IMPACT OF
ELECTRIC POWER OUTAGES
ON
PETROLEUM INDUSTY FACILITIES

A Report of

THE NATIONAL PETROLEUM COUNCIL

1966

IMPACT
OF
ELECTRIC POWER OUTAGES
ON
PETROLEUM INDUSTRY FACILITIES

A Report by the
National Petroleum Council's
Committee on Effects of
Electric Power Outages
on Petroleum Industry Facilities

Harry A. Jackson, Chairman

July 19, 1966

I. INTRODUCTION

This report is submitted in response to a request made by the Hon. J. Cordell Moore, Assistant Secretary of the Interior, in his letter of February 1, 1966, to Mr. Jake L. Hamon, Chairman of the National Petroleum Council.

On November 9, 1965, the Northeastern portion of the United States experienced a massive power failure. An investigation of the power failure was immediately undertaken by the Federal Power Commission at the request of the President. One of the 19 major recommendations made by the FPC in its report of December 6, 1965, to the President, was directed to the petroleum industry. The FPC stated, in Recommendation No. 18, that motorists were unable to buy gasoline because gasoline pumps were dependent upon the system power supply.

The Council was requested by the Department of the Interior to undertake a study of the adverse effects of similar massive power failures on the oil and gas industries and to report its findings along with any recommendations for preventive measures which could be taken by industry and governments to reduce or eliminate any hazards to the petroleum industry and the public welfare.

The Committee on Effects of Electric Power Outages on Petroleum Industry Facilities reviewed the assignment, and decided to make a general assessment of this problem based upon existing detailed information obtained in previous NPC studies, together with other available sources of information. It was felt that an extensive new survey of electric power utilization by oil and gas industry facilities would not be necessary at this time.

II. SCOPE

In assessing, in a general way, the adverse effects of a massive power failure on the oil and gas industries, two aspects must be considered. The first is with respect to what actual damage to physical facilities would result from such a power outage, and the second relates to the effect an electric failure would have on the ability of the industry to supply petroleum and gas products to meet military and civilian requirements.

Also, certain assumptions were made in order to define the term "similar massive power failures" as contained in Interior's study request letter. The discussion set forth in this report is based on a utility power failure which (1) would not exceed a period of 7 days duration, and (2) would be experienced in one broad geographical area (e.g., the Northeast), realizing the improbability of a simultaneous failure throughout the entire United States.

With these assumptions in mind, the Committee has covered in its assessment of the impact of such failures on the oil and gas industry facilities, the four major phases of industry operations: exploration and production; transportation and storage; refining; and marketing.

III. ASSESSMENT OF POWER FAILURE IMPACT

A. Exploration and Production

As regards electric power requirements, the exploration phase of the oil and gas industries is virtually self-sufficient Of approximately 40,000 wells being drilled currently in the United States each year, there is, at almost all of the drilling sites, because of location and the nature of the operation, a self-supplied power source -- generally fuel-driven engines, pumps and generators. A utility power failure as defined in Section II would have no significant effect on exploration and drilling operations or the equipment and facilities.

Throughout the United States, located in 32 states, there are approximately 550,000 producing oil and gas wells. There are a variety of methods employed in lifting the oil and gas from the reservoirs and moving it through gathering lines and lease storage tanks to transportation points. A power failure as defined in this report would not result in any significant damage to the production facilities. However, many pumping units, as well as gathering line systems, do depend on electric powered pumps for their continued operation. In event of utility power failure these facilities would be affected.

It should be pointed out, though, that in addition to the factor of wide geographical dispersion of wells, a large number of wells have a productive capacity in excess of the volume they are permitted to produce each month under the limitations imposed

by state conservation or regulatory bodies. Therefore, production "lost" over a short period of time due to lack of electric power for pumping, can be made up rapidly, upon restoration of power by increasing the production rate. The aggregate effect of a short-term power failure on production, therefore, would be slight.

B. Transportation and Storage

1. Gas Transmission

As indicated in the 1962 NPC report on Oil and Gas Transportation Facilities, there were over 238,000 miles of interstate gas transmission pipelines in the United States. An analysis of the survey data obtained for this study shows that, of approximately 800 compressor station installations above 1,000 HP located along these lines, only 5% were dependent on purchased electric power as the prime mover. The gas transmission and distribution pipeline operations primarily utilize natural gas as the source of energy.

Natural gas pipelines differ from crude oil and products pipelines because they are not dependent upon refinery capacities or storage capacity that might be subject to shutdown in event of utility power failure.

2. Crude Oil and Products Pipelines

Crude oil pipelines transport crude oil to refineries or major terminal points for further shipment by another mode of transportation. As of 1961, crude oil trunk lines represented a total of 147,343 miles of pipeline, and products pipelines represented 53,200 miles, for a total of 200,543 miles of petroleum pipelines in the United States.

In the last several years the significant trends in pipeline transportation include large diameter lines, automation, centralized controls, automatic custody transfers, and expanded use of computers for complex problems in scheduling and operations.

In connection with the previously mentioned 1962 NPC transportation study, a detailed survey was made at that time covering 233 major crude oil pipeline systems, the flow of which was activated by 1,319 pump stations at which were located over 3,800 pumping units. A total of 75 of these pipeline systems, or 32%, were found to be entirely dependent on purchased electric power. One-hundred eighty-one systems (or 78%) were either

partially or completely dependent on electric power. Of the 1,319 individual pump stations located along these crude oil systems, 759, or about 58%, were either partially or completely dependent on electric power as the prime mover.

From the same NPC survey, detailed information was also obtained for petroleum products pipelines. A total of 160 such systems were reported, 123 of these, or 77%, being totally dependent on electric power as the prime mover. One-hundred fifty-two systems, or 95%, were either partially or completely dependent on electric power. Along the 160 products pipeline systems represented were 660 individual pump stations, of which 80% were either partially or completely dependent on electric power. See Tables 1 and 2 for further details stated by geographical areas.

The pipeline facilities of the oil and gas industries continue to progress in technology for increasing the efficiency of operations. New pump stations built in the last several years are generally automatically controlled and equipped with more powerful electrically driven prime movers. As the trend continues toward electrification, the pipeline facilities become very highly dependent upon purchased electric power to energize the pumping units.

A massive power failure would generally have no serious effect on the physical pipeline facilities. Little, if any, damage to the lines, pumping or compressor equipment would be involved. In the case of pipelines totally or partially dependent on electric power, the rate of throughput would be substantially reduced in event of power failure at some or all of the pump stations along the system. Many pipelines do have the ability to operate at reduced flow with only a few key pump stations functioning. Even if all stations were down, a few pipelines would be capable of continuing minimal flow due to gravitational pull. In an emergency situation when key pump stations are inoperable, portable pumps or standby generators can be utilized, as has been done in past emergency situations arising from hurricanes and floods, in order to continue the pipeline flow at reduced rates.

3. Other Transportation Facilities

Transportation by petroleum tankers or barges would not be affected by a power failure. Both are self-powered and can generally load or unload under ship power. Onshore loading and

unloading facilities are susceptible to reduced efficiency or total inoperability depending on the extent of their reliance on electric power supplied from shore or inland sources. Power to marine installations could be temporarily supplied by berthed vessels or barges.

4. Storage Facilities

The 1962 survey of the NPC on Petroleum Storage Capacity covered most holders of crude oil and principal petroleum product inventories at refineries, pipelines, tank farms and bulk terminals. There were 395 million barrels of crude oil storage capacity reported and 754 million barrels of products storage capacity in the United States on September 30, 1962.

As of April 30, 1966, there were 249 million barrels of crude oil actually in storage, and 537 million barrels of petroleum products.

Although there is assurance of an ample supply of both crude oil and products throughout the United States, removal from storage tanks is primarily dependent on electric pumps. A temporary power failure would, in many cases, require a combination of auxiliary pumps and gravity flow to take off crude or products from the tanks. However, an electric outage would have no damaging effect on the facilities themselves.

C. Petroleum Refining

The statements presented for discussion of adverse effects of power failures on refining operations are based on data available from a 1961 NPC survey. A total of 67 refineries were studied at that time, representing approximately 58% of the total United States petroleum refinery capacity. Of the total electric power requirement for operation of these refineries, 70.8% was found to be purchased from utilities and 29.2% self-supplied power (i.e., generated at the site or purchased from an adjacent industrial plant). Table 3 provides further details.

Also included in the 1961 NPC survey were 33 non-self-contained facilities[1/] and 55 self-contained chemical plants. The other non-self-contained facilities represented were dependent

---

1/ A non-self-contained facility, for purpose of the 1961 survey, is defined as a producing plant which must be operated as a part of a larger facility.

on purchased electric power for 53% of their power requirements. The electric power purchased for the self-contained chemical plants represented 93.9% of their power needs.

The power failure that occurred on the Northeast coast the evening of November 9, 1965, did not have a major effect on refinery operations. There was only one refinery that was shut down as a result of the power failure. Other refineries in the area continued normal operations due to either automatic switch-over to auxiliary steam equipment or because they were not actually being cut-off from their outside power source. Of the three refineries affected by the power failure, two were able to switch to auxiliary power sources, and the third resumed all operations within the following 24 hours without any serious damage resulting to the facility.

Most refineries older than 10 years are equipped with complete steam auxiliary equipment for continued operation, at reduced rates, in case of a power failure or any similar emergency. Although plants constructed during the last 10 years are essentially all electric and would experience a shutdown in the event of a power failure, they have sufficient steam auxiliary equipment to permit a normal shutdown with no damage to the facilities. However, where any refinery lacks the steam power to shut down in a rapid, orderly manner, there is a possibility of some damage to the facilities in event of a sudden cut-off of electric power.

D. Marketing

The marketing and retailing functions as related to the oil and gas industries would be handicapped but not shut down in event of a massive power failure as defined in Section II. Because adequate oil and gas supplies are generally in storage at all times or would be obtainable from adjacent unaffected areas, there would be no problems relating to product availability in case of such an emergency.

It should be recognized, in this connection, that during a prolonged power failure, fuel demands would be greatly reduced due to the shutdown of manufacturing plants and businesses. Following the initial surge of people attempting to get home or to an assigned emergency post, traffic would be greatly reduced. Officially, travel within the affected area would most likely be discouraged because of the breakdown of traffic control devices, street lighting, etc.

The industry has many times demonstrated its willingness and ability to place the concern for the welfare of the general public over its own private interests when an emergency exists. This has resulted in the sharing of petroleum products stocks and/or equipment to assure supply to those in need.

Product delivery, which is primarily by truck, to both retailers and consumers would be affected only by slower loading and longer hauls. Also, most service station operators have had considerable experience with local power interruptions because of electrical and sleet storms, hurricanes and other emergencies.

In the case of the recent Northeast power failure and following the belated announcement that the power failure would last longer than originally anticipated, those service stations which normally operate during the night hours did take steps to get their pumps in operation through various means. While some motorists may have been unable to purchase gasoline with normal convenience, there were no reports of any serious incidents resulting from inability to procure gasoline in any community affected by the power failure.

Even though improvisation is the primary means of meeting an emergency, it is this same multiple choice such as the use of trucks as mobile service stations, which offers the greatest assurance that the needs of the community or area can be met. At the same time, having no set solution does mean that a varying amount of lead time will be required before the industry responds. Most natural disasters such as floods and hurricanes are of such a nature that advance warning can be given. An act of military aggression would trigger a rapid response. However, a power failure of unknown origin would generally not initiate immediate action during the initial hours unless information was forthcoming that it would probably continue for a longer period.

It should be remembered that there is a difference between serving needs and providing convenience. The marketing segment's conviction that they would be able to satisfy the public's requirements during such an emergency does not imply that fuel supplies would necessarily be as convenient to obtain as under normal conditions.

IV. CONCLUSIONS AND RECOMMENDATIONS

In recent years there has been and there still continues a definite trend toward electrification in the petroleum industry, particularly in the crude and products pipeline transportation and refining phases of the industry. Presently, these two phases show the highest dependency upon purchased electric power.

In the event of a massive power failure within the terms of this study, damage to the oil and gas industry facilities would be light. The potential problem area would be at those refineries unable to shut down in an orderly fashion due to insufficient auxiliary steam equipment.

The assurance that the industry could continue supplying requirements for petroleum products and gas in a massive power failure can be measured in terms of its widespread pattern of supply and distribution, the geographically dispersed location of its facilities and its considerable inventory position. In event of such an emergency, therefore, the adverse effects upon the oil and gas industries would be minimal and no extreme problem would arise in meeting product requirements, assuming improvisation in the area of distribution, particularly at the retail level.

In respect to gas, the impact would be slight in any phase of operation.

The Committee does recommend that future detailed surveys of oil and gas industry facilities, whether conducted by the industry or by the Government, should be designed to provide for the gathering of additional data relating to electric power requirements and auxiliary generating capabilities, especially in the pipeline and petroleum refining phases of the industries' operations. Such information has applicability not only to temporary massive power failure situations, but also to the field of emergency planning.

Recognizing the general dependency of the petroleum industry on purchased electric power, it is the suggestion of the Committee that those planning to construct new facilities, or expand existing facilities, examine the economics and operational feasibility of auxiliary generating and pumping facilities. In such instances the expertise and views of the electric power industry would undoubtedly be available and prove most helpful.

TABLE 1

ELECTRIC POWER REQUIREMENTS
MAJOR CRUDE OIL PIPELINE SYSTEMS
(BASED ON 1961 NPC SURVEY)

GEOGRAPHICAL AREA[1]	OEP-OCD REGION(S) INCLUDED	NUMBER OF SYSTEMS IN AREA[2]	PUMP STATIONS BY TYPE OF PRIME MOVER						TOTAL PUMP STATIONS ALONG REPORTED SYSTEMS
			TOTALLY ELECTRIC	PARTIALLY ELECTRIC	TOTAL REQUIRING ELECTRIC POWER	PERCENT OF TOTAL	OTHER[3]	PERCENT OF TOTAL	
1. New England, Middle Atlantic, and Great Lakes	1,2,4	41	88	11	99	42.3	135	57.7	234
2. Southeast[4]	3	-	-	-	-	-	-	-	-
3. Middle and Southwest	5,6	171	551	37	588	63.0	345	37.0	933
4. West	7	17	38	12	50	39.1	78	60.9	128
5. Northwest	8	4	22	-	22	91.7	2	8.3	24
TOTAL UNITED STATES		233	699	60	759	57.5	560	42.5	1,319

1/ See Exhibit 1.

2/ Systems located in more than one area are classified in the area containing most of the system mileage.

3/ Gas, diesel, gasoline, etc.

4/ None reported - see footnote 2/ above.

TABLE 2

ELECTRIC POWER REQUIREMENTS
MAJOR PRODUCTS PIPELINE SYSTEMS
(BASED ON 1961 NPC SURVEY)

GEOGRAPHICAL AREA[1]	OEP-OCD REGION(S) INCLUDED	NUMBER OF SYSTEMS IN AREA[2]	PUMP STATIONS BY TYPE OF PRIME MOVER						TOTAL PUMP STATIONS ALONG REPORTED SYSTEMS
			TOTALLY ELECTRIC	PARTIALLY ELECTRIC	TOTAL REQUIRING ELECTRIC POWER	PERCENT OF TOTAL	OTHER[3]	PERCENT OF TOTAL	
1. New England, Middle Atlantic, and Great Lakes	1,2,4	54	169	6	175	84.1	33	15.9	208
2. Southeast	3	6	49	-	49	90.7	5	9.3	54
3. Middle and Southwest	5,6	77	240	8	248	72.9	92	27.1	340
4. West	7	18	37	2	39	100.0	-	-	39
5. Northwest	8	5	17	-	17	89.5	2	10.5	19
TOTAL UNITED STATES		160	512	16	528	80.0	132	20.0	660

1/ See Exhibit 1.

2/ Systems located in more than one area are classified in the area containing most of the system mileage.

3/ Gas, diesel, gasoline, etc.

TABLE 3

ELECTRIC POWER REQUIREMENTS AT PETROLEUM REFINERIES
AS OF 1961
(Including New Construction By July 1, 1963)

OEP-OCD REGION(S)[1]	PETROLEUM REFINING CAPACITY LOCATED IN AREA[2] (Bbls. S/D)	PERCENT OF REFINING CAPACITY REPRESENTED IN SURVEY[3]	ELECTRIC POWER REQUIREMENTS (Figures Stated are in Kilowatt Hours Per Day)				
			PURCHASED FROM UTILITIES	PERCENT OF TOTAL	SELF-SUPPLIED	PERCENT OF TOTAL	TOTAL REQUIREMENTS
1	729,450	69.7	1,176,000	60.6	764,000	39.4	1,940,000
2	1,478,657	67.4	3,967,932	90.9	396,092	9.1	4,364,024
4	1,382,589	45.0	1,555,000	47.4	1,727,000	52.6	3,282,000
3 & 5	4,060,395	69.6	9,451,515	66.2	4,832,367	33.8	14,283,882
7	1,493,152	58.1	3,612,948	89.2	438,000	10.8	4,050,948
TOTAL UNITED STATES	10,010,073[4]	58.2	19,763,395	70.8	8,157,459	29.2	27,920,854

1/ No refineries from Regions 6 and 8 included in NPC survey.

2/ Crude oil charge capacity as of January 1, 1961 - Bureau of Mines.

3/ National Petroleum Council survey for 1963 report - Chemical Manufacturing Facilities of the Petroleum and Natural Gas Industries.

4/ Includes refining capacities of Region 6 (607,830 b/d) and Region 8 (258,000 b/d).

GEOGRAPHICAL AREAS FOR PIPELINES ELECTRIC POWER ANALYSIS

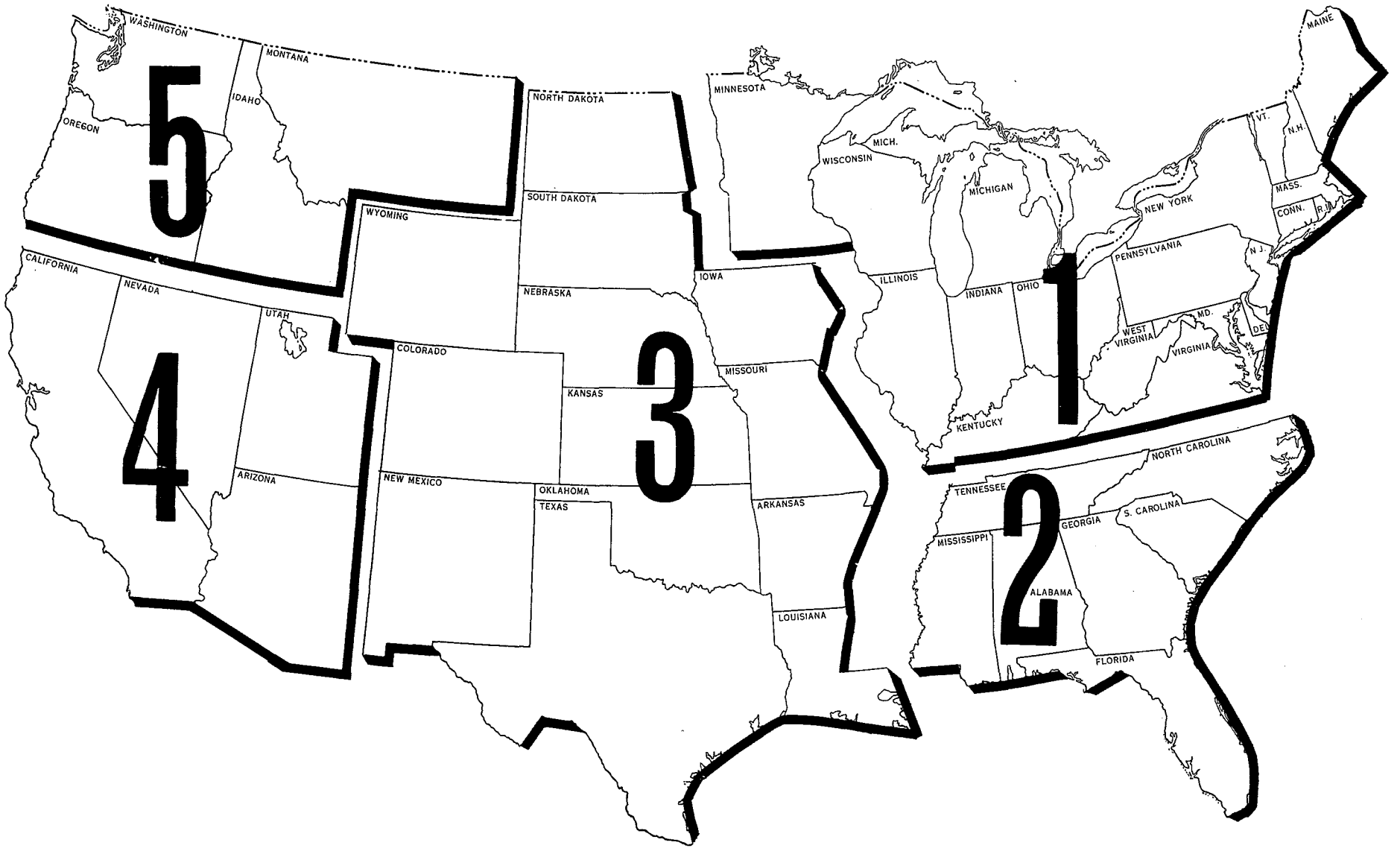


EXHIBIT I

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

C
O
P
Y

February 1, 1966

Dear Mr. Hamon:

In launching a Federal investigation of the massive Northeast power failures on November 8, 1965, President Johnson wrote Federal Power Commission Chairman Joseph P. Swidler:

> "Today's failure is a dramatic reminder of the importance of the uninterrupted flow of power to the health, safety, and well-being of our citizens and the defense of our country.
>
> "This failure should be immediately and carefully investigated in order to prevent a recurrence."

One of the 19 major recommendations made by FPC in its report of December 6, 1965, was specifically directed to the petroleum industry.

Recommendation No. 18 reads as follows:

> "One of the consequences of the power failure was that motorists were unable to buy gasoline because gasoline pumps were dependent upon the system power supply. We recommend to the petroleum industry that it devise a means to solve this problem in order to avoid risk of a transportation breakdown in the event of power failure."

Another of the effects of the power failure was the shutdown of some refining facilities.

The Council is requested to undertake a study of the adverse effects of similar massive power failures on the oil and gas industries and to report their findings along with any recommendations for preventive measures which could be taken by industry and governments to reduce or eliminate any hazards to the petroleum industry and the public welfare.

Sincerely yours,

/S/ J. CORDELL MOORE

Assistant Secretary of the Interior

Mr. Jake Hamon
Chairman
National Petroleum Council
1625 K Street, N. W.
Washington, D. C. 20006

NATIONAL PETROLEUM COUNCIL
COMMITTEE ON
EFFECTS OF ELECTRIC POWER OUTAGES
ON PETROLEUM INDUSTRY FACILITIES

CHAIRMAN

Harry A. Jackson, President
American Petrofina, Incorporated

CO-CHAIRMAN

John Ricca
Deputy Director
Office of Oil and Gas
U.S. Department of the Interior

SECRETARY

Vincent M. Brown
Secretary-Treasurer
National Petroleum Council

* * *

Jack H. Abernathy, President
Mid-Continent Oil & Gas Association

Fred E. Bergfors, Sr.
President
Quincy Oil Company

Harold H. Bible, President
Lion Oil Company

F. Allen Calvert, Jr.
President
Independent Petroleum Association of America

Collis P. Chandler, Jr.
President
Rocky Mountain Oil & Gas Association

Martin Citrin, President
National Oil Jobbers Council, Inc.

Rollin Eckis, President
Western Oil and Gas Association

W. Reid Fitchett
National Tank Truck Carriers, Inc.

John Harper, President
Harper Oil Company, Inc.

P. N. Howell, President
Howell Refining Company

Basil P. Kantzer, President
Transwestern Pipeline Company

M. H. Robineau, President
The Frontier Refining Company

R. J. Rutherford, President
American Gas Association

William Wikoff Smith, President
Kewanee Oil Company

E. H. Tollefson
Consolidated Natural Gas Company

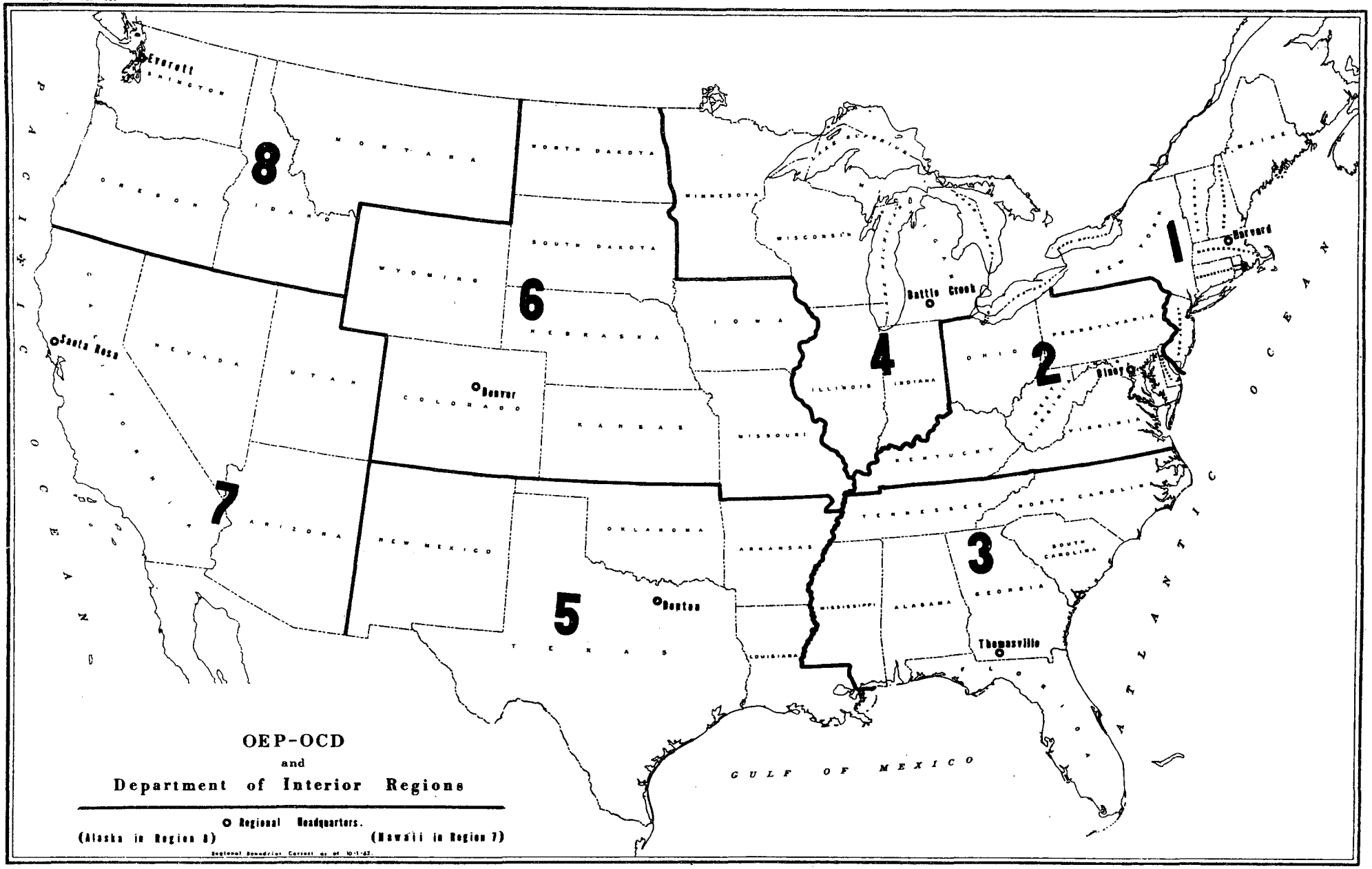
A. Earl White, President
American Association of Oilwell Drilling Contractors

John H. White, President
Port Oil Company

Ralph A. Worley
Natural Gas Processors Association

UNITED STATES
DEPARTMENT OF THE INTERIOR
Office of Oil and Gas

UNITED STATES



OEP-OCD
and
Department of Interior Regions

○ Regional Headquarters.

(Alaska in Region 8) (Hawaii in Region 7)

Regional Boundaries Correct as of 10-1-62.

17830