

PROJECT WAGON WHEEL

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El Paso Natural Gas Company
P. O. Box 1492 -- El Paso, Texas 79978

For further information, please contact:
Joseph T. Arnett, El Paso, Texas
(915) 543-2600, Extension 5401

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WHAT IS PROJECT WAGON WHEEL?

El Paso Natural Gas Company became interested in 1958 in the possible benefits of nuclear stimulation for the western part of Wyoming and the rest of the nation, but technology for the use of these explosives underground was not sufficiently advanced at that time. A decade later, in 1968, the Company began an intensive study -- under the project name Wagon Wheel-- of the feasibility of nuclear stimulation in the Pinedale-Big Piney area of Wyoming. Nuclear stimulation is feasible and Project Wagon Wheel would yield much valuable information necessary in assessing the practicality and economics of nuclear stimulation of a low-yield natural gas reservoir.

Cooperating and assisting in the Project Wagon Wheel study are the U. S. Atomic Energy Commission and the U.S. Department of the Interior. These organizations - along with EPNG - are also engaged in Project Gasbuggy, the world's first experiment in nuclear stimulation. The Project Gasbuggy explosive was detonated on December 10, 1967, in northwestern New Mexico.

Nuclear stimulation involves the use of one or more nuclear explosives in the same wellbore to fracture -- or crack -- so-called "tight" (low-permeability) gas-bearing rock deep underground. This would permit production of gas which is known to exist but which cannot be produced commercially with existing technology.

El Paso Natural has a contract with the U. S. Atomic Energy Commission for a project definition study covering all processes through design of the project. A second contract would be negotiated and signed before the

actual Project Wagon Wheel detonations were carried out. El Paso Natural has not yet proposed to the AEC that this contract be negotiated.

WHAT'S THE REASON FOR THE PROJECT?

Natural gas is a premium fuel. It burns clean, producing virtually no pollution, and is much in demand for industrial and commercial use as well as for home heating, cooling and cooking.

Demand for natural gas in the United States is growing faster than the demand for any other fuel. In the past 50 years, the use of natural gas has increased nearly 20 times. Today, natural gas supplies a third of the nation's energy. The annual requirements for natural gas could be expected to about double in the next 20 years, if the gas were available.

But natural gas is being consumed more rapidly than replacement supplies are found. In 1971, for the fourth consecutive year, more gas was produced than was added to the reserves in the contiguous 48 states.

Indeed, the demand for energy is rising to the point where no single fuel or even any grouping of fuels can supply the total demand from domestic sources. The United States faces the real possibility that its domestic energy supply may not grow fast enough to support the United States' industrial growth and to maintain our standard of living, unless new sources of fuels are found. Additional supplies must be made available from reserves already known to exist but which cannot be produced with existing technology.

SOME POTENTIAL BENEFITS FROM PROJECT WAGON WHEEL

Project Wagon Wheel is one of several experiments aimed at developing the technology of nuclear stimulation and determining whether it will be an economic means of recovering natural gas from "tight" -- low-permeability-- underground rock formations. Two others have already been conducted: Project Gasbuggy (sponsored by El Paso) and Project Rulison (sponsored by Austral Oil Company).

If an economic nuclear stimulation technology is developed, the nation will benefit from a substantial increase in the natural gas energy essential for maintaining and improving the standard of living and producing the goods that the country needs. In addition, Wyoming will benefit not only from this increase in available energy, but also from the income and stimulation of business that will be derived from the development of gas fields and their subsequent production. Most of the Pinedale Unit is on federal and state lands, and royalties to the State of Wyoming and the Federal government would be substantial if a producing gas field could be developed.

THE PROJECT SITE

The location of Project Wagon Wheel will be just off State Highway 351 (formerly Highway 1801) in Sublette County, Wyoming, and about 20 air miles south of Pinedale and an equal distance east of Big Piney. (See map). It is in a sparsely populated area of open desert country with gently rolling, low hills. Elevation at the project site is 7,062 feet. Two rivers, the Green and the New Fork, traverse the general area. The proposed site is about five miles from the nearest river point.

WHY STUDY THE PINEDALE UNIT?

The Pinedale Unit (see attached map) consists of about 90,000 acres of oil and gas leases. This Unit contains substantial quantities of gas which could make an important addition to Wyoming and the nation's natural gas supply.

A 13,551-acre portion of the Unit that has already been explored by drilling has been demonstrated to contain about four trillion cubic feet of natural gas between the depths of 7,500 feet and 10,700 feet. An exploratory well drilled as part of the Project Wagon Wheel study has demonstrated the existence of additional gas. Much more of the Unit acreage as well as acreage lying outside the Unit, is believed to contain great quantities of gas.

The natural gas lies trapped in sandstone layers between layers of non-gas-bearing rock more than 7,500 feet below the surface. The gas is actually held in the microscopic pore spaces between the individual sand grains that make up the sandstone. The amount of pore space is small (about 7.5 percent of the total rock volume) and the pores are poorly connected. This kind of rock is said to have low permeability; that is, the gas flows with difficulty from pore to pore through the surrounding area to a well drilled in the rock.

Although many layers of sandstone contain enough gas to be of interest, in actual practice in commercial gas fields only a few layers are stimulated with conventional methods. This results in gas production from a total vertical thickness of gas-bearing rock of from a few feet to a few tens of feet. In the Wagon Wheel area, conventional methods are not economic. Stimulation with nuclear explosives, however, is expected to stimulate production from all gas-bearing sandstone layers over a total of approximately 2,700 feet of vertical interval.

Eleven wells -- including the Wagon Wheel exploratory well -- have been drilled in the Pinedale Unit but the rates of flow and the total amount of gas that can be produced from these wells is so low that the building of a pipeline to connect the wells to a market outlet cannot be economically justified.

The nuclear explosive stimulation technique being considered for the Wagon Wheel experiment may be the key to unlock these and other similar deposits of natural gas in the United States.

NUCLEAR VERSUS CONVENTIONAL STIMULATION

Two methods of well stimulation have been widely used in the United States. One is "shooting" with high explosives. The other is hydraulic fracturing -- injecting liquids under high pressure. The object of both methods is to fracture the underground rock containing the gas, thus creating new and better pathways for the gas to flow through the rock to the well bore.

A nuclear explosive accomplishes the same result, but on a vastly greater scale. The nuclear explosive is concentrated power; an entire nuclear explosive assembly can be packaged in a cylindrical canister several feet long and less than nine inches in diameter. Into this small package can be built the energy equivalent of many thousands of tons of chemical explosives.

When detonated deep underground, a nuclear explosive creates a "chimney" -- a roughly cylindrical contained chamber standing on end -- filled with broken rock, and a network of fractures extending outward from the chimney (see illustrations) for a few hundred feet through the surrounding rock. Thus, with one step can be accomplished both (1) a vast increase in permeability and (2) the stimulation of many layers of gas-bearing rock which might otherwise

never produce gas. Gas flows into this chimney from the surrounding reservoir and may be produced through a well drilled into the chimney from the surface.

PURPOSE OF WAGON WHEEL

Wagon Wheel is being designed to provide further information essential to determining whether nuclear stimulation will provide a practical means of developing commercial production of otherwise unavailable and essential quantities of natural gas from the Pinedale Unit. The information is also expected to apply to the Rocky Mountains in general.

STEPS IN DEVELOPMENT OF THE PROJECT

Activities and studies connected with Project Wagon Wheel are following an orderly plan. Before any step has been taken, sufficient information has been obtained and evaluated to provide a clear indication that that step should be taken. All such studies may be grouped under four general headings -- preliminary site evaluation, development of the stimulation concept, detailed effects studies and reviews of safety evaluations. The activities began in 1969, when serious consideration was given to the possibility that nuclear explosives could be successfully employed to stimulate production from the gas-bearing sandstones in the Pinedale Unit. Following is a discussion of the step-by-step progression of the studies up to the spring of 1972.

A. How the Site was Chosen (1969)

Initially, from wells drilled previously in the area and from other sources, enough was known about the area to make possible a tentative selection of a site. In 1969, studies were undertaken to determine whether the site tentatively selected was sufficiently promising, in view of the amount of gas

in place and other considerations, to justify the next step: drilling an exploratory well to develop additional information about subsurface conditions. The studies included preliminary investigation of geology, ground water, ground motion, ecology, weather and radioactivity.

Geology. Understanding of the geology of the Pinedale Unit was developed during the drilling of wells then existing in the Unit. Additional refinement of this data was undertaken when the Wagon Wheel study was begun. Studies performed included aerial photography by Knox, Bergman and Shearer and additional seismograph surveys by Seismograph Service Corp. and Geophysical Services, Inc.

Ground Water. Data developed through earlier exploration and drilling operations in the area were assembled and evaluated by El Paso Natural, the AEC, the U. S. Geological Survey (USGS) and Isotopes, Inc.

Ground Motion. In the spring of 1969, El Paso Natural personnel performed a comprehensive survey of man-made and natural features (called a cultural survey) to a radius of 20 miles from the tentative site. Their report and its documentation were supplied to John Blume and Associates through the Atomic Energy Commission. At the request of the AEC, Blume and Associates conducted field work and verified the accuracy of the initial survey, and performed a preliminary evaluation of the Wagon Wheel site. In addition, ground motion predictions were prepared both by El Paso Natural and by Environmental Research Corporation.

Ecology. Additional surveys performed by El Paso Natural in 1969 included preliminary documentation of ecological considerations. The AEC asked Battelle Memorial Institute's Columbus Laboratories and the U. S.

Public Health Service's Southwestern Radiological Health Laboratory (SWRHL) to perform a preliminary field ecological investigation. Battelle emphasized in its study these principal considerations: range livestock, irrigated crops, wild game distribution and harvest. The SWRHL study concentrated on milk cows and people.

Weather. During the summer of 1969, El Paso Natural and the Environmental Science Services Administration's Air Resources Laboratory (ESSA/ARL) compiled weather records and recommended installing weather stations.

Radioactivity. All radioactivity will be contained deep underground at the time of detonation. However, the Public Health Service and El Paso Natural considered radioactivity which would be airborne as a result of flaring of gas during post-detonation production testing of the well.

B. The Current Stimulation Concept (1970)

The 1969 studies showed the location to be satisfactory. The studies revealed that the effects of nuclear detonations of up to 200 kilotons yield would be within the range of experience from the more than 200 announced underground detonations already conducted up to then by the Atomic Energy Commission. As a result of these studies, El Paso concluded that it would be worthwhile to spend the money to drill a hole at the site to gain a more detailed understanding of the subsurface.

In developing the current concept of the method of stimulating the gas-bearing sandstones at the Wagon Wheel location, a water well was drilled at the site to supply water for drilling an exploratory well. Both the water well and the exploratory well were planned and drilled in such a manner as

to supply information essential to evaluating nuclear stimulation at the site. The exploratory well actually had two purposes: (1) to provide information necessary in evaluating nuclear stimulation at the site and (2) to explore deep geological formations that had not previously been explored in that area.

Wagon Wheel Water Well #1. A water well was drilled at the location to supply drilling water. It was drilled to 2,500 feet and cased with 7-5/8 inch casing. A six-inch electric pump was installed after the well was perforated from 130 feet to 2,432 feet in 19 separate water-bearing sandstone intervals. On an initial test the well produced at a rate of 1,600 barrels a day. Although the well is capable of such production, a much lower rate of flow was sufficient for all water needs at the location. By the time the Wagon Wheel #1 exploratory well had been completed, the water well had produced in excess of 340,000 barrels of water.

The Exploratory Well. In October, 1969, drilling was begun on an exploratory well at the proposed site of the Wagon Wheel project. This well attained a depth of 19,000 feet -- nearly 3-1/2 miles. Drilling was completed in November of 1970.

The well was drilled 22 inches in diameter at the surface, then cased with 16-inch casing set from the surface to 2,500 feet and with 10-3/4 inch intermediate casing set at 12,100 feet; a 7-5/8 inch liner was set from 11,755 feet to 19,000 feet. Through this well, which was extensively logged and cored, additional information about subsurface conditions was obtained. The following activities and contractors were involved: drilling of Wagon Wheel #1, Moran Brothers; Wagon Wheel #1 drill cuttings and stratigraphic analysis, American Stratigraphic Company; wireline well logging, Birdwell (a Division of Seismograph Service Corp.) and Schlumberger, Limited;

drilling and mud logging, Rocky Mountain Geo-Engineering; core analysis, Corelab Inc., Terra Tek Inc., U. S. Bureau of Mines' Bartlesville Research Station and Lawrence Livermore Laboratory.

After the information was gathered from these wells, detailed studies were performed. These studies involved predicting chimney size, gas production, temperature, chemical composition of gas and radioactivity constant of gas for a variety of nuclear explosive yields and depths of emplacement. The principal organizations performing these studies were El Paso Natural Gas, Lawrence Livermore Laboratory and Applied Nuclear Corporation. Technical details of many of these studies are contained in the Wagon Wheel Technical Studies Report (PNE-WW-1). Out of these studies came the current plan for the Project.

The Project Design. Nuclear underground engineering projects are designed and conducted so as to contain all radioactivity in the chimney formed by the explosion. But seismic motion cannot with practicality be limited to the project site. Potential seismic motion effects therefore become a limiting factor in any project. From the beginning, the Project Wagon Wheel study has been based on the following limitations to seismic motion: (1) ground motion and its potential effects must be kept well within the range of that which has already been experienced in previous underground nuclear detonations, (2) no damage will occur which will disrupt any structure's or facility's normal function, and (3) ground motion must not interfere with normal, everyday activities in the nearest population centers, Pinedale and Big Piney.

Research and calculations have determined that the ground motion resulting from detonation of a 200-kiloton nuclear explosive would be well within these limitations. However, about 500 kilotons of explosive are needed to

stimulate adequate production from the gas-bearing layers of rock. How, then, can adequate stimulation be accomplished without exceeding the 200-kiloton limit?

The Wagon Wheel project design solves the problem in a very practical way. It provides for sequential detonation of five lower-yield explosives (100 kilotons each) placed one above the other in the same hole; that is, detonation of the explosives one after the other -- from the deepest up -- and with a time interval of five minutes between detonations so earth motion can dissipate completely between explosions.

Not only does this design solve the problem, but it also permits stimulation of a much thicker interval, or span, of gas zones than could be accomplished with a single 500-kiloton explosive.

It is expected that the five chimneys formed by the explosions will connect with each other to form a single, elongated, continuous chimney. (See illustration). If the predicted continuous chimney does indeed form, it is possible that in future projects the same result may be accomplished with fewer explosives placed farther apart in the hole or by using lower yield explosives.

With some relatively minor preparation, the Wagon Wheel #1 exploratory well can be used as the explosive emplacement hole and this is currently planned. The explosives are planned for emplacement at varying depths, ranging from 9,220 feet (about one and three-quarters miles) down to 11,570 feet (nearly two and two-tenths miles). The detonations are expected to stimulate the depth interval from 9,000 feet down to 11,700 feet, a span of 2,700 feet. Studies indicate this zone contains numerous gas-bearing sandstone units that will be stimulated as a single unit.

The energy of the nuclear explosive would create, in about one-tenth second, a spherical cavity containing vaporized and melted rock. As the cavity cools and pressure drops, the vaporized and melted rock would puddle at the bottom. With further cooling of the cavity, the roof would be expected to collapse, forming a roughly cylindrical vertical zone of broken rock called a "chimney".

Each chimney is expected to connect with the one below it to form a continuous cylindrical chimney of broken, highly permeable rock.

The explosions are expected to create three reasonably distinct zones of increased permeability. The first zone is one of almost unlimited permeability -- the rubble zone in the chimney itself. The second zone will surround the chimney and extend from the chimney wall at about 105 feet to about 220 feet from the center line of the chimney. This zone would be characterized by innumerable small fissures and cracks in the rock; most of these spaces would be hardly large enough to slip a sheet of typing paper into. Permeability in most of this zone, however, would be about 18 times greater than before the explosions.

If the rock in the third zone could be visually inspected, it would appear to have changed very little. This zone would surround the chimney from 220 feet to 440 feet from the centerline, with permeability dropping from about a two-fold increase at the edge nearest the chimney, to, at the outer edge of the zone, no change from the pre-existing permeability.

After a wait of four to six months for short-lived radioactive products to die out, re-entry to the top of the chimney would be accomplished through the emplacement hole casing and gas would be produced from this

re-entry hole. Production tests and shut-in pressure buildup tests would be conducted over a period of a year and a half or more. At the same time, information from the project would be evaluated. This evaluation would continue as long as necessary after the end of production and shut-in pressure testing.

Although radioactivity is not expected to be a problem at any time during the experiment, from detonation through evaluation, the area will be continuously monitored with sensitive detection instruments for as long as is necessary. Monitoring has started and will continue at least until the end of the production testing. The Project plan will specify limits on levels of radioactivity and provide for preventive measures should these limits be approached.

C. Detailed Effects Studies (Beginning in 1971)

The current concept for the experiment was adopted early in 1971 and detailed studies of potential explosion effects were started. These studies -- still in progress -- are essential to El Paso Natural deciding whether to propose the experiment to the AEC. The Company awarded contracts for these studies to qualified contractors who have no vested interest in the success or failure of nuclear stimulation.

Ground water. An additional water well was drilled 750 feet southwest of the Wagon Wheel #1 well. Hydrologic tests were performed in depth intervals 2,312 to 2,427 feet and 4,937 to 5,108 feet. This well was drilled to depth of 5,200 feet in 15 days starting April 22, 1971. The tests were completed in July, 1971. The United States Geological Survey participated in design and conduct of the tests.

In 1971, the Water Resources Research Institute at the University of Wyoming examined 425 water wells within 20 miles of Wagon Wheel. With these data, a static water level map has been constructed and water samples from 128 selected wells are being analyzed for natural radioactivity and chemical constituents.

Earthen Structures. Dames and Moore, an outstanding consultant firm in applied earth sciences, is carefully evaluating potential effects upon dams, mines, bridge abutments, river bluffs and cliffs. In addition, the United States Bureau of Reclamation has examined possible effects on facilities designed and operated by that agency. In some cases, these studies have resulted in recommendations for actions to insure that no detrimental effects could result from the experiment.

Bridges, Towers and other Engineered Structures. Degenkolb and Associates, a San Francisco firm specializing in design and analysis of structures in earthquake areas, has performed detailed analysis of 82 structures which could conceivably be affected by Wagon Wheel. These studies have also resulted in recommendations for some measures to assure that use of structures would not be impaired.

Ground motion effects upon low rise buildings such as houses, stores and barns are predicted on the basis of experience with other projects. For the location selected, experience from previous nuclear projects combined with detailed survey of the local area provides confidence that most buildings will experience no damage whatsoever.

Shortly before the detonations, all low rise buildings within the area would be examined and, as agreed upon, loose bricks or other

conditions which could conceivably result in damage would be repaired.

Background Radioactivity. Eberline Instrument Company is measuring background radioactivity in the area. Samples of soil, water, air, vegetation, milk, fish and various types of meat including wildlife are being collected and analyzed for radioactivity on a regular schedule.

Weather Stations. Five weather stations have been installed by El Paso Natural so that radiation monitoring instruments can be properly located downwind.

Ecological Studies. Dr. H. G. Fisser, Professor of Range Management in the Department of Agriculture at the University of Wyoming, is conducting baseline environmental studies in the Wagon Wheel area. These studies are primarily directed toward plant life. Experience on previous projects indicates there is no possibility of any effect upon animals in the area.

D. Reviews of Safety Evaluations (1972)

Many agencies of the Federal and State governments are responsible to the people for consideration of matters potentially affecting the health and safety of the public. El Paso is cooperating with reviews by all such agencies to the extent they desire.

The most comprehensive review is performed by the United States Atomic Energy Commission (AEC). Contractors to AEC consider El Paso Natural's evaluations in detail and perform additional studies as deemed appropriate by AEC to insure that no factor is overlooked. Contractors to AEC and government agencies performing reviews requested by AEC and areas of investigation include: ground motion predictions, Environmental Research

Corporation; ground motion effects, J. A. Blume and Associates; mines, U. S. Bureau of Mines; geology and hydrology, U. S. Geological Survey; bioenvironmental studies, Battelle Memorial Institute; and meteorology, Environmental Science Services Administration's Air Research Laboratory. In addition, these investigations, as well as operational procedures and matters pertaining directly to the nuclear explosives, are carefully considered by experts in AEC and the AEC Lawrence Livermore Laboratory. Work performed by these contractors and government agencies is in turn reviewed by the AEC's independent Panel of Safety Consultants, a number of whom were recommended by the National Academy of Sciences.

AEC has distributed a Draft Environmental Statement to numerous Federal and State government agencies for comment. Comments received provide a further check on the adequacy of evaluations performed.

FLARING AND RADIOACTIVITY

Since the Rulison experiment, a new nuclear explosive has been developed specifically for nuclear stimulation of natural gas wells. This new nuclear explosive results in much less residual tritium (a radioactive form of hydrogen) than the explosives used in Gasbuggy and Rulison. Total residual tritium from the five explosives of 100 kilotons each in Wagon Wheel will be less than from the single 40-kiloton explosive used at Rulison.

The town of Grand Valley, Colorado (1960 population: 245) was the same distance from the Rulison flare as the distance of the nearest ranches from Wagon Wheel. In addition, winds down the canyon at night carried

Rulison flare products directly over farms and toward that town. Those residents who received the greatest radiation exposure were carefully monitored and no radiation exposure due to Rulison was measurable.

There is a continuing and widely publicized academic debate regarding low level radiation exposures. However, much of the public concern aroused by this debate is inconsistent with decisions people make every day. For example, as documented in Rulison, some individuals wearing luminous dial wrist watches received much greater radiation exposures due to tritium from their watches than anyone received from the experiment.

The proposal to flare gas from Wagon Wheel rather than use an alternative expensive disposal method is based upon recognition of the fact that the maximum possible radiation exposure to any person or animal in the area would be minute compared to exposures resulting from many day-to-day decisions unrelated to the experiment. For example: (1) one percent of the radiation exposure many people receive from wearing luminous dial wrist-watches, (2) substantially less than a person would receive in hiking to an altitude of 10,000 feet in the Bridger Wilderness area and back down. The additional exposure from the entire Wagon Wheel experiment is far less than the additional exposure that most people would receive from sitting one foot closer to their television sets.

THE WATER INVESTIGATION

In one year, the first water well at the location produced in excess of 340,000 barrels of water from perforations in 19 intervals between depths of 130 and 2,432 feet. Hydrologic tests were performed on perforations

in the intervals from 2,312 to 2,427 feet and 4,937 to 5,108 feet in the second well drilled. In addition, hydrologic tests were performed in the interval from 6,868 to 7,140 feet in the Wagon Wheel #1 well and a drill stem test of the interval 7,275 to 7,400 feet confirmed that sands at that depth produced gas rather than water. These tests combined with data from wireline logs of all three wells have provided comprehensive understanding of deeply buried water resources at the location.

Potable water is produced by numerous sandstone layers at depths down to 3,731 feet. In the depth interval from 3,731 to 5,630 feet salt water is produced. In the depth interval from 5,630 feet to the deepest water producing sandstone at about 7,200 feet the water is of poor quality but could be consumed under emergency conditions. However, in this deep interval water production is so slow that only about three gallons per minute can be produced even if a high pressure pump is installed as deep as 5,000 feet. It is highly unlikely that water will ever be so scarce that anyone would ever invest the money required for use of water from this deepest interval. No mobile water exists between 7,200 feet and the 19,000 foot total depth of the Wagon Wheel #1 well.

HOW FAST MIGHT FIELD DEVELOPMENT WITH NUCLEAR STIMULATION TAKE PLACE?

There are no firm answers to this question at this time. If Project Wagon Wheel should prove successful, it would form the basis for planning the next project in the series necessary to develop the field. However, because of time required to evaluate results of Wagon Wheel and to prepare for another nuclear stimulation project in the Pinedale Unit, it is now estimated that approximately three to four years would elapse between the Wagon Wheel event and any

subsequent nuclear detonations in the Pinedale Unit.

Highly speculative estimates of how nuclear stimulation may proceed in the Pinedale Unit and surrounding area have been developed. The number of wells stimulated in 1977 could conceivably be as great as ten. In succeeding years, the number of wells stimulated each year may increase by ten per year to a peak of forty to fifty wells per year being stimulated in the 1980's. The number of new wells each year may then slowly decline to maintain gas production from the area at a rate of about five to ten times the present production from the Big Piney-LaBarge area.

El Paso can only guess at what other companies might do and the above figures involve such guesses. However, the figures are believed to be high considering such factors as availability of drill rigs and availability of sufficient money to finance the work.

During field development, all wells stimulated in a given year may be grouped into single short-time periods of a few days.

THE WASP PROJECT - NO CONNECTION WITH
EL PASO NATURAL GAS COMPANY

El Paso Natural Gas Company's Wagon Wheel project and the one designated as the Wyoming Atomic Stimulation Project (WASP) are separate projects entirely. El Paso Natural Gas Company is not connected in any way with WASP.

THE PROJECT GASBUGGY EXPERIMENT

Project Gasbuggy involved the detonation of a nuclear explosive in a natural gas reservoir east of Farmington, New Mexico, on December 10, 1967. It took place after several years of planning and intensive evaluation of the

location. The knowledge and experience gained from more than 200 underground nuclear explosive tests conducted by the Atomic Energy Commission up to that time, and the care exercised in planning and execution, resulted in the conduct of a completely safe experiment.

The explosion, at 4,240 feet below the surface, created a "chimney" about 160 feet in diameter and about 330 feet tall.

About 286 million cubic feet of natural gas has been withdrawn in production tests since a well was drilled into the chimney about a month after the explosion. All gas brought to the surface during the production tests was flared (burned) at the experiment site, except for small quantities taken for samples. The well is currently shut in for pressure buildup observations.

Knowledge gained from the Project Gasbuggy experiment is invaluable, not only in Wagon Wheel and other gas reservoir stimulation projects but also in other possible underground nuclear engineering applications.

WHAT COMES NEXT?

During 1972, investigations begun in 1971 and review of results obtained will continue. In addition, the AEC's Lawrence Livermore Laboratory will continue work on sequential detonation. This is expected to involve one or more nuclear explosive experiments at the AEC's Nevada Test Site.

When warranted by development of sequential firing, and when investigations begun in 1971 are sufficiently advanced, a detailed plan for Wagon Wheel will be written. El Paso Natural Gas Will then decide whether to formally propose to the AEC that the project be jointly undertaken. If the AEC agrees to a joint project, the two organizations will then negotiate a contract for carrying it out.

Many activities would be involved in carrying the project forward.

Involved, would be, among other things:

-- Contracts would be awarded and the instrumentation to make the many ground motion, radioactivity and other measurements would be procured.

--Additional cultural, seismic, hydrologic, geologic and environmental studies would be made.

--Remedial construction to avoid ground motion damage would take place.

--Instrumentation would be installed and checked out.

--After the necessary federal government approvals, the detonations would take place.

--A re-entry well would be drilled.

--Production testing and shut-in pressure tests would be conducted.

--Results of the detonations would be evaluated.

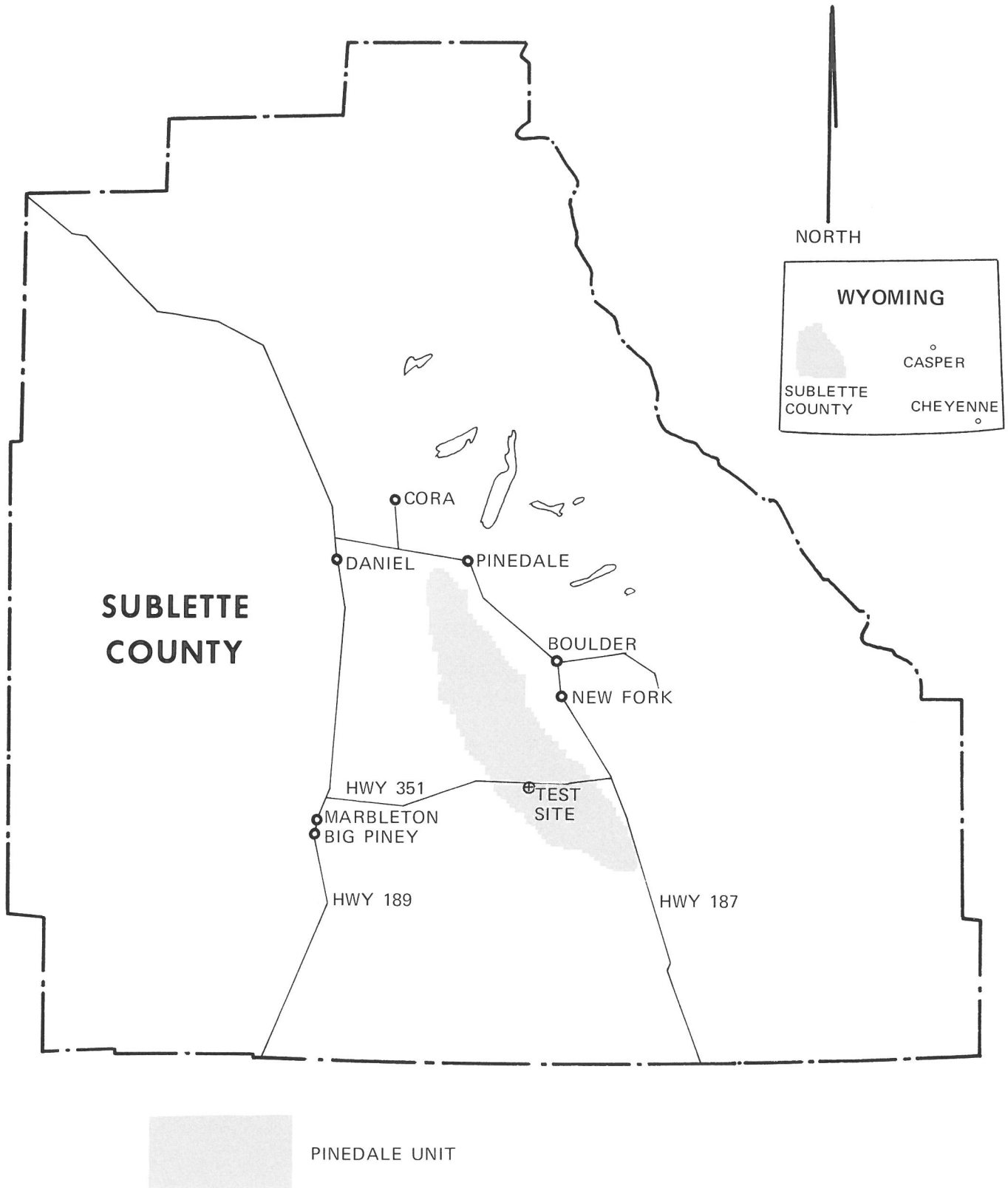
THE TIMETABLE

If all factors develop favorably, the Wagon Wheel detonations could take place during the latter part of the calendar year 1973. Production testing and analysis of results could result in conclusions from the Project in 1975. Subsequent detonations, if any, would be unlikely before 1977.

ABOUT EL PASO NATURAL GAS COMPANY

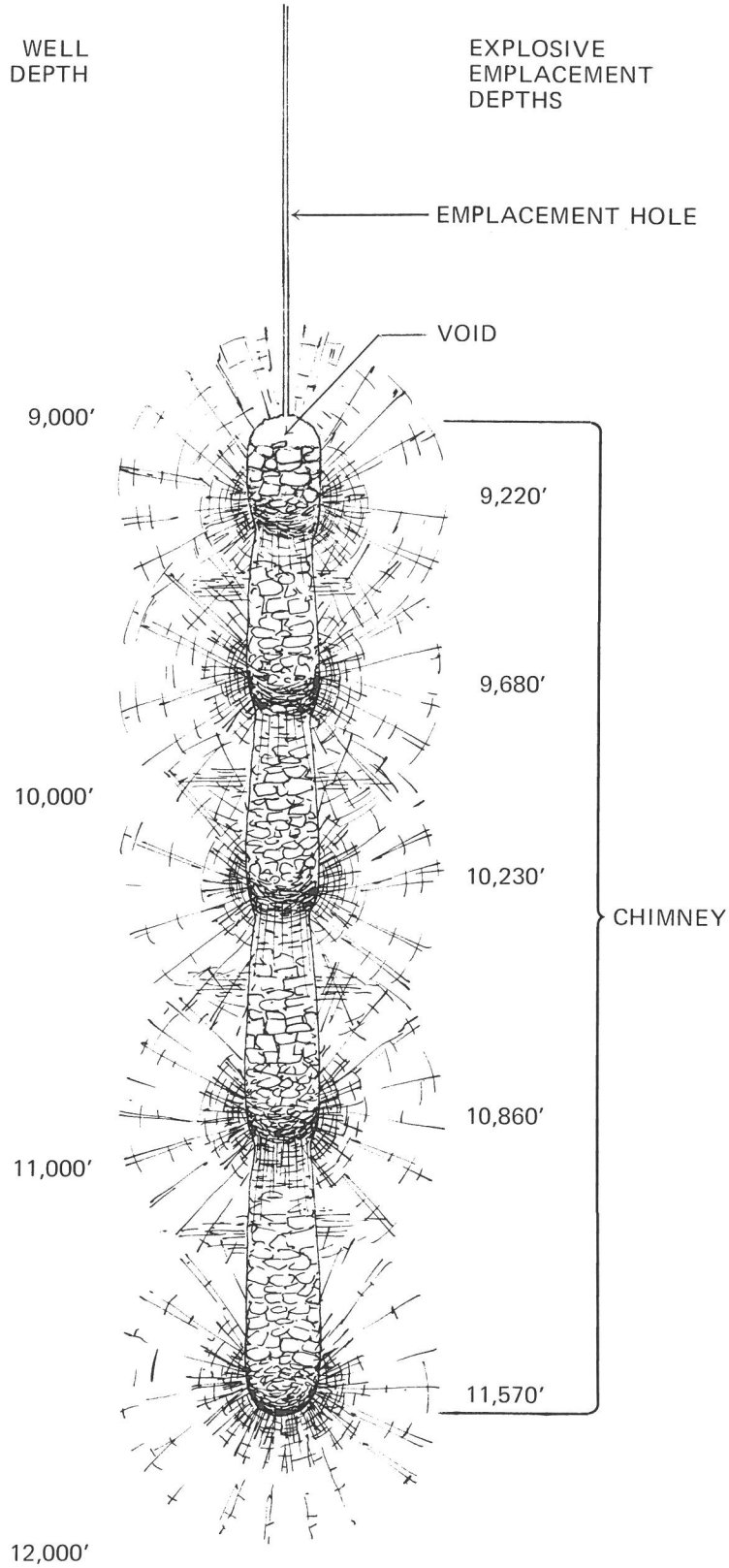
El Paso Natural Gas Company is a diversified natural gas transmission firm which serves customers in eleven western states through a 23,000-mile pipeline network. In addition, it has interests in the fields of petrochemicals, plastics, synthetic fibers, textiles, agricultural chemicals, insurance, wire fabrication, oil and gas production, land development and mining.

PINEDALE UNIT AREA



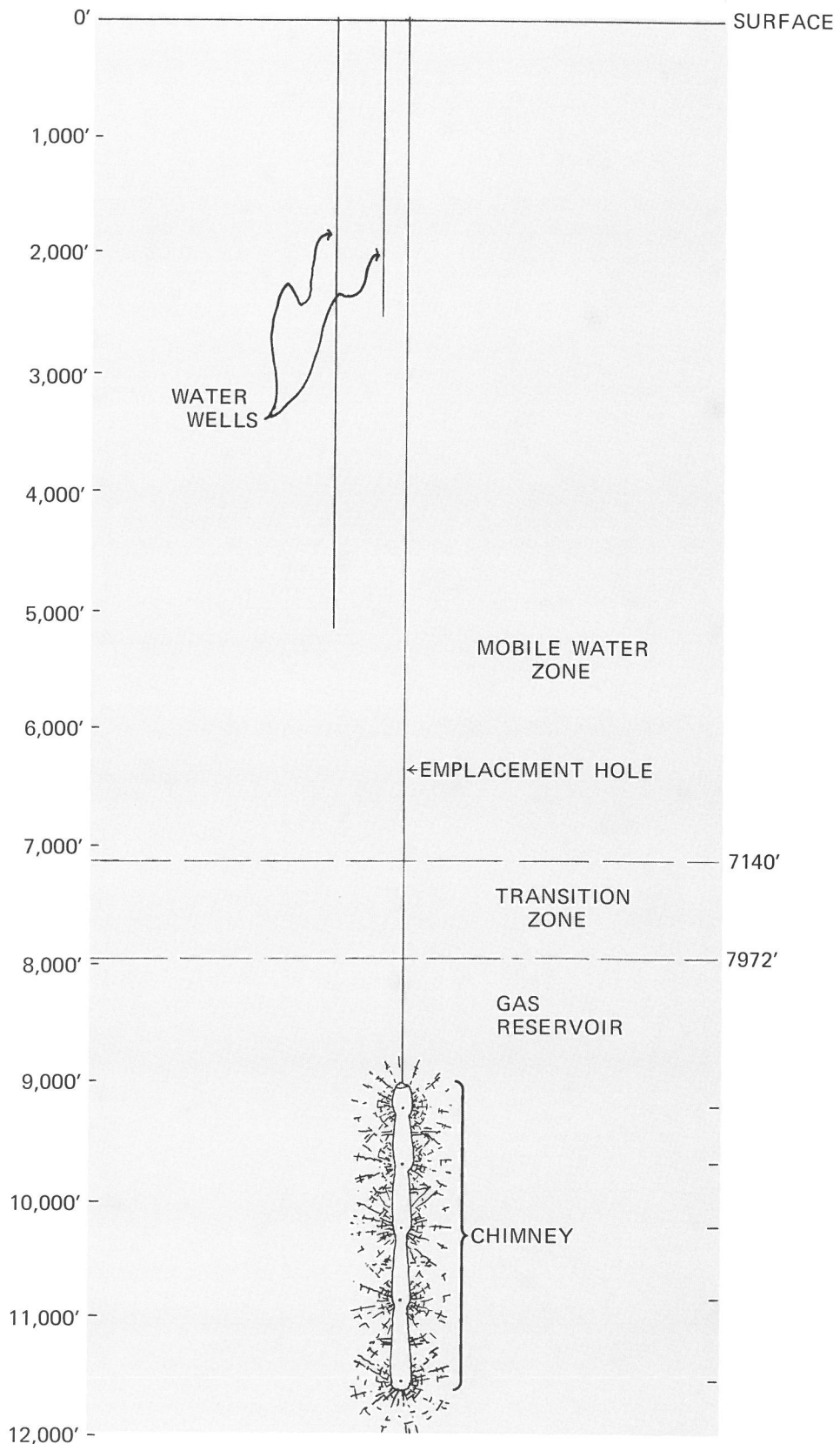
THIS DRAWING APPROXIMATELY TO SCALE

PROJECT WAGON WHEEL PREDICTED EXPLOSIVE EFFECTS



THIS DRAWING APPROXIMATELY TO SCALE

PREDICTED WAGON WHEEL CHIMNEY SHOWING RELATIONSHIP TO EARTH'S SURFACE



SHADING REPRESENTS
AREA 1 MILE WIDE,
12,000 FEET DEEP.

THIS DRAWING APPROXIMATELY TO SCALE

Statement by
H. F. Steen, President
El Paso Natural Gas Company
At Project Wagon Wheel Meeting
February 7, 1973
Washington, D. C.

Let me first express my appreciation to you Senator Hansen, Senator McGee, Congressman Roncalio and to the representatives of the Atomic Energy Commission and the residents of Sublette County in Wyoming for giving us the opportunity to discuss with you the nation's critical energy shortage and the studies we are undertaking which might help alleviate this crisis.

At the outset, let me emphasize that we at El Paso Natural Gas Company recognize and share the concern of all of those here today in whether the nation's best interests can be served through the project we are studying.

As you know, we are now engaged in studies to determine whether a nuclear test in western Wyoming will be of value to the citizens of the U. S.

It's been estimated by the U. S. Bureau of Mines that, if the test we are studying proves feasible and successful, it will demonstrate a technology that could result in more than doubling the recoverable known U.S. natural gas reserves.

The studies we have conducted to date indicate that such a test could pave the way for immense benefits to the entire country.

However, I do want to point out that these studies have not been completed.

They are still being conducted.

And I do believe that everyone here today would agree that, until the studies are completed and a decision as to whether a test of the nature being discussed should even be proposed, it is important for us to have all available facts. Then we can determine whether a test would benefit the nation.

But certainly, we do need the facts before anyone--anyone in this room, anyone in Congress, anyone in the nation--can reach a conclusion on the desirability of what has been called Project Wagon Wheel.

The overriding reason for consideration of nuclear stimulation technology is that there is a grave and deepening energy crisis. The supply of natural gas is no longer adequate to meet current needs. Assuming that future requirements grow at only about half the rate experienced during the 1960's, the nation's gas supply--including imports--will fall substantially short of demand for the foreseeable future. These findings are documented in the recently completed National Petroleum Council U. S. Energy Outlook Study.

The importance of energy goes beyond heat and light. It governs economic growth, employment, social standards, quality of life, and environmental conditions.

One example is the positive relationship of energy to future environmental conditions. Energy is required to achieve more efficient and desirable

forms of waste disposal and waste conversion, improved air and water filtration systems, and development of more desirable and efficient transportation systems. By 1985, energy consumption required to achieve desired environmental standards will represent about 10 per cent of the total energy consumed in 1970.

This nation's involvement in nuclear stimulation technology started in 1958, and we at El Paso were an initial participant along with governmental agencies. The objective then was to obtain vitally needed energy from low permeability reservoirs that could not be made productive with conventional well completion methods. The first nuclear stimulation project--designated Project Gasbuggy--was preceded by years of studies.

The Project Gasbuggy detonation occurred on December 10, 1967, and confirmed the accuracy of the safety projections. The technical understanding gained from that project is being applied to the characteristics of the Pinedale Unit to design an experiment to define its nuclear stimulation potential.

Our studies in the Pinedale Unit area have been conducted on a step by step basis. There must be clear satisfaction, with conclusions reached at each step, before proceeding to the next step of investigation. The studies are grouped under four general headings:

First, selection of a location based upon preliminary safety and geological studies.

Second, development of a project concept.

Third, detailed safety studies.

And fourth, independent reviews of the safety evaluation.

These activities began in 1969 when a tentative site selection was made, based upon preliminary analyses of the geology and weather--and on predictions as to ground motion and the disposition of any possible radioactivity following detonation.

Additional practical criteria were that ground motion effects would not interfere with the function of any structure or facility; and that activities in the nearest population centers, Pinedale and Big Piney, would not be disturbed.

Once test site selection criteria appeared to have been satisfied, elaborate studies were initiated to be able to detect every possible project-related effect: studies of ground water, background radioactivity and ecology.

The objective of these exhaustive investigations is to reveal any effects large enough to be observed and which could change the existing environmental conditions.

As part of the studies, five weather stations have been installed by El Paso to provide local meteorological data. This provides complete knowledge to assure safety during controlled flaring that would be involved in production testing.

Formal reviews of all safety evaluations were commenced in 1972 by technical and scientific contractors to the Atomic Energy Commission. This work by contractors and government agencies is being reviewed by the AEC's independent panel of safety consultants. In addition, El Paso and the AEC have

distributed detailed reports of studies performed and environmental statements to the public, as well as to numerous state and federal agencies to get independent review of all findings.

The comments received are being carefully considered in defining additional evaluations now being performed. A report on these results will be distributed before the public hearing on this project, which is scheduled to be held in Wyoming.

This hearing would be held by the AEC following publication of data and analyses and prior to arriving at a decision on whether the project will be ~~proposed~~ ^{pursued}. A principal purpose of this hearing will be to provide assurance that all interested persons or groups will have the opportunity with full information available to them to contribute or offer testimony as to their views regarding the experiment.

Then the AEC will make an independent judgment on the desirability of the project.

No project will be possible, however, until the required explosives are tested. (You are probably aware that the AEC plans to invite Wyoming residents and news media to observe a nuclear test.)

Also, no project would be undertaken until the full public hearings are held in Wyoming; and until we at El Paso Natural Gas are assured through completion of the studies now being made that a detailed project plan should be prepared to serve as a basis for negotiation of a contract.

I want to underscore two basic points.

First, the natural gas accumulations in the Pinedale Field are large. They amount to several trillion cubic feet. They could make a substantial contribution to the nation's welfare.

And second, we are in the process of making studies that - if the results prove positive - will provide a means of producing not only these supplies but similar supplies throughout the Rocky Mountain area - supplies in the magnitude of 300 trillion cubic feet.

We believe we're doing the right thing. We're at work on the studies. We appreciate the concern of all the Wyoming citizens here in this room. We're not about to move ahead with any project that hasn't been totally investigated, totally studied, and which will conform to the most rigid safety standards.

We must, however, recognize that every one of us - not just here in this room, but everyone throughout the nation - has an obligation to his fellow citizens. We each benefit from this country's remarkable productivity. That productivity is directly related to the availability of energy. And we believe that every possible study, every investigation, every effort to obtain facts that can help assure essential energy to the nation should be made.