SCOMM

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JANUARY 1977

ANALYSIS OF PROPOSED ALASKAN NATURAL GAS TRANSPORTATION SYSTEMS

Compiled by the ORGANIZATION FOR THE MANAGEMENT OF ALASKA'S RESOURCES, INC. (OMAR), Box 516, Anchorage, Alaska 99510

Three applications have been filed for the right to bring Alaska's 30 trillion cubic feet of natural gas south to U. S. consumers. One is an all-land route across Alaska through Canada to the midwest proposed by a consortium called Arctic Gas. Part of the gas would be delivered to Canada. Another is a land and water route from Alaska to California and into existing pipelines across the United States proposed by El Paso Alaska. The projects were initiated in 1969 and 1970 respectively. A third plan originated in March 1976 by Northwest Pipeline. It also is an all-land route which crosses Canada to the U. S.

TRANS-ALASKA/LNG PROJECT PROPOSED BY EL PASO ALASKA COMPANY

INTERNATIONAL CONCERNS

None. U.S. Defense Department says Alaska-LNG route permits full U.S. control and does not require reliance on a foreign government for defense in war and security in peace. Because total pipe mileage is only a fraction of trans-Canada mileage, protection would be greatly simplified. A former Royal Canadian Mounted Police official says defense of the Canadian segments would be "next to impossible."

BALANCE-OF-PAYMENTS IMPACT

Favorable to U. S. No adverse balance. All materials to be supplied by U.S. firms.

ENVIRONMENTAL IMPACT

Miles of new pipe for transmission of 2.4 bcfd to U.S. 1,613

Line to follow 95% of Alyeska oil line (in or near a corridor that has been called "the most exhaustively studied in the world"). LNG carriers would sail from 2,500 square mile Prince William Sound through open waters to remote site on California coast. LNG is not classified a hazardous pollutant by either the Environmental Protection Agency or U.S. Coast Guard.

TRANS-CANADIAN PROJECT PROPOSED BY ARCTIC GAS CONSORTIUM

INTERNATIONAL CONCERNS

Major portion of line crosses a foreign country. Would be subject to control, management and regulation of a foreign government. Would also be legally required to pay Canadian provincial and federal government taxes. Faces opposition of Canadian nationalist groups, environmental organizations and Eskimo and Indian groups which claim ownership of the land the pipeline would traverse.

BALANCE-OF-PAYMENTS IMPACT

Unfavorable to U.S. Adverse balance of \$4.5 billion in taxes, \$4.8 billion in goods and services and \$11 billion in transportation charges, for a total deficit of over \$20 billion!

ENVIRONMENTAL IMPACT

Miles of new pipe for transmission of 2.25 bcfd to U.S. 4,500

Traverses width of 8,900,000-acre refuge (Arctic National Wildlife Range, the largest wildlife refuge in America) and adjacent planned range in Canada.

TRANS-CANADIAN PROJECT PROPOSED BY NORTHWEST PIPELINE (ALCAN ROUTE)

INTERNATIONAL CONCERNS

Major portion of line crosses a foreign country where it would be subject to control, management and regulation by a foreign government. Line in Canada would pay billions in taxes to Canadian federal and provincial governments. Route through northern Canada also faces Indian land claims to the territory pipeline would traverse. By linking up with provincial gas pipelines, Alcan route runs risk of becoming political football in growing rivalry between provinces and Canadian federal government.

BALANCE-OF-PAYMENTS IMPACT

Unfavorable to U. S. Adverse balance of \$3.6 billion in taxes; other dollar amounts not available. (U.S. suffered highest ever balance-of-payments deficit November 1976 - \$906 million!)

ENVIRONMENTAL IMPACT

Miles of new pipe for transmission of 2.4 bcfd to U.S. 5,400

Route follows 540 miles of Alyeska oil line, then generally along Alcan Highway into Yukon, overland in B.C. and Alberta where new sections of pipe would be built parallel to existing provincial pipelines.

Department of Interior estimates risk of delay in completion of Alaska-LNG project at HALF that of Arctic Gas project. With use of Alyeska's haul road and other construction facilities which required 1½ years to build, project has significant head start.	**Subject to numerous delays such as (1) settlement of native land claims, (2) Berger Commission investigation, (3) opposition to crossing Wildlife Range by 15 environmental groups and (4) construction of haul roads, camps and other preliminary facilities before work can begin on pipeline.**	**Subject to (1) and (2) of Arctic Gas project timing problems plus construction of preliminary facilities in Canada. Federal Power Commission and Canadian National Energy Board must consider applications. Other routes have been undergoing examination by FPC and NEB since 1975.**
Approvals and permits required only by U. S. government agencies. President sends route decision to Congress by Fall 1977; Congress ratifies by joint resolution in 60 days or matter returns to President for new decision. Judicial action possible only on constitutional grounds.	Approvals and permits required by U.S. and Canadian agencies. Must compete before Canada's National Energy Board against popular Maple Leaf Project of Foothills Pipe Lines and Polar Gas proposal for Arctic Islands gas. NEB decision faces Canadian Cabinet review, implementing legislation by Parliament and possible judicial action.	Approvals and permits required by U.S. and Canadian agencies. Must compete before National Energy Board against Arctic Gas, Foothills and Polar Gas (application expected to be filed this year for Arctic Islands gas). NEB decision faces Canadian Cabinet review, implementing legislation by Parliament and possible judicial action.
Native claims now settled in Alaska after five years of extensive negotiations in the U. S. Congress. Settlement included 44 million acres of land.	Natives claiming 1.8 million square miles, almost half of Canada. One key government report recommended a 10-to-15-year delay after settlement of land claims before any pipeline is built.	Faces unsettled native claims along pipeline route in Canada. Council of Yukon Indians wants majority control of company building line to protect native interests in addition to ownership of lands claimed.
Each construction segment (pipeline, LNG facilities and ships) can be conducted concurrently, thereby reducing adverse effect of strikes, material shortages, shipping delays, etc., on any construction phase.	Requires the construction of camps, haul roads and other preliminary facilities before construction of the pipeline may begin. Canada's historically higher strike rate could shut down entire project during any construction phase.	Requires 18 months additional geotechnical, environmental and engineering studies after certification before construction could begin, giving this project longest completion schedule. Canadian strike situation applies.
Trans-Alaska proposal is based on use of existing and new gravel roads and year-round construction.	Project includes use of unreliable snow/ice road technique and winter construction on northern segments. Experience in Alaska has shown this to be technically impossible, resulting in project delays and cost overruns.	Year-round construction possible on most segments of line. Use of existing gravel roads planned for part of Alaska construction.
TAX BENEFITS TO UNITED STATES	**TAX BENEFITS TO UNITED STATES**	**TAX BENEFITS TO UNITED STATES**
$12.8 billion to U. S. government entities over life of project.	$2.2 billion to U. S. government entities over life of project.	$4.7 billion to U. S. government entities over life of project.
EMPLOYMENT	**EMPLOYMENT**	**EMPLOYMENT**
Estimated total direct employment in U.S. at peak of construction: 22,500	Estimated total direct employment in U.S. at peak of construction: 10,000	Estimated total direct employment in U.S. at peak of construction: 15,000
Permanent work force in U. S. on project completion: 1,470	Permanent work force in U. S. on project completion: 400	Permanent work force in U. S. on project completion: 600
Total man-years of direct and induced employment in U. S. 749,000	Total man-years of direct and induced employment in U. S. 245,000	Total man-years of direct and induced employment in U. S. 350,000
CAPITAL COST	**CAPITAL COST**	**CAPITAL COST**
Total capital cost in 1975 dollars to bring 2.4 bcfd to U. S. markets	Total capital cost in 1975 dollars to bring 2.25 bcfd to U. S. markets	Total capital cost in 1975 dollars to bring 2.4 bcfd to U. S. markets
----------$6.5 billion----------	----------$8.6 billion----------	----------$6.3 billion----------

OMAR is dedicated to the orderly development of Alaska's natural resources for the benefit of the entire United States of America. For additional information, contact OMAR at Box 516, Anchorage, Alaska 99510.

Why the second choice is a loser

Anchorage Daily News 1-12-77

A.C. "Al" Swalling is chairman of the board of the Alaska Bank of Commerce and president of Swalling Construction.

By A.C. SWALLING

I appreciate being invited to express in this newspaper my views on a matter so vital to the economic health of Alaska, both near - term and for the future. I refer to the natural gas transportation system to bring North Slope natural gas to the South 48.

First, a bit of background. As chairman of the North Commission, established in 1967 by the Alaska Legislature, I was privileged to participate in the various studies carried on by that body. The members of the commission felt very strongly that the proposed oil line should be entirely under American control and so advocated.

THEY ALSO ADVANCED the concept that the natural gas pipeline should generally use the same corridor, terminating within Alaska at tidewater, with liquifaction facilities so sited that LNG could be "made available for transport by rail, truck, ship, or barge to remote villages and towns to bring total energy benefits of Alaska's resources within reach of all its citizens." Such a proposal would make possible the transportation of gas (surplus to Alaska's needs) to the Lower 48 by LNG carrier.

Some in the petroleum industry expressed opposition to a combination pipeline - LNG carrier system to transport North Slope natural gas to the southern markets. Arctic Gas is evidence of their opposition, but the commission persisted in its efforts to interest companies to analyze such a combination transport system.

Of all the companies approached only El Paso Natural Gas Co. evidenced interest. After many months of preliminary study, El Paso announced on Dec. 4, 1972, that they would file to develop and build such a system with a regasification facility on the West Coast and a tie in to the transcontinental pipelines, thereby making gas available to virtually any part of the Lower 48.

THE PROJECT was explained to Alaskans and overwhelmingly endorsed throughout the state. It was endorsed by the former and present governors, as well as the Eighth and Ninth Legislatures.

The filings of El Paso's Alaska project has been detailed and exhaustive. The statements, calculations, estimates, and computations of benefits to Alaska and the nation have withstood the cross examination by Arctic Gas and Alcan representatives as well as questions posed by the administrative law judge of the Federal Power Commission. Such is not the case of the Alcan's presentation whose interest in a competitive route did not surface until recently.

Too often lately we have heard certain media representatives and government officials suggest that because of the considerable momentum that Arctic Gas seems to have, Alaska may have to fall back and support the Alcan proposal as a "compromise" position in the natural gas pipeline controversy. Of course, this incredible idea presumes that the trans - Alaska route is doomed to failure, and Alaska must therefore settle for second best. Well, in my book, second best is a loser; and Alaska should not have to compromise on any issue involving its own interests or its natural resources. Furthermore, the project which will best benefit Alaska in this particular case also provides the greatest advantages to the nation as a whole.

THE TRANS-ALASKA project as sponsored by El Paso will provide many opportunities for Alaska that Alcan simply cannot meet. The comparable advantages and benefits are twice as great with the trans - Alaska route than with Alcan. For example, information available for each project shows that ad valorem and income taxes will be $2.8 billion for trans - Alaska versus just $1.3 billion for Alcan. The difference incidently would be enough to build the Susitna Dam or pay for the capital move. Direct employment during the construction of the project will be 22,000 for Alaska and 15,000 for Alcan. Long - term employment after construction will be 800 for Alaska and 100 for Alcan.

By far the greatest advantage of the all - Alaskan route relates to its terminating at an ice - free tidewater site near Cordova. If Alaska is ever to have a chance to promote the construction of a petrochemical industry, it will be with the El Paso project. The natural gas and the even more valuable natural gas liquids (LPG's) must be delivered to a year - round shipping port to allow marine transportation of the product. Furthermore, Alaska is naturally at such a severe economic geographical disadvantage, that a difference of just a few cents per million - BTU in the cost of pipelining the feedstocks to the plant site, could make or break our ability to compete in a world petrochemical market.

Some would neatly do away with this critical factor by suggesting that a lateral could be constructed from the Alcan pipeline to Prince William Sound. Let's look at this idea more closely. Assuming that both El Paso and Alcan will transport initial volumes from Prudhoe Bay of 2.4 billion cubic feet daily, the state's royalty share would amount to 12½ per cent, or 300 million cubic feet. El Paso's FPC application shows that its pipeline will be 810 miles long and have a yearly operating cost of $503 million. This means that it will cost 51 cents per million BTU to transport gas from the North Slope to Cordova.

THE FPC EXHIBITS for the Alcan pipeline indicate that it will be 720 miles long and have an annual operating cost of $530 million, which translates to 62 cents per million BTU to the Yukon Border. But we must back up to Delta Junction, which would be the point of departure of the new lateral going to Cordova. The transportation cost to Delta Junction via the Alcan line (544 miles) would be 40 cents per million BTU. Then, the new lateral must be built — by someone — to haul the state's 300 million cubic feet of royalty gas southward. It would be 265 miles long and 24 inches in diameter, and would cost approximately $234 million. With annual operating costs of $49 million, the transportation cost between Delta Junction and Cordova would be another 40 cents.

This, the difference between the El Paso cost of service (51 cents) and the Alcan - new lateral cost of service (80 cents) would be 29 cents per million BTU. Delivering 300 million cubic feet of royalty gas each day, the annual savings which would result from the El Paso line for the potential petrochemical customer near Cordova, would amount to $33.9 million. In the highly competitive world of the petrochemical industry, a saving of that magnitude would be a considerable incentive to locate in Alaska. We also hear the suggestion that a lateral could be built from the Alcan line to Haines. This arrangement would produce a transportation cost of $1.27 per million BTU — considerably less attractive than even the lateral to Cordova.

either one of these laterals from the Alcan pipeline. Despite Alcan's representations, we have no real indication that that company would build them. Petrochemical companies are not in the pipeline business, so we shouldn't expect them to build the laterals. It might be possible to expect a new, private company to build them, but we have seen no sign of this happening yet. And finally, I suppose the state could get into the pipeline business, although I would suggest that we could make better use of our tax monies — the Permanent Fund included.

BECAUSE THE EL PASO pipeline, taking advantage of technological advances, will operate at a higher pressure than Alcan (1670 psi vs 1250 psi), it will be a more efficient system and would provide cheaper transportation to any point along its route. If 50 million cubic feet per day were delivered to Fairbanks, I am told that the transport cost would be 33 cents per million BTU for Alcan and 28 cents per million BTU for El Paso, providing approximately $1 million in annual savings for the Fairbanks consumers with the all - Alaska pipeline. I understand that these figures do not include the cost of fuel, and if fuel costs were added, Alaskan natural gas customers would realize even greater savings with El Paso's project. Looking again at the FPC filings, we can see that within Alaska, Alcan requires 15 compressor stations consuming 80 million cubic feet of fuel each day, while El Paso needs just 10 stations consuming less than 45 million cubic feet of gas for fuel each day, thereby, effecting a very substantial saving of this valuable non - renewable resource.

The transportation advantage of the trans - Alaskan - LNG proposal extends beyond those communities along the pipeline itself. If for some reason communities in Southeast Alaska decide that they want North Slope natural gas, it could be delivered by barge in the form of LNG. Here once again, the economies of scale inherent in the El Paso project would result in a far lower transportation cost than Alcan could provide, by, in some cases, more than $2 per million BTU.

It can be fairly stated that the trans - Alaskan route can offer Alaska everything that the Alcan route could, and more. Conversely, the Alcan route can show no advantage over El Paso, economically or otherwise.

UP TO THIS POINT I have only reflected on the benefits to Alaskans under the all - Alaska route. Let us add to those the national interests to be served through the balance of foreign payments, the construction of 11 LNG carriers in United States shipyards, the procurement of 1,500,000 tons of domestic pipe and fittings, as well as the manning of the carriers with American seamen.

North Commission, that the only logical transport system for natural gas from the North Slope to market, is one that is totally under the American Flag.

Returning then to the original problem, we Alaskans simply cannot look upon Alcan as a "good second choice." It is in fact little better than Arctic Gas — which is no good at all for Alaska.

As the FPC staff position paper recently said, "Alcan is just a relocated Arctic Gas Project." Staff also strongly criticized Alcan's concept, costs and schedule as being unrealistic and undefensible. In other words, in my opinion, Alcan simply hasn't shown anyone that they know how to put together a major transportation project.

It should now be clear to all Alaskans that our real competition is Arctic Gas. And when we call Alcan a "good second choice," we are diluting our support for the trans - Alaska route. The end result will be that we'll get Arctic Gas approved — and we'll deserve it!

Fairbanks, Alaska
January 31, 1977

Representative Clark Gruening
Pouch V
Juneau, Alaska 99811

Dear Representative Gruening: Re: Proposed Gas Route Hearings

Mr. Michael E. DeMan of the Alaska Native Foundation has requested I bring materials received from Northwest Pipeline Corporation to your attention.

I have discussed the proposed Alcan route with Mr. Edward R. Hayes of the Northwest Pipeline Corporation at length both in conversations here in Fairbanks and on the phone. I have a record of my conversations with him as well as with others in his company and interested persons in the interior.

It is a matter of considerable importance that the natural gas from Alaska's North Slope be available to Alaskans for further processing into petrochemicals. The substance of the materials that I have reviewed leads to the prospects of establishing a permanent petrochemical industry in the interior of Alaska at the rate of a one-billion dollar plant a year for ten years following the construction of a gas pipeline. The establishment of a permanent petrochemical industry in Alaska's interior is not only worthy of consideration but I have concluded after considerable investigation that it is the most signifigant step in any industrialization which could be begun anywhere in Alaska. Ethylene, the basic feedstock of the petrochemical industry is in short supply, and we do have the ethylene available to us to begin an international-scale industry here. It is my considered opinion that if we allow our natural gas to leave the state without processing it into petrochemicals it will be a giant step backwards in the removal of colonial status for Alaska.

In reviewing the enclosed materials please understand that Northwest Pipeline Corporation has taken the position that while a world-scale petrochemical industry is feasible in interior Alaska, they are presenting this evidence for Alaskans to review in the hopes that we will see this as an opportunity and that we would want to do something about it. They are not interested in entering the petrochemical business.

I have other available information which I have drawn upon for a paper presented at the Alaska Science Conference last Summer and which I am pulling together for the University of Alaska-sponsored Town Meeting on Energy to be held here in Fairbanks in March. I would be glad to provide further testimony at your hearings if called upon.

Sincerely,

Jack O. Hakkila

Jack O. Hakkila

Enc.: Earthquake Probabilities at L. N. G. Sites: Frank Alberti and Associates

Alcan Pipeline Presentation: The Opportunity for Petrochemicals and Hydrogen Refining in Alaska: Speech by Edward R. Hayes

cc: Michael E. DeMan

FRANK ALBERTI & ASSOCIATES

P.O. BOX 99155 · MAGNOLIA STATION
SEATTLE, WASHINGTON 98199
TELEPHONE: (206) 284-0580

October 28, 1976

Alaska Earthquake Probabilities at Gravina Point near Cordova, Starichkaf Site near Homer Alaska, and The Vicinity of Fairbanks, Alaska.

This report is a follow-up on a previous report which we entitled "Earthquake Probabilities at L.N.G. Plant Sites - South Central Alaska" and utilizes the same basic source material of probabilities studies interpolated by recent work performed by W. G. Milne et al. W. G. Milne's work show the Gravina Point area to have a ten year return period for 10% g accelerations at the Gravina Point site.

Interpolations of Milne's charts shows twenty year return periods for the Kenai Peninsula sites and the Fairbanks area. The probabilities are based on history and tectonic arguments and it is noteworthy that there has been a longer history of recording earthquakes in the Cordova and Homer, Alaska areas than there has been at Fairbanks.

It is also noteworthy that considerable uplift and subsidence at Cordova and Homer areas respectively occured during the great earthquake of 1964. We have not encountered any records of vertical displacement at Fairbanks.

It is significant, we think, that the various investigators of the pipeline corridor agree insofar as establishing a lower design earthquake magnitude for Fairbanks (M=7.5) and (Valdez area) Gravena Point (M=8.5) as will be noted in the paper entitled "Ground Motion Values for Use in the Seismic Design of the Trans-Alaska Pipeline System" by Robert A. Page, David M. Boore, William B. Joyner, and Henry W. Coulter.

A considerable amount of damage occured in the 1964 earthquake to Petrochemical facilities in the Cook Inlet and the Prince William Sound areas. Major losses occured to the shore site facilities such as docks, tanks, plants, etc. and involved in many cases the earthquakes secondary effects of generating tidal waves. In this regard Fairbanks would not be affected.

Frank Alberti

P.O. BOX [illegible]
SEATTLE, WASHINGTON 98199
TELEPHONE: (206) 284-85:0

F. J. Becraft
M. E. Benefield
W. P. Diener
G. E. Foulke
E. R. Hayes
R. W. Keener
A.N. Por
J.N. Val
J.D. Wat

Earthquake Probabilities at L.N.G. Plant Sites - South Central Alaska

This is a resume of your requested study performed as you are aware by an engineer who has represented both insureds and insurers in the technical problems of earthquake insurability.

Alaska's earthquake loss history and high probability of frequent destructive seismic occurances make it very difficult to insure earthquake coverage at the best sites and the most desirable construction classes in south central Alaska. The highly protected risk insurers who handle the high values such as in the Petrochemical, Allied Gas and Oil facilities, and more especially LNG plants judge each risk on its individual merits.

El Paso's final choice of sites namely the Gravina Point site near Cordova, Alaska and the Starichkaf site on the Kenai Peninsula near Homer, Alaska are respectively in the first and second worst earthquake sites in any Zone 3 earthquake location in any of the fifty states. The probability charts developed by A.E. Stevens and W.G. Milne show the Gravina Point area to have a one hundred year return period for earthquakes with 100% g peak accelerations (M=8.5), a fifty year return period for 50% g accelerations (M=8.0), and a thirty year return period for 20% g accelerations (M=6.5). In communications with Mr. Milne we were able to follow his method to obtain a ten year return period for 10% g accelerations (M=5 to 5.5). In contrast to this, for example, Milne et al shows for your Plymouth, Washington LNG site a one in one thousand year probability of a 10% g earthquake.

Engineers consider that 10% g as the threshold accelerations that are damaging to ordinary structures on firm soil. It must be considered that LNG containers and their allied plant equipment are not ordinary structures i.e. the N.F.P.A. National Fire Protection Association Standards 59A in relating to LNG plants require a degree of care in earthquake engineering equal to that of nuclear plants. The specific proposed site at Gravina Point according to the FPC report has a foundation described as poorly drained. Although foundation engineering can help this, such foundations often suffer more high intensities (damage) from a given magnitude (acceleration) than do structures on natural firm soil. The FPC report also states that the vertical uplift in the '64 Good Friday earthquake was 4.5 feet and in the horizontal displacement was some 30 feet. This does not meet the stated earthquake criteria of the Federal Power Commission which requires that it not be located on or adjacent to an active fault.

From an insurers viewpoint, at least, the proximity to a fault is considered adjacent when it involves gross changes in land elevations and strong ground shaking even though it may not involve surface faulting.

The Kenia Peninsula site apparently has according to the FPC report better foundation possibilities and somewhat less earthquake risk potential; however, it also involves a serious geological hazard where we witnessed at Homer gross subsidence of 4.5' to 5.7' in 1964. It would appear to be no better than the worst earthquake probability and severity zone in the lower 48 states.

Underwriters are aware that early catastrophic failures of liquified natural gas tanks were solved by metalurgists so that a high degree of reliability exists under normal working conditions when the cryogenic liquid

is stored and processed at -272° F. Added to the many uncertainities is the state of the art of cryogenic and earthquake engineering relative to LNG containers and plant appurtances for resistance to great earthquakes of magnitude 8 or greater.

What we are saying is at the outset on the basis of what has been learned from the geologist, geophysist, and structural consultants reports that the general areas of the site require consideration of design earthquakes of the magnitude of 8 to 8.5 and further that these sites are in areas of distinct geological hazards. Underwriters would question in great depth the specifics of the geology of the sites and the ability of Cryogenic and earthquake engineers to persuasively show that LNG plant structures can be designed to safe limits for containing gas equivalents measuring in the billions of cubic feet involving liquid temperatures at -272° F that already have stretched technology to new limits. In other words the metalurgical problem as it relates to the stresses of great ground vibrations and ground displacements that exceed those found elsewhere in any of the other states appears to present a new problem to technology.

An insurers final review; however, would be based on not only the large area and site geology, the design earthquake magnitude, the distance from epicenter of earthquakes and fault lines, but also it would review the specific design input relative to ground structure interaction, allowable structural deformations, and the extent of deformation under simulated dynamic earthquake magnitude spectrums. Wind forces and direction because of gas dispersion or exposure is also an important factor.

Even if the FPC criteria regarding earthquakes were softened then at least three problem areas would be involved (A) The additional engineering and construction costs plus a feasibility consideration to accomplish completion of a facility that would comply with NFPA 59A particularly as it relates to seismic considerations. (B) The additional insurance costs throughout the life of the project providing the project, for the high values involved, would be insurable and (C) Last but not least the high human life exposure that could result from softening of the stated criteria resulting in basically improper siting of a major LNG plant and marine transfer facility.

At your request we interviewed the Industrial Risk Insurers relative to insurability of this type of risk in Alaska. The answer was quite discouraging to one seeking an earthquake insurance market in south central Alaska for plant locations where there are multimillion and even billion dollar concentrations of values. Currently the upper line limit is four million dollars for earthquake with a one million dollar deductable. Rates are significantly higher than in any of the other states. We are aware from other sources that a two and a half percent or two and a half dollar per hundred dollars of value rate is not uncommon for large industrial risks where there is an element of uncertainty relative to large earthquake forces or construction difficulties. There would; however, be a multiplier factor regardless of the rate for the higher hazard south central Alaska earthquake area. We are including with this study, references that were used in obtaining earthquake probabilities, geological information, and LNG construction requirements.

Frank Alberti

Frank Alberti, P.E.

"Locations that merited further consideration were subjected to additional studies to ascertain the extent to which each location complied with the requirements set forth in the criteria. These studies were concerned with a detailed evaluation of the physical conditions which exist in three major areas of each location: the area which would be utilized as the location of the plant, the area in which the marine terminal would be located and the bodies of water which would be utilized by the LNG carriers. A specific location was considered to be a viable site if it possessed characteristics equal or similar to those defined in the criteria, which are discussed in more detail in the subsequent sections." 1/

The staff is in agreement with the applicant that of the sites that were considered in Prince William Sound, the Gravina site is probably the most viable location on the basis of compliance with the technical requirements of the proposed project. The staff, however, disagrees with El Paso's premise that the Cape Starichkof site is not a viable alternative, since it, too, complies with the technical requirements of the project, and also has the advantage of exhibiting fewer environmental sensitivities and less potential for adverse environmental impacts than the Gravina site.

During the process of reviewing the information contained in the filings submitted by the applicant, the contract study prepared by the Oceanographic Institute of Washington, and numerous additional sources of information the staff has become aware of the potential adversities that could be encountered in the Cook Inlet area, most notably the potential for the disruption of shipping or docking maneuvers through the interaction of winds and masses of sea ice. The Cape Starichkof site apparently lies outside the area of disruption.

Based on the historical record, the Gravina - Prince William Sound area appears to exhibit a higher susceptibility to large magnitude seismic events than does the Cape Starichkof - Cook Inlet area. As is indicated in Figure 89, a greater number of earthquakes ranging in magnitudes from 7 to 8 have occurred in the vicinity of Prince William Sound, than in the Cook Inlet area. During the 1964 earthquake, Gravina Peninsula was subjected to 4.5 feet of vertical displacement upward, and 30 feet of horizontal displacement. The Cape Starichkof area, located within the area of subsidence that resulted from the earthquake, was subjected to no more than 1 foot of subsidence.

1/ Trans-Alaskan Gas Pipeline Project, Site Selection Report.

ALCAN PIPELINE PRESENTATION

THE OPPORTUNITY FOR PETROCHEMICALS AND HYDROGEN REFINING IN ALASKA

Speech by Edward R. Hayes

Northwest Pipeline Corporation

Fairbanks, Alaska, November 5, 1976

I am very pleased to have the opportunity to address this meeting of Professional Engineers of Alaska and to discuss prospects for establishing a major petrochemical industry in Alaska. To be more accurate, I should say to expand Alaska's petrochemical industry, for Alaska already has one of the world's largest ammonia-urea complexes at Kenai.

As you know, most organic chemicals these days are manufactured either from crude oil fractions, natural gas, or natural gas liquids, and can therefore properly be considered as petrochemicals. In this presentation, however, I shall be referring principally to the high volume chemicals and derivatives that dominate the chemical industry, because this is where the prime opportunity for Alaska exists.

In addition, I shall also discuss what I consider to be a great potential for establishing hydrogen refining complexes in Alaska to upgrade Prudhoe Bay crude oil before it is shipped to the lower 48.

There can be no question that the volumes of raw materials that will be available in Prudhoe Bay natural gas will be far more than adequate to support economically sized petrochemical plants in Alaska. Let us for a moment review the quantities of the principal petrochemical feedstocks that will be present in the raw gas at Prudhoe Bay.

(SLIDE: EXHIBIT A)

As shown in Exhibit A, the oil companies at Prudhoe Bay will produce a raw gas containing close to 230,000 barrels per day of natural gas liquids based on a transportable volume of natural gas of 2.0 billion cubic feet

per day. By raw gas, I am referring to the gas that will be separated from the crude oil, as it is produced.

As you realize, the crude oil and natural gas at Prudhoe Bay are intermixed in the same reservoir with some of the gas actually dissolved in the crude oil and the remainder forming a gas cap. The volumes of natural gas liquids which I have shown in Exhibit A are based on a crude oil production rate of 1,600,000 barrels per day which appears to be close to the rate which will be approved by the State of Alaska.

The raw gas must be processed to remove most of the moisture and acid gases (CO_2 and H_2S). In addition, much of the butanes and pentanes plus components have to be removed in order to avoid condensation (or dew point) problems in the natural gas pipeline. No one knows for certain yet just what the final design of the raw gas processing unit will be. The oil companies have supplied an approximate analysis of the sales gas that would be supplied to the gas transmission company. However, it is quite possible and perphaps even likely, that the oil companies will ultimately design their processing system to remove most of the butanes and pentanes from the raw gas and blend these fractions with the crude oil; and concurrently, recover most of the lighter ethane and propane fractions for inclusion in the natural gas pipeline supply. Our calculations suggest that butanes and pentanes will have a much higher potential value in the crude oil than in the natural gas pipeline, perhaps as much as $5 to $6 per barrel higher.

Using the estimated gas analysis provided by the producers, we arrive at the volumes of natural gas liquids shown in Exhibit B. As you will

(SLIDE: EXHIBIT B)

note, Alaska's royalty share of ethane alone is sufficient to support a 500 million pound per year ethylene plant, based on an 80% yield factor. If propane is included, Alaska by itself has almost enough royalty feedstock

for a billion pound per year olefin facility. This would be comparable in size to the largest worldwide facilities now under construction. It is quite possible, however, when a petrochemical project is developed in Alaska, that one or more of the oil companies who control the remaining LPG fractions at Prudhoe would be an active participant and would assign a share of its LPG to the venture.

LPG supplies to petrochemical plants in the lower 48 will continue to decline in rough proportion to the predictable decline in natural gas production. Spokesmen for the petrochemical industry now flatly state that no new olefin plants based on LPG fractions will be constructed. All of the new plants, including several that are now under construction, will have to employ naphthas or gas oils as the feedstock. Olefin plants using the heavier feedstocks cost at least 50% more to construct than if ethane or propane were the raw material. Another disadvantage for plants using naphtha or gas oil is that a very broad spectrum of products is produced, ranging from methane and ethylene all the way to heavy fuel oil. While the yield of ethylene from ethane is around 80%, it is only 25-30% for naphtha. Any company desiring to produce ethylene today would be most fortunate to have a secure, economical long term domestic supply of ethane and propane such as shou'd be available in Alaska in the near future.

Let us consider the range of petrochemical projects based on natural gas and natural gas liquids that could be established in Alaska. There are only two major petrochemical candidates that are manufactured from natural gas or methane: (1) ammonia and its derivatives, and (2) methanol and its derivatives. Both products are high volume commodities. By 1980, consumption of ammonia in the U.S. will reach 21,000,000 tons of which 75% will be consumed as fertilizer nitrogen and 25% will be used to produce industrial chemicals. Worldwide consumption by 1980 will be close to

100,000,000 tons.

Unfortunately, ammonia does not appear to be a very good prospect for Alaska for the foreseeable future. The major problem seems to be one of excessive production capacity combined with rather poor price prospects. As I have previously mentioned, Alaska already has the Union Oil facility at Kenai which is one of the largest ammonia-urea complexes in the world. It would not make much sense during a weak market to establish additional competition for an existing operation. Alaska's internal nitrogen fertilizer consumption is relatively small, around 1,200 tpy of equivalent ammonia. Looking well into the future, it is possible that the world-wide supply/demand picture may improve or that the demand for nitrogen fertilizer in Alaska will increase substantially. If so, ammonia could be considered as a "back-burner" possibility.

The situation for methanol is similar to ammonia. Without going into details at this time, I would also categorize methanol as a future possibility.

This brings us to the LPG fractions; ethane, propane and butane. I believe that the most experienced venture development specialists would identify the establishment of a major olefin producing complex as a prime commercial opportunity for Alaska. The principal olefins, ethylene and propylene, have become the major building blocks in manufacturing a wide range of synthetic resins and/or organic chemicals. Ethylene would be produced by steam cracking of ethane; and propylene by cracking propane. Natural gas would be used for fuel.

(SLIDE: EXHIBIT C)

Ethylene is the starting raw material for the two largest volume synthetic resins or plastics, as they are more commonly called, polyethylene and polyvinyl chloride. The latter is generally referred to as PVC. In

1976, approximately _____ tons of polyethylene and _____ tons of PVC were produced in the U.S. By 1980, these volumes are expected to reach _____ and _____ tpy, respectively. The worldwide growth rate for polyethylene is estimated at 10% annually. By 1986, 100 new high density polyethylene plants will be needed, along with an equal number of low density units.

The production of polyethylene in one or two satellite plants appears to be the best first choice for converting the ethylene into finished commercial products. One of the satellite plants could produce low density polyethylene which is used to produce pliable sheets and films and soft containers. The other satellite plant could convert ethylene into high density polyethylene which is extruded or molded into clear, hard bottles and shapes and is frequently used as an engineering type plastic. Initially, the production of PVC does not have quite as much allure because of the lack of an Alaskan source of chlorine. However, I certainly would not write PVC off as a future possibility.

In rough round numbers, a 500 million pound per year ethylene-polyethylene complex such as I have just described would require an investment of at least $500 million; $250 million for the ethylene plant and $250 million for the satellite conversion plants. Such a complex would provide directly 300 to 400 high quality jobs including a high percentage of technical people - possibly as many as a hundred. It is possible that a larger billion pound per year ethylene plant might prove to be economically feasible.

A second phase expansion program might logically involve a cracking plant to produce propylene from propane. Additional ethylene would be produced as a co-product. Satellite plants would include a polypropylene plant and possibly an ethylene oxide-ethylene glycol unit. Also, co-polymers and polyethylene and polypropylene could be produced, further broadening the product

line. These facilities would probably cost an additional $500 million in 1976 dollars.

To provide feedstock for the petrochemical complex, it would be necessary to construct large, sophisticated extraction plants to remove ethane and propane from the pipeline gas. As the result, propane would be readily available to the public, to industry and to agriculture in central Alaska and could be transported in the existing product pipeline to Haines. Universal availability of propane throughout Alaska would be helpful in improving living standards of the citizens.

Natural gas would be used as fuel in the ethane and propane cracking plants. We could conceivably be looking at an ultimate total investment of in the range of $2.0 billion and a product volume approaching one million tons of product per year. Total direct employment would be close to 1,000 of which about 200 could be from the engineering or chemistry professions.

These products do not sell by the ton. Rather they sell by the pound-currently close to 30 cents per pound for the products which I have described. The value added in Alaska will be substantial as shown in Exhibit D. The

(SLIDE: EXHIBIT D)

present value of ethane and propane from Prudhoe Bay is approximately 17 cents per gallon or about $79 per ton. Ethylene and propylene, the intermediate products, are worth about $240 per ton. Polyethylene and polypropylene, the finished products sell for $600 per ton and there is no reason that a portion of the polyethene and polypropylene could not be further upgraded in Alaska. For example, a polyethylene and polypropylene pipe manufacturing plant could be established that would serve Alaska and the Pacific Coast states; or a polyethylene calendering plant could be built to manufacture various grades of films and sheets.

If the Alcan Pipeline system is certificated, Alaska and its citizens will have the opportunity to develop the state's petrochemical potential.

There will no doubt be a reaction of skepticism from some interested parties who will respond that Alaska is too far from the markets to consider such an enterprise. I reply that if Alaska is not too far away to produce and transport its crude oil and natural gas then it is not too far removed to upgrade these products, and ship them to the markets in the lower 48.

The Province of Alberta was faced with a situation very similar to what you have here in Alaska. Most of its oil and natural gas were being transported out of the province. Just as with Alaska, there were several oil refineries, producing products for local needs, and several ammonia fertilizer plants. But, the really big petrochemical plants based on Alberta's raw materials were being constructed in Eastern Canada.

So the provincial government and Alberta Gas Trunk Line, Ltd., Alberta's largest gas transmission company, cooperated on an aggressive program to establish a major petrochemical industry within the province. Alberta has been successful in this effort. The province has built up a very large petrochemical network involving participation by several leading U.S. chemical concerns, as shown in Exhibit E. What Alberta has succeeded in

(SLIDE: EXHIBIT E)

doing, Alaska can likewise accomplish. I should also like to point out that Alberta Gas Trunk Line, Ltd. is one of the principals in the Alcan project. As you will note on the slide, the investment in these facilities exceeds one billion dollars. Alberta sets a figure of $1.3 billion.

The most promising location for the initial petrochemical installations in Alaska would be in the broad valley of the Tanana River between Fairbanks and Delta Junction. The lack of direct access to the sea is not a critical disadvantage, assuming that reasonable rates could be obtained from the Alaska railroads. A petrochemical industry would provide high volume, steady movement for the Alaska railroad which would be a big benefit to

this vital transportation artery. The cost of transportation to the coast will be a small percentage of the selling price. Obviously, cooperation between the Alaskan railroad and the venture developers will be very important. The Haines product pipeline could be used for transportation of liquid petrochemicals, and if necessary a new product pipeline could be constructed to the Anchorage area.

Earlier this month a representative of El Paso Alaska outlined the potential for creating a petrochemical complex in Alaska similar to the one which I have just described, before the Fifth Alaska Plastic Seminar in Anchorage.

I applaud the El Paso Alaska representative for encouraging citizens of Alaska to think in terms of establishing a prosperous petrochemical industry in their state. However, I disagree with El Paso's stated premise that Gravina Point is the logical location for the complex. A tidewater location normally offers a logistical advantage, but not in this case. The reason is the high earthquake risks that exist in the Gravina Point area. During the 1964 Alaskan earthquake, the land at Gravina Point experienced a vertical uplift of 4.5 feet and a horizontal displacement of 30 feet. A petrochemical facility of the type I have described, with its complex system of absorption towers and fractionation towers, could not be constructed to withstand a tremor as strong as that of the great earthquake of 1964. As a result, the odds of obtaining adequate insurance coverage would be slim. According to an investigation made on behalf of Northwest Pipeline's Insurance Department; the combined, pooled capability of the entire worldwide insurance industry will not issue insurance for any chemical or petroleum facilities above a level of $50 million per installation, at Gravina Point.

The incidence of earthquakes in the Fairbanks area is much less than for southern coastal areas. According to our consultant, the area around

Gravina Point has a ten year return period for earthquakes of 10% "G" acceleration as compared to a twenty year return for Fairbanks. Various investigators of the crude oil pipeline corridor established a lower design earthquake magnitude for Fairbanks, (M=7.5) versus (M=8.5) for Gravina Point. As you realize going from 7.5 on the Richter Scale to 8.5 means 10 times the magnitude of the seismic shock waves.

You can design a hotel to withstand an 8.5 scale earthquake, without collapsing, but there is no way to design and build a huge liquefaction plant or a giant petrochemical plant that could survive such a shock without tremendous damage and possibly catastrophic consequences. It does not appear possible to obtain adequate insurance coverage at Gravina Point and, without total insurance coverage, prospects of obtaining financing are poor. Exhibit F gives you a rough picture of the amplitude and incidence of earthquakes in Alaska.

(SLIDE: EXHIBIT F)

I am not suggesting that it will be easy to establish a petrochemical industry in Alaska. However, if the state and its concerned citizens are willing to expend the effort and cooperate with potential participants, I believe that successful, gratifying results can be achieved. Any one of the major oil producers at Prudhoe Bay would be first class operators. However, we must recognize that they would probably have to defer expansion of existing complexes in order to establish a new complex in Alaska. Other major oil companies as well as multi-national U.S., Japanese, and European chemical companies may be interested in joining an investor consortium just as Dow Chemical Diamond Shamrock have done in Alberta. The State of Alaska could also become an investor.

In addition to the prospects for establishing a petrochemical industry in central Alaska, the state has another equally strong and logical reason for insisting that the natural gas pipeline follows the route of the Alyeska

crude oil pipeline to Fairbanks and Delta Junction. That is to supply natural gas for use in producing hydrogen which will be needed in the 1980's to upgrade Prudhoe Bay crude oil in Alaskan hydrogen refineries.

Crude oil will become so expensive by 1981 that it will become impractical to burn reduced crude in electrical generating plants. Instead, the reduced crude will be upgraded by a process called catalytic hydrocracking. By this technique, virtually the entire range of crude oil fractions can be converted into high value gasoline, diesel fuel, jet fuel, heater oil and petrochemical feedstock.

Having the petrochemical facilities and the hydrogen refineries in close proximity has substantial synergistic affects. The hydrocracking of reduced crude produces large volumes of benzene and other valuable aromatic chemicals which could be recovered and shipped through an existing product pipeline to Haines or by tank car to Anchorage for transshipment to other petrochemical centers in California. Or, these chemicals could be further upgraded in Alaska into such products as styrene and polystyrene. With the addition of butane cracking facilities, a synthetic rubber industry could be established near Fairbanks, Haines or Anchorage. Concurrently, by production hydrogen from the olefin cracking units could be recovered and utilized in the hydrogen refineries.

Much of California's crude oil supply in the 1980's will come from Prudhoe Bay at a time when California's natural gas deliveries are diminishing. Very little or no natural gas will probably be available in California for producing hydrogen for hydrocracking. The replacement gas will be LNG shipped in from Indonesia, South Alaska and possibly Australia, and SNG from coal. All of these sources are very expensive, much too costly for hydrogen production. SNG from oil may run as high as $5 per million BTUs. Using naphtha at California refineries to produce hydrogen will also

be expensive and counterproductive. The oil companies will probably be much better off to have the crude oil upgraded in central Alaska where gas could be made available at reasonable cost.

In addition to converting low value reduced crude into high value products by hydrocracking, it might also prove desirable to upgrade the quality of the naphtha (gasoline) and gas oil (diesel fuel) fractions in Alaska by a process called hydrotreating or hydrofining. These processes to hydrocracking are similar except that the reaction conditions are less severe.

The installation of several hydrogen refineries could provide just as great a boost to the economy of central Alaska as petrochemicals. The new oil refinery now being constructed by the Earth Resources Corporation of Dallas, Texas at North Pole, Alaska represents an excellent initial refining step in central Alaska. The overall investment in hydrogen refining in central Alaska could easily exceed a billion dollars.

Environmentally, the petrochemical and hydrogen refining facilities which I have described are the pearls of industry. I would hesitate to use the term immaculate, but I can assure you that these plants are attractive and clean. Employment will be long-term and stable. This will appeal to native Alaskans. The capital investment per employee will be very high so no heavy burden would be placed on schools, hospitals, and other areas of the Fairbanks' infastructure. Further, there is plenty of territory along the pipeline corridor between Fairbanks and Delta Junction to spread out these installations.

Alaska will lose these great opportunities if Prudhoe Bay gas is routed through the MacKenzie Delta via the Arctic Gas route. By diverting Prudhoe Bay gas from Alaska, Arctic Gas is depriving the state of the benefits associated with new stable industrial growth.

The El Paso project faces many hazards in the southern coastal area as well as strong, determined opposition from environmentalists and landowners in Southern California. In my judgment, Alcan presents the State of Alaska with the most options for developing a long range plan for future economic development. Alcan is the system that gives Alaska the most control over its royalty gas while keeping the door open to the many marvelous opportunities provided by petrochemicals and hydrogen refining.

THANK YOU!

EXHIBIT A

PETROCHEMICAL RAW MATERIAL IN PRUDHOE BAY RAW GAS

(BASED ON 1,600,000 B/D OF CRUDE OIL - 2.0 BCF/D OF SALES GAS)

LPG CONTENT OF RAW GAS

	(BARRELS/DAY)		(TONS/YEAR)	
	TOTAL LPG	ALASKA SHARE	TOTAL LPG	ALASKA SHARE
ETHANE (C-2)	108,000	14,000	2,450,000	307,000
PROPANE (C-3)	60,000	8,000	1,942,000	243,000
BUTANE (C-4's)	34,000	4,000	1,100,000	138,000
PENTANES+ (C-5's)	28,000	3,000	1,245,000	156,000
TOTAL	230,000	29,000	6,737,000	844,000

EXHIBIT B

PETROCHEMICAL RAW MATERIALS IN PRUDHOE BAY SALES GAS

(BASED ON 1,600,000 B/D OF CRUDE OIL - 2.0 BCF/D OF SALES GAS)

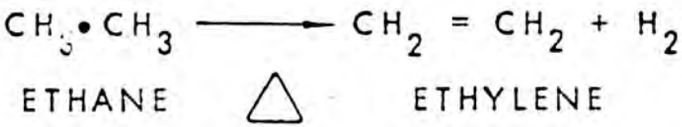
LPG CONTENT OF SALES GAS

	(BARRELS/DAY)		(TON/YEAR)	
	TOTAL LPG	ALASKA SHARE	TOTAL LPG	ALASKA SHARE
ETHANE (C-2's)	103,000	13,000	2,338,000	292,000
PROPANE (C-3's)	55,000	7,000	1,780,000	223,000
BUTANES (C-4's)	20,000	2,500	736,000	92,000
PENTANES+ (C-5's)	4,000	500	178,000	22,000
TOTAL	182,000	23,000	5,032,000	629,000

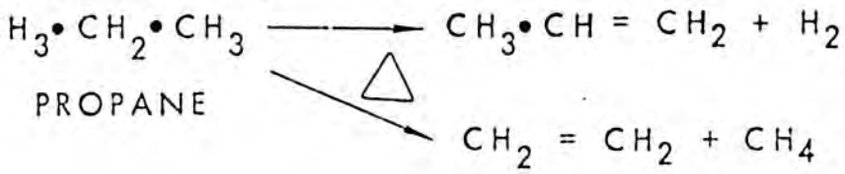
EXHIBIT C

PRODUCTION OF OLEFINS FROM LPG FRACTIONS

ETHANE TO ETHYLENE



PROPANE TO PROPYLENE



BUTANE TO BUTYLENE

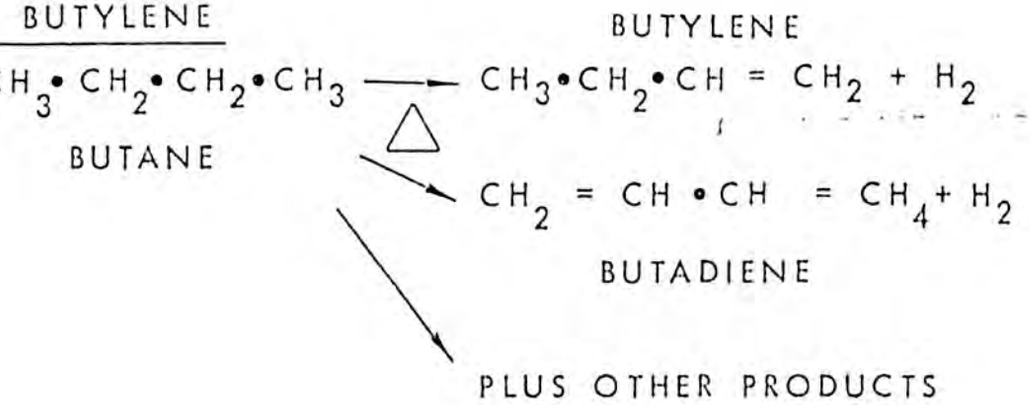


EXHIBIT D

ALASKA PETROCHEMICALS VALVE ADDED

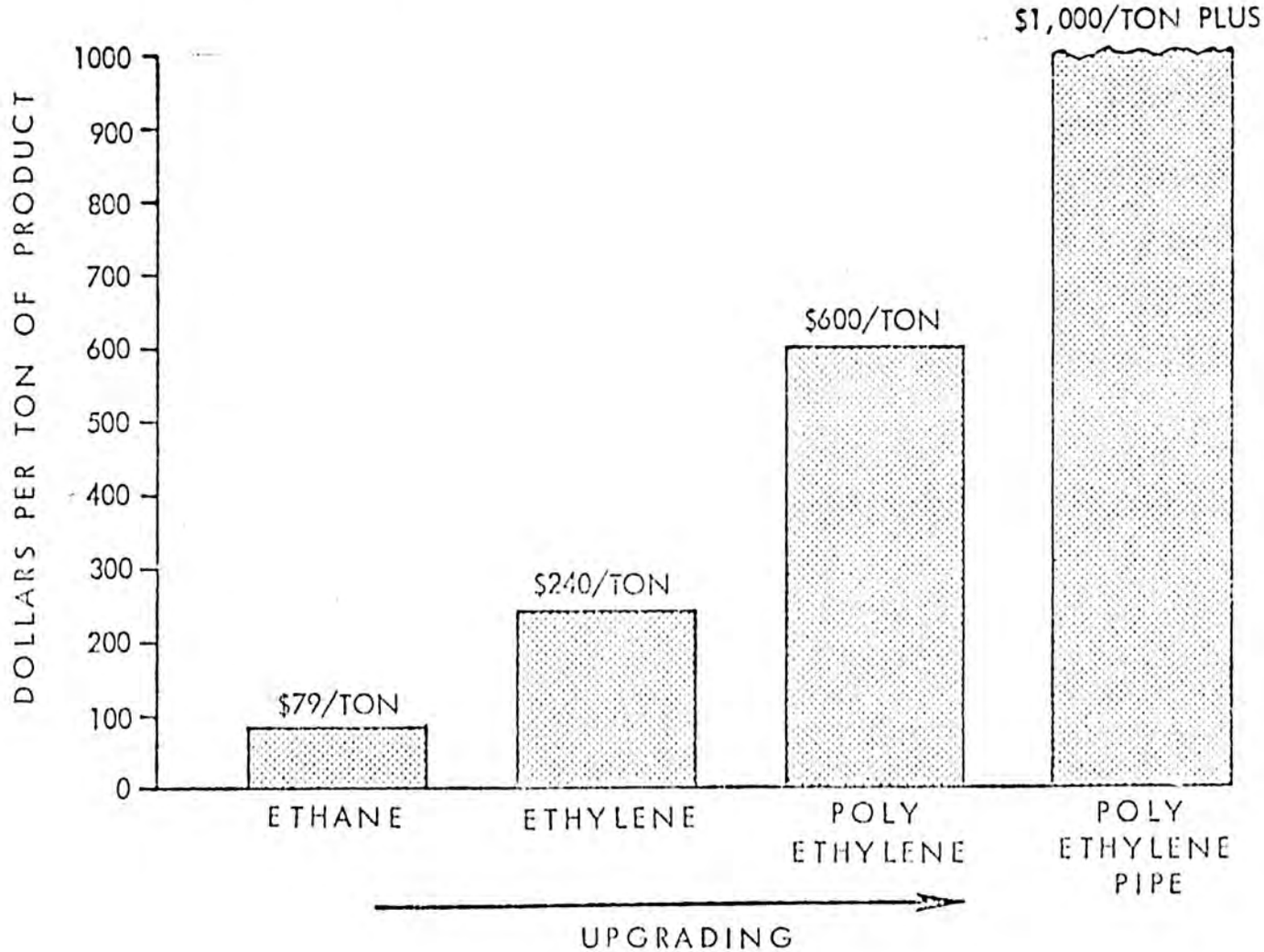


EXHIBIT E

ALBERTA PETROCHEMICAL RUNDOWN ON NEW PLANTS

NATURAL GAS BASED

3 WORLD SIZED AMMONIA PLANTS
2 WORLD SIZED UREA PLANTS
1 WORLD SIZED AMMONIUM NITRATE PLANT
3 WORLD SIZED METHANOL PLANTS
1 WORLD SIZED ACETIC ACID PLANT

NATURAL GAS LIQUIDS BASED

1 WORLD SIZED ETHYLENE PLANT
1 ETHYLENE OXIDE - ETHYLENE GLYCOL PLANT
1 VINYL CHLORIDE PLANT

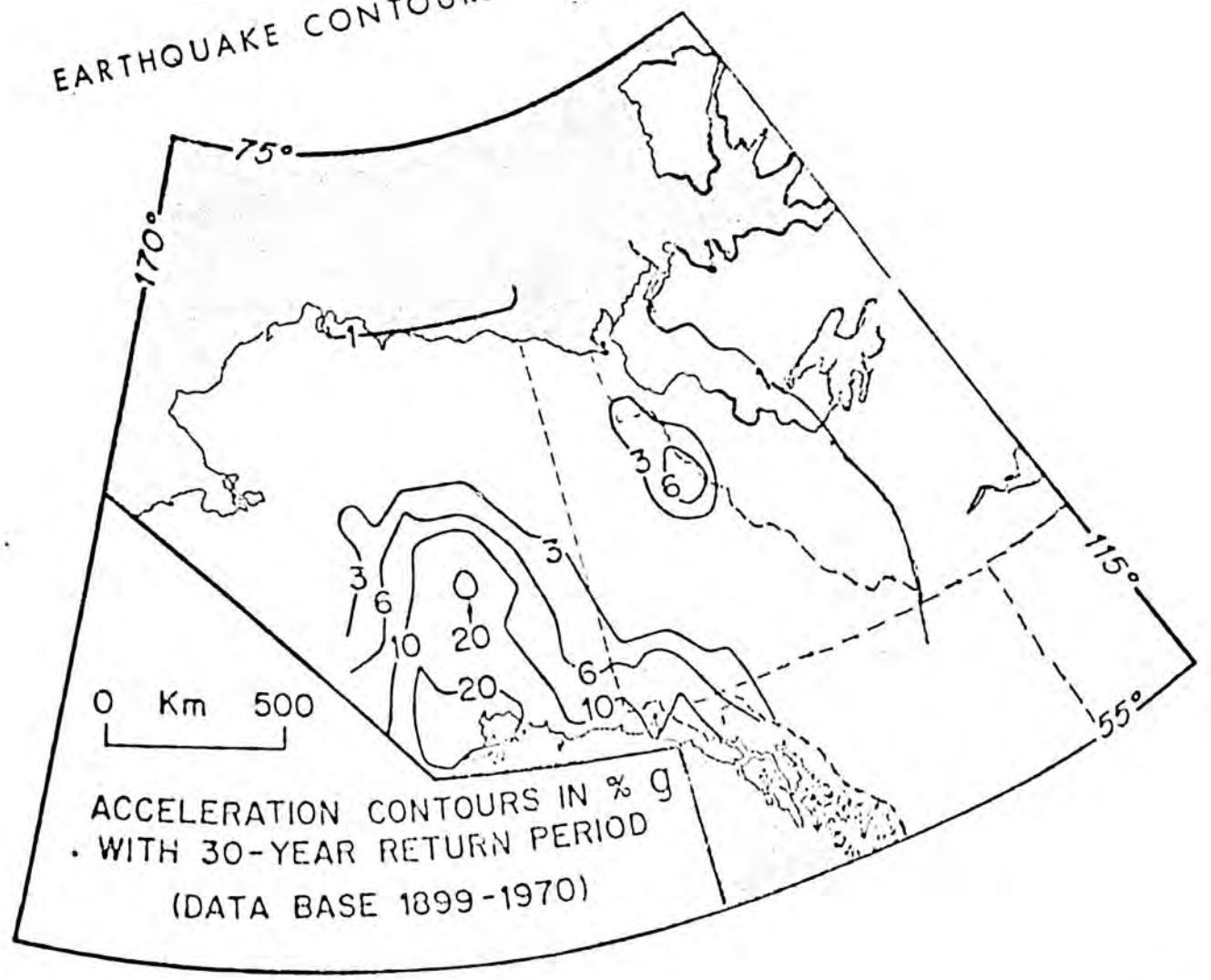
CONDENSATE BASED (PENTANES PLUS)

1 BENZENE - GASOLINE PLANT

VALVE - WELL OVER $1 BILLION

EXHIBIT F

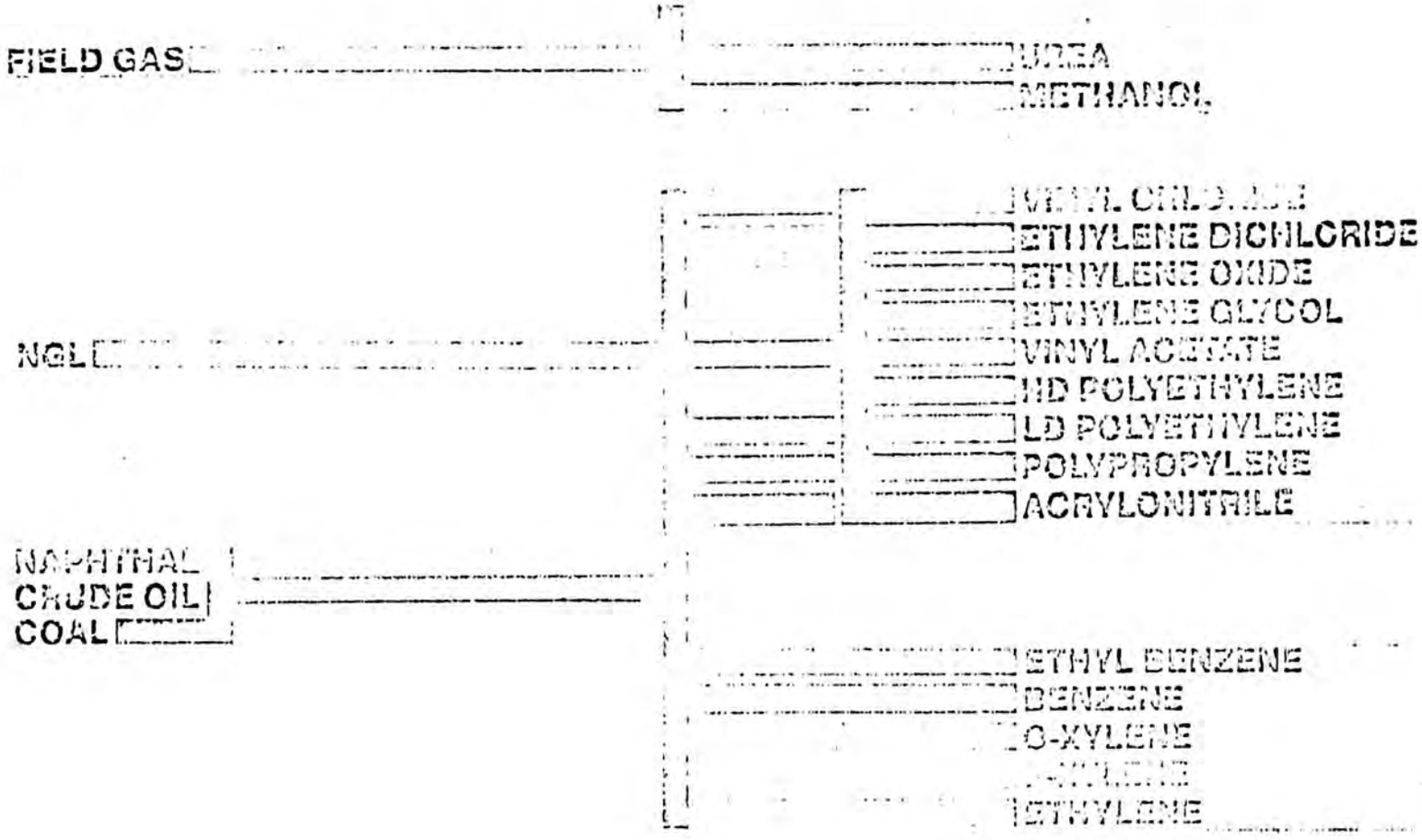
EARTHQUAKE CONTOURS FOR ALASKA



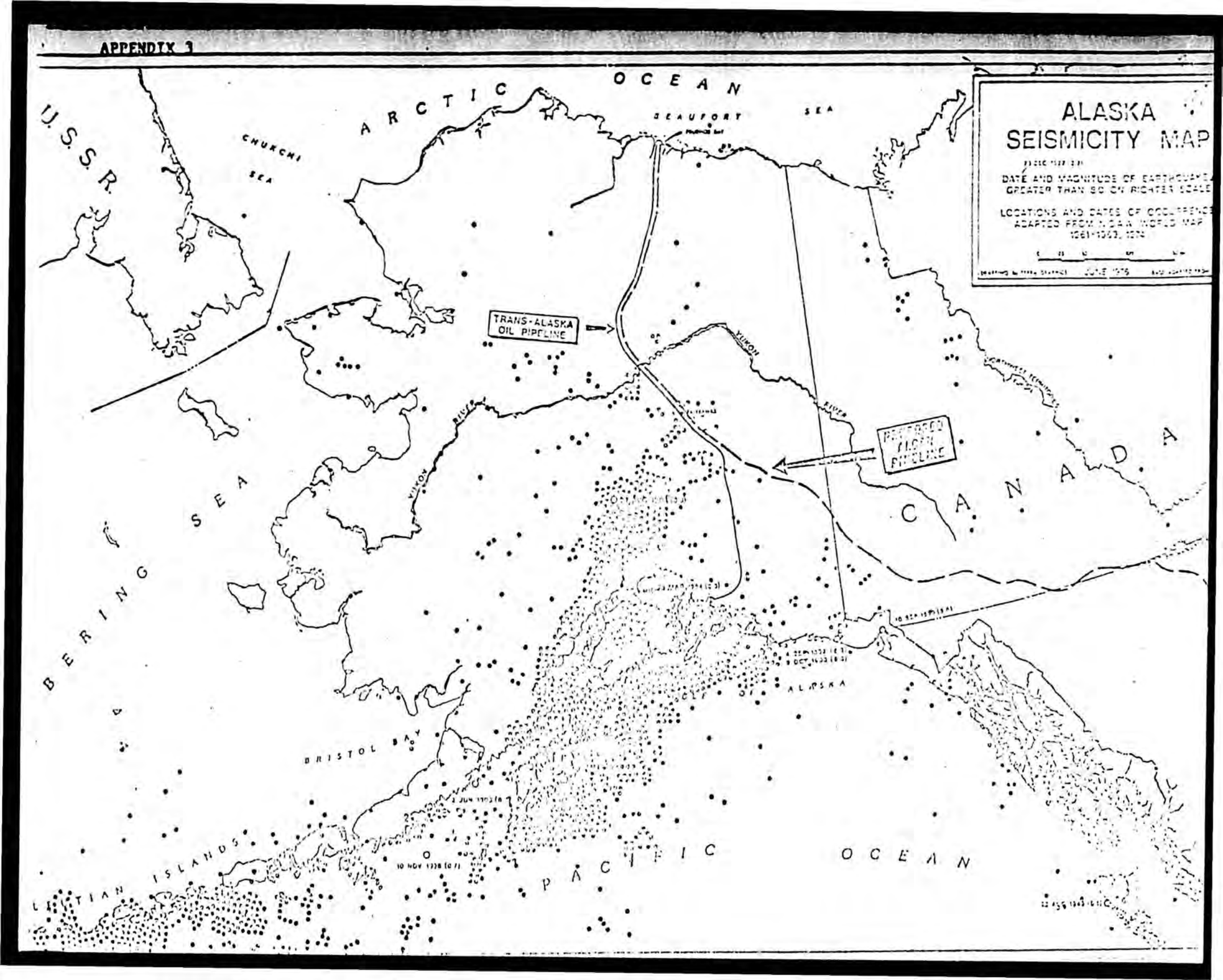
ACCELERATION CONTOURS IN % g
WITH 30-YEAR RETURN PERIOD

(DATA BASE 1899-1970)

CRUDE OIL AND NATURAL GAS ARE THE MOST IMPORTANT RAW MATERIALS IN THE MANUFACTURE OF BASIC ORGANIC CHEMICALS



APPENDIX 3


ALASKA
SEISMICITY MAP
DATE AND MAGNITUDE OF EARTHQUAKES
GREATER THAN 50 ON RICHTER SCALE
LOCATIONS AND DATES OF OCCURRENCE
ADAPTED FROM N.O.A.A. WORLD MAP
1961-1967, 1974
JULY 1975
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
U.S.S.R.
BERING SEA
TRANS-ALASKA
OIL PIPELINE
PROPOSED
ALCAN
PIPELINE
YUKON
RIVER
CANADA
GULF OF ALASKA
BRISTOL BAY
ALEUTIAN ISLANDS
PACIFIC OCEAN