FACTORS AFFECTING COST OF MINING IN ALASKA

by

Chris Lambert
Danny Taylor

Mineral Industry Research Laboratory
University of Alaska
Fairbanks, Alaska 99701

edited
by
John J. DiMarchi
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ABSTRACT

The basic factors which affect the cost of mining in Alaska are discussed herein. Contrary to popular opinion, cold weather is not the major factor. This problem has, for the most part, been solved through experience in Eastern Canada and later efforts in British Columbia and the Yukon.

Remoteness and isolation and its effect upon personnel, inventory and services of all kinds are among the more difficult with which to anticipate and cope. Considerable creativity is required to solve these problems, which differ somewhat with the type and location of mineral deposit, and will quite likely require solutions at variance with the current attitudes and practices of the company involved.

In Alaska, electric power, transportation and land tenure pose difficulties of a type not experienced when existing mines in Canada were developed.
During the initial preparation of this report, it was discovered that voluminous material had been published regarding cold and remote operations which were applicable to Alaska. The amount of material was too great to be integrated into a report of this size. Most of the material was incorporated in a report prepared for the Bureau of Mines titled Significant Parameters of Mining Properties Located in Arctic and Subarctic Areas of North America.

This report covers the salient topics referred to in the above, plus information derived from the authors' experience and visits to mining properties and mines in Alaska, Canada, Norway and Spitzbergen.

Appreciation is extended for the gracious help given by personnel of the Usibelli Coal Mine, United Keno Hill Mine, Cyprus Anvil Mine, Cassiar Asbestos Mine, Whitehorse Copper Mine, Canadian Tungsten Mine, Store Norske Spitsbergen Kulekompani, A/S, Arktik Ugol, A/S Sydvaranger and Repparfjord Copper Mine. Final editing was completed by John J. DiMarchi, MIRL.

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Chapter I

INTRODUCTION

Today there is but one major producing mine in Alaska. This is the Usibelli Coal Mine which produces approximately 750,000 tons of coal each year. Consider the case for mining in Alaska.

The prosperity of a nation's people is a reflection of their contribution to the world's output of wealth. Wealth can be harvested as in the case of farming, forestry and fishing, or wrested from the earth in the form of metals or other valuable raw materials. These may be used directly to support the national economy or they may be exported as a claim on the goods and services of the consuming nations. Wealth may also be created by an expertise or technology which upgrades raw materials into more valuable commodities.

The United States has benefited from the creation of wealth by all the above methods. The minerals industry is the keystone in this process. Products of the minerals industry are essential to the renewable resource industries, the manufacturing industries and the service industries, which in turn provide for the lasting prosperity of the nation.

There appears to be no lessening of the demand for fuels and power, building aggregate, metals, fertilizer, etc. More intelligent use and more efficient recycling practices will substantially reduce the quantities needed, but at best it represents a formidable task, and there are factors working which make it increasingly difficult.

Within the United States, and Alaska in particular, government regulations regarding land, environment, safety and health have severely retarded investment and substantially decreased productivity. The primary purposes of the regulations are praiseworthy and certainly address problems begging solutions, but compliance procedures are methods oriented rather than results oriented. Benefits are not weighed with the resulting cost to the consumer.

Abroad, a godly portion of the underdeveloped land areas of the world are under communist control. Their development is independent of influence of the free world for the foreseeable future, and the reliability of imports of critical minerals from these areas is marginal. The developing nations are becoming more sensitive to the mining activities of foreign companies within their borders. The Arab nations have successfully increased the price of petroleum several fold. Most certainly, raw materials from other countries will be paid for in full measure.

Amid uncertainty and controversy, two facts remain clear. One, the United States is an exporting nation. Were it not for the temporary energy crisis it would be a net exporting nation, and herein lies the capacity for continued greatness. Two, Alaska is the largest undeveloped land mass in the United States, consisting of approximately 368,000,000 acres, an area nearly equal to all of the United States east of the Mississippi River. Most likely it is highly mineralized.

The factors affecting the cost of mining in Alaska are in some ways unique but in more ways they are only different in degree from those factors encountered elsewhere. Contrary to prevailing impressions, cold weather does not pose formidable problems. Operating in sustained sub-zero temperatures has been proven practical in northern Canada and elsewhere over recent years. The troublesome problems are primarily logistical, political and social. They can tax managerial ingenuity and make an otherwise economical mining operation prohibitively expensive.

Political problems can deny access completely. Neither the time nor the method of their resolution can be foreseen. Two basic and interrelated factors are at play. One, land ownership is a four-way tug of war between the Native groups, the State of Alaska, the Federal Government and private interests. The State has rights under the Statehood Act to 103.3 million acres of land. The Native groups, under the Alaska Native Land Claims Settlement Act of 1972, have selective rights to approximately 44 million acres. Private interests own less than one percent of the land. As of June, 1982, the State has either patented or received tentative approval to 61 million acres. The Native groups have received approximately 22 million of their allocated 44 million acres.
The second political factor that affects cost is an attitude reflected by many people who do not recognize how private enterprise and land ownership have benefited the United States. The tremendous benefits that the use of the natural resources of the land have yielded to the citizenry have somehow been identified as benefiting only a select and unidentified few. Hence, an idea prevails quite widely that the public can hope to benefit in the future only through punitive taxation and regulation of those who use the public lands for the ultimate benefit of the public. In effect, an additional tax is being imposed which adds to the cost of products for the public.

Similarly, environmental issues and regulations are often stated in such a manner that implies that one must choose either the environment or unrestricted development. Many do not recognize that nothing could be farther from reality. It is not a matter of choice. The Nation must develop and use its resources if it is to have the ability to protect the environment. Degradation of the environment is an obvious waste, but lost sight of, in many instances, is the fundamental reason for protecting the environment—that the land be made better for our children than it is today.

Eventually, the public lands will be used for what is perceived as the public good. Undoubtedly, mining will become as viable an industry in Alaska as the production of petroleum is now. The interim can be used by both industry and the regulatory agencies to gather information which will make it possible to cope with the eventual ground rules.

Purpose and Scope

The author is reminded of a time, not too long ago, when the company with which he was employed had reason to investigate a property in Alaska. Practically nothing was known beyond the bare bones knowledge of the geology and drill hole data of the property. Knowledge of transportation alternatives were nil. It is the purpose of this report to present information which will be of use in mine planning for those in similar situations, who are not knowledgeable of the State and some of its unique characteristics.

Very little information can be given regarding actual cost of operation. There are too few operating mines, and a display of actual cost is easily identified with an individual mine.

Anyone who has worked for more than one mining company knows that attitudes and management methods differ. What is accepted operating practice at one mine is impossible at another. Sometimes this is the result of closed minds, but more often it is the result of established practices or industrial relations and public relations attitudes. The problem of estimating costs is one of transferring management and engineering attitudes and practices from one environment to another, with full knowledge of the facts concerning the new environment. It is best done by "in house" personnel—not by outsiders. It is the intent of this report to present those facts or factors in such a way that they are useful.

A few generalities are in order. The summer season is short. Its end is final. The author recalls when the late winter sunshine awoke thoughts of the summer garden, but all plans for starting tomato plants indoors to get a rush on the season came to a sudden end. There was no soil in Interior Alaska. It was all frozen under snow and ice. All summer activities must be thoroughly planned well in advance. All expenditures of men, materials and equipment can be useless if the intended job is not completed before freeze up.

A similar threat overhangs all activity in the North. Supply lines are long and sometimes closed. Services and advice just a phone call away in the contiguous states are suddenly lacking at the most inopportune times. Production is the key cost control ingredient in all mining operations. Without a divisor (production), unit cost is infinite. The thought should be paramount in all mine planning in Alaska. Shortages and inferior quality of materials or workmanship cannot be tolerated. The risk is too great. Therefore, expect to pay a premium for specialized and quality supplies and equipment. Expect to offer inducements to labor which may appear excessive, such as high rates, scheduled overtime, free transportation, high insurance and workman's compensation, long vacations and innovations of your own making.

Consider all the facts presented herein, and then add considerable for the unforeseen.
Chapter II

Climate

Alaska can be divided into four general climatic zones to more easily understand expected conditions.

Southeastern Alaska is essentially a temperate rain forest. Precipitation varies from as much as 200 inches annually on portions of Sitka Island, 150 inches at Ketchikan to less than 40 inches in the area of Haines and Skagway. Temperatures are not much colder than coastal Washington and British Columbia. In general, temperatures and rainfall decrease as one proceeds from Ketchikan in the south to Skagway in the north. Likewise, the coast is colder with less precipitation than on the outer islands.

Anchorage is indicative of South Central Alaska, with a climate similar in many respects with that of the north central tier of the contiguous States. The normal daily minimum in January is 4°F. Extreme lows are -30°F. Again, the climate along the outer shore and on Kodiak Island is considerably wetter and milder than at the heads of the inlets. This is particularly true with respect to extreme lows in the winter. Also, depending upon the terrain, conditions can vary rapidly short distances inland.

Extremes of temperatures are found in Interior Alaska, lying between the Brooks Range and the Alaska Range. Fairbanks is typical of the region, with extremes in winter below -50°F and with sustained temperature of -40°F of several days duration and summer highs into the 90's. The western and coastal areas of the interior are somewhat milder, with more precipitation. Annual precipitation averages between 17 and 18 inches as compared with approximately 12 inches near Fairbanks.

The North Slope weather is controlled by the polar easterlies. Extremes are less than the interior, but approach -60°F at times. The region is subject to severe and sustained winds. Precipitation diminishes from the Brooks Range northward, varying from eight to four inches.

Table 1. Climatic Data For Selected Cities*

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<tr>
<th></th>
<th>Juneau</th>
<th>Anchorage</th>
<th>Fairbanks</th>
<th>Nome</th>
<th>Point Barrow</th>
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<tbody>
<tr>
<td>Extreme Low</td>
<td>-21°F</td>
<td>-30°F</td>
<td>-60°F</td>
<td>-42°F</td>
<td>-56°F</td>
</tr>
<tr>
<td>Nor. Daily Min (Jan.)</td>
<td>20°F</td>
<td>4°F</td>
<td>-21°F</td>
<td>-3°F</td>
<td>-24°F</td>
</tr>
<tr>
<td>Extreme High</td>
<td>84°F</td>
<td>78°F</td>
<td>91°F</td>
<td>81°F</td>
<td>78°F</td>
</tr>
<tr>
<td>Nor. Daily Max. (Jul.)</td>
<td>63°F</td>
<td>66°F</td>
<td>72°F</td>
<td>54°F</td>
<td>45°F</td>
</tr>
<tr>
<td>No. Days Below 32°F</td>
<td>149</td>
<td>189</td>
<td>227</td>
<td>240</td>
<td>324</td>
</tr>
<tr>
<td>No. Days Below 0°F</td>
<td>9</td>
<td>49</td>
<td>127</td>
<td>89</td>
<td>169</td>
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* Climatology of the United States, No. 60-49, U.S. Department of Commerce.
Cost of Alaskan operations are increased significantly by the remoteness of the area from major supply and service centers. Not only is this true for Alaska as a geographical unit, but even intrastate supply and service costs to remote areas are significantly higher than in the contiguous states because of undeveloped transportation and communication services.

There are several factors which directly increase transportation and communication costs in Alaska. The first, of course, is the actual distance involved. Fairbanks, the second largest city in Alaska (population 31,000), is the logical supply center for the Interior. Fairbanks is 1,535 air miles from the Port of Seattle, 2,700 from Chicago and 3,300 from New York. Even within the State, Fairbanks is 320 highway miles from the closest seaport (Valdez) and 355 miles from Anchorage (Milepost, 1978). The development of adequate transportation is essential to the development of Alaska and is discussed in detail in a separate chapter. Distances alone are enough to add significantly to costs.

In addition to distance, there is the problem of installation and maintenance of all facilities in an arctic and subarctic environment. Foundations, roads, railroads and air fields are all affected by permafrost phenomena, making permanent installations difficult to build and expensive to maintain. During the winter, sled trails and landing strips can be constructed on frozen ground and maintained at a reasonable cost. Snow roads are environmentally acceptable over delicate terrain. However, once break-up arrives, new facilities are required.

Arctic conditions also wreak havoc with communications. Most communications are by radio. However, the State's proximity to the north magnetic pole causes a magnification of the effect of sun spot activity which often disrupts radio reception, thus isolating remote operations. Radio communications equipment powerful enough to cope with the distances and magnetic disturbances is expensive and costly to service.

There are complexities with communications outside the State. First is the time zone problem. Alaska covers four time zones. The majority of the land mass is on Alaska Standard Time, which is two hours earlier than Pacific Standard Time and five hours earlier than Eastern Standard Time. Early morning calls to the east coast must be placed between 3:00 a.m. and 5:00 a.m. local time. Any east coast communication needs occurring after noon in Alaska will probably have to be postponed until the next day.

In addition, telephone communications from Alaska go through a complex system of ground based and satellite relay stations, often generating noticeable time lags. Also, mobile field transmitters at the job site can result in garbled communications. This can mean not only frustration but also misunderstood data, causing costly mistakes.

Intracompany Operations

Remote Alaskan projects often pose new problems in intracompany operations. Communication, transportation and service between the job site and company headquarters add significantly to the overhead. As stated before, telephone communications can be thoroughly unsatisfying, and the cost for a round trip air coach seat between Denver and Fairbanks is over $750.00 for a six hour flight (not counting layovers) (Alaska Airlines, 1982).

These factors decrease the effectiveness of company staff functions such as accounting, engineering, industrial relations, personnel, etc. Staff support may be available for direct access within only a small time frame. On site personnel must be responsible, accountable, enterprising, and given wide discretionary authority.

Applicability of support generated thousands of miles away without direct knowledge of local situations can also pose problems. It is extremely difficult to design technical support for arctic conditions unless the designer has experienced the environment. Reading the words "fifty below zero fahrenheit with a fifty mile per hour wind" does not actually convey the reality of a winter in Northern Alaska.
Service Availability

Since company staff organizations may not, for one reason or another, be suitable for an Alaskan project, local sources should be considered and their advantages and disadvantages understood. These services can be grouped into four general categories. First are the professional and technical services. These include surveying, assaying, photography and laboratory services. These services are often contracted to local suppliers in any minerals project. However, in Alaska, the nearest "local" source may be 500 air miles distant and have a large order backlog. Therefore careful planning is necessary to assure the availability of competent professional services on a timely basis. For full scale permanent operations, a local staff to provide these services should be considered.

The second category is construction services. These include excavation, road building, drilling and logging, facilities erection and other mining contracting services. Here a trade off between "in house" and outside services can be considered, with the decision criteria being competence and availability. Because of the special problems involved in arctic construction it is often best, especially in the early stages of the project, to contract work to a highly experienced arctic contractor. At this time, decisions can best be made which will minimize labor cost on site. Buildings or major portions can be shipped North in modules. Equipment can be selected wisely with a minimum of diversity. During exploration, a local drilling organization already familiar with ground, water, weather, and supply conditions can prevent costs from soaring. During development, a construction company specializing in frozen ground can put an upper limit on costs for shaft sinking, foundations, roads and the like while providing training for the permanent staff. Even during the production phase, the use of contractors for special projects may be the only way to obtain the needed skills.

The third service area is equipment service and technical support. Equipment can range from underground drills to process control computers. Most equipment suppliers provide a technical support staff for maintenance and trouble shooting, especially on new innovations. However, the time lag between support request and technician arrival may preclude relying on the manufacturer's staff. Furthermore, it is not likely that an adequate inventory of spare parts will be made available in either Anchorage or Fairbanks. Therefore, highly trained competent technicians must be provided for any ongoing project. This includes master mechanics, machinists, electricians and electronics and communications specialists, along with tools and facilities for their use.

The final category of services is best labeled as infrastructure. This includes housing, food, health and even entertainment facilities. The small villages in Interior Alaska cannot be relied upon to provide minimal services of this type, even to providing groceries for a small summer exploration project. For large continuing operations, entire towns will have to be built from scratch, and will involve most of the problems of urban planning in addition to survival in a hostile environment. Further development of this topic can be found in the chapter on personnel.

Supplies

The problem of supplies, including building materials, machinery, spare parts, fuel, explosives, reagents, et cetera is primarily one of minimizing inventory costs. Inventory costs can be broken down into three types: ordering, holding, and shortage. All of these require special consideration in remote locations and must be balanced to determine the optimum quantity of each item to order and hold.

First, an ordering strategy must consider the cost of an order added to the normal freight costs. Economies of scale may be significant. It is a good policy to order in large quantities and especially in amounts equal to the capacity of the transport vehicle. Investigate carefully the impact of volume as well as weight upon shipping rates.

Holding costs involve basically two factors: cost of capital and marginal cost of warehousing. With the current higher interest rates, a project manager must watch carefully the dollar amount of inventory being held. At twelve percent annual interest, every $1,000.00 of inventory results in $120.00 annual cost.
The cold, dry Alaska climate can have beneficial as well as adverse effects on warehousing costs. During the winter months some food supplies may be stored in uninsulated buildings at a cost lower than in a more temperate climate. On the other hand, liquid reagents, lubricants and explosives may require heated storage at considerable expense. Obviously, the warehousing costs and strategy varies with seasonal changes.

Shortage costs are probably the most significant of all inventory costs in a remote area. Lack of a critical item of supply or part can bring the entire operation to a standstill.

Solutions to the inventory problem for mineral operations abound. Whatever method is used, it must be adjusted for remote arctic conditions, including seasonality of costs, Alaskan transportation (cost and frequency of delivery), arctic/subarctic storage and extremely high fixed costs associated with downtime.

Accidents

The implication of accidents at remote Alaskan sites deserves special consideration. As previously mentioned, the cost of down time is magnified by the high fixed costs. Other effects can also be increased due to remoteness and/or the hostile environment.

Any accident involving injury is made more serious by a lack of local medical facilities. It is mandatory that advance arrangements be made to secure emergency aircraft service whenever needed. Even with an onsite clinic, injuries requiring surgery may require air evacuation to a major population center such as Fairbanks and Anchorage. This not only increases the health risk for the injured worker, but can add substantially to the down time losses when key personnel are involved. Accidents are expensive. In remote locations, they can be prohibitively expensive.

Non-injury accidents can also have major effects, especially during the winter season. Perhaps the most serious magnification of a small event would be a power outage. In a climate with daytime high temperatures under -40°, the loss of power for heating and machine movement can quickly cause major damage to piping, tanks and pumps. An extended outage might even necessitate the evacuation of personnel until heat and lighting can be restored, or even a complete shutdown for the season. To avoid this problem, emergency generating and distribution systems must be maintained at increased cost.

A final category of high cost accidents involves structural damage to buildings or equipment. First, extreme cold causes many conventional materials to become brittle and easily damaged by impact. Therefore, areas with high impact loading must be constructed of special materials designed to withstand arctic temperatures (see Chapter 6). In addition, extra care must be taken to prevent damage to buildings by sloppy machine operation. An example here would be a fork lift operator damaging the track of an overhead garage door. In a climate such as Arizona, this would be a minor inconvenience, to be repaired during a slack period. However, under continued severe cold, the consequences are severe, costly and require immediate repair.

The last factor of structural damage under arctic conditions, fire, has been the major cause of damage to these operations since man first brought industry to cold regions. Fires figure prominently in arctic operations for two reasons. First, almost everything on the site must be heated and the chances for an uncontrolled blaze are increased. Second, fighting fires in sub-zero weather is extremely difficult and dangerous, so that before the fire can be controlled the damage is often greater than in more temperate climates. For these reasons, fire prevention and control costs are greatly increased for remote Alaskan operations. The alternative could be catastrophic.

There is a tendency to cluster camp and facility buildings so as to conserve heat and outside movement. This increases the fire hazard, however, camp layout design can accommodate fire barriers within the structures. In recent designs of pipeline camps this has been taken into account. A 1976 fire at District Camp at sub-zero temperatures was contained by the quick action of heavy equipment operators who severed the burning portion of the camp with bulldozers.
Chapter IV
HOUSING AND PERSONNEL

The subject of housing and personnel are too interrelated to be discussed separately. They are best stated by Mr. Jim Lotz (Lotz '68). "The real problem is the creation of the right conditions in northern settlements to attract and hold a labor force made up, for the most part, of skilled men". Successful mining in the north is a public relations problem, an industrial relations problem and a social problem. In short, it is a people problem. Wise selection of a mining method, thorough and accurate appraisal of markets and rapport with government regulatory agencies will not yield the expected profit result if the people problem is not solved.

Solving the people problem in Alaska requires the recognition and proper response to a host of new and difficult situations. Mine development in the remote regions of the contiguous States was simultaneous with the development of other land use industries, primarily ranching and logging. The myriad of private endeavors which had even the remotest chance of success quickly followed the initial stimulus to the economy. Eventually a community, or several communities, became established in the mining area with varying degrees of success. In many cases they continued to prosper long after mining ceased to be profitable. This pattern will not be repeated in Alaska. Because of the climate, land is not as well suited to so many varying pursuits, but most important, there is virtually no private land to support such a pattern of development.

Less than one percent of the approximately 368,000,000 acres of land in the State is in private ownership. The Alaska Native Claims Settlement Act conveys approximately 44,000,000 acres of land to the Natives, but that land will be under control of Native corporations rather than Native individuals. In approximate terms, 61,000,000 acres of the 103,000,000 acres of land awarded Alaska in the Statehood Act have been patented. Approximately 4,750,000 of these 61,000,000 acres are in parks, recreational areas or game management areas. The remaining 43,000,000 acres are in the process of selection. With regard to federal land, all laws by which it can be conveyed to private interests have for all practical purposes been repealed, except for the Mining Law of 1872, and it too is rapidly becoming an increasingly difficult means of obtaining rights to mineral land.

Given the land situation and natural conditions discussed above, the traditional mining community needs consideration. Perhaps there will be no mining community. Such precedent has already been established by the petroleum industry. During construction of the Trans Alaska Pipeline, workers were housed and fed in company camps at company expense. After an eight, nine or thirteen week period, the workers were transported at company expense to their point of hire for a two week rest period. The workers received no pay for the two week rest period unless that period coincided with their vacation. Work time during the eight week work segment varied but was usually seven days a week with time and one half pay for Saturday, Sunday, and hours in excess of eight or ten hours each day.

Another variant is the practice on the Cook Inlet platforms, the Swanson River Field on the Kenai Peninsula and the North Slope production field at Prudhoe Bay. Here the workers are on a one week on and one week off schedule. They are transported by helicopter or plane to and from their place of work, at company expense. The site, however, is Kenai, Alaska rather than their home town. Again, meals and lodging are furnished by the company. The work schedule while working is twelve hours each day and seven days each week with overtime for all work on Saturday, Sunday or in excess of eight hours each day. Those who work on the Kenai Peninsula and live within commuting distance of their homes work the same schedule but drive to and from work daily.

Considering the impediments to developing a community in the North today, aggravated by prevailing attitudes and problems of compliance with state and federal regulatory agencies, these practices may well be the cheaper alternative. However, the production process in the mining industry is far more labor intensive than in the petroleum industry and will remain so for the foreseeable future, regardless of the progress which may be made in automation. Given that the petroleum industry practice is a cheaper and more desirable solution to the housing problem, a sizeable mining operation employing 1000 or more men for a continuing period of 10,
15 or 20 years or more poses an immediate problem—transportation where? It is neither desirable nor practical that Alaska's existing cities continue to absorb all of the State's increases in population. Even though the potential and means exist in both Fairbanks and Anchorage for substantial future growth, serious problems need solutions. The City of Anchorage faces a shortage of potable water. The dead calm of winter together with extremely low temperature inversions create a serious air dispersal and ice fog problem in Fairbanks. So the problem remains. How does one cope with the complexities of a new community without the usual base of private land which has always supported cities in the past?

In Southeastern Alaska, Southcentral Alaska, the Kenai area and along the highway system connecting Anchorage, Delta Junction, Tok and Fairbanks, existing towns and rural sites already commercialized can well serve as support communities for mines. A look at the map will show that a vast area is thus served in the southeast part of the State. Numerous social, industrial relations, public relations and safety problems are avoided. The mine employees would be quickly assimilated and viewed as fellow Alaskans who are not only paying their fair share, but are easing considerably the per capital tax burden of the community.

In such a situation, living accommodations at the mine site can be limited to camp type facilities. Creature comforts can vary from spartan to plush. Also, it is likely that State land will be made available for private ownership in these areas.

North and west of this region there is no transportation network. Towns and villages are few and isolated with a minimum of facilities. Most, as an example, have one telephone to serve the entire community. Only those having some unique and unforeseen advantage will develop into suitable communities for mining employees. Advantages could be: (1) proximity to several mineral sites, (2) a location on a yet to be developed transportation artery, (3) some type of political leverage, (4) a potential recreational or tourist center, (5) a farming region or (6) some location with the complexities of a new community available to the public. There is, however, one likely advantage to village sites. They are the nucleus of the native corporations, and land problems are a private matter between negotiators.

Elsewhere in the State, selection of a town site is a matter of negotiation with the Borough, State or Federal Government. The town will be looked upon as a product of the mining company involved, and a host of problems will present themselves. Sooner or later this problem will be faced and resolved. It is well to be knowledgeable of experience elsewhere, particularly in Canada, and also be aware of the somewhat different political situation in Alaska.

The first group of problems concerns the type of camp or town which is to be built. The size and potential of the ore body is, of course, the first consideration. It is likely that the community will progress through several stages, that is, summer camp, permanent town site with limited services and finally the complete town with adequate services. A good bit of information can be gained by visiting towns in the more remote parts of Canada, particularly Schefferville, Quebec; Cassiar, British Columbia; Faro, Yukon; Freumont, Quebec; and at Canadian Tungsten in Northwest Territories. A report prepared for the Bureau of Mines titled Significant Parameters of Mining Properties Located in Arctic and Subarctic Areas of North America, gives details concerning design of these towns.

Various types of permanent housing can be provided at or near the mine site. There are the rather spartan accommodations in Elsa, Yukon Territory and Tungsten in Northwest Territories; that is, single type board and room arrangements for most, and married housing for a few with a minimum of services such as a dining hall, lunch room, pub, reading room, emergency hospital and a few sport facilities. Faro, Yukon Territory is a complete community with all the services one might expect in a community of 8,000 or more in western United States. Room and board for single employees and separate houses or apartments for married employees are subsidized. Such subsidy increases as time worked for the company increases. An attempt is made by the company to maintain a hands-off attitude as much as possible. A hotel, stores and other services are operated by private concerns. The public affairs of the community are run by elected individuals. At Freumont, Quebec, and Cassiar, B.C. the private aspect is carried a step further. Houses are sold, not rented to employees. The price, however, is less than cost with a buy-back provision. At the other extreme, Atlantic Richfield and Sohio furnish single accommodations only for their personnel at the job site. Meals and rooms compare with that of the best hotels.
Although satisfactory living conditions are vital to employee satisfaction, it is important to remember that loyalty cannot be purchased. There is a tendency to disparage that which is not earned or which is not private. Labor turnover in the mining communities mentioned above is not in proportion to the creature comforts provided. In fact, there is little correlation. The following data, collected from a number of companies of the Mining Association of Canada by Cowsey and Richardson (1978), show that chronic labor turnover and similar problems are to some extent independent of community facilities provided.

<table>
<thead>
<tr>
<th>Facility</th>
<th>No. of Mines With Facility</th>
<th>No. of Mines Without Facility</th>
<th>No. of Mines With Chronic Labor Turnover (200%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports arena</td>
<td>68</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Theater</td>
<td>57</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Restaurant</td>
<td>56</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>Radio Station</td>
<td>42</td>
<td>38</td>
<td>7</td>
</tr>
<tr>
<td>T.V. &amp; Radio</td>
<td>73</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Church</td>
<td>66</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Shopping Mall</td>
<td>46</td>
<td>35</td>
<td>9</td>
</tr>
</tbody>
</table>

Therefore, more considerable inducements other than housing are needed to solve the real problem stated by Mr. Jim Lotz "...creation of the right conditions...to attract and hold a labor force..." Furthermore, these conditions must respond to a different set of criteria from those encountered in the contiguous States. Considerable creative input is needed to identify and effect motivating factors applicable to remote and cold regions.

Consider the environment. Living in a remote location in interior Alaska removes a worker and his family from secure and familiar patterns of activity. He is forced to face up to a style of living which he did not expect and for which he was not prepared. Among them are: (1) the monotony of long periods of cold and darkness; (2) the unfamiliar stimulus of the rapidly changing seasons in the spring and fall; (3) the frustrating feeling of confinement in a vast but yet inaccessible land; (4) the sudden break from strong, accepted and long-standing family ties; (5) strained marital and family relations resulting from a different pattern of living; (6) sudden loss of association with civic, social and religious groups; and (7) loss of a sense of belonging and property rights. The lack of financial commitment is likely the predominant frustration. With no means of building equity, there is a need for seeking it elsewhere. Nothing short of reproducing Main Street, U.S.A. will prevent some or all of the problems. Such is possible only in the established cities and towns, those commercialized sites suitable for development into sizeable towns and those few areas yet to establish themselves as centers for farming, lumbering, fishing, transportation, trade, and possibly mining. Mining activity in such areas holds promise of developing into a permanent community independent of mining, much as in the contiguous states with all the attendant hopes and aspirations of the inhabitants.

Many likely areas of mining in Alaska lack the attributes needed for permanent occupancy. The town site will be temporary. There will be no hope on the part of the workers for sinking roots. Faced with such conditions, it will be necessary to depend upon an existing community by flying workers in and out, or face up to the difficult problems listed above.

The author suggests that serious thought be given to motivating employees. First, seriously consider people living in the area. It is only necessary to respond to their needs. Certainly they will not quit to return south. Dissatisfaction on their part would be a clear indication that the setting would not appeal to anyone.
Second, give the workers the chance to pursue an objective. Perhaps it is a program of improvement. It could be an on the job training program, use of facilities for vocational training, arrangements with universities for degree programs or short courses. It may be advisable to adopt a well thought out and clear promotional opportunity. Programs with other properties within the company or arrangements for an exchange of workers between companies are possibilities. Such ideas are limited only by courage and imagination, but the results could be tremendous.

Third, consider the husband and wife team. Obviously, the working wife is then not at home and prey to all of the domestic troubles which are associated with people adrift in isolated communities. The earning power of two people, both working for high salaries, is a strong incentive for permanency. Also, along this line, some thought could be given to the unmarried couple.

Fourth, consider a larger percentage of female workers. The author recalls a visit to a mining property in Norway. The manager was lamenting that things were not what they used to be. One of his basic problems was the southern migration of trained workers. Shortly thereafter two welders working on a truck body were unmasked and introduced. They were Lapp women well satisfied and proficient at their job. Certainly, things were not what they used to be.

Finally, a chance to go "outside" is needed. Workers and their families require more vacation and leave time than is considered normal. In the Norwegian mines of Spitzbergen, workers frequently over extend their long vacation and leave time because they are investing their time and money in a family farm or fishing business. It is the unofficial policy to rehire the workers when they return. It is cheaper than breaking in new employees. A policy of this type may be coupled with the idea of encouraging a worker to pursue an objective.
Chapter V

Cold Weather Maintenance and Operations

Introduction

Factors increasing direct operating costs for equipment in northern climates can be divided into four general categories, namely: (1) viscosity and freezing characteristics of fluids such as fuels, lubricants, coolants, hydraulic fluids and compressed air, (2) the structural integrity of equipment over extreme temperature ranges, (3) the problems of materials handling in freezing weather, and (4) consideration of operating and maintenance personnel working in extreme cold.

The conditions in the arctic winter which magnify and distort normal maintenance and operating conditions are: (1) Cold. Temperatures can drop to -65°F with sustained periods of under -40°F. (2) Wind. High winds derived from the polar easterlies produce cooling effects which can magnify the already sub-zero temperature. (3) Snow and ice. Although much of Alaska is arid to semi-arid in terms of precipitation, the snow that falls in November will be on the ground for break-up in May. Accumulations of snow and ice must be dealt with in any operating plan. (4) Darkness. During much of the arctic winter artificial illumination is required around the clock, due not only to the decrease in sunlight but also the occurrence of ice fog produced from internal combustion engines and power plants.

Fluids

Fuels for Alaska conditions are produced locally both at Anchorage and at Fairbanks. For most operations, specification of a cloud point of at least -65°F and a sulfur content of less than 0.2 percent is sufficient for Diesel fuel (Carr, et al., 1964). However, temperatures can fall below -65°F. Heating of equipment fuel systems and fuel storage systems should be considered. Additionally, engine fuel systems may need to be redesigned to utilize engine heat and eliminate constrictions or short-radius bends in the fuel lines. Fuel additives can be used to prevent icing in both gasoline and Diesel systems (Burrous, 1974).

Lubrication procedures vary with the season. The method of application as well as a change in the actual lubricant used may be desirable. Automatic lubrication systems have caused repeated problems, and a manual system for applying a lighter lubricant is often used in extremely cold conditions (Scarborough, 1966).

Gear boxes operating intermittently, such as in the final drives on a crawler mounted drill, may require immersion heaters to insure proper lubrication. These are often installed without thermostats to decrease maintenance and increase reliability (Carr, et al., 1964).

For engine oil, it is usually best to consult with the lubrication engineering division of the supplier. Most oil companies now produce a synthetic oil specifically for cold weather operations. One example is Mobil Delvac 1 with an API gravity of 30 but a pour point below -65°F and a flash point of 440°F. This type of range is a necessity for arctic conditions.

Closely related to the engine oil problem is the choice of engine coolant. An ideal mixture of 68 percent ethylene glycol and 32 percent water will provide protection down to -70°F. However, if the cooling system is not properly maintained, leaks can develop in the engine oil system. The reaction with ethylene glycol can severely affect lubricating characteristics and cause engine damage. Some operators have gone to an all water system to avoid this problem. However, this method has two disadvantages. If an emergency shutdown occurs in the field, the cooling system must be completely drained at once. There is also a possibility that ice will form in an all water system even with the engine running. This can block coolant flow and cause differential heating of the block and head resulting in warping or cracks (Carr, et al., 1964). It is standard practice to reduce air flow to the radiator. Commercial covers for this purpose are available for most equipment.

An often better solution to the problem of oil contamination is regular chemical analysis of crank case oil. This can detect small leaks between cooling and lubricating systems before any damage can occur (Kidman, 1971).
Hydraulic fluid systems also must be modified for cold weather. Essentially three alternatives exist. Ordinary hydraulic fluid can be diluted with kerosene for the winter season. This will reduce the viscosity and give adequate performance, but the diluted fluid will not function properly at warmer temperatures and must be replaced. An alternative is to use immersion or radiant heaters to maintain the temperature when the system is idle. Unfortunately, a power loss will require a complete reheating before operation can commence. The best solution is to use a fluid specifically designed for a wide range of temperatures, such as Conoco's DN-500 (Burrous, 1974). Other brands are, of course, available locally.

Freezing of moisture condensed in the line is the obvious problem with compressed air. The best solution appears to be to use larger diameter lines and redesign the system to eliminate low points where the condensate can collect. Automatic water drains in reservoirs have been used with some success, as well as alcohol injection systems (Carr, et al., 1964).

In general, all fluid distribution systems (fuel lines, radiator hoses, etc.) need to be modified for arctic conditions. Systems should be redesigned to prevent restrictions where icing or increased viscosity can decrease the flow below operating limits. Heating of the system can be accomplished with either waste heat from the engine or with electric heaters. The piping involved should meet arctic standards. Hoses of teflon, nylon, fiberglass, silicones and polycarbonates have been developed for arctic use. Some companies have had success replacing original equipment lubricating tubes and air lines with large diameter metal-braid Aeroquip high pressure hose (Scarborough, 1966).

Structural Considerations

There are two basic methods for dealing with the structural failure of equipment caused by cold weather operations. Strengthen the equipment and/or lighten the loading. Because of the temperature induced brittleness in ordinary mild steels, special alloys should be specified for all equipment. For ordinary structural members, USS T-1, a quench tempered, low carbon, nickel alloy steel, is satisfactory for temperatures down to -50°F. Steel meeting ASTM specification A-203 or A-300 should be used for high stress members and parts (Burrous, 1974).

A cast alloy will give better service than ordinary forged medium carbon steel for machine parts such as large gears. A forged gear will have a grain orientation parallel to the circumference which is inherently weaker than the random orientation of the cast part (Ritcey and Kilburn, 1963).

Reduction of stresses can be accomplished in several ways. One operation in Canada replaces the 5 yard shovel buckets used during warm weather with 4 yard buckets for the winter (Scarborough, 1966). This practice reduces shock loading to the truck bed and reduces rapid unloading stresses in the shovel components. The possible necessity of smaller sizes of equipment during cold weather should be considered in all equipment sizing considerations.

Perhaps the most effective methods of reducing excessive loading is proper operation. Operators should be trained to avoid habits which can damage cold, weakened parts. Shovel and loader operators should plan bucket loads so that large boulders are dumped into partially filled boxes, not onto bare metal. Operators of crawler mounted equipment must avoid tramping over obstacles which can damage tracks or track frames. This is increasingly important for crawler mounted shovels and drills where the frames are not designed for extremely rough terrain (Scarborough, 1966, Carr et al., 1964).

Some operations have attempted to directly decrease temperature induced brittleness by heating structural members. However, the use of strip heaters on components has not always proven acceptable. The resulting differential expansion can cause stress patterns which can weaken the member more than a uniform sub-zero temperature (DeMelt, 1973).

Materials Handling

The principal problem in materials handling during an arctic winter is with moist, unfrozen ground. When this material comes in contact with sub-zero metal, it immediately freezes to the surface. This implies trouble in cleaning loader and shovel buckets, truck beds and
railroad cars. If the material is wet and sticky, such as at IOCC's mine at Schefferville, Quebec, bucket cleaning becomes a major concern. The most promising solution is to mount electric heaters on the bucket to prevent freezing. At Schefferville, eight 1,500 watt heaters are used on 4 yard shovel buckets (Carr et al., 1964). The procedure of burning oil soaked straw in the bucket is one of the least acceptable, due to possible bucket damage from the uncontrolled heat.

Truck bodies in the arctic are almost universally equipped with double walled beds with provisions to circulate hot exhaust gases between the walls. This is a cost efficient use of otherwise wasted heat. It prevents material from sticking to the metal and also reduces the temperature induced brittleness of the metal in the truck bed.

Railroad cars traveling any long distance should be covered with tarpaulins to prevent snow and ice accumulation. However, this will not prevent the freezing of the contained moisture. As contained moisture freezes from the outside in, osmotic pressure will cause the remaining moisture to migrate toward the frozen layer where it freezes, forming a "halo" of hard frozen material (MacFallan, 1973) which must be unfrozen before the car can be unloaded (or sampled). The usual procedure is to store the cars in a heated building until they are thawed. The total amount of heat needed is a function of initial moisture content and the conditions encountered during shipping.

Not only are open gondola cars subject to freezing on a delivery run, they also fill with ice and snow on the return trip. This must be removed before the car can be used. A unique solution to this problem is used at Schefferville. Two surplus J47-19 jet engines are mounted above the tracks with the exhausts pointing downward into the car. The $175^\circ F$ exhaust blasts the snow away, and quickly melts any ice build up. These units operate at 70 percent maximum power and burn 245 gallons of fuel per hour. A similar unit has been mounted on a flat car for clearing ice and snow buildup from tracks and switches (Carr, et al., 1964).

Work Performance

Consideration of both human efficiency and mechanical factors dictates that most scheduled maintenance should be done during the warmer months or in heated buildings. Most arctic operations plan major equipment refitting for the late summer and fall. This is especially important for equipment too large for inside work. At the same time as the equipment is checked for structural soundness, fluid systems are inspected and refilled for cold weather operations.

A similar major maintenance program occurs in the spring after break-up, when small jobs postponed during the winter are completed. Summer weight fluids are then installed. Thus, in terms of time and material, two major maintenance activity periods are scheduled each year (Gregoire, 1977).

During the winter, maintenance should be done in a heated building as much as possible. These buildings can be large or small, permanent or temporary and near the mine or mill. The chance that maintenance work will be performed properly is much greater in a warm, well-lit ship than in the dark in severe cold. Obviously, some maintenance, both preventative and corrective, will have to be done in the field. In this case, a temporary enclosure is constructed around a major job. Also, service trucks providing heated work space and heated storage of oil, grease, pumps, et cetera can be used to good advantage.

Welding repairs are perhaps the most difficult of arctic winter jobs. Because of the need to supply enough heat to warm the entire member, large welding repairs often cannot be properly done in the field even with temporary enclosures. Some operations have resorted to stocking parts, such as shovel track frames, which under normal conditions would be repaired rather than replaced (Scarborough, 1966). The broken parts are then warmed, repaired and allowed to "cure" before returning to service. Practices such as this will, of course, increase inventory holding costs and must be evaluated carefully.
Chapter VI
POWER

Power is expensive in Alaska but under favorable circumstances and in favored locations it should decrease relative to the general cost level. Natural gas may yet be the fuel of the future in Alaska, and coal is found extensively throughout the State. Essentially, each city, town or village has its own power system. A few interconnections do exist, such as those which serve the area around Fairbanks and those which serve the Anchorage area. There is no power grid, supplied in large part by hydropower, as in the Yukon Territory and other parts of Northern Canada.

The scattered communities of the State do not have the financial base to provide for themselves all the accepted amenities of modern living. Municipal services are supported in large measure by the State. Power appears to be another such State support service. The 1976 Legislature provided for the Alaska Power Authority, just now becoming functional, with broad authority to investigate and develop sources of power. In the present political setting, hydroindustrial power funded by the State could easily become a highly emotional issue. On the other hand, should events lead to a different set of priorities or values, it could just as easily become the mechanism for subsidy.

Power sources in Alaska are not wanting. The State has the largest untapped hydrosupply in the United States, but it is unused except in Southeast Alaska and one or two places in South Central Alaska. The initial capital outlay can be conservatively termed substantial. Current estimates for a proposed hydroproject on the Susitna River just east of the Anchorage-Fairbanks corridor vary from $1,000 to $2,000 per kilowatt. A 20-megawatt hydropower development at Terror Lake on Kodiak Island is estimated to cost $40 million (McKinney, 1977). Many, perhaps most, sites may be withdrawn from consideration should some bills now under consideration by Congress become law.

Oil and gas are potential fuel sources for electric power. In the case of heating oil and diesel fuel, there are currently only two producing locations—North Pole and Kenai. Both have their markets and marketing systems. But there is considerable political pressure to attain maximum benefit from Alaska's royalty oil. This will lead to a greater utilization of the product within the State. As a fuel for electric power, it must compete with coal from Healy at any location along the Alaska Railroad, and is competitive only because of current emission standards applicable to coal fired power plants. Crude oil is being used as a feed for refineries producing simple distillates. Diesel and fuel oils will certainly be readily available in Fairbanks and Anchorage.

Natural gas is currently in short supply in the contiguous States. Few shortages prove to be of lasting duration in a free enterprise system, and particularly with regard to a product as desirable as natural gas. Should events make Alaska natural gas noncompetitive in the midwestern and eastern markets, the incentive exists to make it a readily available fuel in Alaska, because its nonpolluting qualities are most important in the Arctic.

The type of power used is highly dependent upon location. Any location close to the Alaska Railroad has access to coal from Usibelli Coal Company at Healy, Alaska. This coal now (1962) sells for $30.00 per ton spot at Healy. Long-term contracts can be negotiated from 10 percent to 15 percent lower. Transportation cost on the railroad is $7.43 per ton, from Healy to Fairbanks. Costs from Healy to Nenana is approximately $4.50 per ton. A small underground mine near Carmacks in the Yukon Territory supplied coal for a time for the drying of concentrates at the Cyprus Anvil Mine near Fair, a truck haul of 105 miles. Coal is found in Alaska in the Matanuska Valley area, near Cordova, near Baluga Lake across the Cook Inlet from Anchorage, near Healy, on the Kenai Peninsula, in vast quantities in the Colville River area just north of the Brooks Range, and in many other scattered locations throughout the State. It is likely that many mineable mineral deposits will occur close to one or more coal deposits. A small coal mine could well supply the energy needs of the mine, mill and town.

Locations along the coast and the inland waterways can be supplied with Diesel fuel from Fairbanks, Anchorage or West Coast ports. There is also the possibility of hydropower installations, particularly in South Central and Southeast Alaska.
Diesel Power

With few exceptions, diesel generator sets are used to provide power for small towns and villages. Low capital cost, availability, and ease of installation are the reasons for their popularity. Furthermore, they require the same maintenance attention as mobil equipment used in mining operations. They afford an excellent opportunity to lower inventory substantially. Identical motors can be used in both types of equipment.

Two complete V16 generator sets can be loaded on a Hercules aircraft and delivered 350 miles from Fairbanks for $8,000 (source AIA, phone call, 1982). Each V16 unit produces 700 to 800 K.W. of continuous power. Diesel units with a capacity of 5,000 K.W. or more can be installed in the Arctic for $250 per K.W. at 1974 price levels (Power Plant Design for the Mining Industry, CIM Bull. Jan. 76).

Diesel fuel for remote locations is expensive. As of the summer of 1982, the price of number 1 diesel fuel suitable for cold weather use was $1.082 per gallon in tank car lots loaded at Anchorage and $0.975 at North Pole. The cost of shipping from Anchorage to Nenana is $1.68 per 100 pounds in 20,000 gallon tank cars and $1.82 per 100 pounds in 10,000 gallon tank cars. Costs from North Pole to Nenana are $0.66 and $0.72 respectively. Nenana is the point of trans-shipment to the Tanana and Yukon River barge system.

Hydroelectric Power

Hydroelectric projects have the advantage of being exempt from future price increases. They have the advantage of being a clean source of power but have their own regulatory complications, including fish and wildlife migration patterns and changes in water flow and quality, to name a few.

For the larger power need, a private hydropower system should be investigated if a sizable stream or lake site is nearby. South Central and Southeast Alaska offer the best potential because the weather is more temperate. In the interior, ice can freeze to depths of five to six feet; yet systems can operate effectively in all but the coldest months. The hydrodam on the Yukon at Whitehorse is operational 12 months of the year.

Davis-Goetz Construction in Anchorage (Davis, 1977) is promoting the advantages of hydropower units as small as 100 K.W. capacity. A good velocity and head are needed to make small hydropower practical. The Yukon River velocity is identified as too slow. A good head is described as at least 50 feet. No installation of this type is known in Alaska; but these types of innovative ideas are needed to make small scale mining a success.

The Canadian Government has found it beneficial to build hydroelectric stations to supply power to remote mine and town sites. The Northern Canada Power Commission surveys, plans, constructs and operates electric utility systems north of 60° latitude. The Northern Canada Power Act requires that the projects be self-sustained.

Utility Power

Electric utilities may become a more viable source of power for the mining industry than now appears likely. Regardless of the eventual mode of development of the North, some systematic power grids will be necessary. Each extension, of course, is unique.

Electric power has best served society as a controlled monopoly with rates based upon the capitalized costs and operating costs of a coordinated system serving diversified needs. Privately owned coal and hydroelectric power plants may serve some of the more sizeable mining operations in Alaska. It is well to consider their future relationship with nearby sources and needs. Perhaps a nearby source could be called upon to supply the larger quantities of power needed in the future. On the other hand, nearby needs could be the stimulus now or in the future to take advantage of economies of scale and income from customers.
As a quick guide for cost estimating, the commercial rates for electric power for the Fairbanks and Anchorage areas are given below.

**Anchorage**

<table>
<thead>
<tr>
<th>Demand</th>
<th>kW</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>10-50 kw</td>
<td>$4.77 per kw* plus $0.02 per kwh</td>
</tr>
<tr>
<td>Demand</td>
<td>&gt; 50 kw</td>
<td>$4.42 per kw* plus $0.02 per kwh</td>
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**Fairbanks**

<table>
<thead>
<tr>
<th>Demand</th>
<th>kW</th>
<th>Charge</th>
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</thead>
<tbody>
<tr>
<td>Demand</td>
<td>710 kw</td>
<td>$6.25 per kw* plus $0.09 per kwh</td>
</tr>
</tbody>
</table>

*Kw demand is determined by the highest kw draw for an averaged 15 minute interval measured for the first 11 months of the billing year (Golden Valley Electric Association and Chugach Electric, personal communication).
Chapter VII

TRANSPORTATION

Introduction

The development of a transportation system for Alaska is essential for mineral development. This development must include not only transportation within, but also to and from the State.

Alaska is an isolated area. Only one land route, the Alaska Highway, connects it to major production and market centers. All other import and export traffic is by air or sea. The only year round ice free ports lie south and east of Anchorage. So, from the beginning, Alaska operations must carry a heavy freight burden.

In addition, surface transportation service for Interior Alaska is at best limited and usually nonexistent on a year round basis. In area, Alaska contains almost one-sixth the land mass of the United States, yet its transportation network consists of less than 2,500 miles of paved highways and less than 500 miles of railroads. These routes form a roughly triangular area between Anchorage, Fairbanks and Valdez. Outside of this triangle, paved roads are practically nonexistent. The area north of the Yukon River, approximately one third of the State, is accessible on land by snow machine, tractor or the 500 mile Fairbanks to North Slope Haul Road (unpaved). The only other surface transportation to the Interior is via low draft barge up the Yukon–Tanana–Porcupine and Kuskokwim River systems, which is limited to five to six months each year. During the winter, access between outlying areas is only by air.

In the Yukon Territory, aside from the Alaska Highway, the road system serves primarily to connect mineral producing areas. Obviously, mineral development and production in Alaska will have a major impact on transportation development and vice versa.

Development

Development of new transportation systems for arctic mining operations involves moving men and material to the site and moving ores, concentrates or finished products out. Any new transportation plan must provide for this two-way flow.

For example, the construction of the Trans Alaska Pipeline necessitated the building of the Haul Road, which now serves as a vital supply link to the North Slope. Likewise, shipping points for minerals tend to become ports of entry for men and materials. Valdez is currently expanding its harbor facilities to become the major shipping port for goods into Interior Alaska.

Additionally, this two-way flow must be considered in the total development of an area. Once the initial route is established, previously unknown potential can be realized. The existence of the Haul Road does decrease the total cost of developing the mineral belts paralleling the Brooks Range. The joint benefit of the final system should be considered when planning access routes.

Unless the joint benefit and costs are adequately defined, there is little likelihood that any proposed system would be approved by the various governmental agencies involved. It is likely true that the benefits of a new road system, to be shared by the mineral developers and affected communities involved, can be determined and probably shared on an after the fact basis. But in fact the initial developer will carry the full burden of cost, or proof that the government should share the cost. There is considerable historical precedent that road costs are a tax supported expense, and comparing their benefit with that of the myriad other governmental activities supported by the taxpayer, they are relatively small. However, it must be recognized that, in Alaska, many of the mineral areas will never support an economy other than that of the mining venture for which they were developed.
Transportation To and From Alaska

Water Access

Currently year-round ice-free ports for Alaska are limited to the area south and east of Anchorage, with surface interior connections at Anchorage, Seward, Whittier, and Valdez. Future shipment of minerals from the Interior will be either limited to these sites or shipped on a part-year basis. This can be accomplished for the product by trans-shipping and stockpiling. However, the movement of men and materials into an area must proceed on a year-round basis, at least to some extent. This may mean considerable stockpiling of supplies at the site and use of aircraft for personnel movement and light cargo. If so, inventory costs could become considerable (see Chapter III).

Another alternative would be the use of reinforced barges and icebreaking tugs to extend the useability of icebound ports. For example, a proposed port at Lost River would be ice-free only four to five months each year. With reinforced hulls, ships could be used about 10 months per year. This would greatly cut down stockpiling of supplies and products, but would increase unit shipping costs (Rhodes, 1979).

One final aspect of the Alaska port problem is lack of deep water facilities. Most of the possible port locations for servicing Western Alaska are in shallow tidewaters. The deep draft vessels needed to economically sustain large scale mineral development simply cannot be used. This means, barring the use of harbor deepening schemes such as Project Plowshare, that utilization of northern ports will be by means of a lighterage system, ocean-going shallow draft barges and tugs, or pipelines. All will add to the final freight costs (Clark, 1973).

Land Access

The Alaska Highway from Dawson Creek, B.C. to Fairbanks, Alaska, originally built during World War II as a war supply route, remains today the only land freight route into the State. Although the road is unpaved through most of Canada, it does carry year-round truck traffic and provides an alternative to ocean shipping. However, the length of the haul, rough roads, and high fuel costs detract from the economy of this route.

Currently the Canadian government is conducting an investigation into extending the Canadian railway system into northern British Columbia and the Yukon Territory. If this were to occur, the Alaska Railroad could be extended from Fairbanks to the Yukon border and greatly reduce the costs for freight movement to and from the State. In part, this decision will depend on the final disposition of the Alaska Highway Gas Pipeline and so is some years in the future.

Transportation Within the State

Water Routes

Alaska's rivers provide a major supply link to its interior communities. Riverboats and barges have been carrying freight to support mineral development since the turn of the century, and today continue to be the only heavy freight link for many settlements on the Yukon-Tanana-Porcupine and Kuskokwim River systems. Modern mineral development could utilize this existing service for moving materials into development sites. With some modification, a large scale barging operation could carry production to either lighterage ports on Norton Sound or the Alaska Railroad connection at Nenana. In either case, low cost inland water transport is potentially available.

Unfortunately, the rivers in Alaska are navigable only five to six months out of the year. Therefore, the utilization of this system would be seasonal and not be acceptable for some operations.
Air Routes

Year round usage of Alaska rivers is currently being investigated through a study of hovercraft applications. For this system, ground effects vehicles capable of carrying 50 to 100 tons each are being investigated and tested for possible arctic use. For overland use these machines require at least some road construction and maintenance. However, by using the river systems for routes, a fairly smooth, even grade, natural highway is available summer and winter. Craft of this type and size are currently carrying passengers and freight across the English Channel (Rhodes, 1979). Whether or not the system can be modified for Alaska conditions is not yet known.

The prime disadvantage of hovercraft is the high freight cost, which is slightly higher than fixed-wing aircraft (Rhodes, 1979). Their main advantages are high pay loads and the fact that no sophisticated landing facilities are required.

Air travel is one of the mainstays of communication and transportation in Alaska. Many northern villages have State financed improved and maintained gravel strips, but light aircraft on pontoons or skis are the only effective means of transportation for substantial portions of the State. Air cargo may represent the only means of transport for some mineral projects due to surface access restrictions. The thought of flying out products such as precious metals with a high unit value does not startle people. However, studies show that annual tonnages on the order of 60,000 tons of blister copper could be flown from Northern Alaska for a cost of around $0.30 per ton mile, using Boeing 747F Aircraft (Wolff et. al., 1973). At the 1982 price level and considering an air mile distance of about 550 miles, this would add approximately 20 cents per pound delivered to a deepwater port such as Anchorage. Such numbers indicate that the use of fixed-wing air transport of mineral products may be feasible for base as well as precious metals.

For movement of men and materials into the site, both fixed-wing craft and helicopters may provide the most economic alternative. During the exploration and early development stages this may be the only acceptable method of transportation. With short take-off and landing (STOL) cargo planes and high lift capacity helicopters, most equipment and supplies can be disassembled into loads small enough to be air transported yet large enough to provide for field assembly. Even though this may add significantly to the supply costs, it may be cheaper and more practical than coping with the required regulatory agencies during the early stages of a project.

Land Routes

Land routes in Interior Alaska face the major obstacles of the physical environment and government regulations. The Alaskan environment creates unique problems for road building. Permafrost conditions must be considered and thermal balance maintained or road beds will disintegrate after a few seasons of freeze and thaw. This becomes extremely critical for railroad construction. Track is not easily "patch repaired" and severe speed restrictions may be required. Luckily, however, the engineering parameters for construction of arctic roads have been well investigated. Road costs will be higher for arctic conditions, but permanent routes can be built and maintained on a full year basis using existing technology.

However, the engineering problems for surface transportation in Alaska are slight compared to the governmental regulations regarding right-of-way. At present many practical and potential surface access corridors into Interior Alaska's mineral belts are closed through direct withdrawals (parks, monuments, scenic rivers, etcetera). These withdrawals amount to a total of approximately 150,000,000 acres and are clearly identified in the Alaska National Interest Lands Conservation Act passed by the 96th Congress. The Act also addressed transportation systems in and across these areas, but the provisions have yet to be interpreted. There is no way of estimating the cost burden this can have on any specific project.

Railroads

Rail haulage can provide uniquely low cost transportation for Alaska minerals development. Most people tend to think of Alaska in terms of high rugged mountain terrains such as Mt.
McKinley and the Brooks Range. In fact, a large amount of Alaska is comprised of wide, gently sloping river valleys and low mountains. For example, Fairbanks, located on the Tanana River nearly 1,000 river miles from the Bering Sea, has an elevation of only 400 feet above sea level. The Alaska Railroad through Mt. McKinley National Park passes between peaks of over 15,000 feet, yet crosses the Alaska Range through Broad Pass at an elevation of under 4,000 feet over a pass distance of several miles. These topographic conditions mean that railroads could be constructed with minimal need for mountain construction techniques such as tunnels, widening of steep canyons and construction of high bridges and snow sheds.

The permafrost conditions will require higher costs for road bed construction, but the engineering problems are well defined and can be overcome, as witnessed by the current Soviet construction of a rail line from Lake Baikal to the Amur River through over 1,500 miles of Siberian terrain similar to that in Alaska.

Currently the only rail system in the State is the Alaska Railroad, a total of 480 miles from the ports at Seward and Whittier through Anchorage, over the Alaska Range to Nenana on the Tanana River and thence to Fairbanks. This system is federally owned and provides both passenger and freight service to the Interior. Coal is hauled on the northern section of the line to the Fairbanks area from the State's only operating coal mine at Healy.

Several additions to this system have been studied primarily to open the minerals potential in Northwest Alaska. These would involve branching off the main line at Nenana (already a major river traffic center) and building connections to the Kobuk River Valley (430 miles), with the possible extension to a port on the Seward Peninsula (additional 400 miles) and Kupowruk on the Arctic Ocean (additional 420 miles). This addition of between 430 and 1,250 miles of track would open up several known mineral deposits to development and offer exploration possibilities for unknown others (Wolff et al., 1973).

Unfortunately, with construction cost estimates ranging over $2,000,000 per mile (excluding government regulation and environmental costs), individual companies will find it difficult to justify the needed expenditures on single projects. But if consortiums of companies can be formed to develop several projects in the same area, and if government support can be obtained to develop transportation to benefit outlying communities, then the shared cost may be acceptable. For example, the Trans Alaska Pipeline costs eventually reached almost $10 million per mile but these costs were shared by a group of four major oil companies, and tariff costs are deductible from state royalties.

Roads

As previously stated, the Alaska system of highways varies from barely adequate to nonexistent, with only one route north of the Yukon River. However, this route (The North Slope Haul Road) could provide a central core for road development into northern Alaska. Connection through Bettles to the Kobuk Valley would yield access to several known mineralized areas along the south flank of the Brooks Range and could be extended to ports at Nome, Teller, Kotzebue or elsewhere.

Road systems, although cheaper than railroads, are expensive, with estimates approaching nearly $1 million per mile (Wolff et al., 1973). But once again, the consortium approach may allow for development if government will help, or at least not hinder, the construction.

Winter roads may provide initial temporary access. These are roads constructed after freeze up and can be used either by sled trains or heavy trucks. Construction costs for winter roads are significantly less than permanent roads, estimated at around $5,000 per mile including maintenance during the winter period (Wolff et al., 1973). Unfortunately, this would be an annually recurring cost and the road would be available only part of the year with restrictions as to use depending upon snow cover. However, the low cost may be a deciding factor in the early stages of development or for heavy equipment supply for locations otherwise served by air or summer barge.
Accessible Areas

For the most part, this chapter has dealt with transportation into remote Alaska locations. Fortunately, all of Alaska's mineral potential is not quite so isolated. Potential locations in South Central and Southeast Alaska are seldom more than fifty air miles from a highway or port facility. Even though mountainous conditions will increase construction costs, the construction and maintenance of a 500 mile thoroughfare will not have to be allocated to a single project. In fact, from a transportation point of view, some "ideal" locations exist. The Quartz Hill project in Southeast Alaska requires less than fifteen miles of road construction to link it to a deep water, ice-free, sheltered port location.

Alaska is a large area with a wide range of climate and topography to match an equally wide range of mineral occurrences. The solutions to the transportation problems will range from simple low cost projects to extremely complex high cost projects. It should also be remembered that no matter what the solution, final decisions on utilization of a proposed system rests currently with government agencies, and the major problems (and perhaps the major costs) in development will not be engineering but political.
Chapter VIII

LAND USE

Introduction

The utilization of land for mineral development is one of the foremost problems facing the United States mineral industry today. Nowhere in the country is the problem more apparent and intractable than in Alaska. Presently, over 200 of Alaska's 368 million acres are withdrawn for mineral entry and location. More significantly, the majority of the State's known metallic mineral resources are included in the withdrawn areas. For example, of the twenty major mineral occurrences in Alaska, cited in an Engineering and Mining Journal report, all but two are closed to entry (Dayton, 1979).

Yet the situation is even more critical. As mentioned elsewhere in this study, transportation is one of the keys to Alaska mineral development, and those minerals and mineral areas not directly included in withdrawn areas have their surface access corridors blocked by withdrawals. All in all, the land use situation in Alaska seems rather bleak for mineral development. The problem pivots on a few key issues which require closer inspection.

History

Alaska was acquired from Russia in 1867 for $7.2 million, which works out to about two cents per acre. At that time, Russian settlement of this 586,000 square miles was confined to the sea coasts with practically no interior exploration. This remained the situation until the Klondike and subsequent gold strikes at the turn of the century, which initiated development along the Yukon-Tanana River systems. Most of the interior was still untouched and left to the native peoples for their subsistence needs.

Alaska's natives were first recognized by the United States government as having valid land claims in 1884 in the Organic Act for Alaska, which provided for future legislation to convey title to lands they used and occupied. This future legislation was finally passed in 1971 as the Alaska Native Claims Settlement Act (ANCSA).

The Statehood Act passed in 1958 contained two land provisions which form the basis of today's conflicts. First, the State was granted the right to select a total of 103.3 million acres for ownership to provide an economic base for development and growth. The State was allowed 25 years to make its selections. Second, the rights of the Natives (Indians, Eskimos, and Aleuts) were again recognized and the State waived all claim of title to Native land. Subsequently, in 1966 the Secretary of Interior imposed a "land freeze" on all federal land transfers in Alaska, except the staking of metalliferous mineral claims, until the final passage of ANCSA.

The passage of the ANCSA in 1971 awarding 44 million acres to Alaska Natives should have had a settling effect on the Alaska land problem. Unfortunately, the Act contained Section 17(d)(2) commonly known as "D-2". D-2 is a provision for the maintenance of environmental quality. It directed the Secretary of Interior to withdraw up to 80 million acres of federal land to be considered by Congress for inclusion in the national parks, forests, wildlife refuges and wild and scenic river systems. In 1973, Secretary of Interior Roger Morton designated 83 million acres for consideration. December 18, 1978 was the deadline for Congress to act on classifying these D-2 lands. A bill (HR.39) was passed by the House and sent to the Senate late in the 1978 session of the 95th Congress. However, the Senate adjourned without resolving the D-2 question.

In mid-November 1978, Secretary of Interior Cecil Andrus withdrew 110 million acres from mineral entry and State selection under the Federal Land Policy and Management Act of 1976 (BLM Organic Act). Then on December 1, President Carter included 56 million acres of the 110 million in newly created national monuments, parks and wilderness areas.

In December of 1980, the 96th Congress passed the Alaska National Interest Lands Conservation Act. Approximately 103 million acres were set aside as new or additions to existing national parks, national monuments, wilderness areas, wild and scenic rivers or otherwise with-
drawn from mineral exploration. An additional eight and one quarter million acres of national forest land was transferred to the wilderness system or made more inaccessible to mineral activity.

The size of the recently withdrawn areas is formidable (100 million acres is about the size of New England, New York and Pennsylvania combined). The locations appear to be designed to preclude any economic development. But the size and richness of Alaska's deposits are also formidable. The Quartz Hill deposit is estimated to be the second largest molybdenum deposit known in the world. Mt. Prindle, north of Fairbanks, has surface shows of uranium running over seven percent $\text{U}_3\text{O}_8$. A potential reward may in some cases justify the added legal costs.
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