THE NORTHERN ENGINEER

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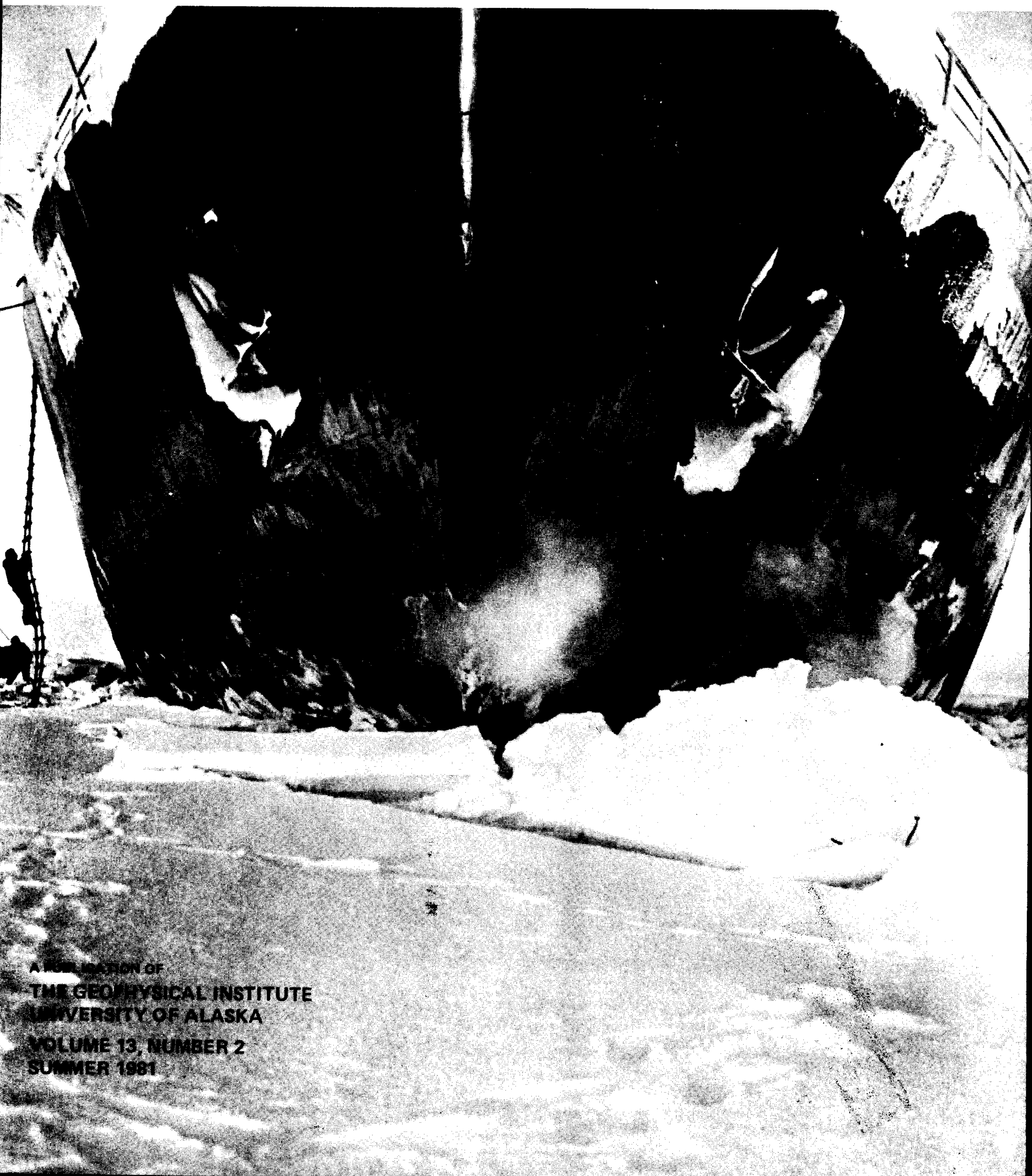

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COVER

In honor of the two icebreaker articles in this issue, the cover presents a portrait of the Soviet nuclear-powered icebreaker *Lenin* in annual sea ice. (From the book *The Two Poles* by Gennady Koposov; print courtesy of William Sackinger.)

THE NORTHERN ENGINEER is a quarterly publication of the Geophysical Institute, University of Alaska - Dr. Juan G. Roederer, Director. It focuses on engineering practice and technological developments in cold regions, but in the broadest sense. We will consider articles stemming from the physical, biological and behavioral sciences, also views and comments having a social or political thrust, so long as the viewpoint relates to technical problems of northern habitation, commerce, development or the environment. Contributions from other polar nations are welcome. We are pleased to include book reviews on appropriate subjects, and announcements of forthcoming meetings of interest to northern communities. "Letters to the Editor" will be published if of general interest; these should not exceed 300 words. Subscription rates for *THE NORTHERN ENGINEER* are $10 for one year, $15 for two years, and $35 for five years. Some back issues are available for $2.50 each. Address all correspondence to THE EDITOR, THE NORTHERN ENGINEER, GEOPHYSICAL INSTITUTE, UNIVERSITY OF ALASKA, FAIRBANKS, ALASKA 99701, U.S.A. The University of Alaska is an EO/AA employer and educational institution.

by Michael J. Economides

NORTH SLOPE GAS— A BETTER APPROACH?

INTRODUCTION

Alaska's North Slope natural gas could provide a major boost to national energy needs. Although natural gas is one of the most efficient and cleanest forms of energy, it poses cumbersome problems of transportation. The remoteness of the North Slope reservoirs from the energy-hungry markets to the south and the high construction costs in Alaska further complicate the picture.

In the political climate of the 1970s, following the Arab oil embargo and Project Independence, no cost was too great to pay for utilizing the United States' own resources. Offshore drilling and exploration in remote and harsh areas of the U.S. became common characteristics of the petroleum scene. The development at Prudhoe Bay, the trans Alaska pipeline, and the Valdez terminal tapped the vast reserves discovered on the Slope. A natural gas pipeline was considered an obvious followup to complete the reservoir exploitation. In the past few years, however, other options for utilizing North Slope natural gas have been suggested.

The Prudhoe Bay field is a giant petroleum reservoir, the largest ever discovered in North America. Recoverable reserves for this field have been estimated at 26 x 10^{12} cubic feet (scf) of gas and 9.7 x 10^{9} barrels (bbl) of oil.[1] The present production is 1.5 x 10^{6} barrels per day and is expected to remain at roughly this level, which represents that of maximum production from the reservoir. Production from primary recovery is expected to decline soon, although secondary recovery (waterflooding) is expected to pick up the slack.

Presently, the gas—oil ratio (GOR) at Prudhoe Bay is 900 standard cubic feet per barrel. The overall gas—oil ratio is 2700 scf/bbl based on recoverable reserves. Hence, one would expect a sizable increase in the amount of gas produced at Prudhoe both because of the decline in pressure and the "sweep" due to the anticipated waterflood.

At present the gas is reinjected into the reservoir at the rate of 1.2 x 10^{9} scf per day, while some of the available gas is used as fuel for the operation of the field and some of the pumping stations. For reasons explained below, the reinjection practice will have to be terminated within three to four years. The issue is what to do with the available gas when that happens.

There are three options that appear to be technically feasible: 1) transporting the natural gas via a pipeline connecting Alaska with Canadian and Lower 48 locations; 2) flaring, which will become necessary if no means of useful disposal are implemented; and 3) converting the natural gas at Prudhoe Bay to other liquid compounds that could be transported via the under-utilized trans Alaska pipeline. The desirability or lack thereof of the three options will be discussed in this article.

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GAS REINJECTION

The cessation of gas reinjection becomes necessary at some point in the life of any petroleum reservoir because of the fundamental behavior of oilfield fluids.

Liquid oil, natural gas and water are the fluids found in a petroleum reservoir. The nomenclature of these substances, if not scientifically exact, is at least descriptive for the temperatures and pressures found in typical reservoirs.

Due to "gravity segregation" and the hydraulic pressure gradient, gas inhabits the upper strata of the reservoir, oil the middle and water the bottom, as one would expect. Hence, there exists a gas-oil contact and an oil-water contact; a phenomenon called capillary pressure "fuzzies" the contacts. Water inhabits the entire reservoir at a minimum, "irreducible", water saturation.

The phase of a fluid in a reservoir will change as pressure declines due to production. The temperature remains largely constant, so most reservoir depletion calculations are made assuming isothermal conditions.

A successful oil well is one that is completed in the oil zone. Figure 1 demonstrates a reservoir with the three distinct zones and with wells completed in the oil zone. A well represents a pressure "sink", and hence a pressure gradient is created. This gradient forces the fluid through the reservoir, up the wellbore and to the surface.

Production from the pore spaces results in voidage and pressure depletion. This in turn causes an expansion of the gas cap. Because of the pressure reduction, gas comes out of solution or, more precisely, the oil undergoes an isothermal distillation. Hence, gas can be produced either because the reservoir pressure is reduced below the "bubble point" pressure, or because the gas cap expands to the point that the gas-oil contact falls below the level of the well completions. This phenomenon is often called "gas coning".

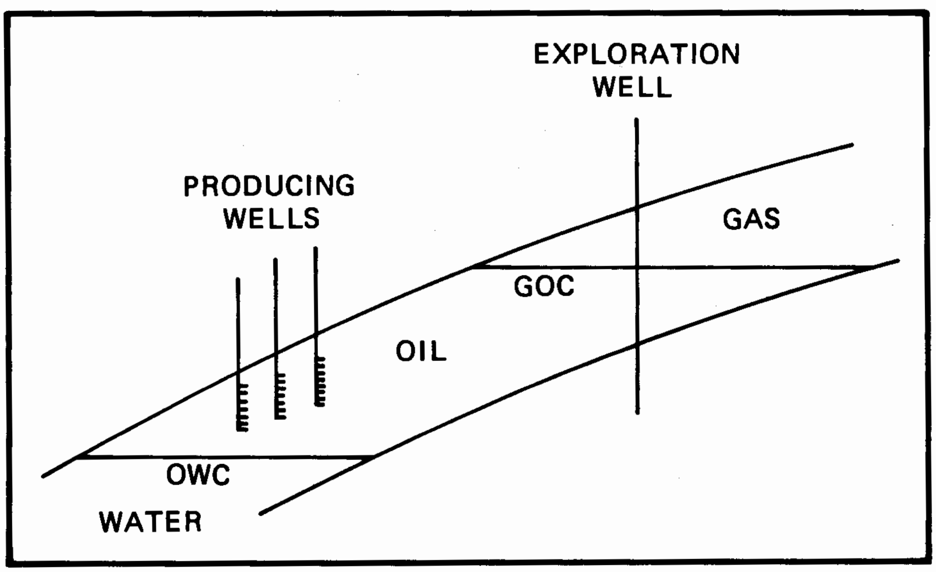

Figure 1. Reservoir configuration showing gas, oil and water zones and contacts. Note successful completions in the oil zone.

The production of natural gas from a typical oil reservoir is expected to increase in relation to the production of liquid. More precisely, the gas-oil ratio (GOR) increases as the reservoir pressure decreases.

At early stages in the life of a reservoir, the gas is reinjected with powerful compressors into the ground, through wells appropriately called injectors. If the only purpose was pressure maintenance, a good injection design would complete the wells in the gas cap. An expanding gas cap at sufficiently high pressure can sustain the underlying oil zone at a high enough pressure to overcome the hydraulic head in the wellbore and thus permit the oil to reach the surface without artificial lift (such as pumping units).

A more sophisticated use of produced solution gas is gasflood. Carefully selected patterns (known because of the relative well numbers and configuration as "5-spot", "7-spot", "line drive", etc.) are used to inject gas to displace oil towards adjoining producers. Thus, pressure-depleted reservoirs are offered a "helping hand".

An ideal type of displacement is called "piston-like"; the nomenclature is self explanatory. However, a reservoir fluid property known as relative permeability allows gas to "finger" through the passageways or "override". Gas, then, short-circuits the process and eventually creates a swift path between injectors and producers. Thus, much energy is expended to re-produce recently produced and injected gas without the benefit of oil production.

The simultaneous gas cap expansion and the associated gas coning would greatly increase the GOR. An uneconomical remedy would be to lower the completion level by redrilling the production wells. The underlying water zone poses another undesirable component.

It thus becomes obvious that gas injection has technological, economic and physical time limitations. The economic and physical limit of gas injection at Prudhoe Bay is expected around the middle of the decade. Gas will then no longer be reinjected because it will adversely affect the reservoir production.

THE PIPELINE POSSIBILITY

Pipelines are almost invariably one-phase carriers. Boosting equipment (such as pumps or compressors) are rarely designed to handle two-phase flow. Irreversible damage to the hardware may occur if the wrong phase is injected or allowed to form in a pipeline.

A pipeline carrying a number of components with wide-ranging boiling points will have a wide margin between the bubble point (pressure above which only the liquid phase exists) and dew point (below which only the gaseous phase exists). In order to transport the mixture as a gas, the pressure must be maintained below the dew point. A very large pipeline or several pipelines would be needed, since the volume of the fluid would be greatly expanded. The building costs would expand accordingly.

Alternatively, the fluid could be transported as a liquid but at a much higher pressure (above the bubble point). Massive quantities of gas would be needed to fill the line initially. The subsequent pumping costs would be very large since the high pressures must be maintained to avoid "vapor locks" on the pumping units.

Separation of the "light ends" (largely methane) from the "heavier ends" (primarily ethane, with smaller quantities of propane and butane) becomes imperative. The light ends are then transported in a gas pipeline while the heavy ends, known as natural gas liquids (NGL), are transported as such.

The NGL are unlikely candidates for the existing trans Alaska pipeline, since at its present operating temperature of 140°F, they would vaporize. Therefore a new natural gas liquids pipeline would be necessary. The NGL pipeline would serve as the feed to the contemplated petrochemical industry.

Table 1 depicts the composition of the natural gas from the three batteries of separators at Prudhoe Bay. As can be seen, the carbon dioxide concentration is high. A natural gas pipeline connected to a gas conditioning plant would result in the release of massive quantities of CO_2 into the atmosphere. This carbon dioxide possibly could be used in an enhanced oil recovery process, if its feasibility is demonstrated for the Prudhoe Bay reservoir.

The option of constructing a natural gas pipeline involves then a gas conditioning plant to separate mostly methane from NGL, another pipeline to transport the NGL and a major problem in disposing of large quantities of carbon dioxide. The CO_2 can be used beneficially in an enhanced oil recovery process but it can also pose a critical environmental issue if reservoir injection was not deemed appropriate.

In 1977 the Carter administration endorsed the Alaska Natural Gas Transportation System (ANGTS) which would require building a 4800-mile long, mostly 48-inch diameter pipeline to bring the gas to markets in the lower 48 states. The initial cost estimate of the project was set at $10 billion. The start-up of the pipeline has been moved backwards several times since then; in 1979 the *Oil and Gas Journal*[2] suggested that the pipeline would not be built until 1984.

James[3] analyzed the various economic parameters in 1979 and suggested that private financing of the gas pipeline seemed unlikely. In March of 1981 *The Wall Street Journal*[4] supported the contention that the pipeline would not be constructed at all.

The *Journal* stated that the cost of the ANGTS is estimated now at $35 to $40 billion. This translates into a price for gas delivered in Chicago of $15 per million scf. The present wellhead price in the Lower 48 is $1.55 for that amount of gas, with delivered prices of $2.53 and $4.20 to industrial users and households respectively.

For these reasons, *The Wall Street Journal* article characterized the project as "economically suicidal" and concluded with: "eventually someone will figure out some economic use for the Prudhoe Bay gas, and the ANGTS pipeline will be forgotten as a bad dream."[4]

FLARING

Since the reservoir constraints will dictate a stop to the reinjection of natural gas and since the ANGTS appears to be economically unfeasible, flaring the gas becomes an ominous possibility. Flaring of natural gas has been a trademark of the Middle Eastern oil fields and widespread publicity has been afforded the sensational quantities of gas burned in this way in Saudi Arabia. Yet the same route may be followed in Alaska if no alternative methods of disposal are found. Flaring is a non-fruitful and yet potentially unavoidable means of coping with the gas.

THE METHANOL OPTION

In 1979 Marsden[5] proposed the chemical conversion of North Slope natural gas to methanol at Prudhoe Bay, with this methanol then being pumped in the surplus-capacity trans Alaska pipeline to Valdez. Methanol would then be separated in a standard refinery for subsequent use.

Marsden[5] forcefully suggested the construction of prefabricated modular methanol production plants to be transported on barges from industrialized areas

TABLE 1

Composition of Prudhoe Bay Natural Gas[1]

Mole Percent	*1st Separator*	*2nd Separator*	*3rd Separator*
CO_2	15.3	18.8	12.9
N_2	0.8	0.2	------
C_1	73.9	55.7	24.0
C_2 - C_9	10.0	25.4	63.0

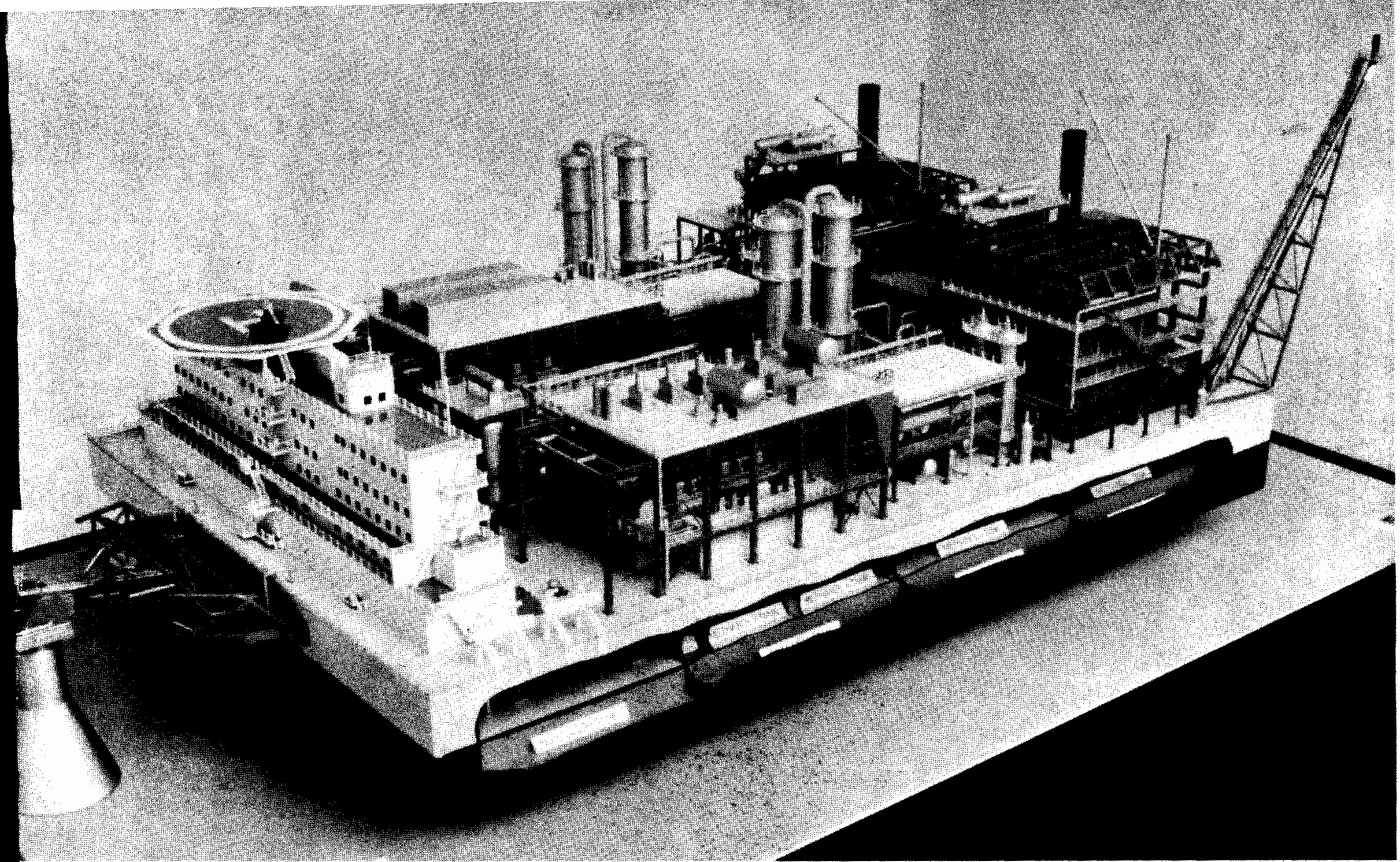

Figure 2. Model of barge-mounted methanol production train. (Photo courtesy of Litton Industries.)

to the Arctic. A model of a proposed plant is shown in Figure 2. Since construction costs at Prudhoe are several times those elsewhere, the transportation of completed plants from remote sites is economically attractive. The same method has been used for many of the living and working quarters on the Slope.

Ostby and Marsden[6] presented the technical dimensions of gas to methanol conversion in offshore gas fields while Ostby and Nystad[7] presented an economic and technical feasibility study for a 1000-tons/day methanol plant in the North Sea. Modular plants have made developing remote offshore gas commercially feasible: Huebel and Skeds[8] dealt with the subject in general and concluded that the concept was favorable; Jackson[9] dealt with the extensive use of floating methanol plants to develop remote offshore gas reserves.

A "train" of three 1000-tons/day units on a single barge is the optimum design, according to industry experts.[5] The production of 3000 tons/day of methanol requires 10^8 scf/day of gas. With the present gas production at Prudhoe there will be a need for 14 such trains. The small increment of 3000 tons per day is attractive since new units can be added gradually as the gas production increases. This is in contrast to a gas pipeline, where a large pipeline may be grossly underutilized at first and then reach full capacity several years later—and thereafter a new, initially underutilized pipeline would be needed. The ability to increase incrementally and smoothly is a major advantage of the modular methanol-producing units. Furthermore, the initial "fillup" of the ANGTS pipeline would require very large quantities of natural gas to be accumulated at Prudhoe Bay and compressed at appropriately high pressures. Interim storage facilities do not exist there, however, nor would they be economically attractive.

The suggested methanol production at Prudhoe would amount to less than the excess capacity of the existing oil pipeline (2×10^6 barrels per day). It should be noted that a pipeline much smaller than that proposed for ANGTS will have to be built to carry the natural gas liquids from Prudhoe Bay to the site of whatever petrochemical industry there may be in the state, if that industry is to be developed.

METHANOL PRODUCTION

Methanol usually is produced by a two-step process: first, conversion of the methane into a more convenient-to-use collection of reactants referred to as synthesis gas, and then the controlled recombination of the elements of the gas into methanol. Both steps require high levels of quality control to ensure the purity of the products and to minimize the conversion of useful products into undesirable by-products that would require separate handling. When effective controls are used, however, conversion efficiencies can exceed 15% per pass during the recombination phase; recirculation results in near total conversion. Purities of typically 99.9% are realizable with only one distillation step (separation from water). A typical flow diagram for methanol production is shown in Figure 3.

The production of methanol from natural gas is therefore feasible, in fact rather easy, from a technological viewpoint. The excess carbon dioxide present at Prudhoe is beneficial here, since it can be converted with the excess hydrogen into more methanol. This is in contrast to the ANGTS pipeline option, where the presence of CO_2 may become environmentally hazardous.

The conversion process is a heavy energy user, with 30% to 40% of the energy in the starting material lost in the process.[5] The penalty is necessary to convert difficult-to-transport gas to easily transportable liquid. The conversion to methanol is called "chemical liquification", while the conversion to liquified natural gas (LNG) is called "physical liquification". That process is also a high energy user because of the high compression requirements.

METHANOL AND ITS USES

Methanol is the simplest alcohol. It is liquid at standard conditions, boiling at a temperature of 65°C (149°F). Of more significance is the fact that methanol is totally miscible with crude oil, lending itself well to transportation with crude oil. It is slightly corrosive and moderately toxic. It is a poison when ingested, but spills are a lot less dangerous and less lingering than those of crude oil, since methanol has a high flash point.

Major uses for methanol are (a) as a feedstock to the petrochemical industry and (b) as a fuel. Example products formed by methanol reactions are formaldehyde and acetic acid.

Methanol utilization as an energy resource can be large and varied. It can be used as a direct fuel in specially retrofitted engines. The efficiency and pollution levels have been about the same as those of diesel or gasoline engines.

A wider use of methanol can be in the form of gasohol. A 10% blend of methanol in gasoline has been used effectively in automobiles with little or no retrofitting. The blending octane value (BOV) of methanol is exceptionally high (120 to 130). Its use will reduce the need for leaded gasoline. (Tetraethyl lead has been cited repeatedly as a major pollutant; the emergence of unleaded gasoline is a response to adverse effects of leaded gasoline.) Gasohol could be a valuable addition to the fuel mix in transportation.

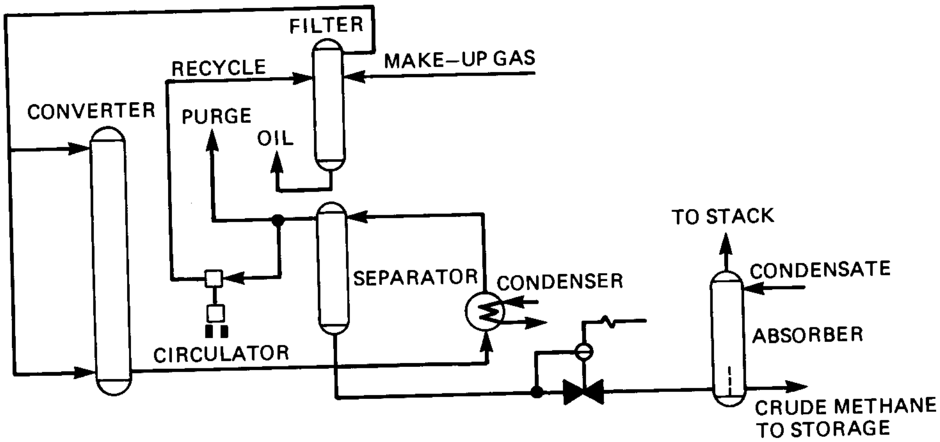

Figure 3. Schematic flow diagram for medium-pressure methanol synthesis.

CONCLUSIONS

Most industry analysts believe that private financing for the ANGTS is not feasible. Government financing may take place, but for such a project that would be nothing less than a gargantuan fiscal leviathan.

The case has been aptly made that the methanol conversion option is infinitely more desirable from both the total and incremental economic viewpoint. If the methanol option were implemented, a 3000-tons/day plant on a barge could be delivered for $300 million. A two to three year period from ordering to delivery is estimated. Hence the total cost for 14 such units is $4.2 billion, an order of magnitude less than the cost of ANGTS. Environmental considerations also favor the methanol option.

If the giant Prudhoe Bay reservoir is to produce efficiently, the decision to use the methanol option must be made soon. Time is of critical importance.

ACKNOWLEDGMENT

The author thanks the Alaska Energy Center for partially financing this study. The Center neither espouses nor rejects the conclusions presented here.

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by Claus-M. Naske

THE BOARD OF ROAD COMMISSIONERS

The great Klondike gold rush lured thousands of people to Alaska and the Yukon; it also convinced the United States government that the Alaska Territory was in need of investigating – and governing. Federal bureaus, some new to the north, began work to fill the gaps in knowledge about the region and to disseminate the information available in their respective fields. For example, the Bureau of Navigation published a circular on navigational conditions on the Yukon and Porcupine rivers; the Labor Department issued bulletins on opportunities, prices, and problems of capital and labor in the gold fields; and the Department of Agriculture dispatched investigators to evaluate agricultural possibilities in the north.[1]

Congress reacted to the gold rush by passing legislation, and by 1900 had established criminal and civil codes as well as the first tax system for the Territory. Inspired by all the activity, the United States Senate appointed a subcommittee of its Committee on Territories to journey to Alaska in 1903 and make a "thorough investigation of existing conditions, her resources and her needs, with the purpose to ascertain and report what, if any, legislation is required for that district."[2]

THE SENATORS' TOUR

The four senators assigned to the subcommittee met in Seattle and sailed for Alaska on June 28. They cruised through the Inland Passage to the head of Lynn Canal, stopping at various settlements along the way. They went over the White Pass to Lake Lebarge, the Lewes River, and along the upper Yukon to Dawson City, where they visited the gold fields and examined the Yukon Territory's form of government. From Dawson the group continued downstream all the way to St. Michael, stopping at various settlements and army forts. At St. Michael the U.S. Revenue Marine Service cutter *McCulloch* took the senatorial party aboard, and they visited Nome, St. Paul in the Pribilof Islands, Dutch Harbor, and Unalaska, and then passed through the Aleutian Islands into the North Pacific. They continued their journey along Alaska's southern coast, stopping at Karluk, Kodiak, Valdez, Sitka, and at Juneau for a second time.

Sitka, early 1900s. (Photo courtesy of the Frank Barr Collection, U. of A. Archives, Fairbanks.)

Throughout their extensive journey, the senators held hearings and took test-

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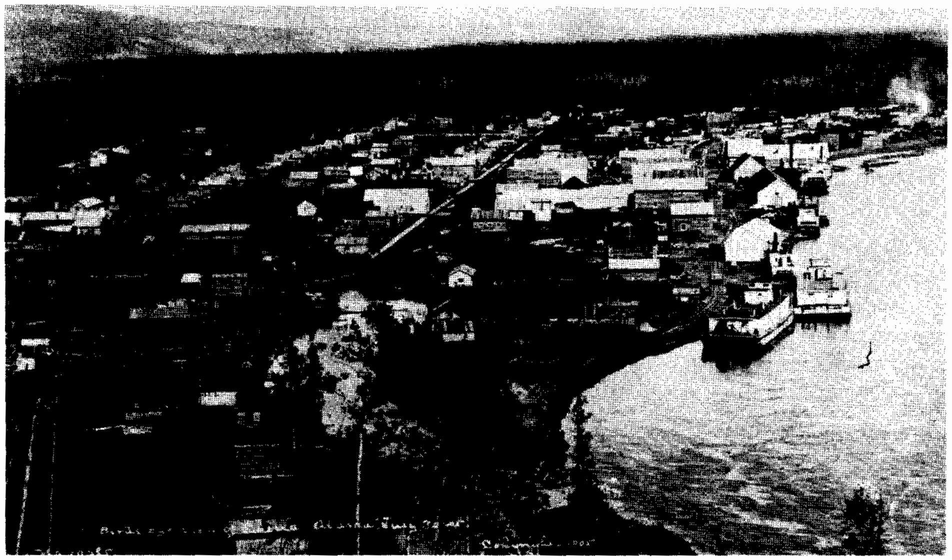


Chena, 1905. (Photo courtesy of the Wilson F. Erskine Collection, University of Alaska Archives, Fairbanks.)

imony from 61 witnesses in 11 settlements and towns. The witnesses were concerned with a wide variety of subjects, ranging from agriculture to boundary questions, coal and copper deposits, the necessity for an elected delegate to Congress, fish hatcheries, freight rates, game laws, the insane, the need for lighthouses and better mail service, surveys and taxes, the need for a territorial government and for better transportation. Numerous individuals addressed the lack of roads and trails.

Testimonies

William Daily of Ketchikan told the senators that he represented the Unuk Mining, Smelting, and Transportation Company of Danville, Illinois. The company's mines were located 42 miles from the mouth of the Unuk River. Daily told the group that his company was constructing a wagon road to its mines at an estimated expense of $50,000. Daily reminded the senators that the Canadian government built roads into territories to aid economic development, but no similar provisions were made in Alaska.[3]

At Eagle on the Yukon River, the senators called on Lieutenant William "Billy" Mitchell of the U.S. Signal Corps, then in charge of building part of the Alaska telegraph system, to testify on territorial conditions and needs. Mitchell told the senators that it would cost more than $2 million to construct a fair wagon road from Eagle to Tanana Crossing and from there to the head of steamboat navigation at Chena at the confluence of the Chena and Tanana Rivers, a distance of about 520 miles. He related that a wagon road from Tanana Crossing to Copper Center, 165 miles, would be easier to construct because the country was not as rugged as along the Tanana or near Eagle. It would be as expensive as the others because materials would have to be transported across the difficult coastal mountains. A continuation of the route from Copper Center to Valdez, although only 103 miles long, would be difficult to build because of the mountainous character of the country. Although very crude, the military trail already existing between the two settlements made possible the transportation of supplies with pack animals.[3] This trail connected with another one and led to Tanana Crossing.

Abraham Spring of Fairbanks pointed out that roads and trails ranked next in need only to a comprehensive mining code. The lack of good trails and wagon roads made mining very expensive. Only Congress could appropriate the sums necessary to construct the wagon roads connecting Alaska's principal settlements, though miners themselves could build the feeder roads. Spring suggested that miners be permitted to perform road work annually in lieu of the required assessment labor on claims and that the whole system of road building should be under the direction of commissioners who knew the needs of the various districts. Miners and trading companies had built many trails and bridges by subscription, each contributing as much as they could afford, but each fall the winter trails had to be reconstructed, and each spring the summer trails and bridges had to be rebuilt. Spring explained that there was "no intelligent supervision of the work, there is no engineering skill."[3]

Wickersham's Views

Federal Judge James Wickersham supported the contention of many witnesses that the cost of getting provisions from the navigable streams, particularly the Yukon, was so high as to be almost prohibitive. He explained that the development of large areas of low-grade mining ground around Nome had been made possible only by competitive, cheap ocean transportation. Goods and supplies were landed almost as cheaply as they could be bought in Seattle, Portland, or San Francisco. Supplies destined for the areas along the Yukon, however, either came down the river via Skagway and Dawson or upriver from St. Michael. Miners had to wait until winter to transport their goods on dogsleds from distribution points on the Yukon and its tributaries to the mines. Supplies destined for miners working at Coldfoot on the Koyukuk landed at Bettles for $135 per ton. From Bettles, supplies had to be forwarded to Coldfoot in the summer by a scow pulled by horses walking along the riverbank or, even more laboriously, by poling boats, and in the winter on dogsleds. This added $200 a ton to freight costs, making the total $335 per ton at Coldfoot. Thus, the freight on a 50-pound sack of flour delivered at Bettles came to $3.37½. Transporting the same sack to Coldfoot cost an additional $5.00 or a total of $8.37½. The 50-pound sack of flour eventually retailed for well over $10.00.

...building Alaska's first roads meant breaking trails in Washington...

Wickersham told the senators that to develop interior Alaska's mining potential, the following wagon roads were essential:

1) a road from Valdez across to Eagle City by way of the Fortymile River;
2) a branch road from Tanana Crossing, north along the Tanana River to Fairbanks and thence across to Rampart;
3) a branch road from Circle City on the Yukon to Fairbanks;
4) a continuation of the Tanana Valley road to Coldfoot on the Koyukuk; and
5) branch roads from these main trunk lines to the various mining centers.

When asked what institutional framework was needed for road building, Wickersham suggested that a three-member road commission be appointed in each of Alaska's three judicial districts with the territorial governor serving as an ex officio member of each commission. The chief executive was the right person for the job, Wickersham suggested, for he received a good salary and had very little to do. The construction should be financed by the monies raised in each division from license fees paid outside of incorporated towns.[3]

In addition to much testimony by individual witnesses favoring the construction of roads and trails, two communities also submitted formal resolutions to the senators. The citizens of Eagle regarded the lack of roads and trails as the main drawback to development of the country. The construction of roads and trails would encourage the mining industry; furnish routes for the Postal Department and decrease the cost of mail delivery; save the judiciary thousands of dollars annually in traveling fees and reduce per diem expenses of marshals, witnesses, and jurors; and save the War Department thousands of dollars in freight costs. Nome citizens urged Congress to make liberal appropriations for the construction of permanent roads, trails, and bridges between Nome and settlements in the interior and on the coast, and recommended that the trails and roads be provided with guideboards or stakes of sufficient height to be readily visible above the snow line.[3]

THE SENATORS' REPORT

By the time the senators returned to Seattle on August 26, 1903, they had covered a distance of 6600 miles, but only 111 of those miles were on land.[2] They had been awed by Alaska's vastness and surprised at the lack of transportation facilities. "Outside the few and scattered settlements called towns, which are found in different parts of Alaska proper, and most of which are but the centers of mining interests," they commented in a report to their colleagues, "there is not to be found a single public wagon road over which vehicles can be drawn summer or winter." It was true.

The senators observed that Alaska's development depended "more upon the improvement of transportation facilities than upon any other one instrumentality." The federal government had done nothing to construct a transportation system. "It has neither built roads nor provided other means of transportation," the senators stated, "and the hardy and adventurous who have sought the wealth hidden in the valley of the Yukon, the Koyukuk, and Seward Peninsula have done so amidst difficulties that can only be understood by those who have made a study of the situation." The senators contrasted federal inactivity with Canadian achievements in the Yukon Territory. Between 1898 and 1903, the Canadian government had spent $1,025,000 to construct and maintain 850 miles of wagon roads and winter trails leading to the camps from Dawson. Some 225 miles of the total had been thoroughly constructed and carried the heaviest of freight, such as machinery so large as to require the use of six to 12 horses.[2]

Recommendations

The subcommitte recommended that the government construct a system of transportation routes and that the basis for such a system should be a well-built wagon road connecting the Pacific Ocean at Valdez with Eagle on the Yukon River, a distance of approximately 400 miles. The road should follow the general lines of the existing military trail, which Captain Abercrombie and his men had built in 1899 - 1900, and the recently-completed military telegraph line. The committee explained that Valdez was the finest northern harbor on the Pacific Coast, open and ice free throughout the year, a natural gateway to the interior and a key to its economic development. Eagle, once connected by a road, should become the distributing point for American goods to most of the vast Yukon basin. Most important, the committee believed that a system of wagon roads and trails would allow miners to use modern heavy machinery in extracting minerals, induce immigration, and even result in a permanent population "wedded to the soil." In conclusion, subcommittee members stated that it was "as much of a duty to build the road (between Valdez and Eagle) and secure the American interests of the district to the United States as it was to build the first Pacific railroad to connect the Pacific Coast with the territory east of the Rocky Mountains." To finance such road construction, the senators suggested that the taxes on salmon fisheries be increased and that, together with already available revenues, these monies would "constitute an annual fund which, if wisely used, will result in a grand advance in Alaska's development and wealth."[2]

The subcommittee distributed its report to the full Senate on January 12, 1904, and on the 15th a deluge of Alaska bills descended upon both houses. Most of these measures were referred to the Committees on Territories, and those bodies held extensive hearings in an attempt to coordinate the different parts of the Alaska program. An appropriation to conduct a preliminary survey of a wagon road from Valdez to Fort Egbert at Eagle and for a military trail between the Yukon River and Coldfoot was quickly passed. The Secretary of War was to make all the necessary arrangements.

Thereupon, the War Department appointed J.M. Clapp, an assistant engineer in the Seattle office of the Corps of Engineers, to head the survey parties. Clapp assigned four of these parties, with a total of 48 men, to the Valdez - Fort Egbert survey, each to cover approximately 100 miles of the proposed wagon road. The first two parties sailed from Seattle on May 31, 1904 for Skagway. From there they went via the White Pass and upper Yukon to Fort Egbert. The remaining two, with 25 packhorses, left Seattle on June 1, 1904 for Valdez to begin their work at that end. On August 14, 1904 the four parties had completed the 430-mile survey, and Clapp estimated that it would cost $3500 per mile or approximately $1.5 million for building the wagon road from Valdez to Fort Egbert.[4]

Clapp had appointed Oscar A. Piper and two assistants to survey the Yukon - Coldfoot route. Piper, his men, and his pack animals went downstream on the steamer *John Cudahy* and on June 21 landed opposite Fort Hamlin, an abandoned Alaska Commercial Company trading post, 40 miles northeast of Rampart. After cutting trail for a couple of days, the party left the Yukon on June 24, surveyed in a northwesterly direction, and reached Coldfoot on July 12. The party concluded its field work on August 14. Piper found about 80 well-built cabins at Coldfoot, most of them deserted for the mining season. He estimated that Coldfoot had a winter population of about 60 souls, and the whole Koyukuk Valley a population of approximately 300 miners. He calculated that it would cost about $6000 to build a 126-mile trail sufficient to meet the current needs of the miners.[4]

THE BOARD BEGINS

Knute Nelson, U.S. Senator from Minnesota since 1895 and the subcommittee member most actively involved with Alaska legislation since the visit north, introduced a measure in 1904 reapportioning the money received for all licenses issued outside of the towns. It designated such fees the "Alaska Fund" and gave five percent to the Secretary of the Interior for the care of the insane, 25 percent to elected school boards under the superintendency of the territorial governor for the education of white children, and the remaining 70 percent to the Secretary of War for road construction. Roads were to be built under the direction of a board of road commissioners composed of an engineer officer of the U.S. Army, to be appointed by the Secretary of War, and two other officers drawn from troops stationed in Alaska. The board was empowered,

> *upon their own motion or upon petition, to locate, layout, construct, and maintain wagon roads and pack trails from any point on the navigable waters . . . to any town, camps or settlements . . . , if in their judgement such roads or trails are needed and will be of permanent value for the development of the district.*

The board was not to build roads or trails to transitory settlements. Any work worth more than $5000 was to be let for bid and awarded to the lowest bidder, but if all bids were deemed too high, the board possessed the power to perform the required work by buying the necessary materials and hiring the required men. The board also was responsible for the maintenance of this transportation network.[5,6]

President Theodore Roosevelt signed the legislation creating the Board of Road Commissioners for Alaska on January 27, 1905, and in March, at the President's request, the Secretary of War designated Major Wilds Preston Richardson of the 9th Infantry president of the Board and filled the remaining two positions with the appointments of Lieutenants George B. Pillsbury and Samuel C. Orchard. Richardson, then 44 years of age, was already an old Alaska hand. He had received orders in August 1897 to serve in Alaska, where, except for a few brief details elsewhere, he was to remain for 20 years.

The War Department directed the new board to meet at Skagway on May 15, 1905. On the way to Skagway from Seattle, Richardson and Pillsbury stopped at Ketchikan and Juneau, where Orchard met the two, and then at Haines. The men made a preliminary inquiry into the road needs of southeastern Alaska. They soon found that citizens in the region were concerned about the expenditure of monies from the Alaska Fund, preferring to have these spent in the region in which they were collected. Richardson pointed out that "on account of the somewhat exceptional status of the courts in Alaska, embracing as it does, certain extra executive and administrative functions, a sort of sentiment of territorial division has grown up in the minds of many of the people." The board president decided to ignore these divisions and instead try to accomplish what was best for all of Alaska.[6]

During the summer of 1905 board members traveled widely. Richardson went down the Yukon River via the White Pass, visiting Eagle, Circle, and Rampart. He went up the Tanana River to Fairbanks and from there to St. Michael, Nome, the Ophir Creek (Council City) districts, and other parts of the Seward Peninsula. Orchard inspected the Valdez Trail and determined what improvements were necessary. Pillsbury examined a section of a road from Whitehorse to Yukon Crossing in the Yukon Territory; he went to Ketchikan and ordered a survey for a road across a short portage of four miles on Prince of Wales Island from Cholmondely Sound to Hetta Inlet; he also ordered a survey for a road from Haines Mission up the Chilkat and Klehini Rivers toward the international boundary. Deciding that was not enough for one short season, Pillsbury then went to Valdez in September and crossed Big Delta Pass into the interior, the proposed route of the new trail from the coast. From Fairbanks he went downriver to St. Michael and Nome and left Alaska by ocean steamer late in the fall.[6]

RICHARDSON'S RECOMMENDATIONS

Richardson estimated that the new town of Fairbanks had a population of approximately 3000, with another 5000 working claims on creeks in the vicinity. The Fairbanks Chamber of Commerce appealed to Richardson to have a wagon road constructed between the camp and adjacent mines, for with spring breakup, the two stage lines had been forced to suspend operations because the trails had become nearly impassable.

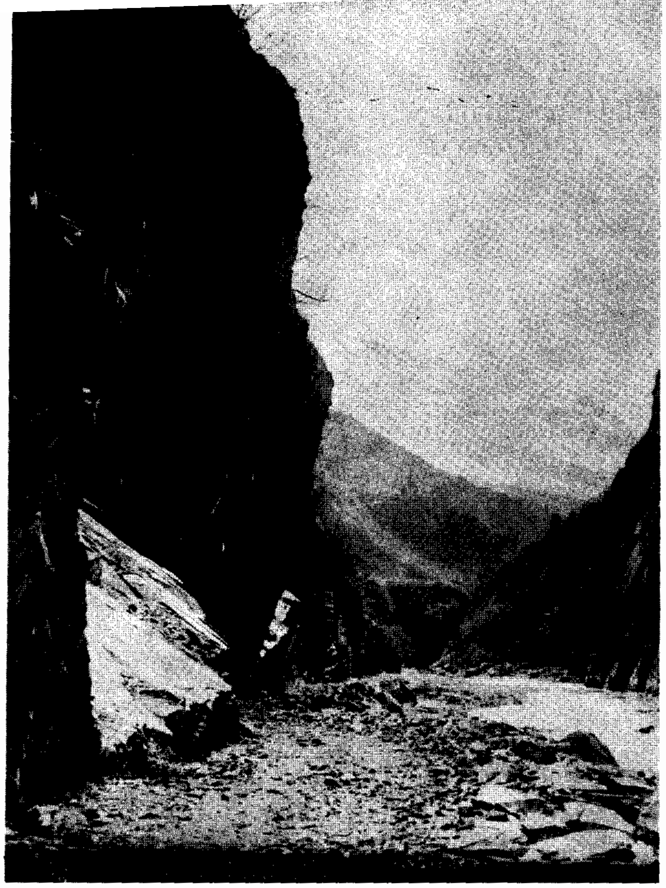
The town could now only be reached on foot, and it was not uncommon to see miners come in here (Fairbanks) late in the evening, almost exhausted, with their clothing torn and draggled in the mud, after a trip of some thirty miles over a trail from six inches to two feet deep in mud, and from forcing their way through the brush and timber to avoid some of the worst places.[6]

Richardson quickly concluded that Chester W. Purington's 1895 observations on road building in the subarctic had been correct. Purington remarked that

a serious detriment to the making of a road in Alaska is the thawing of the ground beneath the moss. It has been the universal experience that wherever the moss is cut into, thawing immediately commences, and the trail which was passable becomes a filthy, slimy mass of mud, roots, and broken stone, a difficult route for men on foot, a slow and tiresome road for loaded animals, and an impassable obstacle to any sort of vehicle. In regions further South under temperate conditions, trails frequently are developed into fair wagon roads by much usage. Such development can never take place in any part of the Northwest.

Purington recommended that in sections with poor drainage the moss be left intact, even be added to by material taken from the side ditches, and then be corduroyed with heavy brush or poles. On top of this a covering of gravel would add insulation.[6]

On Richardson's recommendation, the board then spent a total of $7851 in the Fairbanks area, building a six-mile road from Gilmore to Summit, designated as route No. 7, and a trunk road from Summit to the mines on Cleary Creek. The Board of Road Commissioners for Alaska contracted the work since it had no employees of its own.[6]



Government wagon road above Keystone Falls, Valdez-Fairbanks Trail. (Photo courtesy John Zug Scrapbook, U. of A. Archives, Fairbanks.)

Major Richardson was particularly concerned with the development of interior and northwest Alaska. This necessitated the speedy development of the Valdez-Fairbanks route, consisting of three separate trails. The first, from Valdez to Copper Center, essentially followed the military trail Abercrombie had built earlier; the second led up the Tanana River from Fairbanks; and the third connected these two from Copper Center to the mouth of the Delta River or to Isabel Pass. He reported that some work had already been accomplished on trails 4, 5, and 6, consisting primarily of repairs and improvements, such as replacing approximately 3032 feet of worn-out corduroy with stone ballast and building numerous small bridges over dangerous crossings. He proposed that the challenging Tanana River be crossed just above the mouth of the Delta River.

Richardson arrived in the Nome district on August 22 to survey conditions and assess needs. He described existing forms of transportation, which consisted of a few narrow-gauge railroads — the Wild Goose route, or the Nome Arctic Railway, which crossed Anvil Creek and extended about 16 miles across to the valley of the upper Nome River; the Solomon River Railroad from the mouth of the Solomon up to the mouth of the East Fork, approximately 14 miles; and the Council City and Ophir Creek Railroad, running from Council to claim No. 15 Ophir, approximately eight miles. There were a few stagecoaches and numerous gasoline boats and "horse boats," five-ton scows pulled by horses walking along the banks of the creeks where safe footing could be found or in the stream when it was not too deep. When all else failed, men poled the scows upriver. Residents of Nome petitioned the board to survey and construct a road leading directly into the heart of the peninsula, a distance of about 175 miles. Although the road was too expensive to construct all at once, Richardson believed that short sections should be built where most needed as funds permitted.[6]

Richardson proposed to the War Department the construction of about 300 miles of roads and approximately 1200 miles of trails, all urgently needed to further economic development. He estimated that it would cost about $2500 to $3000 per mile of road and approximately $250 per mile of trail. The Alaska Fund was totally inadequate and Richardson suggested that Congress appropriate $1 million outright. "Such an expenditure at this time," he argued, "would be of immense benefit to the country in the way of increased production and the opening up of new fields." With such an appropriation, the board could purchase its own animals, tools, and equipment and organize its work on the most economical basis. The board had overexpended its $28,000 budget by $1,786.61, he explained, made necessary by building a permanent organization.[6]

The board could look back on a productive first year. It had directed various reconnaissances and surveys, undertaken some repairs and improvements, and built short stretches of road from Haines up the Chilkat River to the Indian villages of the Chilkat Valley, as well as similar projects in the Fairbanks and Nome districts. However, the three men agreed that the monies accruing to the Alaska Fund and available for road construction were wholly inadequate to meet even the most immediate and pressing transportation needs of the territory. Furthermore, the monies from this fund varied and were received at irregular intervals, making it almost impossible to plan ahead and commit funds for long-range projects. The members of the board were united in their opinion that the law which had created the Board of Road Commissioners for Alaska needed to be amended. In November 1905 the army called Major Richardson to Washington to give a personal report and spell out needed changes. In early 1906 Congress amended the legislation, regularizing the collection of license monies and raising the cost of roadwork which could be performed by government forces from $5000 to $20,000.[7] Congress also made a direct appropriation of $150,000, to be expended at the direction of the board, rather than the $1 million Richardson had first proposed.

Bridging a stream near Valdez, on the Valdez-Fairbanks wagon road. (Photo courtesy John Zug Scrapbook, U. of A. Archives, Fairbanks.)

The hazards of early travel. (Photo courtesy John Zug Scrapbook, U. of A. Archives, Fairbanks.)

ACCOUNTING PROCEDURES

To carry out the necessary work over such a vast territory, properly supervise it, and protect expenditures, the board gave much thought to the organization of the office and to the transfer of funds and methods of payment. It divided Alaska into districts, with suboffices and with a civil engineer as superintendent in charge of each district. These superintendents were to act as disbursing agents for the board. After the board had laid out the work, the engineer officer became responsible for seeing it carried out. For that reason he was in charge of the organization of all working parties and for their immediate direction in the field, as far as possible and consistent with the responsibilities of the other board members. The disbursing officer, for similar reasons, had great freedom in supervising all office details relating in any way to his responsibility of accounting for funds, property, and records.[8]

In order to pay for labor and supplies at distant points, the board made agreements with local banks to cash checks drawn by the various superintendents. The board had suitable checkbooks printed and distributed. The superintendents were to keep receipts and make a careful accounting. Since there were no banks in some areas where work was performed, it soon became necessary to extend this system to some kind of arrangement with commercial or trading companies. This was done by entering into a written agreement with such companies to furnish supplies and pay the laborers. Eventually, the board established a system of payment on the overdraft principle. It reimbursed the bank or commercial company each month (or more often if desired) for amounts paid out, paying a negotiated rate of exchange varying from one-fourth to one-half of one percent.

With the procedural framework in place, the board accepted a 1906 budget of $230,500, an eightfold increase over the initial appropriation for the previous year. Of the total, $80,500 accrued from the Alaska Fund. Congress also appropriated an extra $35,000 for a reconnaissance and preliminary survey for a 600-mile mail and pack trail from the navigable waters of the Tanana River near Fairbanks to the vicinity of Council City on the Seward Peninsula. The board hired civil engineer J.I. McPherson, who selected a feasible route.[9]

THE WORK BEGINS

The Board of Road Commissioners for Alaska was not idle during the winter of 1905-06. It shipped rations, forage for animals, and tools from Valdez and Fairbanks and distributed them in caches along the trail; constructed a bridge across the Tazlina River; made a reconnaissance of part of the route from Fairbanks to Rampart; and flagged 247 miles of exposed trails on the Seward Peninsula. The board used two assistants and a seven-dog team for flagging – red flags placed 50 to 150 feet apart (depending on the terrain) to make winter travel less hazardous by marking the trail. Another 40 miles of road had been improved, 285 miles of new trail had been cut, and another 200 miles already in use had been upgraded. Additionally, the board had located and surveyed another thousand miles of roads and trails.[9]

The board accepted $7,366.50 collected by Nome citizens to enable construction of a road from that town to the so-called second beach line, about three miles back from the coastline. That, together with what the board was able to spend, built "a veritable boulevard, 22 feet between ditches, over which thousands of tons have been transported" where formerly only the lightest wheeled traffic was possible.[9]

Specifically, that season the board accomplished the following location surveys:

Place	*District*	*Distance*
Gulkana to Donleys	Valdez	121 miles
Fairbanks to Donleys	Fairbanks	127 miles
Delta to Banner	Fairbanks	13 miles
Donleys to Banner	Fairbanks	51 miles
Fortymile to Eagle	Fairbanks	57 miles
Rampart to Glenn	Fairbanks	30 miles
Hope to Sunrise	S.W. Alaska	39 miles
Preliminary survey	Fairbanks	18 miles
Tolovana-Glenn	Fairbanks	unknown
Sundry surveys	Seward Peninsula	19 miles
		475 miles

It constructed and marked the following mileages:

Wagon road . . . . .46.5 miles
Roads maintained and improved. . . . . .40.0 miles
Sled trails – full width for double sleds . . . . 181.0 miles
Trails – cleared half width . . . . .81.0 miles
Winter trails flagged . . . . .247.0 miles
Bridge over the Tazlina River
Maintenance of the Bonanza Ferry[9]

Bonanza River Ferry. (Photo courtesy of the Pope Collection, U. of A. Archives, Fairbanks.)

Portion of Road Commission Camp at Saina River Bridge. (Photo courtesy of John Zug Scrapbook, U. of A. Archives, Fairbanks.)

Early in the construction season the board decided to purchase its own horses rather than to pay the high price of hire. Team rentals at Nome, Fairbanks, and Rampart cost between $15 and $18 per day. At that price, the board reasoned, it paid monthly what it would cost to buy a team outright. And if funds permitted in 1907, it intended to purchase its own animals for all projects.[9]

In 1906 the board began to work closely with the Signal Corps. Wherever practical, the Corps changed the route of telegraph lines, following the location of permanent trails to facilitate line maintenance. For example, it changed the course of the line to follow the cut-off section from Gulkana to the mouth of the Delta River and modified the line between Fairbanks and Rampart and the one from Kaltag to Unalakleet.[9]

By the end of 1906 the board had given form and structure to its organization and had become an important federal agency. Major Richardson, as president of the board, had gained considerable influence in Alaska; the agency he directed had begun to provide northerners with the basic framework of a transportation system, and he also controlled a sizable payroll.

The board's work quickly produced numerous economic benefits. For example, in the Fairbanks district it had built a road 4.07 miles long, costing $2439 per mile, connecting Summit to Cleary. Some 5000 tons of freight moved over this segment at a reduction of $10 per ton, saving the Cleary miners $50,000. A parallel road from Summit to the mines of Fairbanks Creek, 9.22 miles in length and costing $1300 per mile, had reduced freight rates by $20 per ton. The Fairbanks Creek miners had saved an estimated $40,000 on transportation of their supplies.[10]

Improvements in the overland mail trail had provided speedier deliveries. In 1906 the first winter mail arrived in Nome on December 5, taking only 49 days from Seattle. The previous year it had not arrived until December 29, and the year before that not until December 31. This time saving was greatly appreciated by the citizens of Nome and the Seward Peninsula. Between November and April, mail and passenger stages left Valdez and Fairbanks weekly. It usually took nine days to reach Fairbanks and eight going back to Valdez; the stage company set a record for the 1906 - 07 winter season of six days, 10 hours, and 10 minutes.[11,12]

Back in Washington, Richardson's lobbying efforts with Congress paid off handsomely when it allotted $250,000 for his Alaskan projects for the 1907 fiscal year. Together with $90,000 from the Alaska Fund, the board disposed of a record budget of $340,000.[11]

Unfortunately, requests for road and trail construction from all sections of Alaska poured into board headquarters "so far in excess of the abilities of the board to meet, with the funds available or likely to become available in the near future," that board members thought it wise to issue a circular explaining to Alaskans their policies and limitations. In its circular, the board drew a distinction between monies accruing from the Alaska Fund and special congressional appropriations for the "construction and maintenance of military and post roads, bridges, and trails." The board had decided to use monies from the Fund mainly for local improvements and from Congress for "the location and construction of main trunk lines of communication through the territory, and especially the through mail route from Valdez to the Seward Peninsula." The board welcomed petitions for projects but requested that each be accompanied by the best information available, such as character of the route desired, tonnage to be transported, number of people to be benefited, the probable permanence of the community, and the approximate cost of the desired undertaking. But the board also reminded its constituents of Alaska's vast size and that it would take years before all regions requiring aid could even be examined. Actual construction work had to wait for these preliminary reconnaissances. Finally, the board encouraged monetary contributions from communities in order to stretch funds.[11]

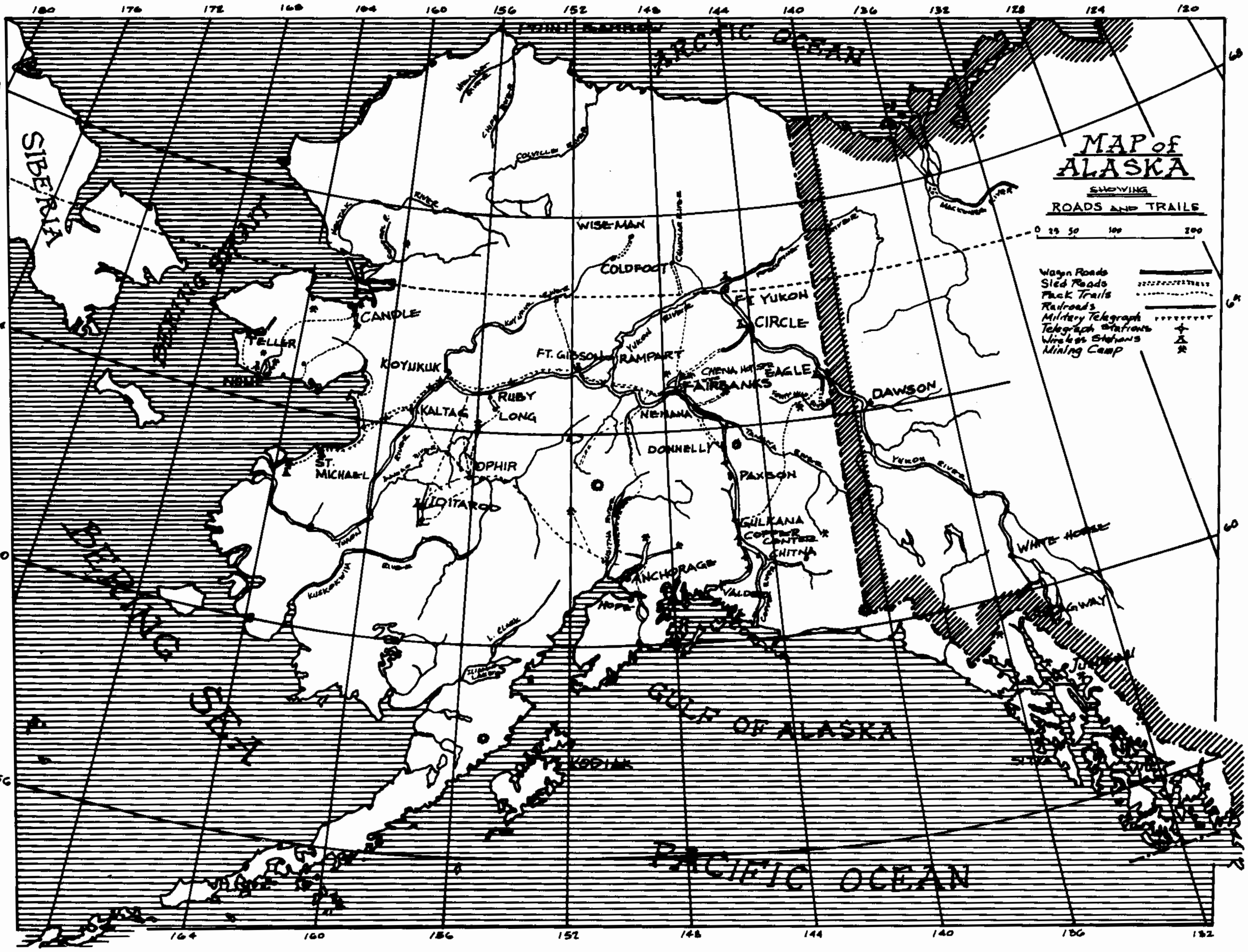
In his report to the Secretary of War, board president Richardson differentiated among three different types of construction used. Wagon roads had to accommodate year-round traffic of considerable tonnage. Therefore, they had to be located with suitable grades and be crowned, ditched, and drained and corduroyed or planked where necessary. Winter sled roads had to meet the requirements of winter travel only, so no crowning, ditching, or draining was necessary nor was extensive corduroying required. They did have to be wide enough through timbered areas and sidehill cuts to permit the passage of double teams, however. In addition, winter sled roads had to have the proper grade for fairly heavy loads, and most of the tree stumps and surface inequalities had to be removed to provide a fairly even surface. Some stretches of winter sled roads had been so well built, in fact, that they even permitted light wheeled traffic in summer. Lastly, dog team and pack trails were the least expensive to build. They differed from winter sled roads in that they were narrower and had steeper grades and more surface unevenness. By 1907 the board had completed, in 41 locations scattered about the Territory, about 166 miles of wagon road; 384 miles of winter sled road; 242 miles of dog sled and pack trail; 382 miles of flagged winter trail; and had built three river bridges and installed three ferries.

The board had to cope with wide variations in construction costs in various regions of Alaska. During the 1907 season, for example, the cost of labor had ranged from $2.50 to $5 per day. Board was provided, and subsistence costs ranged from slightly more than $0.50 per day in southeastern Alaska to $3 per day in the interior. The higher expenses reflect the inadequate transportation system: southeastern Alaska, for example, could rely on competitive and cheap ocean freight rates. Similarly, wages differed significantly, again reflecting the cost of living in the differing regions. Superintendents, locating engineers, foremen, and assistant foremen received anywhere from $150 per month to $10 or more per day. The cost of hiring work animals also varied greatly, ranging from $10 per day for a four-horse team including feed to $13 per day for a single horse without feed. Given these circumstances and the added diversity in climatic, timber, and soil conditions, mileage costs of construction ranged from a low of $100 to a high of several thousands of dollars per mile. And although considerable economy had been achieved with the purchase of four road machines for ditching and sidehill grading, each drawn by a team of six to eight horses, it still cost an average of approximately $2200 for each mile of wagon road built. Winter sled roads cost $250 and pack trails $100 per mile.[11]

Richardson continued to lobby successfully for special congressional appropriations. For the next four fiscal years (1908-1911), Congress provided $244,857.18, $236,674.97, $237,498.50, and $100,000. Together with monies from the Alaska Fund, this gave the board total budgets ranging from $365,269.90 (1908) to $266,777.95 (1911).[13]

ACCOMPLISHMENTS

In 1911 the board reported that a total of 759 miles of wagon roads, 507 miles of winter sled roads, and 576 miles of pack trails had been built. Additionally, every year the board had staked several hundred miles of winter trails over treeless and exposed sections of the territory for the guidance and safety of travelers during storms. It also had continued its program of constructing bridges and installing ferries. The board once again called attention to its wagon roads and explained that this designation had been applied in a restricted sense in Alaska and they certainly did not meet the standards of those found in the contigu



Alaska's road and trail system by the time of Richardson's departure (after an original from the Annual Report of the Board of Road Commissioners for Alaska, 1917; courtesy of the University of Alaska Archives, Fairbanks).

ous United States. Alaska's wagon roads, the board explained, were designed to be good country roads capable of accommodating year-round traffic of considerable tonnage. They had been located with appropriate grades, been crowned, ditched, drained, and corduroyed or planked where necessary. Wherever soil quality permitted, ordinary graded earth roads were built. In areas with poor soil conditions, the board had put down a light corduroy of small spruce trees covered with several inches of earth. In fact, most of the wagon roads consisted merely of earth roads and therefore rutted badly. While the board had worked in most sections of the territory, it had constructed the best system of local roads in the Fairbanks and Nome mining districts, in part because of the substantial financial assistance local residents had rendered.

Back in 1904 Congress had passed legislation that required all able-bodied Alaska males between the ages of 18 and 50 who resided outside incorporated towns either to work two days each year on the public roads, to furnish a substitute, or to pay $8. Gradually, the court commissioners had made the law effective, and by 1911 it had yielded the equivalent of approximately $100,000 in labor and money payments. In fact, roads were in such good shape in the Fairbanks mining district in the summer months that automobiles carried both passengers and freight between the town and the creeks.[14]

By 1910 census records showed that Alaska's interior, principally Fairbanks and the Tanana Valley, had a total population of 13,064. The board members agreed that it was of the utmost importance to connect this thriving mining district with the coast at Valdez. Construction of the Valdez - Fairbanks wagon road would continue on a priority basis. Already more than half the total wagon road mileage in the territory had been constructed along this route. A branch had been added by building some 90 miles inland at Willow Creek and from there to Chitina on the Copper River and Northwestern Railroad, which connected with Cordova. In short, the board could point to substantial accomplishments in 1911. Its system of wagon roads, winter sled roads, and pack trails had reduced the expense of moving freight, made possible speedy and regular mail service to interior and northwestern Alaska, and increased the safety of travel in general.[14,15]

POLITICAL PASSIONS

Major Richardson was an ambitious and capable man. In order to gain success and prestige in his profession as a military engineer on the frontier, he had needed to build his own organization and substantially increase the size of the budget. This, he probably reasoned, would give him the flexibility to build a transportation system in the north which, in turn, would enhance his career.

It did. In time, Richardson was called upon by members of the executive and legislative branches of the federal establishment for advice on many matters affecting the north. Beginning in 1905, at the end of the construction season each year the War Department recalled him to Washington, where he served in various capacities between November and April. In the course of his work Richardson came into contact with many influential lawmakers and bureaucrats, and over the years he developed friends in high offices.

By this time he also had developed at least one significant enemy. James Wickersham had been elected as Alaska's delegate to Congress, taking his seat in the House of Representatives in March 1909. One of his campaign promises had been to win legislation permitting Alaska some home rule, including having its own legislature. Unfortunately for that plan, President Taft believed that an appointed commission, similar to the one with which he had served as governor general of the Philippines, was the best way to rule Alaska. Numerous federal bureaucrats, lobbyists for corporations with financial interests in the territory, and the governor and an ex-governor of Alaska supported the President's scheme; so did Major Richardson. Wickersham attacked the plan and its supporters vehemently, and though they had been acquainted for years, he was annoyed particularly with Richardson, whom he believed to have played a major role in drafting the offending legislation. It was not long before the delegate and the major became implacable enemies. Their animosity continued, sometimes spectacularly, until Richardson left Alaska *(see box, p. 20).*

Between pressure from Delegate Wickersham and the court-martialling of his disbursing officer, the years 1911 and 1912 had been difficult ones for Richardson. His 1912 annual report was brief. He explained that the Board of Road Commissioners for Alaska had expanded its work continuously and had included new projects each year, some in remote sections and not on established mail routes. And although Congress had appropriated $125,000 for the work, the money did not become available until late August of that year. Fortunately for the continuation of the board's work, the governor of Alaska had transferred $80,000 for roads from the accumulated reserve of the school portion of the Alaska Fund. This, together with the usual receipts from the Alaska Fund, allowed construction to go forward.[24]

Major Richardson. (Photo courtesy of the Historical Photograph Collection, U. of A. Archives, Fairbanks.)

Unfortunately, however, the 1912 construction season was poor because excessive rains damaged the Fairbanks-Valdez wagon road considerably, especially the stretch along the Tanana and Delta Rivers. The Copper River and Northwestern Railroad, the only other outlet to the ocean, had been damaged severely and had been forced to suspend traffic for several weeks. Richardson reiterated that the board had petitions for road construction in its files which, conservatively estimated, would require expenditures of approximately $1,600,000. The board was not allowed to submit an estimate for funds to meet such demands unless allowed by a new law to do so. In past years the appropriations supplementing the Alaska Fund had been carried as a charge against the support of the army, but now they became limited to only such sums as absolutely necessary to maintain and repair the existing military and post roads.[24]

By June 30 the board had spent $317,303.72 of the total $317,646.59 available and had built 18 additional miles of wagon roads, 52 miles of winter sled roads, and 32 miles of trails. The board had also allotted $5000 to begin construction of an approximately 80-mile winter trail from Fairbanks to Chena Hot Springs and staked about 450 miles of trails for winter travel only. In addition, the board undertook the following important new projects during the season: 3.1 miles of wagon roads from Juneau to Sheep Creek; 5 miles from Douglas to Gastineau Channel; a 10-mile extension from Circle City to Central House; 29 miles of sled roads from Ruby to Long Creek; and a 12-mile extension from Moose Pass to the Kenai Peninsula.[24]

THE FIGHT FOR HOME RULE

The period was an eventful one for Delegate Wickersham as well. In hearings held in 1910 on the Beveridge bill, which embodied President Taft's plan for governing Alaska, it had soon become evident that there was strong opposition to the measure. After some political maneuvering the administration had abandoned its proposal, defeated in no small part by Wickersham's skillful use of the conservation issue to obtain support for Alaska home rule. He pointed out that the resources of Alaska should be used for the benefit of the entire country, yet so far the territory had been exploited by a few large, absentee-controlled corporations, such as the monopolies which harvested the fur seals and salmon and mined the copper deposits. Home rule, Wickersham asserted, would allow proper utilization of Alaska's wealth.[25]

Wickersham's home-rule scheme gaine substantial support in 1911 from th legislatures and commercial association of Washington and Oregon. The senators and representatives from those states were instructed to vote for Alaska home rule. Democratic presidential aspirants, such as Woodrow Wilson, Oscar Underwood, and William Jennings Bryant, were pledged to support the home-rule plank of their party. In this favorable atmosphere, hearings on Wickersham's home-rule bill began in the spring of 1911 before the House Committee on Territories, and by late summer the passage of the Wickersham measure seemed reasonably assured.

In a special message to Congress on February 2, 1912, President Taft urged Congress to enact legislation which would help Alaska develop its resources. On April 24 the House unanimously passed Wickersham's elective legislative assembly bill, and three months later the Senate passed the delegate's measure in essentially the form he had drafted. On August 24 the President signed the Wickersham measure into law. This Organic Act of 1912 gave Alaska a senate of eight members and a house of 16 to be chosen equally from the four judicial divisions. Although limited in powers, the legislature could nevertheless deal effectively with a wide variety of matters.[25]

TERRITORIAL ROAD LAWS

The first territorial legislature met in Juneau early in 1913 and, among other matters, it dealt with road construction. It repealed the road-tax law which had required two days' labor on public roads or the payment of $8, in its stead enacting a flat tax of $4 inside as well as outside incorporated towns. A substantial amount of work had been accomplished on local projects under the 1904 road tax law, but there never had been any coordination between projects nor planning of any kind. In some districts, superintendents of the Board of Road Commissioners for Alaska had supervised the work, although never formally charged with the authority or responsibility for handling it.[26]

In 1915 the territorial legislature created road districts that corresponded with judicial divisions and provided for an elected road commissioner for each district. Each commissioner was to receive as compensation five percent of all money expended by him. And although each road commissioner could appoint two assistants as inspectors, the legislature made no provisions for their compensation. To pay for the work, the lawmakers appropriated 75 percent of forest revenues.[27]

Judge Wickersham. (Photo courtesy of the Mary Whalen Collection, U. of A. Archives, Fairbanks.)

In 1917 the territorial legislature appropriated $20,000 for shelter cabins, to be expended under the general supervision of the governor of Alaska by the road commissioners, who were to receive five percent of this fund for their services. It also created the Territorial Board of Road Commissioners and instructed it to submit estimates for the construction of essential road work. Within each road district it created a divisional board, consisting of an elected chairman (receiving an annual salary of $2000) and two other members to be appointed by the territorial board (receiving expenses when working). Each divisional board was required to submit an annual report to the territorial board. The legislature also appropriated $400,000 for the biennium, to be equally divided among the four road districts.[28] The work of the territorial legislature in the transportation field indicated that it would soon develop some sort of relationship with the Board of Road Commissioners for Alaska.

THE BOARD REVIEWS ITS WORK

While the Alaska railroad boom engaged the attentions of northern residents during the middle of the decade (*TNE* Vol. 12, No. 2), the Board of Road Commissioners for Alaska continued its construction and maintenance work but also took the time to assess the work it had accomplished between 1905 and 1913. Congress had appropriated $1,375,000 for the "construction and maintenance of military and post roads, bridges, and trails" in Alaska, and the Alaska Fund had yielded $1,160,829.62 in that time span, for a total of $2,535,829.62 from both sources. With those funds, the board had constructed and maintained the following mileage of roads and trails: wagon roads, 862 miles; winter sled roads, 617 miles; and trails, 2167 miles. The cost per mile, including maintenance and all expenditures by the board, had amounted to: wagon roads, $2489.68; winter sled roads, $278.80; and trails, $90.44. Also, at different times since 1905, the towns of Fairbanks, Nome, Cordova, and some of the large mining companies had made cash donations of approximately $20,000 to aid the board's work.[8]

During its eight years of existence, the board had accomplished much, although the mileage constructed so far constituted only the very beginning of a proper transportation system for Alaska. The board considered the 419-mile-long wagon road from Valdez to Fairbanks, including the Willow Creek-Chitina branch, to be its most important achievement so far. With an average expenditure of about $1500 per mile, the board thought it

Clashes and A Court Martial

Lt. Sam Orchard. (Photo courtesy of the Francis Pope Collection, U. of A. Archives, Fairbanks.)

The conflict between Richardson and Wickersham seems to have been fueled by many things. Richardson was not only a West Point graduate but also a former instructor at the military academy, with a service record in frontier garrisons even before he came to Alaska.[16] His commitment was to the Army. Wickersham, a federal judge before he became Congressional delegate, had a keen commitment to Alaska as he envisioned it – an Alaska in which the military and its officers might play a useful, but not leading, role. The view from Washington was closer to Richardson's perspective: as perceived there, the military's mission required improving transportation and communication in the territory, just as once it had been charged with Alaska's exploration. Possibly Taft's plan for governing Alaska merely brought an inevitable disagreement into the open.

By early 1910 Wickersham was complaining to the Secretary of War that Richardson had "arrogated to himself the duty of controlling general legislation for Alaska in a way which I decidedly resent" and that after they had exchanged sharp words at a Congressional hearing, he met Richardson in the corridor and "in an angry tone he threatened me for what I had said before the Committee of the Senate about his connection with those bills and said that only his position as a Major in the Army, and my position as a Delegate in Congress, protected me."[17] Richardson's response accused the delegate of making statements "wholly false as to fact, malignant in motive, and unwarranted. . ." The Secretary of War rejected Wickersham's complaints; Wickersham immediately fired off another list of allegations to the Secretary, keeping up a steady barrage of accusations against Richardson in letters to constituents and in public speeches. Richardson responded as best he could, with a letter to the Fairbanks newspaper: "His outrageous assault upon me was unjustified by any single act of mine, official or personal, toward himself or the people of Alaska. It was as unexpected as it was vindictive and malevolent and it is now continued. . . with no restraint of moral responsibility, respect for the truth, or sentiment of common decency."[18]

Into this public acrimony fell the case of Lt. Samuel Chandler Orchard, disbursing officer for the Board of Road Commissioners since its inception. In the summer of 1911, Wickersham heard from his constituents that local rumor accused Orchard of embezzling Board funds. He quickly carried the report to the War Department, where he learned that an official investigation was already underway. Before long, the army convened a general court martial to try Orchard.

This development must have come as an acute embarrassment to Richardson, who had rated his subordinate highly. His 1910 efficiency report on Orchard, for example, noted that the lieutenant was qualified for his position, should be entrusted with important duties, and had performed his responsibilities as disbursing officer well. To make matters worse, Orchard told friends that all his troubles had arisen because Richardson had "turned against him and that it was due to politics."[19] Wickersham made sure that Alaskans knew about Orchard's "embezzlement of $17,000 that you paid into the Alaska Road Fund" and compared the territory's road-building efforts unfavorably to those in Canada, where the "road business. . . wasn't ruled by incompetency as it is here."[20] In February 1912, the court martial declared Orchard guilty of having embezzled $16,731.28 and sentenced him to be dismissed from the army, fined an amount equal to the embezzled funds, and imprisoned for five years at hard labor. Orchard protested his innocence still, and wrote his father that "Richardson has brought all the influence possible to bear to keep me here (in Leavenworth prison) until he leaves Alaska. . ."[21]

Even before the court martial verdict was in, the War Department had notified Richardson that, because of a new policy to reassign officers who had been on special duty for four or more years, he would be relieved of his duties by November 1912. Mortified, Richardson explained to his superiors that his relief "would naturally give rise to conclusions in certain quarters as to the integrity of my work . . . unjustified by the facts, and which constitute a grave reflection upon me professionally." Wickersham in particular had seized upon the Board's imperfections "to bolster up in part an unwarranted and malevolent attack, for political purposes, . . . aimed directly at myself, but indirectly and persistent since, in the effort to discredit the War Department and Administration generally in the Territory."[22] Richardson managed to convince President Taft to intervene on his behalf. The President directed his Secretary of War to exclude Richardson from the new rotation policy, because ". . . it is to the advantage of the country, especially of Alaska . . . to have him on duty in that new territory with which he is familiar from one end to the other . . . "[23] By the slimmest of margins, Richardson had weathered the Orchard scandal, Washington policies, and Wickersham's attacks.

could be improved to the standards of a fair automobile road. In fact, during the late summer of 1913, the board had sent a three-quarter ton field truck "of the type being experimented with by the Quartermaster and Medical Corps of the Army" on a round trip from Valdez to Fairbanks. The vehicle left Valdez on July 28 and returned on August 19, after having made a side trip to Chitina. The truck had covered 922 miles, making about 50 miles per day. In some instances, the truck had to be helped through soft spots on steep grades, but overall the trip had been successful.[8]

The board also had prepared an estimate of what it would cost to complete a system of roads and trails for Alaska that would meet traffic needs 10 years in the future, namely:

Maintenance of present roads	$1,250,000
Completion of projects already started and maintenance after completion	$1,420,000
Projects approved but unconstructed	$2,780,000
Projects not yet of importance but will become so as other roads are constructed	$1,800,000
TOTAL	$7,250,000

Additionally, the board considered the matter of railroad construction but concluded that Alaska needed wagon roads first. While disavowing any intent to discourage railroad construction, the board nevertheless pointed out that

after several years of careful observation and study of the land transportation conditions and of the natural inducements to development and settlement which exist, (the board) is convinced that no rapid or general development will follow the construction of trunk lines of railroad into the interior unless preceded or accompanied by the construction of numerous wagon roads and trails as feeders, and even then the development will be slow.[8]

In 1914 the board reported that Congress had appropriated $155,000 but that $54,787.83 had been spent to build a dike around Valdez in order to protect the terminals and buildings of the military cable and telegraph system from glacial floods. The Alaska Fund had yielded $170,688.37. There just had not been enough money to construct much additional road and trail mileage since nearly all of the funds were required for repairing and maintaining the existing system. In fact, board president Richardson cautioned that "this will become practically a fixed condition from year to year, with the amount of mileage now required to be maintained unless some provision shall be made for increasing the fund to take care of new projects."[29]

RICHARDSON VS. WICKERSHAM – THE FINAL ROUND

Communities throughout Alaska presented meritorious projects to the board every year for which there just were not any funds. Fairbanks, for example, had unsuccessfully petitioned the board to build a bridge across the Chena River, which divided the city. It then had contacted the Secretary of War and asked for help. Delegate Wickersham also was informed of the request. The delegate quickly fixed the blame for unaccomplished work. It was simple: Richardson just did not ask for enough money in his annual budget presentations. For the fiscal year ending June 30, 1916, Richardson, through the War Department, had requested a mere $125,000. "Instead of asking for $750,000 as Richardson has always talked to you about," Wickersham stated,

he only asked for a piddling amount, and then he comes to Alaska and lies to you people by saying that he cannot get the appropriation he asks for. The truth is that he makes no effort to secure any appropriation except merely to keep the work going from year to year and to keep up his commission. He does not want to build the bridge across the slough at Fairbanks and never will build it until the Northern Commercial Company tells him to. You know and I know and everybody else knows that Richardson and his Road Commission is under the control of the Northern Commercial Company. . .

Wickersham did not mention that since 1913 the Board of Road Commissioners for Alaska was authorized only to submit estimates necessary to maintain the existing road system. The War Department had made this ruling because the special congressional funds for Alaskan road work had always been charged against the general financial support of the army.[30]

Richardson soon enough heard of the delegate's allegations. On November 25, 1913 he had submitted a special report on the needs for work in Alaska to the War Department and accompanied it with a request for a supplemental appropriation for $750,000. He had not been encouraged by the department, but told Alaskans during the summer of 1914 that he still hoped Congress would consider the request favorably. That had not happened. Calling him a liar and claiming the board was under the control of the Northern Commercial Company was totally unjustified, Richardson stated, and indeed it was Wickersham who

is a purposeful and malignant liar himself and depends upon his position as a member of Congress to escape the just results of any defamatory attack he may choose to make. His entire letter is without justification in any existing facts and is perhaps what one might expect from a scurrilous, political blatherskite, permanently afflicted with about every phase of mental perversion and a complete moral idiocy.[31]

It was Wickersham's turn to be outraged. After persecuting Richardson for years, he now found the latter's remarks "so ungentlemanly and abusive in its character as not to deserve reply . . ." But reply he did, and in great detail at that. Basically, Wickersham's complaint was that Richardson seemingly never had

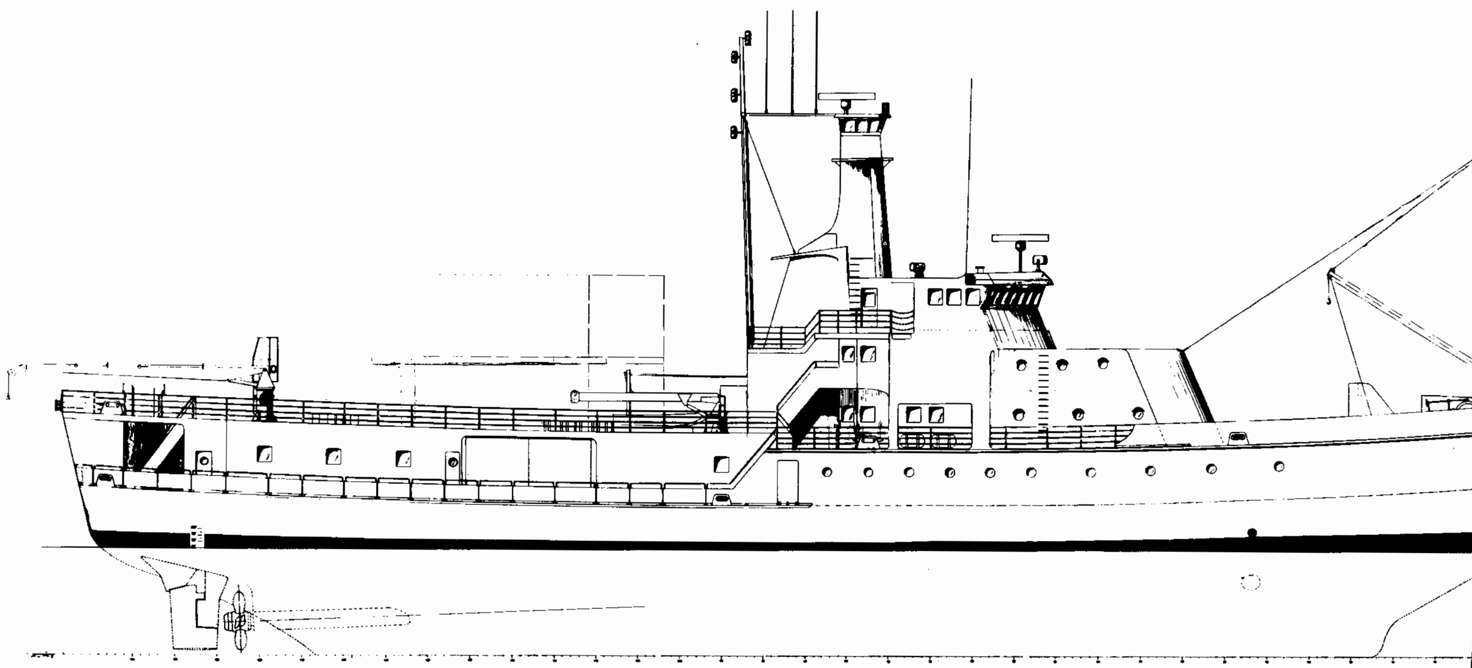
a very clear conception of the duties of the delegate from Alaska whose rights you have always treated as of minor importance, while you have always magnified those of your own position and assumed to extend them to cover those of a representative in Congress. It is often difficult to tell from your acts whether you or the delegate is the representative from Alaska.

Wickersham lengthily lectured Richardson on differences between their respective duties and prerogatives. What particularly bothered the delegate was that Richardson always spent winters in Washington and was on good terms with

(Continued on page 35.)

by Robert Elsner and Jonathan Leiby

AN ARCTIC RESEARCH SHIP



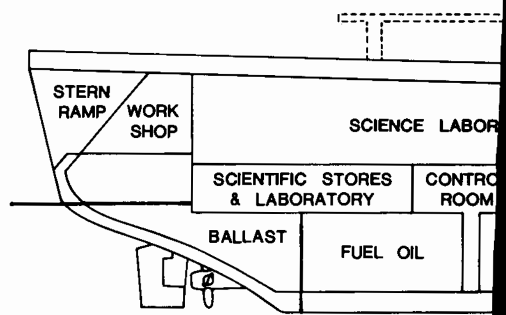
Outboard profile of ice-strengthened polar research vessel. (Illustrations courtesy of the authors.)

INTRODUCTION

The human urge to understand the polar marine regions of the world has been increasing rapidly for two general reasons: scientific curiosity and resource exploitation. The intellectual interest accompanied by the inseparable and demanding pragmatic requirement to find and use the food and energy resources with which these regions are endowed is not new; New England whaleships and scientific exploratory vessels shared the waters of both polar seas for their different purposes a century and more ago. To this mix we have now added the recognition that it is vital to protect the global environment from deterioration, and the partial understanding of how important these marine regions are to that whole environment.

The United States' commitment to polar marine science has been variable and inconsistent. The *Eltanin* represented a successful dedication to Antarctic oceanography; this vessel made possible the first circumpolar studies of all aspects of the Southern Ocean, the most comprehensive since the British *Discovery* expeditions of some 50 years ago. However, *Eltanin* was transferred to Argentina in 1974 and later retired from service, and much of the scientific initiative and enthusiasm the ship's work generated seems to have departed with the ship.

Our efforts in the Arctic have been characterized by steadily growing scientific interest and occasional bursts of activity. The current Outer Continental Shelf program, a series of studies preparatory to offshore Alaska petroleum development, and PROBES, a study directed toward an understanding of the unusually high productivity of the Bering Sea shelf, are examples of recent major scientific activities. Both have been conducted



partly in areas dominated by seasonal sea ice, and both have been handicapped by the lack of available ice-working research ships.

Our national fleet is strikingly deficient with respect to ice capability, especially when compared with other countries such as Canada and the Soviet Union. U.S. Coast Guard icebreakers are committed primarily to other missions, and even when researchers can use them, they are unsuited for many scientific

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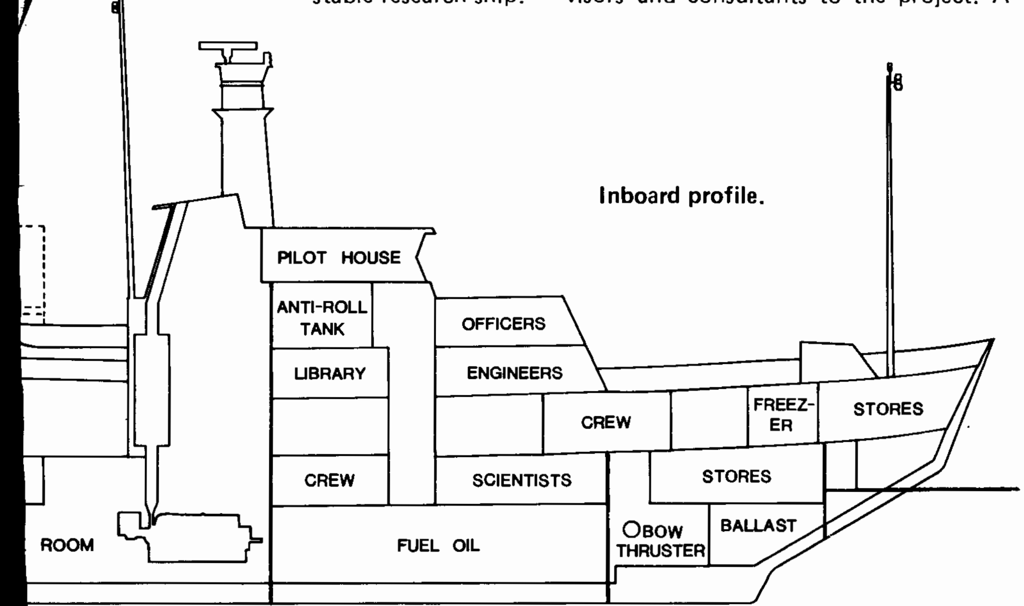
THE PRELIMINARY DESIGN

purposes. The need for research platforms capable of operating in seasonal sea ice and high latitude open ocean conditions is now widely appreciated. Though modern solutions to investigating polar marine problems can include the technology of satellite imagery, long-range aircraft, submarines, drifting ice stations and remote sensing, much of the important research required can be accomplished most effectively and economically from an ice-strengthened, stable research ship.

United States, the first task was to examine the extent and nature of the need U.S. scientists had for a ship able to operate in extreme high-latitude seas.

The actual requirements of the U.S. oceanographic community in terms of polar geographical regions, environmental capability and scientific needs were established in several ways. A national advisory board whose members included polar marine scientists and marine operators in the academic fleet served as advisors and consultants to the project. A questionnaire was developed and circulated to marine scientists, with good response. The topic was discussed at several meetings and reports were prepared to further the process.



Inboard profile.

BACKGROUND

The project to provide a design for a national polar research vessel originated with the University National Oceanographic Laboratory Systems (UNOLS), an advisory group for the National Science Foundation responsible for research ship support and operations; the NSF is the federal agency which owns many of the research vessels in the nation, though they may be assigned to different institutions for years at a time. Though it was acknowledged that other nations of the world having commitments to polar science were in general better equipped with suitable research vessels than is the

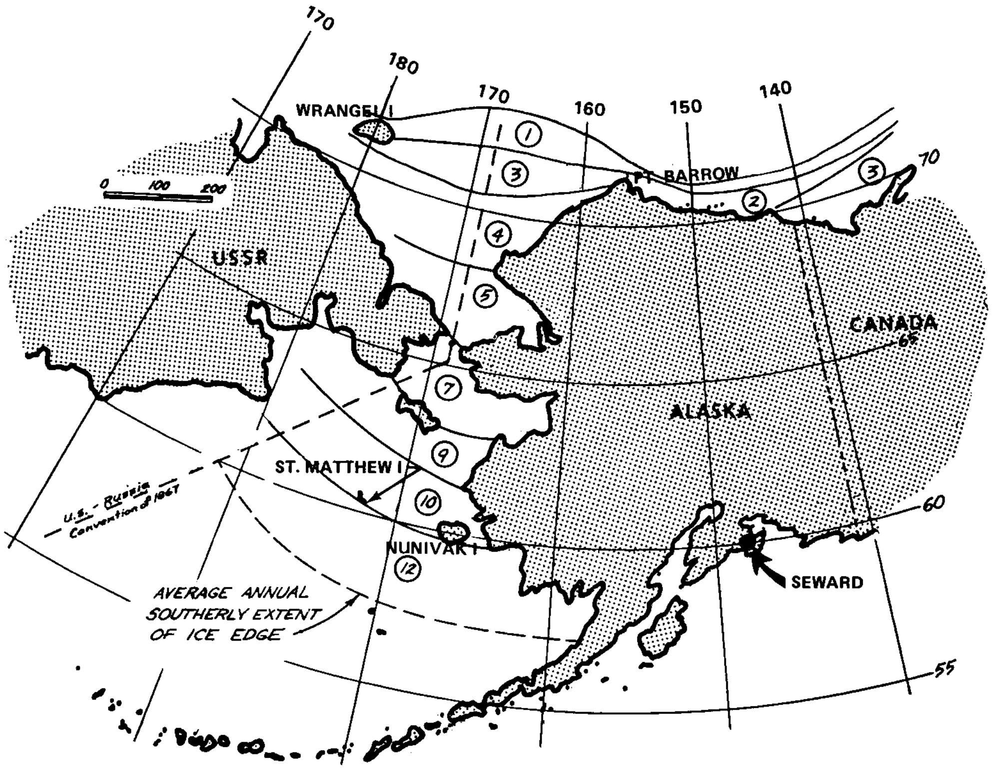
By 1977 a conceptual design for the polar research vessel had been prepared. This design was an exemplification of conventional ice-worthy ship design plus the requests of the oceanographic community. It was intended to permit difficult questioning and rigorous testing of the design ideas generated to that point. The testing process led to the present design, which we consider a preliminary one.

THE PRESENT DESIGN

The design priorities established were (1) safety, simplicity, and reliability; (2) seakeeping and ice-worthiness; (3) range, endurance and speed; and (4) arrangement and scientific capability. At first it seemed that these priorities would call for different ships for arctic and Antarctic operations, and the first conceptual design proposal was for two separate vessels. However, it became increasingly clear that the regions of greatest scientific interest and potential were in the seasonal sea ice and the nearby high latitude open oceans, so an ice-strengthened ship rather than a true icebreaker was called for. Further study and the need to meet Canadian requirements led to the choice of one vessel for both polar regions. The present design meets the requirements for Canadian Arctic Class 2 and also the American Bureau of Shipping ice classification of 1AA. (Ice-worthiness ratings are calculated by weighing a complex of factors from hull plate thickness to shaft horsepower; accurate definition of the various ratings is far beyond the scope of this article. As a rule of thumb, the Canadian class number is approximately equal to the thickness in feet of the level fresh sea ice through which the ship can proceed continuously. The U.S. Coast Guard icebreakers *Polar Sea* and *Polar Star* would be rated Class 6.)

The PRV specifications require that the ship will be able to run at three knots through level ice 1.5 feet thick and broken floes that are three feet thick; in ramming mode it should be able to attack ice pressure ridges seven feet thick. The vessel is intended to operate in the seasonal sea ice at both poles for two to twelve months per year.

Overall size has been dictated by the requirements of maintaining stability when two compartments are flooded and for power, endurance, and scientific capabilities. The vessel will be 247′ long



Number of operating months for icebreaker — Alaska (from an ARCTEC original).

(225′ on the waterline), 48′ wide, and will draw 17′. It will be subdivided by seven watertight bulkheads extending to the main deck and two extending to the upper deck. Displacement is 3000 long tons (1 long ton = 2240 lbs). The engines will develop 5200 SHP; top speed for the PRV will be 16 knots, and maximum range will be 20,000 miles (37,000 km) at 13 knots. The vessel will have a crew of 24 and will carry 20 to 26 scientists.

SAFETY AND STABILITY

Computer studies by the Massachusetts Institute of Technology show that the design overall has very good seakeeping behavior — that is, it will be able to perform as the relatively stable platform required. The design calls for bilge keels and an anti-roll tank, because without them the ship would roll to an unacceptable extent. A comparison made with five other U.S. research vessels indicated that at low speeds, when most oceanographic equipment is deployed and research personnel are most likely to be working on deck, the polar research vessel will have excellent comparative seakeeping performance.

A hazard for any vessel operating in high latitude oceans during the cold season is caused by freezing sea spray. The ensuing icing can build up on decks and superstructures to a dangerous extent. With that danger in mind, the PRV design minimizes superstructure appendages to reduce the areas on which icing can accumulate. Calculations established that the ship as designed will maintain adequate stability even with double the amount of icing expected and the fuel oil mostly consumed (a condition of least stability).

PROPULSION AND STEERING

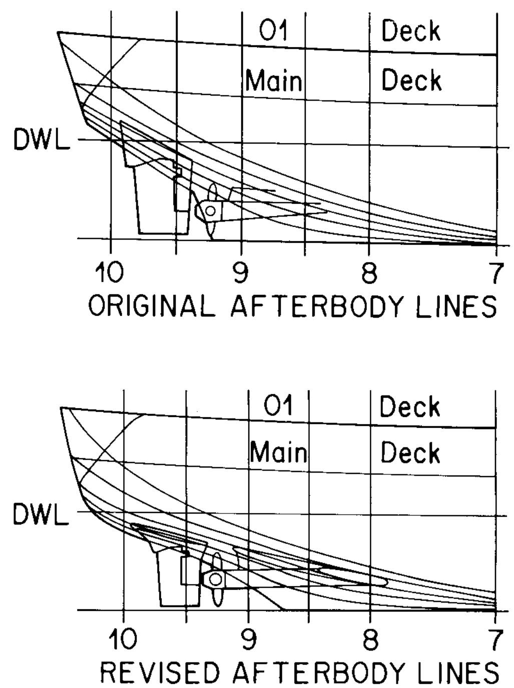
Though a first impression might be that an icebreaker is most susceptible to damage at its bow, since that is where the most spectacular action takes place, the ship's greatest point of vulnerability is aft — with the propeller, shaft, and rudder.

Rudders

The conceptual design called for a twin screw, twin rudder configuration because of the great maneuverability this arrangement offers. With one propeller, the turning circle is equivalent to 2½ - 3 ship lengths; with two propellers and two rudders operating in the water stream from the turning screws, plus a bow thruster, a ship can turn in its own length. During review of the conceptual design, one of the frequently-expressed concerns was the vulnerability of the rudders to ice damage, especially when backing. A single centerline propeller/rudder combination would be better protected, but the redundancy offered by the twin screw/twin rudder arrangement seemed essential for reliable operation in remote areas. International operators and builders of icebreaking vessels were using the two-and-two arrangement, with varying degrees of success. The majority seemed to believe that with extra-strength construction, the configuration was adequately reliable. Nonetheless, the concerns seemed sufficiently justified so the propeller-rudder configuration was a design feature marked for special attention and testing during the next phase.

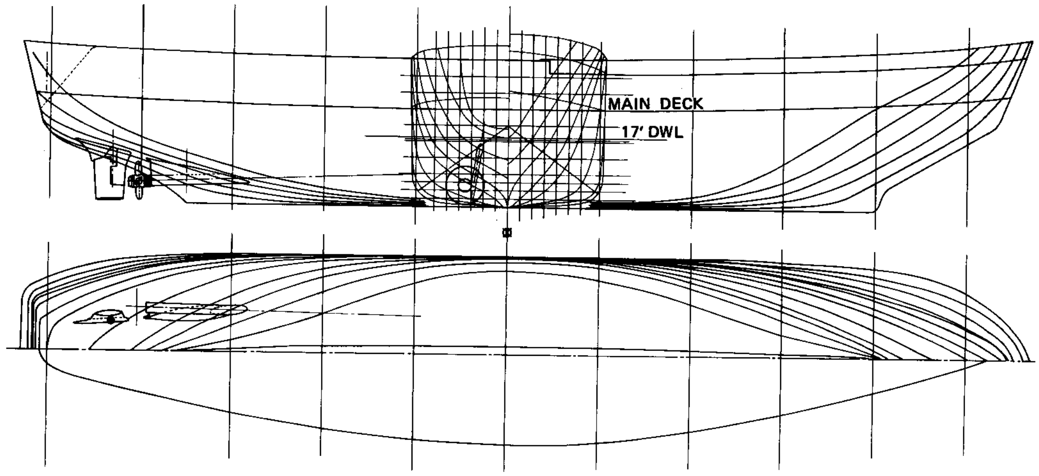
Ice model tests conducted in the ARCTEC scale basin during January 1979 showed that the critics were partially right. The surface-piercing rudder ice horns, protective structures mounted above the movable rudder vanes, tended to trap ice. In broken ice, an ice jam formed that extended from the waterline to the keel; in level ice, the ice horns lodged in floes and prevented effective backing.

Further testing showed that rather than abandoning twin screws/twin rudders, the best fix was to alter the lines of



Comparison of original and revised afterbody lines.

the whole stern and steering apparatus. The major requirement was to locate the rudders and rudder ice horns below the design waterline, at a depth greater than the 1.5 ft ice thickness design level. This meant easing the buttock angles, extending the waterline farther aft, and reducing the size of the rudders and ice horns slightly. The after edges of the ice horns were faired into the hull so ice pieces would be deflected rather than trapped. The aim of all changes was that ice should flow freely beneath the hull whether the ship was going ahead or astern. Underwater movies in the model basin showed that the changes achieved that aim. The new stern shape broke ice by flexure before it touched the rudder horns when the vessel was backing. In ice that was already broken, when the model was going astern the ice was displaced downwards and to the sides and was not trapped.

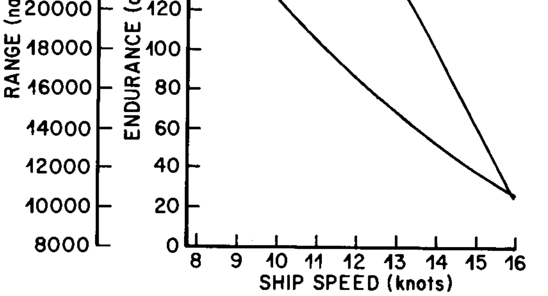


Hull lines of ice-strengthened polar research vessel.

Propellers

The afterbody alterations did not affect propeller placement. During the conceptual design phase it had been recognized that past twin-screw applications had been vulnerable to ice damage because of insufficient clearance between propeller tips and the hull and too shallow submergence of the propeller tips beneath the water surface. On the U.S. Coast Guard's *Wind* class icebreakers, for example, the propeller tip to hull clearance is on the order of 13 inches, even though this class has the capacity to operate in continuous ice 2.8 ft thick. Thus ice chunks can be wedged between the hull and the propellers, where they are physically milled by the propeller tips. The polar research vessel will have a propeller tip to hull clearance of 2.5 feet. Also, though the *Wind* class icebreakers are designed to operate in thicker ice and draw nearly ten feet more than the PRV, the PRV will have a design depth for the propeller tips of eight feet below the water surface, the same as the Coast Guard craft.

Stalling has been the most frequent cause of damage to icebreaker propulsion systems. If a propeller jams in the ice, it can stall the shaft and even engine, with undesirable mechanical consequences. Even if that does not occur, if the ship is still moving while the propeller is stalled, the blades may expose their weakest section to collision with the ice, and broken blades are a likely result. When an icebreaker is ramming into thick ice, it must reverse frequently and often quickly. Power reversals require that fixed-pitch propellers be stopped briefly, and this intentional stopping of the shaft can have the same effect as unintentional stalling if the ship is moving forward when the power is reversed.



Range and endurance of the polar research vessel.

Designers have pursued several courses of action to eliminate the stalling problem, including placing the propellers so as to avoid ice contact as much as possible, as described above. Controllable pitch propellers circumvent much of the difficulty. These propellers eliminate the need to stop a shaft during power reversals; they also place the system in the best possible position to resist stalling, because of the kinetic energy stored in the constantly rotating masses of the propulsion system. It was believed that the geared diesel/controllable pitch propeller system would prevent damage when the ship operated in ice-covered waters. This was the design subjected to testing with a dynamic simulation model during the next phase.

Propulsion

Once again, the tests showed that the conceptual design would not meet expectations. The problem was not with the controllable pitch propellers, however; it was with the diesel engine, which was shown to possess unfavorable torque-speed characteristics for icebreaker ship operations.

The model consisted of several differential equations which described the complete propulsion system, from the bridge controller to the translational movement of the ship. These equations were solved on a digital computer that provided time responses of key variables in both tabular and graphic form. The case studies made showed that the system would be marginally satisfactory at best, so the ship could be expected to suffer frequent propeller or shaft damage during its working lifetime. Unfortunately for those who would rather blame the model than the design, the simulation approach had been verified in other vessels, where the model had correlated very well with full-scale trials.

Icebreaker designers have realized for some time that diesel engines' torque-speed characteristics made them far from ideal, but their superior fuel economy made them hard to dismiss. The next step was to consider changes in the transmission system to find some way to convert the torque-speed characteristics into ones more favorable when reflected in propeller speed.

Diesel-electric propulsion systems have the necessary rate of response to allow for rapid changes in the propeller speed without causing the engine to lose power or the system to go unstable. The characteristics of the diesel-electric propulsion systems allow for maintaining high torque at low engine revolutions. The motor and the circuitry must be greatly oversized in order to withstand the large armature circuit currents necessary to produce the required torque at reduced rotational speed. In practice, the constant power operation of the motor is carried only to the point where the torque developed is necessary to overcome the ice load.

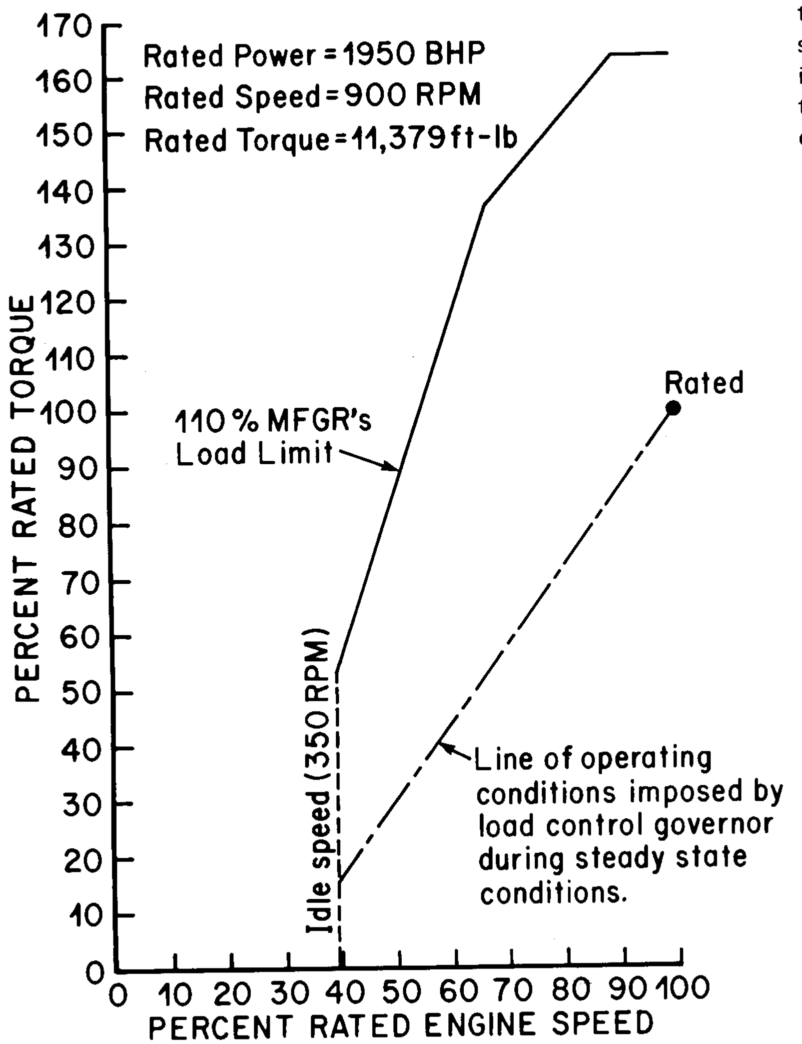
The simulation was altered to represent the approximate performance of a diesel-electric propulsion system. Computer runs showed that even under the worst possible loading conditions, with the propellers cutting through ice equal to the full length of the blades, the shaft did not stall. The investigation also showed that the controllable pitch propellers were still desirable, because they obviated the need to stop shafts during power reversals and permitted taking constant advantage of all the installed power to prevent shaft stalling.

The preliminary report on the propulsion simulation tests is being reviewed by U.S. and foreign designers of polar ships. An alternative propulsion system which is receiving attention is the concept of mounting the propellers in fixed ducts or nozzles. That technique has been successfully used for several years to produce more propulsive power in tugboats and supply boats. Recent experience in Canada, Germany, and Scandinavia indicates that it might be the simplest and least expensive way to provide added power and protection in ice-working ships.

PRICES AND PROSPECTS

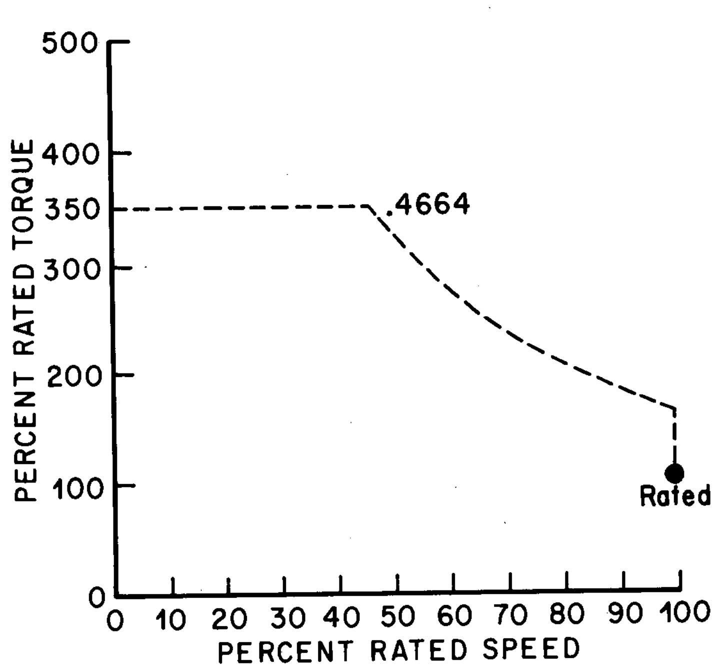
After the final changes demanded by the various tests and investigations were made on the design and equipment list for the PRV, the cost estimates were drawn up. As of January 1980, the construction cost was calculated to be slightly more than $21 million, including $3 million for navigational and oceanographic equipment. Annual operating costs, again based on early 1980 figures, would be around $3.3 million.

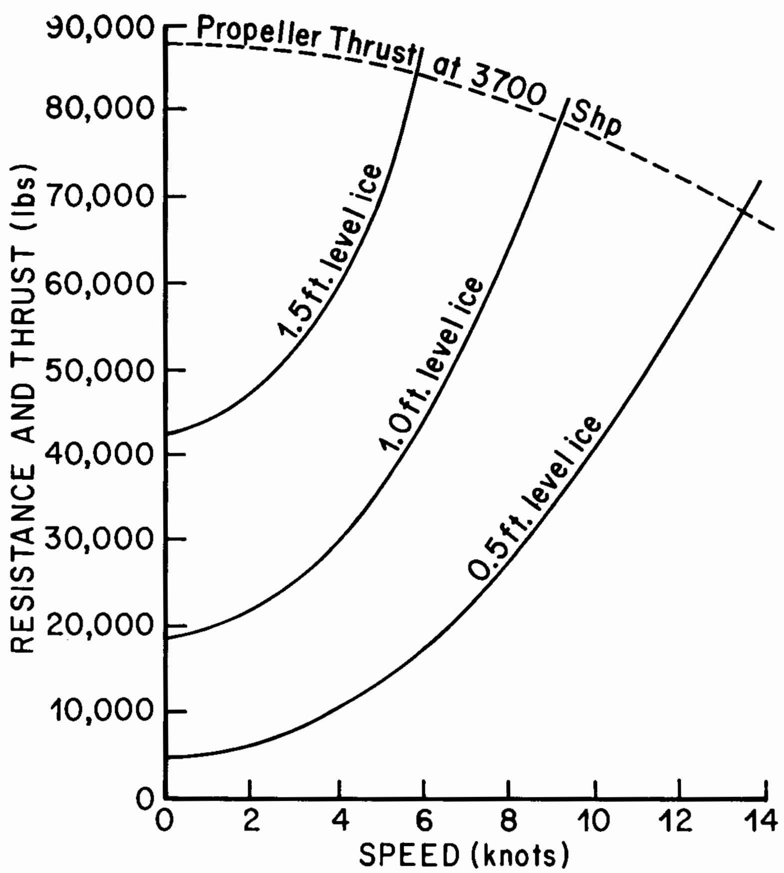
What sort of return could be expected for such a substantial investment? As the table accompanying this article shows, the vessel will not lift the United States into contention for having the best arctic research fleet; we would need many more such ships if the aim were to improve national prestige. But the goal actually



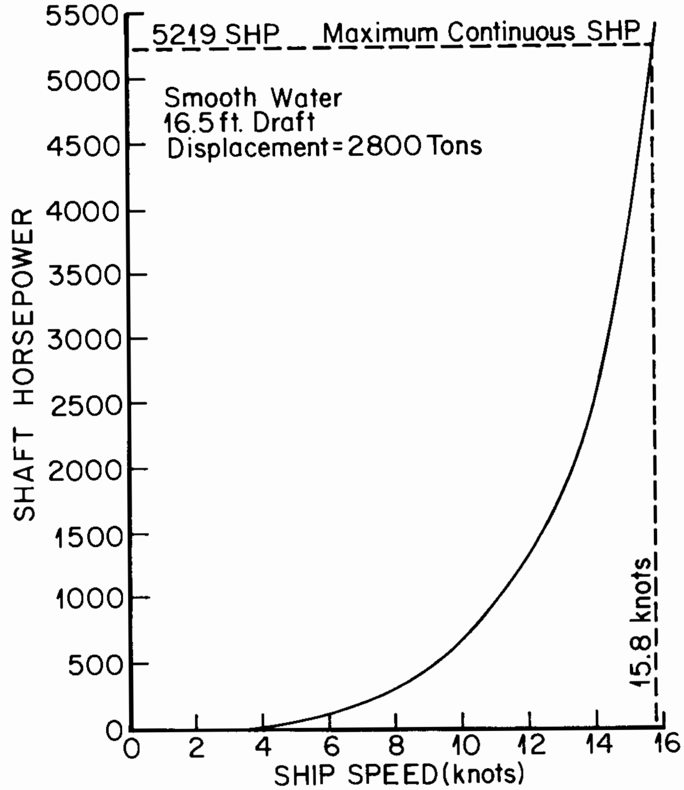
Left: **Torque-speed characteristics of proposed diesel engine (900 rpm rating).**

Below: **Torque-speed characteristics of electric motor assumed for base study.**





Prediction of full-scale icebreaking performance.



Speed vs. power, polar research vessel.

has been to improve the quality and quantity of knowledge available about the polar seas and coasts, and for that purpose — with its attendant improvement in understanding of the resources and problems in those regions — an investment in the polar research vessel could provide prodigious returns.

ACKNOWLEDGMENTS

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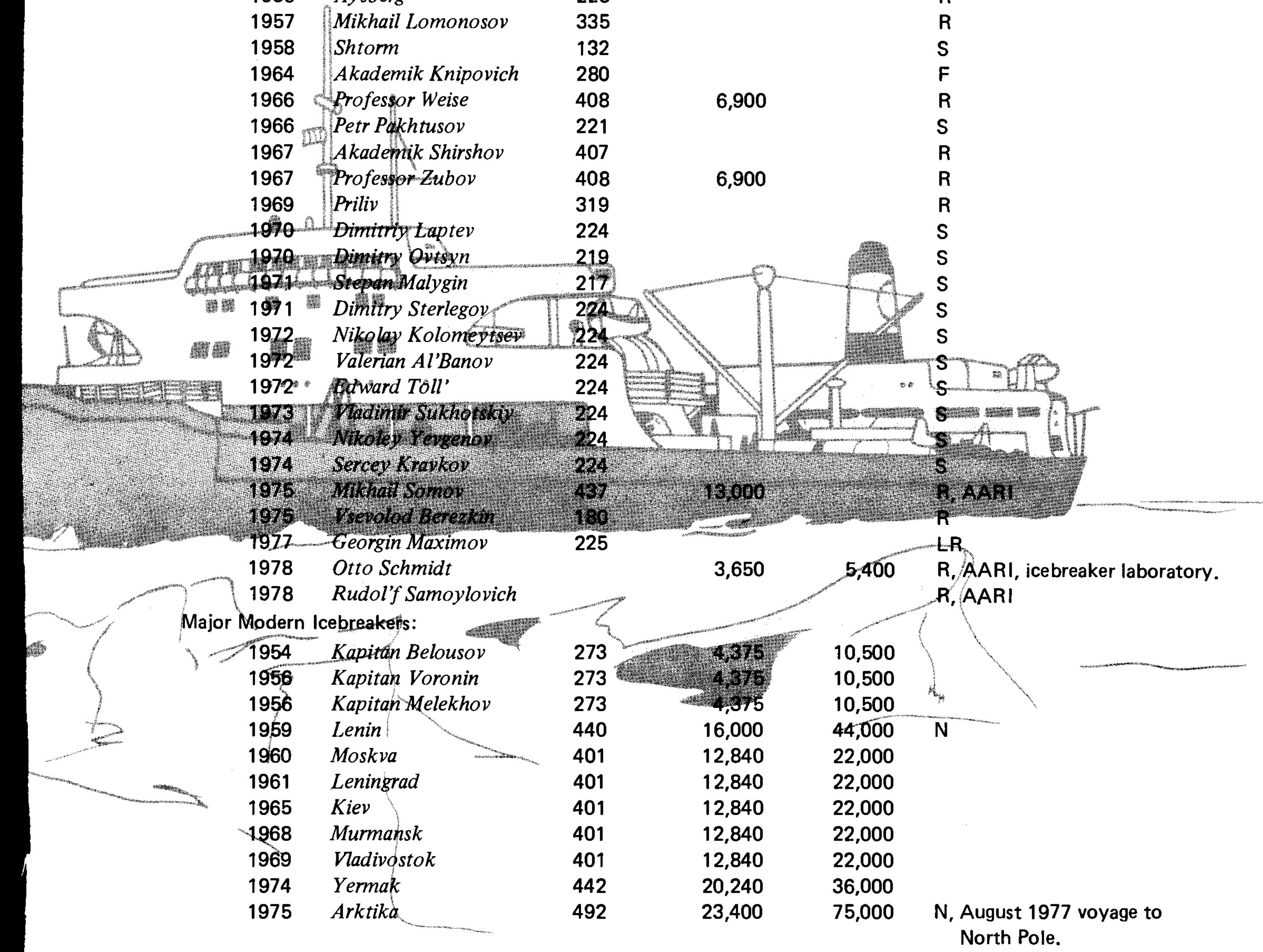
John Dermody was a major participant in the early part of the design work.

Major subcontractors for engineering and design were Arctec, Inc., Columbia, Maryland, and John W. Gilbert Associates, Inc., Boston, Massachusetts. Additional work was performed by the Massachusetts Institute of Technology, Department of Ocean Engineering, and Stevens Institute of Technology, Davidson Laboratory, Hoboken, New Jersey.

Overleaf: **the comprehensive tabulation of ice-worthy research ships of the world. First compiled by author Elsner in 1971, the table has been updated several times since, most recently in 1980. Not included are so-called ice-strengthened ships, such as the R/V *Alpha Helix*, presently assigned to the University of Alaska; these vessels are designed to operate to the edge of sea ice, and are incapable of proceeding safely through it unaided. Information is still incomplete for many countries, including the USSR (which alone accounts for approximately a third of the 120-vessel world inventory of icebreakers in service and on order). Poland has modern ice-worthy trawlers, and at least one research vessel used in exploratory investigations of Antarctic krill. Also not listed are the Swedish working icebreakers, one of which *(Ymer)* performed a scientific voyage in the Arctic during 1980. Australia is planning a research ship specifically for Antarctic work, and Canada has plans for a "Polar 10" icebreaker of 150,000 shaft horsepower. Wärtsilä of Finland is the primary supplier of icebreakers to the world; it has provided at least one-half of the entire tonnage built in this category since 1945.**

ICE-WORTHY RESEARCH SHIPS OF THE WORLD
Including Icebreakers (IB) of Limited Scientific Capability and Availability

	Year Built	Name	Length (loa, feet)	Displacement (tons)	SHP	Remarks
Argentina	1952	*General San Martin*	280			IB
	1979	*Almirante Irizar*	386	12,000	16,200	IB
	1979	*Puerto Deseado*	250			
Canada	1956	*Baffin*	285	4,200		R
	1958	*A.T. Cameron*	177			F
	1962	*G.B. Reed*	177			F
	1963	*Narwhal*	251	2,220		S
	1963	*Hudson*	296	4,660		R
	1965	*Endeavour*	207			R
	1967	*Dawson*	196			R
	1967	*Parizeau*	199			R
	1954	*Labrador*	269	5,300		IB
	1960	*John A. McDonald*	290	9,000	15,000	IB
	1968	*Louis St. Laurent*	345		24,000	IB (extensive scientific fitments).
	1978	*Pierre Radisson*	320	8,300	13,600	IB "R" Class (one under construction).
	1979	*Franklin*	320	8,300	13,600	IB "R" Class.
	1979	*Canmar Kigoriak*	300	7,700	16,300	Dome Petroleum experimental icebreaker.
Denmark	1957	*Thala Dan*	247			Two of J. Lauritzen Lines polar vessels frequently chartered for antarctic or arctic supply and scientific missions. Also 5 icebreakers.
	1961	*Nella Dan*	247			
Federal Republic of Germany	1955	*Anton Dohrn*	205			Also 4 icebreakers.
	1973	*Explora*	234		3,500	(New 16,500 SHP research icebreaker planned.)
Finland	1953	*Aranda*	173			Refurbished in 1976. Also 9 icebreakers, some available for scientific work.
France	1961	*Jean Charcot*	246			Antarctic resupply and research.
	1972	*Marion-Dufresne*	365			
Japan	1965	*Fuji*	325	9,000	12,000	(New research icebreaker planned.)
Norway	1958	*Johan Hjort*	172			F
	1960	*H.U. Sverdrup*	127			F
	1951/77	*Polaris*	175			Available for charter as research vessels. G.C. Rieber & Co., Bergen, Norway. 214 foot ship planned.
	1968	*Kvitbjørn*	135			
	1970	*Kvitungen*	135			
	1971	*Carino**	145			
	1974	*Arctic Explorer**	162		2,500	*Canadian subsidiary, Carino Co., Ltd.
	1975	*Polarbjørn*	162		2,500	
	1976	*Polarsirkel*	162		2,500	
Peoples Rep. of China		*Kexue No.2*	280			Planned.
Union of S. Africa	1961	*RSA*	223			S
	1978	*Agulhas*	354		6,000	Antarctic resupply and research.
United Kingdom	1955	*Explorer*	202			
	1962	*Discovery*	260			
	1968	*Endurance*				Formerly *Anita Dan* (1956), converted.
	1970	*Bransfield*	325	4,800	5,000	Antarctic resupply and research.



USA	1968	*Hero*	125	640	760	NSF antarctic wooden trawler-research vessel.
	1943	*Westwind*	269	5,300	10,000	IB, refurbished 1974, 1975.
	1945	*Northwind*	269	5,300	10,000	De-commission in 1980s.
	1954	*Glacier*	309	8,700	16,900	IB
	1975	*Polar Star*	399	12,000	18,000	— IB
	1977	*Polar Sea*	399	12,000	60,000	
USSR	1952	*Polyarnik*	126			R
	1954	*OB*	426			R
	1956	*Pervenets*	128			R
	1956	*Okeanograf*	128			R
	1956	*Aysberg*	225			R
	1957	*Mikhail Lomonosov*	335			R
	1958	*Shtorm*	132			S
	1964	*Akademik Knipovich*	280			F
	1966	*Professor Weise*	408	6,900		R
	1966	*Petr Pakhtusov*	221			S
	1967	*Akademik Shirshov*	407			R
	1967	*Professor Zubov*	408	6,900		R
	1969	*Priliv*	319			R
	1970	*Dimitriy Laptev*	224			S
	1970	*Dimitry Ovtsyn*	219			S
	1971	*Stepan Malygin*	217			S
	1971	*Dimitry Sterlegov*	224			S
	1972	*Nikolay Kolomeytsev*	224			S
	1972	*Valerian Al'Banov*	224			S
	1972	*Edward Tôll'*	224			S
	1973	*Vladimir Sukhotskiy*	224			S
	1974	*Nikolay Yevgenov*	224			S
	1974	*Sercey Kravkov*	224			S
	1975	*Mikhail Somov*	437	13,000		R, AARI
	1975	*Vsevolod Berezkin*	180			R
	1977	*Georgin Maximov*	225			LR
	1978	*Otto Schmidt*		3,650	5,400	R, AARI, icebreaker laboratory.
	1978	*Rudol'f Samoylovich*				R, AARI
Major Modern Icebreakers:						
	1954	*Kapitan Belousov*	273	4,375	10,500	
	1956	*Kapitan Voronin*	273	4,375	10,500	
	1956	*Kapitan Melekhov*	273	4,375	10,500	
	1959	*Lenin*	440	16,000	44,000	N
	1960	*Moskva*	401	12,840	22,000	
	1961	*Leningrad*	401	12,840	22,000	
	1965	*Kiev*	401	12,840	22,000	
	1968	*Murmansk*	401	12,840	22,000	
	1969	*Vladivostok*	401	12,840	22,000	
	1974	*Yermak*	442	20,240	36,000	
	1975	*Arktika*	492	23,400	75,000	N, August 1977 voyage to North Pole.
	1975	*Admiral Makarov*	442	20,240	36,000	
	1976	*Krasin*	442	20,240	36,000	
	1976	*Kapitan A. Radzhabov* (and two sister ships)	183	2,045	5,350	"harbor icebreakers"
	1977	*Sibir*	492	23,400	75,000	N
	1977	*Kapitan Sorokin*	433	14,900	22,000	
	1978	*Kapitan Nikolayev*	433	14,900	22,000	

ABBREVIATIONS: **R** - dedicated research vessel; **F** - fisheries research; **S** - survey vessel; **IB** - icebreaker, limited scientific capability or availability; **ARRI** - Arctic and Antarctic Research Institute, Leningrad; and **N** - nuclear powered. ♦

by Frank Abegg

Small-Scale Waste Oil Incinerators

Burner # 1 operating in a barrel stove.

INTRODUCTION

Waste oil poses a significant environmental problem in rural Alaska. Careful management of the fragile environment is difficult without adequate means to dispose of waste oil from crankcases of vehicles, generators and other machinery. Commercially available incinerators do not meet the requirements for bush application, where a waste-oil incinerator capable of being transported in small aircraft is needed. The U.S. Environmental Protection Agency agreed that the problem needed investigation, and the work reported here was performed for their contract order (# B1376NTSA).

This article details the design and operation of two waste oil incinerators. One unit is capable of burning up to 1.0 gallon/hour and the other may burn up to 10 gal/hr of waste oil products. The small burner is designed to be used for space heating of residential or workshop areas, whereas the larger burner can be used at a collection center as an incinerator to dispose of large quantities of waste oil.

The incinerators discussed in this report may serve as an approved means of disposing of waste oil at its source. The burners are designed for easy air transport, being constructed of lightweight materials and made for easy assembly. Both units utilize common materials available throughout Alaska and have been designed for a reasonably safe and simple operation. Neither unit should be left to operate unattended, due to the varying characteristics of the fuel and to their simple fuel handling systems. Routine attention will be required during operation.

The waste oil used to test both burners was collected from various sources in Fairbanks. It is a mixture of all known types; more than half of it was used vehicle motor oil, about a third machinery lubricants, and the remainder aircraft lube oils, solvents, and automotive rear-end grease and transmission fluids. Approximate grade of the mixture was between an SAE 20 and SAE 30 weight for viscosity and flow characteristics.

BURNER # 1

This unit operates on gravity-fed waste oil from an elevated supply tank. The burner is installed on a barrel stove made from a standard 55-gallon steel drum. The unit's oil nozzle uses compressed air to atomize the dense waste oil for combustion. The amount of fuel burned depends on the air pressure at the nozzle, which can be adjusted by a regulator mounted at the rear of the burner. A fuel control valve tunes the oil flow for a proper flame pattern at the nozzle. Approximate total cost of the unit is $515 (Fairbanks, Alaska 1980).

A very small amount of compressed air is required to operate the burner, ranging between 0.1 and 0.3 standard cubic feet per minute (scfm). Any small portable shop compressor with a storage tank can easily provide this amount. A typical ½ horsepower compressor with a tank capable of 1.5 scfm at 40 pounds per square inch pressure (100 psi max),

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consuming 800 watts of 110-volt AC, is adequate. The unit's storage tank allows it to cycle efficiently and maintain continuous operation without overheating the compressor head.

The burner is started using a standard propane bottle torch, which the operator aims into the side air ports of the burner flame chamber. With the torch lit, the air pressure to the burner nozzle is adjusted to 30-40 psi and the oil control valve slowly opened until ignition occurs. The oil control valve must be adjusted so sufficient oil is supplied to the nozzle to keep a steady flame. Too much oil will cause the burner to smoke and the used oil will also drip from the end of the nozzle instead of being entirely vaporized. Once a steady flame is achieved, the burner will continue to ignite the waste oil without the propane torch.

The manufacturer's instructions state that any suitable tank or barrel may be used for an oil supply tank. The tank may be located outside the building with a pipe of at least one-inch diameter leading into the filter inside the building. The outlet of the tank must be raised sufficiently above the burner to give the needed head pressure (gravity feed).

If the ambient temperature is below freezing or if high viscosity oil is being used, the oil supply line just in front of the manual oil control valve should be heated for approximately one minute. If the temperature is extremely cold or if extra-high viscosity oil is to be burned, an insulated storage tank is needed and more preheating may be required.

As the oil heats up in the supply line, it will flow faster and the oil flow valve should be closed enough to obtain a bright and steady flame. Once the stove reaches its operating temperature, this oil flow setting should remain fairly constant.

When the stove reaches its operating temperature, the air pressure should be reduced to about 10 to 20 pounds or less and the draft control closed. This causes more suction through the burner can. The more draft or suction, the less air pressure needed. But the stove must be hot before the draft is completely closed or this suction will pull the flame down out of the burner can and extinguish it.

The air pressure regulator should always be set for the amount of heat desired. If more heat is desired, more air pressure will be required to give a smooth, even spray pattern. If too little air pressure is used, the oil will not be broken up well enough, the resulting flame will be rich, and there may be carbon buildup in the burner can. If too much air pressure is used for a given flow setting, the flame will tend to surge and may go out. This burner is designed to work well on from 5 to 50 psi air pressure, depending on the size of flame desired.

Following the manufacturer's instructions for barrel-burner assembly did not produce satisfactory performance, and alterations were made accordingly. The burner was mounted onto the barrel stove door, which positions it near the barrel's center. Firebrick also lines the bottom of the barrel to radiate heat upward into the flame and help atomize the oil spray for improved combustion. Also, an adjustable air intake on the stove door has been modified to introduce preheated over-fire air at the outlet of the burner to provide additional combustion air and turbulence at the higher burning rates. These changes improve combustion efficiency and reduce smoke conditions over the burner's full range of operation.

Tests were run on the new stove design to verify actual combustion performance, using a Dwyer Model 1100 Portable Combustion Analyzer; results are summarized in Table I. The stove is capable of burning between 0.3 and 0.9 gal/hr of waste oil

TABLE I

Burner # 1 Combustion Data

Nozzle Air – psi	*Oil Use gal/hr*	*(-.05" W.G.† Draft at Stack)* **Smoke #*	*%CO_2*	*Temp. (°F)*	*Burner Efficiency*	*Over-fire Damper Position*	*Net Heat Output – BTU/hr*
20	0.33	1	6	660	64%	¼ open	29,570
30	0.48	1	6.5	700	65%	½ open	43,680
40	0.65	2	8	770	66%	¾ open	60,060
50	0.73	2	10	850	68%	¾ open	69,496
60	0.82	3	12	900	68%	full open	78,064
70	0.92	4	13	940	69%	full open	90,800

* The smoke number is assessed on the Bachrach scale of 1 to 10, wherein a standardized test produces at 1 a barely perceptible trace on filter paper, at 10 an opaque black smear. A smoke number of 6 is the maximum permitted for a gravity-feed space heater.

† W.G. = "Water Gauge", in reference to a standard scale (related to water movement in a device partially evacuated by the draft to be measured).

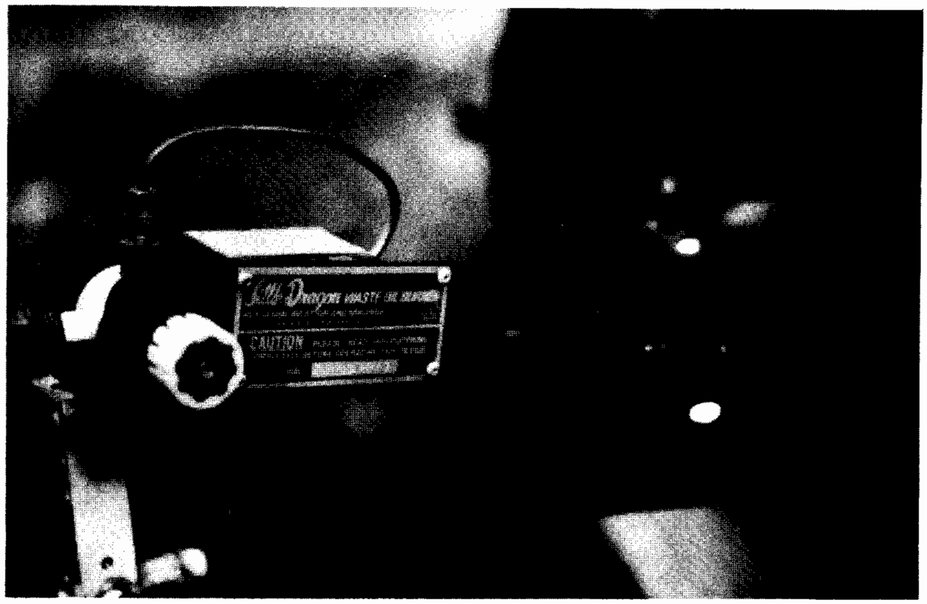
efficiently with no visible smoke emissions. Operation showed CO_2 levels between 6% and 13% at the stack, indicating good fuel-air mixing at a minimum excess air ratio of 30%. Burner heating efficiencies range from 64% up, as measured by a Dwyer test kit monograph, which is nearly equivalent to a conventional residential fuel oil-fired furnace.

In Fairbanks, Alaska, an average home requires about 30 BTU of heating per square foot (ft^2) of floor space to meet the winter's maximum heating demand (-50°F outside and maintaining +70°F inside). Burner # 1 could satisfy the heating requirements of a 3000 ft^2 home or easily provide supplemental heating in small buildings such as workshops.

The burner should not be operated unattended primarily because of the fouling characteristic of used oils. If the flame goes out, the burner nozzle continues to spray oil into the barrel. This is a hazardous condition which could result in an explosion, should the accumulated oil re-ignite. So the final stove design calls for a flame detector and automatic oil shutoff valve system to be installed for protection. These systems are common to all approved fuel-oil fired furnaces. Parts used for this safety system cost approximately $125 (Fairbanks, Alaska 1980). The system supervises the burner's operation and will prevent flooding of the combustion chamber if the flame goes out. With the system installed, the burner is operated as follows:

Startup Procedure

1) The lighted torch is placed near the burner as before, air and oil adjusted as normal and flame detector reset button pushed to open oil shutoff valve.
2) The oil shutoff valve will remain open for about 45 seconds or stay open once the detector senses flame at the burner.
3) As long as flame is present, the detector will keep the fuel oil shutoff valve energized and open.
4) If the flame goes out, the detector will de-energize the fuel oil solenoid valve within 45 seconds and oil will stop flowing to the nozzle.
5) The controller limit switch must be reset manually to reopen the fuel oil solenoid valve.



Close-up view of Burner # 1.

The flame detector is mounted onto the barrel so it can detect the light of the burner's flame. The controller reset allows the stove sufficient time after flameout to vent the hot gases inside the barrel before re-ignition. This detection system is recommended for all installations, since waste oil is variable in viscosity and tends to foul control valves and cause flameouts. It was noted during performance tests that oil flow to the nozzle always declined over a period of time, even with the air pressure constant at the nozzle. This required the control valve to be adjusted periodically to avoid flameouts. Apparently, the small foreign particles in the used oil were bridging at the control valve seat and restricting the gravity-fed oil supply. For this reason, the oil line should be run through a felt-type oil filter to trap most of these contaminants and improve the burner's reliability.

BURNER #2

This unit has been designed to dispose of large quantities of waste oil (up to 10 gal/hr) with little effort made to utilize the fuel's heat release. The incinerator is composed of standard 55-gallon steel drums mounted vertically to form a smokestack. The bottom two barrels are lined with an insulating castable refractory, forming the unit's combustion chamber. The barrels are separate and stackable using guides that are brazed along the barrel bottom rim to keep the rims aligned and the stack straight. If the incinerator does not need to be portable, the barrels can be permanently joined. The burner is installed at the bottom side of the first barrel through a 6" diameter air intake port. The burner is constructed from a standard model used on any residential oil-fired furnace (typical fuel range of 1-2 gal/hr). However, its fuel nozzle is replaced with a "Sonic Nozzle" designed to atomize waste oil. Approximate cost of materials is $1025 (Fairbanks, Alaska 1980).

Operation

This burner operates similar to a standard fuel oil burner; it has an electric squirrel cage fan and high-pressure oil pump for combustion, using a high voltage transformer and spaced igniters at the nozzle. The main difference is that its nozzle uses air pressure at the tip to atomize the heavier used oils to a fine mist that can be ignited by the arc from the burner's igniters.

The size of the stack and air intake areas are designed to provide sufficient draft and over-fire air mixing or turbulence to promote complete combustion and acceptable limits to visible emissions. The bottom barrel has a smoke collar at its top, which reduces the inside outlet to a 19" diameter. This 2"-wide ring aids combustion by stabilizing air flow at ignition and helps to funnel the exhaust gases toward the center of the stack as they travel upward. The ring compresses the gases to increase velocity and turbulence at the location where over-fire air is injected. Four over-fire air ports (2" x 5") are spaced equally around the bottom edge of the second barrel, just above the smoke collar. As the burner increases its fuel burning rate, the incinerator's stack temperature goes up and the resulting draft increases. This draft differential pressure naturally encourages primary and over-fire air into the gas stream.

TABLE II

Burner # 2 Combustion Data

Nozzle Air	*Pressure Oil*	*Oil Use gal/hr*	*Stack Conditions (at -.15" W.G. Draft) Smoke #*	*$\%CO_2$*
25	4	2.0	0	3
25	5	4.0	1	6
25	8	8.0	2	12
40	10	6.0	2	10
40	12	8.0	2	11
40	16	10.0	3	12
40	18	12.0	5	13

Initial testing of the burner showed that additional primary air was needed at the burner inlet for complete combustion at 10 gal/hr, so the burner was shifted outward to allow more air to enter around the burner throat. The best position is with the burner throat end flush with the barrel's side. A small residential burner is not designed to provide sufficient air from its fan to burn 10 gal/hr.

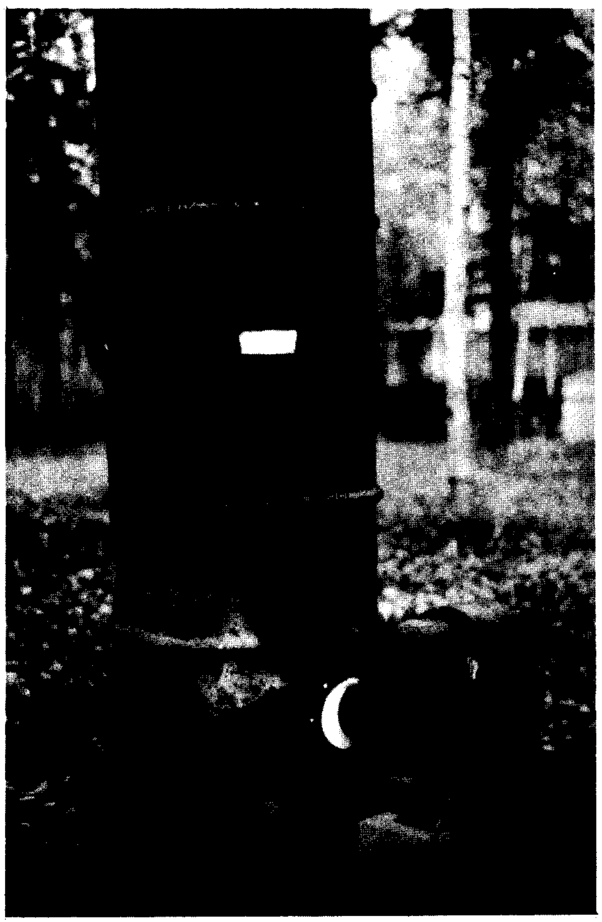
The inlet fuel filter was not adequate for the 10 gal/hr continuous flow; the filter was increased in size to a General model # 2A-200A, which is similar in construction but rated over 30 gal/hr for # 2 fuel oil. With this filter, the pump could deliver the 10 gal/hr flow rate under pressure.

Table II gives the final test results on the incinerator. The air pressure to the nozzle changes the burner's range of operation. It needs at least 20 psi to atomize the oil effectively and 40 psi to attain 10 gal/hr at good combustion. A disadvantage is that the oil supply must be at least 50°F to atomize properly; colder oil will not ignite with the electric arc in the burner.

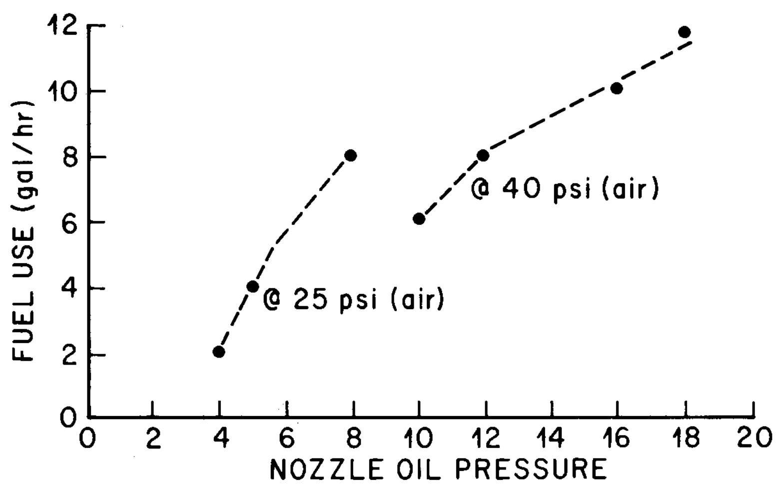
The accompanying graph shows the incinerator's oil burning rate vs. nozzle pressure. The flames begin entering the second barrel when it is fired over 6 gal/hr. Smoke conditions never exceed 20% opacity; the present Alaska standard for commercial incinerators is 30%. Inside stack temperatures exceed 1000°F, which require the barrels to be lined with the castable refractory to protect the barrel metal from overheating and also to reduce radiant heating near the burner. Otherwise the barrel life will be marginal and the burner motor will operate at overload temperatures and fail quickly.

The burner can also operate outside the incinerator combustion chamber. The flame is stable and will maintain ignition

Burner # 2 set up for use.



Fuel use curve of Burner # 2.



without the firebrick or draft from a combustion chamber, so it would be suitable as an ignition source for a commercial refuse incinerator in remote Alaskan communities, where approved land fills are not available.

Burner # 2's ability of self-ignition of the waste oil is a real advantage over Burner # 1. It can be set up for intermittent service to satisfy a temperature demand or control device, such as in a commercial refuse incinerator. Standard flame detector systems on the burner provide adequate safety for flameouts; however, with constant ignition from the electric igniters, the possibility of a flameout is remote compared to Burner # 1's operation. In summary, Burner # 2 can provide a safe and simple means for disposing of waste oil at its source quickly and effectively. The unit is designed for quick setup and minimal maintenance, using parts that are easily obtainable in Alaska and are familiar to anyone who has worked with standard fuel oil-fired furnaces.

BEYOND DISPOSAL

In Europe, waste oil has been utilized as a reliable source of heat, both residentially and commercially, for the past ten years. Some countries have nation-wide waste oil distribution systems and a full range of furnaces available to burn waste oil safely. The results of my experiments prove how simple and easy waste oil is to burn. It is a resource which should be more studied — and more used.

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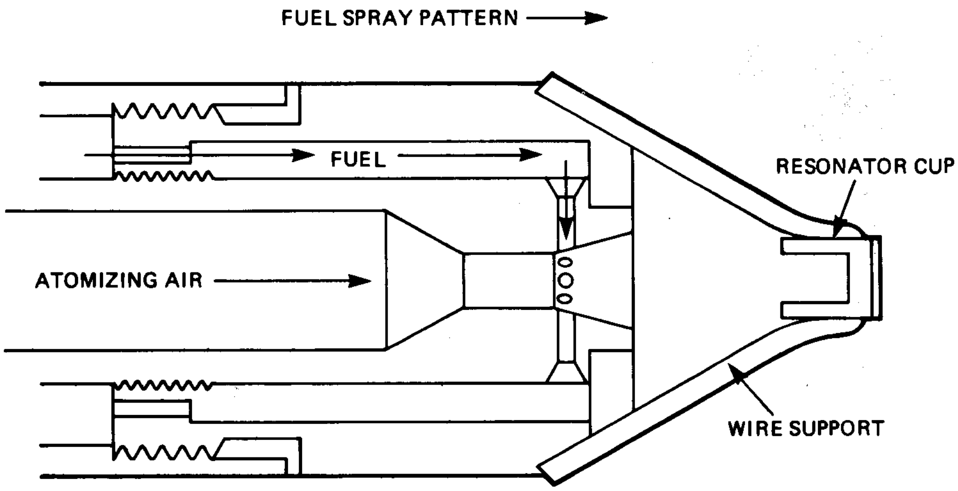
[2] Smith, W.S. 1962. Emissions from Fuel Oil Combustion. Public Health Service Publication # 999-AP-2, U.S. Dept. of Health, Education & Welfare.

* * * * * *

Author Abegg is willing to help readers with the details of waste oil burners to the extent his experiments have given him information. We will forward to him correspondence received here in our office. ◆

Burner # 2 in operation. Notice absence of smoke at top of burner.



Interior view of "Sonic Nozzle": Resonator cup forms a shock wave that breaks up the fuel entering.

ROAD COMMISSIONERS
(Continued from page 21.)

many members of Congress and the executive branch. Wickersham furthermore was convinced that Richardson had always lobbied "in opposition to his (the delegate's) efforts to procure better legislation for Alaska, and both in Alaska and Washington you have threatened, abused, cursed, and otherwise harassed and impeded him in the performance of his duty." Wickersham recounted a long list of grievances, real or imagined, which he harbored against Richardson, including meddling in Alaska local politics, favoritism toward the Northern Commercial Company and various other large economic interests, and incompetency in building roads and trails, bridges, and ferries. In conclusion, Wickersham reminded Richardson that it was the delegate's right and duty to protect the interests of Alaskans

from your viciously incompetent mismanagement of the road fund, and if you think you can prevent it by threats and profanity you are greatly mistaken. If you could be taught to appreciate your position, . . . to give more attention to the building of roads . . . and less to politics, to use less liquor and more temperate language . . . to let your road work out by bids to contractors and draw your checks on a government depository, to compel your foremen to work more and play poker and pangingi less – then you might get to the point where the people would have some confidence in you and less disgust at your failure.[32]

Doubtless, Wickersham disliked Richardson so intensely because he saw in him a competitor for power and influence, and he did not forgive him for having championed President Taft's scheme for a military government for the territory. In addition, the colonel had a power base in Alaska through his control of a sizable payroll. The delegate, rightly or wrongly, was convinced that Richardson used his territorial powers and influence to hurt him politically. The colonel was convinced that Wickersham was out to wreck his military career.

Early in 1916, Richardson again requested a supplemental appropriation of $500,000 for 1917 in order to finish the Valdez-Chitina-Fairbanks military road and continue work on the Ruby-Long Creek Road (see map). The two antagonists appeared before the House Committee on Military Affairs on April 11, 1916 and asked for the extra money. Wickersham argued that it was high time for the board to finish its work in Alaska, while Richardson maintained that the army, which had done much of the pioneer work in opening American frontiers, was doing the same thing in Alaska. Committee members listened attentively but did not make any promises.[33]

A year later, Wickersham had changed his mind about the requested supplemental appropriation and noted that he had been "working up an assault on the appropriation carried in the Military Appropriation Bill of $500,000 for the Alaska Board of Road Commissioners . . ." He did not want to go on record as opposing the money, so he asked a colleague from Ohio to make the point of order against the item. "I intend to put every obstacle in the way of the Board and hope finally to drive it out of existence. I feel fully justified in doing it for it seems the only way to protect the 'Alaska Fund' and prevent the Board from wasting it also." The next day his colleague, as agreed, raised the point of order that the money was not authorized by any previous law. The Speaker of the House sustained the objection, "and out went the $500,000 appropriation for the support of Colonel Richardson's wagon road work in Alaska." Wickersham recalled that he "sat quietly in my seat and heard the fight without saying a word. The *Congressional Record* of this date contains the record of the beginning of the end of the Alaska Board of Road Commissioners – a proper end." On February 25 the delegate noted that Richardson had been busy telegraphing friends in Alaska, telling them that "I killed his appropriation and I am getting telegrams urging appropriation." Wickersham contacted his Alaskan friends and told them to look at the *Congressional Record,* which proved that he had not objected to the appropriation. Privately, he remarked that "It is necessary to the freedom and development of Alaska that this appropriation be fully and finally beaten, so we may be rid of Richardson and his domination, and I intend to see that it is done be the consequences good or bad to me."[34]

Much to the delegate's chagrin, however, the Senate restored the $500,000 and, even worse, the War Department promoted Richardson to the rank of brigadier general in the National Army. But much to Wickersham's delight, the new general resigned as president of the Board of Road Commissioners for Alaska on December 29, 1917 and left Alaska shortly thereafter to assume command of the 78th Infantry Brigade, 39th Division, then at Camp Beauregard, Louisiana, but destined to see fighting in France.

AFTERWORD

The board's work as the federal agency responsible for road and trail construction and maintenance in Alaska continued for many years after Richardson's departure. The Board of Road Commissioners for Alaska became the Alaska Road Commission during the 1920s. Still operating under the War Department in that period, it also obtained its first automotive equipment – military surplus from World War I. Heavy construction equipment gradually replaced hand labor and horse-drawn wagons; by 1932 the Commission had abandoned work on the system of trails and sled roads and instead was building airfields.

In that year the Alaska Road Commission came under civilian control, when a federal reorganization moved it into the Department of the Interior. During the 27 years when the agency operated under the military, from 1905 to 1932, Alaska had gained an elaborate system of trails and sled roads totaling more than 10,000 miles, but less than 500 miles of low-standard roads.

Richardson did not live to see the end of military control over Alaska's roads and trails. After he left the Board of Road Commissioners, his career had taken him from France to the command of the American forces at Murmansk, Siberia, and earned him the Distinguished Service Medal. He retired in 1920 and died at Walter Reed Hospital in Washington nine years later at the age of 68.[16]

Any pleasure Wickersham may have felt in the Road Commission transfer must have been blunted by his defeat in the 1932 elections. In 1938, a year before his own death, the ex-delegate published *Old Yukon*. In the book, he paid tribute to his former adversary: ". . . the Richardson Highway, from Valdez to Fairbanks, is a fitting monument to the first great road-builder in Alaska, General Wilds P. Richardson."[35]

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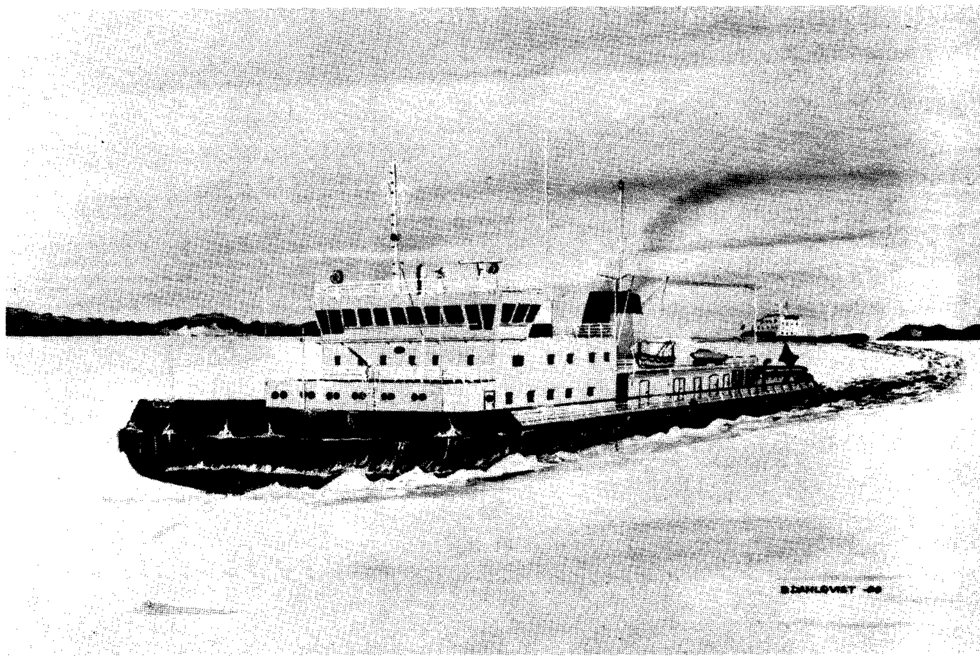
Wärtsilä Activities:
NEW VESSELS, NEW FACILITIES

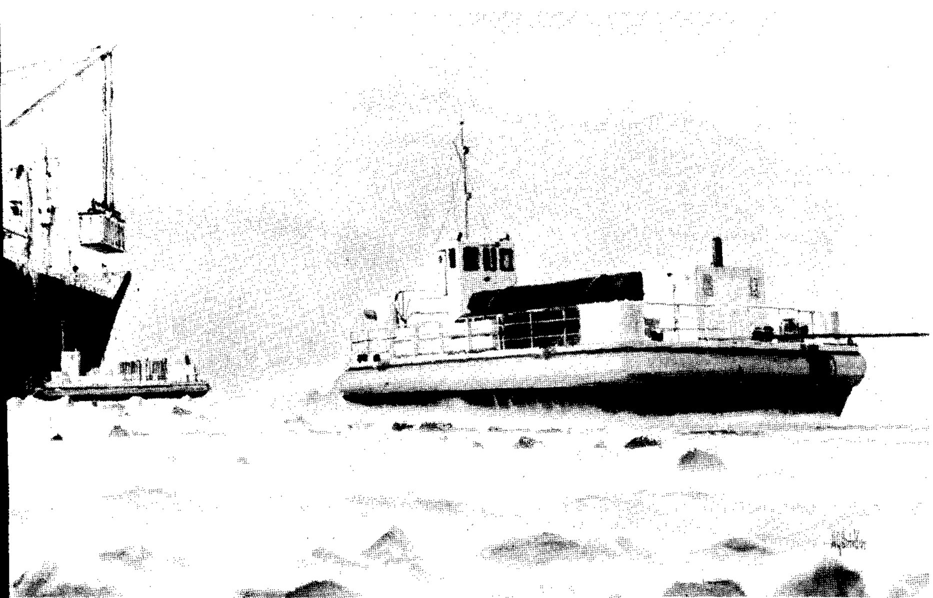


The unique problems of transporting goods over northern waters have stimulated development of special shallow-draft icebreakers, air-cushion vehicles, and a new icebreaking laboratory at Wärtsilä Helsinki Shipyard in Finland.

Shallow-draft Icebreakers

Seven new icebreakers have been ordered by the Soviet Union from Wärtsilä for delivery in 1983-84. Their draft of 2.5 meters makes them technically unique, since only a few years ago it was thought impossible to design an icebreaker requiring so little water under its keel. Development work on this type of vessel has been underway for more than three years; its feasibility has now been established by model tests carried out at the Wärtsilä icebreaking laboratory and by full-scale tests with the river icebreaker *Kapitan Chechkin,* carried out in Siberia at -50°C. The new icebreakers are destined for service under similar conditions on Siberian rivers.

The vessels will be equipped with diesel-electric machinery, with the primary power being supplied by three diesel engines each developing 1605 kW (2180 horsepower). These engines drive AC generators supplying four 950 kW (1292 hp) DC propelling motors over thyristor rectifiers. Main particulars are: length max. 76.8 m; breadth max. 16.6 m; draught 2.5 m; and shaft output 3800 kW (5170 hp).

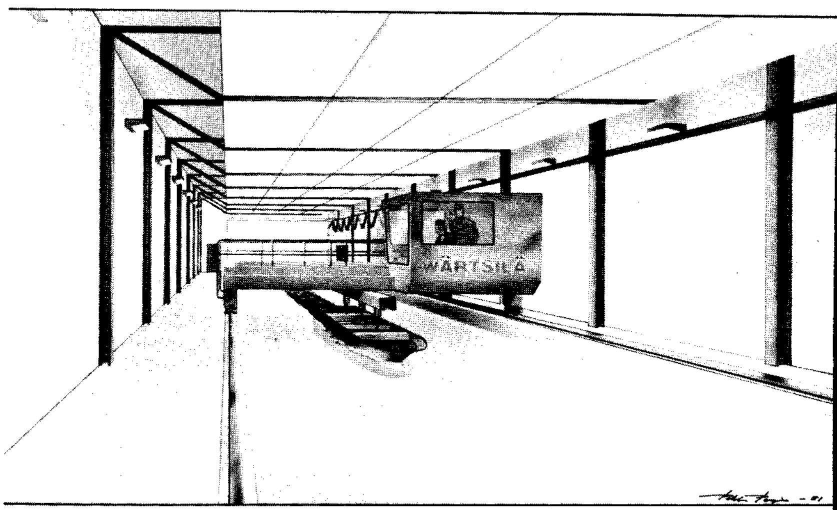


Air-cushion Vehicles

Nine air-cushion vehicles, representing a new line of production for Wärtsilä, have also been ordered by the USSR. Slated for delivery in 1982 and 1983, the ACVs will be used as cargo transfer vehicles, lightering freight ashore in areas lacking harbor facilities and with shallow coastal waters and difficult ice conditions. They are intended to be used with the multipurpose icebreakers the Soviet Union ordered previously from Finnish yards (*TNE* Vol. 12, No. 3). Technical particulars of the new air-cushion vehicles are: length max. 20.7 m; breadth max. 9.9 m; hovering height 0.6 m; power output (diesel engines of Soviet make) 590 kW; and loading capacity 38 tons.

Illustrations and information courtesy of Wärtsilä Helsinki Shipyard.

Wärtsilä presently has another air-cushion vehicle under construction. This vessel is a ferry, ordered last year by the Finnish Board of Roads and Waterways, intended to operate during the winter in the southwestern archipelago of Finland where sea lane channels in the ice cause difficulties. *(Readers interested in reading more about the use of air-cushion vehicles for lightering might want to review Bob Thomas' article in* TNE *Vol. 11, No. 2.)*



Icebreaking Laboratory

The icebreaking laboratory in Helsinki, scheduled to begin operation in 1983, was designed for investigating the icebreaking performance of ships and other structures by using scale models operating in simulated ice fields. Nucleus of the new laboratory is a towing basin with a total length of 79 m, breadth of 6.5 m and water depth of 2.3 m, making it the biggest of its kind in the world. The new basin allows testing of models up to 14 m long and 3 m wide. It is intended primarily for ships and floating structures, but testing of other structures such as lighthouses and locks is also possible.

One new ice field can be produced per day, and all natural ice conditions can be simulated. During the freezing process, the minimum temperature in the test basin room is -37°C. Furthermore, a cold room with minimum freezing temperature of -60°C will be built for testing materials and equipment under extreme environmental conditions. Space has been reserved for possible lengthening of the test basin and for building additional test facilities for arctic research.

The new laboratory will replace Wärtsilä's present icebreaking model basin which has been in service since 1969 (*TNE* Vol. 5, No. 2). The services of the new icebreaking model basin will be available in Canada through Saint John Shipbuilding and Dry Dock Co. Ltd. and Canfin Arctic Consultants Ltd. ♦

MEETINGS

The first bulletin has been published for the **Fourth International Conference on Permafrost**, a meeting noted here in an earlier issue. We bring it to your attention again — even though the Conference will not take place until July 1983 — because the recently-issued bulletin contains a planning questionnaire to guide the organizers in scheduling field trips and filling program sessions. So if you plan (or even hope) to attend the Conference, you should fill out and send in that questionnaire to make your interests known. That means if you have not yet received a copy of the first bulletin, you will need to request one: write to *Dr. William Sackinger, Permafrost Conference, Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701.*

* * * *

The U.S. Army Cold Regions Research and Engineering Laboratory, the Army Research Office, and the State of Alaska together are sponsoring the **Third International Symposium on Ground Freezing.** The "ground freezing" in this instance is specifically artificial freezing of ground to stabilize earth materials and control ground water seepage. The Symposium will be held June 22 - 24, 1982, at the USA CRREL facility in Hanover, New Hampshire.

Provisional program topics include Thermal Properties and Processes in Earth Materials, Mechanical Properties and Processes in Earth Materials, Engineering Design, and Case Histories; authors submitting case histories should be aware that the organizers are particularly interested in discussions of difficulties encountered. Abstracts should be submitted by September 1 of this year; completed papers are due by February 1, 1982, to *ISGF 82, USA CRREL, P.O. Box 282, Hanover, New Hampshire 03755.* That is also the address to write for further information about the Symposium; the phone number is *(603) 643 - 3200.*

* * * *

The **3rd Alaska Alternative Energy Conference** has been scheduled for Anchorage Community College on November 13 - 15. The organizers state that this one will be even more comprehensive than its predecessors: "From rural experimenters to government planners, this year's conference will offer something for everyone involved in alternative energy technology and policy." They would like to hear from anyone interested in presenting a paper or an exhibit; organizing a forum or holding (or attending) a professional training session; or helping out in any other way — and they would like to hear as soon as possible, please. Send word to, or ask for information from, the *Conference Steering Committee, Alternative Energy Resource Center, 1069 West 6th Avenue, Anchorage, Alaska 99501.*

* * * *

Managing Energy Through Energy Storage is the title and the theme of an international conference sheduled for October 19 - 21, 1981, at the Seattle Marriott in Seattle, Washington.

This gathering will feature paper presentations, case studies, films, and a general review of the state of knowledge on seasonal thermal and compressed air energy storage (STES/CAES). The organizers promise a program of more than 60 presentations, representing the latest activities in research, development, demonstration and operational experience in STES and CAES. Major research in the United States and important projects in many parts of Europe and Asia will be included.

For a complete brochure and conference information, write *MCC Associates, Inc., 8534 Second Avenue, Suite 400, Silver Spring, Maryland 20910; phone (301) 589-8130.*

* * * *

With the support of a grant from the National Science Foundation, the Center for the Study of Ethics in the Professions at Illinois Institute of Technology will host the **Second National Conference on Ethics in Engineering**, to be held at the Palmer House in Chicago on October 2-3. The Conference theme is **Beyond Whistle-Blowing: Defining Engineers' Responsibilities**. Philosophers, academic engineers, and scholars in other fields will join with practicing engineers in sessions featuring both formal papers and case studies. The topics to be considered include Responsibility in Organizations, Regulating Technology, Designing for Safety, Technological Decision Making, Cost/Benefit Analysis, and The Role of Engineers in the Political Process.

All inquiries regarding the program or registration should be directed to the *Director of the Conference, Dr. Vivian Weil, Center for the Study of Ethics in the Professions, IIT Center, Chicago, Illinois; phone (312) 567 - 3472.*

* * * *

Arctic Design Criteria, a workshop sponsored by the Petroleum Division, American Society of Mechanical Engineers, will be held September 13-15 at the Dallas Sheraton Hotel, Dallas, Texas.

The workshop is intended to be "comprehensive and instructive", according to the announcement received here. It will cover arctic engineering techniques, engineering management, and environmental/geotechnical factors relating to some of the most challenging and largest oil and gas production projects in existence and planned for the North Slope of Alaska, both on- and offshore.

Four half-day technical sessions will be held: Civil Structural Considerations; Planned North Slope Projects; Piping; Trans Alaska Pipeline Operating and Maintenance Problems.

Information on registration, special activities and complete technical program details is available from: *Frank Demarest, Arctic Workshop, P.O. Box 59489, Dallas, Texas 75229; phone (214) 247 - 1747.*

LETTERS

A better view of the mountains

Dear Editor:

Thank you very much for publishing (Spring '81) the information about the new journal *Mountain Research and Development* which the International Mountain Society is co-publishing with United Nations University.

However, *Mountain Research and Development* does not aim to "stress clear advocacy positions in its contents" as is suggested in the announcement. The editorial policy is to endorse neither a conservationist nor a resource development viewpoint, but to follow that difficult middle of the road pragmatism. The aims of the International Mountain Society are to strive for a better balance among mountain environment, development of resources, and the well-being of mountain peoples. Included in the inaugural issue of the journal is a paper on environmental conflict management.

To maintain this realistic balance we do need participation from those who regard themselves as 'developers' as well as those who are labelled 'conservationists'. We hope readers of *The Northern Engineer* will help to establish and preserve this balance. We welcome papers and short contributions, especially ones describing practical applications of research and new techniques which would be relevant in the 'developing' areas of the world.

Pauline Ives
International Mountain
Society
Boulder, Colorado

We apologize for misreading the International Mountain Society's brochure, and thus misrepresenting its new journal, and trust Ms. Ives' letter will serve to set the record straight.

Delayed thanks

Dear Editor:

Relative to our article "Environmental Noise Studies in the Arctic" (Vol. 13, No. 1), regrettably we did not forward the acknowledgements which had been prepared as a separate page of the manuscript. Furthermore, we neglected to discover this omission in a review of the galley proof. With all due respect to the sponsors, we want to say that the training and research programs reported in the article were supported by the Alaska Eskimo Whaling Commission, Inupiat Community of the Arctic Slope, and the North Slope Borough. The motivation, enthusiasm, and assistance of the students considerably aided the work. The authors are especially indebted for the encouragement and assistance provided by the late Honorable Eben Hopson, former Mayor, NSB; the Honorable Jacob Adams, Mayor, NSB; Miss Marie Adams, Executive Secretary, AEWC; and Mr. Ray Dronenburg, Field Program Coordinator, AEWC.

William C. Cummings
William T. Ellison
D. Van Holliday
The authors.

* * * *

Though it will not emphasize northern concerns, the **International Symposium on Bearing Capacity of Roads and Airfields** will inevitably consider them: the host country is Norway, and the Symposium sponsors are the Public Roads Administration (Oslo), The Norwegian Institute of Technology (Trondheim), and the Civil Aviation Administration (Oslo). The Symposium will be held in Trondheim on June 23 - 25, 1982.

Prospective authors and participants are requested to write to the *International Symposium on Bearing Capacity of Roads and Airfields, c/o Director of Studies, The Norwegian Institute of Technology, N – 7034 Trondheim – NTH, Norway* as soon as possible.

NOTED

Do ducks burn oil? Not quite, but work by a researcher at the University of Alaska's Institute of Water Resources indicates that the aquatic fauna on Alaska's North Slope runs partly on fossil fuel.

According to Dr. Don Schell, peat is the fuel that provides the vital subsidy. The peat has been accumulating since the last glaciers receded from the Slope about 12,000 years ago, permitting tundra vegetation – the source of the peat – to return. Most of the peat is a solidly-frozen part of the permafrost, but on shorelines moving water washes lumps of it loose. Once in the water, the thawed and dispersed organic matter provides food for bacteria, which provide food for microscopic animals, which are in turn eaten by insect larvae and crustaceans – and so on up the food chain. That chain would not have much of a basis in the winter without the subsidy the peat provides.

Because the peat is several thousand years old, standard radiocarbon dating techniques can be used to assay how much a given animal has depended on the peat: any organism feeding upon it acquires an apparent radiocarbon age proportional to the peat source for its food. Thus Schell and his colleagues were able to determine, for example, that Colville River grayling derive a third of their winter food energy from the peat-based food chain. The top fossil-fuel consumer in their study was an oldsquaw duck that contained 64% peat-source carbon in its tissues.

* * * *

Words: Last issue we were called to task by a reader for inconsistent numbering systems, but we also on occasion have been twitted about uneven terms in the non-numerical sense. That big tube running across this state, for example; once upon a time it appeared in these pages as the Trans-Alaska Pipeline, abbreviated TAPS. Then, following our colleagues in more high-powered publishing endeavors (i.e., newspaper journalists), we began using the more understated trans-Alaska

Putting more on ice

Editor (or, since this is a direct reply to Doug Campbell's letter in the Spring '81 issue) Dear Doug:

I was very interested in the Lumberman's Safety Association ice thickness table you sent. The table illustrates the reason I wrote my Guide for Operating Cars and Light Trucks on a Floating Ice Sheet, which had ice fishermen and other over-wintering birds in mind. (Unlike New York, where the birds go to Florida when the ponds freeze, our birds go to Hawaii when they want to melt the snowballs out from between their toes.) The public does need better ice thickness information.

A fair amount of information about the Lumberman's table can be developed from internal evidence. I judge that the original source was a Russian military ice-thickness table developed during or just after World War II – close to 40 years ago. A number of such tables were translated into English during the 1950s, and the Canadians undoubtedly picked it up at that time. Finally, it was botched up by someone working for the Lumberman's Association who might have had a great deal of practical experience with ice but who was not too knowledgeable about its basic behavior.

The Russian origin of the table may be deduced from its similarity to other Russian tables of the same type dating from the war. I have such a table showing that a soldier requires 5 cm of ice to support him and infantry in single column requires 7 cm. However, my table also shows that individuals should be separated five meters and infantry in column should be separated by seven meters. The Canadian government people would have recognized the significance of the spacing but the Lumberman's Association probably did not and so dropped this information. The military origin of your table is suggested by the entry for a group in single file. This type of information would not be of much importance for civilians but would be very important to a platoon leader or company commander.

A clue to the age of the table is given by the "snowmobile" grouped with the two-ton car. This snowmobile is not your handy Bombardier Olympique or flashy Arctic Cat – instead it is a substantial vehicle with about the same weight and size as the car. A further clue to the age of the table is the classification of a truck weighing eight tons as a "Heavy truck".

Canadian involvement is indicated by the adjustment of the ice thickness for the "white" or slush ice, while the fact that it is garbled indicates that the Lumberman's Association did not understand it. Certain (but not all) Russians felt that the "white" ice on the top of an ice sheet was weaker than the "blue" ice that makes up the lower levels of the ice sheet, and the supposed weakness of the "white" ice could be compensated for by using only half its thickness in calculating the ice strength. For example, if a nine-inch ice sheet is made up of five inches of "blue" ice and four of "white", the equivalent ice thickness would be $5 + 4/2 = 7$ inches. This approach was probably never generally accepted in Russia, but it was included in some translations of Russian ice studies during the 1950s. Canadian ice workers picked it up, adopted it, and have subsequently included it in numerous publications. It seems to have achieved immortality and the approximate status of revealed truth in Canada although it is based on too many fallacies to have become generally popular.

If you have trouble finding "clear blue ice", forget the aesthetics and take a sample of ice out of the ice sheet. The pipeline. Finally, deciding that the owners ought to know what it was called, we began following the style of Alyeska Pipeline Service Company press releases and took out the hyphen. Grammatically it might be trans-Alaska, but if the owner companies want to call it trans Alaska, we shall honor their prerogative.

A term that can't be made consistent by consulting a press release is that which describes the zone beginning a few degrees north of Fairbanks: by convention it's the Arctic, where the ground is covered with low arctic vegetation until you come to the Arctic Ocean. The Arctic Ocean is an editorial nuisance, because it has a coastline that can be Arctic (if the author means that ocean specifically, as in Atlantic or Pacific) or arctic (if far northern waters in more general ways are what's being discussed — the Chukchi Sea has an arctic coast too). The other polar zone is easier, because Antarctica is a continent. Thus there can be only Antarctic vegetation, however skimpy, and Antarctic coastlines. . .but recently antarctic weather conditions have been reported in the South Atlantic Ocean, or perhaps it was the south Atlantic.

As you see, even if English units go extinct, we'll find a way to be inconsistent as long as we use the English language.

PUBLICATIONS

Kindling is the informal, informative — and free — newsletter of the Energy Alternatives Program at the School of Agriculture and Land Resources Management here at the UAF. The copy received here had a two-page article on zeolites (*TNE* Vol. 11, No. 2); a book review for *How to be Your Own Power Company*, which touts using the family vehicle for house power; and several short reports on interior Alaska alternative energy projects and publications. The local emphasis means the newsletter will be most pertinent to the interests of interior Alaska

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lower ice will appear transparent, while any slush ice will appear white or opaque. The transparent ice sometimes looks vaguely blue, but if you consider "clear" and "blue" separately, you may have better luck in finding ice to meet your ideas.

My overall reaction to your table, Doug, is that it is a lot better than no guidance. The ice thicknesses you are apt to use, two inches for one person and 7½ - 8 inches for a car or light truck, are reasonable values though slightly conservative. The "adjustment" for slush ice disturbs me somewhat, but its net effect is to talk you into requiring additional ice that may not be needed — and few accidents happen to ice fishermen who drive on ice that is too thick.

Phil Johnson
Fairbanks

Phil mentioned also that he would like to have copies of different ice thickness guides. If you send us a spare copy of yours, we'll forward it to him — trusting we won't need a truck to haul them. (Canadian readers are requested kindly to send no letter bombs, no matter how aggravating the foregoing letter may have been.) Who knows — maybe you too have been guided by Soviet World War II surplus information.

Once more around the convection loop

Editor:

Wish you used bylines in your reviews. I feel uncomfortable addressing a function like "Subscription Dept.", rather than a person like "Jane Doe". But when it comes to articles or reviews, where we are talking about the writer's function and abstract ideas, I feel downright crippled in addressing "Editor" rather than "Helfferich" or "Matthews". Grumble, grumble.

I really got a charge out of your Fall '80 coverage. (Is there a theory that because it's so blasted cold up there that you Alaskans have to hop around and be lively?) I laughed out loud when I read about "preaching...around the edge of the equations..."!

I wish we were at a point in human shelter as we are in transport so that I could write about housing the way that Fred Toman can write about cars. (Not that I don't think that the auto industry is a blind alley we have wasted 80 years on. But rather, since it is an overly developed discipline, it's easy to be empirical in 'improving' it. Therefore, "philosophy" is embedded in *why* Toman is alert enough to have the hands and brains that make sense; and *why* a technical periodical is willing to publish him — though I notice that he couldn't get published in the Society of Automotive Engineers' journals.)

But, in the housing industry, we (many of us) are at the *beginning* of the process of developing a *new* technique, a revolutionized industry. I like to think that is why we have to talk about the "bigger" issues, the more abstract ideas, so much. Of course, there is a cultural trend, a habit, an iconoclastic and preachy style that clogs up (and sometimes enlivens) the works.

The reasons why the convective loop technique is "not respectable" with the solar establishment make a challenging question — one that caught me by surprise. Maybe inertia; maybe prior commitment (vested interest). We need all the help we can get; *help*, not disdain. Thanks.

Jim Berk
Solar Clime Designs
Stanford, California

No disdain here, Jim; the north needs breakthroughs in housing design.

This writer, by the way, is Helfferich, who is the usual source of unsigned reviews, editorial remarks and italic comments dropped in front of, into, or after other people's words. Matthews is the usual source of the blue pencil marks that keep those remarks clean, correct, and comprehensible. For TNE, *the editorial "We" isn't a formality, it's a fact.*

As far as liveliness goes — the people who read your Convection Loops *newsletter know that what you publish isn't exactly placid gray literature either. However, we admit that north of 60° a certain amount of quickness helps one evade the hazards like cold, grizzly bears, and tax collectors — but there is no truth to the rumor that the new Alaska license plates bear the motto, "Live Fast or Die".*

readers, but the general how-they-did-it notes on homespun technology and the publications mentioned could be useful anywhere. To receive *Kindling*, send your name and address to *Energy Alternatives, School of Agriculture and Land Resources Management, University of Alaska, Fairbanks, AK 99701.*

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A fair number of northerners are involved with **Ocean Science and Engineering**, a journal formerly published as *Marine Science Communications:* the Associate Editor for Ocean Science is at the University of Alaska, the Associate Editor for Ocean Engineering is at The Norwegian Institute of Technology, and Scandinavians and Alaskans dot the editorial advisory board. The brochure announcing the name change presented the table of contents for the current issue, which indicates that the northerners are not parochial in their editorial tastes: The titles were *The effects of shear on vortex shedding patterns in high Reynolds number flow: an experimental study; A sensitive turbidity controller for phytoplankton suspensions applied to bioaccumulation studies of mussels; Perspective on the importance of the oceanic particulate flux in the global carbon cycle;* and *Localized corrosion of aluminum alloys for OTEC heat exchangers.*

Subscriptions for a four-issue volume are $40 for individuals, $80 for institutions, with additional postage charges for non-U.S. subscribers. Order from the publisher, *Marcel Dekker Journals, P.O. Box 11305, Church Street Station, New York, NY 10249.*

* * * *

Highly unusual: Inside the plain brown envelope from the Cold Regions Research and Engineering Laboratory was a report with the CRREL symbol and a cartoon on the cover . . . A cartoon? From CRREL?

Pothole Primer, subtitled *A public administrator's guide to understanding and managing the pothole problem,* "gives general information on the causes of potholes, preventive maintenance programs, and basic patching procedures" in non-technical terms, according to the explanatory press release accompanying the report. That it does, and very well. The *Pothole Primer* is also entertainingly written and illustrated; which means that not only is the intended audience of administrators likely to read it, but they can pass it along to inform — and perhaps garner some support from mayors and taxpayers. Though the 24-page pamphlet is not intended for engineers, it makes a very good model for any engineer who must write something to be understood and used by non-technical readers.

The *Primer* was developed at a workshop sponsored by USA CRREL and the Asphalt Institute in September 1980. Robert A. Eaton of CRREL and Robert H. Joubert of the Asphalt Institute (New England states) compiled the publication. Copies may be obtained from *CRREL, Box 282, Hanover, NH 03755.*

* * * *

Another mailing list worth joining for alternative energy information is that of the **Department of Transportation Research Section** *(Attn: Barbara Trego, 2301 Peger Road, Fairbanks, AK 99701).* DOTPF Research has several useful reports in preparation, such as *An Alaskan Greenhouse Manual* and the *Solar Design Manual for Alaska,* and some already published, including the second edition of *Alaska Wind Power User's Manual.*

* * * *

Not quite in the same league — and definitely not at the same cost — is the as yet unnamed newsletter of **Alaskans for Alternative Energy**. This group describes itself as "a statewide membership advocacy organization dedicated to the development of energy conservation and decentralized approaches to energy production in Alaska." The newsletter is AEE's official publication; the first issue promises that it will be published bimonthly during the legislative session and monthly during the rest of the year. Subscription rates are $15/yr for individual subscriptions, $30 for businesses or institutions. (Incidentally, these are the AEE membership rates as well, and membership includes a subscription to the newsletter.) Address queries or send checks to *Alaskans for Alternative Energy, 536 Bonanza, Anchorage, AK 99502.*

* * * *

Elsewhere in this issue is an announcement for the *Second National Conference on Ethics in Engineering,* provided by the same group who now has issued a publication on an earlier gathering: **Report of the Workshops on Ethical Issues in Engineering.** According to the preface by editor Vivian Weil, the Report "contains summaries . . . of all the presentations and some of the discussions. Neither speakers nor discussants may entirely agree with the editor's interpretation of their remarks."

Neither may other engineers, for the Report is thought-provoking and unlike any other publication from an engineering meeting. The emphasis at the Workshops was on helping participants prepare to teach engineering ethics, but the formal sessions concentrated not on ethics courses but on moral issues confronting and involving engineers. That approach committed the participants to begin with descriptions of what engineering is, who engineers are, considering both perceptions and misperceptions held inside and outside of the profession. This effort connected to case studies and to devising courses to help engineers cope with ethical problems. The reader receives a compressed version of what was said, and also often of who was saying it, how it was said, and the writer's opinion of all these factors: "The image which Dockendorff conveyed mirrored the set of traits which are commonly associated with engineering students and fostered in engineering schools. He was unemotional and dry in his delivery and focused on a narrow, technical area . . . He supplied participants first hand acquaintance with a prevalent attitude which, though well-intentioned, is far too simple and partial for the complex and vexing problems engineers confront."

At 65 pages, the book is a provocative sketch by a candid and thoughtful writer of what must have been a very lively meeting. It could provide splendid fuel for discussion — and dispute — among engineers. We recommend you write *Dr. Vivian Weil, Center for the Study of Ethics in the Professions, Illinois Institute of Technology, Chicago, IL 60616* to request a copy. ◆

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