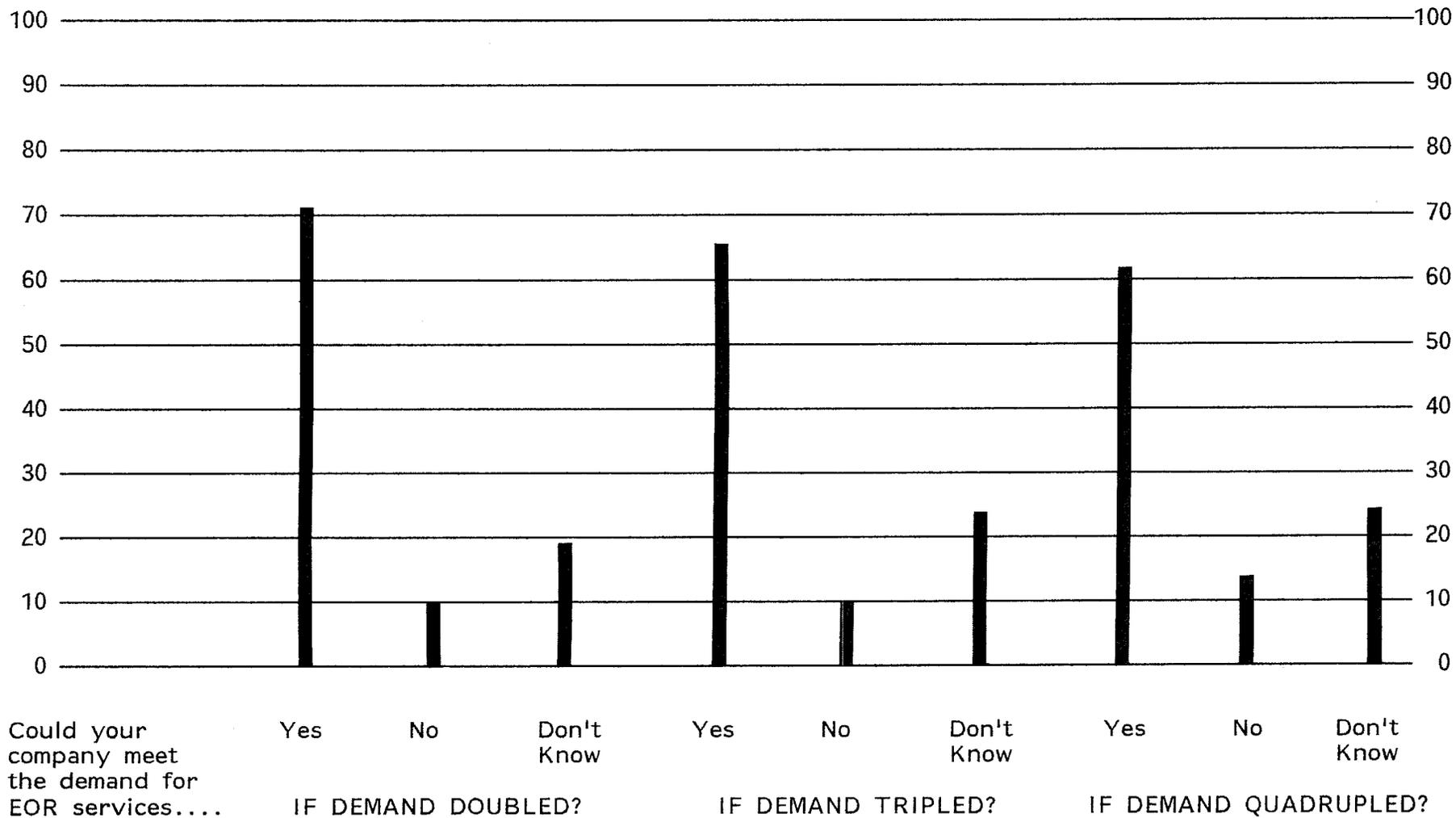
OIL FIELD SERVICE COMPANIES

Exhibit 10

EOR Service Capabilities

(Base 21)

PERCENT

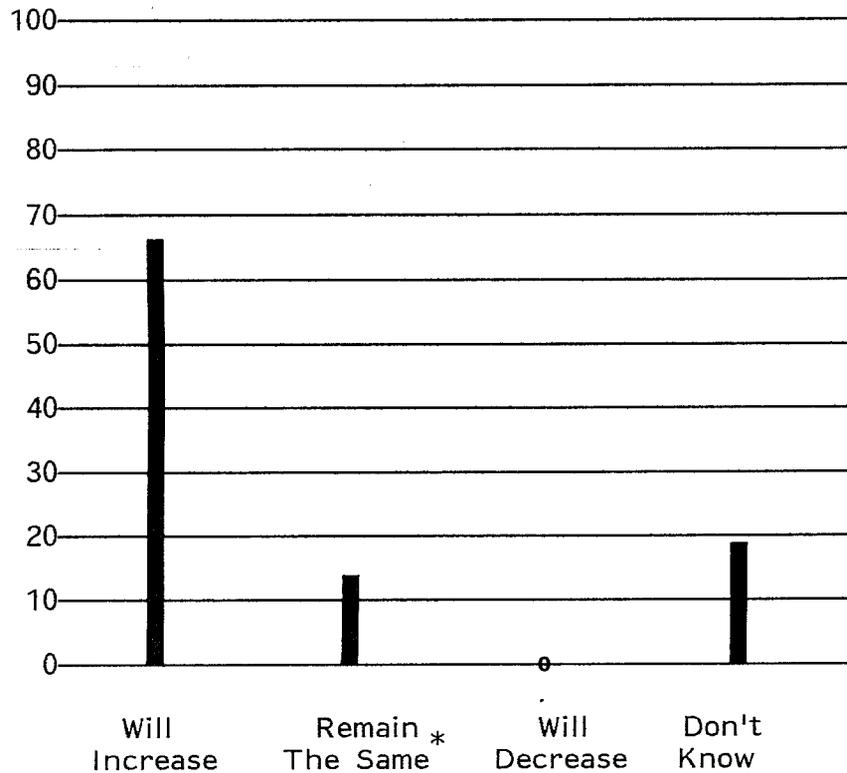


OIL FIELD SERVICE COMPANIES

Exhibit 11

Future EOR Information Needs

(Base 21)



CHANGE IN INFORMATION NEED

*All who gave this response are already highly interested in EOR. In other words, at least 81 percent will be monitoring the progress of EOR closely.

CHEMICAL SUPPLIERS

Number in survey: 19.

Typical level of respondent: Manager of market development or product research and development.

Current level of EOR expertise: High for chemical-related processes. Low for other processes.

Direct experience with EOR: Manufacture of sulfonates, polymers and co-polymers used in EOR. While all companies have knowledge of how process works, they are primarily interested in selling production capacity. Comparatively few have actually provided chemicals for an EOR project.

Impact on EOR: Produce chemicals used in the polymer and micellar polymer processes.

Attitude toward EOR: View EOR as a market of opportunity. Little long-term commitment. Somewhat discouraged because chemical EOR has not blossomed as they expected. Most do some research in EOR but funding seems to be minimal except for work "commissioned" by oil companies.

Perceived constraints:

1. Financial considerations (ROI)
2. More attractive uses of corporate funds
3. Technological uncertainties
4. Inability to obtain feedstocks
5. Technological breakthrough
6. Cost effectiveness

Opinion of DOE role:

1. Decontrol oil prices
2. Create economic incentives for oil companies (and chemical companies)
3. Fund basic research in chemical processes
4. "Underwrite" risk

Familiarity with DOE programs: Highest of all commercially oriented ancillary groups (90 percent are familiar with the cost-share program).

Familiarity with BETC: Most receive BETC information. Quarterly Progress Review is received by 60 percent. Annual reports and EOR symposium information receive some distribution.

Assessment of BETC information: Good to fair. Most common criticisms are lack of timeliness and lack of detail. Its greatest strength is its consistent format.

Information sources:

1. Technical journals
2. Seminars
3. Oil companies
4. Technical reports
5. Trade journals

Information needs:

1. Technical reports (process)
2. Cost analyses
3. State-of-the-art summaries
4. Technical trade-off evaluations (process)
5. Quarterly report

Information levels:

1. Manager of R&D
2. Manager of product development
3. Manager of planning and market development
4. Manager of technical sales

Information Format: Hard copy.

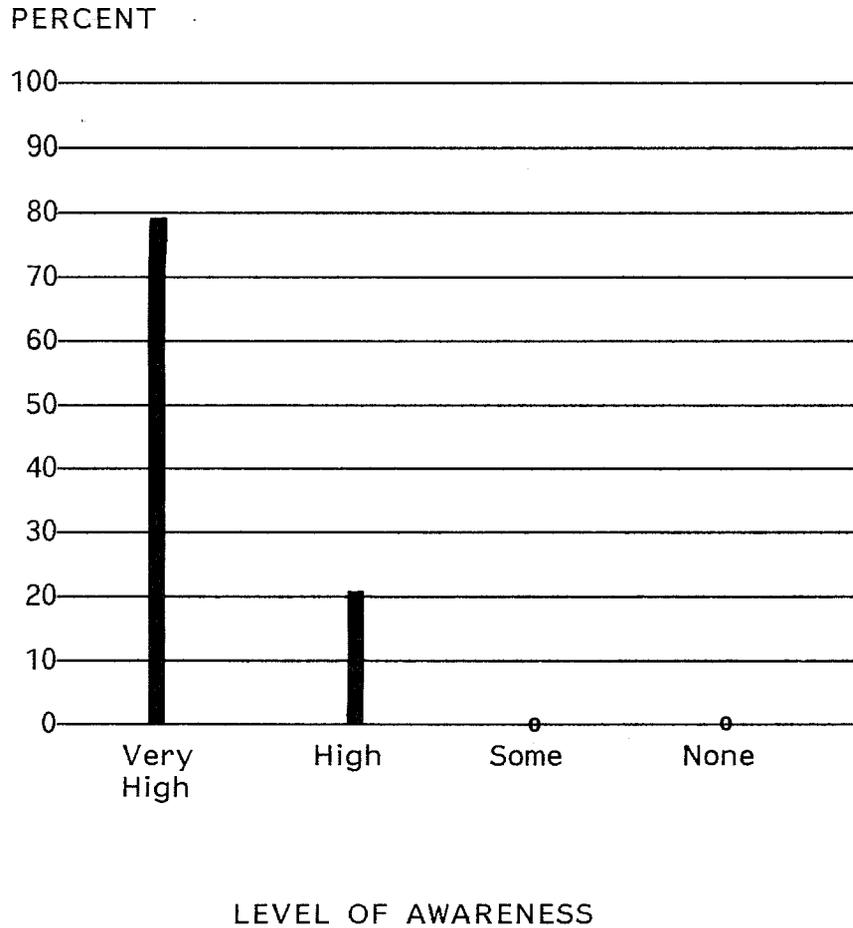
Usefulness of EOR Technical Information Center: Would be occasional source.

Additional Comments:

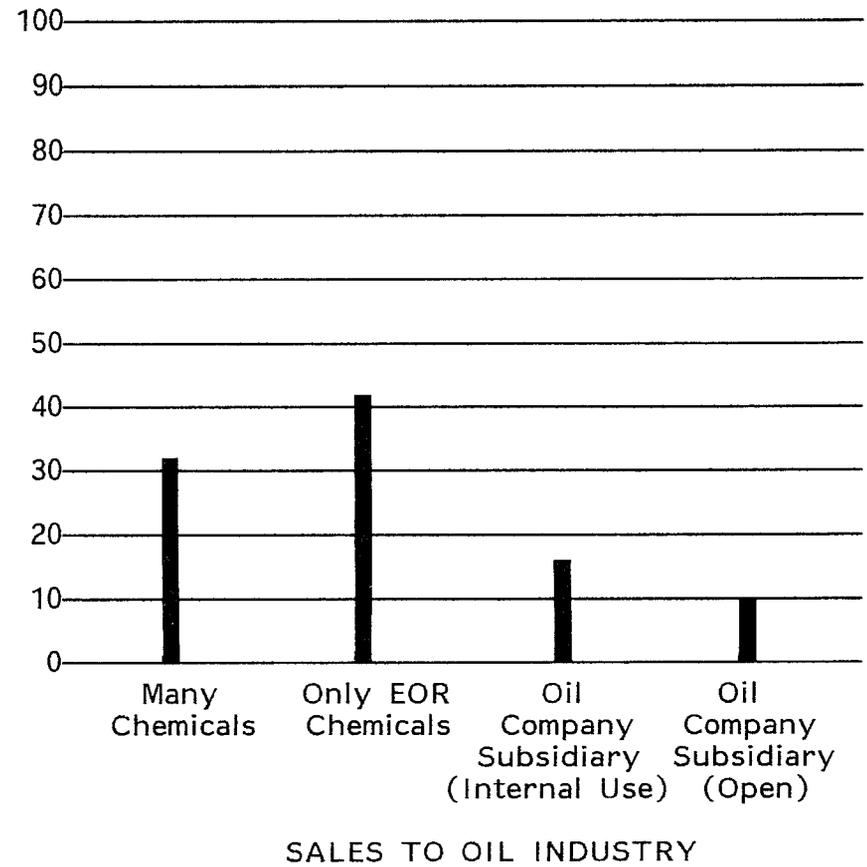
- o Chemical suppliers are specialists. In many cases, they know more about polymers and surfactants than oil companies. Because of this expertise and the narrow scope of their interest in EOR, they can keep up better than others. EOR chemicals make up an extremely small segment of the total chemical market. As a result, EOR is a marginal business at best and greater commitment cannot be expected in the near term. Comments on the DOE role and shortcomings of BETC information must be viewed in the light of both of these points.
- o Over 70 percent of the chemical suppliers contacted are involved in EOR research.
- o Enthusiasm for EOR appears to be declining among chemical manufacturers. Because breakthroughs in surfactant flooding have not occurred and the boom for specialty surfactants has not materialized, production capacity has not been increased. As a result, some manufacturers predict that supply "bottlenecks" could develop if demand should suddenly rise.

- o Oil field chemicals represent less than 1 percent of the total sales of the U.S. chemical industry. With enhanced oil recovery chemicals currently accounting for approximately 1 percent of all oil field specialties, it is understandable why manufacturers are more inclined to concentrate on products which offer greater marketing potential.
- o Very little interaction with colleagues in other companies. Companies view each other with suspicion.
- o The heterogeneity of most reservoirs make accurate reservoir descriptions a must in designing chemical process requirements. Most surfactants have narrow ranges of operational efficiency and require a much higher degree of definition to assure proper fluid flow and performance tolerances. Twenty years of research have not revealed the answer to these problems. Therefore, we foresee chemical EOR processes having very little impact on domestic production before adverse economics force abandonment of many candidate reservoirs.
- o Because independent producers cannot afford to assume the long-term risks of chemical EOR, a change in lease ownership must occur before the fields owned by the smaller companies can be expected to have chemical EOR processes applied.

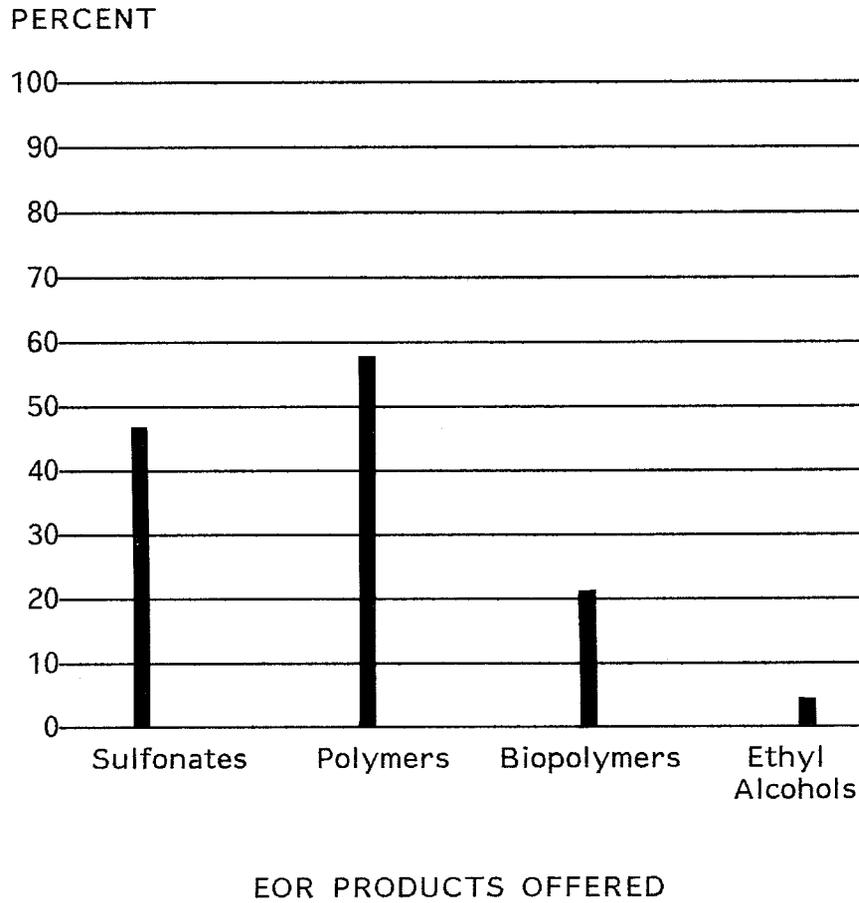
CHEMICAL SUPPLIERS
 Exhibit 1
Awareness of EOR Technology
 (Base 19)



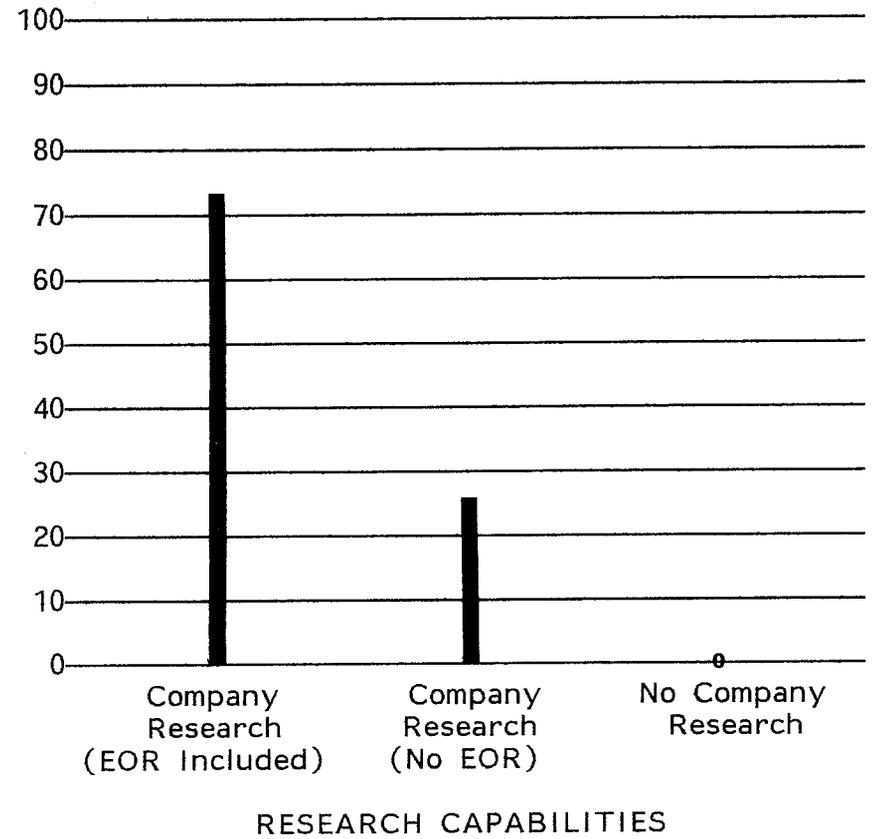
CHEMICAL SUPPLIERS
 Exhibit 2
Involvement in Oil Industry
 (Base 19)



CHEMICAL SUPPLIERS
 Exhibit 3
Interest in EOR
 (Base 19, Multiple Responses)



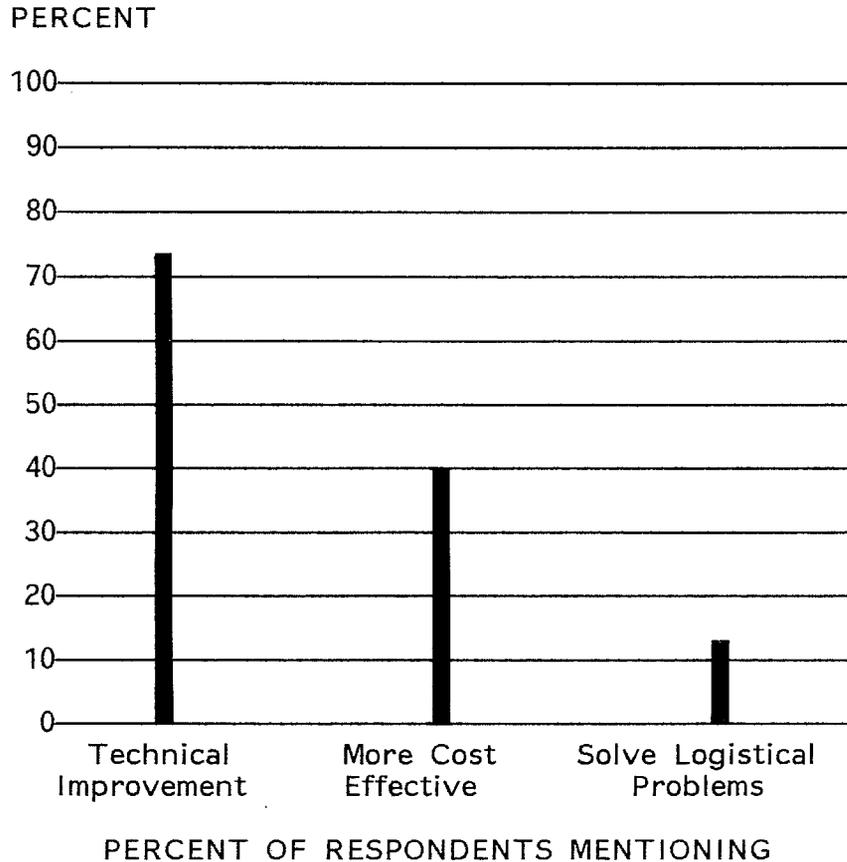
CHEMICAL SUPPLIERS
 Exhibit 4
Internal Research Capabilities
 (Base 19)



CHEMICAL SUPPLIERS

Exhibit 5

Product Improvements Needed
(Base 15, Multiple Responses)*

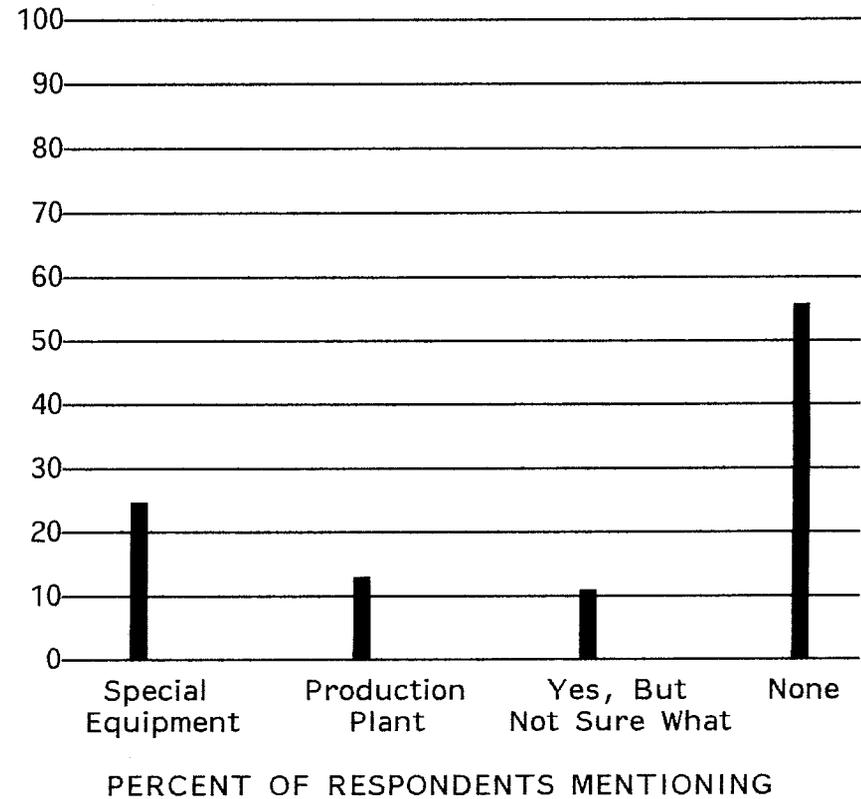


*Four respondents said they could think of no areas for improvement.

CHEMICAL SUPPLIERS

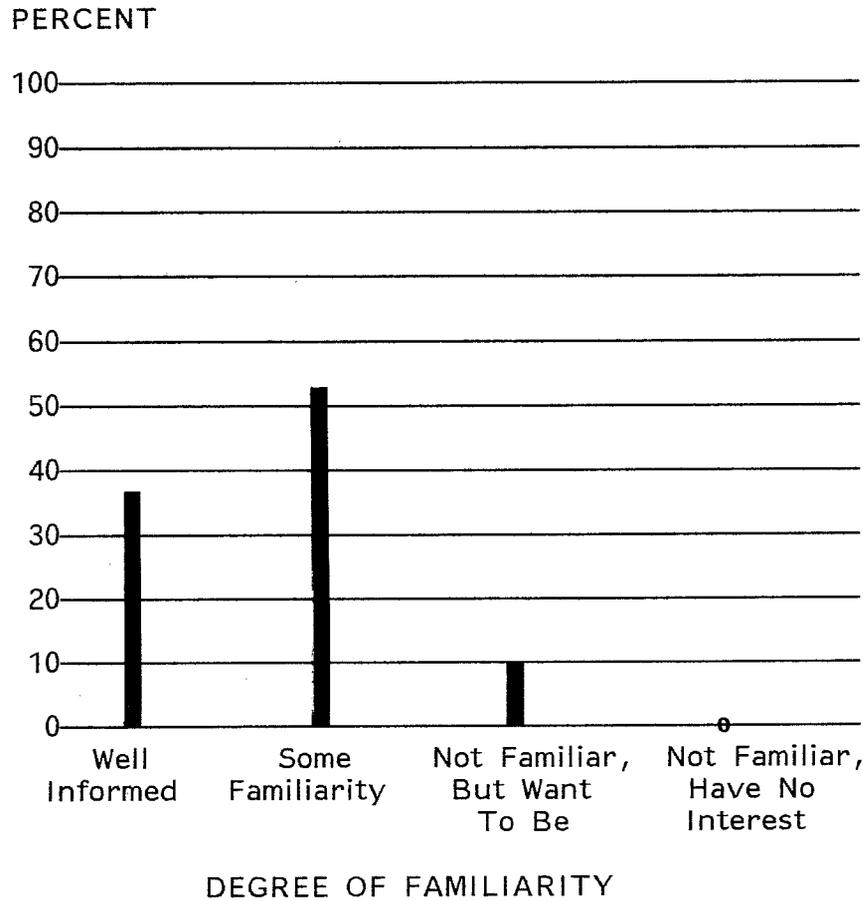
Exhibit 6

Special Requirements for EOR
(Base 16)*

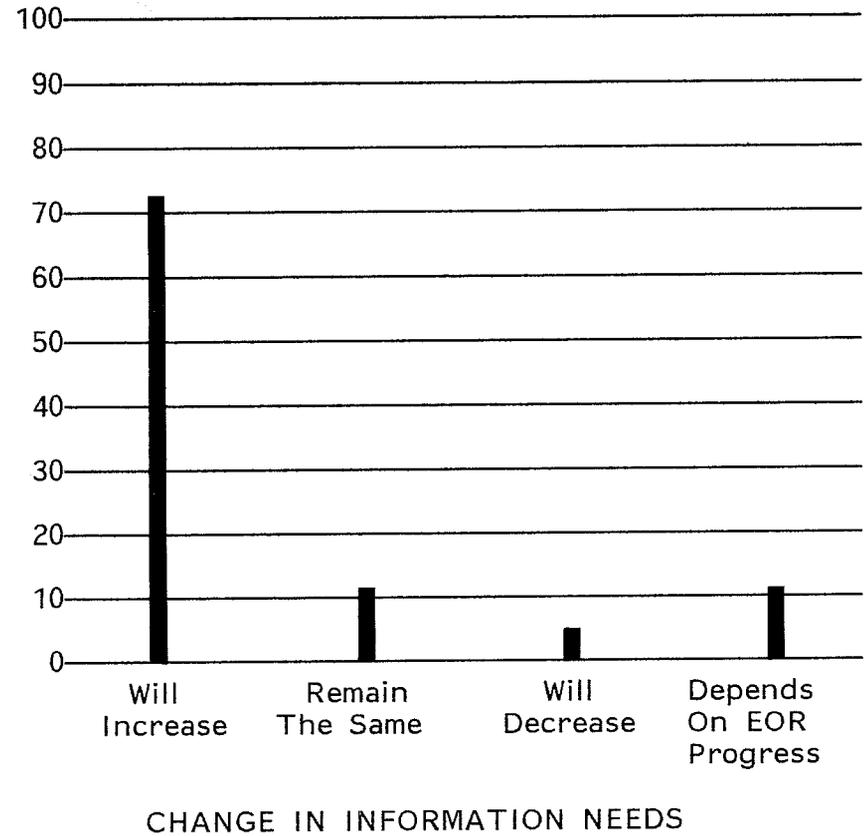


*Three respondents gave no response.

CHEMICAL SUPPLIERS
Exhibit 7
Familiarity with DOE Cost-Share Program
(Base 19)



CHEMICAL SUPPLIERS
Exhibit 8
Future EOR Information Needs
(Base 19)

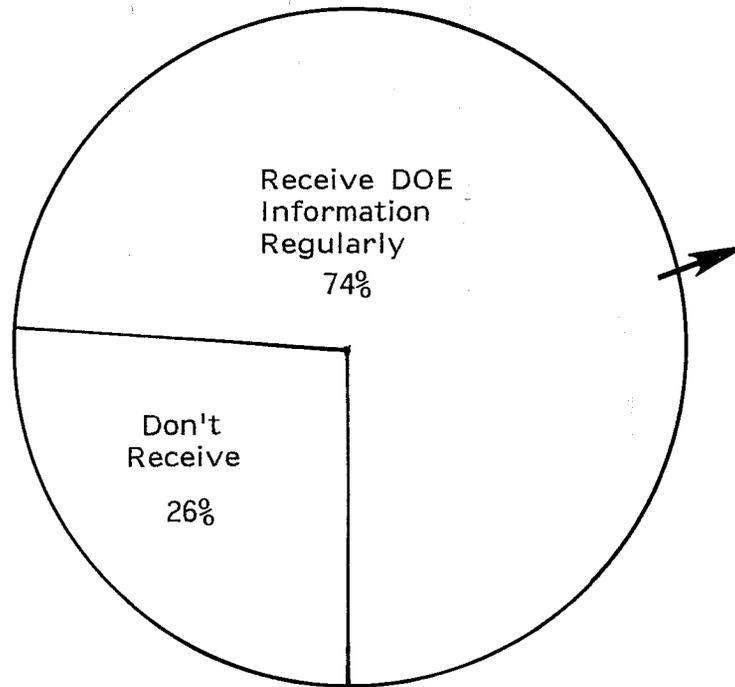


CHEMICAL SUPPLIERS

Exhibit 9

EOR Technical Information Received from DOE

(Base 19)

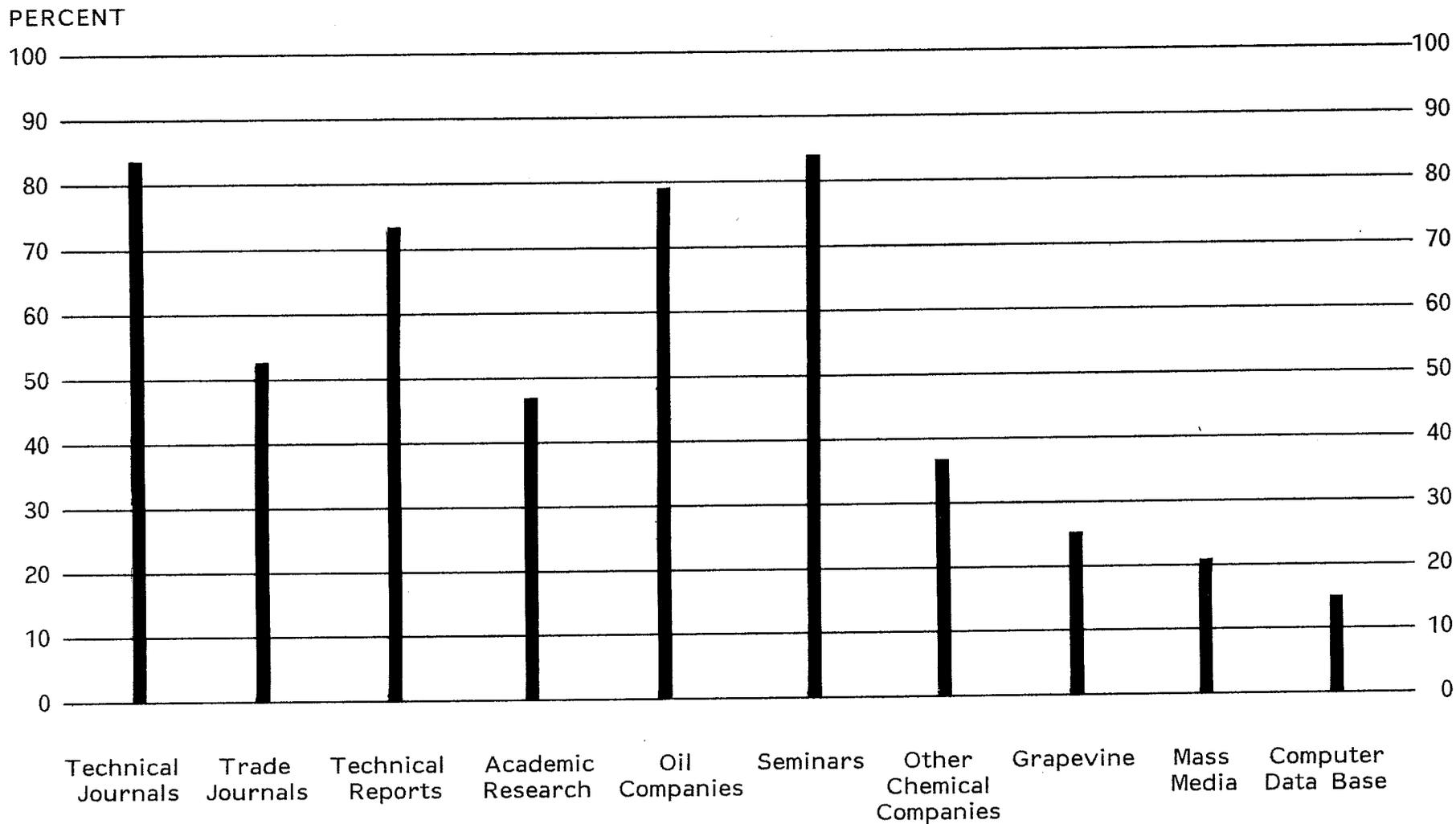


TYPES OF INFORMATION RECEIVED
(Base 14, Multiple Responses)

	<u>Total Mentions</u>
Quarterly Report	12
Annual Report	4
Other Information*	8

*Includes special reports, process reports, and information on EOR Symposium.

CHEMICAL SUPPLIERS
 Exhibit 10
Sources of Technical EOR Information
 (Base 19, Multiple Responses)



PERCENT OF RESPONDENTS MENTIONING

CHEMICAL SUPPLIERS

Exhibit 11

Assessment of Information from BETC

(Base 19)

PERCENT



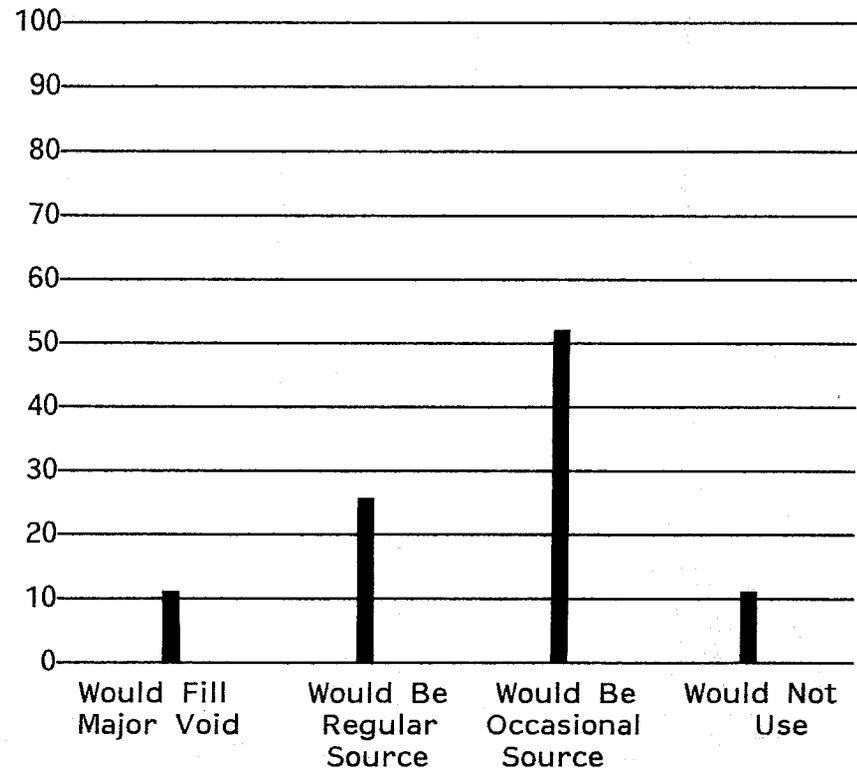
OVERALL ASSESSMENT

CHEMICAL SUPPLIERS

Exhibit 12

Usefulness of EOR Technical Information Center

(Base 19)



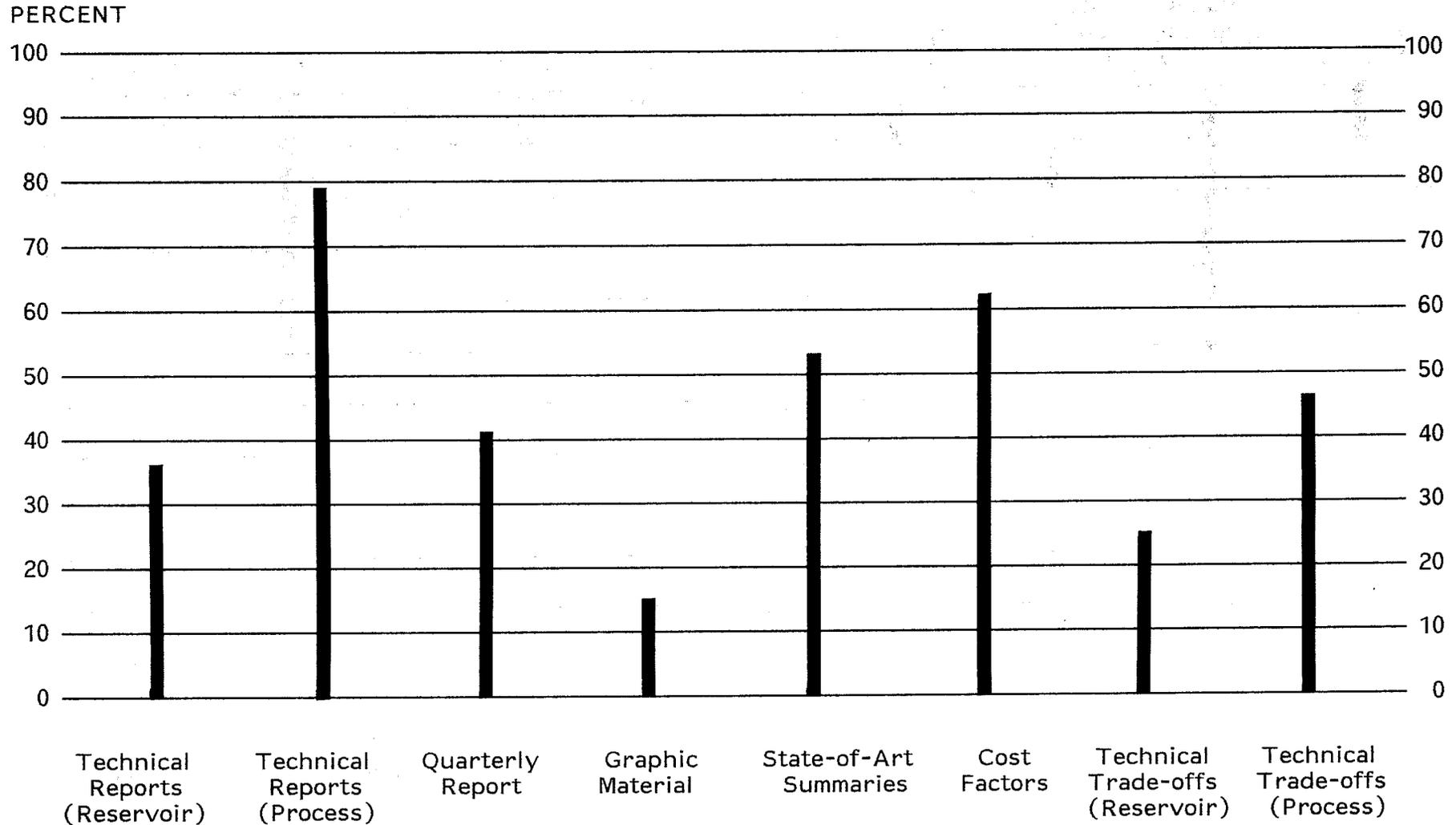
LEVEL OF USEFULNESS

CHEMICAL SUPPLIERS

Exhibit 13

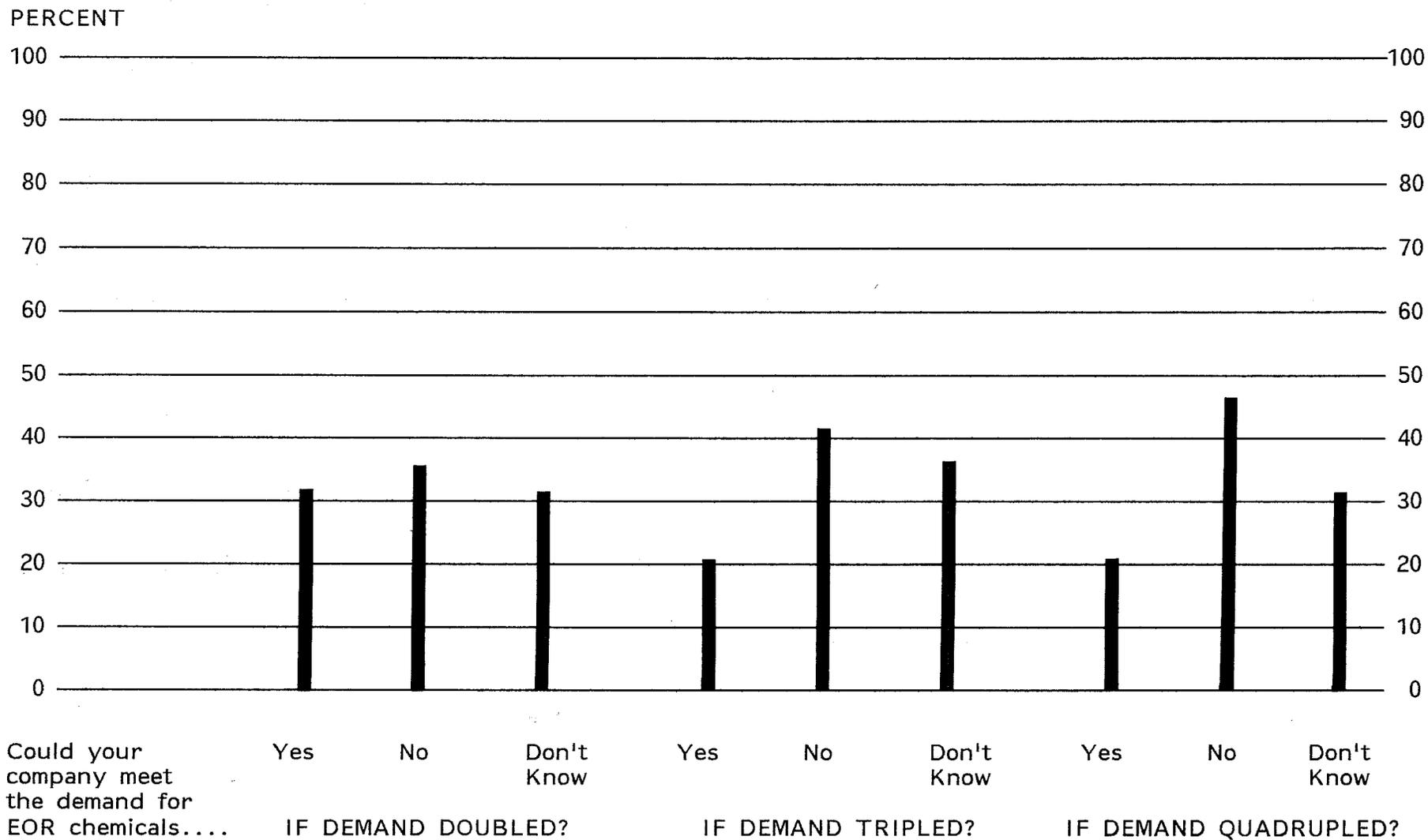
Types of Information Desired from BETC

(Base 19, Multiple Responses)



PERCENT OF RESPONDENTS MENTIONING

CHEMICAL SUPPLIERS
 Exhibit 14
EOR Chemical Production Capacity
 (Base 19)



FINANCIAL INSTITUTIONS (BANKS)

Number in survey: 27.

Typical level of respondent: Officer in energy or petroleum lending division.

Current level of EOR expertise: Familiar with concept or general principles.

Direct experience with EOR: Very low.

Impact on EOR: Major. Primary source for project financing.

Attitude toward EOR: It is a developing technology. Banks will not get involved until risk is substantially reduced.

Perceived constraints: Technical and economic uncertainties too great for bank to assume. Not in venture capital business.

Opinion of DOE role:

1. Provide loan guarantees.
2. Assume financial risk until a project (or process) is proven.

Familiarity with DOE programs: Vague, but want to know more.

Familiarity with BETC: Low. Banks want to be included on mailing lists, however.

Information sources:

1. Trade journals (O&GJ, World Oil, Pet. Eng.)
2. Other bankers
3. Technical journals (JPT, SPEJ)
4. Seminars
5. Customers

Information needs:

1. Process performance summaries (with emphasis on finance)
2. Production case histories
3. Detailed cost analysis
4. Screening guides (for technical staff)

Information levels:

1. Top bank management
2. Energy division lending officer
3. Energy engineering/research staff

Information format: Hard copy.

Usefulness of EOR Technical Information Center: Would be an occasional source.

Additional Comments:

- o Traditional petroleum banks indicate an unwillingness to lend money for EOR project financing under current loan procedures.
- o Some banks new to petroleum lending have developed a reputation for having less restrictive financing requirements than traditional petroleum banks, but EOR is not likely to benefit. If applied, those more lenient

credit restrictions apply to new exploratory drilling. If anything, banks new to petroleum lending have tighter restrictions on EOR than traditional petroleum banks.

- o Given the uncertainties of EOR, normal banking channels will not be available to oil producers for EOR projects without some sort of loan guarantee. The only possible exception is thermal projects in areas of proven potential.
- o Bankers often discuss lending criteria with colleagues. As a result, a "group opinion" develops which is resistant to rapid change. This financial "inertia" is currently working against EOR.
- o Many bankers say oil producers best source of EOR funding is likely to be equity participation by other oil companies or refiners.
- o In general, bankers are familiar with the economic and technical aspects of oil production, but their understanding of EOR lags. In all cases, the traditional petroleum banks have a higher level of awareness than banks new to petroleum lending.
- o Of all banks interviewed, 67 percent have petroleum engineers on staff. Most have only one or two engineers on staff, but two banks had 8 to 10 on staff.
- o Although only 11 percent of the banks interviewed had made loans on EOR projects (all thermal), more than half anticipated making EOR project loans in the future.
- o Bankers rely heavily on trade journals (primarily the Oil & Gas Journal) for information on EOR. Other bankers and technical journals are also important sources. In contrast, only 7 percent of the banks interviewed receive information from BETC.

- o The majority of bankers expressed a desire to receive state-of-the-art summaries, Progress Reviews, and detailed cost information from BETC.

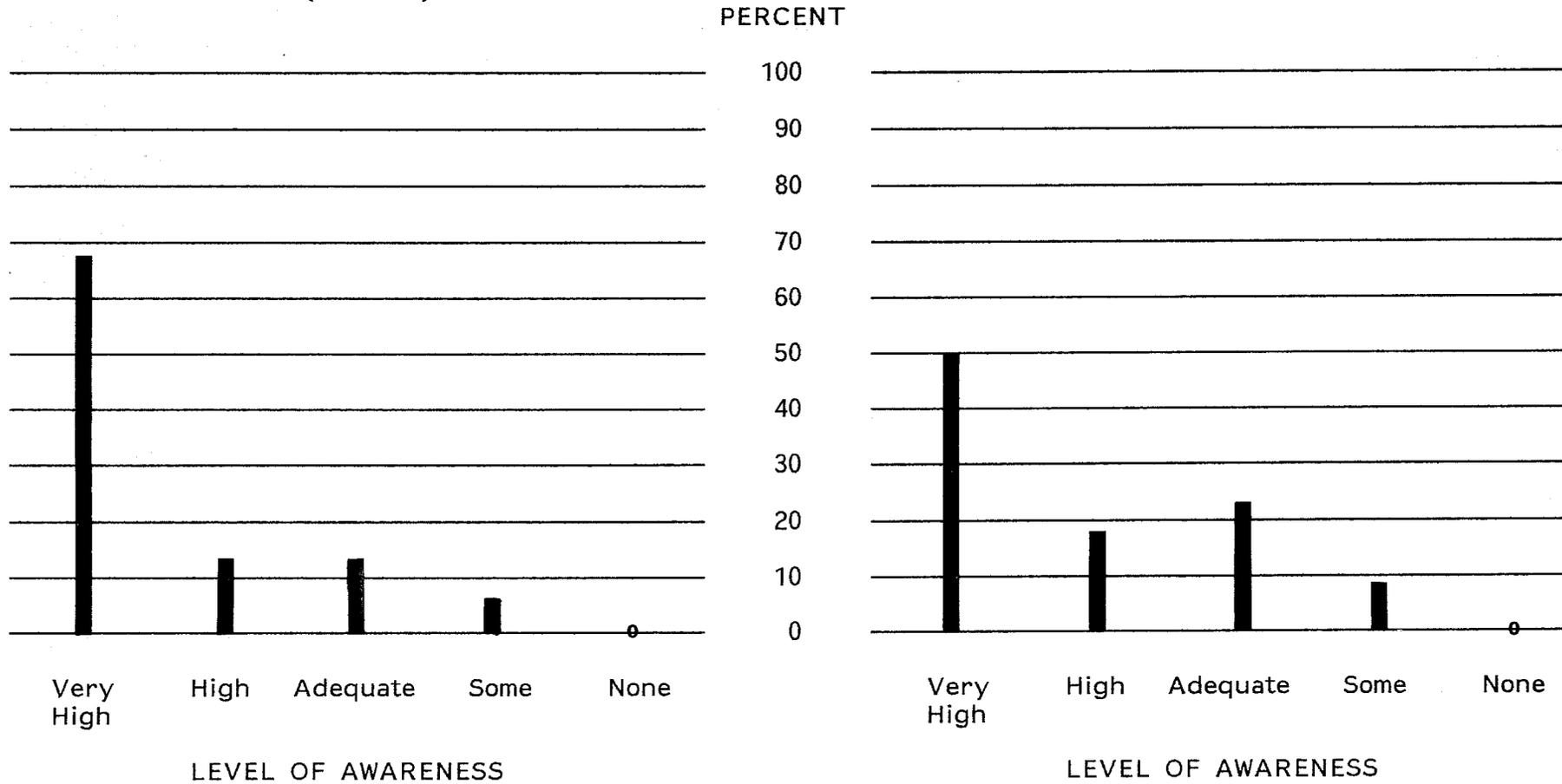
FINANCIAL INSTITUTIONS

Exhibit 1

Awareness of the Technical Aspects of Oil Production

TRADITIONAL PETROLEUM BANKS
(Base 16)*

ALL BANKS SURVEYED
(Base 22)*



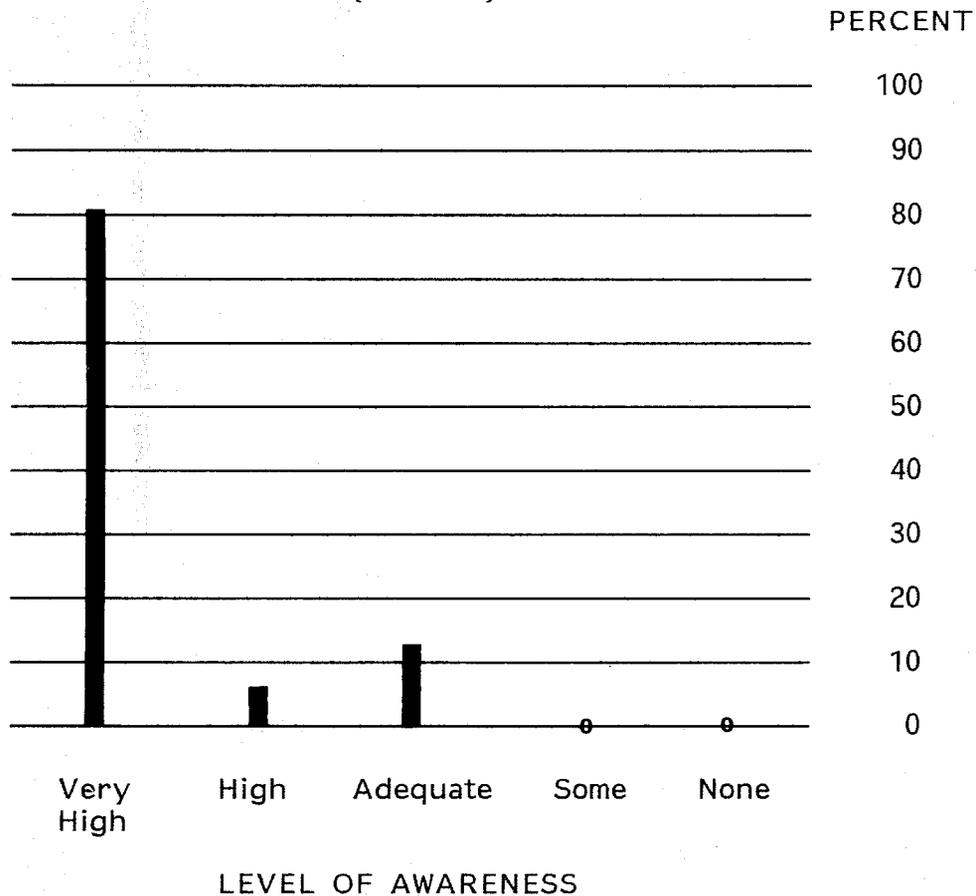
*The five traditional petroleum banks interviewed during the pretest were not asked to respond to this question.

FINANCIAL INSTITUTIONS

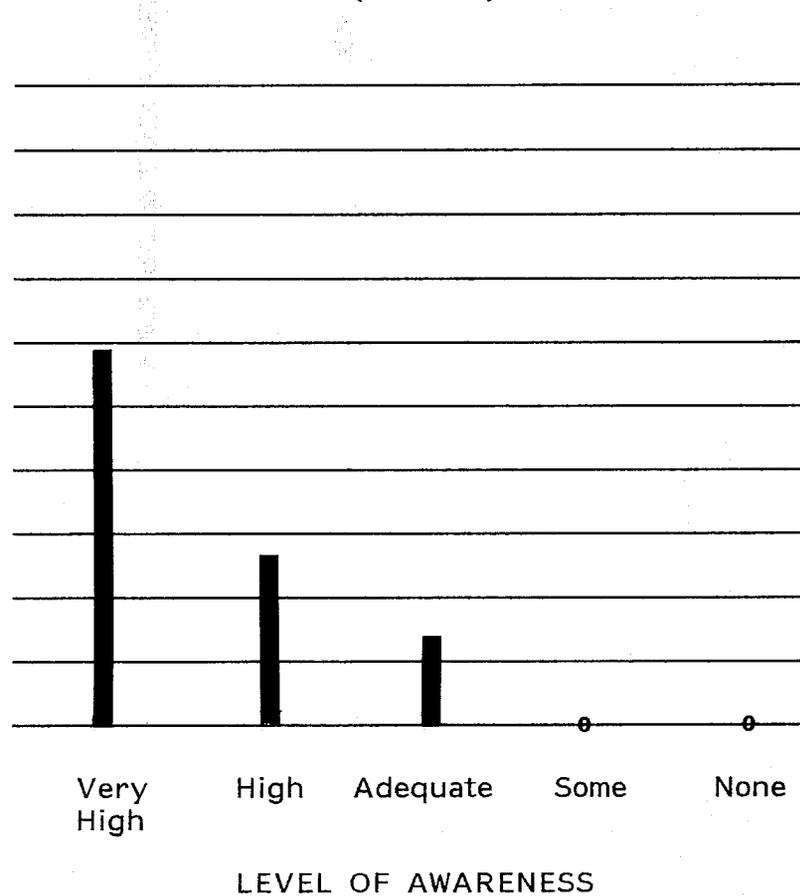
Exhibit 2

Awareness of the Economic Aspects of Oil Production

TRADITIONAL PETROLEUM BANKS
(Base 16)*



ALL BANKS SURVEYED
(Base 22)*



*The five traditional petroleum banks interviewed during the pretest were not asked to respond to this question.

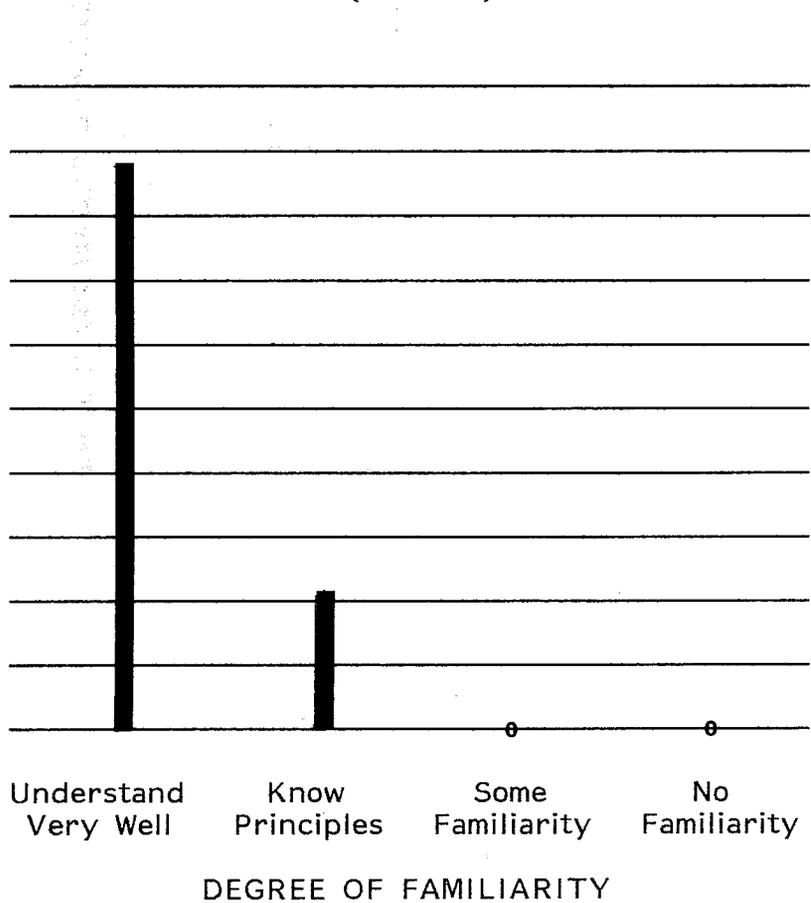
FINANCIAL INSTITUTIONS

Exhibit 3

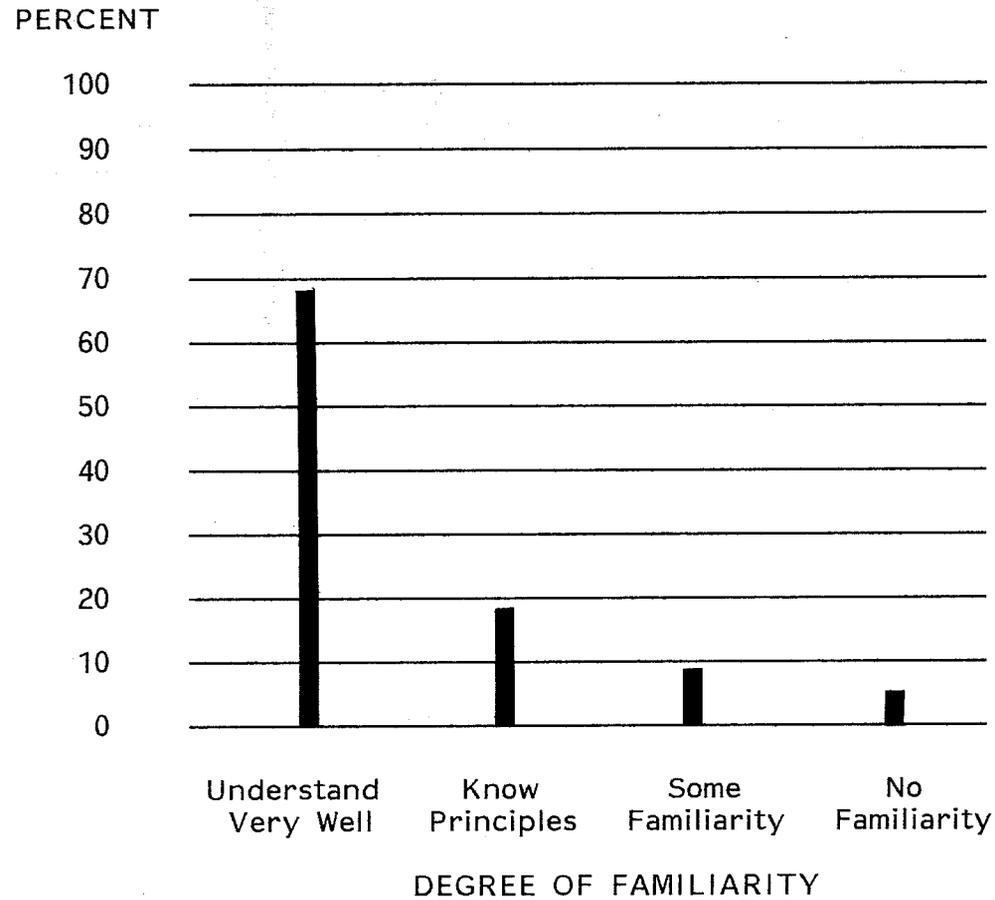
Familiarity with Three Stages of Oil Production

(Primary - Secondary - Tertiary)

TRADITIONAL PETROLEUM BANKS
(Base 16)*



ALL BANKS SURVEYED
(Base 22)*

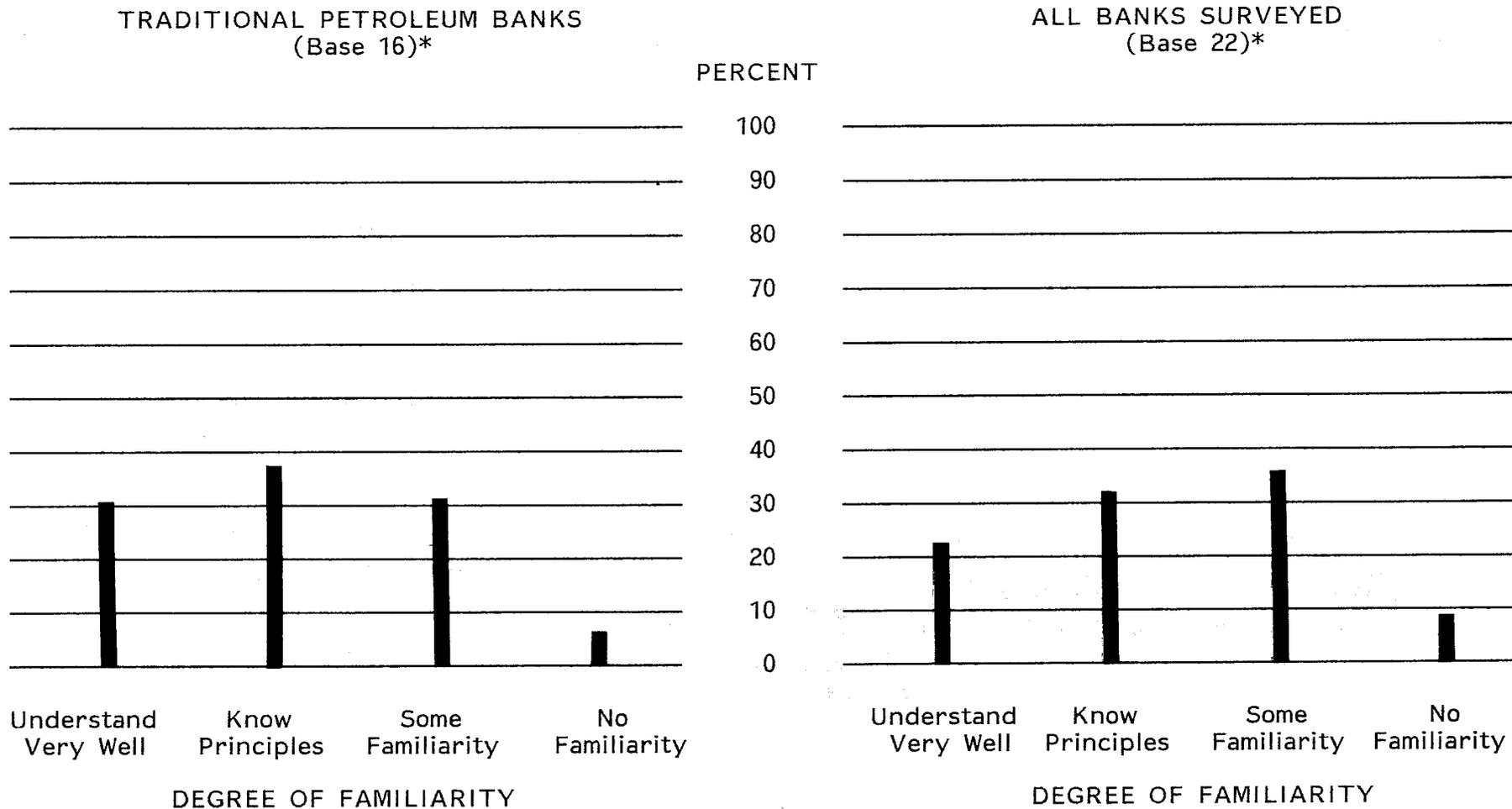


*The five traditional petroleum banks interviewed during the pretest were not asked to respond to this question.

FINANCIAL INSTITUTIONS

Exhibit 4

Familiarity with Technical Aspects of Tertiary Recovery



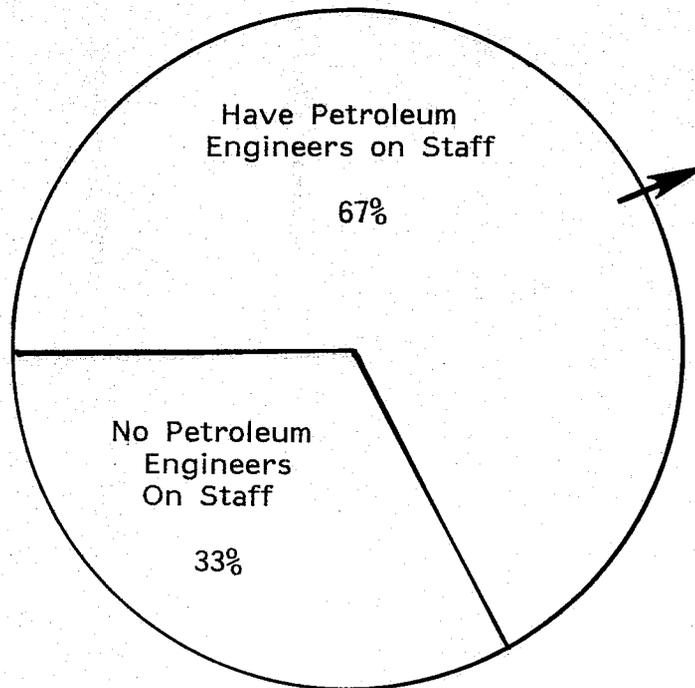
*The five traditional petroleum banks interviewed during the pretest were not asked to respond to this question.

FINANCIAL INSTITUTIONS

Exhibit 5

Petroleum Engineers Employed by Banks*

(Base 27)



PETROLEUM ENGINEERS ON STAFF

<u>Number of Engineers</u>	<u>Banks Responding</u>
8 to 10	2
5 to 7	5
3 to 4	3
1 to 2	8
None	<u>9</u>
TOTAL	27

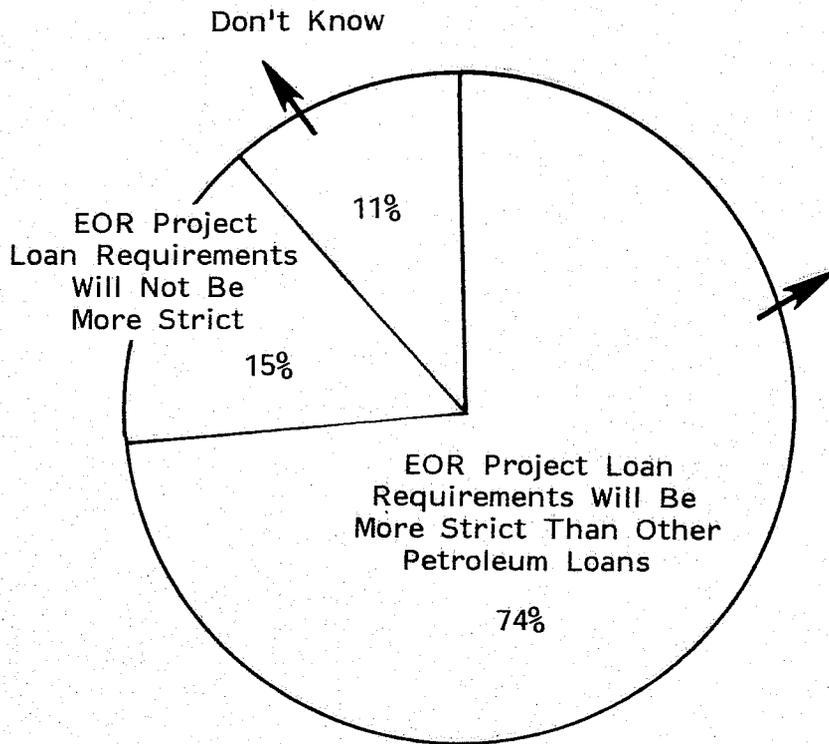
*The survey sample included six banks which have recently entered the petroleum-lending field. Of these, none has petroleum engineers on staff. Only one of those banks indicated an intention to employ petroleum engineers. The others said they would continue to rely on consultants.

FINANCIAL INSTITUTIONS

Exhibit 6

Stringency of EOR Project Financing

(Base 27)



PRIMARY DIFFERENCE IN BANK'S ATTITUDE TOWARD EOR LOANS

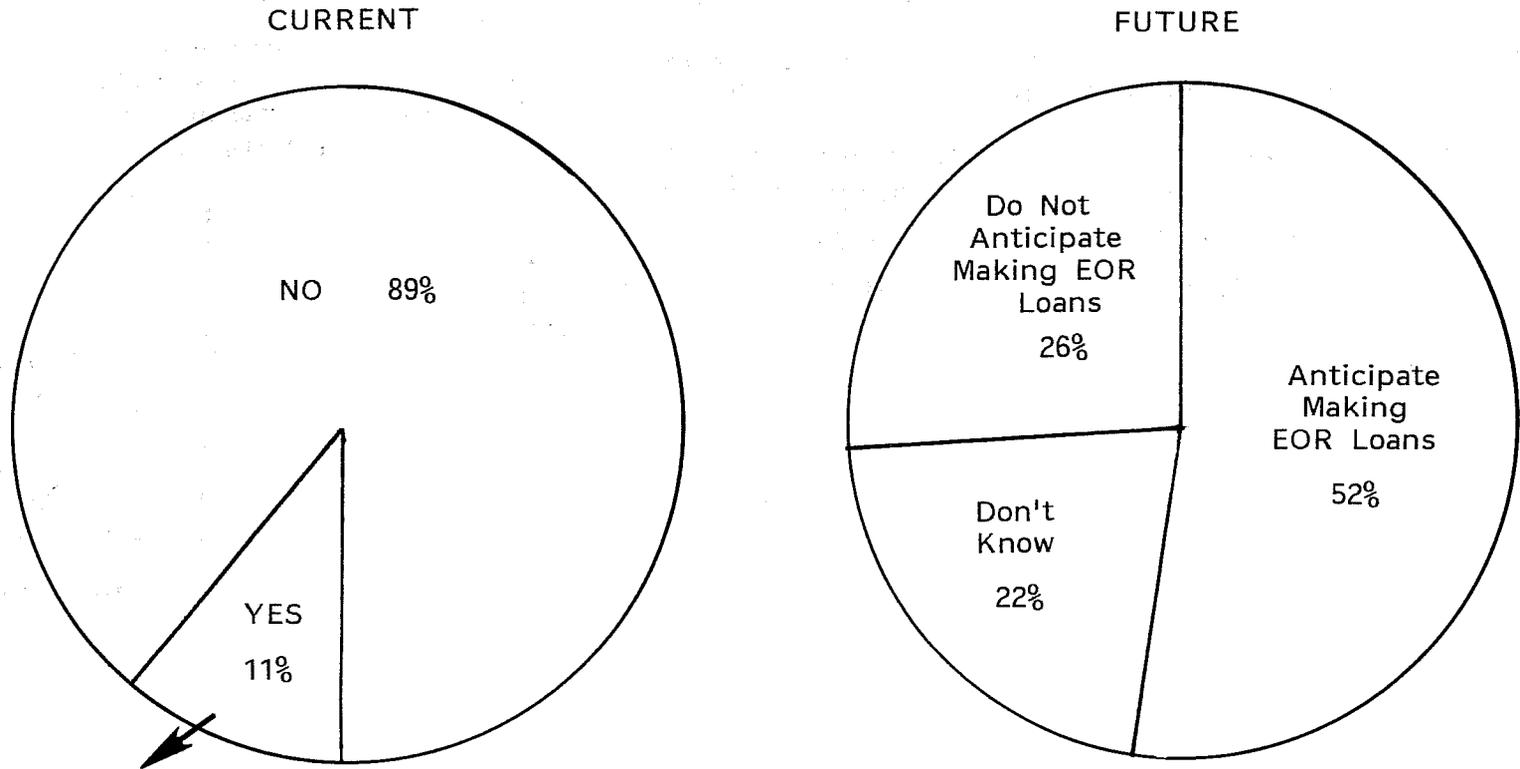
	<u>Banks Responding</u>	<u>Percent</u>
Will consider only with federal guarantee	3	15%
Will require pledge of more proven production	5	25
Will require additional guarantees or reserve pledged until project production proven	4	20
Will require more information regarding history of process in other areas	5	25
Wouldn't make an EOR loan under any circumstance	<u>3</u>	<u>15</u>
	20	100%

FINANCIAL INSTITUTIONS

Exhibit 7

Status of Banking Industry's Participation in EOR Project Financing

(Base 27)



Three traditional petroleum banks (located in California, Colorado, and Texas) indicated they had financed a tertiary project. All of these projects were steam floods.

FINANCIAL INSTITUTIONS

Exhibit 8

Attitude Toward EOR Loan Applications in the Future

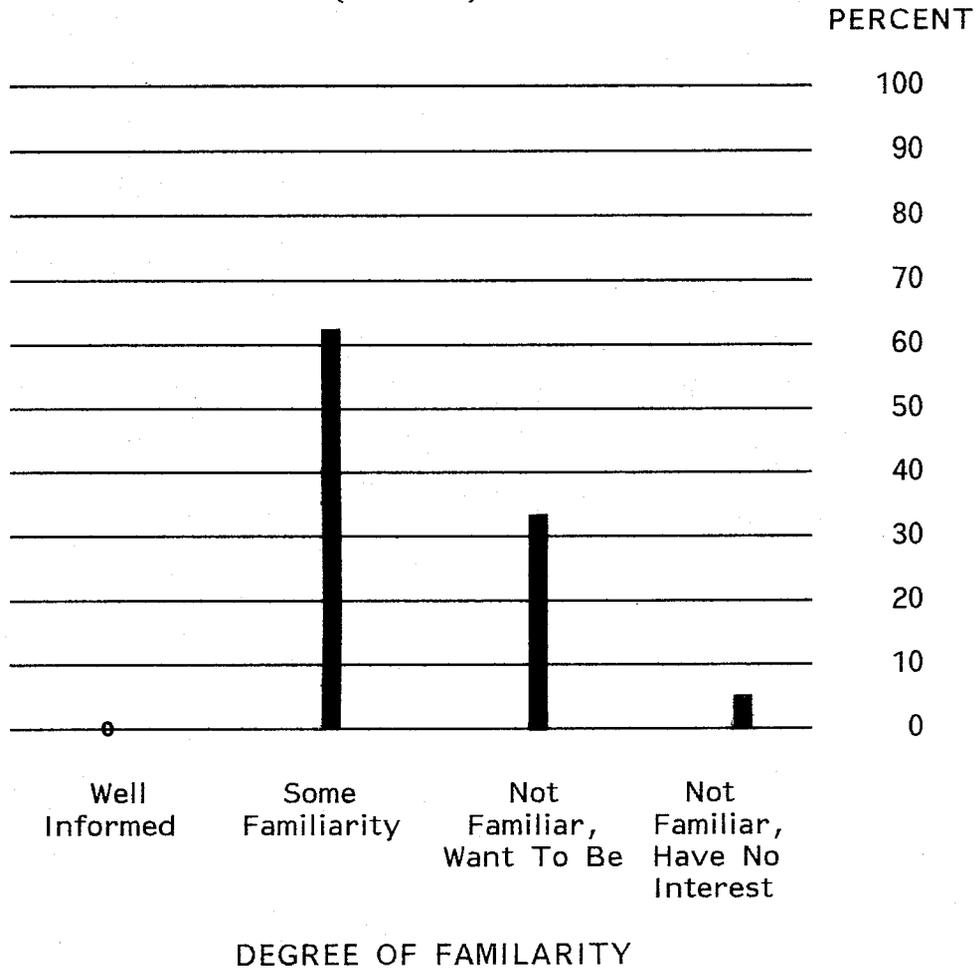
<u>ATTITUDE</u>	<u>Traditional Petroleum Banks (Base 22)</u>	<u>All Banks Surveyed (Base 27)</u>
• Expect to approve EOR loans soon	5%	4%
• Glad to discuss and evaluate on project merits	38	48
• Will discuss, but don't think it would be approved	19	19
• Out of question without guarantee of some kind	24	19
• Don't want anything to do with EOR	10	7
• No answer	<u>4</u>	<u>3</u>
	100%	100%

FINANCIAL INSTITUTIONS

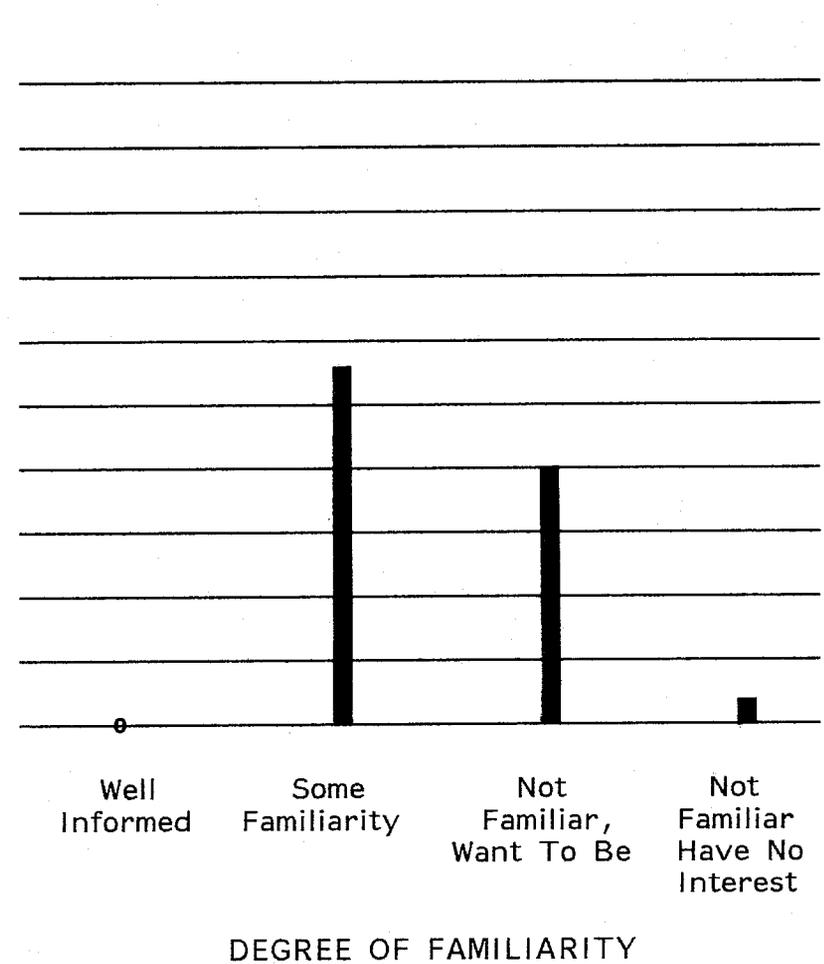
Exhibit 9

Familiarity with DOE Cost-Share Program

TRADITIONAL PETROLEUM BANKS
(Base 21)



ALL BANKS SURVEYED
(Base 27)

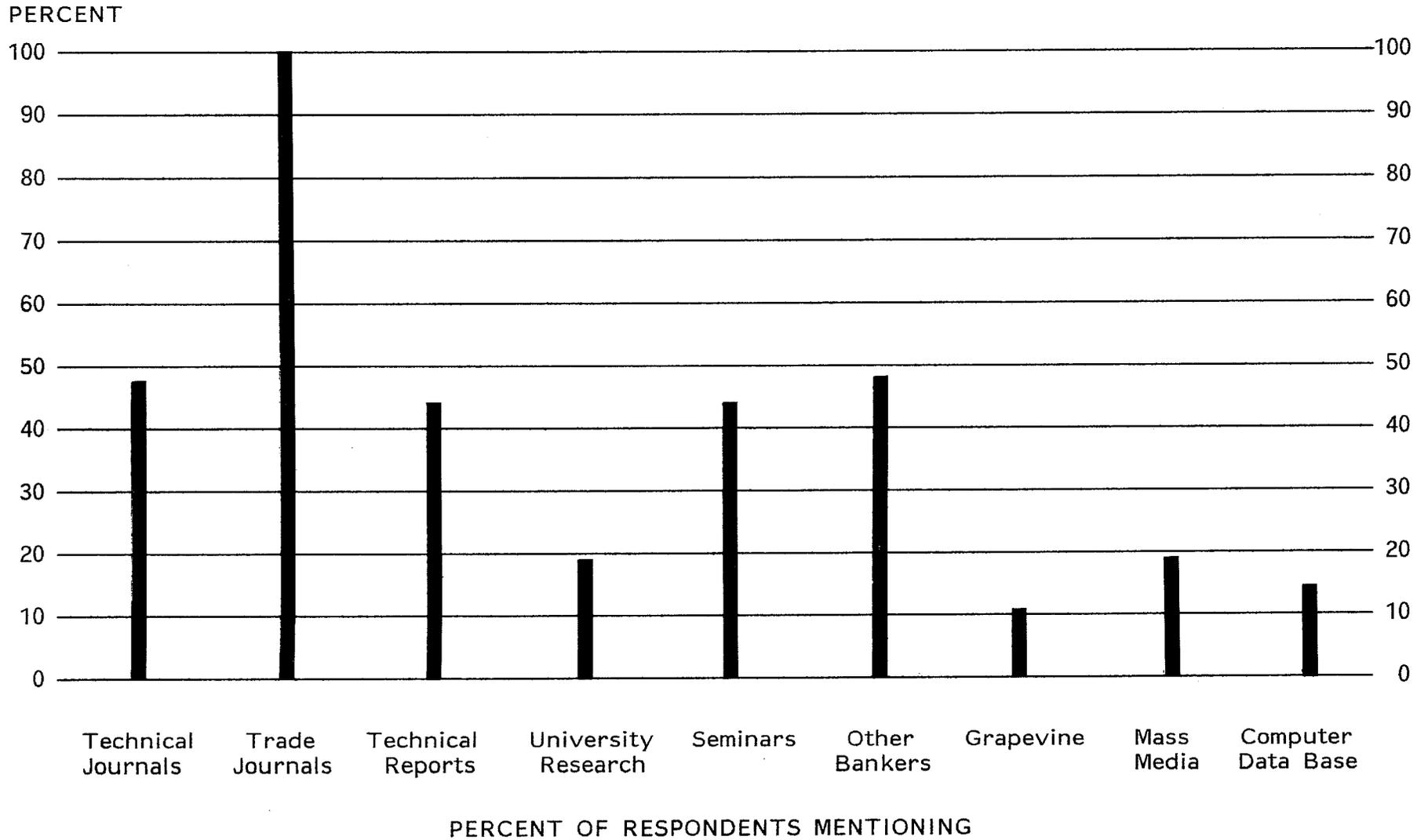


FINANCIAL INSTITUTIONS

Exhibit 10

Sources of Technical EOR Information

ALL BANKS SURVEYED
(Base 27, Multiple Reponses)



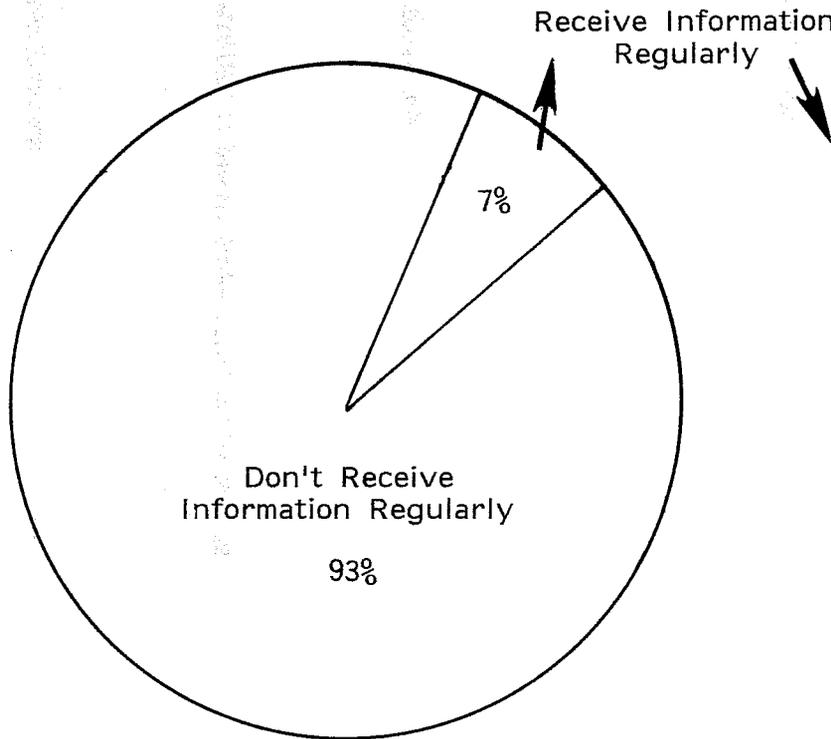
FINANCIAL INSTITUTIONS

Exhibit 11

EOR Information Received from DOE

ALL BANKS SURVEYED

(Base 27)



TYPES OF INFORMATION RECEIVED
(Base 2, Multiple Responses)

	<u>Total Mentions</u>
Quarterly Report	2
Annual Reports	0
Other Information	0

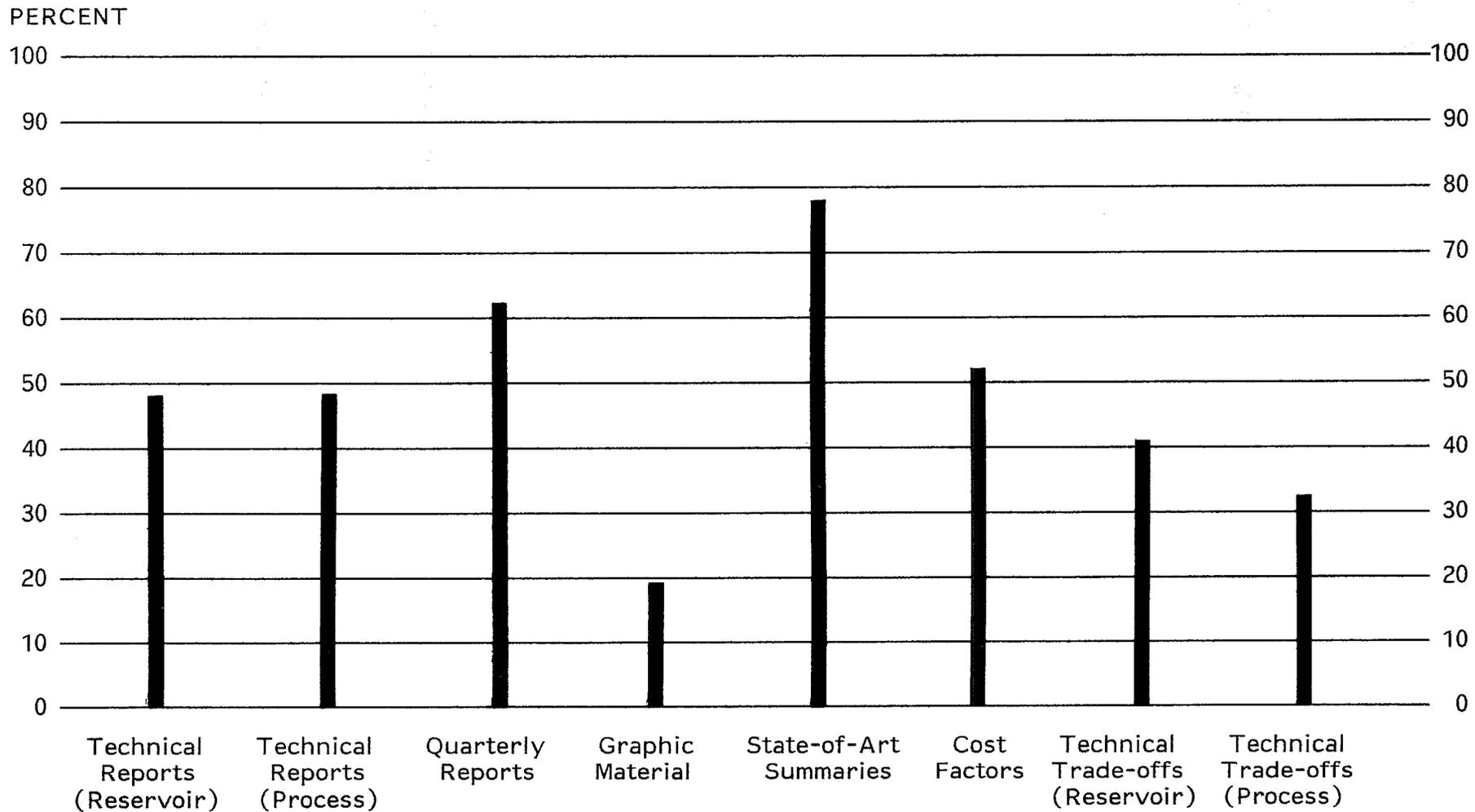
FINANCIAL INSTITUTIONS

Exhibit 12

Types of EOR Information Desired from BETC

ALL BANKS SURVEYED

(Base 27, Multiple Responses)



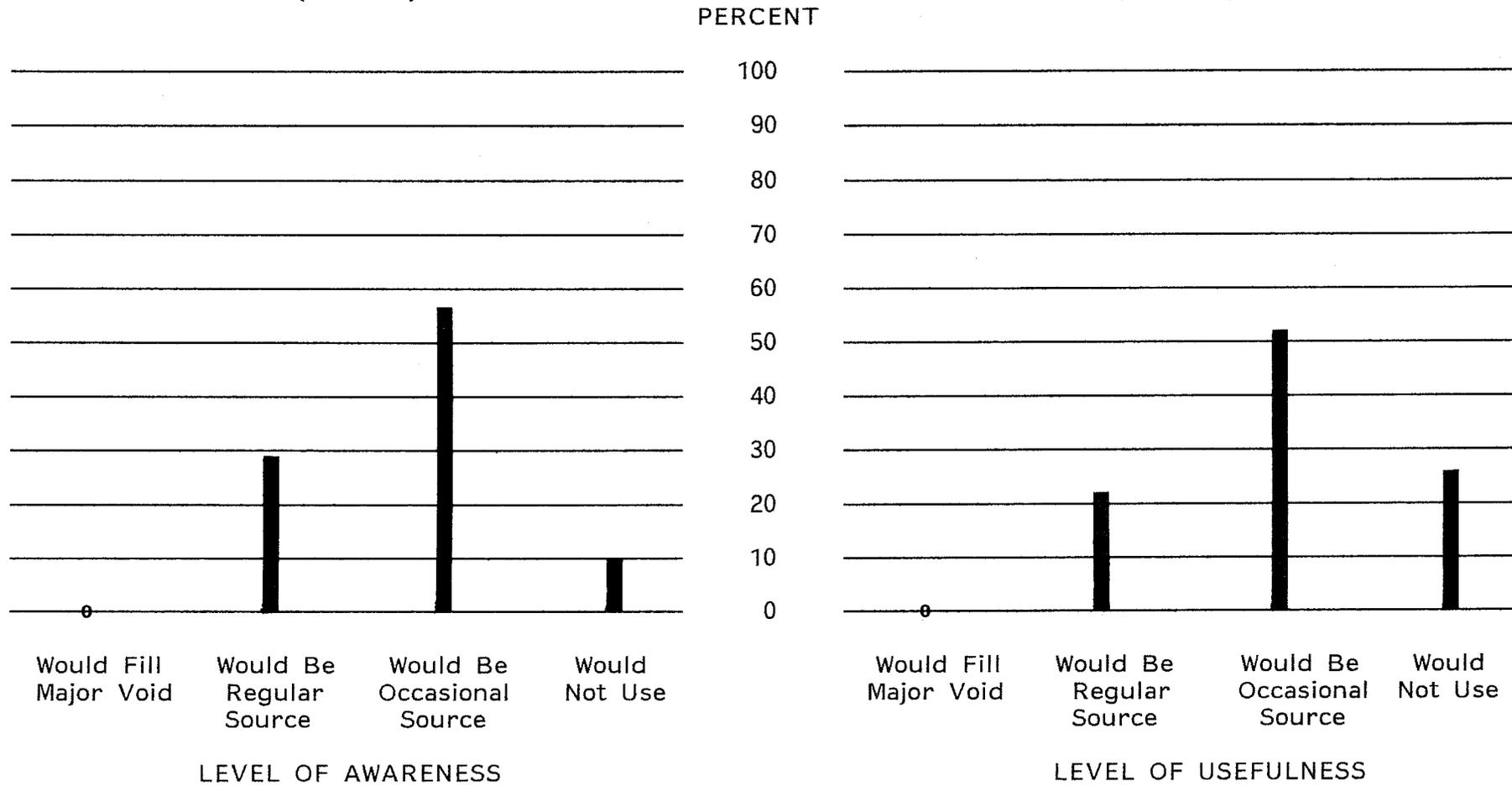
FINANCIAL INSTITUTIONS

Exhibit 13

Usefulness of EOR Technical Information Center

TRADITIONAL PETROLEUM BANKS
(Base 21)

ALL BANKS SURVEYED
(Base 27)



UNIVERSITIES

Number in survey: 23.

Respondent level: Professor or associate professor of petroleum engineering. (Universities were pre-selected on the basis of their involvement in EOR research.)

Current level of EOR expertise: Very high among survey sample. Outside of those performing EOR research, awareness and interest appear to be low.

Direct experience with EOR: Mostly in laboratory research.

Impact on EOR: Lower than generally believed. Those producers with the resources to undertake EOR research tend to rely more heavily on internal research (and other oil industry sources) than on academic research.

Attitude toward EOR: Overall, university researchers feel there are major technical difficulties in commercializing EOR. Perhaps prejudiced by their inherent need for research funds, they voiced a unified need for more basic research.

Perceived constraints:

1. Lack of time (teaching duties and other research limit time available for EOR)
2. Lack of manpower (both grad students and faculty)
3. Department "politics"
4. Lack of lab space
5. Lack of funds

- Opinion of DOE role:
1. Provide consistent funding for research
 2. Serve as information clearing house
 3. Force oil companies to provide access to their lab data
 4. Minimize project reporting paperwork

Familiarity with DOE programs: High among survey respondents (primarily because DOE was the major, if not sole, source of funds for their research).

Familiarity with BETC: Very high (95 percent receive BETC information regularly). They rate the Progress Review "good" but believe reports are inconsistent in quality and often sufficient technical detail. Recommended changes include:

1. Tighten up on reporting requirements
2. Provide more abstracts and summaries of all EOR-related work (academic and applied)
3. Provide screening guides
4. Provide detailed reports on successes

- Information sources:
1. Technical journals
 2. Technical reports
 3. Seminar papers
 4. Academic colleagues
 5. Computer data base

Professional interaction with colleagues: High (80 percent view it as a major information source).

Information needs:

1. Detailed technical reports
2. Access to proprietary data of major oil companies
3. Quarterly Progress Reviews
4. Information on cost factors
5. Better bibliographical abstracts and indices

Information level: Professors conducting EOR research.

Information format: Computer data base preferred (particularly for bibliographic search), but hard copy acceptable for all needs. Of all respondents, university researchers are those most comfortable with computer systems, but they dislike "holes" in them. Primarily because of cost, they use university systems.

Future EOR information needs: Will increase over the next three years.

Use of EOR Technical Information Center: Would be used often (especially if it contained up-to-date bibliographic material). Primary uses would be literature search and simulation modeling. Would be most useful if information were screened to eliminate old "chaff."

Additional Comments:

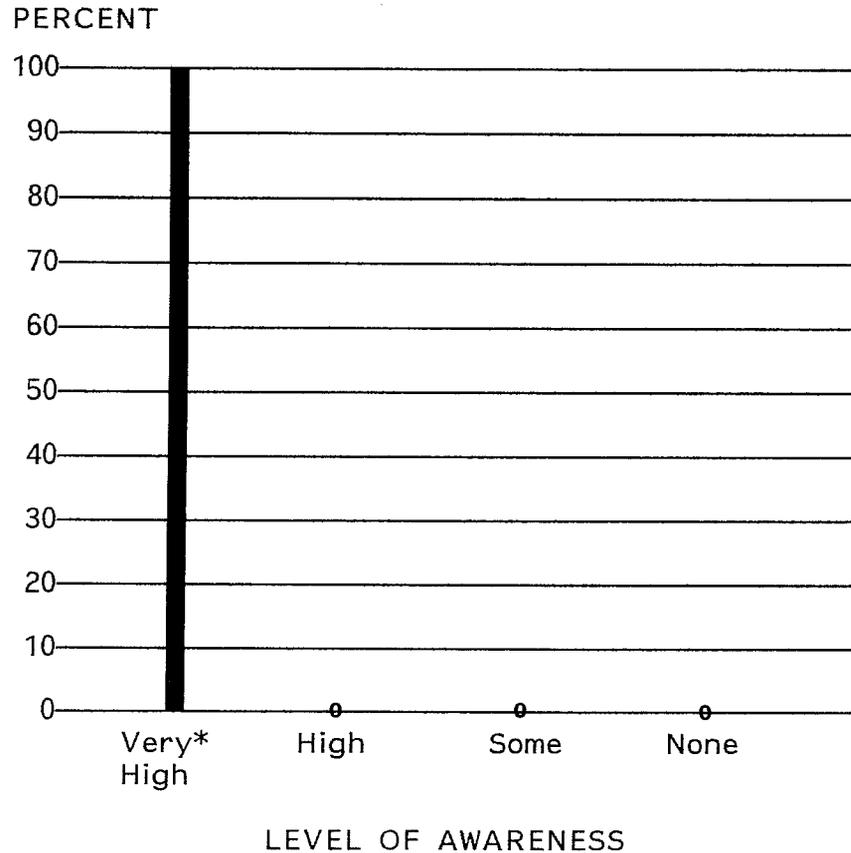
- o Academicians covet oil industry in-house data. The greatest problem for BETC is joining academic and industrial researchers in a unified technology transfer effort.
- o Some universities are seeking to broaden their involvement in "applied" research. Oil companies are reluctant to share this function and tend to protect proprietary research data. Thus, universities look to the federal government to bridge the gap with funds and information.

UNIVERSITIES

Exhibit 1

Awareness of EOR Technology

(Base 19)

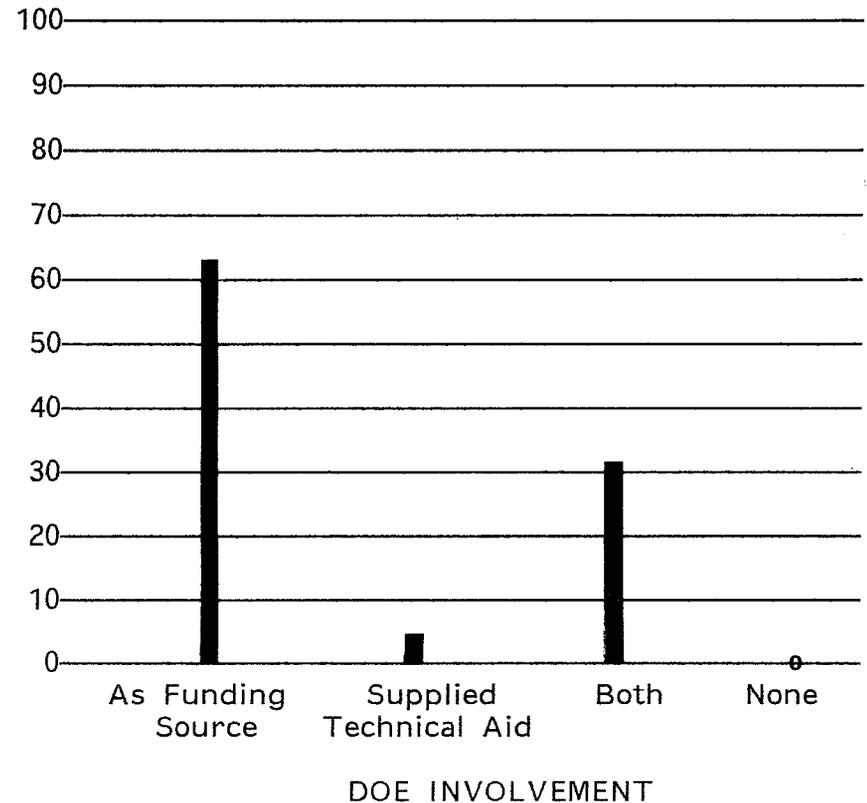


UNIVERSITIES

Exhibit 2

DOE Involvement in Research

(Base 19)



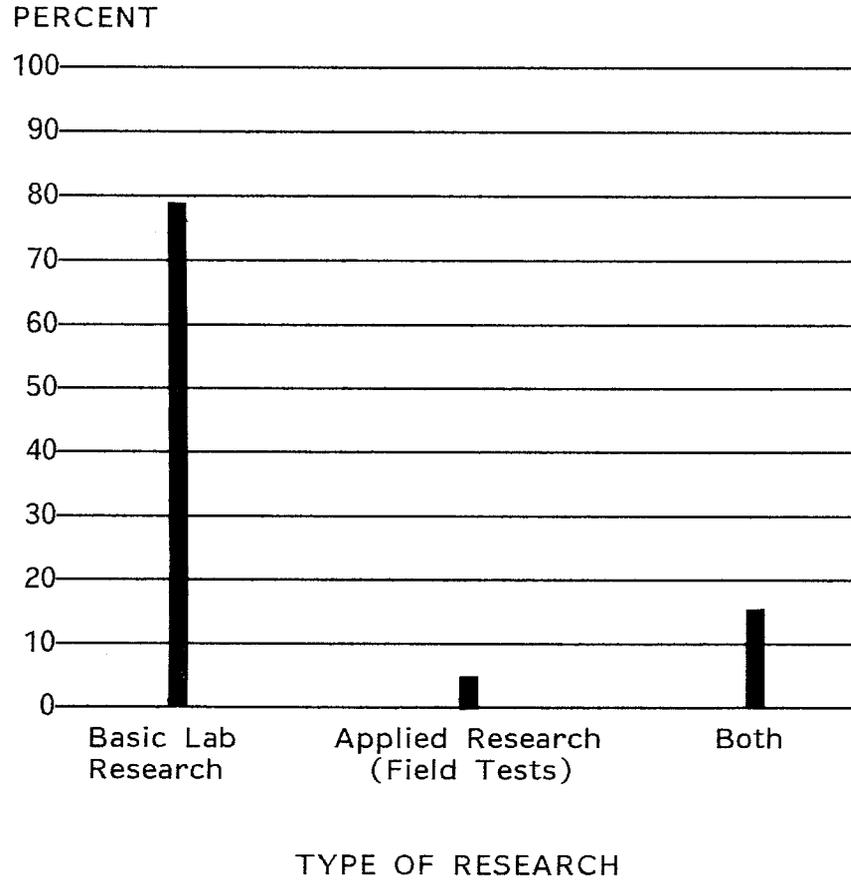
*This is not a random sample. University respondents were chosen on the basis of their involvement in EOR-related research.

UNIVERSITIES

Exhibit 3

Best Use of Research Capability

(Base 19)

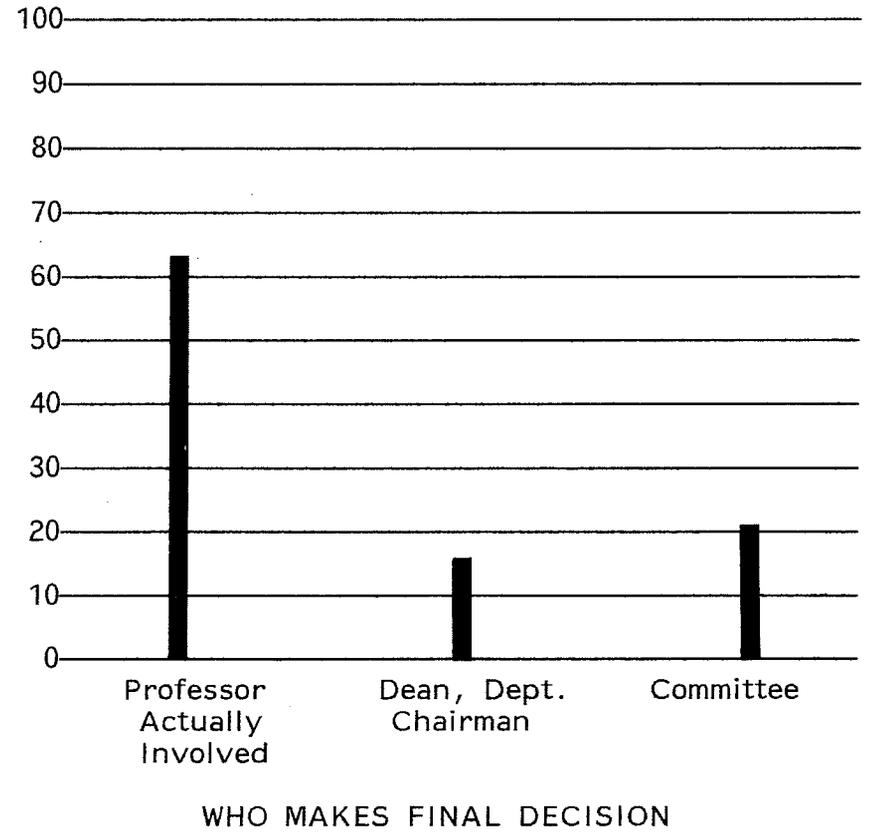


UNIVERSITIES

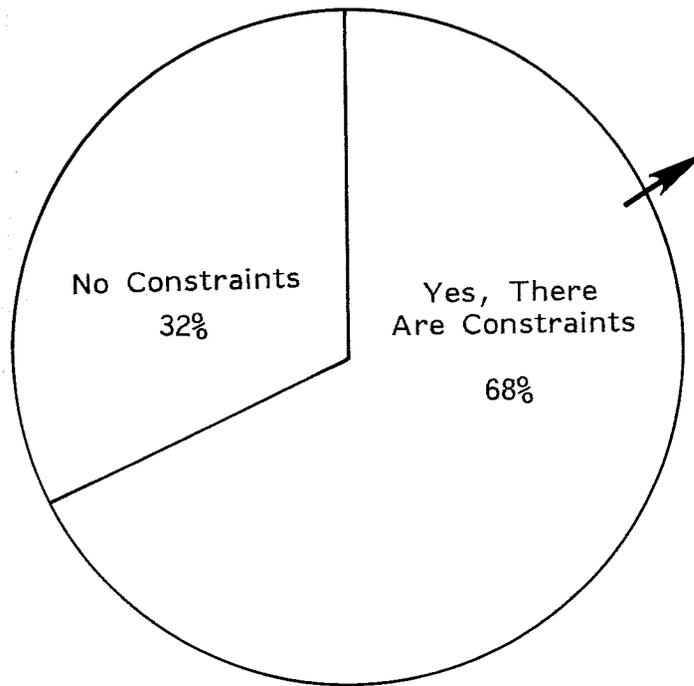
Exhibit 4

Final Decision to Undertake EOR Research

(Base 19)

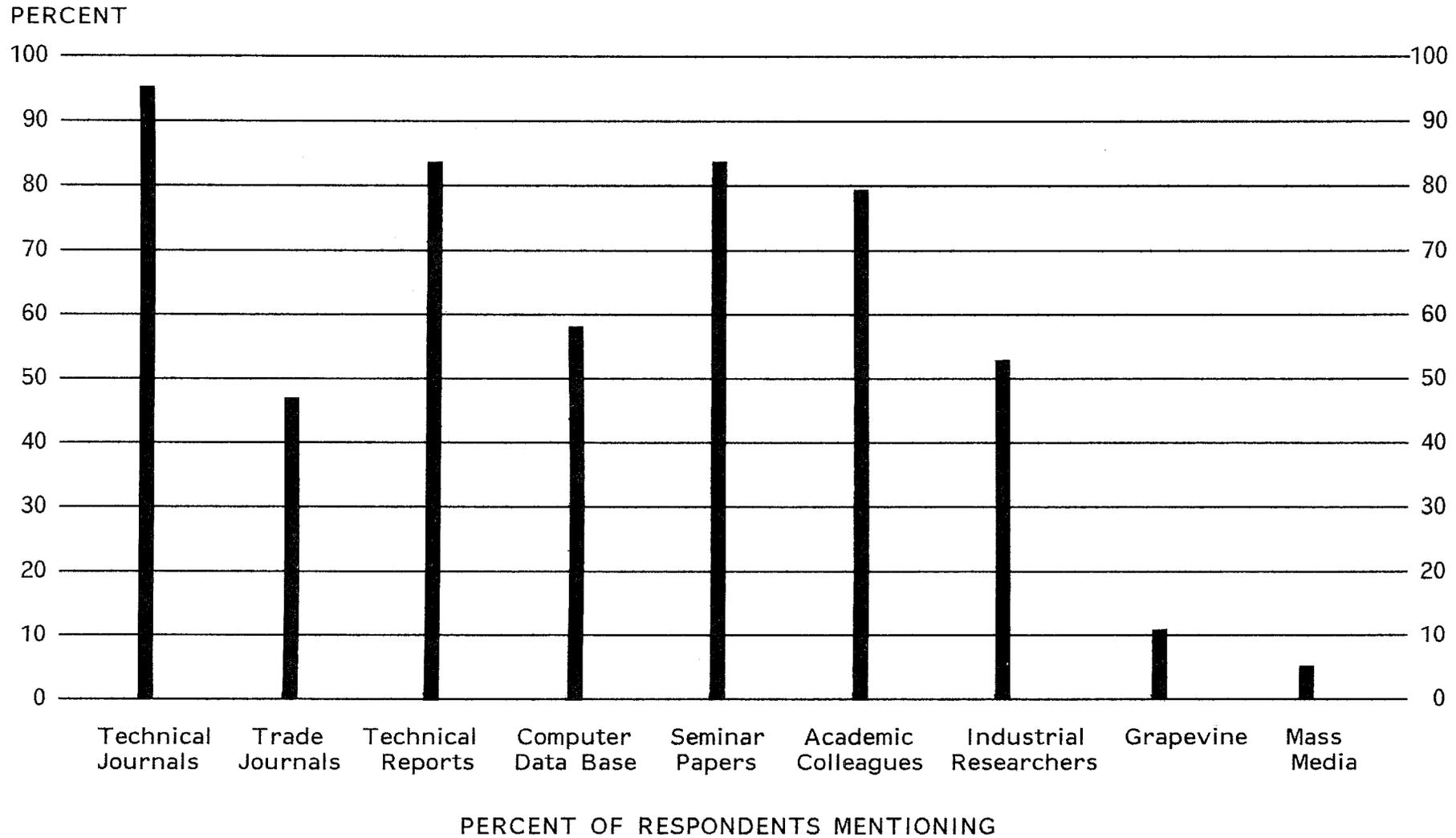


UNIVERSITIES
 Exhibit 5
Constraints to Participation in EOR Research
 (Base 19)



<u>TYPES OF CONSTRAINTS</u> (Of 27 Total Responses)	
	<u>Total Mentions</u>
Lack of Time (Teaching duties, other research)	9
Lack of Manpower (Grad students or other faculty members)	7
"Political" Problems (Department research policies, project request process)	4
Lack of Lab Space	4
Lack of Funds	3

UNIVERSITIES
Exhibit 6
Sources of Technical EOR Information
(Base 19, Multiple Responses)

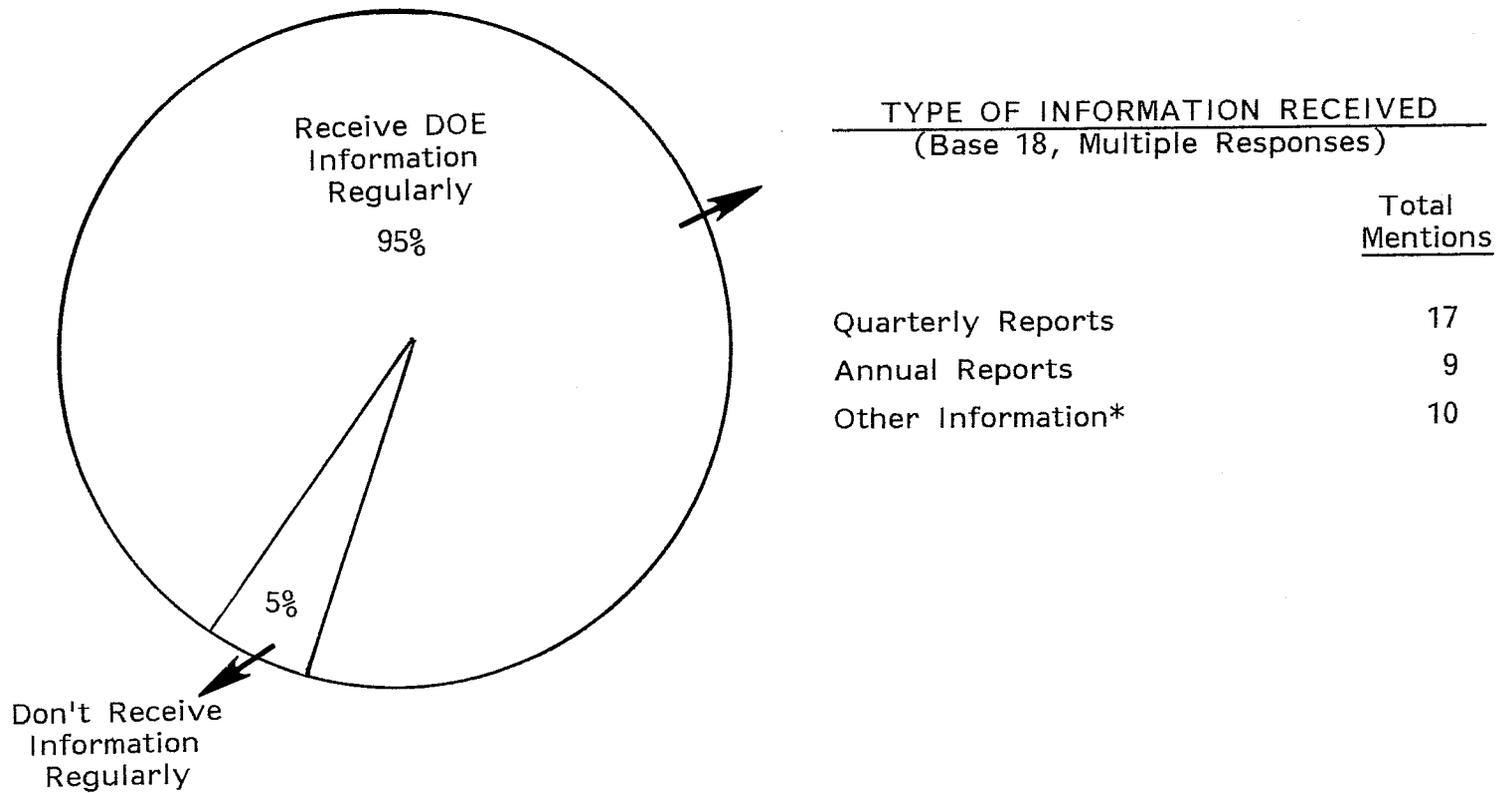


UNIVERSITIES

Exhibit 7

Types of EOR Information Received from DOE

(Base 19)



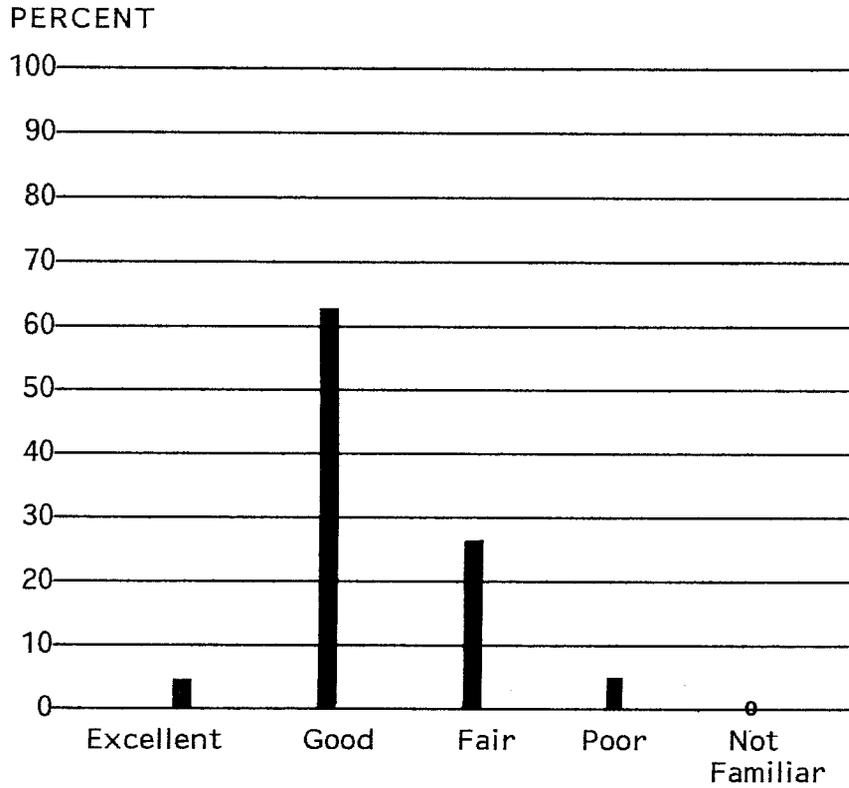
*Includes special reports on specific projects (6), monthly reports (2), other unspecified reports.

UNIVERSITIES

Exhibit 8

Assessment of EOR Information from BETC

(Base 19)



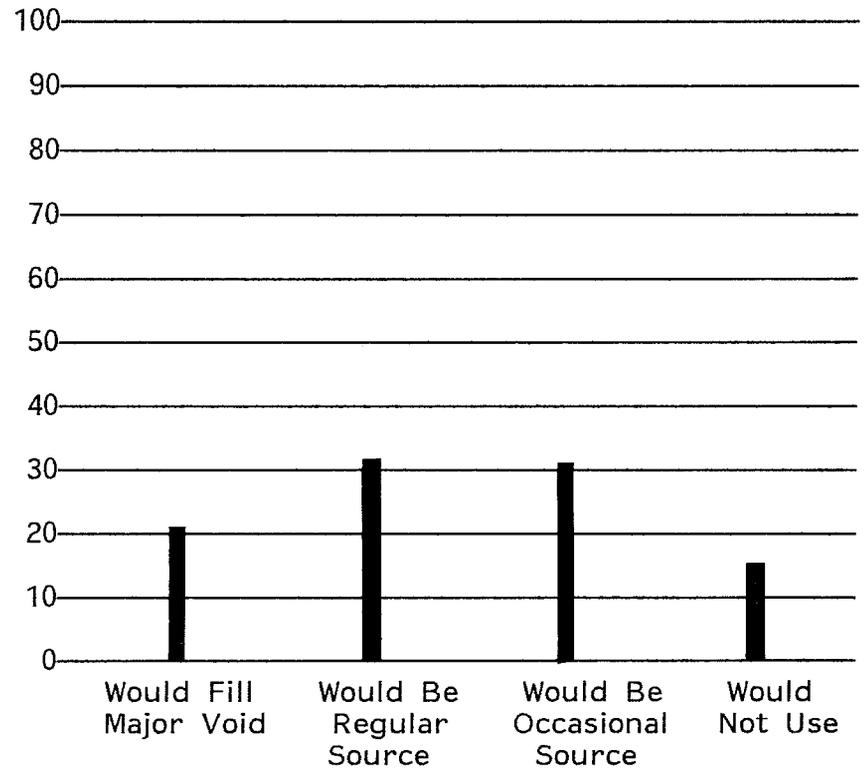
OVERALL ASSESSMENT

UNIVERSITIES

Exhibit 9

Usefulness of EOR Technical Information Center

(Base 19)



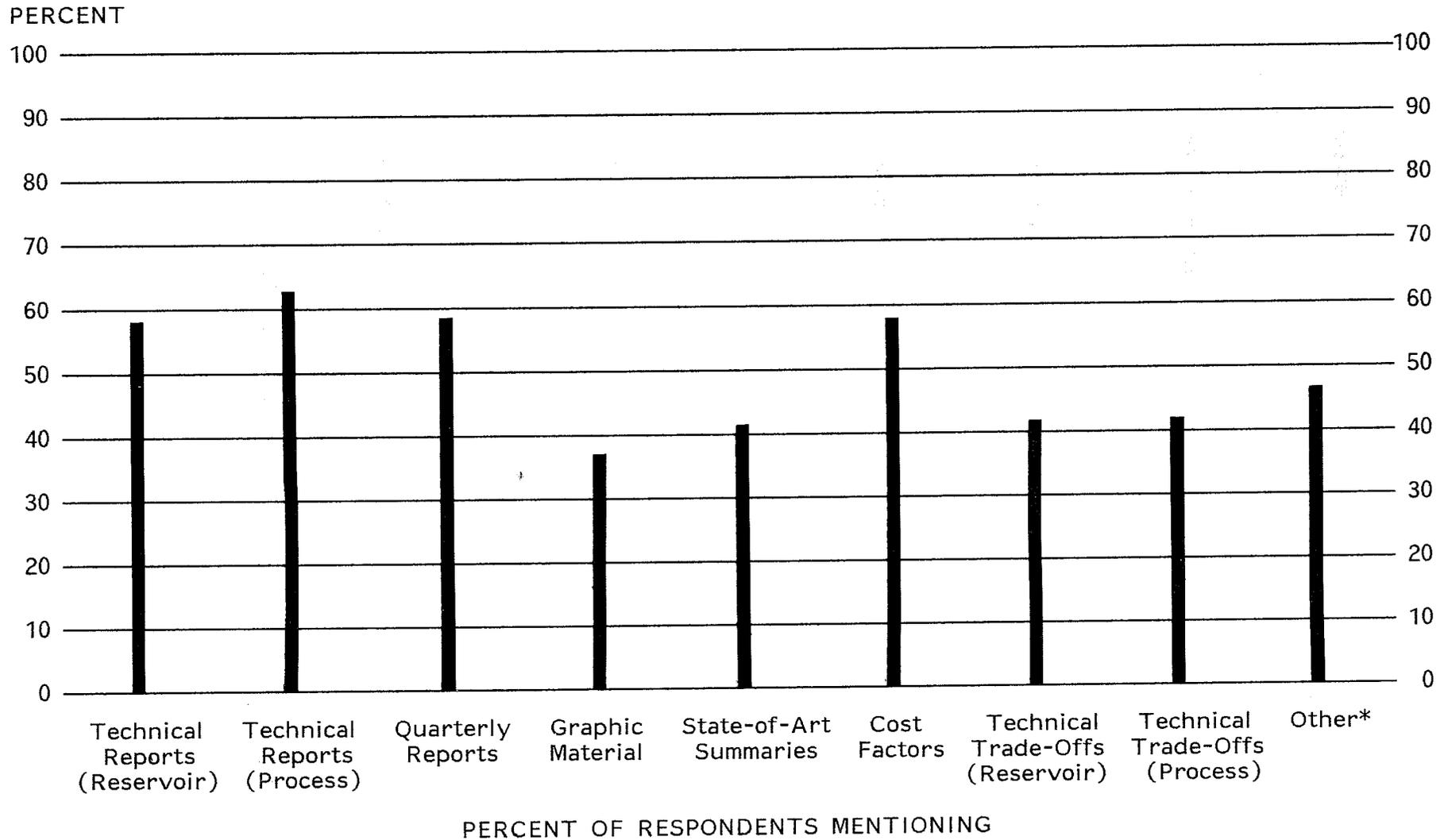
LEVEL OF USEFULNESS

UNIVERSITIES

Exhibit 10

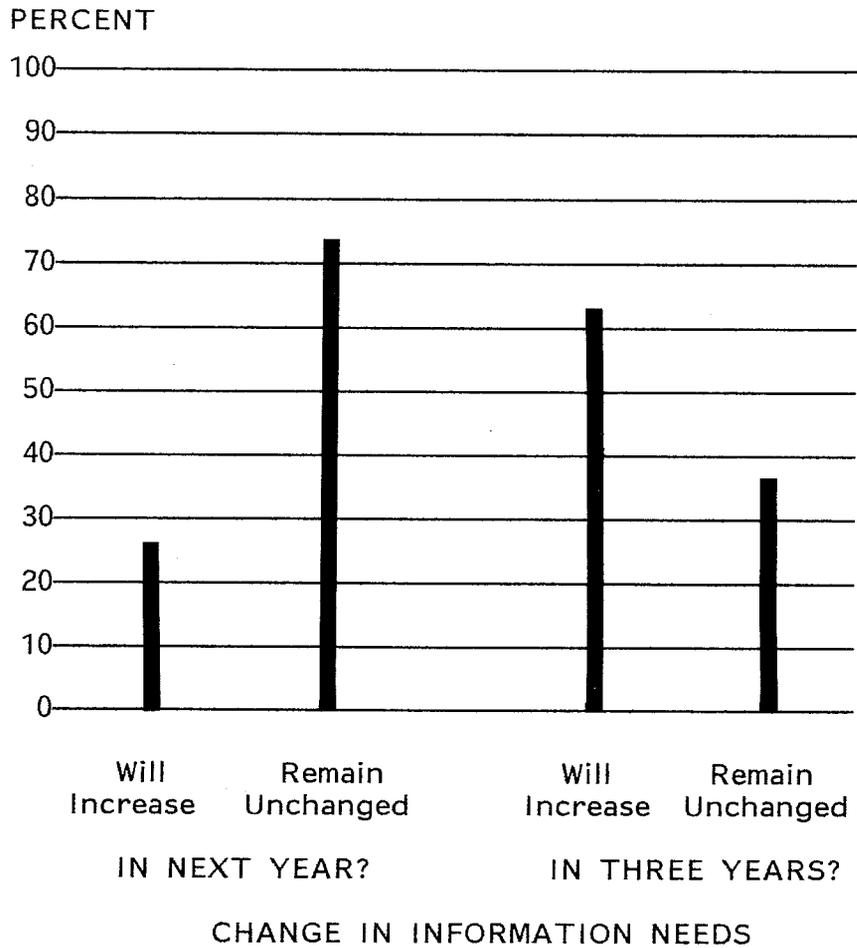
Types of EOR Information Desired from BETC

(Base 19, Multiple Responses)



*Includes bibliographic abstracts (5), reports on successes, lab data from oil companies, performance prediction methods, index of all research projects.

UNIVERSITIES
Exhibit 11
Future EOR Information Needs
(Base 19)



FEDERAL POLICY GROUPS

Number in survey: 9 (Because of the diversity of federal policy-making bodies, interviews were designed to produce qualitative, not quantitative, information).

Respondent level: Chief energy aide to member of Congress or energy-related committee.

Current level of EOR expertise: Low. Most do not have even a general awareness of the technical aspects of conventional oil and gas production.

Direct experience with EOR: None.

Impact on EOR: Considerable. Congress and various regulatory agencies establish the climate within which EOR must operate. Incentives favoring EOR or regulations restricting it are likely to come from federal policy makers.

Attitude toward EOR: Virtually all expressed high expectations for the potential of tertiary oil production to offset the domestic production decline while alternative energy sources are developed. Most support federal participation in stimulating this type of production.

Perceived constraints:

1. Lack of understanding
2. Too much conflicting data
3. Opinions of constituents
4. Political realities

Opinion of DOE role:

1. Develop workable programs.
2. Inform Congress of technical aspects in relation to policy needs.
3. Interact with other agencies and policy making bodies to assure production is increased.

Familiarity with DOE programs: Well aware.

Familiarity with BETC: Low.

Information sources:

1. Congressional Research Service
2. Constituents
3. Special interest groups
4. Public hearings
5. Government reports

Information needs:

1. Descriptions of processes (in laymen's terms)
2. Advantages and disadvantages of EOR
3. Realistic benefit -- cost estimates
4. Effect on national energy supplies

Information levels:

1. Chief energy aides
2. Agency heads (executive-level interaction)
3. Congressmen and Senators (executive-level interaction)

Information format: Hard copy summaries with bottom-line assessments that can be applied to policy decisions.

Future EOR information needs: Will increase as decisions are focused on developing a national energy policy.

Usefulness of EOR Technical Information Center: Little direct usage. Most information will be requested through established congressional research service or personal contacts within DOE and industry.

Additional comments:

- o The Federal Government, through Executive, Legislative and Judicial branches, can have significant impact on the EOR program. Close interaction is required to assure that adequate incentives and controls are maintained to create a business climate favorable to EOR.

- o There is a great deal of distrust and misunderstanding among federal officials about how the oil industry operates. To obtain necessary support for constructive energy programs, special efforts need to be undertaken to increase the level of understanding.

STATE LEGISLATIVE BODIES

Number in survey: 18.

Respondent level: Senior member of legislative committee responsible for oil and gas policy matters.

Current level of expertise: Very low awareness of technical aspects of oil production in general. Little or no familiarity with technical aspects of tertiary recovery or oil.

Direct experience with EOR: None.

Impact on EOR: Few state legislative actions are directed specifically at enhanced oil recovery, but many policy decisions significantly impact the operation of an EOR project. Included are:

1. State environmental laws or regulations
2. State laws relating to unitization.
3. State tax laws relating to oil and gas production.

Attitude toward EOR: Wait and see.

Perceived constraints:

1. Assuring balance between protection of the environment and increased oil production.
2. Lack of adequate information
3. Total costs involved.

Opinion of DOE role: Should relieve financial burden and assume risk with a minimum of bureaucratic influence. DOE should also provide easy access to latest information.

Familiarity with DOE programs: Some familiarity. All would like to know more about the program.

Familiarity with BETC: None

Information sources:

1. Special interest groups
2. Staff research
3. Government reports

Information needs:

- o Summary information on current EOR state-of-the-state.
- o Information relevant to current or future policy on oil production
- o Description of the cost versus risks involved
- o Any special problems associated with a process

Information levels:

1. Individual legislators holding position with jurisdiction over oil and gas policy
2. Legislative research staffs
3. Other governmental agencies which provide technical information to the legislative process

Information format: Printed materials with concise summaries.

Usefulness of EOR Technical Information Center: An occasional source.

Additional Comments:

- o Although a high level of interest and understanding was initially expressed by legislators, most state legislative officials actually seem to be extremely limited in their knowledge and interest in the technical aspects of EOR (over 90%).
- o Interest is highest in the states with greatest EOR potential indicating a receptive audience for accelerated technology transfer efforts. Over 80 percent indicated they would be at least occasional users of an EOR technical information center.
- o Although 94 percent of those surveyed do not currently receive information being distributed by DOE, an almost equal amount expressed a desire to be added to the system.
- o Legislative committees at the state level appear to rely more heavily on non-technical sources for EOR information. Special interest groups outside the industry provide a major input to policy analysis. Eight-three percent use information supplied by special interest groups. The most frequently mentioned source was environmental groups.

STATE REGULATORY AGENCIES

Number in survey: 25.

Respondent level: Director or staff member of the state agency responsible for monitoring petroleum operations (e.g., Oil and Gas Commission, Department of Natural Resources).

Current level of EOR expertise: High level of awareness of economic aspects and general technology of oil production. Solid understanding of the general engineering principles of EOR, but only passing familiarity with state-of-the-art technology.

Direct experience with EOR: Practically none (except perhaps in California, Louisiana, Texas, and Oklahoma).

Familiarity with DOE programs: Most are somewhat familiar. A few are well informed. Most important, however, the vast majority of those unfamiliar are interested in knowing more.

Impact on EOR: Make and enforce the regulations that affect the individual states' climate for EOR. The environmental difficulties experienced by Getty at Kern River are evidence of the importance of state government.

Attitude toward EOR: Although regulatory agencies tend to be more familiar with EOR than state legislators, the absence of definitive replies about EOR problems from either group (when producers can supply long lists of problems) seems to indicate a lack of "hard" EOR knowledge. This may be because state governments have had very little involvement with EOR. They may become involved in the future, but they currently view it as a matter between oil companies and the federal government. They will become involved in the near term if EOR causes problems.

Perceived constraints:

1. Oil price
2. Federal red tape
3. Poor federal leadership

Opinion of DOE role: State regulatory agencies believe the federal government is mishandling the job through price controls and inconsistent policies. Many wish the federal government would allow states to play greater role. Recommended actions include:

1. Decontrol oil prices
2. Cut red tape
3. Give states greater say (and more money)
4. Re-evaluate programs and establish a definitive energy policy

Information needs:

1. Summarized statements explaining the effects of state-of-the-art technical developments on policy-making.
2. Quarterly Progress Review
3. Detailed technical reports will be appropriate
4. Discussions of cost factors involved
5. Overview material outlining EOR's place in oil production and the nation's energy needs

Information sources:

1. Government reports
2. Trade journals
3. Oil companies
4. Other government agencies
5. Technical journals

Information level: Heads of the appropriate departments (with the understanding that an aide handling energy matters will actually be the prime recipient of most information).

Information format: Hard copy.

Familiarity with BETC: Most (56%) receive some DOE information. The quarterly Progress Review is the most widely distributed publication (but recipients are in a minority). Those who are familiar with it consider it "Excellent" or "Good."

Usefulness of EOR Technical Information Center: Would be an occasional source.

Additional Comments:

- o Because state regulatory agencies have little stake in the success of EOR, they respond to the progress of EOR rather than leading the way. However, the impact of California state agencies (notably the Air Resources Board) indicates the power of state agencies to slow down EOR if they choose to. These agencies are interested in keeping up with state-of-the-art technical development, but they want interpretation of what the development means to their regulatory responsibilities.
- o Most state regulatory agencies have a "friendly" rapport with oil producers. They view their function as supportive in accelerating domestic oil production.
- o Twenty-five agencies interviewed more than half (56%) regularly receive information on EOR from government sources.
- o Eighty percent indicated technical information of this type was useful in formulation of policy considerations.

- o Government reports were the most frequently mentioned source for technical information on EOR. Other non-technical sources mentioned were industry trade journals, oil companies, public hearings, and special interest groups.
- o Nearly 90 percent of the administrative officials surveyed indicated they would utilize an EOR Technical Information Center. Most agencies in oil producing states felt they would become increasingly involved in EOR over the next three to five years. As projects increase and expand into commercial venture, administrative involvement will become more widespread.
- o Many expressed concern over the conflict which exists between environmental protection and the need to produce more domestic oil. Many environmental restrictions may severely inhibit EOR development in the short-term. This is especially true in California where air emission standards are most severe.
- o Another area of concern is the impact which pending federal legislation will have on underground injection of toxic substances and hazardous waste management. Once these laws are finalized, the states must develop enforcement procedures. Until these issues are resolved, oil producers are expected to make only cautious advances in EOR.
- o The overwhelming majority of state officials felt they should be included in the regular dissemination of EOR progress. They want to be continually kept abreast of the developing state-of-the-art.

Colleague interaction can play a large role in the information transfer process of state agencies. EOR understanding could be increased by regional conferences.

STATE GOVERNMENT

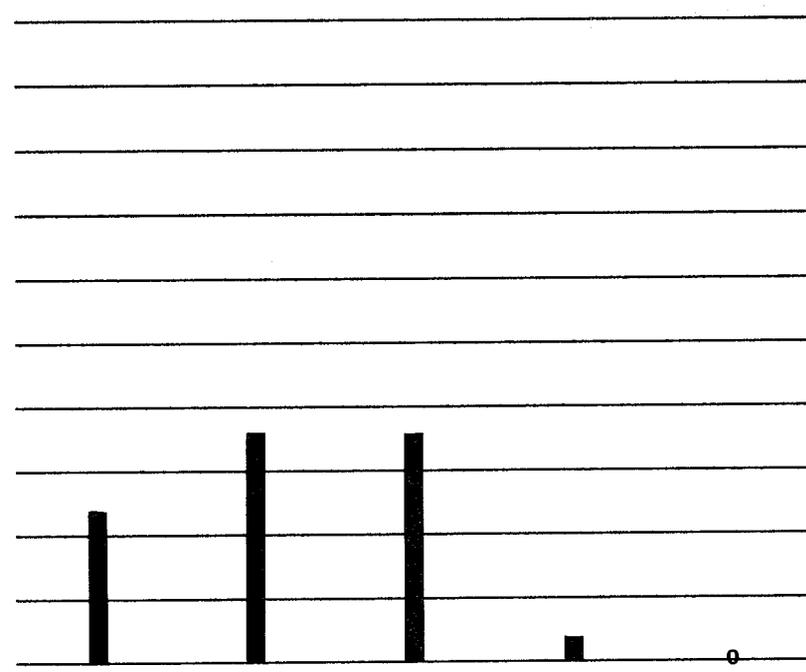
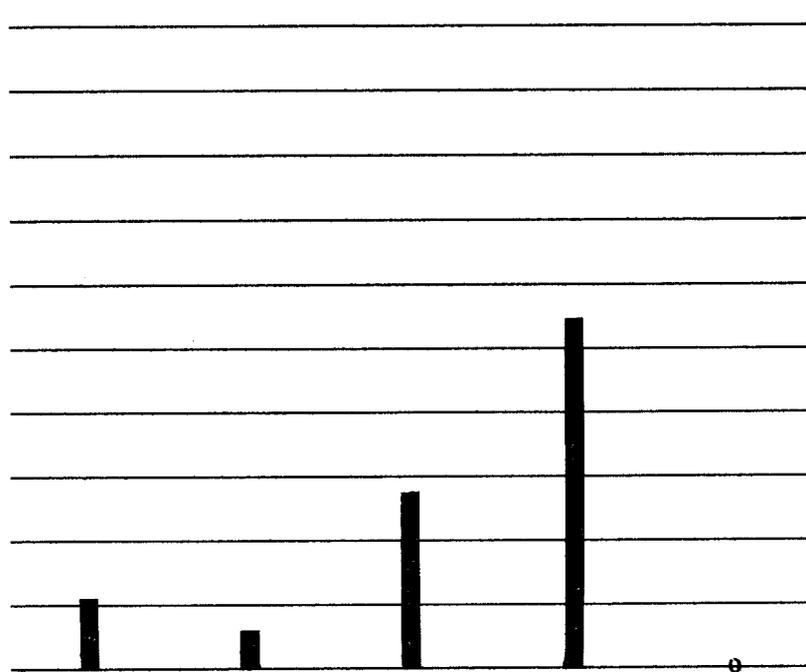
Exhibit 1

Awareness of the Technical Aspects of Oil Production

STATE LEGISLATIVE
(Base 18)

STATE REGULATORY
(Base 25)

PERCENT



Very High High Adequate Some None

Very High High Adequate Some None

LEVEL OF AWARENESS

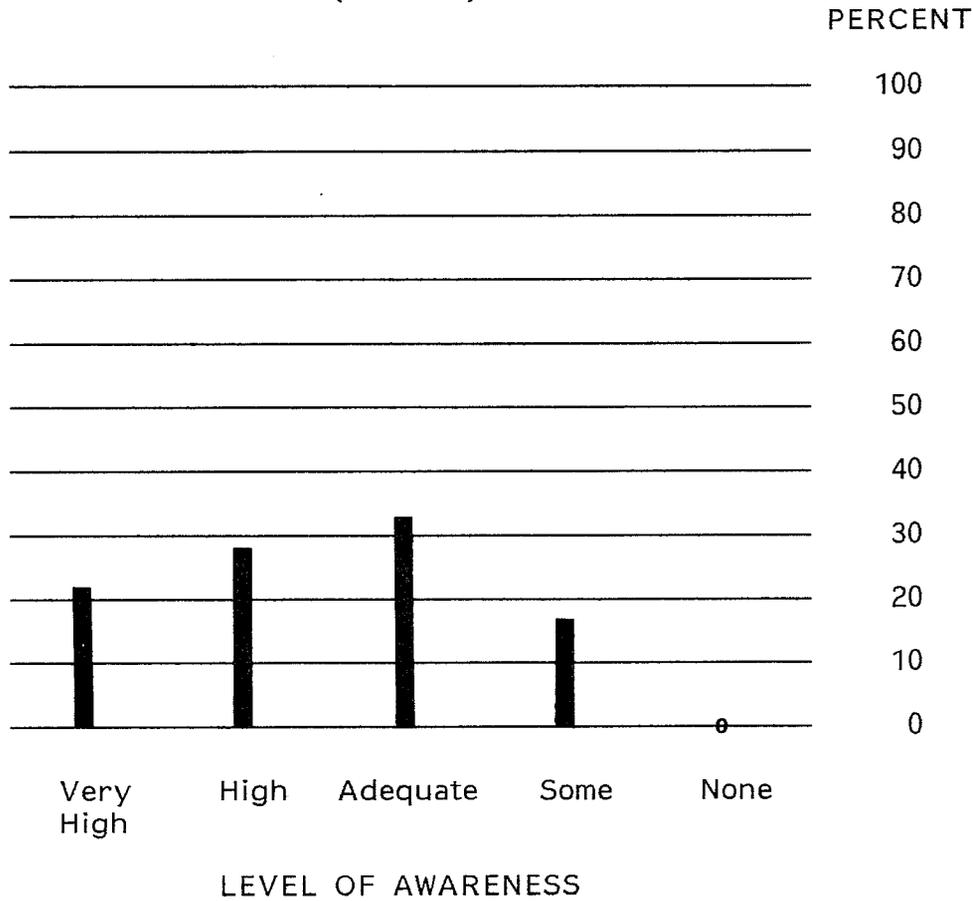
LEVEL OF AWARENESS

STATE GOVERNMENT

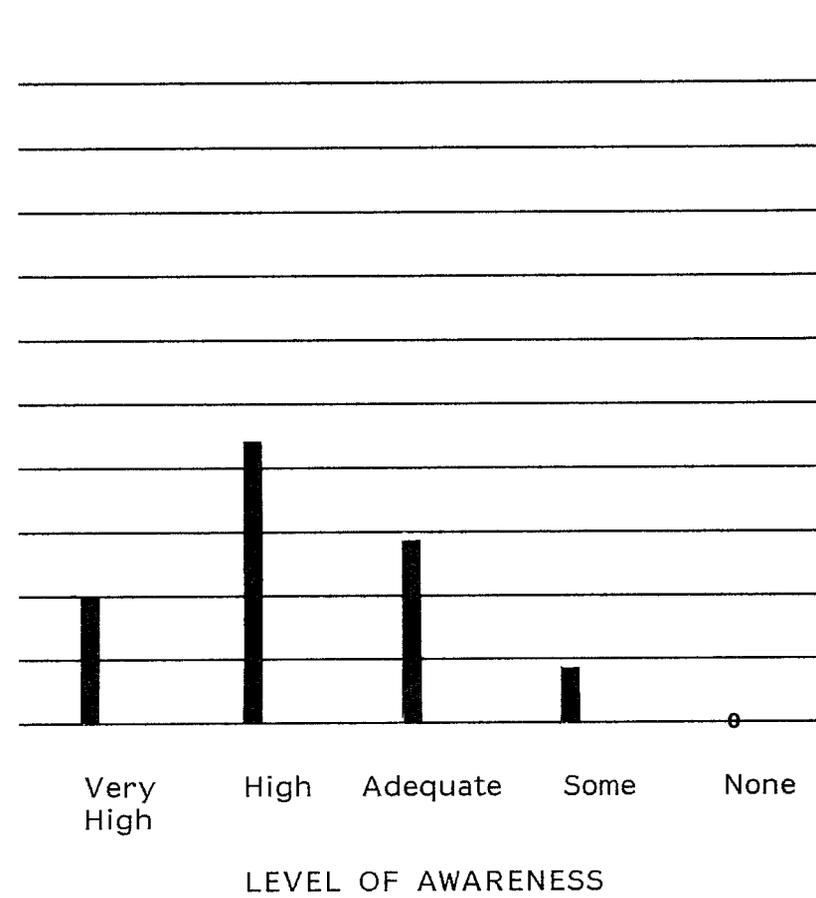
Exhibit 2

Awareness of the Economic Aspects of Oil Production

STATE LEGISLATIVE
(Base 18)



STATE REGULATORY
(Base 25)



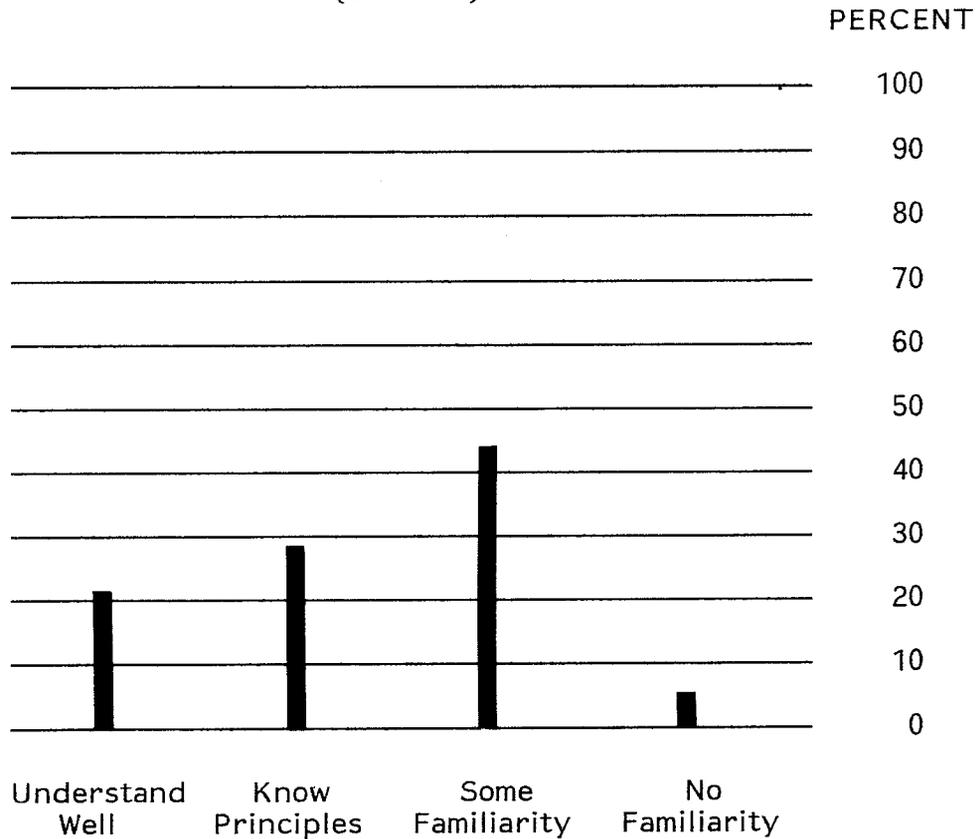
STATE GOVERNMENT

Exhibit 3

Familiarity With Three Stages of Oil Production

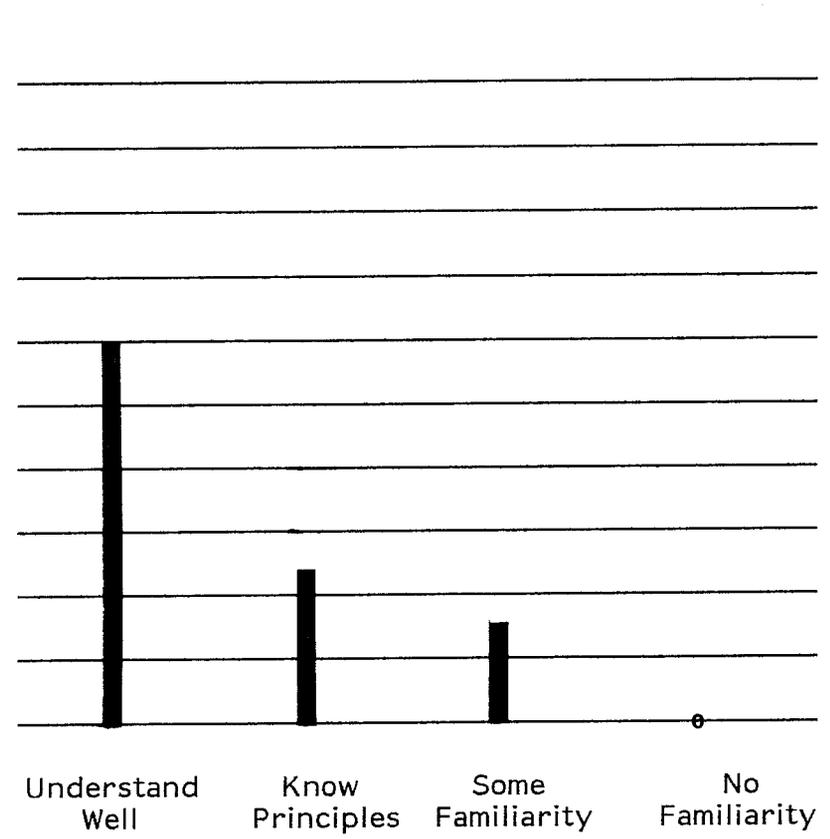
(Primary - Secondary - Tertiary)

STATE LEGISLATIVE
(Base 18)



DEGREE OF FAMILIARITY

STATE REGULATORY
(Base 25)



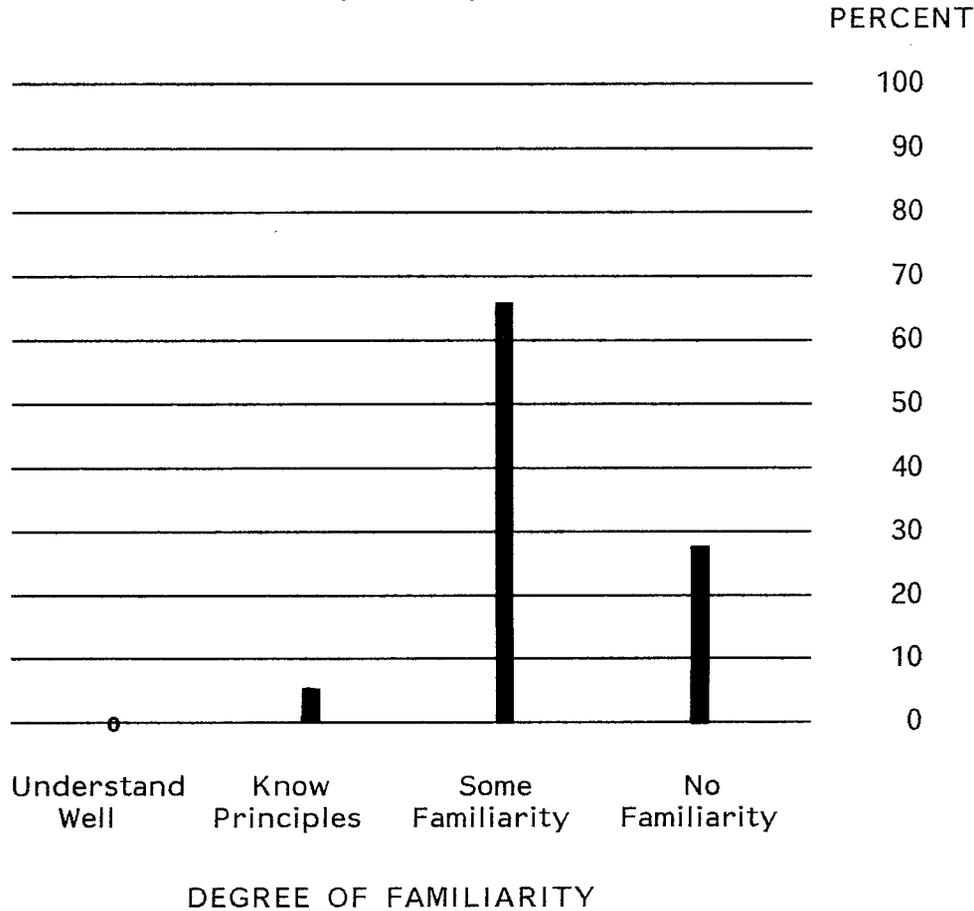
DEGREE OF FAMILIARITY

STATE GOVERNMENT

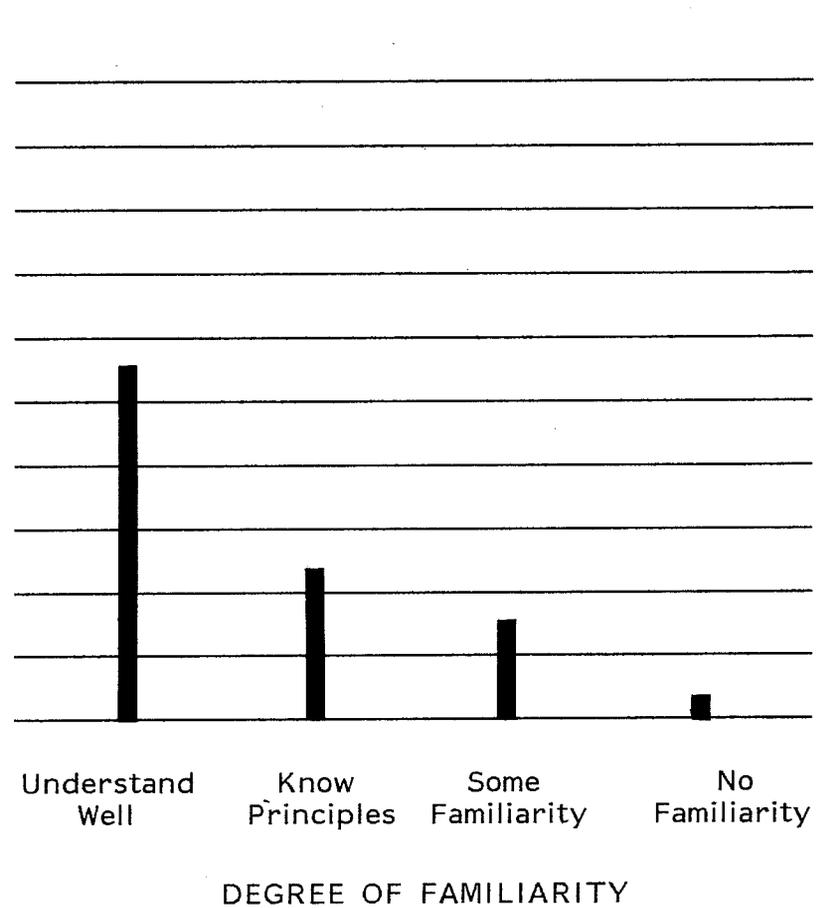
Exhibit 4

Familiarity With the Technical Aspects of Tertiary Recovery

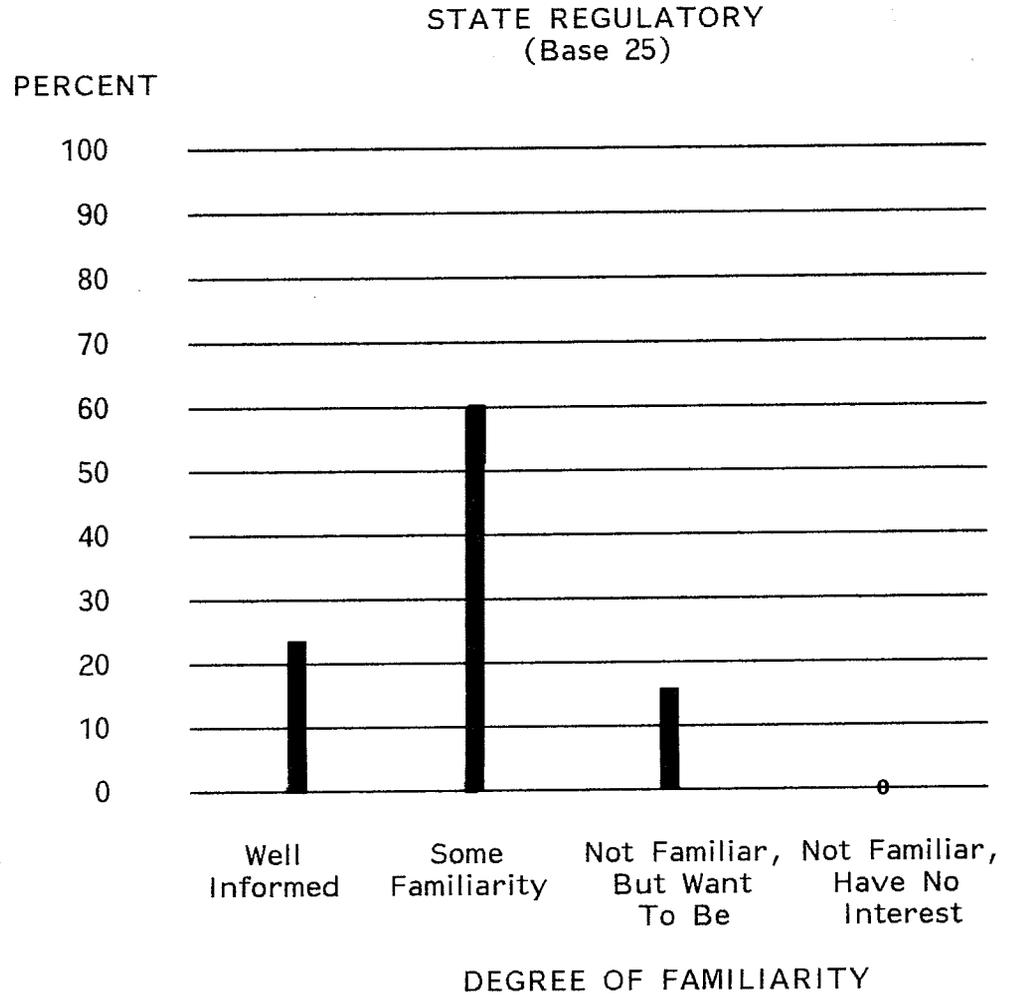
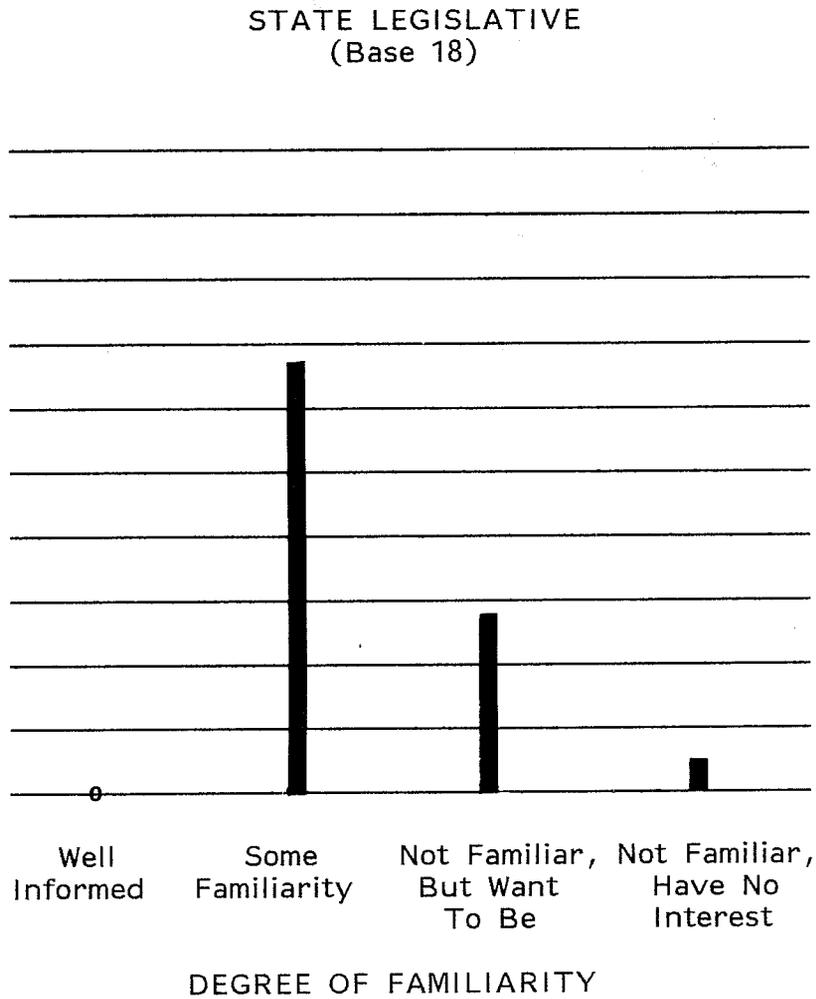
STATE LEGISLATIVE
(Base 18)



STATE REGULATORY
(Base 25)



STATE GOVERNMENT
Exhibit 5
Familiarity With Cost-Share Program

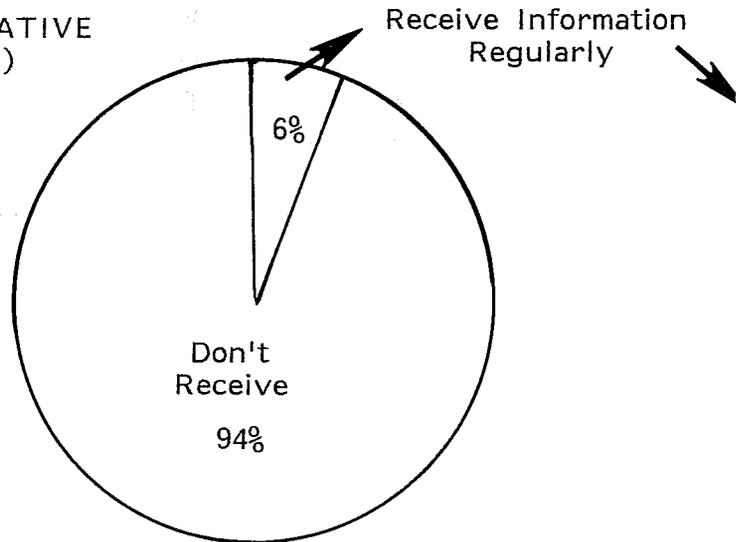


STATE GOVERNMENT

Exhibit 6

EOR Technical Information Received from DOE

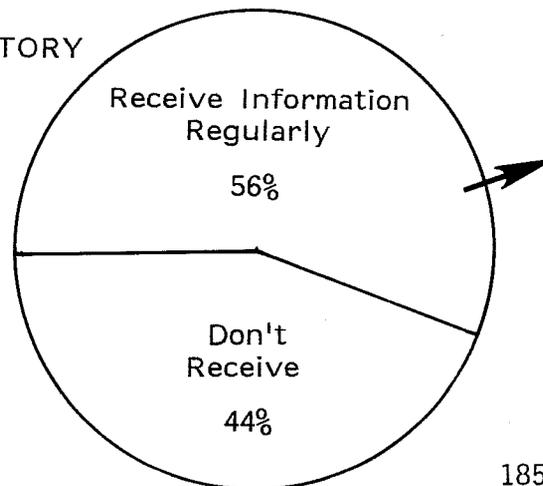
STATE LEGISLATIVE
(Base 18)



TYPES OF INFORMATION RECEIVED
(Base 1, Multiple Responses)

	<u>Total Mentions</u>
Quarterly Report	0
Annual Reports	0
Other Information (Includes "various periodicals")	1

STATE REGULATORY
(Base 25)



TYPES OF INFORMATION RECEIVED
(Base 14, Multiple Responses)

	<u>Total Mentions</u>
Quarterly Report	8
Annual Reports	2
Other Information (Includes BETC Monthly Reports, BETC Special Reports, and Miscellaneous DOE publications).	8

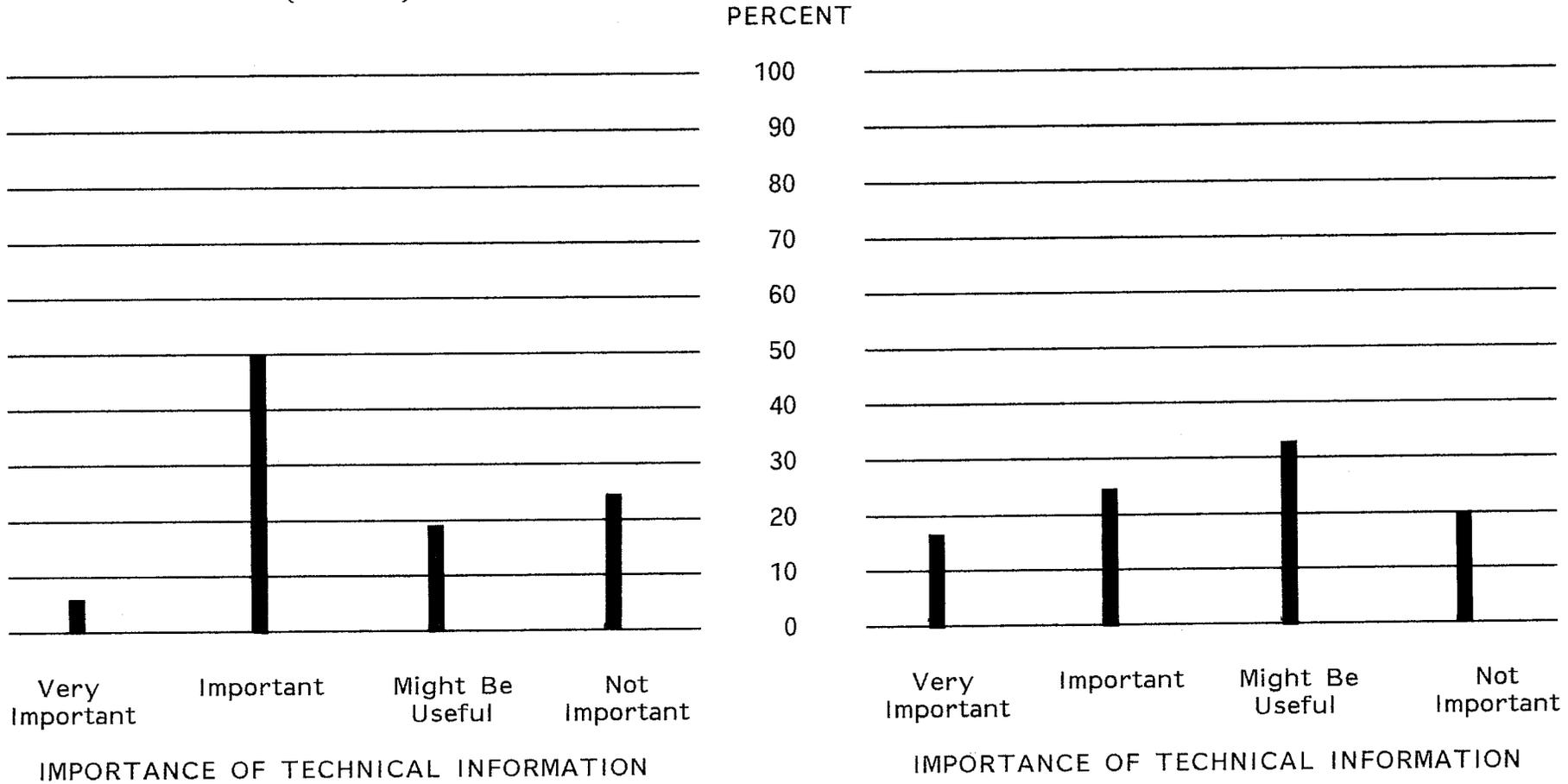
STATE GOVERNMENT

Exhibit 7

Importance of Technical Information in
Oil and Gas Production Policy Considerations

STATE LEGISLATIVE
(Base 16)*

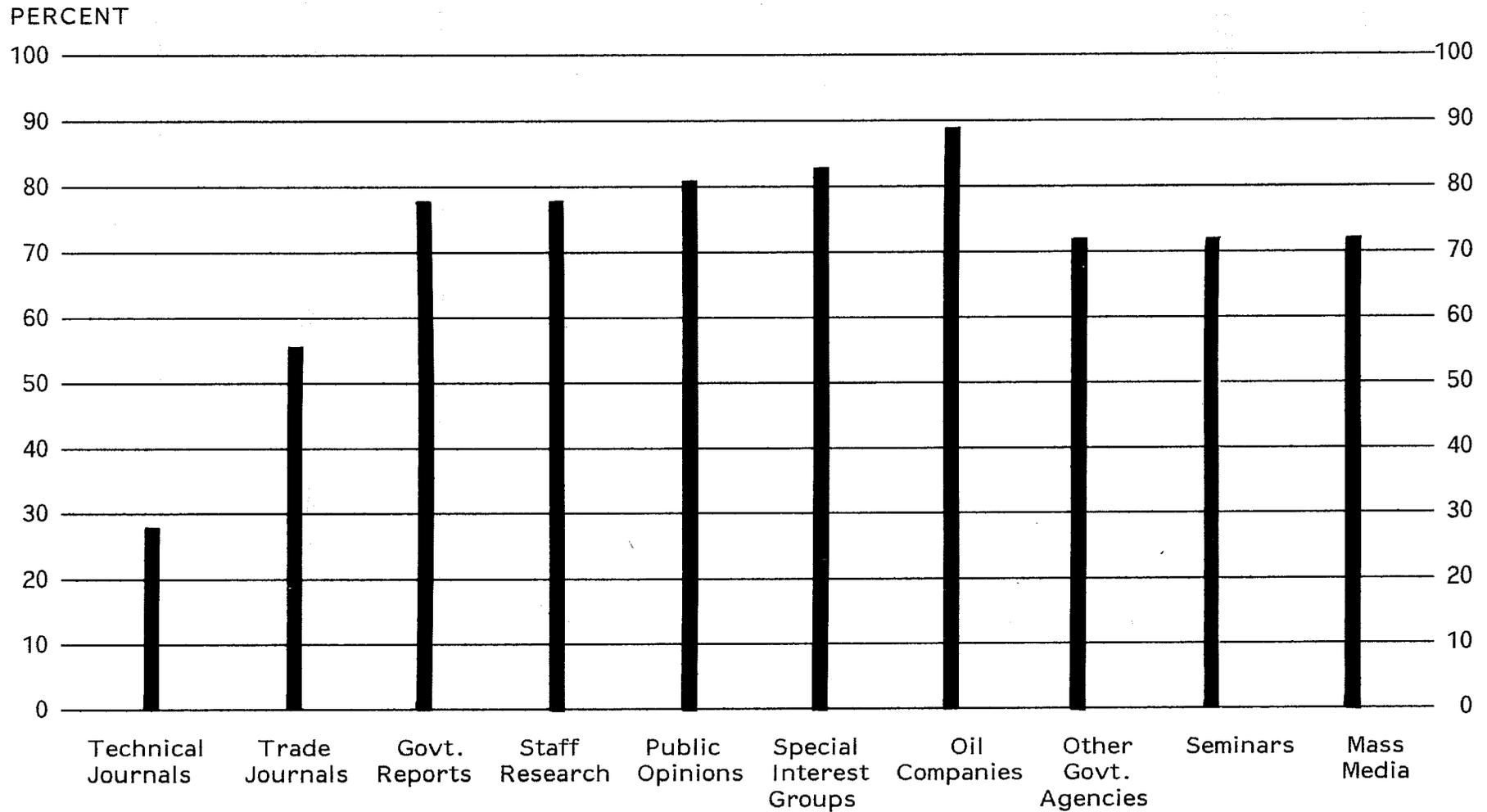
STATE REGULATORY
(Base 24)*



*Those giving no response were not included in percentages.

STATE GOVERNMENT
Exhibit 8
Sources of Technical EOR Information

STATE LEGISLATIVE
(Base 18, Multiple Responses)



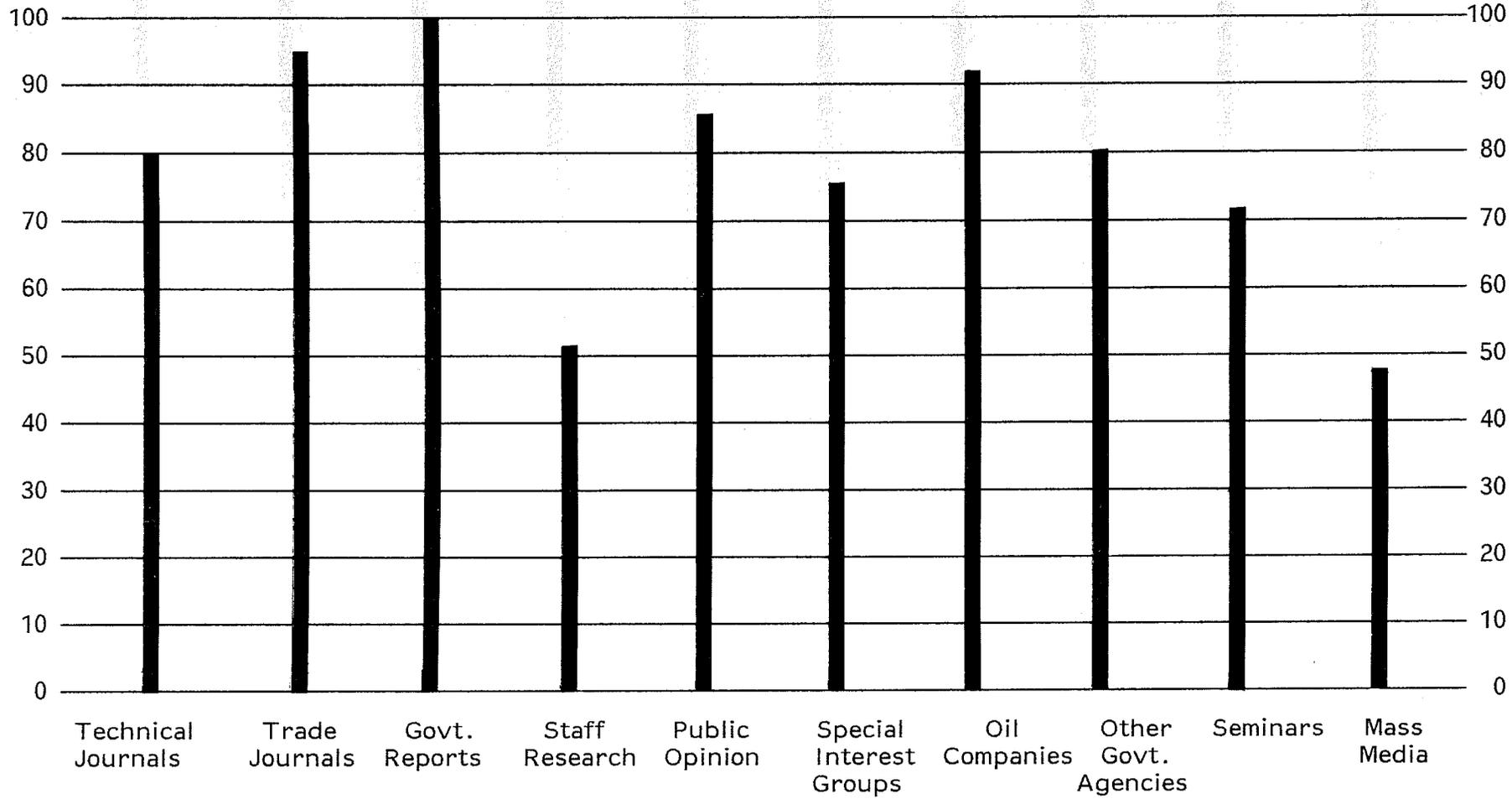
STATE GOVERNMENT

Exhibit 9

Sources of Technical EOR Information

STATE REGULATORY
(Base 25)

PERCENT



PERCENT OF RESPONDENTS MENTIONING

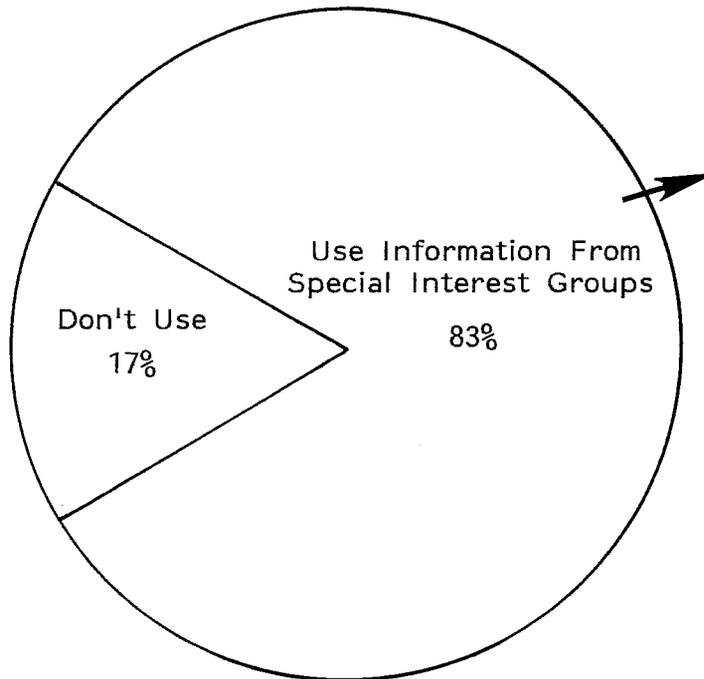
STATE GOVERNMENT

Exhibit 10-A

Special Interest Groups Used as Sources of EOR or Technical Petroleum Information

STATE LEGISLATIVE

(Base 18)



SPECIAL INTEREST GROUPS MENTIONED

(Base 15, Multiple Responses)

	<u>Total Mentions</u>
Environmental Groups	9
Oil Producer Groups	8
Various Business Interests	4
Land Owners	1
Consumer Groups	1

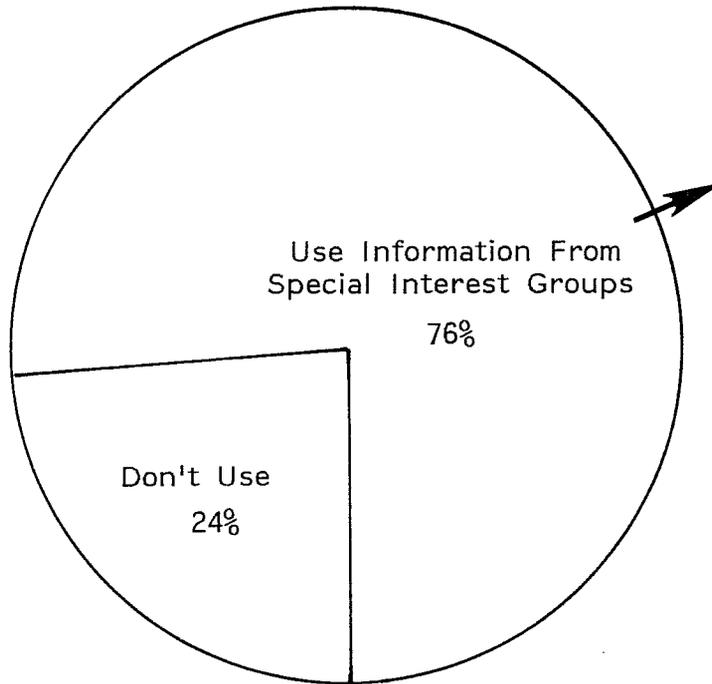
STATE GOVERNMENT

Exhibit 10-B

Special Interest Groups Used as Sources of EOR or Technical Petroleum Information

STATE REGULATORY

(Base 25)



SPECIAL INTEREST GROUPS MENTIONED
(Base 19, Multiple Responses)

	<u>Total Mentions</u>
Oil Producer Groups	16
Environmental Groups	7
Land Owners	2
Various Business Interests	1
Consumer Groups	1
League of Women Voters	1

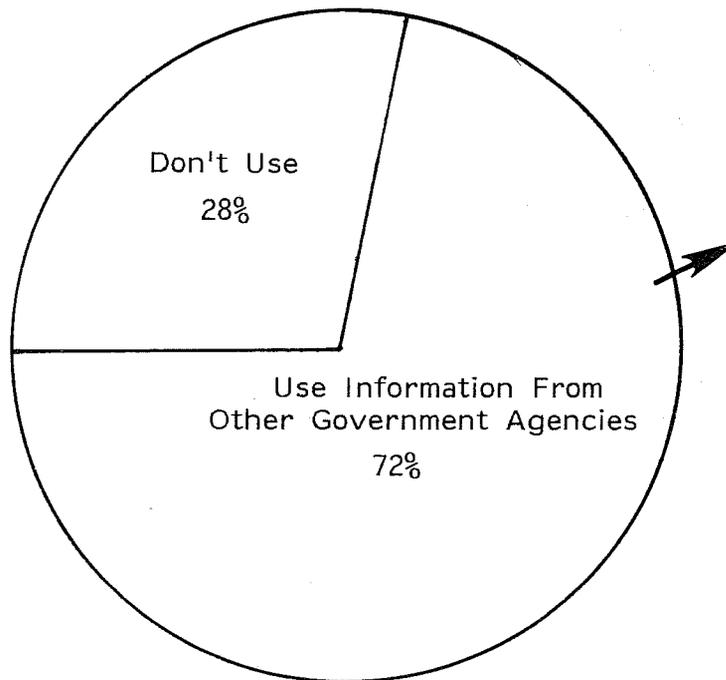
STATE GOVERNMENT

Exhibit 11-A

Government Agencies Used as Sources of EOR or Technical Petroleum Information

STATE LEGISLATIVE

(Base 18)



AGENCIES MENTIONED
(Base 13, Multiple Responses)

	<u>Total Mentions</u>
U.S. Department of Energy	5
U.S. Environmental Protection Agency	3
State Oil and Gas Commission	3
State Natural Resources Department	3
State Transportation Department	2
U.S. Geological Survey	1
Other State Agencies (Includes energy, land and environmental commissions)	3

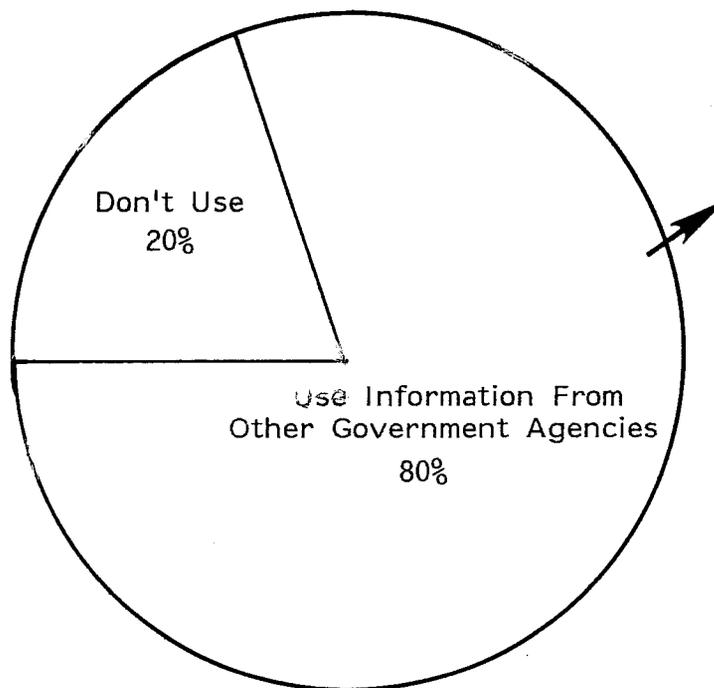
STATE GOVERNMENT

Exhibit 11-B

Government Agencies Used as Sources of EOR or Technical Petroleum Information

STATE REGULATORY

(Base 25)



AGENCIES MENTIONED
(Base 20, Multiple Responses)

	<u>Total Mentions</u>
U.S. Department of Energy	6
State Mines and Minerals	6
State Water Resources	6
State Air Resources	5
U.S. Geological Survey	5
U.S. Environmental Protection Agency	4
State Geological Survey	3
State Environmental Protection Agency	3
Other Federal Agencies*	3
Other State Agencies**	8

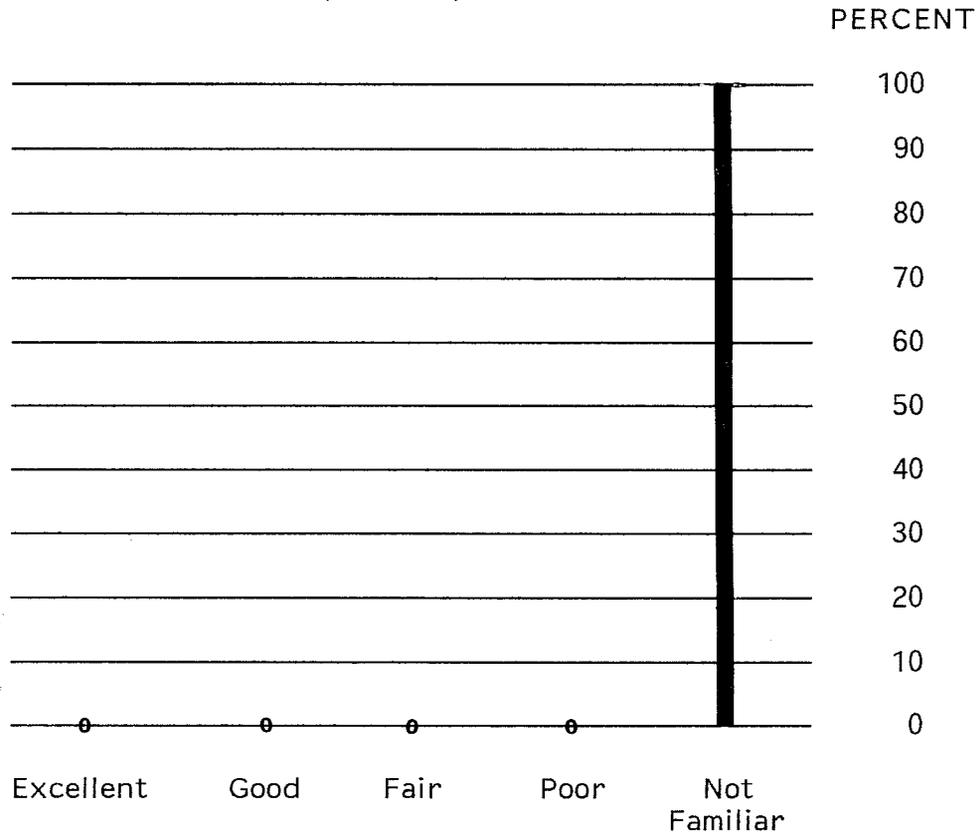
*Includes U.S. Forest Service, Bureau of Land Management and Department of Agriculture.

**Includes state finance, wildlife, energy, highway, engineering and land departments, and state corporation and oil and gas commissions.

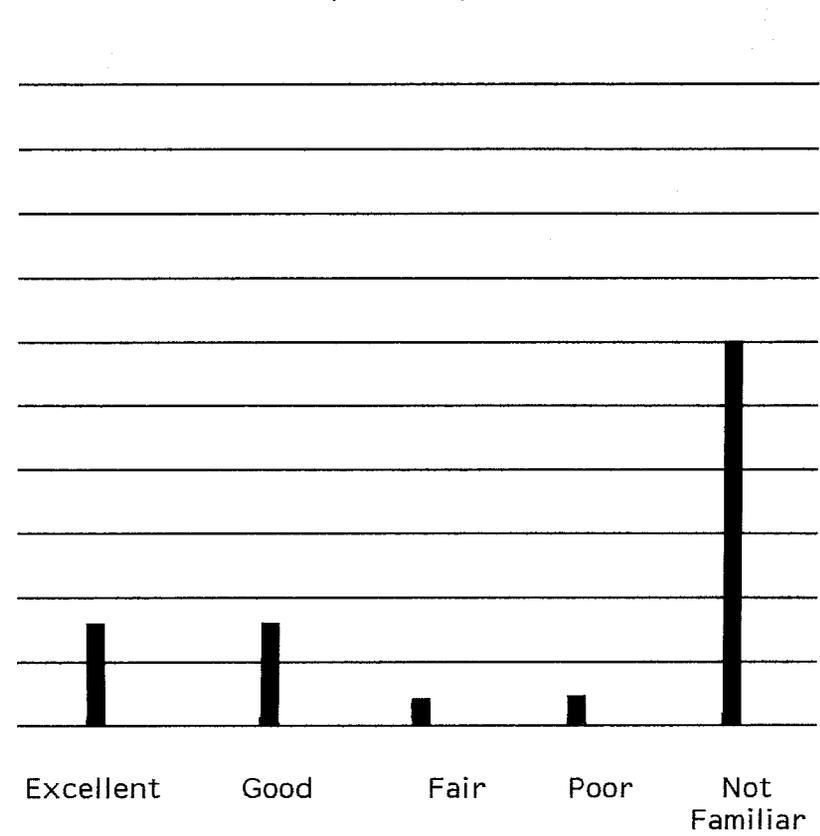
NOTE: Apparent lack of oil and gas commission responses is because most survey respondents were members of such commissions.

STATE GOVERNMENT
Exhibit 12
Assessment of Information From BETC

STATE LEGISLATIVE
(Base 18)



STATE REGULATORY
(Base 25)



STATE GOVERNMENT

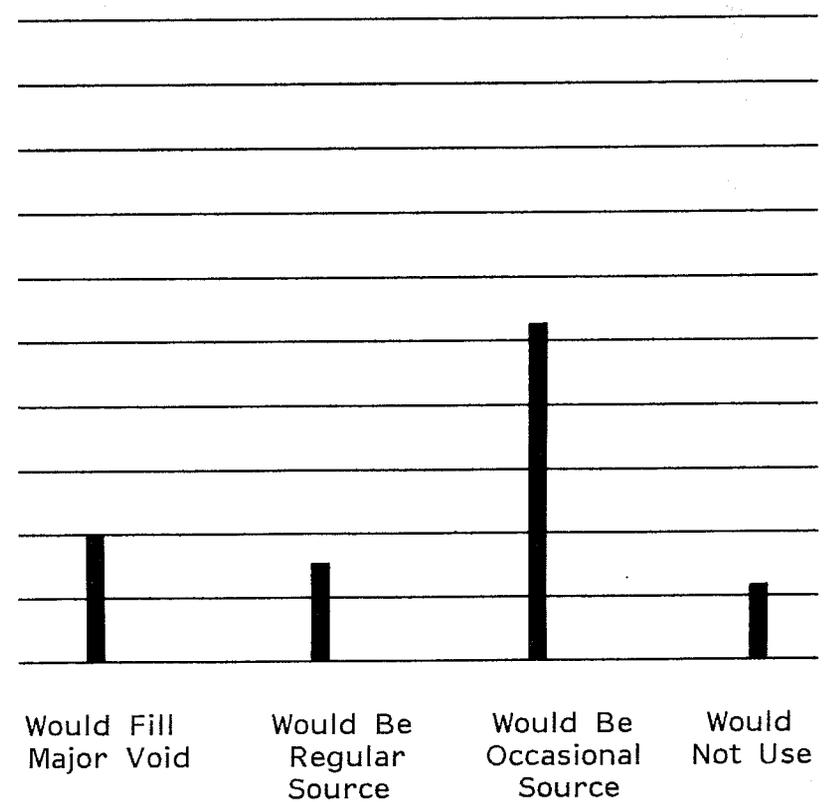
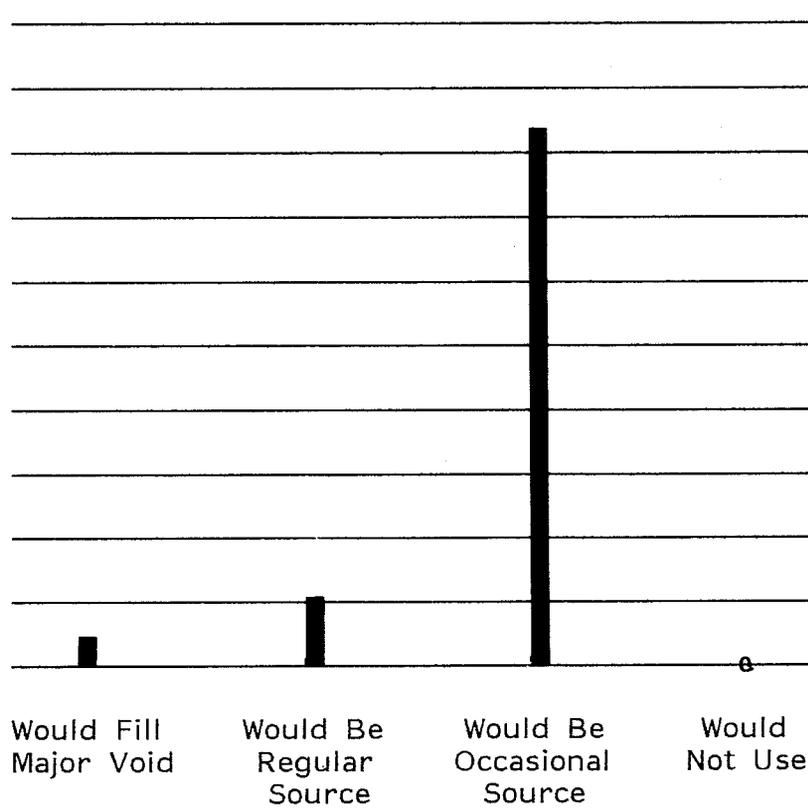
Exhibit 13

Usefulness of EOR Technical Information Center

STATE LEGISLATIVE
(Base 18)

STATE REGULATORY
(Base 25)

PERCENT

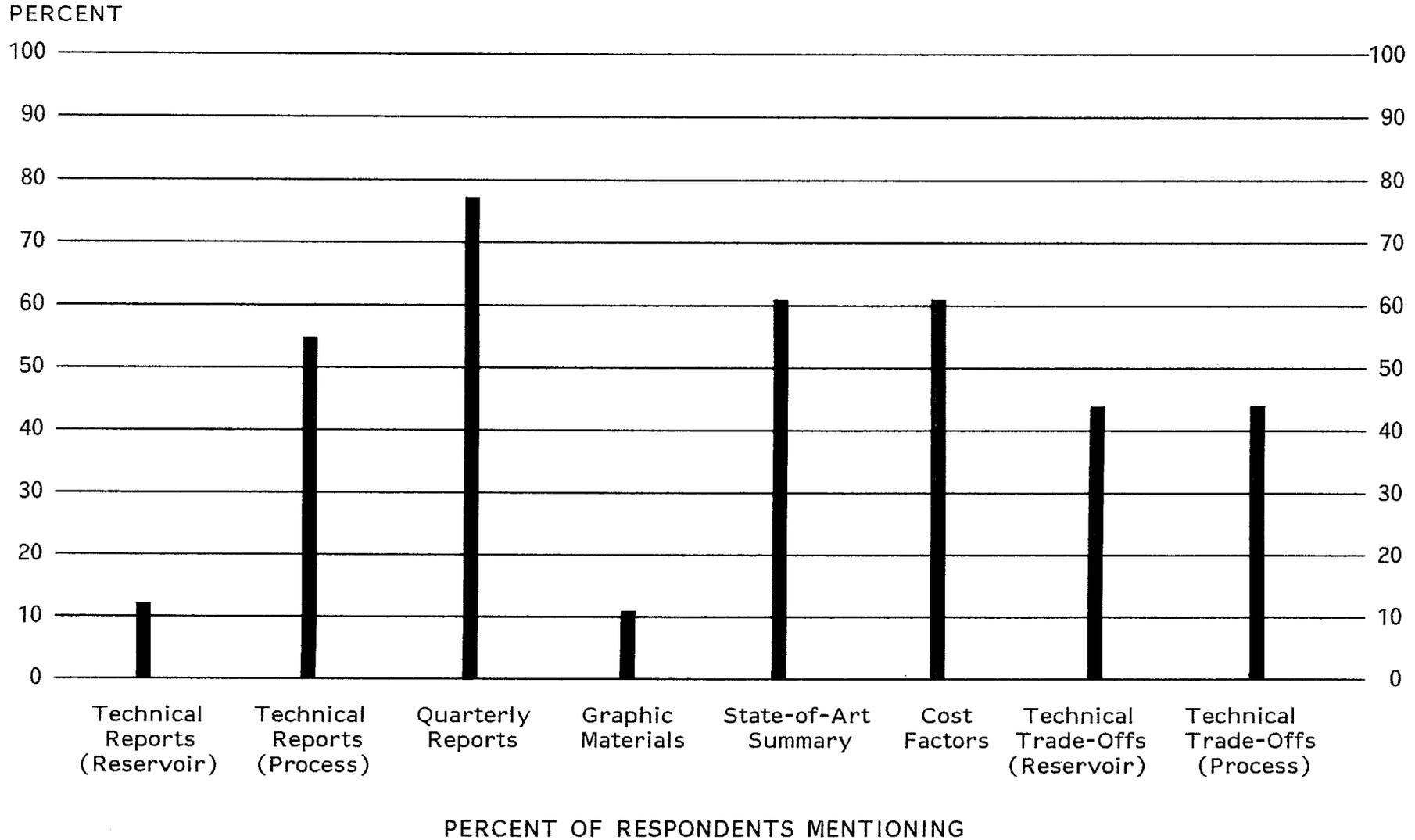


STATE GOVERNMENT

Exhibit 14

Types of Information Desired From BETC

STATE LEGISLATIVE
(Base 18, Multiple Responses)

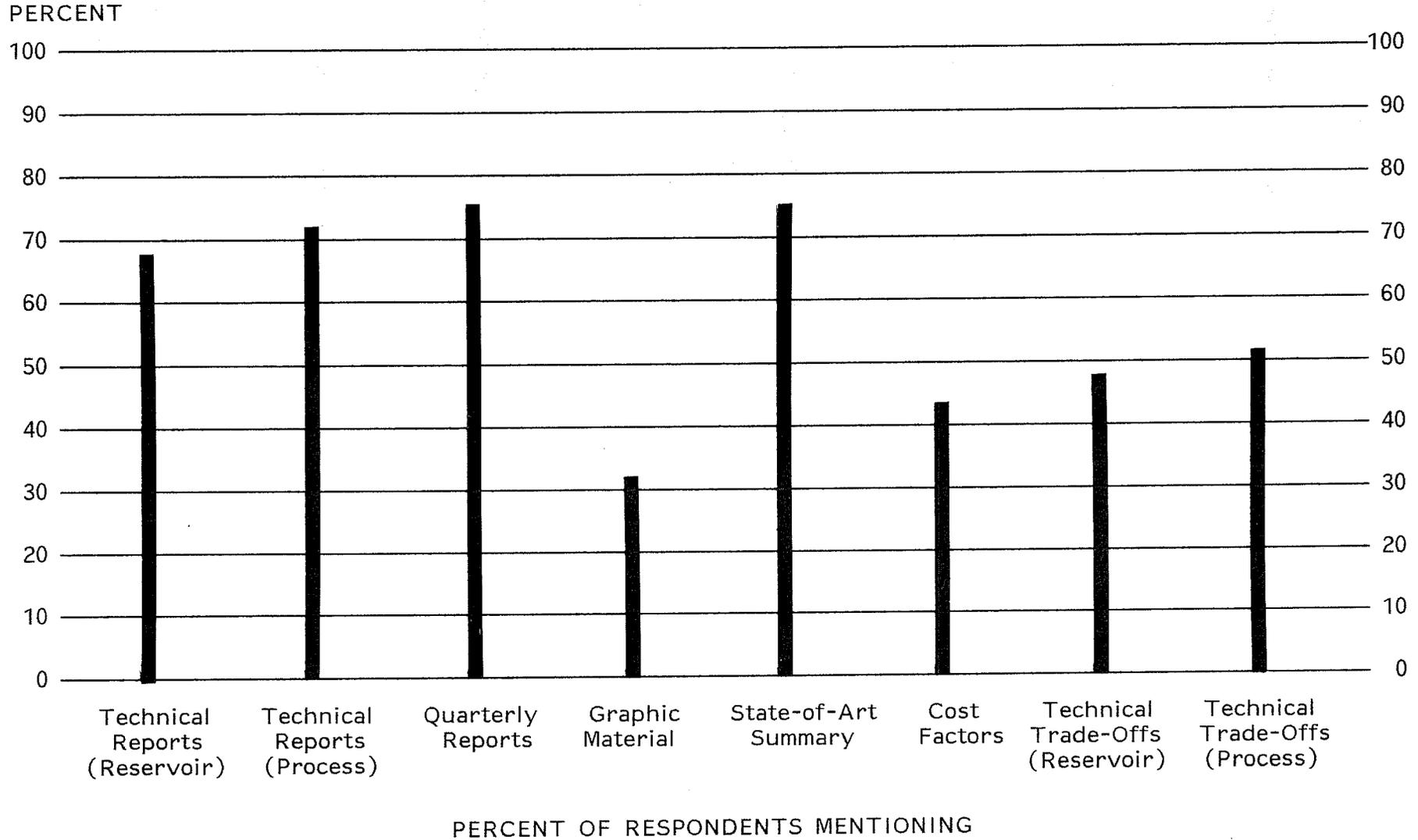


STATE GOVERNMENT

Exhibit 15

Types of Information Desired From BETC

STATE REGULATORY
(Base 25, Multiple Responses)



ENVIRONMENTAL GROUPS

Number in survey: 8 (Several others were contacted, but they declined an interview.)

Respondent level: National officer or lobbyist.

Current level of EOR expertise: Little or no familiarity with EOR.

Direct experience with EOR: No specific position on EOR, but concerned with waste disposal, chemical injection, and offshore drilling operations in general.

Impact on EOR: Relatively low. Primary impact is their influence on environmental law and support of alternative energy sources.

Attitude toward EOR: Oppose government funding of EOR. Support use of funds for development of non-fossil fuel energy sources. Most have no opinion on EOR.

Opinion of DOE role: Support should be directed toward development of "clean energy" DOE should cooperate more with EPA.

Familiarity with DOE program: Low.

Familiarity with BETC: None.

Information sources:

1. Public hearings
2. Government reports
3. Other environmental groups

Information needs: Utilize very little technical information. Government reports on status of EOR technology will suffice.

Information levels: A general public awareness program aimed at informing rank and file environmentalists. Top levels (staff included) have little interest in understanding technical aspects of petroleum production.

Information format:

1. Hard copy summaries.
2. Feature articles in mass media

Usefulness of EOR Technical Information Center: Most would utilize occasionally.

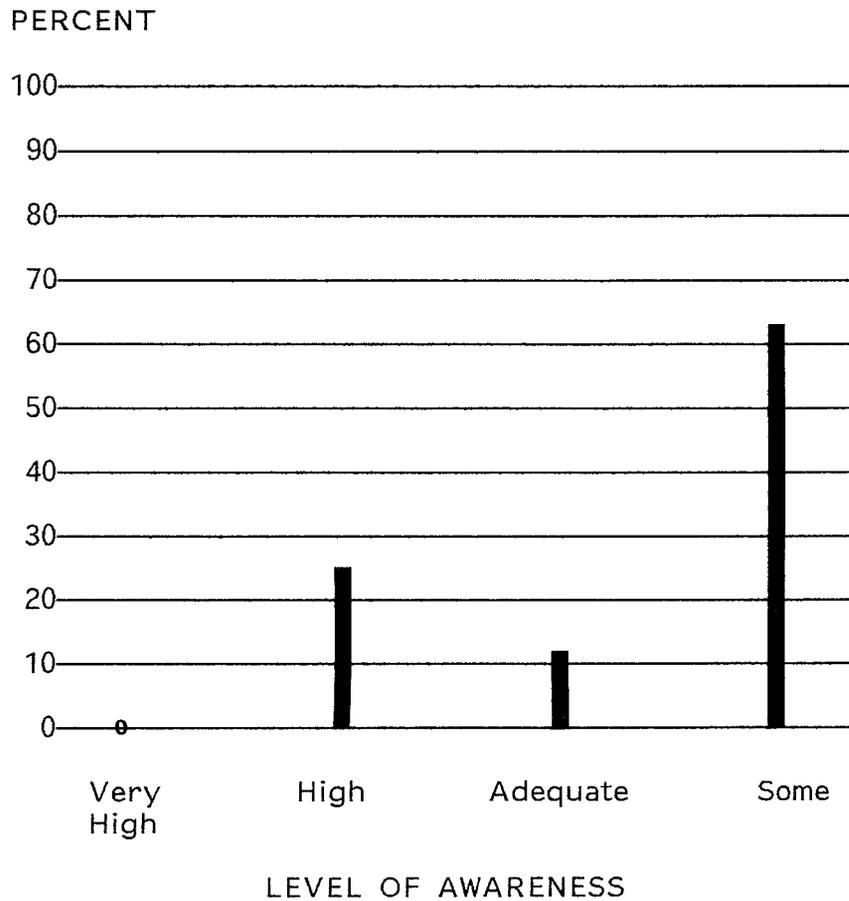
Additional comments:

- o The prime outlet environmental groups use to convey their positions on issues is direct contact with government policy-making bodies (hence, the need for BETC to maintain effective communication with the same government entities).
- o Environmental groups rely heavily on government reports for their technical information. Of the eight groups which agreed to in-depth interviews, half used input from petroleum engineers in developing the group's position on issues related to oil and gas production.
- o Half of the eight said they would like to receive BETC's quarterly Progress Review.
- o The majority said their solution to America's energy problems was greater conservation and rapid development of alternative fuels. One group was specifically against subsidies for EOR. One group, however,

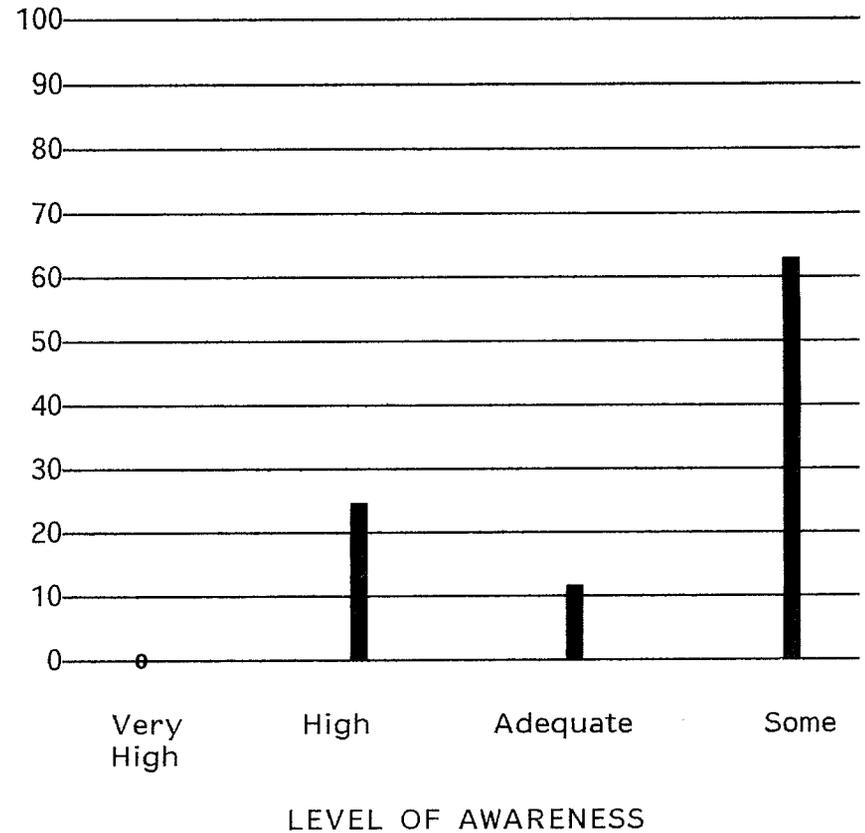
viewed EOR (with strict environmental controls) as an attractive energy option because it minimized the need for drilling in new areas.

- o Nearly two-thirds of the groups interviewed expressed the desire to have some form of personal contact (letters, telephone calls, personal visits, etc.) from agencies such as BETC. It can be inferred that such groups are fearful of "not being heard" and need the added assurance of personal contact.

ENVIRONMENTAL GROUPS
 Exhibit 1
Awareness of the Technical Aspects
Of Oil Production
 (Base 8)



ENVIRONMENTAL GROUPS
 Exhibit 2
Awareness of the Economic Aspects
Of Oil Production
 (Base 8)



ENVIRONMENTAL GROUPS

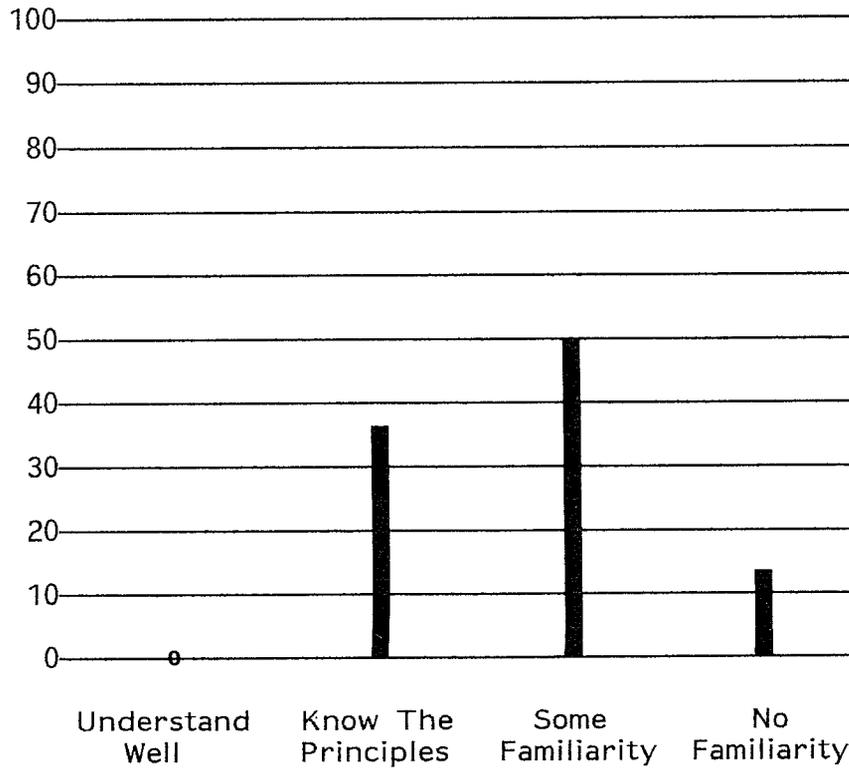
Exhibit 3

Familiarity With Stages of Oil Production

Primary - Secondary - Tertiary

(Base 8)

PERCENT



DEGREE OF FAMILIARITY

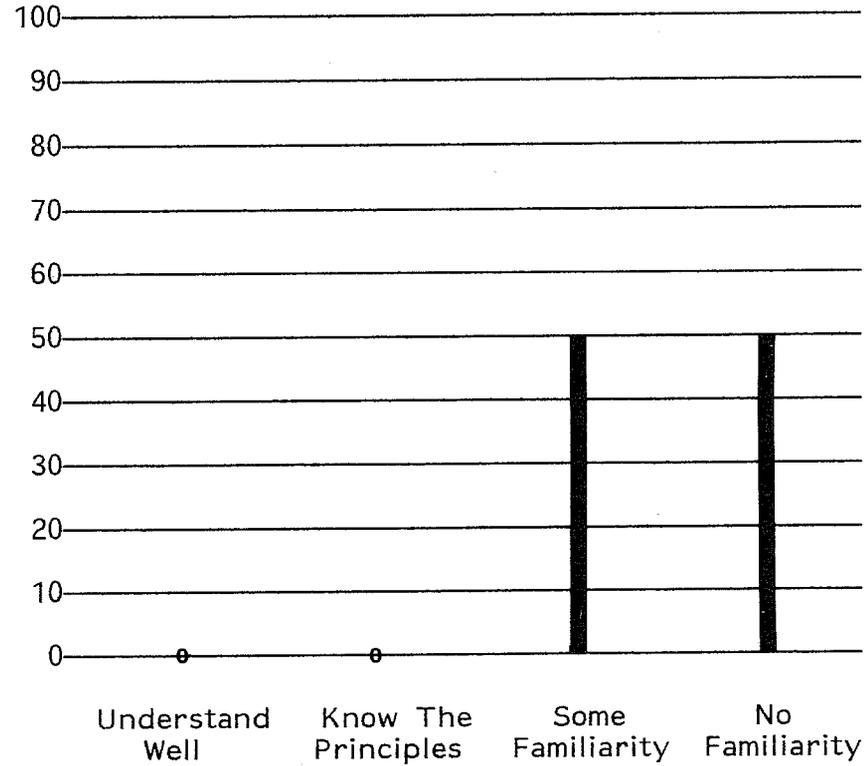
ENVIRONMENTAL GROUPS

Exhibit 4

Familiarity With Technical Aspects

Of Tertiary Recovery

(Base 8)



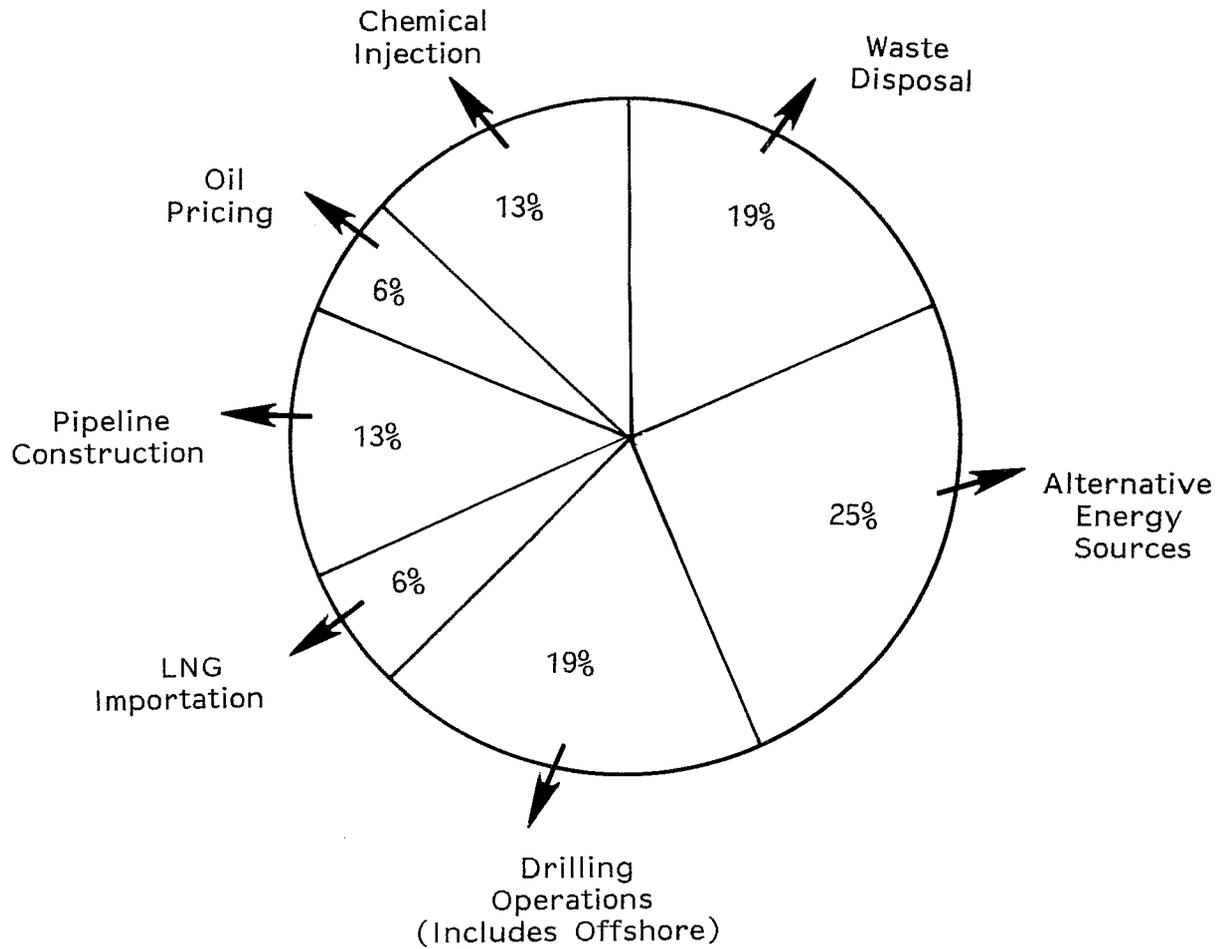
DEGREE OF FAMILIARITY

ENVIRONMENTAL GROUPS

Exhibit 5

Environmental Issues Related to Oil and Gas Production

(Based on 16 total responses)

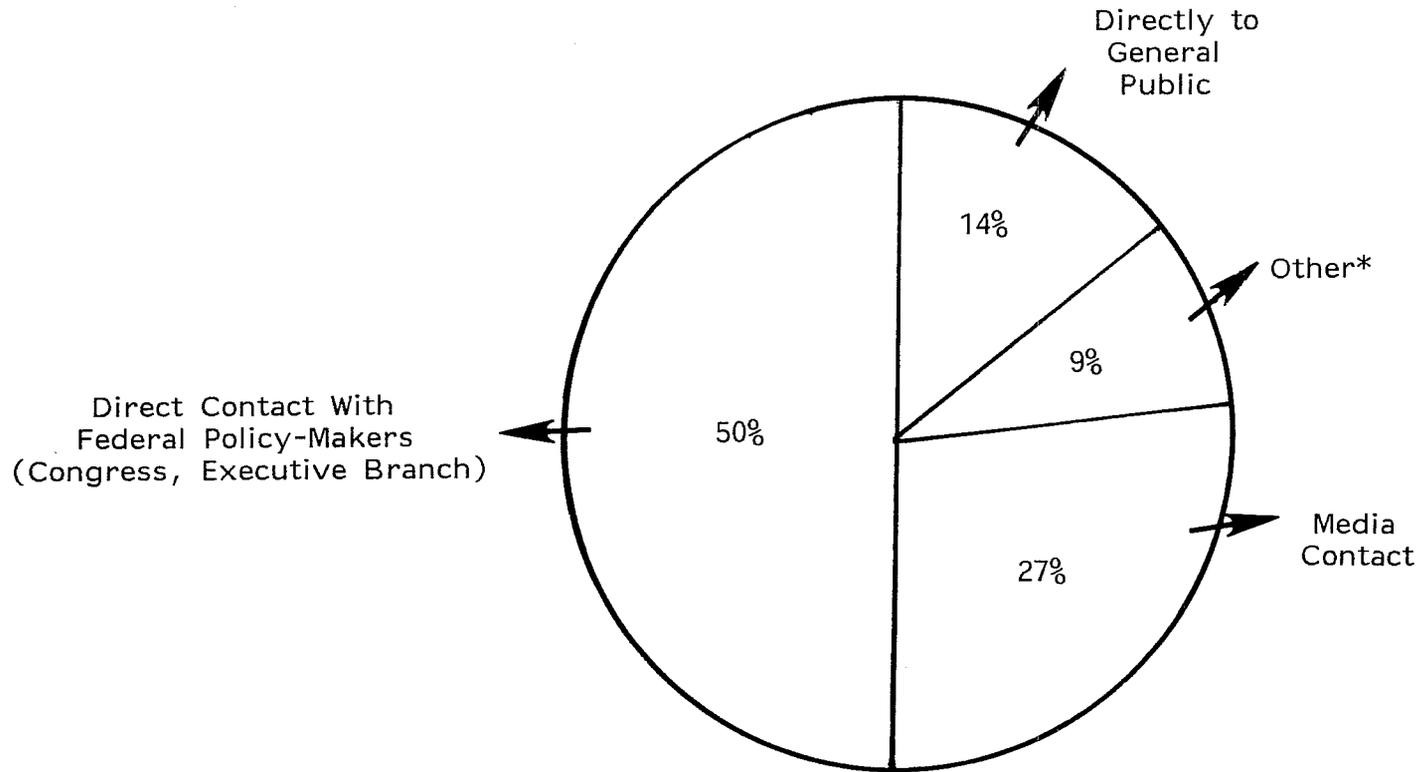


ENVIRONMENTAL GROUPS

Exhibit 6

Methods Used to Communicate Group's Position on Issues

(Based on 22 total responses)



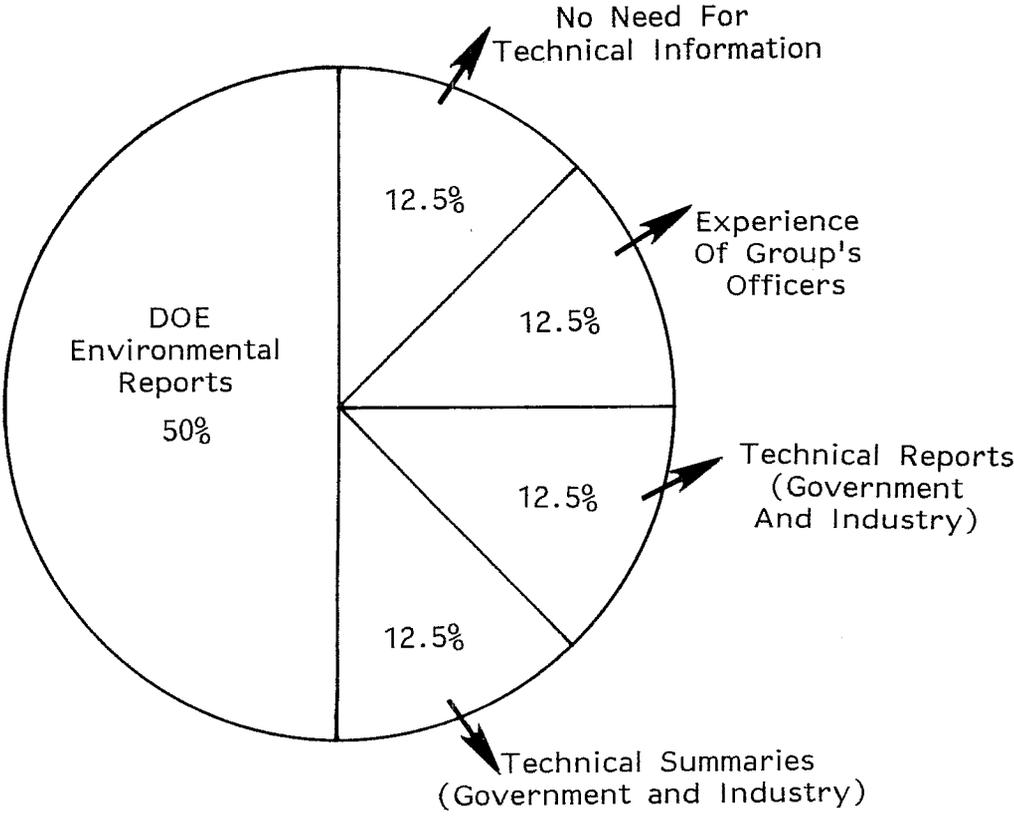
*Includes "letters to thought leaders" and "form coalitions."

ENVIRONMENTAL GROUPS

Exhibit 7

Primary Source of Technical Information Used to Develop Group's Position on EOR

(Base 8)

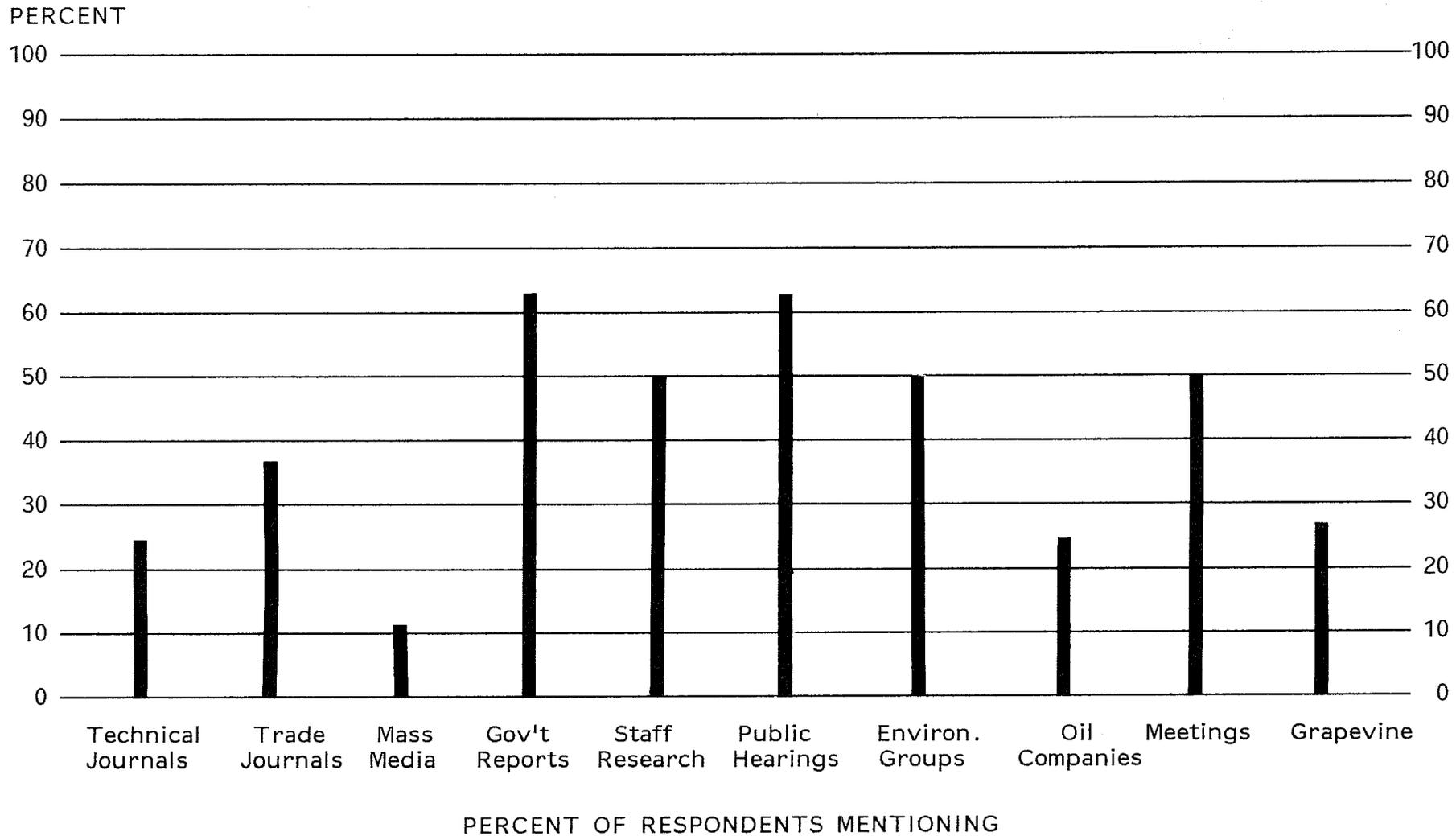


ENVIRONMENTAL GROUPS

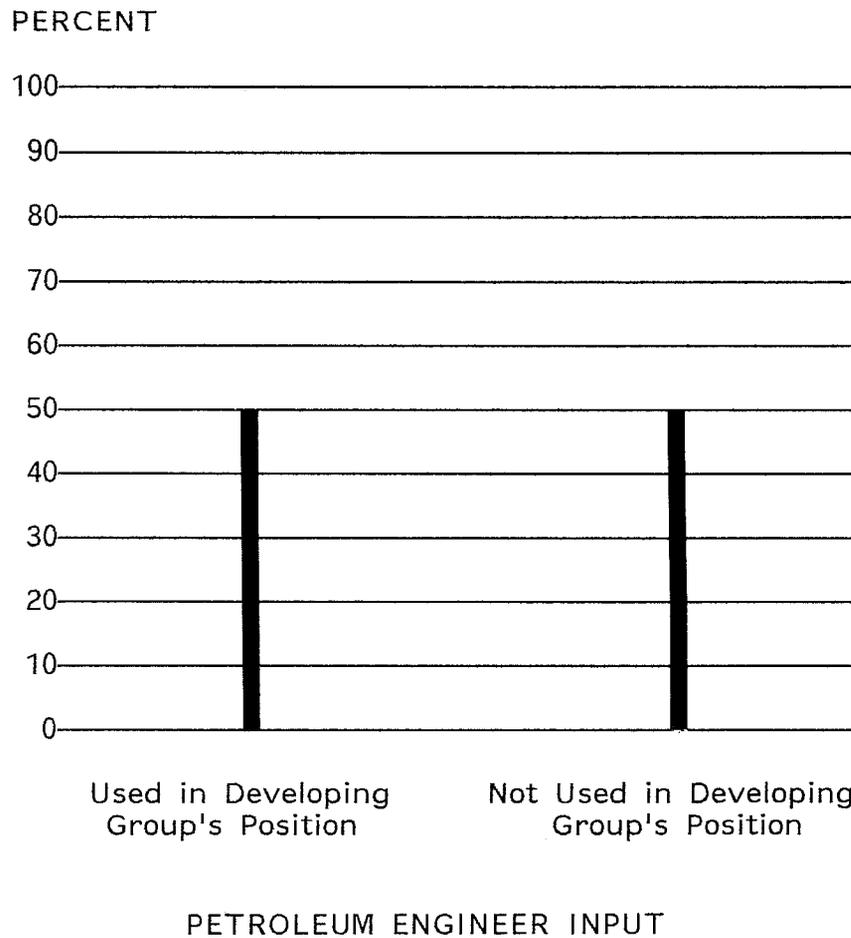
Exhibit 8

Sources of EOR and Technical Petroleum Information

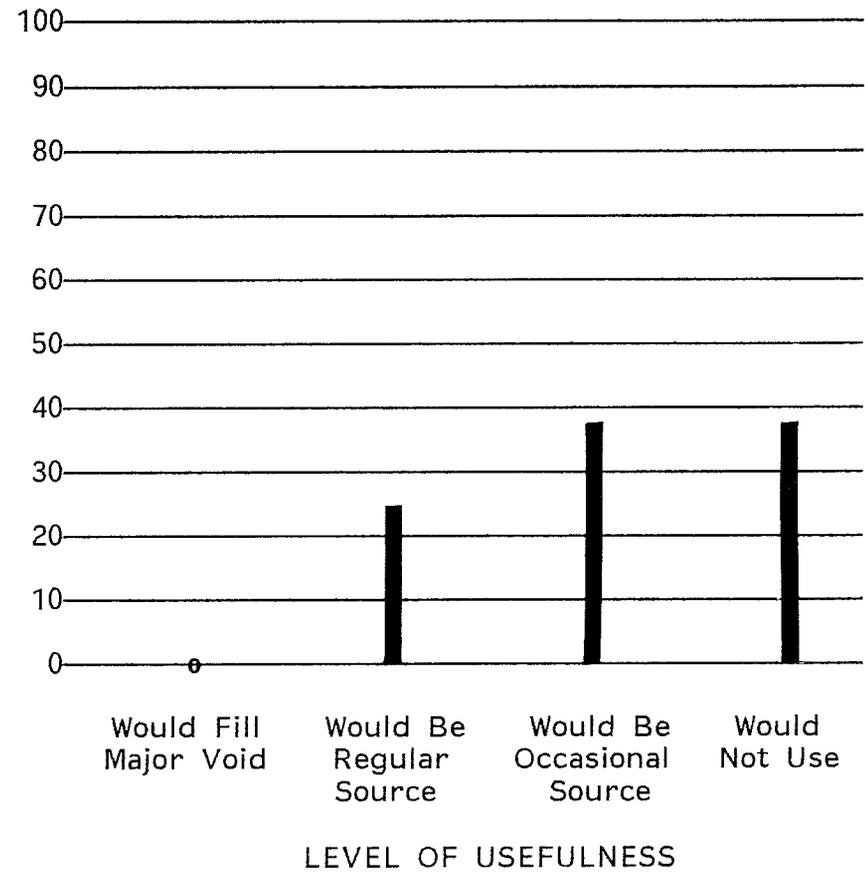
(Base 8, Multiple Responses)



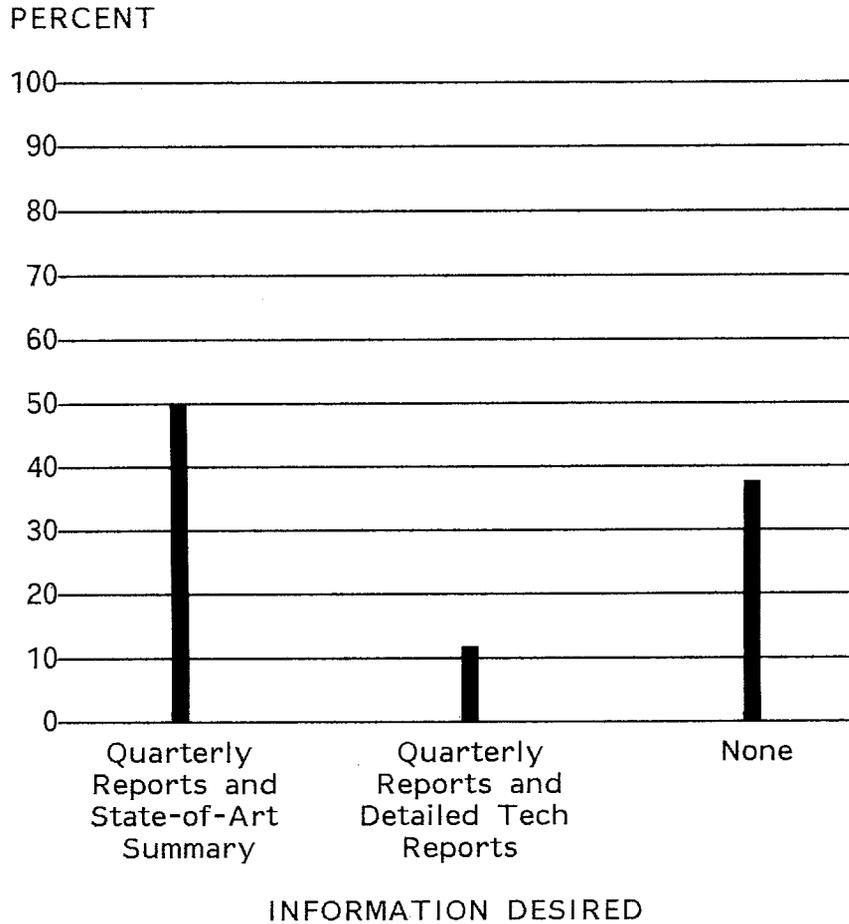
ENVIRONMENTAL GROUPS
 Exhibit 9
Input from Petroleum Engineers
 (Base 8)



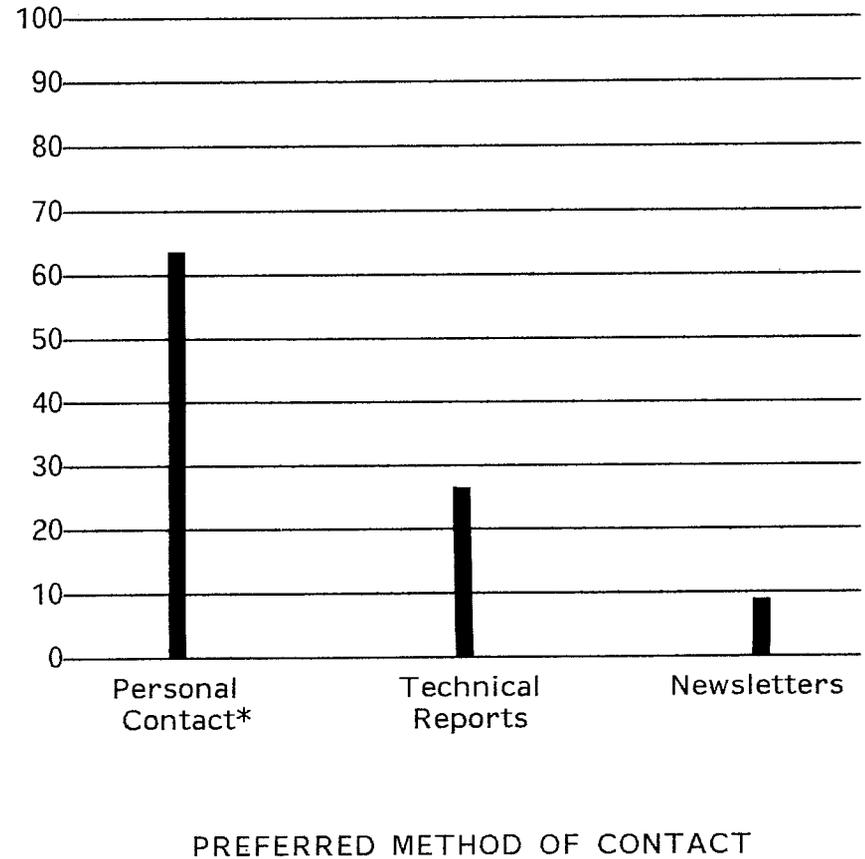
ENVIRONMENTAL GROUPS
 Exhibit 10
Usefulness of Technical Information Center
 (Base 8)



ENVIRONMENTAL GROUPS
 Exhibit 11
EOR Information Desired from BETC
 (Base 8)



ENVIRONMENTAL GROUPS
 Exhibit 12
Preferred Method of Receiving EOR Information
 (Of 11 total responses)



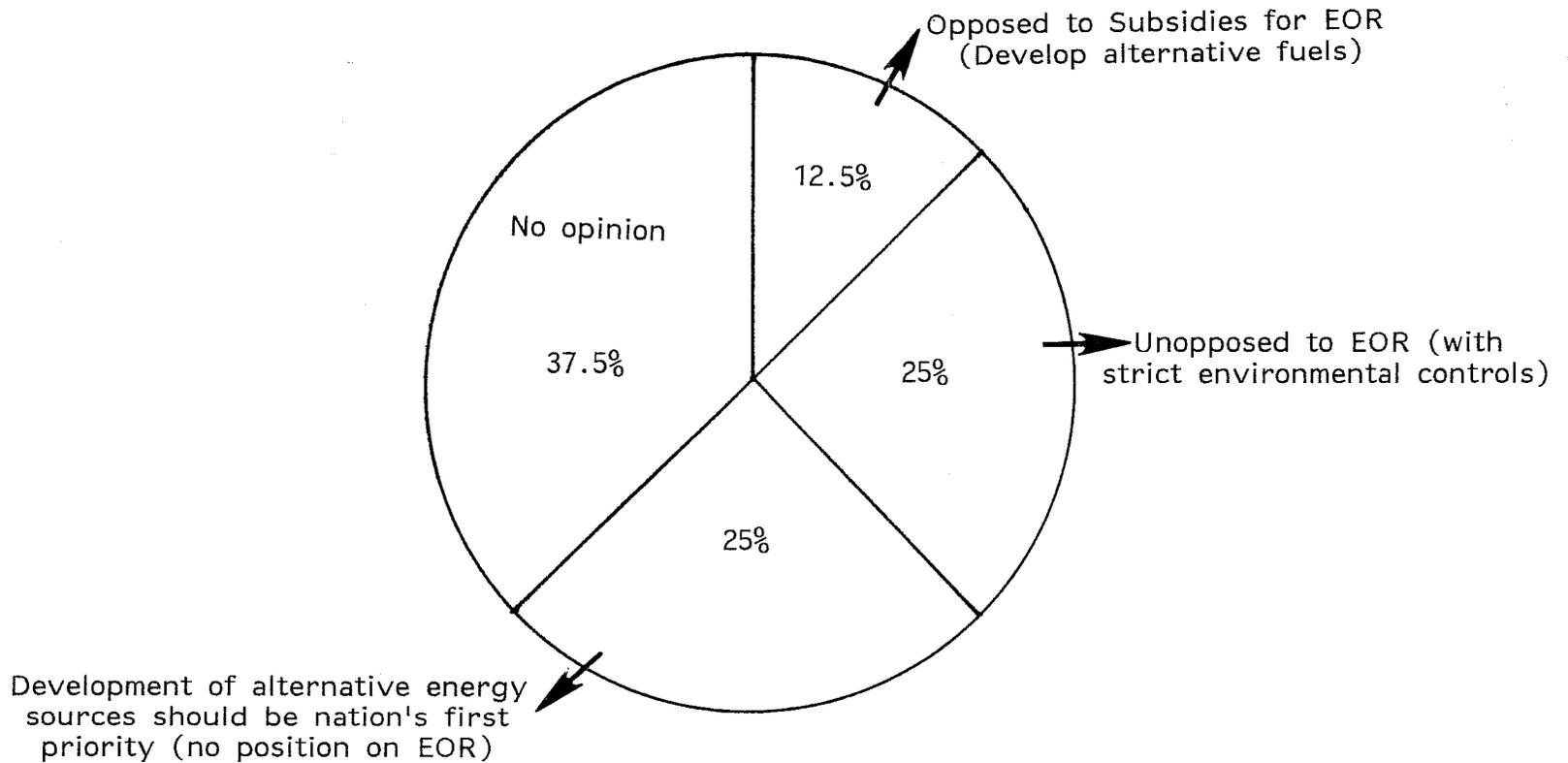
Note: Personal contact includes letters, telephone calls, and other types of one-to-one communications. One might conclude that environmentalists are fearful of "not being heard" and need the added assurance of personal contact.

ENVIRONMENTAL GROUPS

Exhibit 13

Group Position on EOR*

(Base 8)



*Overall 63 percent of respondents favor national policy of petroleum conservation and rapid development of solar, wind, and geothermal energy technologies.

