DETERMINING THE PROJECT RISK PREMIUM FOR THE ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

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TABLE OF CONTENTS

I. OVERVIEW - SUMMARY

On December 1, 1978, the Federal Energy Regulatory Commission ("FERC") issued the terms and conditions regarding an Incentive Rate of Return ("IROR") procedure for equity investment in the Alaskan segment ("the Project") of the Alaska Natural Gas Transportation System ("ANGTS").* As described in this order, the rate of return on equity invested in the Project during its construction period would be computed as follows:

> The Operation Phase Rate of Return - The rate of return on equity invested in the Project after the Project is constructed and its rate base has been adjusted in accordance with the IROR procedure. This rate takes into account the operating risks peculiar to the Project.
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> plus
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> The Project Risk Premium - An addition to the Operation Phase Rate to account for the Project's peculiar construction risks (other than the IROR procedure itself).
>
> equals
>
> The Non-Incentive Rate of Return - The rate of return on equity invested in the Project during the construction period. This rate reflects the Project's peculiar operating (the Operation Phase rate) and construction (the Project Risk Premium) risks.

On January 17, 1979, FERC directed its Alaskan Delegate to provide the Commission by February 15, 1979, with a report examining the Project risks borne by equity investors

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* See Commission Order No. 17, Docket RM 78-12.

during construction (other than risks stemming from the IROR procedure itself).* This report is to be used as a basis for determining the Project Risk Premium.

a. Summary of Project Risks

In order to compare effectively the Project's risks during construction with those normally borne by investors in other regulated gas pipelines, the risks first have been separated into two time periods: the precertification phase and the period when construction is underway. The risks have been further grouped into three general categories: technical, regulatory/political, and economic. The nature and magnitude of the risks in precertification and construction phases are discussed in Parts II and III, respectively, and summarized below.

Precertification Phase

The fundamental risk during the precertification phase is that the project will be abandoned before construction begins. This could occur for technical, regulatory/political, or economic reasons. Specifically:

- Technical
  - (1) Ongoing design shows Project to be infeasible.
  - (2) Problems associated with other ANGTS segments.

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* See Commission Order No. 17-A, Docket RM 78-12.

(3) Estimates of Prudhoe Bay gas supply revised substantially downward.

° Regulatory/Political

(1) Inability to resolve key federal terms and conditions and/or FERC certification issues.

(2) Project becomes embroiled in political controversy in Alaska or Canada.

(3) Government decisions on key issues delayed.

° Economic

(1) Alaskan gas cannot be marketed in lower-48.

(2) Adequate financing cannot be obtained.

All these factors are unique to the Project and thus are risks that must be borne by Project sponsors over and above those normally associated with regulated pipeline construction.

Construction Phase

The basic risk that must be borne during the construction phase also is that the Project will be abandoned before construction is completed, although the probability is small relative to the probability during the precertification phase. Again, abandonment could occur because of any technical, regulatory/political, or economic factors. Specifically:

° Technical

(1) Catastrophic natural occurrences.

(2) Unexpected design/construction problems with no economic solution.

- Regulatory/Political

  (1) Governmental/citizen challenges to the Project resulting in extended delays and cost overruns.

  (2) Restrictive government interpretation of terms and conditions resulting in extended delays and cost overruns.

  (3) Canadian political conflict leading to Project termination.

- Economic

  (1) Huge cost overruns exhaust committed funds and make it impossible to raise additional capital.

  (2) Unforeseen changes in energy picture result in the abrogation of gas sales contracts.

The probability that non-completion will eventuate from any of these situations is small in absolute terms, but is relatively large compared with other pipelines. Because of the unprecedentedly large size of the Project, this constitutes a potentially disastrous financial loss to the Project sponsors.* Clearly, the risks will be at a peak during the precertification phase and will diminish steadily thereafter as uncertainties are reduced.

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* Although there is no assurance at this time of cost recovery from FERC in the event of non-completion, the Project sponsors would undoubtedly make such a request taking into consideration a statement made by FERC in an order issued March 24, 1978 (Docket CP 78-123, 124, 125). This order precluded any shift of the risk (that ANGTS would not be completed) to the consumer, but also made the statement that in the event of non-completion, an approach would then have to be made to the Commission seeking "some form of amortization...based upon the unique circumstances...."

Appendix A presents the likely perspective of the financial community on the unusual risks which investors in ANGTS must bear during the precertification and construction phases. From the viewpoint of potential contributors of capital, several summary points can be made:

- The risk premium must adequately reflect potential investors' perceptions of risk vis-a-vis alternative investment opportunities if capital is to be attracted.
- The risk premium will affect not only potential equity contributors, but also institutional lenders who must be assured of continuing equity support as may be needed over the period of construction.
- Potential equity investors perceive the following: 1) the large size of ANGTS, 2) an unfavorable economic climate, 3) the precedent of TAPS delays and cost overruns, 4) uncertainty about alternative gas sources, and 5) an unfavorable regulatory climate characterized by delays and unhelpful decisions.

The latter point was highlighted by the Project sponsors' recent decision to curtail their funding commitments and limit them to the first half of 1979 until a proper regulatory climate is established. In sum, potential equity contributors perceive a very high level of risk.

b. Determining The Project Risk Premium

Part IV of this paper presents a straightforward method for computing the Project Risk Premium necessary to compensate a "risk-neutral" investor for assuming the risks of the precertification and construction phases. The method hinges upon assessments of the probability of project abandonment for each year prior to the commencement of pipeline operation. Sensitivity analysis of reasonable abandonment probabilities indicates that an appropriate Project Risk Premium would be at least 5%. This is a

<u>mimimum</u> value; an additional increment will be necessary to induce investments by "risk-averse" investors.

II. PROJECT RISKS PRIOR TO CERTIFICATION

The fundamental risk to equity investors during the preconstruction phase is that a final FERC certificate cannot be obtained, in which event the project collapses and all equity investments are jeopardized. Risks borne by equity investors are greatest during this period because of the unusual technical, regulatory/political, and economic risks which make final certification and ultimate Project completion very uncertain outcomes.

a. Technical Risks

During the preconstruction phase, Project sponsors must confront numerous technical issues in order to prepare a construction plan and Project cost estimate. The principal technical risks borne by equity investors during this phase can be categorized into three groups:

- Major design changes
- Dependence on other system elements
- Gas availability.

(1) Major Design Changes. Changes in important design parameters may show the Project to be infeasible. Project design must include an extraordinary array of technical accommodations for the planned scope and location, including high operating pressure, frost heave mitigation measures, stringent pipe metallurgy, seismic design, refined pressure and

and temperature controls, and mechanical gas refrigeration. Additional design considerations, such as proximity to TAPS and use of the Yukon River Bridge, may require continuing involvement with Alyeska.

Although important aspects of Project design have not been resolved, preconstruction planning must continue if the Project is to be completed on the current schedule. The risk to equity investors is that the outcome of either tests undertaken to determine prudent design specifications or final government decisions will invalidate initial expectations and make construction unexpectedly difficult or costly, or in the extreme, render the Project infeasible.* The demanding Alaskan environment, the necessity of a sophisticated design to accommodate this environment, and the dependence upon negotiations with private parties make Project technical risks much greater than those experienced in the construction of lower-48 pipelines.

(2) Dependence on Other System Elements. Problems encountered by other ANGTS segments may force Project abandonment. In addition to the natural

*Two key testing programs, which will extend over the next several years--the frost heave program and the ductile fracture control (i.e., "burst test") program--are being conducted on a "confirmatory basis" in order to avoid a multi-year delay. If results of these programs are not as anticipated, the consequences could be severe.

gas pipeline through Alaska, ANGTS depends upon the Prudhoe gas processing plant, the Foothills Pipelines, the Western leg, and the Eastern leg. There are important technical (and economic) interdependencies among these system components which could undermine delivery of Alaskan gas to the intended markets in the lower-48 if each segment is not completed on schedule and close to budgeted cost. For example, an agreement might not be reached for construction of the gas plant, perhaps because gas conditioning costs are included by FERC in the wellhead price. The risks represented by the Project's dependence on other segments are not confronted by lower-48 pipeline projects which typically are under consolidated management control.

(3) Gas Availability. Reduced estimates of Prudhoe Bay gas availability could undermine the entire ANGTS. As FERC has pointed out, oil and gas reservoir production performance can confidently be predicted for the same length of time as the length of the production history on which the predictions are based. Because the Prudhoe Bay reservoir has a production history of less than two years, the risk to equity investors is that as the production history of the field unfolds, gas availability will be reduced from 2.0 Bcfd as planned to a level that

forces Project abandonment.

Although the risk of reduced gas availability is common to any new gas production venture, the degree of risk to the Project is extraordinary due to the unavailability of alternative gas supplies in the short-run in Alaska, and the potential consequences for the Project are extreme because of the unusually large equity commitments that would be jeopardized. Potential reserves in Alaska are substantial, but recent drilling has not developed any known new reserves.

b. Regulatory/Political Risks

The likelihood that Project construction will ever begin is influenced crucially by the decisions of regulatory/political entities. The decisions of these entities could smooth the way for expeditious completion or bring the Project to a standstill.

The principal regulatory/political risks borne by equity investors during the precertification stage can be categorized into three groups:

- Unacceptable government requirements
- Political controversy
- Delay in government action.

(1) Unacceptable Government Requirements. Project construction will be governed by important stipulations which will be attached to the final certificate of public convenience and necessity issued by FERC. Federal stipulations cover the technical, environmental, and general terms and conditions, and State stipulations will address the

socioeconomic effects of the Project.* The risk to equity investors is that the stipulations will make construction more difficult, time-consuming, and costly, compounding the inherent and already substantial technical risks and perhaps making the Project infeasible.

The Project sponsors are exposed to an unusually large risk of unacceptable certificate conditions because the cost of the delivered gas will be high. Even if the conditions are not stringent, there are multiple jurisdictions making demands of the Project, and the scope and location of the Project will make compliance with these demands very expensive.

(2) Political Controversy. The Project could become embroiled in political controversy in Alaska and Canada. Because of the magnitude of the Project and the pervasive involvement of the Federal government, equity investors bear the risk that various governmental entities will view the pipeline as a public works project and impose demands for substantial benefits. In Alaska, for example, demands have been made for high taxes on pipeline property and income, liberal tariff terms for gas taken off the line in Alaska, authorization to sell gas now for out-of-state consumption and to retrieve it later for use within the State, extraction of gas

*Additionally, individual Federal departments and agencies will attach their own stipulations to various permits and authorizations.

liquids for intrastate industrial use, local labor hiring and business contracting preference, and exceptional measures to protect the environment and to protect and aid affected communities. The Project has a finite capacity to support such demands; exceeding this capacity may force the equity investors to abort the Project.

Although the proposed pipeline route received U. S. and Canadian endorsement partly because it was relatively free from native claims disputes in both countries, uncertainty over settlement of native claims along the route may nevertheless impede construction. The risk borne by equity investors is that a controversy over native claims will delay construction or cause pipeline realignment, increasing costs to an unacceptable level.

Unlike most other pipelines, ANGTS is subject to multiple political jurisdictions. Because its primary markets are far removed from the source of the gas, intermediate jurisdictions with no interest from a consumer viewpoint are endowed with great negotiating power, rendering equity investors unusually vulnerable to their demands. The recent designation of the Tetlin Wildlife Refuge on the path of the proposed pipeline alignment raises additional uncertainty.

(3) Delay in Government Actions. Government decisions on key issues could be delayed or produce delays that result in cost increases that jeopardize certification or financing (the effect of a one year delay in ANGTS construction has been estimated to be $1 billion). The Project already has suffered substantially from delays in obtaining the 1978 Natural Gas Policy Act. Further delay and cost increase have resulted from the continuing lack of approval of: a Federal Inspector, the limited executive reorganization plan, the proximity of the gas pipeline to the Alyeska oil pipeline, and the system design pressure.

Unlike other pipelines, government decisions relating to ANGTS may be delayed as a result of shifting national priorities (e.g., if energy is superceded by inflation, recognizing that the two issues are nevertheless related), inadequate cooperation at various levels (state v. federal, agency v. agency, U. S. v. Canada), or the complexity of underlying political issues. For whatever reasons, governmental delays could jeopardize the credibility of the ANGTS concept and force Project abandonment. Construction of pipelines in the lower-48 typically is less dependent on government decisions preparatory to certification.

c. Economic Risks

The economic risks borne by equity investors arise from the cost effects of the technical and regulatory/political risks previously discussed. The expected cumulative effects of these risks may be so large as to threaten the marketability of Alaskan gas in the lower-48 and thus prevent the Project sponsors from obtaining the necessary commitments for construction capital.

More specifically, the risk in the preconstruction phase is that prospective gas shippers will conclude that the price at Project completion will exceed the amount that distribution companies, and ultimately consumers, will be willing to pay, and therefore refrain from signing gas purchase contracts with the producers. The cost of the gas and the likelihood that shippers will refuse to sign purchase contracts increase as the technical and regulatory/political risks materialize.

The marketability risks that equity investors must assume are without precedent because of the high cost of delivering the gas to lower-48 markets and the expectation, supported by the TAPS experience, that there will be further real increases in this cost--increases that could reduce or eliminate the price advantage of natural gas over substitute fuels, notwithstanding rolled-in pricing.

III. PROJECT RISKS DURING CONSTRUCTION

As in the preconstruction period, the fundamental risk that equity investors must accept during the construction period is that the Project will be abandoned before completion. The probability of this event once construction commences is small relative to the probability during the precertification phase, but still relatively large as compared with other pipelines. Moreover, the potential financial impact of abandonment is unusually large in absolute terms.

a. Technical Risks

During the preconstruction phase, the Project sponsors will have designed acceptable solutions for most of the problems that could arise in the Arctic environment. Nevertheless, unforeseen difficulties surely will be encountered numerous times during the three principal years of Project construction. In a typical regulated pipeline construction environment, risks of the magnitude that the Project continually will face simply do not exist. The principal technical risks can be categorized into two groups:

- Catastrophic occurrences
- Unexpected design/construction problems with no economic solution.

(1) Catastrophic occurrences. The potential risk that a catastrophic occurrence will cause Project abandonment is significantly greater than for a

comparable lower-48 project because of the size and complexity of the Project and the construction environment. For example, a massive earthquake which permanently damaged the Alyeska oil line or disrupted production from the Prudhoe field could result in gas line abandonment. Other Project risks that should be included in this category include such events as the abandonment of one of the other ANGTS segments.

(2) Unexpected design/construction problems with no economic solution. Once field construction begins, the Project sponsors anticipate that a number of the drawing board engineering solutions that have been prepared to solve particular problems will require extensive modification. In particular, the probability of geotechnical problems occurring during construction is high. This especially is the case with those portions of the Project not in proximity with the TAPS system. For example, unforeseen soil conditions might require a major realignment of the route in selected areas.

Similarly, major difficulties with equipment logistics or pipeline installations could lead to extended Project delays and major cost increases. The Project sponsors expect to develop both

primary and alternative plans for all major problem areas. Nevertheless, the risks associated with execution of these plans will be high due to the harsh Arctic environment and limited construction windows.

b. Regulatory/Political Risks

Because of the extensive Federal and state monitoring that the Project will encounter during the construction phase, the unusual national interest in the Project, and the problems always associated with an international joint venture, the Project's most significant construction phase risks will be in the regulatory/political category. Obviously, no pipeline constructed in the lower-48 has ever had to accept such a variety and magnitude of regulatory/political risk.

The principal regulatory/political risks can be categorized into three groups:

- Restrictive interpretations of Terms and Conditions
- Government/citizen challenges
- Canadian political conflict.

(1) Restrictive interpretations of Terms and Conditions could result in extended delays and cost overruns. For example, if a government monitor rejects the design of a particular ANGTS segment during field construction, the Project could be halted while redesign is completed. If additional equipment is required, Project delays

of up to one year are possible. That such events are possible can be documented by reference to Alyeska's experience.

(2) Government/citizen challenges to the Project could result in extended delays and cost overruns. The continuing environmental controversy surrounding the Seabrook Nuclear Power Plant and the cancellation of the Tellico Dam under the Endangered Species Act are two prominent examples of regulated projects that court suits have frustrated.

(3) Canadian political conflict could lead to Project termination. Any number of possible events in Canada could result in a Canadian government decision to terminate or defer construction on the Foothills segment of the ANGTS. This type of risk is not borne by a typical lower-48 project.

c. Economic Risks

As the previous sections have underlined, once construction begins, there undoubtedly will be important technical and regulatory/political problems that must be overcome. The economic risk borne by equity investors is that the cumulative costs of resolving construction period technical and regulatory/political problems will exhaust the available pool of construction capital and prevent raising any additional money. Furthermore, large cost overruns could jeopardize project

economics, particularly if abundant new sources of lower cost, substitute fuels become available. In the worst case, shifting economics could cause the abrogation of supply contracts by distributors who can no longer pay for Alaskan gas or by state public utility commissions to protect consumer interests. Although the probability of these occurrences is small, the potential financial loss is calamitous and unique to the Project.

IV. QUANTIFICATION OF THE PROJECT RISK PREMIUM

Parts II and III of this paper identify the unusual financial risks which must be assumed by the Project's equity investors and emphasize the ways in which these risks exceed the preconstruction and construction risks which characterize conventional natural gas pipelines in the lower-48. The appendix presents the likely views of the financial community on the unusual risks of Project abandonment during the preconstruction and construction phases. Finally, Part IV presents an analysis of the magnitude of the risk premium necessary to attract and compensate equity investors.

Quantifying the appropriate risk premium is difficult because it depends upon investors' attitudes toward risk and rates of return available on competing equity investments. The analysis presented in this section justifies a minimum risk premium of five percent to compensate a risk-neutral investor for assuming the unusual precertification and construction phase risks.* To attract the necessary equity capital, this minimum premium will have to be adjusted upward to compensate equity investors for assuming the risk arising from the variance in the rate of return (including the potential for a negative rate of return which would result from project abandonment).

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* The concept of a "risk neutral" investor is elaborated upon on page 32.

The analysis presented in this section hinges upon subjective but nevertheless informed assessments of the probability of Project abandonment in each year prior to the commencement of pipeline operation. These probabilities reflect only the unusual risks which distinguish the Project from conventional pipeline construction in the lower-48. There are three major steps in the analysis. First, the expected value of the equity portion of the rate base is calculated under the circumstances which apply to conventional pipeline construction in the lower-48 (15% equity AFUDC rate).* Second, the annual probability of Project abandonment is used in conjunction with the annual expected value of the rate base to determine the dollar premium necessary to compensate a risk-neutral equity investor for assuming the estimated risk of loss. This is done by structuring a "fair bet" with an expected value neither greater than nor less than the expected value of an investment in a lower-48 pipeline. Important assumptions are made about the time profile of equity investments and their recoverability upon abandonment. These annual dollar premiums are summed across the entire precertification and construction periods. Third, the total dollar risk premium is converted to a rate of return through a straightforward mathematical calculation.

*A 15% rate falls in the general area of rates granted for companies with a capital structure of about 75% debt and 25% equity, as is contemplated for the Alaska segment of ANGTS.

The following sections treat the quantification of Project risks and the computation of the Project risk premium in more detail.

a. Quantification of Project Risks

The fundamental risk which equity investors must bear in the precertification and construction periods is the risk of Project abandonment. This risk must be quantified as a range of probabilities if the Project Risk Premium is to be determined systematically.

The probability of Project abandonment in any year depends upon the distribution of the underlying technical, regulatory/political, and economic factors over the precertification and construction time horizon, and can be estimated realistically by individuals well-informed about the gravity of each. These estimates are unavoidably subjective because of the uncertainty which surrounds any potential outcome.

In this paper, the probability of Project abandonment has been determined on the basis of either those risks peculiar to ANGTS, or common risks of unusual magnitude for ANGTS. This approach recognizes that lower-48 pipelines may experience risks similar in nature, but that even so, the probability of abandonment is much lower--very close to zero--and the amounts of equity at risk are, in comparison, negligible. For example, during the precertification phase the Project sponsors will invest over one-third of the total estimated equity investment, in comparison to a lower-48 project where little or no equity is subject to a total loss.

Two realistic Project risk profiles are presented in Exhibit 1. These profiles show the estimated probability of Project abandonment in each year, conditioned upon the probability that the Project is not abandoned prior to that year. This approach recognizes that there are important milestones which if achieved will reduce the level of risk in future periods. For example, the discussion of risks in Parts II and III suggests an important reduction in the risk of Project abandonment once a final certificate is obtained.

The risk profiles are based entirely on the combined assessments of a number of individuals either employed by or directly associated with the Northwest Alaskan Pipeline Company. The group included separate Northwest officials with technical, legal, financial and government responsibilities. It also included outside legal counsel, financial advisors and economic consultants. These individuals were each asked to independently assess the annual probabilities of project abandonment for both the seven and eight year preconstruction/construction periods. These assessments were based on each individual's judgment concerning how the multitude of factors previously discussed would be resolved. Several individuals were also able to incorporate their firsthand knowledge concerning the current perceptions of potential equity investors into their assessments.

Exhibit 1. Project Risk Profiles --

The Annual Probability of Project Abandonment

	1978	1979	1980	1981	1982	1983	1984	1985
Profile 1	.125	.35	.125	.125	.05	.02	.01	-
Profile 2	.125	.35	.20	.125	.125	.05	.02	.01

Then multiply

To get the given probability of completion

ie $\begin{array}{r} 1.00 \\ -.35 \\ \hline .65 \end{array}$ $\begin{array}{r} 1.00 \\ -.20 \\ \hline .80 \end{array}$ ect Then .65 x .80 x ect

$\approx$ 0.35 or 50 or 2 changes out

of 3 that NWE will abandon

This table presents two project risk profiles. Each profile provides a realistic probability of project abandonment for each year prior to project completion, conditional upon the probability of actually making it to that year.

The gasline*

After obtaining the initial risk profiles from each individual, several group sessions were held to permit a general discussion of those factors that appeared most relevant to the assessments. Individuals were then asked to reassess their initial probabilities in light of any new information. The resulting profiles were then averaged to obtain the group distributions used in the analysis. Interestingly, the revised risk profiles show a substantially lower probability of abandonment in each year than did the initial assessments.

In general, the two Project risk profiles show a low probability of abandonment in the first precertification year (1978). Although technical risk diminishes during the precertification period as Project design, special testing programs, and field data collection and analysis proceed, the probability of abandonment increases markedly in 1979 to reflect uncertainty about the regulatory environment, and then decreases as final certification is approached. In each profile, the probability of abandonment decreases to .05 in the first construction year. The probabilities are then reduced progressively until Project completion, reflecting the favorable effect of a successful construction season in diminishing technical and regulatory uncertainty.

The annual probabilities which comprise these risk profiles are discussed in the sections whcih follow.

These sections summarize the major considerations surfaced during the group meetings to assess the probability of project abandonment.

1978. The probability of Project abandonment in 1978 is judged to be in the range of .10 to .15, an average of .125. This low probability was estimated as it would have been judged in early 1978, and therefore reflects the optimism and confidence which the President's Decision fostered during the first year of the precertification period. A favorable regulatory environment was expected to result in prompt selection of a Federal Inspector and implementation of the limited executive reorganization.

1979. The probability of Project abandonment in 1979 increases to .35 as perceptions of the regulatory environment have reversed. The Federal Inspector has not been appointed, the reorganization plan has not been implemented, and in many instances government agencies have been unresponsive to requests for decisions or action. This situation, apparent in the final months of 1978, caused the Project sponsors to curtail equity support during the first half of 1979, awaiting crucial government actions.

Three other factors contribute to the high risk of abandonment in 1979. First, growing public awareness of the obstacles facing the project is causing the feasibility of ANGTS to be seriously questioned. For example, in January 1979, a report was prepared by an independent consultant at the request of the Alaska State Legislature which asserts that ANGTS is "floundering" because of its marginal economics, the abundant uncertainties and risks, and the absence of measures to satisfactorily allocate these risks.* This report was subsequently praised on the floor of the Senate by Senator Edward Kennedy (D-Mass.) and printed in the Federal Register. Almost simultaneously, a report prepared for Alaska's Royalty Oil and Gas Development Advisory Board stated that "Regulatory delays, high transportation costs, and a general negative perception of the business climate in Alaska have resulted in an impasse over the matter of gas production and sale." The report concluded that "the various uncertainties surrounding the Alaska gas pipeline will be resolved unfavorably."** Second, the reports cited above should be viewed against the backdrop of optimistic reports concerning potentially vast Canadian and Mexican natural gas supplies. Addressing ANGTS in this context, Senator Kennedy remarked on the Senate floor that "Circumstances have changed substantially since the Congress approved the gas pipeline. Huge reserves in Mexico and Canada have been brought to public light;

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*The Alaska Highway Gas Pipeline: A Look at the Current Impasse, a Report to the Alaska State Legislature, Arlon R. Tussing and Connie C. Barlow, January 12, 1979.

**A Current Perspective on Use of Natural Gas Liquids for Petrochemical Production in Alaska, prepared for the Royalty Oil and Gas Development Advisory Board of the State of Alaska by Bonner and Moore Associates, Inc., January 10, 1979.

'glut' has developed in the natural gas market; substantial reserves within the lower-48 states now appear to be within reach, contrary to expections and representations during the natural gas debate last year...In this light it is all the more important that the Congress reexamine the pipeline question."* Third, continuing uncertainty surrounds construction of the gas processing plant and the "pre-built" sections of ANGTS. All of these factors cause a high assessment of abandonment by potential investors, jeopardizing the Project's financing plan.

1980. The probabilities of Project abandonment drop off to the range of .125 to .20 in 1980. Profile 1 reflects expectations that important government decisions will be made during 1979, and Project planning will accelerate to permit filing for a final FERC certificate at mid-year. Profile 2, on the other hand, reflects the possibility that time lost in 1979 will require one additional year in the precertification period; consequently filing for the final certificate would not occur until 1981. This outcome will materialize if capital commitments cannot be obtained in 1980 or if preconstruction planning for the gas processing plant has not progressed.

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* "DOE Responds to Questions from Senator Kennedy on Alaskan Pipeline," Congressional Record--Senate, February 26, 1979, p. 1827.

1981. The probability of abandonment has been reduced to .10 - .15, an average of .125 in 1981. In Profile 1, this is the year in which the final certificate is issued. Capital commitments would have been obtained in the previous year; when an "unencumbered"* certificate has been obtained, debt funds will be made available to complete the Project. The expected completion of the prebuilt sections in this year further reduces the chance that the Project will be abandoned. In Profile 2--with an additional precertification year--1981 is the year in which capital commitments are obtained to accompany the filing for a final FERC certificate.

1982. In Profile 1, abandonment risk has been reduced to .05 in 1982. The expectation is that the final certificate will be obtained in mid-1981, all legal challenges will be resolved by year-end, and the pool of committed capital will be released in time for the civil construction phase to commence in the spring of 1982. Construction of the gas processing plant is also expected to be underway. In Profile 2, lagging the other by one year, the probability of abandonment is reduced only to .125. Final certification is expected sometime during the year; until this event occurs, the pool of committed capital will not be available.

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* The final certificate issued by FERC will be subject to challenges in the U.S. Court of Appeals for the District of Columbia. In accordance with the expedited judicial review provisions of the Alaska Natural Gas Transportation Act, 150 days following issuance of a certificate must be allowed for any challenges to be resolved. Constitutional issues, if raised to the U.S. Supreme Court, could extend this period. Once court challenges have been resolved, the final certificate is described as "unencumbered."

1983. In Profile 1, the probability of abandonment is reduced to .02 in view of successful completion of the first full construction season and satisfactory progress on the gas processing plant. Major technical and regulatory problems have not surfaced, or if they have, the Project has passed the point of abandonment save for the gravest of unforeseeable circumstances. For Profile 2, 1983 is the first construction year, wherein the risks parallel those reflected in the other scenario one year earlier.

1984. The probability of abandonment is reduced to .01 for Profile 1, with construction to be completed by year-end. Profile 2 has a risk of abandonment of .02.

1985. In 1985 Project construction has been completed under Profile 1. The probability of abandonment in Profile 2 is reduced to .01 as completion of construction is anticipated by year-end.

In the next section, the compensation necessary to induce investors to assume these risk profiles will be determined, and the corresponding Project Risk Premium will be calculated.

b. Determination of Compensation for Risk

Equity investors in a typical lower-48 regulated pipeline do not assume risks of the magnitude and consequences associated with ANGTS. Their equity investment therefore earns a "normal" rate of return on the actual rate base

accumulated during construction after adjustment for AFUDC (RB). In contrast, equity investors in ANGTS assume unusual risk that their investments will be lost.

The IROR mechanism established by FERC recognizes that equity investors must be compensated for these risks by incorporating a Project Risk Premium. This Project Risk Premium, in conjunction with the Operation Phase Rate and the IROR risk premium, forms the basis for the incentive rate which is used to calculate a rate base adjustment intended to compensate equity investors for risk. Unfortunately, FERC has not suggested any method for directly estimating an appropriate Project Risk Premium rate that can be applied to the normal rate base for the hypothetical 25 year depreciation period. However, Order No. 17 suggests that a rate of approximately 2 percent is being considered.

An alternative procedure to simply estimating the Project Risk Premium rate is to derive it after first estimating the appropriate risk adjusted rate base (RB_A). A hypothetical risk adjusted rate base can be easily calculated using standard probability theory to calculate the minimum adjustment to the rate base required in each year to fairly compensate a "risk neutral investor" for accepting the risk of Project abandonment.* Once the risk

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* The analysis contained in this section is based on the assumption that equity investors are risk-neutral (as explained on the following page). Because potential investors for ANGTS are almost surely risk averse, the risk premium rate developed must be considered to be the minimum acceptable rate.

adjusted rate base is known, it is straightforward mathematics to derive the Project Risk Premium rate that should be used to adjust the normal (including AFUDC) rate base.

This process is described in the following two sections:

- Estimate Risk Adjusted Rate Base
- Calculate the Risk Premium Rate.

(1) Risk Adjusted Rate Base

Within the framework of traditional economics, it can be demonstrated that a risk neutral investor will be indifferent between committing funds to two projects with identical expected values over the same time period. Thus, a project with a known, certain return can be transformed into a project with two possible outcomes described in probabilistic terms. For example, a risk neutral investor will be indifferent between investing $1 with a guaranteed 1-year return of $1.10 and investing $1 with a 50% chance of no return and a 50% chance of receiving $2.20. Both investments have equal expected values of $1.10.

Using this straightforward framework, the minimum appropriate risk adjusted rate base is estimated to be between 27 and 42 percent greater than the hypothetical rate base that would include only AFUDC at the normal rate of return on lower-48 pipeline projects. These estimates depend on the Project Risk Profile described previously, the number of years in the Project's preconstruction and construction periods, and the percentage of total equity investment in each year.

Prior to receipt of the unencumbered FERC certificate, only equity capital is expected to be expended on the Project. Thus, a relatively high percentage of total Project equity capital will have been committed during the Project's early years. Based on preliminary budget projections, and assuming completion of construction in 1984, the equity investment profile, expressed as a percent of total equity, is as follows:

1978	1979	1980	1981	1982	1983	1984
8	8	11	13	20	20	20

However, if the critical actions currently pending with the government are not resolved in a timely and responsive manner, it is likely that project completion will be delayed an additional year--until 1985--resulting in an 8-year preconstruction/construction period. The equity investment profile would be as follows:

1978	1979	1980	1981	1982	1983	1984	1985
8	8	8	10	12	18	18	18

In either case, the "normal" rate base (including AFUDC at 15%) would be calculated by allowing an annual return of 15 percent* on the accumulating equity investment.

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* Fifteen percent is considered to be the minimum rate of return that would be allowed for investment in a lower-48 pipeline with a 75/25 debt to equity ratio. See, for example, the discussion by FERC's Alaskan Delegate on pages 20-21 of his report to the Commission covering Tariff and Operation Phase Rate Issues (2/16/79).

lower-48 pipeline project can earn
with virtual certainty. In fact,
has pointed out that: "Risk for
l is the result of certain events
r realized rates of return to devi-
turn allowed by the Commission"
eration Phase Rate Issues; 2/16/79).
rs can recover their full capital
turn even in the extremely unlikely
ipeline project is cancelled. This
rough adjustments to already out-
ch are being depreciated with reve-
itions.

Alaskan, on the other hand, has no
mechanism exists for recovery of
the equity investment following
S. Thus a potential pipeline inves-
a certain return of capital with
thereon for a lower-48 pipeline
ment in the Alaskan project where
ally be negative.

a risk-neutral investor contemplating
ANGTS will require a rate base pro-
value at least equal to the annual
t is available on a lower-48 pipeline
n-year preconstruction/construction

period this would result in an equity rate base of $164.51 for each $100 invested. The corresponding normal rate base for the 8-year project would be $177.24.

Using the project risk profiles described in the previous section, together with the expenditure profiles, the minimum risk adjusted rate base (RB_A) is calculated for <u>each year</u> prior to completion of construction, starting with the prior year's risk adjusted rate base and adding new equity additions at a "normal" rate of return (e.g., 15%). From this figure is subtracted the expected value of the capital recovered in the event of abandonment ($P_t \cdot E_R$), and the remainder is divided by the probability that the project will <u>not</u> be abandoned in that year. Thus:

$$RB_A = \frac{RB_N - (P_t \cdot E_R)}{1 - P_t}$$

Where:

RB_N = The rate base at the end of each year that results from allowing only a normal (i.e., 15%) rate of return on the risk adjusted rate base (RB_A) from the preceding year plus the equity invested in the current year.

RB_A = The rate base adjusted to include the minimum risk premium that would be required by a risk neutral investor.

E_R = The equity recovered by investors in the event of project abandonment. In the examples, it is assumed that 50 percent of the actual investment would be recovered as permitted by FERC.

P_t = The probability that the project will be abandoned during a given year t conditional on its survival through the preceding year.

S ing this equation for RB_A each year yields a cumulative risk adjusted equity rate base of $208.74 for each $100 invested over a seven-year preconstruction/construction period. The comparable eight-year period figure is $251.86. (See Exhibit 2)

(2) Risk Premium Rate

Once the risk adjusted rate base is known, it is straightforward mathematics to calculate the risk premium rate that, when added to the Operating Phase Rate and the IROR risk premium, yields the Incentive Rate at the center point of the IROR Schedule. The formula is:

$$\text{Risk Premium Rate} = .2023 \frac{RB_A}{RB} - .2023$$

where:

RB_A = The risk adjusted rate base

RB = The normal rate base (with AFUDC)

.2023 = A constant, which depends on the number of years in the depreciation schedule (assumed to be 25), and the appropriate discount rate (assumed to be 15%).

Applying this formula to the normal and risk adjusted rate bases, illustrated in Exhibit 2, yields a minimum risk premium rate of 5.4% for Profile 1 and 8.5% for Profile 2. (See Exhibit 3 for an example calculation which replicates the mathematics used in Table 1 of FERC's Order No. 17.) These rates would be used with the Operating Phase Rate and the IROR risk premium to determine the incentive rate

of return at the centerpoint of the IROR schedule. (Assuming a 15% Operating Phase Rate and no IROR risk premium, these risk premium rates are equivalent to rates of 22.2% and 24.0% respectively, applied solely during the period of construction.)

In contrast to the assumed risk-neutral investor herein, if an accurate representation of the degree of risk aversion typical to a potential equity investor in the ANGTS could be developed, a fair risk premium* would be significantly higher than the rates developed in this illustration. This fact was recently highlighted by the Alaskan Delegate in his Tariff and Operation Phase Rate Issues report:

> It is generally recognized that some compensation to investors should be given for greater variance in rates of return even though the realized rate is just as likely to be above the allowed rate as below it. In other words, investors prefer a certain return rather than a return that could fluctuate both up and down. (pp.15-16)

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* In fact, the term "risk premium" as used throughout this paper is misleading because the illustrated procedure, in reality, establishes only a "fair bet" situation. A true risk premium above the calculated "risk premium rates" would be necessary to compensate risk-averse investors for assuming the risk arising from the variance in the rate of return (including the potential for a negative rate of return which would result from project abandonment).

Thus, considering both risk aversion and the spread of rates that exists because of uncertainty over project timing (i.e., the seven- or eight-year preconstruction/ construction period), FERC should consider establishing a risk premium rate significantly exceeding five percent to provide adequate risk compensation.

EXHIBIT 2.

MINIMUM EQUITY RISK COMPENSATION FOR ANGTS*

	1978	1979	1980	1981	1982	1983	1984	1985
PROFILE 1 (7-year Preconstruction/Construction)								
Equity Investment ($)	8	8	11	13	20	20	20	-
Year-End "Normal" Rate Base (RB) (with 15% AFUDC) ($)	9.20	19.78	35.40	55.66	87.01	123.06	164.51	-
Risk Profile (P_t)	.125	.35	.125	.125	.05	.02	.01	-
Risk Adjusted Year-End Rate Base (RB_A) (with 15% AFUDC + Risk Premium) ($)	9.94	27.44	48.59	78.09	117.16	160.14	208.74	-
PROFILE 2 (8-year Preconstruction/Construction)								
Equity Investment ($)	8	8	8	10	12	18	18	18
Year-End "Normal" Rate Base (RB) (with 15% AFUDC) ($)	9.20	19.78	31.95	48.24	69.27	100.37	136.12	177.24
Risk Profile (P_t)	.125	.35	.20	.125	.125	.05	.02	.01
Risk Adjusted Year-End Rate Base (RB_A) (with 15% AFUDC + Risk Premium) ($)	9.94	27.44	47.94	73.72	109.38	152.51	199.25	251.86

*The calculation is per $100 of actual total equity invested in the project. Critical assumptions in this analysis are: 1) the equity investment profile, 2) the risk profile (P_t), and 3) an estimated 50% recovery of equity capital upon abandonment, which is used in the calculation of RB_A (See page 4 and 37).

Exhibit 3.

Example of One-Time Adjustment Procedure
(for $100 of equity investment)

Year	Return of Equity[1]	Return on Equity[2] (Nonincentive Rate: 20.4%)	Total[3]	Discounted Total[4] (15% Discount Rate)
1	$ 6.58	$ 33.62	$ 40.20	$ 34.96
2	6.58	32.28	38.86	29.38
3	6.58	30.93	37.51	24.67
4	6.58	29.59	36.17	20.68
5	6.58	28.24	34.82	17.31
6	6.58	26.90	33.48	14.47
7	6.58	25.55	32.13	12.08
8	6.58	24.21	30.79	10.07
9	6.58	22.86	29.44	8.37
10	6.58	21.52	28.10	6.95
11	6.58	20.17	26.75	5.75
12	6.58	18.83	25.41	4.75
13	6.58	17.48	24.06	3.91
14	6.58	16.14	22.72	3.21
15	6.58	14.79	21.38	2.63
16	6.58	13.45	20.03	2.14
17	6.58	12.10	18.69	1.74
18	6.58	10.76	17.34	1.40
19	6.58	9.41	16.00	1.12
20	6.58	8.07	14.65	.90
21	6.58	6.72	13.31	.71
22	6.58	5.38	11.96	.55
23	6.58	4.03	10.62	.43
24	6.58	2.69	9.27	.32
25	6.58	1.34	7.93	.24
	$164.50	$437.11	$601.62	$208.74

[1] Return of $100 actual equity investment, plus AFUDC at 15%, depreciated over 25 years, (see Exhibit 2, Row 2).

[2] The nonincentive rate multiplied by the non-depreciated equity outstanding during the year. The nonincentive rate equals the operating rate (e.g., 15%) plus the risk premium rate (e.g., 5.44%).

[3] Sum of two preceding columns. This column replicates the nominal cash flow that would occur each year if the equity rate base was $164.50, the operating rate 15% and the risk premium 5.4%.

[4] The hypothetical total return (column 3) discounted to the start of year one using the formula $[\text{return}/(1 + .15)^{i}]$ where i equals the year of the return. The sum of this column represents the equity rate base that would be allowed if FERC establishes a 5.4% project risk premium (see Exhibit 2, Risk Profile Case 1). This risk adjusted equity rate base would then be permitted to earn an operating rate of return as established by FERC using traditional procedures.

APPENDIX A
FINANCIAL PERSPECTIVE
ON PRECERTIFICATION AND CONSTRUCTION PHASE RISKS

At the outset, two observations are in order. First, in calculating the appropriate amount of risk premium, it is crucial to recognize that the premium must reflect not the assessment of precertification and construction risks that an engineer or academician would make, but rather the risk evaluations of investors confronted with a variety of investment opportunities that are much more conventional in size and complexity than the Project, and, more importantly, enjoy fundamentally superior risk/reward relationships. In the latter regard, it cannot be overemphasized that to compete for capital the Project must overcome the handicap of offering only a regulated return, in exchange for the assumption of the truly entrepreneurial risk that the Project may never be completed and the invested capital lost. The limitation on the Project's return will cause prospective investors to be considerably more risk averse in their evaluation than might otherwise be the case.

Second, the amount of the risk premium significantly will affect evaluations of the Project by institutional lenders. While the risk premium will not directly compensate lenders, it largely will determine the capacity of the Project to raise equity and will thereby influence the willingness of lenders to assume construction risk.* Lender decisions will

*Institutional lenders, who rarely assume project construction risk, will be asked to assume ANGTS construction risk to virtually the same extent as equity investors. If the Project is abandoned prior to completion, only a small portion of the funds expended will be recoverable through liquidation. Consequently, debtholder seniority over equity investors is practically meaningless.

be influenced by the capacity of the Project to attract equity because:

(a) They will not commit to fund a pool of construction capital unless the equity funds that will be expended first have been precommitted.

(b) Regardless of the size of the initial construction capital pool, lenders must be convinced that if the pool is exhausted, the Project can offer a high enough return to attract completion capital from equity investors who did not participate in the initial financing.

This brief financial perspective examines the likely views of potential equity investors on Project risks during the precertification and construction phases. These views underline the need for a Project Risk Premium which fully compensates equity investors for the risks which must be assumed prior to Project completion and operation.

a. Precertification Phase

From a financing standpoint, the most crucial stage of the Project unquestionably is the period prior to receipt of a final FERC certificate and the commitment of construction capital. During this time, it will be necessary to build Project momentum and attract several hundred million dollars of equity capital to fund precertification activities and thereby maintain the Project's construction schedule. This must be accomplished despite the fact that the concerns of potential equity investors--that construction financing for the Project will not be forthcoming--will reach a pessimistic peak during

the precertification phase.

In evaluating the risk that the Project will not receive the required construction financing commitments, potential equity investors will consider that capital markets already perceive technological, regulatory and economic problems to be so vast and complex as to approach unmanageability in the context of conventional risk/reward analysis. These problems include the following:

(a) The very size of ANGTS, the largest private financing ever undertaken, generates skepticism in the financial community. ANGTS' capital requirements would make it one of the ten largest industrial corporations in America.*

(b) The current economic climate is very unfavorable, making it more difficult to raise the necessary capital:

(1) Interest rates are approaching a new all-time high, reflecting fierce competition for capital which will continue to be exacerbated by forthcoming Federal budget deficits.

(2) Concern over domestic inflation and the strength of the dollar have impaired the competitiveness of dollar-denominated returns in world capital markets.

(3) The consensus among economists is that the United States faces an impending recession.

(c) The spectre of TAPS delays, cost overruns, and regulatory, engineering and administrative problems

*See, Fortune May 8, 1978, p. 240.

never can be removed completely from the investment community's assessment of the Project risks.

(d) The publicity afforded the current lower-48 gas glut, new sources of gas in Canada and Mexico, and exotic (and as yet technologically or economically infeasible) domestic alternatives has caused some doubt in financial circles that Alaska gas will be marketable.

(e) Most importantly, the year-long delay in the passage of the 1978 energy legislation and the perceived absence of recognition by Federal agencies of the Project's need for timely and constructive regulatory rulings have fundamentally undermined the central premise of the Project's financing plan--that the Project will be the beneficiary of a unique cooperative effort between the Federal government and the Project sponsors. The sensitivity of equity contributors to this consideration was highlighted by the decision of the existing partners in the Alaskan Northwest Natural Gas Transportation Company, the Project's owner and operator, to reduce significantly their funding commitments for the first half of 1979, until a proper regulatory climate is established.

Additional capital from the Project sponsors and, a fortiori, outside equity sources, will be forthcoming only

if there emerges a demonstrable pattern of support for the Project from Federal regulatory agencies. Investor interest in the Project will increase with evidence of regulatory support in two important areas. First, there must ensue a pattern of timely and positive regulatory rulings on such issues as environmental and technical stipulations and the scope change and inflation adjustments in the IROR procedure. This will alleviate the existing open-ended character of the regulatory risk which currently threatens the Project's financeability. Second, once this financeability risk has been reduced to assessable proportions, prospective precertification equity investors must be offered a premium sufficient to induce them to bear that risk. The premium must reflect the unprecedented degree, scope, and complexity of precertification phase risks as well as the construction risks evaluated in the following section.

b. Construction Phase

As has been explained, once capital has been committed and building gets underway, the risk of abandonment will be reduced significantly. Nonetheless, the Project will continue to face a unique set of risks that could exhaust the Project's construction capital pool and jeopardize the marketability of Alaska gas. Moreover, the threat of abandonment is multiplied by the Project's dependence on the completion of the other segments of ANGTS and the fact that the price of Alaska gas will reflect the costs of all segments of ANGTS.

In sum, the risk of Project abandonment during the construction phase, while relatively less than that during the precertification phase, is perceived by the financial community as substantially more significant than the construction risks of any lower-48 pipeline.

STATE OF ALASKA
THE LEGISLATURE

POUCH Y - STATE CAPITOL
JUNEAU, ALASKA 99811
907-465-3800

LEGISLATIVE AFFAIRS AGENCY

MEMORANDUM April 17, 1979

SUBJECT: Assessment by Northwest Alaskan Pipeline Company of Project Abandonment Probabilities

TO: Special Joint Committee on Gas Pipeline Financing
Other Interested Legislators

FROM: Gregg K. Erickson
Director of Research

The attached report was prepared by Northwest Alaskan Pipeline Company to support their position on the pipeline rate of return issues before the Federal Energy Regulatory Commission. Its purpose is to assess the risks that will have to be accepted by investors in the Alaska Natural Gas Pipeline Transportation System. Its findings are that these risks are extremely high, and that investors will have to be compensated for these risks with substantial premiums.

Overall, it is a remarkable document, reading in part like the prospectus for a krypton mine on the moon. For example, the table on page 24 shows that the probability of project abandonment during the period 1979 to 1985 is between 53% and 60%.*

The risk profiles which support this probability distribution are "based entirely on the combined assessments of the number of individuals either employed by or directly associated with the Northwest Alaskan Pipeline Company."

Attachment

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* These are the cumulative probabilities of the pipeline failing within the seven years from 1979 to 1985. They are calculated by multiplying the probabilities of project survival in each year (1 minus the amounts listed on p. 24) and subtracting the result from 1. The formula is:

$$P = 1 - \left[\prod_{\eta=1979}^{1985} (1 - P_\eta) \right]$$

where: P = The probability of abandonment during the period 1979-1985; and

P_η = Probability of abandonment in the ηth year.