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In 1968, a feasibility cost study estimated that an oil pipeline system from Prudhoe Bay to Valdez, Alaska, would cost $863 million for a 500,000 barrel-a-day line or $1.046 billion for a 1.2 million barrel-a-day capacity. After construction began in 1975, the Alyeska Pipeline Service Company, the agent for the companies designing and building the pipeline, established a base control budget of about $6.4 billion. By December 1977, this budget had been exceeded by about $1.5 billion (23%). The $19.8 million additional direct labor hours needed to complete the project accounted for most of the $1.5 billion increase. Findings/Conclusions: Several key lessons can be learned from Alyeska's experience and applied to similar future projects: (1) first and subsequent cost estimates should be viewed with skepticism; (2) as much site-specific data as is economically practicable should be obtained; (3) technical and geological uncertainties should be thoroughly investigated; (4) Government approval should be contingent on detailed planning for management control, including budgetary controls; and (5) the Alaska natural gas pipeline project's expenditures should have an ongoing Government audit to protect the public interest. Alyeska's contract with its execution contractors were reimbursable cost-plus-fixed-fee and fixed overhead; the contractors did not have the financial incentive to minimize costs as they would have had under other contractual arrangements such as fixed-price contracts. Alyeska's experience showed that the no-strike clause in the project labor agreement prevented section-wide or project-wide strikes. Contractor personnel generally interpreted the environmental requirements less restrictively than did Government personnel, and Alyeska

had to make some adjustments to accomodate the Government's interpretation. (RBS)

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Lessons Learned From Constructing The Trans-Alaska Oil Pipeline

Lessons learned from constructing the trans-Alaska pipeline system should be used to minimize costs and improve the effectiveness of future large-scale arctic construction projects.

This report concentrates on the issues of project budget estimates, management and labor, and Government involvement.

It was made at the request of the Chairman, Senate Committee on Energy and Natural Resources.

UNITED STATES GENERAL ACCOUNTING OFFICE

EMD-78-52

JUNE 15, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-174944

To the President of the Senate and the
Speaker of the House of Representatives

This report describes the growth in cost estimates for building the trans-Alaska oil pipeline. The report draws upon the experience gained in constructing the oil pipeline to illustrate potential areas of concern for future projects such as the proposed Alaskan natural gas pipeline project.

We made our review using authority granted under Title V of the Energy Policy and Conservation Act (42 U.S.C. 6381-6384), and pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and the Secretaries of Energy and the Interior.

R.F. Keller

ACTING Comptroller General
of the United States

D I G E S T

It is widely known that construction of the trans-Alaska oil pipeline turned out to be a costly experience. This experience should be applied to future large-scale Arctic construction projects (such as the Alaska natural gas pipeline) in the hope of keeping costs under control.

LESSONS LEARNED

The following lessons from the oil pipeline apply to similar future projects.

--First and subsequent cost estimates should be viewed with skepticism.

--As much site-specific data as is economically practicable should be obtained.

--Technical and geological uncertainties should be thoroughly investigated.

--Government approval should be contingent on detailed planning for management control, including budgetary controls.

--The Alaska natural gas pipeline project's expenditures should have an ongoing Government audit to protect the public interest.

COST ESTIMATES

In 1968 a feasibility cost study estimated that an oil pipeline system from Prudhoe Bay to Valdez, Alaska, would cost $863 million for a 500,000-barrel-a-day line or $1.046 billion for a 1.2-million-barrel-a-day capacity. These estimates, based on minimal site-specific data, contained no allowances for cost escalation.

The $7.9 billion final cost estimate reflects better estimates based on more system design and engineering, greater system sophistication, improved system definition, general price and wage inflation, and actual construction experience. Most of the increase was identified before a large amount of construction had been completed.

Shortly after pipeline construction began in 1975, the Alyeska Pipeline Service Company--the agent for the companies designing and building the pipeline--established a base control budget of about $6.4 billion. By December 1977 this budget had been exceeded by about $1.5 billion (23 percent). Pipeline construction costs increased roughly $1.0 billion, terminal and pump station construction costs increased about $500 million.

The 19.8 million (54 percent) additional direct labor hours needed to complete the project accounted for most of the $1.5 billion increase. The labor hour increase resulted primarily from unexpected site conditions and construction difficulties.

More geotechnical and site-specific work before construction would have reduced the number of surprises encountered once construction started. This is especially true since the pipeline route crosses a wide variety of terrain, goes from arctic to temperate climatic zones, and is located in permafrost and earthquake-prone areas.

PROJECT MANAGEMENT

Alyeska's contracts with its execution contractors were reimbursable cost-plus-fixed-fee and fixed overhead. Contractors would not bid fixed-price type contracts because a definitive design did not exist. Other factors, such as soil conditions and labor productivity in extremely cold climates, were unknown.

While Alyeska was able to negotiate a reimbursable cost contract more quickly, the execution contractors did not have the same financial incentive to minimize costs as they would under other contractual arrangements--such as fixed-price type contracts. For example, labor costs were reimbursable and labor hour overruns did not adversely affect the contractors' fee.

The management systems Alyeska had when construction began in April 1974 were not satisfactory. They were modified during the construction period.

The cost reporting system initially could not provide detailed up-to-date information on actual costs. The May 1975 budget control estimate and the September 1975 pipeline cost center report did not use actual costs. Alyeska's cost control system did not function properly until December 1975--the end of the second construction year.

PROJECT LABOR

Alyeska negotiated an umbrella-type project labor agreement with 17 international unions in late 1973 and early 1974. The agreement included a strong, enforceable no-strike clause.

Alyeska's experience shows that the no-strike clause in the project labor agreement prevented section- or project-wide strikes. As far as GAO could determine, relatively few work stoppages occurred for a construction project of this size.

GOVERNMENT INVOLVEMENT

The Federal Government and the State of Alaska granted Alyeska right-of-way agreements to construct the pipeline on public lands. These agreements contained requirements to protect the public interest in these lands. Many were to minimize

environmental degradation during construction. To insure Alyeska's compliance, both Governments reviewed Alyeska's system design and construction plans and monitored construction activities.

Some disagreements over the meaning of requirements occurred during construction. Alyeska personnel generally interpreted the environmental requirements less restrictively than Government personnel. Alyeska had to make some adjustments to accommodate the Government's interpretation.

Environmental organizations filed a suit in 1970 which delayed construction for several years. Although environmental organizations generally were not allowed on the right-of-way, Alyeska believes that Government agencies' technical staff members represented environmentalists' interest. Environmentalists are currently concerned with the adequacy of the oil spill recovery plan and the effect of opening the haul road to the public in future years.

NO ONGOING AUDIT

The right-of-way agreements contained no requirement that the Government conduct an audit during construction to assure that moneys spent were justified in order to be considered allowable expenses to be included in tariff submissions.

Future agreements granted for similar large-scale projects should contain such a requirement and include a provision for the Government's direct access to project files and records. With such a requirement, the developer would know what costs should be recoverable through the tariff before project completion; the Government could more effectively audit costs and have a better understanding of the project's ultimate costs and its effect on consumer costs.

COMMENTS ON THIS REPORT

The Alyeska Pipeline Service Company disagreed with GAO's lessons learned. Differences of opinion exist about whether

--enough site-specific geotechnical information was obtained before construction;

--fixed-price type contracts for execution contractors were possible;

--any benefits would result from a Government audit during construction; and

--project approval should be contingent upon management systems being operational before starting construction.

The Department of Energy made no substantive comments, noting that the report's information may be useful to Energy in assessing future pipeline construction projects.

The Department of the Interior replied that the regulatory agency responsible for establishing a tariff might appropriately require an ongoing audit.

Formal replies are reproduced as appendixes I, II, and III.

GAO carefully evaluated each comment received and appropriately revised this report.

Tear Sheet

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CHAPTER 1

INTRODUCTION

The Chairman of the Senate Committee on Energy and Natural Resources requested that we examine the increases in the original cost estimates to construct the Trans-Alaska pipeline system. We were also requested to address the implications that this project would have on similar future large-scale energy projects.

In a previous report, 1/ we presented the results of our literature research into published information available on Alaskan oil.

This report focuses on the lessons learned from building the system and highlights the issues of project budget estimates, project management, project labor, and Government involvement which can be useful in assessing similar future projects.

COMPANIES RESPONSIBLE FOR THE PIPELINE SYSTEM

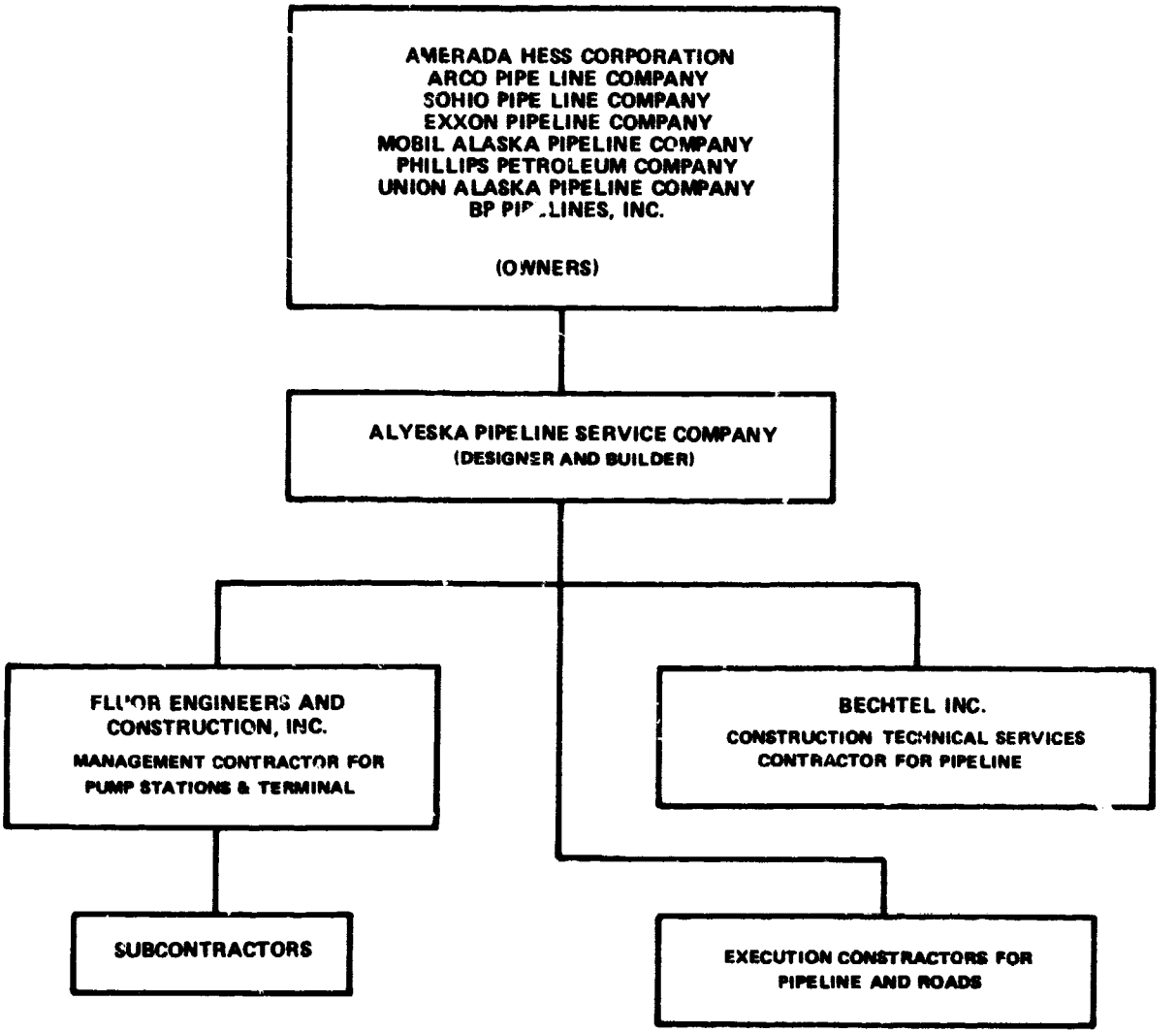
In August 1970 the permittee companies formed the Alyeska Pipeline Service Company as their common agent for designing, constructing, and operating the pipeline system. The organization of the private interests involved in this undertaking is shown on page 2.

In 1972 Alyeska hired Fluor Engineers and Constructors, Inc., as its prime contractor for the stations and terminal; the contract included management of subcontracts. In 1973 Alyeska hired Bechtel Incorporated as construction management contractor for the pipeline. Bechtel's responsibility included managing the execution contractors (contractors that were to perform the actual construction work). In early 1975 Alyeska relieved Bechtel of its responsibility as construction management contractor for the pipeline but retained it as construction technical services contractor for the pipeline. Alyeska removed Bechtel because of its performance in certain areas, a desire to simplify a duplicative management structure, differences in management philosophy, and the owner companies' desire for more direct control.

1/"Survey of Publications on Exploration, Development, and Delivery of Alaskan Oil to Market," EMD-77-11, Jan. 14, 1977.

CHART I

COMPANIES RESPONSIBLE FOR DESIGNING, BUILDING, OR OPERATING THE TRANS–ALASKA OIL PIPELINE SYSTEM



On January 23, 1974, the Secretary of the Interior and the owner companies signed the agreement and grant of right-of-way for the trans-Alaska pipeline. On May 3, 1974, the State of Alaska and owner companies signed the right-of-way lease.

Pipeline system construction officially began on April 29, 1974. In 1974 Alyeska constructed a 361-mile-long, 28-foot-wide, gravel-surface road roughly parallel to the pipeline route from the Yukon River to the Prudhoe Bay oil field. Alyeska also built construction camps in 1974 and began site preparations.

Actual pipeline construction began in early 1975; the construction schedule called for completion of the pipeline system in phases, and the pipe was to be installed by November 1976. The system was to be capable of transporting 600,000 barrels of oil a day by mid-1977, when five pump stations and the terminal would be complete. The system was to have a nominal design capacity of 1.2 million barrels a day when it was completed. However, due to the oil's thickness, which affects the oil flow through the pipeline, the pipeline's actual capacity is 1.16 million barrels a day.

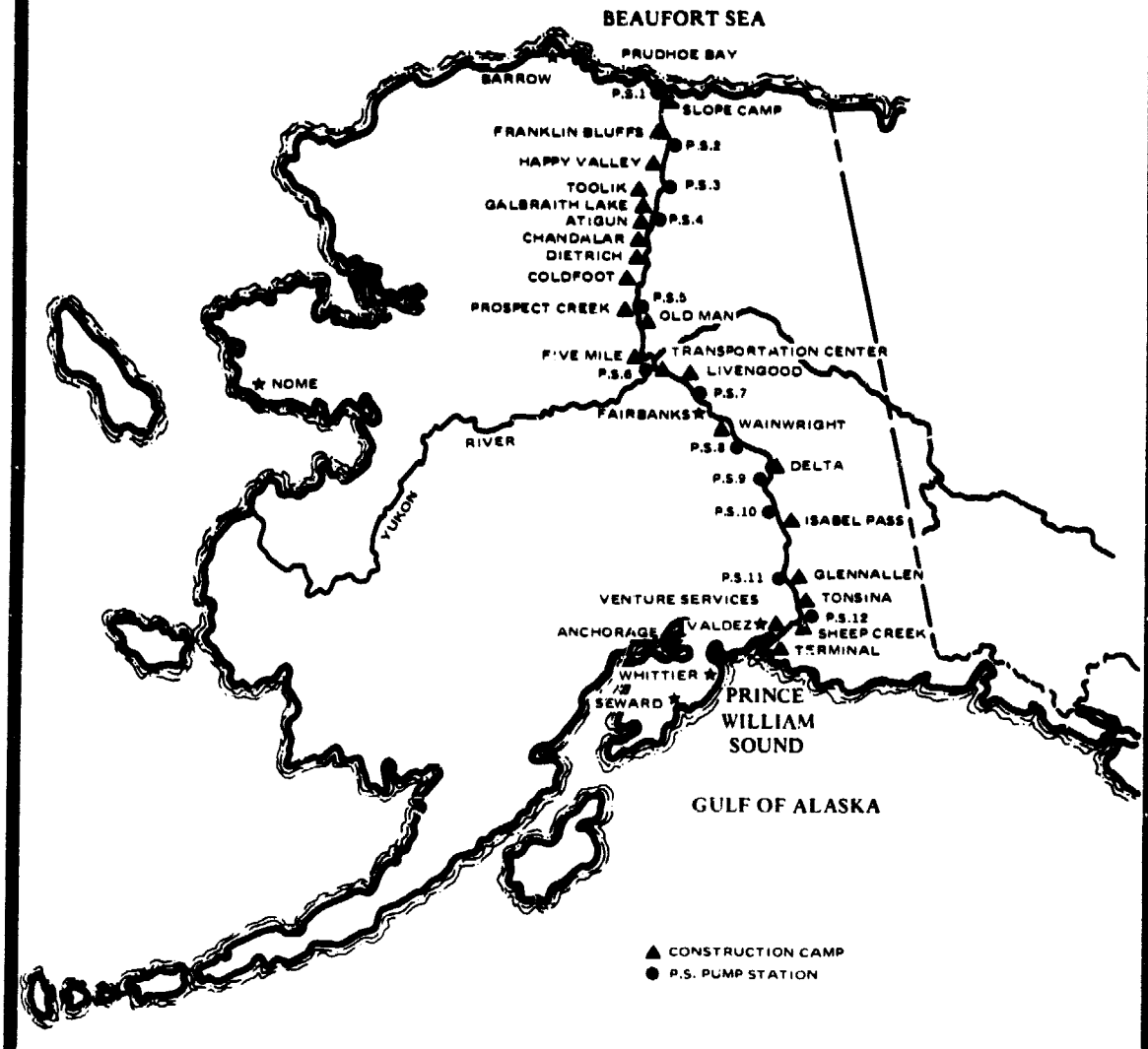
Pipeline construction was completed in May 1977, and the first oil entered the line on June 20, 1977. On July 8, 1977, an explosion at pump station 8 destroyed the main pump building and, as a result, the oil flow through the pipeline did not approach capacity until April 1978.

The pipeline system was privately financed by the owner companies. As of December 1977 the estimated cost of construction, excluding interest, was $7.940 billion. The assets are owned in common; each owner is an individual common carrier and files for its own tariff rate in accordance with State and Federal laws and regulations covering its share of the capacity. The owners each collect their own revenues payable by shippers under such tariffs.

THE TRANS-ALASKA OIL PIPELINE SYSTEM

The trans-Alaska oil pipeline extends from Prudhoe Bay on Alaska's North Slope to Port Valdez (see map on p. 4). The pipeline system consists of about 800 miles of 48-inch pipe, 12 pumping stations, a communications system, and a terminal at Port Valdez.

TRANS-ALASKA OIL PIPELINE ROUTE



Before the start of pipeline construction, the right-of-way was cleared and a work pad was constructed. The gravel work pad, which covers most of the right-of-way, was needed to support construction and maintenance activities and to protect the tundra. To support pipeline construction, Alyeska constructed and operated many temporary facilities, including 14 airstrips and 19 pipeline construction camps. Nine pump stations and the terminal also had temporary construction camps to house, feed, and supply the workers. Permanent State airfields were constructed near three camps.

Other than the three pump stations which are pass-through stations, the pump stations are equipped with pumps, pressure-relief systems, storage tanks, shops, warehouses, personnel housing, a food service facility, electrical generators, a central heating plant, water treatment and storage facilities, a sewage and waste disposal system, and an automatic fire detection and extinguishing system.

The 1,000-acre terminal site will have the capacity to store about 9.2 million barrels of oil. The terminal also includes

--three fixed berths and one floating berth for tankers,

--a treatment facility to process the ballast water received from incoming tankers prior to discharge into the sea,

--a vapor-recovery system to prevent oil fumes in the storage tanks from escaping into the atmosphere, and

--a computerized control center and various administrative buildings.

To prevent damage from earthquakes, the terminal facilities at Valdez are built largely on bedrock and well above the level of potential seismic sea waves.

The pipeline's communication system consists of a microwave system, a backup satellite communications system, and a radio communications system. The 41 permanent microwave stations link all pump stations. pipeline maintenance stations, and remotely controlled block valves with the Valdez control center.

The climate, soil, and seismic conditions along the pipeline route are unusual and required special construction techniques. Temperatures range from 90 degrees F. in the

summer to minus 70 degrees F. in the winter, the soil under much of the route is permanently frozen, and earthquakes in the area may range as high as 8.5 on the Richter scale. All posed special construction and design problems.

In those areas where the soil becomes unstable when thawed, the pipeline was installed above the ground on support platforms that are 50 to 70 feet apart. A support platform consists of a crossbeam installed between two vertical supports placed in the ground. To compensate for the expansion and contraction of the above-ground pipe due to temperature changes, the line was built in a zigzag configuration and secured in an assembly that allows the pipe to slide on a cross beam. (See pp. 8 and 9.) About 422 miles of the pipeline were constructed in the above-ground mode.

About 341 miles of pipeline are buried in the conventional manner where the soil remains stable even when thawed. There are also about 4 miles of buried pipeline that required a special ground refrigeration system, and 32 miles of river and steam crossings.

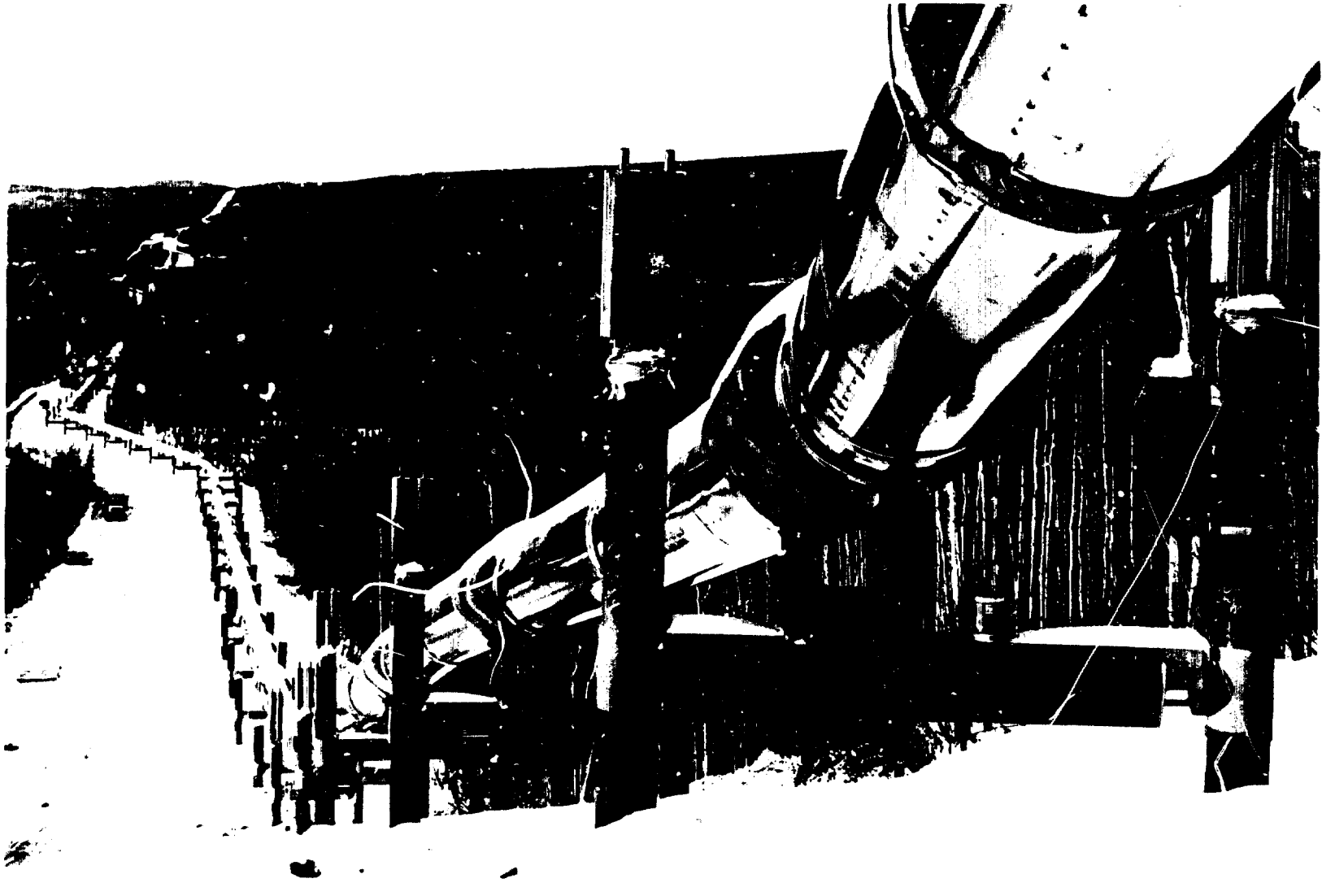
SCOPE OF REVIEW

We reviewed documentation of the Alyeska Pipeline Service Company at their offices in Anchorage, Alaska. At the time of our study, three separate Government audit groups needed Alyeska data. Alyeska hired a law firm to respond to these requests and to act as liaison. Alyeska stated that they established this procedure to protect its rights in the event of any future litigation. In the interest of obtaining as much information as possible for hearings held by the Senate Committee on Energy and Natural Resources, we agreed to this. While we can appreciate Alyeska's need for the arrangement, it caused us procedural difficulties in getting the information necessary to carry on our review, and left us with much uncertainty about the completeness of the information given in response to our requests. Furthermore, we cannot attest to the accuracy of the information obtained.

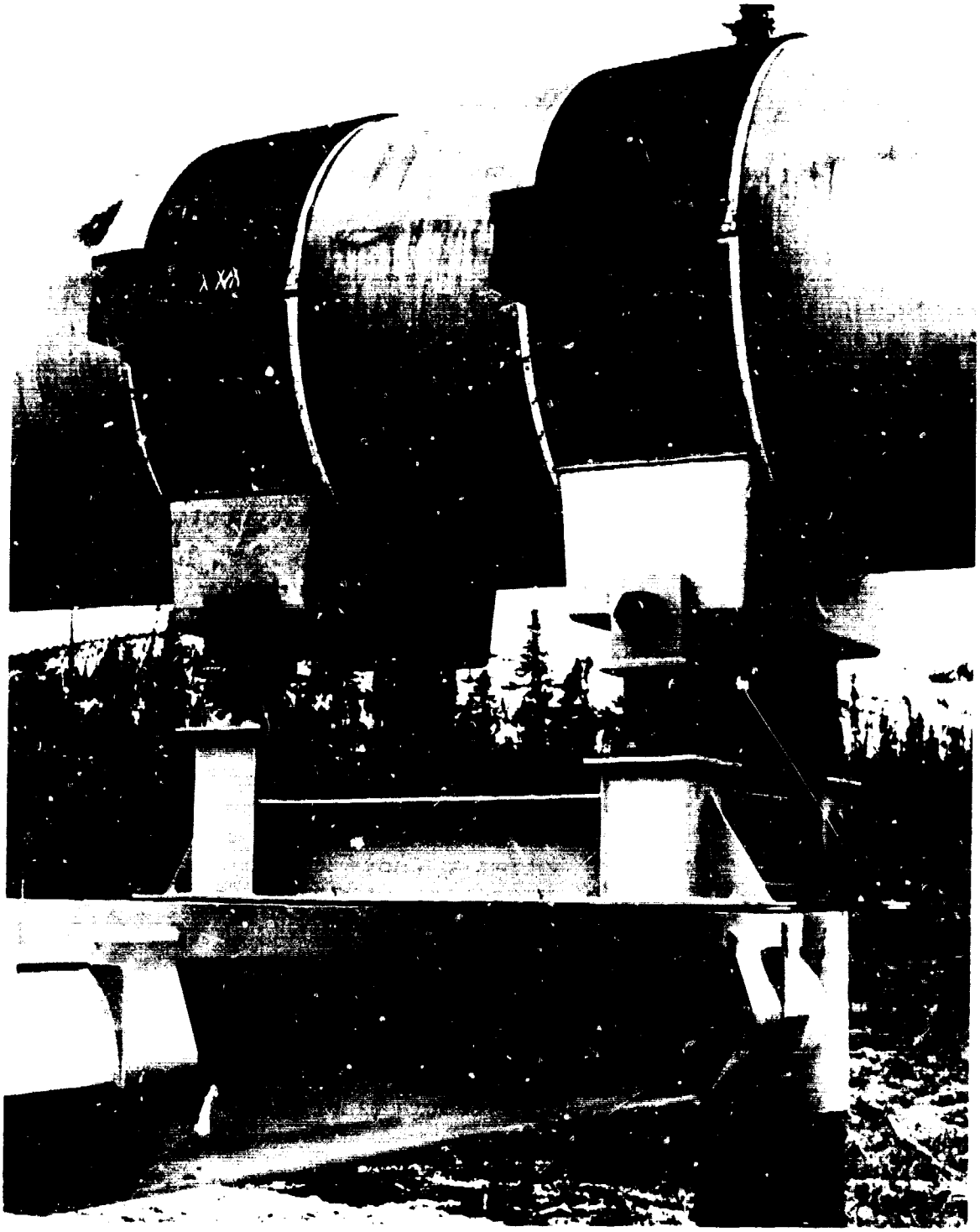
We interviewed officials of Alyeska, the construction management contractors, several execution contractors, unions, and the Department of the Interior's Alaska Pipeline Office.

With assistance from a labor relations consultant, we evaluated the project labor agreement under which the project was constructed.

We also reviewed information presented in public hearings held from 1968 to 1977 relating to the granting of the right-of-way and protection of the environment. We discussed the environmental concerns with current officials of environmental organizations in Washington, D.C.; Anchorage, and Fairbanks, Alaska.



This above-ground section of the trans Alaska pipeline crosses the Tatalina River valley about 15 miles south of Livengood, Alaska. The zigzag pattern of the pipeline allows for expansion and contraction of the pipe during temperature changes. Alyeska Pipeline Service Company



Above ground sections of the Alaska pipeline are secured in a shoe-and-saddle assembly, which allows the pipe to slide on the crossbeam as the line expands due to temperature changes.
Alyeska Pipeline Service Company

CHAPTER 2

COST ESTIMATES INCREASED DURING PLANNING AND CONSTRUCTION OF PIPELINE SYSTEM

A 1968 feasibility cost study for a 500,000-barrel-a-day pipeline system from Prudhoe Bay to Valdez, Alaska, showed the cost to be $863 million. At the same time a 1.2 million-barrel-a-day pipeline system was estimated to cost $1.046 billion. Between 1968 and December 1977, cost estimates for the 1.2-million-barrel-a-day system increased from $1.046 billion to $7.940 billion. This increase reflects better estimates that are based on more system design and engineering, greater system sophistication, improved system definition, general price and wage inflation, and actual construction experience.

Most growth occurred before a large amount of permanent construction work had been done. Nearly half occurred before the start of 1974 preconstruction work (roads, camps, and site preparation). Table I shows estimated construction costs at four different times.

Table I

Estimated Costs for Constructing the 1.2-million-barrel-a-day Pipeline System

(in billions)

Date	Event	Estimated cost
1968	Initial estimate (note a)	$1.046
May 1974	Start of preconstruction	4.088
April 1975	Shortly after start of permanent pipeline construction	6.375
December 1977	After 6 months of operation	b/7.940

a/Based on 1968 feasibility study.

b/Construction cost estimate as of December 31, 1977, includes the cost estimate for reconstructing pump station 8.

INITIAL ESTIMATE NOT BASED ON SPECIFIC INFORMATION

The initial estimate was developed from a 1968 feasibility cost study prepared by several owner companies. It was based on limited information available at that time and prepared before the pipeline had been designed or engineered,

and before extensive soil studies were performed. It was based on 1968 material and labor prices with no allowance for cost escalation and no expectation of the subsequent 4-year delay in start of construction because of a lawsuit filed by environmentalists.

The owner companies' estimate provided very little leeway for such unforeseen developments, even though there was a lack of historical experience on which forward projections could be made. In 1968 there was no experience on pipeline construction in the Arctic. The estimate included about a 10-percent contingency allowance even though in normal engineering practice initial estimates based on an outline design are expected to be accurate only to within a 15- to 30-percent margin. Even a 30-percent contingency would have been way off, given that the actual cost will be several hundred percent over the original estimate. Alyeska states that inflation contributed significantly to this increase.

However, the 1969 oil pipeline estimate also:

--Greatly underestimated the number of miles of elevated pipeline required. It anticipated about 240 miles of elevated pipeline; about 422 miles were constructed in the more expensive above-ground mode.

--Did not anticipate the need to construct a highway bridge across the Yukon River.

--Did not anticipate the need to construct a 361 mile gravel-surface road from the Yukon River to the Prudhoe Bay oil field.

--Assumed a system and design having a much lower level of environmental standards than was subsequently required.

--Gave no consideration to the magnitude of the support structure, such as camps and airstrips that would be required.

--Contained no provision for a work pad south of the Yukon.

--Included no provisions for the vapor recovery facilities at the Valdez terminal and at pump station number 1, which were required for maintaining air quality standards.

--Contained no provision for the sophisticated ballast water treatment system required to meet water quality standards.

--Did not anticipate the sophisticated elevated pipeline system needed, in part, to meet seismic and thermal stipulations, but, rather, contemplated an above-ground system consisting of pipeline mounted on wooden piles or raised gravel.

In making the estimate, the owner companies recognized the pioneer nature of the project. They concluded that satisfactory materials metallurgy, construction methods, construction equipment, and logistic means would have to be developed through design efforts. A more definitive design would be prepared when the main pipeline route was settled and other design factors were developed.

COST ESTIMATES INCREASED TO $4.088 BILLION PRIOR TO START OF CONSTRUCTION

From 1969 to May 1974 construction activity awaited resolution of court actions and the issuance of Federal and State right-of-way agreements. During this time, the cost estimate increased several times--rising to $4.088 billion to reflect more detailed system definition and design, additions to system size and sophistication, delay costs, route and design changes, and the results of cost estimates prepared by outside companies under contract with Alyeska.

Alyeska did not develop a detailed, comprehensive budget for the pipeline portion until after construction started in May 1974, by which time Federal and State right-of-way agreements had been signed.

ESTABLISHMENT OF $6.375 BILLION BASE CONTROL BUDGET

Alyeska, the owner companies, management contractors, and execution contractors made substantial efforts in 1974 and early 1975 to develop a more accurate and detailed budget estimate for the pipeline portion. The $6.375 billion budget control estimate shown in table II was ultimately developed as a control mechanism and accepted by the owner companies. The pipeline base control estimate was the first estimate supported by firm commitments for nearly all permanent materials and for most construction equipment, support services, camps, and other temporary facilities.

Design engineering was about 90-percent complete at this stage, but uncertainties still existed about soil conditions, labor productivity, and equipment durability and effectiveness. According to Alyeska substantial design-related uncertainties remained. For example, the design of Antigun Pass was not finally approved until June 1976, and the alignments for Keystone Canyon and Thompson Pass were still uncertain. The work pad design for several areas was still uncertain and the alignment of the fuel gas line in the northern portion was still unresolved.

The haul road and construction camps had been built, and pipeline construction had begun, with the terminal and pump stations being about 5- and 3-percent complete, respectively.

Table II

Base Control Budget as of April 30, 1975

(in billions)

Division	Estimated cost
Pipeline and roads	$3.969
Stations and terminal	1.421
Alyeska corporate	0.985
Contingency allowance	-
Total	$6.375

Pipeline and roads

In October 1974 Bechtel submitted a pipeline and roads control estimate of $3.216 billion. This estimate was based on detailed construction plans and schedules and on labor and equipment requirements prepared by the execution contractors. Firm commitments for nearly all permanent materials and for most construction equipment, support services, and camp and other temporary facilities supported the estimate. It included preliminary appraisals of spare parts, catering, transportation requirements, and communications.

In December 1974 a joint Alyeska/Bechtel task force started to update Bechtel's October 1974 estimate and provide more detailed support. In March 1975 the results were issued for support services, materials, and logistics without update for labor hours and other requirements for actual construction of pipeline segments.

In April and May 1975 Alyeska estimated the labor hours and equipment use required by the execution contractors as of April 30, 1975, and then modified support service costs. The effort generally followed the recommendations of the task force formed by the owners to review cost estimates. The pipeline and roads estimate became $3.969 billion.

Terminal and pump stations

In October 1974 Fluor completed a detailed $1.409 billion estimate for pump stations and a terminal. Previously, according to the Fluor project director, Fluor had prepared a $1.613 billion estimate which greatly understated costs because Alyeska and the owner companies wanted to keep the cost estimate low. For example, submitted terminal site preparation costs were about $68 million less than Fluor's own private estimates. Alyeska cut another $65 million and did not approve inclusion of a contingency allowance, which lowered the estimate to $1.409 billion. However, part of the reduction was due to scope changes. The owners reviewed and approved the $1.409 billion figure as a control estimate on October 30, 1974.

As of April 30, 1975, approved changes brought the pump stations and terminal estimate to $1.421 billion and the Alyeska Corporate estimate to $985 million.

Thus, as of April 30, 1975, the total estimate was $6.375 billion without a contingency allowance. At that time, road and camp construction, surveying, and site preparation had been substantially completed. As for pipeline construction status, ditching for buried pipe and erection of supports for elevated pipe had just begun.

Contingency allowance

In issuing the base control estimate, Alyeska cited labor and equipment productivity, abnormal weather conditions, and design changes caused by new geological data as factors which could signficantly affect project cost and schedule. Alyeska recommended a contingency allowance of $330 million--5.2 percent of the base control estimate. The owners reviewed the recommended contingency and decided that the $6.375 billion control estimate containing no contingency amount should be used to control the expenditures of Alyeska and Alyeska's contractors. The owners considered that a contingency figure might adversely affect Alyeska's efforts to minimize construction costs.

Alyeska's vice president for construction, on loan to Alyeska from Exxon, stated that an Exxon project would have a contingency allowance of more than 10 percent until its scope and problems were much more clearly defined than this project was at the time the control estimate was made. This would be particularly true in light of the lack of historical data on labor and equipment performance, the lack of prior construction along the pipeline route, and the amount of engineering design completed. Alyeska's manager for cost engineering and scheduling said that normally, when substantial site-specific data are available, a 10-percent contingency fund would be included in the budget, and management would attempt to hold costs to within an additional 10 percent of budget. He also said that a 15-percent contingency fund would probably have been appropriate because the unknowns were much greater than on a normal construction project. According to the Fluor project director, in addition to the 10-percent specific contingency allowance Fluor proposed for terminal and station construction, he would have added a 5-percent general contingency allowance in estimating final cost--roughly a 15-percent total contingency allowance for stations and terminal.

REASONS FOR INCREASE OVER BASE CONTROL BUDGET

As pipeline construction proceeded from 1975 to 1977 (when oil entered the pipeline) the control budget was continually revised upward through hundreds of amendments. By December 1977 the approved control budget had increased to an estimate of about $7.9 billion, about $1.5 billion (23 percent) above the control budget.

About $1 billion of the increase occurred in pipeline construction; the other $0.5 billion increase occurred in terminal and pump station construction. The principal reason for the increase was that 54 percent more direct labor hours (19.8 million hours) were needed to complete the project than estimated. The labor hours shown in table III were supplied by Alyeska in commenting on a draft of this report. We could not reconcile these figures with other estimates Alyeska supplied during our audit.

Table III

Direct Labor Hour Estimates

(in millions)

	May 1975 Budget	June 1977	Change hours	Change percent
Pipeline	20.0	34.7	14.7	73
Stations	6.9	8.0	1.1	16
Terminal	9.9	a/13.9	4.0	40
Total	36.8	56.6	19.8	54

a/Terminal hours as of July 1977.

The increase in direct labor hours over the May 1975 estimate was caused primarily by unexpected site conditions and construction difficulties. These factors also caused schedule slippage into winter months which further increased the number of labor hours required. The increased labor hours also resulted in increases in equipment requirements and various support activities. Alyeska stated that the labor hour increase on the pipeline portion was caused primarily by construction difficulties in installing the above-ground pipe.

All these factors were not beyond Alyeska's control. More geotechnical and site-specific work before the start of construction would have reduced the number of surprises encountered once construction started.

Alyeska states that had more site-specific exploratory work been economically and practically feasible, the surprises encountered during construction would have been reduced and a more realistic prediction of the work difficulty in areas such as Antigun Pass and Thompson Pass could have been made as well as a more realistic estimate of the high cost of work in these areas. According to Alyeska, there still would have been surprises and the work to overcome the difficulties caused by soil conditions still would have been required--even if the conditions had been predicted.

Unanticipated work caused by site conditions

Alyeska officials stated that numerous problems encountered during construction were not expected during design and estimating. For example, site conditions along the pipeline route varied far more than envisioned. Alyeska did not know the specific site conditions until ditches were excavated or holes for vertical supports were drilled. In the

terminal and several stations, unanticipated site conditions greatly increased the work to be done.

Some unexpected site conditions and construction difficulties encountered in pipeline construction were:

--In many areas, much more groundwater existed during the warmer months than had been expected. This required continuous pumping on sections of ditch for underground pipe and also interfered with vertical support installation.

--The ditch for belowground construction often had to be dug deeper and wider than planned for both pipe and valves; the greater depth, in turn, required more backfill material.

--Soil conditions changed so quickly from one location to the next that the vertical support depth could not be determined in advance. As a result, longer vertical supports and thermal devices which fit inside the vertical supports were needed. To compensate for the longer lengths, available sizes were joined together and workers were moved to another location pending shipment of the proper length material. This created an erratic work pattern.

--The permafrost was harder to move and drill than planned. This increased blasting requirements and the time necessary for drilling holes for vertical supports.

--The number of sites for obtaining backfill materials for belowground pipe was fewer than planned, and the amount of hauling was consequently greater than planned.

--The alignment tolerances for aboveground and valve support structures and for belowground valves were far more critical than planned. Thus, alignment required more time. Also, temperature changes and slight settlement of vertical supports caused sufficient movement of the pipe to require realignment.

--Because of subsurface conditions, terminal site preparation increased even beyond Fluor's informal expectations, which were much higher than those on which the base control budget was estimated.

At the terminal site, because of unstable slopes, about 8,000 rockbolts had to be driven 30 to 50 feet into a mountain--a totally unexpected requirement.

In regard to pump stations, when efforts to get past permafrost and establish a satisfactory conventional foundation on bedrock proved unsuccessful, it was necesary to redesign three stations and refrigerate under the foundations to keep the soil frozen.

By obtaining more site-specific geotechnical data, Alyeska could have, in our judgment, improved the engineering and system design and reduced the number of subsequent design changes. In turn, this would have improved the base control budget's accuracy and improved Alyeska's chances of negotiating fixed-price type contracts for pipeline construction. Alyeska officials stated that because Alaska soil conditions vary greatly within just a few feet, increasing the number of soil borings along the route might not substantially improve design but might be prohibitively expensive. In Alyeska's opinion, increasing the number of soil borings would not have substantially improved design or significantly lessened construction difficulties.

Schedule slippage into the winter months

The numerous problems encountered during construction caused Alyeska to do more winter work on the pipeline than originally planned in order to maintain their 3-year construction schedule. Construction began on April 29, 1974, with the goal of getting oil flowing in the line 3 years later (by the summer of 1977).

With firm target dates and camp capacity limiting the number of workers, the only alternative other than overtime (which had a limit since the actual workweek for pipeline construction exceeded the planned 70 hours) was to do more work later in the construction season.

It takes more labor hours to accomplish the same amount of work during the cold winter months in the Arctic and subarctic. The effects of Arctic and subarctic weather on worker performance are significant. At minus 20 degrees labor productivity is only about 25 percent of summer productivity; at minus 35 degrees and below, outside workers' efficiency is reduced to almost zero. Temperatures in Alaska range down to minus 70 degrees. When extremely low temperatures are coupled with wind, the result can be a wind chill equivalent to a still air temperature as low as minus 100 degrees. An Alyeska official stated that when working in minus 65 degrees with a 40-knot wind, workers spent 15 minutes working and 15 minutes in a warming shack.

Worker efficiency

Several factors affected worker efficiency. The required labor force was so large that there were insufficient experienced workers available to meet the demand. This necessitated hiring inexperienced/unqualified personnel who required considerable training and whose productivity could be expected to be lower than normal.

In addition, the Alaska hire/fire law gives priority to Alaskan residents when hiring or laying off workers. According to Alyeska officials, the law contributed further to the hiring and continued employment of inexperienced workers.

Indirect effects

The increased direct labor hours and the accompanying schedule slip added to indirect labor hours and nonlabor budget items such as equipment, equipment repair, spare parts, camps, and catering.

For the terminal and the stations, actual indirect hours through May 1977 were more than double those estimated in May 1975--about a 6.5 million hour increase. Pipeline indirect hours increased by about 5 million, or about 26 percent, between May 1975 and June 1977. Underbudgeting some base control details also increased the budget estimates for these items. For example, labor hour increases within a relatively fixed time frame required additional equipment to keep the increased manpower productive. In addition, Alyeska had expected to release heavy construction equipment from the pipeline construction in sufficient time for other uses. With slips in the pipeline schedule, additional equipment had to be obtained to do other work on the project.

WHY PROJECTS ARE UNDERESTIMATED

There have been similar patterns of costs spiraling after optimistic estimates in other projects of the same type; it happened in North Sea oil development, for example. A 1975 management study 1/ pointed out that many North Sea project developers submitted grossly optimistic initial cost estimates--estimates which made totally inadequate allowances for the cost of overcoming the many problems likely to occur during any large development project. These difficulties are inevitable in untried areas such as the Arctic and the North Sea.

1/"North Sea Costs Escalation Study," Peat, Marwick, Mitchell and Co., London, Atkins Planning, Surrey, England, Dec. 19, 1975.

Why do project managers tend to make such unrealistically low assessments? The study noted a cluster of beliefs which have widespread industry acceptance:

--Teams assessing a project's feasibility generally believe that realistically high estimates might result in worthwhile projects being rejected too early. Since these teams frequently develop a deep personal involvement with a project, they may in fact become promoters rather than objective evaluators.

--Estimates which start at a low level and then gradually rise over time are more acceptable than those that are realistic.

--Final costs will tend to rise to meet any approved estimate or amount of money available.

Clearly the public interest is served by insisting on realistic initial assessments. Lacking historical data, the most reliable basis for establishing budget estimates is the development of preliminary engineering design based on as much site-specific data as is economically practicable. Further, in the absence of relevant experience, it is the estimator's duty to emphasize the problem of inexperience and to attempt a quantification of the risks. Risks must be accommodated in the estimate by contingency allowances.

CHAPTER 3

HOW ALYESKA MANAGED THE PROJECT

After the discovery of oil on the North Slope, the owner companies developed a project staff which conducted a feasibility study. Based on the study, the owner companies decided to construct the Alaska pipeline. The eight owner companies entered into an agreement in August 1970 to form Alyeska, a separate corporation, to act as their common agent to engineer, design, construct, and operate the pipeline system. Alyeska top management consisted primarily of personnel on loan from the owner companies. The owner companies retained control of the project through an owner's construction committee. Alyeska top management met monthly with the committee, which approved or modified all major decisions. For instance, the committee approved Alyeska's selection of the construction management contractors and construction execution contractors. The committee approved the budget control estimate and all construction amendments to this budget above $5 million.

The time between August 1970, when Alyeska was formed, and November 1973 when the Trans-Alaska Pipeline Authorization Act (Public Law 93-153) authorized the start of pipeline construction, provided the owner companies and Alyeska the time to refine engineering designs, develop control budgets, and enter into contracts with construction management contractors to assist them in planning for the project. The owner companies, however, proceeded very slowly during this period and resisted Alyeska's original requests for permission to quickly enter into contracts with construction management contractors.

A four-tier management structure existed. Alyeska hired two management contractors: Fluor in December 1972 for the terminal and pump station construction and Bechtel in October 1973 for the pipeline construction. In June 1974 Alyeska contracted with five execution contractors for pipeline construction, while Fluor became the execution contractor for the terminal and the pump stations. Alyeska assumed management responsibility for pipeline construction in early 1975.

The primary objective of management was to complete construction at the earliest practicable date to start oil flowing on schedule and to avoid the large costs to the owner companies that would have resulted from construction delays. Construction began on April 29, 1974, with the goal of getting oil flowing in the line 3 years later (by the summer of 1977). The project managers' primary objective was to insure that milestone dates were met. If they were not, this meant hiring more workers, paying for more overtime, and (or)

having more work done in the winter, when productivity was lower. The managers from the eight owner companies faced strong internal pressures for meeting the 3-year construction schedule.

REIMBURSABLE COST CONTRACTS WITH EXECUTION CONTRACTORS

Alyeska's contracts with its execution contractors were reimbursable cost plus fixed fee and fixed overhead. One advantage to Alyeska in awarding these reimbursable type contracts was that this form of contract could be negotiated more quickly than a fixed-price type contract. According to Alyeska, reimbursable type contracts were used to attract the most qualified contractors to the project, to permit the maximum flexibility of project control and management by Alyeska, and to avoid legally committing the owners to pay contract prices that might be inflated by contingencies potentially greater than any cost increases experienced under cost-reimbursement arrangements.

All parties, including Alyeska, lacked adequate information on which fixed prices could be negotiated. Contractors would not bid on a fixed-price type contract because there was no definitive design. Also, other factors such as soil conditions and labor productivity in extremely cold climates were unknown.

Alyeska stated that (1) no responsible contractor would have entered into a fixed-price type contract underwriting financial risks 2 to 6 times its net worth and (2) the Government's unprecedented involvement precluded negotiating such contracts since no one knew what the Government might eventually require. These statements must be balanced with other factors. Specifically, (1) firms frequently construct projects in excess of their net worth by using performance bonds and (2) a fixed-price type contract can be negotiated to allow revisions for undefined Government requirements which, once defined, could be brought under the same fixed-price type contract at a later date.

Under cost-reimbursement contracts, the contractor has little financial interest in controlling costs because final project costs do not affect his profits. Thus, the contractor does not have the same incentive to minimize costs as would exist under other contractual arrangements, such as fixed-price type contracts. A fixed-price type contract provides the most incentive for efficiency because contractor profits are directly affected by costs. Since fixed-price contracts require precise project specifications and detailed design, this is yet another reason why as much site-specific

data as is feasible should be developed early and thoroughly. We recognize that it is not always possible to enter into this type of contract. However, a contractor should have incentives to control costs whenever possible.

Alyeska selected its five-pipeline execution contractors on this basis: the construction management contractors developed a prospective bidders list for each pipeline section, and Alyeska modified the list on the basis of owner company experiences with particular construction firms. Of 45 contractors expressing interest, Alyeska narrowed the field to 18; of the 18, 13 submitted formal proposals; 5 were selected as execution contractors. Alyeska attempted to match contractors to the sections in which their special expertise or experience would be most useful.

Table IV lists the original and settlement costs which Alyeska provided for the five pipeline execution contractors. The costs shown in the table vary substantially from contract costs Alyeska previously supplied--some costs were higher, some were lower. We could not reconcile the differences.

Table IV

Summary of Execution Contractor Costs

Section		Fixed overhead and equipment cost	Fixed fee	Reimbursable
1	Original	$30,393,818	$13,354,392	-
	Settlement	33,519,917	16,777,440	$232,708,716
	Difference	$ 3,126,099	$ 3,423,048	-
2	Original	$22,333,238	14,045,451	-
	Settlement	a/16,374,042	16,374,042	$234,598,315
	Difference	$(5,959,196)	$ 2,328,591	-
3	Original	$29,552,013	$20,827,200	-
	Settlement	33,240,911	23,645,910	$179,085,101
	Difference	$ 3,688,898	$ 2,818,710	-
4	Original	$11,197,263	$ 4,364,263	-
	Settlement	16,702,803	6,711,862	$198,302,784
	Difference	$ 5,505,540	$ 2,347,599	-
5	Original	$35,792,235	$21,109,235	-
	Settlement	36,877,590	18,251,714	$353,720,791
	Difference	$ 1,085,355	$(2,857,521)	-

a/Part of these costs converted to reimbursable.

CONTROL SYSTEMS WERE UNSATISFACTORY

The complexity and tight construction schedule of the Alyeska project dictated the need for comprehensive systems for project control, properly integrated throughout the project's management structure, to be in existence and effectively operating when construction activities began. To develop such control systems successfully, management must have

--a clear definition of the project,

--sufficient time to develop and prove the system, and

--accurate input data.

When construction began in April 1974, some management control systems in use were not satisfactory. The systems, which included cost control, inventory control, and security programs, were modified over the 3-year contruction period. For example, Alyeska's cost reporting system initially could not provide detailed up-to-date information on actual costs. The May 1975 budget control estimate was not based on such actual costs because of inconsistent and erroneous coding of costs in 1974 and early 1975. Furthermore, even though Alyeska's first overall pipeline cost center report was not published until September 1975, at that late date the report could not use actual costs since no central computerized system to collect actual cost by control center had been developed. It was not until December 1975--the end of the second construction year--that this cost control system began to function properly.

Owner company auditors and a certified public accounting firm audited various Alyeska systems. Their early audits of procurement and inventory systems identified numerous system shortcomings and improvements which could be made. Alyeska modified their systems in response to these audits, and later audits found that these problems had been resolved.

TOTAL PROPERTY LOSSES--ABOUT $1 MILLION

Alyeska instituted procedures to systematically report property lost or stolen in December 1975; information relevant to the period prior to December 1975 may be incomplete. Alyeska's security manager stated that the loss figures for 1974 were particularly unreliable because the project was just getting started and the security contractors had just started working.

According to Alyeska's security manager, a significant percentage of reported losses and recoveries consisted of

project vehicles misappropriated at one location and abandoned or recovered at another. In June 1977 the security manager stated that no heavy construction equipment was missing or stolen. He also said that all vehicles stolen in 1975 and 1976 had been recovered.

From January 1, 1974, through April 30, 1977, Alyeska security reported $3.1 million worth of property stolen or missing. According to Alyeska, about 68 percent ($2.1 million) of that property has been recovered, leaving a net loss of about $1 million. Most losses reportedly were easily portable items such as small tools, radios, calculators, tires, supplies, and parts.

AN ONGOING GOVERNMENT AUDIT SHOULD BE REQUIRED

The right-of-way agreements granted to Alyeska did not contain any requirement that the Government be allowed to conduct an audit during construction to insure that moneys expended were justified in order to be considered as allowable expenses to be included in tariff submissions.

A clear and specific requirement in the right-of-way agreements that provided the Government with direct access to project files and records for conducting an audit while construction proceeded could have eliminated the doubt, both on Alyeska's and the Government's part, about which costs should be permitted to be eventually recoverable through the tariff. Information developed by such an audit may not be binding on the regulatory commission that has the authority to determine which costs will be recoverable through a tariff. However, the audit would furnish information which should minimize the chances for disallowing construction costs, as well as protect consumers from excessive or unnecessary costs. Further, the Government would be in a far better position to conduct a more effective audit of costs and thereby have a much better understanding of the project's ultimate cost.

CHAPTER 4

PROJECT LABOR AGREEMENT

Alyeska negotiated an umbrella type project labor agreement with 17 international unions in late 1973 and early 1974. The agreement was for the duration of construction and included a strong, enforceable, no-strike clause. It provided for uniform working conditions and adopted Alaska wage rates, including fringe benefits.

HOW THE AGREEMENT EVOLVED

For many years, labor-management relations in the U.S. pipeline industry have been handled by the Pipe Line Contractors Association, an industry association located in Dallas, Texas. The basic collective bargaining agreement is the National Pipe Line Agreement, made up of the agreements between the Pipe Line Contractors Association and four unions: Teamsters, Operating Engineers, Laborers, and Welders. These unions provide all the skills required to construct a pipeline without involving the many building and construction trade unions which normally supply labor on a construction job. Work crews in pipeline construction are made up of workers from the four craft unions exercising their respective skills but having the flexibility to cross craft lines on a short-term basis, where necessary, to complete a job. This sharply contrasts traditional building and construction trade union practices.

In 1969, when construction of a crude oil pipeline in Alaska appeared imminent, the Pipe Line Contractors Association negotiated a supplement to its existing National Pipe Line Agreement to cover pipeline construction work in Alaska. By 1972, Alyeska had concluded that a nontraditional pipeline required a nontraditional collective bargaining agreement, namely a project agreement as opposed to the National Pipe Line Agreement.

In 1972 Alyeska formed a task force of labor relations specialists from several of the owner companies. The task force canvassed opinion in the oil industry, the pipeline construction industry, and among construction labor relations experts to develop a package proposal on bargaining for Alyeska's consideration.

Alyeska, union officials, and the labor experts generally agreed that a project agreement was necessary for the following reasons:

--To stabilize the project by (1) involving the general presidents of 17 international unions, and their local unions and (2) including an enforceable no-strike clause and comprehensive procedures to resolve jurisdictional disputes.

--To have a single, umbrella type collective bargaining agreement, subsuming all the construction work on this project and binding on all 17 international unions.

--To facilitate meeting State and Federal Government requirements.

--To establish uniform working conditions covering all workers.

Alyeska also stated that the project agreement was needed to provide for off-site fabrication.

The task force tried to find experienced labor relations people in the construction industry who would assume responsibility for negotiating the project agreement. The construction companies contacted had little interest in such a proposal unless Alyeska would promise a large share of the construction in return for rendering the negotiation service. Alyeska therefore decided to do the negotiating itself.

HOW THE AGREEMENT WAS NEGOTIATED

Alyeska decided to run the project as a union job, provided the unions would agree to certain basic conditions which were taken up with the international general presidents and not the Pipe Line Contractors Association. According to Alyeska's chairman, the Pipe Line Contractors Association was informed of all important matters.

Alyeska's labor relations people spent 8 to 9 months working in preparation for negotiations, which did not begin until the Federal Government issued a permit to begin construction. Negotiations continued for about 5 months during 1973-74 with an average of two meetings per week.

Twenty-two people--5 management and 17 union--made up the bargaining committees. Once the agreement was consumated, only two of them (both from Alyeska) were to have anything to do with the day-to-day administration of the agreement.

None of Alyeska's bargaining committee had indepth large-project construction experience or firsthand knowledge

of Alaska working conditions. However, Alyeska did use other people with labor relations expertise to advise and counsel them. For example, Alyeska kept Bechtel informed of the progress of negotiations and consulted their labor relations people on specific issues.

There is no substitute, however, for being present. Presence at the bargaining table provides firsthand exposure to all the issues, unfiltered by anyone else's perception, and an understanding of the intent of the parties. Having this kind of participation in negotiations would also provide on-the-spot contributions of people such as the construction management contractors who would administer the agreement.

Bechtel and Fluor, the construction management contractors, were absent from the bargaining table partly because Alyeska would not have to contend with the residue of past confrontation and whatever dormant union antagonisms might be mobilized by having Bechtel and Fluor representatives at the bargaining table.

Although the local union representatives from Alaska were not included on the union bargaining committee, the international unions kept them advised as bargaining progressed and reviewed the agreement with them once tentative agreement was reached. However, the elements of understanding, identification, and insight into the contractors are important to the union in doing its job of policing the agreement. Also, the local union representatives were familiar with Alaska working conditions and practices, whereas only 2 of the 17 union negotiators were.

While the bargaining committees could probably not have included all these people at the bargaining table, the committees could have been kept to a workable size by using subcommittees, if necessary. Such an approach would have been more cumbersome and time consuming, but may have led to a clearer understanding from the beginning on the part of all concerned.

THE AGREEMENT'S TERMS AND CONDITIONS

The collective bargaining concept adopted by Alyeska and the 17 international unions was to negotiate a total project agreement setting forth all the usual provisions which make up a collective bargaining agreement.

No-strike clause

Alyeska wanted the strongest possible no-strike clause incorporated into the project agreement. As a result, the

prohibition against strikes, slowdowns, and other disruptive activity appears in one form or another in eight different places in the agreement. The adopted no-strike clause was comprehensive and noteworthy in that it provided a detailed procedure for enforcement in the form of expedited arbitration.

Wages, hours, and working conditions

The wages, hours, and working conditions provision established uniformity in an area where great diversity existed among the various unions. The project agreement was not intended to establish hourly pay rates and employer contributions to benefit funds. Alyeska did what is done in most project agreements negotiated in this country--it adopted the existing local wage rates and employer contributions to established fringe benefit funds. These contributions are over and above the hourly wage rates. However, Alyeska negotiated wage rates for the welders and pipefitters, trades which had no appropriate wage rates in effect in Alaska.

Under the agreement, local labor contracts were renegotiated between contractors and unions as the contracts expired. Alyeska, through its adoption of local contracts, committed itself to applying whatever increases were negotiated during the course of the project. This represented exposure to substantial annual increases in labor costs over which Alyeska exercised no control.

Construction in Alaska is more expensive than in the continental States. Alaska wage rates in 1974 averaged about 25 percent higher than the Pacific Northwest area. The contractor contributions to pension funds in Alaska were, in several instances, many times higher than in nearly all of the lower 48 States.

Wage controls ended in 1974, prior to the execution of the project agreement. Consequently, a substantial increase in wage settlements was to be expected during the construction period. According to a study done by the Contractors Mutual Association, the Anchorage wage rates for the 17 major building trade unions for the period 1974 through 1976 exceeded the national average, as shown in table V.

Table V

Comparison of Average Percentage Increases in Wages and Fringe Benefits

Year	United States (note a)	Anchorage
1974	9.6%	14.0%
1975	9.1	13.5
1976	7.0	13.7

a/U.S. Bureau of Labor Statistics.

The agreement provided a weekly guarantee obligating the contractor to pay a minimum of 40 hours per week to each employee ready, willing, and able to work and on the payroll for the previous week, even if less than 40 hours of work was made available.

Alyeska wanted to get as much work done as possible in order to stay on schedule and to keep the workers occupied, since they had little else to do in the camps. At times, the actual work week was over 80 hours on a 7-day basis. It is difficult to imagine that people could work much more than an average of over 11 hours a day, 7 days a week, or that they were able to work effectively for so many hours per week. However, the long work weeks were made more tolerable by one or two weeks of unpaid rest and recreation every eight or nine weeks.

Very little information is available to indicate the effect of overtime on the unit cost of labor in construction crafts when more than 70 hours per week are worked. A study 1/ shows that for a 60-hour work schedule, after 4 weeks the effective return 2/ on overtime hours is only 50 percent; after 6 weeks--30 percent; after 8 weeks--10 percent; and after 9 weeks, no return on overtime hours exists. In addition, a reduction in productivity occurs for the entire work week--not just for the overtime hours worked. If this data is accurate for 60 hours, when is the point of no return on overtime hours reached at the 70- to 80-hour level?

1/Business Roundtable Report, "Effect of Scheduled Overtime on Construction Projects," Coming to Grips With Some Major Problems in the Construction Industry, 1974, pp. 1 to 14.

2/Weekly productive return as a percent of overtime hours worked.

On this project, unions and workers alike were able to benefit from labor hour overruns and schedule delays. The unions benefited since employee benefits (such as pension, health, and welfare benefits) were paid for on an hourly basis.

Alyeska's payments for pension, health, welfare, apprentice training, and industry advancement were as high as $4.33 per hour. For one union, 2,500 workers generated about $900,000 per week in Alyeska contributions to these funds; this union's peak employment was about 5,000.

Workers benefited, at least financially, from working more hours. For example, a ditch digger earning $12.85 per hour could earn over $1,000 per week (before taxes) based on a 70-hour work week. Some other representative hourly wages are shown in table VI.

Table VI

Hourly Wage Rates as of July 1, 1976

Camp worker (waiter, waitress, general helper, janitor, misc. workers)	$10.71
Fork lift operators (up to and including 5 tons)	12.25
General laborers	12.85
Bulldozer operator	13.76-14.78
Powderman	14.02-14.30
Journeyman carpenter	14.81
Journeyman millwright	15.34
Dump truck operators (over 100 yards)	15.95
Journeyman welder	18.34

Alyeska made no provision for trainee, helper, or sub-journeyman rates--wages 30- to 40-percent below the full-scale rate--for employees such as Alaska residents, and others who had to be hired but who had no construction experience or skill. Rather, they received the full rate of the lowest wage rate--apprentice rates--in the wage scale of the applicable craft. While reduced rates are not usually found in construction contracts, such rates could be justified at least during the period of on-the-job training when the job's minimum requirements were not met.

The labor force

During the 1974-77 pipeline construction period, pipeline construction in the lower 48 States was at a relatively low ebb. Some say that Alyeska had a relatively good supply

of qualified labor; others say that the prolonged low level of construction activity in this industry caused the work force to convert to other skills and work elsewhere.

Getting key craft people working as early as possible to get the job started well and to train others, where necessary, is also critical on any construction project. Consequently, the proper flow of people on the job is extremely important.

The project agreement provided for the construction industry custom of job referral or hiring hall, with the union dispatching workers as requested by the contractor and with the contractor retaining the right to reject any job applicant the union refers.

Local Alaska agreements in many cases entitled the contractor to request, and provided for the union to refer, a limited number of employees who had previously been employed by the contractor within a prescribed period of time before the project. A State of Alaska local hire law limited this provision's practical values, however. The law contained a stipulation granting an employment preference to Alaska natives, women, and minorities.

Terminating an unsatisfactory employee was very difficult in some situations. The Alaska local hire law was interpreted to mean that Alaska residents had to be terminated or laid off last, even though it meant that more qualified, experienced lower 48 State employees would have to be laid off first. If a violation occurred, the law required that the qualified Alaska resident be paid triple the wages lost. Also, contractors believed that they had to be cautious when terminating an Alaskan native, woman, or other minority member to avoid a discrimination complaint and thereby jeopardize their permits.

CHAPTER

HOW THE GOVERNMENT WAS INVOLVED

The trans-Alaska pipeline was constructed almost entirely on public lands. Alyeska obtained permission to use these lands through right-of-way agreements with the State of Alaska and the Department of the Interior. To protect the public interest in these lands, the right-of-way agreements include environmental and technical requirements that Alyeska has to comply with when constructing and operating the pipeline system. To assure compliance with these requirements during construction, the State and Federal Governments reviewed Alyeska's system design and construction plans and monitored construction activities to see that plans were being implemented as approved.

During construction, some disagreements arose over the meaning of the requirements. Alyeska personnel generally interpreted the requirements less restrictively than Government personnel. For example, the right-of-way agreement states that the parties shall balance environmental values with economic practicalities. Alyeska personnel advocated strong consideration for economic values and a less-restrictive interpretation of the stipulations of the right-of-way agreement, while Government agencies supported a stricter concern for environmental values.

Because of the differences in interpretations, Alyeska had to make some adjustments to accommodate the Government interpretation of the requirement. Alyeska claimed that the requirements complicated the task of designing and building the pipeline system. According to Alyeska, the Government's role in design and construction was more ambitious than what had been expected when the system was planned. As a result, Alyeska believes that regulations produced significant environmental and social benefits but complicated Alyeska's design approach, construction plan, and schedule. Alyeska stated that whether a proper balance was struck between environmental and economic values is a matter of dispute, depending on the evaluator's perspective.

ENVIRONMENTAL AND TECHNICAL STIPULATIONS

The most significant requirements placed on Alyeska were the stipulations included in the right-of-way agreements with the State and Federal Government. While designed specifically for the trans-Alaska pipeline project, these stipulations also required Alyeska to comply with applicable existing Government regulations and industry codes. The Federal

right-of-way agreement contains 14 environmental and 10 technical stipulations; the State agreement contains almost identical stipulations.

The environmental stipulations were designed to minimize the environmental damage during construction, operation, maintenance, and termination of the pipeline system. Included are provisions relating to fish and wildlife and their habitats, explosives, erosion control, pollution control, buffer strips, land clearing, off right-of-way traffic, restoration, esthetics, oil spills, contingency plans, material purchases, and environmental briefings.

The technical stipulations established requirements for pipeline standards, construction mode, earthquake design, slope stability design, corrosion protection, and containment of oil spills.

MONITORING THE PROJECT

The Federal and State Governments established special organizations to monitor implementation of their respective right-of-way agreements. The Federal monitoring organization, the Alaska Pipeline Office, was headed by the authorized officer, who was responsible directly to the Undersecretary of the Interior. The State Pipeline Coordinator's Office was under the direction of the State pipeline coordinator. The Joint State/Federal Fish and Wildlife Advisory Team advised both these offices on matters concerning fish and wildlife.

The amount of pipeline right-of-way on State lands was much less than it was on Federal lands, and the State monitoring organization was smaller than the Federal organization. These organizations employed 184 persons during the peak of construction activities, but the staffing phased down as construction was completed, as shown below.

	August 1975	November 1976	August 1977
Alaska Pipeline Office (note a)	119	88	73
State Pipeline Coordinator's Office	32	27	17
Joint State/Federal Fish and Wildlife Advisory Team	33	30	35
Total	184	145	125

a/Includes technical services contractor employees.

Two phases existed: (1) design review and (2) construction monitoring. The design review process was to assure that the pipeline system design and construction plan complied with the technical and environmental stipulations of the right-of-way agreements. The construction monitoring effort was to assure that the appropriate designs, plans, and construction stipulations were followed.

Design review

The Trans-Alaska Pipeline Authorization Act directed the Secretary of the Interior and other appropriate Federal officers and agencies to issue, administer, and enforce right-of-way permits, leases, and other authorizations necessary for or related to the construction, operation, and maintenance of the pipeline system, including roads and airstrips.

The right-of-way agreement specifies that Alyeska shall begin construction only after receiving written permission from the authorized officer. Permission is given in a "notice to proceed" that authorizes construction only for the particular segment of work described in the notice. The authorized officer issued the notice to proceed after review of the system design and construction plans and only when the construction and operation proposals conformed with the provisions of the stipulations. The State right-of-way agreement contains similar provisions for reviewing and approving construction plans.

Conditions along the pipeline route imposed various design constraints. The pipeline route from the Prudhoe Bay to the Valdez terminal crosses three major mountain ranges, many rivers and streams (including the 1/2 mile wide Yukon), arctic to temperate climatic zones, and vegetation ranging from tundra to heavy spruce and cottonwood forests.

Permafrost is nearly continuous, thick, and cold in the far north; along the central portion of the route it occurs frequently but is less thick and warmer; south of pump station 12, permafrost is not present. Earthquake danger is the greatest in the south.

BALANCING ENVIRONMENTAL VALUES WITH ECONOMIC PRACTICALITIES

The right-of-way agreements provide that the parties shall "balance environmental amenities and values with economic practicalities * * * so as to be consistent with

applicable national policies." Alyeska officials contend that Government monitoring seldom balanced environmental values with economic practicalities.

Government officials responsible for reviewing the pipeline system design to assure compliance with technical and environmental stipulations said their reviews were based on technical considerations. They said that they made recommendations to the authorized officer and State pipeline coordinator, and that it was the responsibility of those officials to assure a proper balance in their decisional review of the recommendations.

According to the acting authorized officer, the statement in the right-of-way agreement on balancing environmental and economic values was included to assure reasonableness in the use of the stipulations, and, while there have been a few exceptions, the Government had generally been reasonable in its interpretation of the stipulations. He pointed out that, while Government advisors have written numerous spotcheck reports and field memorandums on problems noted in the field, only a small percentage were passed on to Alyeska as requirements.

Generally, a major difference of opinion existed between Alyeska and Government officials on the proper balance between environmental and economic values. Alyeska officials generally advocated strong consideration for economic values; Government officials generally supported stricter concern for environmental values. Notable examples of this were the disagreements over fish passage and restrictions on working in fish streams.

The stipulations establish that Alyeska shall provide for uninterrupted movement and safe passage of fish. The problems that developed at Minton Creek exemplify the disagreements that developed between Alyeska and the Government over what was required to comply with this stipulation.

Alyeska began constructing a work pad in the vicinity of the south fork of Minton Creek in the spring of 1975 after receiving a notice to proceed, but before submitting adequate area construction plans--including rechannelization plans required by the stipulations and previously requested by the Government. At that time, Government fish and wildlife advisors had not confirmed the presence of fish in that portion of the stream but were concerned about the area because it is part of the Salcha River system--which is a known fish stream. This early work in Minton Creek violated stipulations prohibiting disturbance of natural waters without prior Government approval; about 200 feet of the stream was rechanneled without proper authorization.

To force Alyeska to develop adequate plans for proper construction of the work pad through the Minton Creek area, the State pipeline coordinator shut down construction activity in the area until the plans had been developed. Subsequent testing in Minton Creek has shown that there are fish in the stream in the vicinity of the pipeline right-of-way. Alyeska officials said that it was not economical to require compliance with this requirement on streams such as Minton Creek, that contain few, if any, fish.

The stipulation on zones of restricted activities also states that there may be restrictions on activities in key fish areas during spawning and major migration periods. In accordance with this stipulation, the Government prohibited construction work in fish streams during critical periods. Alyeska considers this to be another example of not balancing economic practicality with environmental values, and said that this requirement had the greatest impact on the project of any stipulation relating to fish and wildlife protection.

ENVIRONMENTAL ORGANIZATIONS' CONCERNS

Several private environmental organizations filed a suit in March 1970 against the Department of the Interior; their primary issue was whether Interior complied with the requirements of the National Environmental Protection Act.

The suit delayed the start of project construction several years; however, environmentalists believe that the issue was never adequately resolved because the Congress passed the Trans-Alaska Pipeline Authorization Act on November 16, 1973, which prohibited further delay in the pipeline's construction.

The following paragraphs discuss some major concerns private environmental organizations had before construction, during construction, and after system completion.

Before construction

Some environmental organizations believed in 1973 that a trans-Alaskan pipeline route was not the most advantageous method of transporting North Slope oil to market. They believed that an oil pipeline route from the North Slope through Canada to the United States would cause less environmental damage than the proposed trans-Alaskan route. They stated that a trans-Canadian route was environmentally more acceptable because it would

--avoid the high earthquake-prone areas along the trans-Alaskan route,

--eliminate the need for a terminal in Prince William Sound and the potential pollution of the Sound,

--eliminate the need for tanker traffic,

--provide for a common corridor for both oil and a future gas pipeline, and

--deliver oil to the Midwest--the section of the United States most in need of the oil.

During construction

Environmental organizations generally were frustrated in their attempts to determine if construction was causing environmental damage. Most had no authority to monitor construction effects and Alyeska generally did not allow them to be on the right-of-way. Several organizations stated that construction records (such as field reports or notices to proceed) were not made available for their review.

The failure of most environmental organizations to obtain information about pipeline construction prevented them from evaluating the effect of construction on the environment. In general, because of their limited resources most did not devote a great amount of time to assessing the extent of environmental damage.

One organization did evaluate the effect of construction on the environment, based in part on field reports obtained from the Alaska State Pipeline Coordinator's Office and the Alaska Department of Fish and Game. Their September 1976 evaluation states that the most serious types of damage were:

--inadequate protection of fish and wildlife resources, especially the destruction of fishery habitat from river and stream crossing activity.

--Repeated water quality standards violations, including siltation from in-stream construction.

--Oil spills at campsites.

--Erosion over the length of the construction project.

Another group of environmentalists toured the pipeline route and observed construction in October 1974, May 1975, and July 1976. This group noted that, while the environmental protection and restoration were generally good, some shortcomings existed with the intent of the agreed upon stipulations. They recognized, however, that a project of

the pipeline's magnitude could not be built in such diverse and difficult environments without negative effects--both short- and long-term.

Alyeska stated that camp space generally limited environmental groups' access to the right-of-way. However, Alyeska believes that the Government's technical staff members represented the environmentalists' interests.

After construction

Environmentalists stated that they are concerned with the lack of public discussion about the haul road's future use. If the road is opened to the public, they believe the road will attract tourists and bring future development, which will have adverse environmental effects on the interior of Alaska. They also feel that this would negatively effect the native people's lifestyle in the interior. Environmentalists also are apprehensive about the adequacy of the oil spill recovery plan.

CHAPTER 6

LESSONS LEARNED

Several key lessons can be learned from Alyeska's experience. These lessons should be applied to any future project, such as the Alaska natural gas pipeline project, and certainly those projects where public lands or funds are involved:

First and subsequent cost estimates should be viewed with skepticism--The initial cost estimates for constructing the trans-Alaska pipeline system were grossly optimistic. These estimates had omissions and totally inadequate allowances for the cost of overcoming the many problems which should have been expected during construction of a project this size.

Most cost estimate growth came before establishing a base control budget. After the base control budget was established, the estimate increased about 23 percent. (See table I, p. 10.)

Once the Congress approved the project's construction, Alyeska and the owner companies developed a budget control estimate as a means of controlling expenditures. However, this estimate contained no allowance for contingencies because the owners wanted to keep the estimates as low as possible.

As much site-specific data as is economically practicable should be obtained and technical and geologic uncertainties should be thoroughly investigated--A major factor in the underestimating was that planning was based on minimal site data. More geotechnical and site-specific work before construction would have reduced the number of surprises encountered once construction started. For example, unexpected subsurface conditions were encountered at the Valdez terminal site once excavation was started. This led to much more extensive site preparation work than planned. Also, once ditching operations were started to lay the pipe, many areas had more groundwater than anticipated. This work was costly.

Alyeska stated that their experience confirms the desirability of obtaining site-specific data and thoroughly investigating technical and geological uncertainties to the maximum extent that is legally permitted and economically practicable.

Realistic initial assessments are clearly in the public interest. Further, estimato are responsible for

assessing a project's unknowns and including a contingency allowance in the estimate to indicate how high actual costs might probably turn out to be.

Lacking historical data, the most reliable basis for establishing budget estimates is to develop preliminary engineering design based on as much site-specific data as is economically practicable. The earlier and more thoroughly that site-specific work can be done, the better will be the project engineering. If project engineering and systems design are based on more complete data, both become less subject to change.

Government approval should be contingent on detailed planning for management control including budgetary controls--Management control over project costs and execution requires information generated by management control systems, such as cost control, inventory control, and security. Alyeska's systems were unsatisfactory when construction began in April 1974 and were modified during the 3-year construction period. We believe that appropriate cost and other control systems should be operational before the start of construction.

The Alaska natural gas pipeline project's expenditures should have an ongoing Government audit to protect the public interest--A clear and specific requirement should be established in future agreements to provide the Governments with direct access to project files and records. At the time of our study, three separate Government audit groups needed Alyeska data. Alyeska hired a law firm to act as liaison to respond to these requests and to protect its rights in the event of any future litigation.

This arrangement caused us procedural difficulties and left us with much uncertainty about the completeness of the information given in response to our requests. We, therefore, cannot attest to the information's accuracy.

Further, the agreements granted to Alyeska contained no requirement that the Government be allowed to conduct an audit during construction to assure that moneys expended were justified in order to be considered allowable expenses to be included in tariff submissions. An audit of this project, because of its size, is extremely difficult to do when the project is nearly complete.

The costs of comparable future projects, therefore, should be audited during construction to benefit both the project's developers and the Government. Project developers would not be left in doubt until project completion

about which costs should be recoverable through a tariff. The Government would be in a far better position to conduct a more effective audit of costs and thereby have a much better understanding of the project's ultimate cost and its effect on consumer costs.

APPENDIX I

Department of Energy
Washington, D.C. 20545

Mr. Monte Canfield, Jr., Director
Energy and Minerals Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Canfield:

Thank you for the opportunity to review and comment on the GAO draft report entitled "Lessons Learned From Constructing the Trans-Alaska Oil Pipeline." Upon review, we find that we have no substantive comments to offer. However, the report is interesting and contains information which may be useful to us in assessing future pipeline construction projects within the Department of Energy.

Sincerely,

Fred L. Hiser, Director
Division of GAO Liaison

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

Mr. Monte Canfield, Jr.
Director, Energy and
Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

APR 27 1978

Dear Mr. Canfield:

We have reviewed your proposed report entitled "Lessons Learned From Constructing the Trans-Alaska Oil Pipeline." It reflects considerable research on a very complex construction project. No recommendations are made to the Department of the Interior (DOI), but we offer the following comments on some of the points made in the report.

DOI has certain statutory responsibilities to assure that the public lands and their resources are protected and that public safety is served. It is not DOI's responsibility to determine whether or not a right-of-way holder is operating efficiently. Our role is to see that the requirements of law are met.

Our responsibilities for oil and gas pipelines stem only from section 28 of the Mineral Leasing Act, 30 U.S.C. § 185 (Suppl. 1973), where such pipelines require a right-of-way over Federal lands. The only financial responsibility we have under that statute is that the Secretary determine that an applicant has the technical and financial capability to construct the project prior to issuing a right-of-way authorization. We believe it would probably be inappropriate for DOI to reserve a right of the United States to conduct a continuing audit of private expenditures as we have no tariff responsibility or authority. However, it might be appropriate for the regulatory agency, if any, having jurisdiction over a project to place such a condition in any authorization they might make, i.e., FERC for natural gas pipelines and the ICC for oil pipelines.

On the subject of cutting costs by requiring more front end engineering, we would point out that prior to granting the TAPS right-of-way, this Department required a very large amount of engineering information. The company's project description was nearly thirty volumes long. Many of the problems faced by Alyeska involved state-of-the-art engineering, and solutions, such as the special burial technique and the "super pig," had not existed before they were developed for the TAPS project.

Thank you for the opportunity to review the proposed report.

Sincerely,

Larry Meierotto
Deputy Assistant Secretary -
Policy, Budget and Administration

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

APPENDIX III

Alyeska pipeline SERVICE COMPANY

1835 SOUTH BRAGAW STREET 99504, P.O. BOX 4-2 99509, ANCHORAGE, ALASKA TELEPHONE 907 [illegible]

May
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Monte Canfield, Jr.
Director
Energy and Mineral Division
United States General Accounting Office
Washington, D.C. 20548

File No. 78-389-G

Dear Mr. Canfield:

We have reviewed a draft of a proposed report (the "Draft Report") by the Comptroller General to the Congress entitled "Lessons Learned From Constructing the Trans-Alaska Oil Pipeline." While we commend the GAO for the efforts it has devoted to studying the Project, we feel that certain portions of the Draft Report reflect an inadequate appreciation of the circumstances surrounding the construction of the Project, and in some instances, a misunderstanding of the facts. As a consequence, some of the recommendations of the report are unrealistic.

This letter addresses five particular subjects on which the Draft Report's comments are, in our view, seriously misconceived. Those subjects are: (1) preconstruction geotechnical investigation, (2) use of fixed-price contracts, (3) the recommendation that project approval be contingent upon management systems being fully operational prior to start of construction, (4) the comments made in the Draft Report about the Minton Creek stop order, and (5) the recommendation for ongoing government audits during construction. We cannot, of course, undertake in a single letter to point out each and every statement in the Draft Report which we believe to be inaccurate or unfounded. Thus, the fact that we have confined our response to five subjects should not be construed as an indication that Alyeska agrees with the remainder of the Draft Report's text.

1. Pre-Construction Geotechnical Investigation

No one can quarrel with the simplistic truism that it is desirable to obtain as much site-specific geotechnical

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information prior to construction as is "economically practical." What is "economically practical" under the circumstances of a particular case is the key issue, and on this point the Draft Report offers no analysis or discussion of the constraints that were determinative of what was "economically practical" prior to the issuance of Federal and State Permits for the TAPS project in early 1974. Instead, the Draft Report simply implies that Alyeska may not have obtained as much site specific geotechnical data as was economically practical prior to construction. That implication is fundamentally wrong and could not be made by anyone who understands geotechnical engineering, much less by anyone of recognized authority in the field of soils mechanics.

Alyeska's preconstruction soils investigation program was as well conceived and as extensive, if not more extensive, than any ever undertaken on a large scale construction project. More than $25 million was spent on soils investigation before 1974, notwithstanding severe legal and practical constraints, as well as great uncertainty whether the Project could ever go forward. The program was carried out with the assistance of several leading geotechnical engineering firms, as well as some of the foremost geotechnical authorities in the world. In the considered judgment of these recognized experts, Alyeska's geotechnical program was exemplary of the very best. As stated in 1972 by Dr. Ralph B. Peck, the leading authority alive today in the field of soil mechanics:

> ". . . few projects to my knowledge, except possibly nuclear power plants with their obvious and immediate hazard to human life in the event of an accident, have been so thoroughly investigated and conservatively designed with respect to their geotechnical features." 1/

Alyeska's consultants agreed that it was not possible to gain exhaustive knowledge of site-specific soils conditions prior to construction, that it would be uneconomic to attempt to do so and that more information was not needed for design purposes.

1/ Ralph B. Peck, "Geotechnical Aspects of 'Comments on the Environmental Statement for Trans-Alaska Pipeline'" (1972).

APPENDIX III

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The Draft Report reflects not only a failure to understand the scope and nature of Alyeska's preconstruction soils investigation program, but also a failure to recognize the constraints which made it economically impractical, if not virtually impossible, to conduct more investigation work during the 1970-1973 preconstruction years. The pendency of the court injunction in the Wilderness Society litigation severely restricted the types and extent of soils drilling programs that government agencies could permit. Access restrictions limited exploratory work in some situations to helicopter transported drilling rigs. Moreover, the remote and precipitous terrain in certain areas such as Atigun Pass and Thompson Pass made it impossible to conduct definitive exploratory work in these areas before the construction of access roads. Finally, the extreme variability of soils and subsurface ice conditions in Alaska imposed a very practical constraint. Even if it had been physically possible and legally permissible to conduct significantly more soil borings, the additional data produced by such borings would not have enabled a definitive definition of the soils conditions and any benefits gained would have been far outweighed by the enormous costs of such a program.

Significantly, more soils information would not have alleviated the construction difficulties which are mentioned in the Draft Report. Additional soils data acquired within economic and practical limits would not have significantly enhanced preconstruction engineering and design nor obviated the need for field confirmation of the design. Nor would additional soils data have significantly improved the accuracy of the base estimate. As to the latter, no amount of soils testing could compensate for the lack of historical productivity data for the performance of the unprecedented pipeline work tasks, particularly those associated with installation of aboveground pipe.

Further, the availability, or lack, of preconstruction site-specific data did not significantly affect Alyeska's ability to enter into fixed-price contracts. The greatest uncertainties precluding fixed-price contracts had nothing to do with the quantum of preconstruction site-specific data and these uncertainties would not have been resolved by spending tens of millions more on soils testing.

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2. Fixed-Price Contracts

The assertion that fixed-price contracts should be used "whenever possible" is misguided in the context of the Draft Report's discussion of TAPS. As the GAO is aware, Alyeska did utilize fixed-price contracts whenever the circumstances made such contracts possible and prudent. But with respect to the major contracts for the pipeline work, fixed-price contracts realistically were impossible and, indeed, would have been foolhardy.

In the first place, the work required of the execution contractors on the pipeline was replete with uncertainties that precluded fixed-price contracting. To bid on a lump sum basis a contractor must be able accurately to predict his costs within a relatively small margin of error. It was absolutely impossible for the major contractors to do this. The uncertainty was pervasive, as it is bound to be on huge developmental projects pushing the state-of-the-art. Many elements of the pipeline design were state-of-the-art, particularly with respect to the above-ground design and the construction techniques that had to be developed and refined during construction. Consequently, there was no experience upon which to base accurate predictions of man-hour and equipment requirements. Moreover, data on labor productivity in the arctic and subarctic regions were skimpy. Extremely variable weather conditions created an uncertainty cutting across all facets of construction. Much of the equipment used was newly developed, prototype equipment. Moreover, because of lack of construction experience under arctic conditions, it was difficult to predict the performance of even conventional equipment.

The extreme remoteness of the project from supply centers, the lack of any construction infrastructure in Alaska, and the 800 mile geographic spread of work also created logistical risks and uncertainties. Moreover, no large scale construction had ever been attempted in much of the area traversed by the pipeline, and in areas of particularly rugged terrain, such as Atigun and Thompson Passes, it was difficult to predict the construction techniques that ultimately would have to be employed. On any construction job, the most difficult element to predict is the subsurface foundation work. To a large degree, the pipeline consisted of 800 miles of foundation work, and this caused significant uncertainty, particularly since it was known that soils

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conditions along the right-of-way were extremely variable and unpredictable.

When the pipeline execution contracts were being negotiated in early 1974 the primary governmental reviewing agencies were just being created and staffed. No one -- neither the government personnel, Alyeska personnel, nor the contractors -- could predict how the newly created, multiple agency regulatory structure would work, how detailed the design and construction plan review would be, what design or alignment changes might be required by the permitting authorities, what changes in construction plans and schedules might be imposed as conditions for work to proceed, or what other requirements might be imposed from day to day by federal or state monitors.

It was necessary for Alyeska to have control over the execution contractors in order to assure compliance with the Federal and State Stipulations. The obligations imposed by the Stipulations were not transferable, and any failure of compliance with Stipulation requirements would risk financial liabilities for the Owners, as well as delays and extra costs. Accordingly, Alyeska had to have centralized control over all aspects of interaction with government regulators and had to retain absolute authority to direct changes in execution contractor construction techniques and work plans as required to ensure compliance with interpretations placed upon the Stipulations by government personnel. In addition, Alyeska needed to exert centralized project control to reduce costs. To this end, Alyeska provided most of the equipment, permanent material, supplies and support services used by the pipeline execution contractors. Such unified control by Alyeska of all these elements of the project necessarily deprived prospective contractors of ultimate control over a great number of factors affecting their cost and scheduling performances, thus compounding the multitude of uncertainties which they faced.

In addition to all of these uncertainties, the very size of the Project imposed an overriding economic constraint that precluded fixed-price contracts for the pipeline execution contracts. A fixed-price contract is a

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meaningless piece of paper if the risks allocated to the contractor exceed his financial resources. Even though the execution contractors for the pipeline work included consortia of some of the world's largest civil and pipeline construction companies, none had the financial ability to assume the enormous financial risks involved. In most cases the contractors' own estimates of the cost of the work exceeded their net worths by two to six times. No responsible contractor could have entered into a fixed-price contract underwriting financial risks of that magnitude. Had Alyeska imprudently insisted on fixed-price bids, the best, most capable and most responsible contractors likely would have been unwilling to bid. And any less responsible contractors willing to gamble by submitting a fixed-price bid would have been required to hedge their bets by inflating their bids with 100-200% contingencies. Insistence on, and acceptance of such bids would have committed the owners to pay huge amounts in excess of what might reasonably be anticipated under cost reimbursable contracts but without any realistic cost protection.

Further, it was vitally important that a contractual structure be chosen, particularly for pipeline execution contracts, which would permit maximum flexibility of control by project management and a capability of quick adaption to major problems and unanticipated conditions that are bound to occur repeatedly on developmental projects of such immensity. Fixed-price contracts would have introduced a rigid superstructure inherently resistive to change, adaptation, and centralized managerial control. A contractor operating on a fixed-price basis would demand a greater voice in determining project strategies, alternatives and trade-offs. Because of the contractor's risk under fixed-price contracts, the relationship between the owner and the contractor tends not to be between manager and managed, but between two independent entities discussing what is increasingly seen as their respective rights and interests. Had the pipeline contractors been operating under fixed-price contracts, routine stop work or rework orders issued by quality control inspectors would have been difficult to enforce expeditiously. Each such directive would have occasioned delay and dispute over whether the work was deficient as well as costly administrative processing of change order requests for the rework. Indeed, any directive with cost implications issued by Alyeska would have met with resistance and change order demands from the contractors. The administrative costs would have been enormous.

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Alyeska needed to have complete control over all aspects of relationships with government and regulators and the capacity quickly to implement governmentally imposed requirements for rework, design changes, schedule changes, and changes in construction techniques. It was also necessary that Alyeska's relations with its contractors be sufficiently flexible to permit Alyeska to reassign work among contractors, to shift equipment and resources, to require one contractor to adopt cost-effective techniques innovated by another and, as required, to step in and take over facets of the field management. Consequently, from the perspective of Alyeska and the owners, the need for project management to maintain a capability for adaptiveness and flexible response to unanticipated problems was a most significant consideration weighing in favor of cost reimbursable plus fixed-fee contracts.

Alyeska and the owners carefully evaluated all the different types of contractual arrangements that might be utilized for the pipeline execution contracts. They were aware that fixed-price contracts are desirable mechanisms for allocating risk. They were also aware, however, that fixed-price contracts can be a disaster when naively utilized in situations where the risk protection afforded to owners is an illusion and the potential for imparting organizational rigidity is great. Under the circumstances, the reasons favoring use of cost reimbursable fixed fee contracts were compelling; and we submit that those same reasons will be compelling on any future projects of comparable scope and nature.

3. Government Approval of Fully Operational Management Control Systems Prior to the Start of Construction

The Draft Report states that governmental approval of a project should be contingent upon appropriate management control systems being fully operational prior to the start of construction. This recommendation is unrealistic if it assumes that exceedingly complex control systems, interfacing with the disparate systems of scores of contractor organizations, can be definitively developed and superimposed on a project in full blown operational splendor prior to construction start up, and all without the benefit of any operational

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experience or need for adaptation and change during the subsequent real-world life of the project. Nothing of the sort is realistically or economically attainable on a vast, one-time project such as TAPS. Where scores of contractor organizations are brought together for a one-time undertaking, each with its own particular systems, traditions and approaches to project control, it necessarily takes a period of operational experience to fine-tune project-wide control systems, particularly since the complex organizational structure is likely to undergo changes and adjustments during the start-up period of construction.

A requirement that there be government approval, prior to start of construction, of "fully operational" management systems would likely result in a great deal of costly and unproductive effort being spent on developing elaborate, detailed reporting systems that inevitably would have to be modified and adjusted in response to changes made in the organization and unexpected problems encountered during the shake-down, learning period of the project. Moreover, the greater the premium put on creating elaborate control systems based on textbook models rather than on the organizational realities experienced during the early stages of construction, the greater is the risk management will rigidly rely on planned control systems rather than innovatively developing systems tailored to deal with unanticipated problems encountered during construction.

The complexity of a project such as TAPS requires simple and flexible field cost control systems which can be implemented rapidly through the organizations actually responsible for the work. There is no need for all elements of the system to be "fully operational" prior to the overall start of construction. Rather, each element should be in place prior to commencement of that phase of the work for which it is designed to provide control information. The purpose of such systems is not the collection of extreme detail, but the rapid collection and reporting of relevent data to enable project management to identify problems and instruct the proper field personnel or organizations to take corrective action on a timely basis. That purpose is not furthered by a requirement such as is recommended in the Draft Report.

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4. Minton Creek

It is indisputable that governmental regulation complicated the construction of TAPS. This is not to imply criticism of the government personnel. Nor do we mean to comment on the reasonableness of government regulation. Such an evaluation would require an assessment of the worth of environmental protection measures and certainly reasonable men can differ as to the proper balance between environmental and economic values. Nevertheless, it is an obvious fact of life that superimposing a new, complex regulatory scheme on an already complex undertaking such as TAPS inevitably compounds the difficulty of scheduling, planning and executing the work. Neither the Alaska Pipeline Office nor the State Pipeline Coordinator's Office was fully organized and staffed when the permits for the Project were issued in early 1974. When construction began, there was great uncertainty as to how the multiple-layered regulatory process would work, how detailed the design review would be, how stipulations would be interpreted, and the like. Necessarily, both the regulators and the regulated had to feel their way through a learning period. Inevitably, there were differences of judgment and opinion, and resolution of those differences in the context of state-of-the-art engineering and construction problems caused delays and significant scheduling complications.

It would be impossible to describe and document each of the many occasions when regulatory decisions or actions forced significant scheduling revisions. The GAO uses Minton Creek as an example and it is as good as any. However, the Draft Report is seriously wrong in its comment that Alyeska commenced construction at Minton Creek without prior submission of adequate plans. The fact is that prior to construction in the Minton Creek area Alyeska had submitted its plans to the State Pipeline Coordinator's Office, and the SPCO had issued Alyeska a Notice to Proceed for work pad construction in the area. That NTP, a copy of which was provided to GAO, constituted approval by the SPCO of the routing of the pipe referenced in the NTP application. Moreover, the GAO is likewise aware that the State Field Surveillance Officer (SFSO) a month before the stop-order at Minton Creek had issued field authorization for the first portion of the work in question. In fact, Alyeska's field biologist had discussed the rechannelization with the SFSO and with representatives of the Joint State/Federal Fish and Wildlife Advisory Team before work began. However, because

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of the very small size of the creek and its ice cover, some government personnel apparently failed to note, until the ice melted, that a portion of the work pad was to be located in the creek bed. It was at that time -- after the requisite government approvals had been given -- that State concerns focused on the placement of the work pad in the creek bed. Thus, the controversy did not arise because Alyeska lacked prior government approval -- Alyeska had received the necessary government NTP prior to construction at Minton Creek.

5. Recommendations for Government Auditing Authority During Construction

The Draft Report concludes with a recommendation that government personnel be authorized to conduct ongoing audits of a project during construction. The assumed benefit of such proposal is that it could eliminate doubt, both on the project owner's and the government's part, as to which costs should be permitted to be eventually recoverable through the tariff. With all respect, this notion overlooks the fact that under the present regulatory scheme, Congress has committed to the Federal Energy Regulatory Commission sole authority to determine all factual and legal issues as to what costs should be recoverable through a tariff. Neither a GAO auditor nor any other government auditor could make determinations during construction, or at any time, binding on the Commission. Hence, the perceived benefit of an ongoing government audit during construction is a legal impossibility, since uncertainty regarding tariff-recoverable costs could not be resolved by auditors. Moreover, even if auditors had legal authority to make binding determinations, it is clearly unrealistic to assume that auditors untrained in engineering and project management would have the qualifications to make reliable, on-the-spot judgments about complex engineering, design and construction technology matters. The likely result would be added uncertainty and delay, not elimination of uncertainty.

Effective project control requires that project management be singularly accountable to the project's owners regarding all significant expenditures and business decisions. It is the owners whose money is being spent and placed at risk, and they have every right and need to demand such accountability. Of course, on a project like TAPS, management

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decisions necessarily are constrained by decisions made by government agencies having oversight responsibility for design review, environmental protection, and the like. But to go beyond such regulation, and have government auditors intrude upon day to day business decisions is not only unnecessary, but would undercut management's accountability to the owners and the owners' ability to control the expenditure of their funds.

Finally, a word is in order about the Draft Report's comment that an ongoing audit during construction could have enabled a better understanding of the project's ultimate "impact on consumer costs." If anything is clear, it is that an audit of the project during construction was not necessary to develop such an understanding. The simple fact of the matter is that "consumer costs" will not be impacted one iota by the project's cost as reflected in the filed tariffs.

We appreciate having been accorded the opportunity to comment on the Draft Report.

Sincerely,

E. L. Patton

E. L. PATTON
Chairman

INTERNATIONAL UNIONS REPRESENTED ON THE BARGAINING COMMITTEE

International Association of Heat and Frost Insulators and Asbestos Workers

International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers, and Helpers

Bricklayers, Masons, and Plasters International Union

United Brotherhood of Carpenters and Joiners of America

International Brotherhood of Electrical Workers

International Union of Operating Engineers 1/

International Association of Bridge, Structural, and Ornamental Iron Workers

Laborers International Union of North America 1/

Piledrivers, Bridge, Wharf, Dock Builders, and Divers

Wood, Wire and Metal Lathers International Union

International Brotherhood of Painters and Allied Trades

United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada 1/

Operative Plasterers and Cement Masons International Association

United Slate, Tile, and Composition Roofers, Damp, and Waterproof Workers Association

Sheet Metal Workers' International Association

*International Brotherhood of Teamsters, Chauffeurs, Warehousemen, and Helpers of America

Hotel and Restaurant Employees and Bartenders International Union

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1/Parties to the National Pipe Line Agreement with the Pipe Line Contractors Association.