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ENVIRONMENTAL IMPACT ASSESSMENT: CHEMICAL EXPLOSIVE FRACTURING PROJECT,
PETROLEUM TECHNOLOGY CORPORATION/COLUMBIA GAS TRANSMISSION CORPORATION,
LINCOLN COUNTY, WEST VIRGINIA

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January 19, 1977

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*Natural Gas
Wells*

PREFACE

This review of the plans for the chemical explosive fracturing (CEF) of the Devonian shales of Lincoln County, West Virginia, also includes an assessment of the environmental effects of the proposed project. This document was prepared at the request of the Nevada Operations Office of the Energy Research and Development Administration, and is intended to provide the information and data required for the preparation of an environmental assessment of the construction and testing program.

This report was compiled from material provided by Petroleum Technology Corporation of Redmond, Washington, and Columbia Gas Transmission Corporation of Charleston, West Virginia, during a site visit in October, 1976.

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I. Introduction

The Devonian shales of the eastern United States will be the target for this natural gas stimulation project by an innovative chemical explosive fracturing technology (CEF). The program will be carried out in the southern region of the West Virginia, Lincoln County, Sheridan District, in a region of low productivity natural gas wells, (Fig. 1-2). This joint/industry government project will be undertaken by the Petroleum Technology Corporation (PTC) of Redmond, Washington, a subsidiary of Rocket Research Inc., and by the Energy Research and Development Administration (ERDA). To date PTC has spent \$3 million developing chemical explosive technology and has tested a downhole explosive mixing technique in the lab and in the field at Kanawha County, West Virginia. The program is to be carried out in conjunction with other chemical explosive fracturing experiments to be performed in the Devonian shales of eastern Kentucky and the Canyon sands of central Texas.

The program proposed by PTC, to be performed in conjunction with the Columbia Gas Transmission Corporation, will include the drilling and stimulation treatment of between three and five wells, to be located on a 1,258 acre farmout leased to PTC by Columbia. The number of wells ultimately drilled and tested will be dependent on the progress of the project and on information obtained from each successive well. Although precise locations for the wells have not been selected, the spacing will be such that a total of up to five wells may be drilled on this farmout acreage (Fig. 3-4).

Chemical explosive fracturing might be considered to be the optimal technique for stimulation of natural gas reservoirs in the Devonian shale from the point of view of possible formation contamination by a hydraulic fracturing technique — or the possibility of contaminating another level of the formation which might contain another economically recoverable resource, i.e. coal.

II. Objectives of the PTC Chemical Explosive Fracturing Project

The Devonian shale formation underlies the Appalachian region of the eastern United States, extending from Ohio south to Kentucky and West Virginia. Some economically productive wells have been drilled in this area, but in general, the formation is characterized by low permeability (micro-darcy) rock with a large volume of natural gas distributed over a wide area. The development of a fracturing technology which would allow this extensive formation to be exploited for its natural gas reserves would be useful on a large scale in the eastern United States, an area with high energy demand and relatively small energy reserves. The immediate benefits of such an experimental program could be realized in terms of production of gas from the test wells, which would be fed into the already existing natural gas pipelines which cross West Virginia. Also, the existence in this same area of the country of other experimental fracturing programs (foam, CO₂, massive hydraulic fracturing) will provide a basis for inter-comparison of the efficiency of each technology.

The objective of this program is to further the state of the art of chemical explosive fracturing technology by evaluating the following:

- a) the safety factors associated with downhole mixing of the explosive, as contrasted with the more traditional use of nitro-gel explosives to complete a well;
- b) the effectiveness of using massive amounts of the explosive mixture (30,000 lbs);
- c) the advantages of clean out after the rubblelization process;
- d) the possibility of interconnection of the natural fractures through explosive fracturing;

- e) the comparison between the CEF technology and MHF (massive hydraulic fracturing) technology being tested at Columbia wells near the CEF experimental area; and
- f) the comparison of open hole vs cased hole well completion using CEF.

The purpose of drilling and treating three to five wells in this single area is to obtain adequate data on the effects of the chemical explosives on a single formation. Differences in procedure will be tested at each experimental well. Results will permit the direct inter-comparison of the different completion techniques. Also the testing of more than a single well will allow for localization of the richest gas bearing zones thereby optimizing gas production.

III. Proposed Action

The PTC/ERDA project in West Virginia will be assisted by Columbia Gas Transmission Corporation in the drilling and fracturing of between three and five new wells within the farmout area. The drilling procedures will be conventional, using air drilling by cable tool rig. Once the well has been drilled and the casing installed, the actual PTC Astro-Flow II process will be carried out. This chemical explosive fracturing (CEF) program was designed to test a new concept which would permit mixing of two originally nondetonable chemicals downhole to form a liquid explosive which may be used to create additional fractures in the formation or to connect existing fractures.

The PTC/Columbia project, to be conducted in West Virginia, will be carried out in three phases, as detailed in the response to RFP 261-76-6:

Phase 1: Open Hole Displacement CEF Test: This phase will include the drilling, logging and completion of one open hole well in the Devonian shales. This well will then be stimulated by detonating 30,000 lbs of PTC-4 explosive (mixture of hydrazone/water and ammonium perchlorate/ammonium nitrate) of which some part will be injected into the open hole joints and fractures under pressure.

Phase 2: Open Hole Displacement CEF Test: This phase calls for similar procedures to Phase 1 except that the 30,000 lbs of PTC-4 explosive will be contained with an inflatable open hole packer.

Phase 3: Cased Hole Displacement CEF Test Through Perforations: This test calls for the drilling and casing of one well in the Devonian shales. The 30,000 lbs of PTC-4 explosive will be injected into the formation through casing perforations.

The precise dimensions of the wells to be drilled and treated will not be known until the final site selections are made. However, based on past well drilling experience in this region of West Virginia it is known that the wells to be tested will be approximately 3500 feet in depth, with the Devonian shale formation being located approximately 3000 feet below the surface. Well borehole diameter will be approximately 6 1/4 inches and will be cased to approximately 2000 feet below the surface, where the downhole mixer will be located. Separate piping and tubing strings will be run from the tank trucks on the surface down to the mixer, 100-300 feet below the surface, where the explosive components will be combined to form the PTC-4 explosive. This explosive mixture will then be displaced into the target formation at a rate of about 1 gallon/second.

Each successive well treatment will be designed to improve on the technology and to determine which procedure will result in the greatest amount of stimulation. Intercomparison will be made possible due to the proximity of the 3-5 experimental wells to each other. All wells will be located within Lincoln County, West Virginia.

Also, ERDA has contracted with Columbia Gas to test massive hydraulic fracturing and foam fracturing technology in this same area of West Virginia. These experimental results can then be compared with those obtained from the chemical explosive fracturing program in order to determine the optimal fracturing technology for use in the Devonian shales of West Virginia.

At each selected site (as of the present time actual sites for the drilling of the initial wells have not been selected) a drilling pad and treatment area will be cleared and leveled to allow for the movement of the machinery. Necessary roads to the drilling site will be leveled and graveled. Each site will be approximately an acre in area. In some cases it might be necessary to clear the area of trees and level part of a hillside in order to construct a platform for the experimental program. All previous well sites in the area have undergone similar construction.

The actual drilling of the wells will involve a minimal amount of surface impact. The clearing of the drill pad will result in some disturbance to the area. Mud pits and storage water tanks will not be required as the drilling will be carried out using air. Solid debris will be temporarily deposited on site and properly disposed of at the completion of the operation.

The fracturing process will entail temporary disruption to the land surface because of the necessity of bringing tank trucks containing the component chemicals on site and the running of pipes from the two trucks to the wellbore. There will also be a control van present to monitor experimental conditions and record explosion data.

Depending on the experimental treatment being used at the particular well under consideration, the wellbore may or may not be cleared of rubble following the detonation of the downhole chemical mixture. Such a clean-up would necessitate the surface disposal of rock cuttings. This may be accomplished by removal of the debris from the site or excavation of a disposal pit.

Water requirements for the drilling operation will be minimal. What supplies are necessary may be removed from nearby creeks which flow through the farm-out area. Water will not be required as part of the fracturing process.

Pipeline gathering systems already exist in close proximity to the sites of the proposed wells. Less than a mile of new pipeline per well will be laid underground to allow for collection of the stimulated gas.

In general, roads in the area are light-duty, with small, wooden bridges being used to cross the frequent streams and creeks. Roads leading to the actual well sites will probably be steep, uncut dirt paths. It will be necessary to level, grade, and gravel approach roads to accommodate the heavy machinery for this project. In some cases approach bridges will have to be widened and reinforced or merely bypassed to allow for the passage of the drill rigs and the chemical tank trucks.

IV. Description of the Environment

The farmout area is located in a hilly region of West Virginia, in the southwestern part of the state. It is located within the Appalachian Basin and is characterized by an eastern deciduous forest type of vegetation. All of the proposed sites for experimental wells are located within Lincoln Co., Sheridan District, near the border of Wayne Co., West Virginia. To the east of the designated area is the Guyandotte River, whose tributaries (including Sulphur Springs) flow through the well area. Elevation varies with hill crests being from 800 to 1000 ft in height above sea level. Situated between the hillsides are narrow hollows, which are moderately developed and used for farming and grazing by the local population.

The natural ecosystem type is predominately deciduous hardwoods, such as white oak, tulip poplar, and maple. Understory species include poison oak, sumac, and dogwood. In the forested areas of the hillsides may be found populations of white tailed deer, skunk, opossum, rabbit, wild turkey, and numerous small bird and mammal populations.

The prevailing climate in this region of West Virginia is mild, with humid summers and wet winters. There may be 2-3 heavy snowfalls throughout the winter, although rains are particularly frequent during this time of year. Such conditions make travel increasingly difficult into the less developed hill region where the experimental sites will be located.

Potable drinking water is available from the numerous small creeks, which are known to fluctuate in level with the seasonal changes in rainfall. Fresh ground water aquifers are located within inches of the surface down to about 100 ft below the surface. Between 100 and 1000 feet there are some salt water aquifers.

Although there are economic to subeconomic deposits of gas, oil, and coal in this area, there is no substantial exploitation of those resources within the farmout area. A number of natural gas wells have been drilled in the Devonian shale formation to the east of the designated tract. However, only two dry wells are known to exist on the farmout acreage, which were attempted completions in shallower formation above the Devonian shale. Columbia Gas Transmission Corporation owns rights to the minerals in this area which will insure that no new wells or coal mining operations will be begun within 15 miles of the experimental operations. Deposits of low sulfur coal may be exploited in the future, but there are no immediate plans for their recovery. These coal resources will be protected in each of these CEF treated wells by casing that section of the well which breaches those deposits.

Columbia Gas maintains a pipeline system through the farmout area which may be used for the transport of the gas obtained from the experimental wells. These lines are buried several feet underground and are evident only at pump/compressor stations.

Principal land use in this area of Lincoln County would appear to be small farming and grazing. A number of small, primitive houses have been constructed along the winding, dirt and gravel roads that follow the stream hollows among the hills. Most of the level land along the stream beds has been developed for small fields of corn and forage crops. The steep slopes of the surrounding hills have been left relatively unexploited. Scattered, individual homes and farmhouses characterize the area, with the nearest population center being located at Branchland, a small village on the banks of the Guyandotte, to the east of the proposed well sites. The total population of the Lincoln County area is 18,912, with most of the population

finding employment outside of that county. The largest population center is located about 30 miles away at Huntington, West Virginia. In general, the Lincoln County area of West Virginia is characterized by small farms producing lower than average incomes for the inhabitants.

Because of the limitation on the amount of flat area within the farm-out, some of the proposed well sites may be within 800 feet of already existing homes or farm structures.

V. Effects on the Environment of the Proposed Action

The small scale nature of the proposed project will result in only moderate impacts to the experimental area. Because of the proximity of human habitation to the proposed sites there will be some interference with the inhabitants' activity over a short period of time (3-4 month period from drilling to post fracturing logging and cleanup).

This project will produce a limited environmental impact because of: the small scale of the operation, making use of 3-5 acres of the 1,258 acre leased area; the short duration of the program (a three well program is planned for a 10 month period); the limited number of workers involved; and the selection of a drilling and fracturing program which will tend to minimize disruption to the surface environment.

There will, of necessity, be some disruption of the surface environment. The drilling/fracturing pad will have to be leveled for each of the experimental wells, and access roads and additional feeder pipeline will be constructed. This will result in some destruction of the natural ecosystem, some air emissions, and inconvenience to the local population, which make use of these same roads for transportation. Noise pollution will result from the rotary or cable tool drilling procedures and, to a limited extent, from the detonation of 30,000 lbs of explosive downhole. The noise generated from such an explosion is comparable to that produced by a fully loaded truck traveling down a highway. However, since the explosive will be displaced downhole, under pressure, the noise from the pumping engines will also produce temporary noise disturbance.

Air pollution, over the limited time period included in the drilling and fracturing operations, will be produced from the operation of the drill rig pumping engines used in the processes.

The use of air rotary equipment for the initial drilling of the experimental wells minimizes the need for water as the drilling medium and also results in the production of less debris that would be deposited on the surface. The two chemical components which make up the explosive mixture for the CEF process will be consumed in the explosion and thus their disposal presents no problem. There will be no proppant added to the well; it is planned that some of the rubble produced in the explosion will serve to keep the fractures open and allow the gas to flow into the well from the surrounding formation. The rubble in the well bore may not be cleaned out depending upon its effect on the gas flow as determined from comparative testing. Following downhole detonation the downhole mixer will be removed along with the tubing which had been used to transport the chemical components downhole. Any debris which is brought to the surface may be removed from the site or buried in an excavated pit. Licenses for waste disposal will be issued to Columbia Gas by the State of West Virginia.

The activity and clearing of the drilling pad will result in some disturbance of the natural flora and fauna of the area. Should one of the wells be located in a cleared field, animal habitat and plant cover destruction will be minimal. Should it be necessary to site one of the wells on a slope within the farmout, it will be necessary to alter the topography of the area and level out a part of the hillside. The blasting associated with this procedure would have considerably more impact on the surrounding communities than merely locating the well site on the level ground in the bottom of natural hollows. However, establishing sites on level ground may not always be possible due to the necessity of well spacing within the leased acreage.

Construction of additional roads to the well sites and improvement of the already existing roads to allow for transport of the drilling and CEF vehicles and machinery will result in increased disruption to the

natural ecosystem and to the farming and hunting activities of the local inhabitants. Increased traffic will result in an increase in erosion rate along these new and regraded roads and may serve to increase air and noise pollution over the period of time of the experimental program.

Very little water will be necessary for either the drilling or the fracturing processes. Some of the wells may be located near the Sulphur Spring creek which runs through the leased acreage. However, dumping of any type of debris into the streams is strictly regulated by state law. Therefore, the impact on surface waters as a result of the proposed program will be minimal.

The subsurface aquifers will be protected by the practice of casing the wells within the region of known fresh water supplies. This extends from the surface to a depth of about 100 ft. It is also required that parts of the well which penetrate through formations which contain recoverable energy resources, such as coal, must also be cased to prevent contamination. In each case production casing will be run from the surface to at least the top of the shale at 3000 ft. Detonation will be targeted at about 3000 ft below the surface. Even with the possibility of vertical fracturing, it is not expected that an induced fracture will penetrate one of the fresh water aquifers because of the depth of the explosion and the shallowness of the existing aquifers. Fractures which are propagated in the shale formation will not extend beyond the shale-sandstone interface, above which these aquifers are located.

There may be some concern regarding the detonation of this large amount of explosive below ground and the consequences to surface structures and subsurface mines and wells. It has been determined that there are no oil or gas wells which are actively producing within a 15 mile radius of the proposed experimental well sites. Previous experiments with the Astro-Flow II process have indicated that at a depth of 3,000 feet the explosion will produce ground velocity displacement of about 0.1 inch/sec, which is imperceptible on the surface. It is specified by state law that surface structures be a minimum of 500 ft from the site of well operations. These specifications will be met in the selection of the sites. However, it is apparent that at least one of the 3-5 wells

could be located relatively close to human dwellings. In this case, evacuation of the inhabitants and all non-essential personnel for a radius of one mile around the test area during the actual detonation will be undertaken. PTC will also be insured with a commercial underwriter against any structural damage which may result as a consequence of these explosions.

An in-house analysis performed by Hercules Inc. for PTC indicates that the risk to workmen involved in CEF is equivalent to or less than the risk involved in any typical work situation. Although this particular method of natural gas well stimulation may be safer than the conventional use of 80% nitro-gel in the completion of such wells, there still exists some question as to the safety of individuals who handle and are exposed to the explosive under consideration. Accidents have occurred in the past while handling the explosive mixture on the surface. However, now PTC has devised a system of mixing the explosive downhole to eliminate the possibility of surface detonation. There have been failures in the operation of a downhole command detonator which have resulted in reliance on a time detonator which is placed at the bottom of the well prior to the pumping downhole of the explosive mixture. However, a newly designed downhole command detonator will be tested on these wells.

The sites which will be selected in West Virginia are not well isolated from human intrusion. All these points should be taken into account when considering the overall environmental hazard presented by the testing and possible full-scale use of this new technology.

The Appalachian Basin is not a seismically active area. Any concern that such explosive treatment might induce seismic events is not warranted. In many of the natural gas wells drilled in the West Virginia-Kentucky area, "shooting" the well with nitro-gel is a standard procedure for completion of that well. These explosive treatments have not as yet resulted in any abnormal subsurface movement.

Because of the small-scale, experimental nature of this program in West Virginia, its impact on the socio-economic structure of the area will be minimal. Workers at the 3-5 wells will be employees of PTC, brought in

from Washington, and drilling crews supplied by Columbia Gas, with headquarters in Charleston, West Virginia. No additional employment will result as a consequence of this project. There will be no requirement for additional support facilities due to the short time span of the project. The wells will be drilled successively, thus requiring a minimum number of employees being present at the site at any one time. The only disruption from this project will be the increased traffic and noise which will result from the proposed development. Use of some farmland or grazing land might be pre-empted during the experimental phase. However, following the explosive treatment and post-fracture testing phase, the equipment will be removed and the drill pad leveled and reseeded.

Environmental impacts of the proposed project in the West Virginia area will be relatively minor and limited in duration. Increased noise pollution, air pollution, and accelerated erosion will result from the drilling and fracturing of the 3-5 experimental wells. Present land use might be disrupted temporarily. However, these impacts will be mitigated by the short time span involved and the limited area needed for this experimental project.

VI. Alternatives to the Proposed Action

As in the case of most developmental projects, there are a number of alternatives to the PTC program which may be considered. These include the development of some different types of stimulation technology, experimentation with explosive fracturing under different conditions or in another location, and the abandoning of the technology completely.

Possible alternative stimulation technologies include: well completion using conventional nitro-gel explosives; hydraulic fracturing of the formation; massive hydraulic fracturing; or nuclear explosive fracturing. In addition, large volume chemical explosive fracturing may be considered with reference to another type of chemical explosive mixture.

Massive hydraulic fracturing may be considered a useful technology with reference to the stimulation of natural gas in impermeable shales and tight sands. Conventional hydraulic fracturing was initially used in well stimulation in 1949. These two types of stimulation technologies are designed to by-pass wellbore damage and to stimulate a specific zone of interest. The use of a proppant material (sand or glass beads) is designed to permit the newly created fractures to remain open and thus to allow for gas flow. One of the negative considerations which must be evaluated when determining the best technology for use in a particular field would be the effects of fluid retention by the formation. Additional water absorbed in the tight pore spaces might be extremely difficult to remove, thus impeding the flow of gas through the fractured formation. The consideration of cost effectiveness may also enter into a decision to hydraulically fracture a formation. Many MHF treatments make use of large volumes of fluid (500,000 gallons) and sand proppant (million pounds) and treatment chemicals, which are all costly.

The possibility of the development of an alternate method of chemical explosive fracturing exists. Prior experience with conventional explosives has done much to point up the hazards associated with their use in such stimulation projects. Accidents have been common and the safety of workers is of constant concern. At the present time, the PTC Astro-Flow II explosive has been proven safe in field and lab tests. The concept of downhole mixing of nonexplosive components to form a detonable material would appear to be the safest method of delivering the explosive to the formation. In surface handling and transportation, such a method must be considered to be superior to conventional explosive methods.

Another explosive technology, natural gas stimulation using nuclear explosives, has been tested at Rio Blanco, Colorado. This technology does not appear appropriate for use along the relatively populous Appalachian region of the United States.

Yet another alternative to the proposed program would be to site the experimental work in some other part of the Appalachian Basin. Although

this may be acceptable and is indeed being done by PTC in the eastern region of Kentucky, strong arguments might be raised in favor of development on the present site. The Lincoln County location may be considered to be optimal for a number of reasons: the location of a main pipeline through the farmout area, the relatively low population density of the county, the proximity of the site to the operations headquarters of Columbia Gas Transmission Corp., and the presence of economically non-competitive natural gas wells in the area to allow for intercomparison.

An argument against efforts to develop the potential gas reserves of the Devonian shales might be furthered by those who would prefer to see efforts directed towards development of some alternate source of energy, i.e., oil shale, coal gasification or geothermal resources. It is preferable that a number of alternate energy sources be developed simultaneously to allow for rapid buildup of energy reserves in the United States. The environmental hazards associated with the CEF technology would appear to be less severe than those of many other energy development technologies. Also the clean burning characteristics of natural gas make it an acceptable energy source in terms of environmental concerns.

A final objection to the exploitation of the natural gas supplies trapped in the Devonian shales of the Appalachian Basin might be made by conservationists who argue for the preservation of remaining fossil fuel reserves for use by future generations. Such a philosophy would leave untapped an estimated 285 trillion cubic feet of gas resources in the Devonian shales of the eastern United States. The need for increased energy supplies in the very near future by the U.S. and the undesirable alternative of reliance upon foreign sources of fossil fuels would argue strongly against this alternative.

VII. Mitigating Factors

The small scale of this experimental project will result in relatively minor environmental damage to the surrounding countryside and minimal disruption of human activity in this area of West Virginia.

Land use in the Lincoln County area of West Virginia should not be adversely affected by the 3-5 experimental wells to be drilled within a 10 month period. The short duration of the experiment, the limited land needed for the drilling/fracturing platforms (3-5 acres) and the almost complete absence of gaseous effluents, as well as of solid or liquid waste discharges accompanying the experimental phases all tend to minimize any environmental hazard that might accompany such development.

To further minimize impact on the land, Columbia Gas Transmission Corporation will make use of already existing roads and approaches to the well sites. In the selection of those sites, priority will be given to locating them as far as possible from human habitation, preferably in a flat area to prevent excessive alteration of the landform.

Any disruption of plant or animal life which may result from development will be limited in duration and extent. Following the drilling, explosive and clean-up phases of the experiment, the sites will be leveled and reseeded and the debris removed. The limited use of water and the absence of mud pits at the drilling sites make this method of explosive stimulation preferable to hydraulic stimulation techniques at this particular site. From a socio-economic viewpoint, impacts should be minimal, if not altogether absent. No new personnel will be relocated in the area on a permanent basis. There will be little taxing of the present community facilities as a result of this experimental program.

VIII. Irretrievable and Irreversible Commitment of Resources

Those materials which will be consumed during the course of the experimental program which will be irrevocably lost include: 30,000 lbs of explosive per well (hydrazine/ammonium perchlorate/ammonium nitrate), command and time bomb detonators, 200-800 ft of tubing below the packer, the packer, wiper plugs, baffle and setting nipple which is positioned below the packer. The natural gas produced from the stimulated wells will be collected in Columbia's pipeline and transported interstate to be used commercially to meet the energy demands of the East. The gas flared during the recovery process will also be irretrievably lost, as will be the fuel expended by the drilling rigs, trucks and compressor engines which will be operating during the drilling and pumping stages.

IX. Adverse Environmental Impacts Which Cannot Be Avoided

A temporary increase in general activity, noise and surface disruption will result from the proposed program. Surface erosion due to site preparation, vehicular traffic and construction of new roads will be unavoidable. Temporary disruption of some animal habitat should be expected, although this will be a short-lived impact. Some small amount of additional air pollution will be contributed by the drilling and pumping machinery operation. There will be a temporary increase in the noise level due to the explosive process and as a consequence of the drilling and pumping activity.

The leveling and grading of additional access roads and the laying of additional lengths of underground pipeline will result in disruption of the ground cover. As a result, use of the land for farming, grazing, and hunting might be interfered with. However, this impact will also be of short duration.

X. Cost Benefit Analysis

This limited project for the development of chemical explosive stimulation of natural gas deposits located in the Devonian shales of the Appalachian Basin might result in a widespread use of the technology to "liberate" more of this tightly held gas. As of the present time, a number of wells in this formation are producing marketable quantities of gas. The success of a stimulation technology in this area could conceivably increase the natural gas reserves of the U.S. by 285 trillion cubic feet.

Much of the gas present in the natural fracture systems of this region has already been collected and delivered to commercial consumers. At present, economics have made it difficult for producers to continue to exploit many of the still producing wells.

Exploration and drilling costs for marginal wells have exceeded what can be obtained for the gas on the current market due to the regulation of natural gas prices by the U.S. Congress. Recently (November 1976) the Federal Power Commission (FPC) has ruled that prices paid for interstate

natural gas supplies may be increased from the previous ceiling of \$0.52/Mcf to \$1.42/Mcf for 1975-76 vintage gas and \$1.01 for 1973-74 vintage gas. This will cause a slight improvement in the present situation. In the Devonian shales of West Virginia and Kentucky, the low interstate gas prices have caused gas transmission companies to cap wells which are producing as much as 60 Mcf/day. Instead of free market supply and demand regulating the cost of the gas, the artificial price level has resulted in a very conservative attitude of producers toward developing the marginal resources and experimenting with various stimulation technologies.

This slight improvement in the price outlook for natural gas supplies will make commercial concerns more interested in technology development. Should deregulation become a reality, development of such stimulation technologies might accelerate. This would ultimately result in the creation of a more positive position for the U.S. in the world energy market.

XI. Potential Conflicts with State, Regional or Local Plans and Programs

The West Virginia farmout acreage to be used by PTC for their drilling and explosive stimulation program was leased from Columbia Gas Transmission Corporation, who is the owner of the mineral rights to that area. There are no known plans or programs for the development of this acreage by any state or local government organization which would conflict with the proposed use of the land for the PTC chemical explosive fracturing program.

Well drilling on the farmout will be performed by Columbia Gas, a company which has extensive drilling experience in West Virginia. Permits to drill the required wells will be obtained from the Division of Oil and Gas, West Virginia Department of Mines. Procedures regarding the transportation, handling, and use of explosive materials will be in compliance with Department of Mines regulations. There are no specific requirements for environmental impact assessments for such projects within the state of West Virginia.

XII. Relationship of Short Term Use to Long Term Productivity

If the proposed program should prove successful, this will allow for an increased production of natural gas in an area of the U.S. which already has an extensive pipeline system to transport the gas, and an ever increasing demand for clean energy sources. This clean burning fuel would not only help satisfy the energy requirements of the industrial East, but would also permit compliance with federal air quality standards.

Should this technology prove to be successful in "liberating" those resources trapped within the Devonian shales, it could represent an increase of as much as 285 trillion cubic feet of natural gas reserves within the United States. In addition, this technology may be used to possibly further increase the recoverable reserves of natural gas and oil in other areas within the United States: the Devonian shales of the West and the Canyon Sands of central Texas.

The short term program includes the drilling and fracturing of 3-5 wells in Lincoln County, West Virginia. Over the short run potentially important data could be collected regarding the technology and the nature of the resource and the formation. Such information might lead to the development of an optimal fracturing technology and the subsequent increase in our national reserves. However, this experimental program might demonstrate the ineffectiveness of CEF in stimulating natural gas in the Devonian shales. In that case, a limited amount of time and money will have been expended.

XIII. Determination

The proposed project (chemical explosive stimulation of natural gas wells) does not constitute a major federal action significantly affecting the environment as defined by the National Environmental Policy Act of 1969 (NEPA), Section 102(2)(c).

It is held that this assessment represents a negative statement regarding major environmental degradation which might result from this project. Therefore, no full-scale environmental impact statement need be prepared in advance of the carrying out of the PTC project.

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Figure 1.

Figure 2.

GEOLOGIC MAP OF WEST VIRGINIA.

WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY

Robert B. Erwin, State Geologist

1969

Figure 3.

State of West Virginia; Nestlow and Branchland Quadrangle

- Farmout area
- Well locations

Figure 4.

Location Map, Proposed Columbia Farmout
Lincoln Co., West Virginia

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