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GEOGRAPHIC INTELLIGENCE REPORT

THE SOVIET ARCTIC

CIA/RR-G 59-1

(Revision of CIA/RR-G-15 dated December 1956)

July 1959

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CENTRAL INTELLIGENCE AGENCY

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THE SOVIET ARCTIC*

Summary

The Arctic region of the Soviet Union is a tundra plain underlain for most of its extent by permafrost and covered by marshy land dotted with a myriad of lakes. The winters are dominated by cold temperatures accompanied by total darkness or only short periods of daylight. Summers are short and cold. This barren, inhospitable region has recently come into prominence because of both its strategic position and its economic potentialities. The Arctic Basin provides the shortest routes between the United States and the USSR and, in event of global conflict, aircraft and missiles would probably fly over these routes.

The economic development of the Soviet Arctic began on a large scale with the establishment of the Chief Directorate of the Northern Sea Route in 1932 and has progressed rapidly since then. The economy is based on the extracting and processing of natural resources, herding, and a small number of fabricating industries. Lumber, pulp, and paper mills use trees from forests south of the Arctic, and the finished products are exported in large amounts to foreign countries by way of the Arctic seas. The mines supply a significant part of the Soviet mineral production of nickel, copper, cobalt, tin, and coal. Noril'sk supplied one-third of the refined nickel and one-fifth of the cobalt produced in the USSR in 1957. The Arctic ranks second to the Soviet Far East as a producer of fish and fish products, the Barents Sea contributing the greatest amount. The economy of the indigenous tribes is based on reindeer herding, and nearly all the products are used locally. Shipbuilding is the only fabricating industry of national importance and is centered at Severodvinsk (formerly Molotovsk).

The population of the Arctic has been increased greatly by the introduction of both free and forced labor. Most of the settlements are along the coast and river valleys, with the greatest concentration within the European Arctic at Murmansk and Arkhangel'sk and within Siberia along the lower Yenisey area at Dudinka, Igarka, and Noril'sk.

Transportation in the Arctic is limited chiefly to water and air routes. Land routes are sparse because of the difficulties of constructing and maintaining both roads and railroads. The Northern Sea Route is the single most important transportation artery and supplements the Trans-Siberian Railroad as a freight carrier. It brings supplies and equipment to the Arctic settlements and takes out mineral ores, timber, and other products. Naval vessels, some carrying troops, have followed the sea route; but its military use

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* The information in this report is based on the best sources available to this Office as of 1 July 1959.

and commercial use are limited by a navigation season of only 4 months, July to October. The rivers in the Arctic flow to the north, and three of them -- the Ob', Yenisey, and Lena -- connect the Trans-Siberian Railroad with the Northern Sea Route. River navigation is also limited by the short ice-free season.

Air facilities have been greatly expanded in recent years, and nearly 100 airfields and seaplane stations have been established within the Arctic. The majority of the military airfields are concentrated in European USSR, whereas fields for Polar Aviation and Aeroflot aircraft are widely scattered. Polar Aviation operations are limited chiefly to the coastal region and include ice reconnaissance and freight transport. Aeroflot flights originate in the south and carry mail and passengers.

Land transportation is limited chiefly to railroads, which are concentrated in the European Arctic and terminate at Murmansk, Arkhangel'sk, and Vorkuta. The Murmansk-Pechenga, and Noril'sk-Dudinka lines provide limited east-west transport.

Scientific activity in the Soviet Arctic entered its era of greatest intensity with the inauguration of the International Geophysical Year. This program was similar to the research program already in force, and only minor changes were made in the activities. Observations from drifting stations, together with information from polar stations along the coast, flying observatories, high-latitude air expeditions, and oceanographic expeditions, are supplying vast amounts of oceanographic, meteorological, terrestrial, geophysical, and upper atmosphere information of great value for economic and military operations.

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I. Introduction

Since the outbreak of World War II, considerable attention has been focused on the economic and strategic significance of the Soviet Arctic.* This interest stems from the increasing magnitude of maritime, scientific, and military activities and from the increasing strategic importance of transpolar air routes. The scope of recent Soviet scientific activities throughout the Arctic Basin suggests that military as well as economic motives prompted the extensive program. Further indication of the importance attached to the Arctic is revealed in the periodic economic plans (Five-Year Plans and the more recent Seven-Year Plan) which have included large appropriations for Arctic research and development.

Although development has been in progress throughout the Arctic over a period of many years the major activities, both economic and military, have been centered in the Northwest European part and to a lesser extent on the Chukotsk Peninsula opposite Alaska. With a few exceptions the significant economic and military operations in the vast intervening territory are a development of World War II and the postwar era. Arctic operations, once seasonal in character, are carried on the year round, thus (1) increasing the capabilities of the Northern Sea Route as a major shipping and naval route, (2) permitting greater exploitation of the natural resources of the Arctic, and (3) making possible the collection of a formidable mass of physical environmental data through scientific research. This combination of activities in the Arctic is viewed with considerable interest -- and with apprehension regarding Soviet intentions.

The importance attached to the Northern Sea Route is revealed by the chain of polar stations, navigational aids, ports, and related coastal installations that have been established along the Arctic littoral from the Kola Peninsula eastward to the Bering Sea to facilitate shipping operations. Approximately 100 polar stations of various sizes are located along the coast, most of which are in operation on a year-round basis. In conjunction with improved shipping and the development of mining, ports along the Arctic coast have become active transshipment points for large areas of the sub-Arctic as well as the Arctic. Although the population of the Arctic is numerically small, some of the more active ports -- notably Murmansk, Arkhangel'sk, Severodvinsk, and Igarka -- as well as the mining developments of Noril'sk and Vorkuta have become sizable centers of urban population. Many of the coastal and river ports have also become important centers for the expanding lumbering and fishing operations.

*For a delimitation of the Soviet Arctic, see pp. 6-7.

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Geological exploration in the Soviet Arctic has revealed valuable mineral deposits throughout the region, many of which are currently being exploited. Mining activities centered at Noril'sk, Vorkuta, Nikel', the Pevek area, and Iul'tin, have become foci of Soviet economic activity. Nickel, copper, coal, tin, and tungsten in addition to uranium, cobalt, and other strategic minerals essential to Soviet industries are mined at one or more of these centers. Many of the mines as well as other projects were initially worked by forced labor, which has since been replaced to a large degree by free contract labor. Noril'sk, with large reserves of copper-nickel ore and coking coal, has become the largest metallurgical center in the Soviet Arctic.

Aside from the transportation capabilities of the Northern Sea Route the Soviets have placed increased emphasis on the use of air and rail transport as a means of rapid year-round transportation. Nearly 100 airfields and seaplane stations have been established in various parts of the Arctic. Many of these facilities serve as bases for Polar Aviation operations, which include year-round ice and weather reconnaissance, as well as for the transport of high-priority mail, supplies and personnel, and for the support of extensive scientific operations. The successful year-round operations of the drifting stations are attributed to the increasing logistic capabilities of Polar Aviation.

Despite serious environmental obstacles such as terrain and climate, which pose costly and difficult construction problems in the Arctic, the Soviets have made significant progress in the construction of rail lines to facilitate year-round transport to remote parts of the region. Concentrated within the European north are railroads that provide access to the rich mineral resources of the region and to the major naval and shipping ports of Murmansk, Arkhangel'sk, and Severodvinsk as well as to strategic airfields on the Kola Peninsula. The most recent construction in the European Arctic is the extention of the Kotlas-Vorkuta Railroad from Khal'mer-Yu to Kara and a branch line from Mikun' to Mezen'. Sections at both ends of the latter line have been completed or are under construction. Particular emphasis is focused on the construction of a line along the Yenisey River that will provide a link between the ports of Dudinka and Igarka on the Northern Sea Route and the Trans-Siberian Railroad at Achinsk. A stretch of the line from Achinsk northward to Maklakovo is currently under construction.

The strategic significance of the Soviet Arctic is evident from its proximity to the North American Continent. In the event of a future global conflict, intercontinental aircraft and guided missiles would undoubtedly take advantage of transpolar air routes as the shortest distance between the USSR and the United States. Throughout

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much of the Soviet Arctic, major airfields capable of staging medium and heavy bombers have been constructed and expanded since 1950. The existence of surface-to-air missile sites near Murmansk has been suggested but not confirmed. [redacted] 25X1

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The build-up of military air facilities has been noted particularly on the Kola Peninsula and to a lesser extent on the Chukotsk Peninsula, both of which lie close to the North American Continent. Operating from the larger known airfields -- notably Severomorsk, Mal-Yavr, Tiksi, and Mys (Cape) Shmidta -- the Soviet heavy turboprop bomber, the Bear, could reach virtually any target in the United States. The development of inflight refueling techniques also strengthens Soviet strategic air power in the Arctic by providing greater range capabilities, thus increasing the number of potential long-range aircraft.

Although these airfields have the advantage of proximity to North America they are vulnerable to retaliatory air attacks from the United States and Western Europe. Furthermore, potential air capabilities of the region are limited somewhat by adverse climate, which imposes (1) seasonal flying restrictions, (2) logistic problems, and (3) aircraft- and runway-maintenance difficulties. On the other hand, many additional air and guided-missile bases could be remotely located deep within the Soviet Arctic, where the danger of retaliatory measures would be at a minimum.

The strategic importance of wartime sea operations in the Arctic, other than the supply functions of the Northern Sea Route, is focused mainly on potential submarine activities. Naval installations concentrated along the deep-water inlets of the ice-free Kol'skiy Zaliv (Bay) and in the White Sea at Severodvinsk permit year-round operation of submarines and other naval vessels. The development of atomic-powered submarines would permit year-round naval movement by submarines throughout the region, including their deployment between the Atlantic and Pacific Oceans via the Arctic. In addition to the strategic importance of the Northern Sea Route as an east-west communication link, maritime shipping along the route is a vital necessity for transporting supplies to the numerous scientific stations, air facilities, ports, and mining centers as well as to possible future guided-missile bases within the Arctic.

From the point of view of defense, the coastal installations will serve as an early-warning line to detect enemy planes approaching the mainland since the major polar stations and the larger airfields are equipped with both radar and radio facilities. Radar sites are

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*References in arabic numerals refer to sources listed in Appendix B.

concentrated along the coast from the USSR-Norwegian border to 80°E in the western Arctic and around the Chukotsk Peninsula in the east. In the middle sector, radar stations are sparsely distributed.

With the great amount of polar scientific activity, especially during the IGY, the Soviets have acquired a formidable mass of physical environmental data on the Arctic unmatched by the rest of the world. The intensive scientific program, focused upon hydrometeorological and oceanographic research, is closely interlinked with a wide range of other scientific research, including terrestrial geophysics (geomagnetism, geoelectricity, seismology, and gravimetry) and upper-air physics. This comprehensive program could lead to a Soviet superiority over the rest of the world in understanding variations in natural conditions and in forecasting meteorological, cryological, magnetic, and ionospheric phenomena that are important to surface and submarine navigation, air operations, and communications. Such Arctic superiority would also give the Soviet Union an increasing ability for the rapid mounting of forward offense bases for air or missile attacks that could be staged under cover of the winter night. The collection of geomagnetic and gravity data is particularly significant in relation to Soviet capabilities for the positioning and navigational control of long-range missiles.

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The total area of the vast east-west Arctic expanse, including the islands, covers over 872,000 square miles (1,400,000 square kilometers) or roughly 10 percent of the USSR land mass. The region as defined for the purposes of this study, lies mostly north of the tree line, the generally accepted southern limit of the Arctic. South of the tree line is the taiga or coniferous forest belt usually associated with the Soviet sub-Arctic. Although the major settlements of Arkhangel'sk and Igarka lie within the forested sub-Arctic, they play an active role in the politico-economic development of the Arctic and therefore are included in this study of the Arctic area. In the Far East, where a series of mountain chains has limited tree growth to approximately 60°N, a relatively straight line from Nizhniye-Kolymsk eastward to Zaliv Kresta was drawn as the southern boundary of the Arctic. South of this line, most of the activity is oriented toward the Bering and Okhotsk Seas and the Far East port of Vladivostok rather than to the Arctic.

The traditional boundary of all Arctic regions has been the Arctic Circle at 66°33'20"N. This line is not satisfactory within the Soviet Union since it either includes areas that would be considered temperate on the basis of vegetation and wildlife or excludes areas, such as the Chukotsk Peninsula, which on the basis of climate and other characteristics are largely Arctic. In defining climatic regions, Köppen chose the isotherm of 50°F for the warmest month as the southern border of the Arctic since this isotherm is the limit of tall tree growth.

The Soviet Union, however, has rejected most geographic theories and has defined the Arctic in terms of administrative jurisdiction. According to a 1931 decree the southern boundary of the Far North (Kraynyy Sever) region appeared to follow, in general, the northern limit of relatively continuous population. 2/ At that time the European Arctic included Murmanskaya Oblast' and the northern portions of Arkhangel'skaya Oblast' and Komi ASSR; the Siberian Arctic included most of the area north of 60°N. East of Ozero (Lake) Baykal, however, the line dipped south to 55°N and even to 50°N in the Soviet Far East.

In the past, the territory controlled by the Chief Directorate of the Northern Sea Route (Glavnoye Upravleniye Severnogo Morskogo Puti--GUSMP) also has frequently been associated with the areal limits of the Soviet Arctic. Until 1938, this area included all islands and seas of the European north and all land north of 62°N latitude east of the Urals. Many of the activities of GUSMP up to this date were conducted by seven Territorial Administrations, which served as administrative and functional organs of GUSMP. These administrations were (1) Arkhangel'sk, with headquarters at Arkhangel'sk; (2) Omsk, with headquarters at Tobol'sk; (3) Krasnoyarsk, with headquarters at Igarka; (4) Yakutsk, with headquarters at Yakutsk; (5) Far Eastern, with headquarters at Vladivostok; (6) Leningrad, with headquarters at Leningrad; and (7) Murmansk, with headquarters at Murmansk. After the reorganization of GUSMP in 1938, however, the Territorial Administrations were abolished, and its efforts were concentrated on the operation of the Northern Sea Route, the conduct of scientific work, and the construction and outfitting of ports, shipbuilding facilities, and living quarters along the Arctic littoral.

In contrast to a somewhat arbitrary southern boundary, the northern limit of the Arctic is sharply defined by a Soviet decree of 15 April 1926 based on the so-called "sector theory." Under this decree the Soviet Union claims unlimited sovereignty over all lands and islands that lie between 32°04'35"E and 168°49'30"W. 3/ Within this wedge the Kara, Laptev, East Siberian, and Chukotsk Seas are claimed as internal waters through which there is no right of innocent passage. In addition the USSR claims a 12-mile limit in waters along its coasts;

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in the Barents Sea this has the effect of closing Proliv (Strait) Karskiye Vorota, the entrance to the Kara Sea. In the Bering Strait, where the territorial waters of the USSR and the United States overlap, namely between Ostrov Ratmanova (Big Diomede Island) and Little Diomede Island, the international boundary has been fixed at the center of the mid-channel. 4/

The water area north of the Kara, Laptev, East Siberian, and Chukotsk Seas is claimed as polar seas having a status nearly identical with that of territorial waters. So far as is known, there has been no official decree concerning the status of this portion of the Arctic Ocean, although Soviet jurists have claimed the Soviet Union exercises sovereignty over the water and ice areas as well as the land in its polar sector. This claim is essential to the Soviet Union if it expects to control the air space above the sector since, according to a principle of international law, a State is entitled to sovereignty over the air space above its territorial waters.

Although the Arctic, as defined for this study, lies completely within the RSFSR, it includes a variety of administrative subdivisions within this major republic of the Soviet Union. From west to east, it includes the northern portions of Murmanskaya Oblast', Arkhangel'skaya Oblast' proper, Nenetskiy Natsional'nyy Okrug (N.O.) of Arkhangel'skaya Oblast', the Komi ASSR, the Yamalo-Nenetskiy N.O. of Tyumenskaya Oblast', the Taymyrskiy (Dolgano-Nenetskiy) N.O. of Krasnoyarskiy Kray, the Yakutskaya ASSR, and the Chukotskiy N.O. of Magadanskaya Oblast'. By far the greater part of the Arctic area is divided among various nationality units. These national divisions were created to give some degree of autonomy to the various racial groups, depending on their size and stage of advancement. The Komi and Yakutskaya ASSR's have constitutions and are under the supervision of a union republic (SSR). The national okrugs, which are inhabited by small ethnic groups that are little advanced culturally, enjoy a lesser degree of autonomy, and are under the jurisdiction of administrative oblasts or krays.

II. Population and Settlements in the Soviet Arctic

A. Character of the Population

The recent growth of population in the Soviet Arctic closely parallels the intensified economic and strategic developments during the postwar period. Since 1945, the population has increased steadily along with the intensified efforts (1) to establish the Northern Sea Route as an east-west communication link and shipping lane for settlements and installations along the northern coast and (2) to exploit the vast resources of the Arctic. In conjunction with the operation of the Northern Sea Route, the Soviets have placed considerable emphasis on the growing military importance of the region, which is associated with the construction of airbases on both the mainland and the Arctic Islands, the increase in Polar Basin research, and the recent extension of railroad lines. Most of the advances have been limited to four major areas: (1) the Kola Peninsula, (2) the southeastern shore of the White Sea, (3) the lower Yenisey Basin, and (4) the Chukotsk Peninsula. Within these areas are the principal ports, industrial centers, and military installations and most of the population.

The population of the Soviet Arctic exceeds 1,000,000. Although the total population is numerically small, it is highly concentrated in settlements of significant size, such as Arkhangel'sk (238,000), Murmansk (170,000), Severodvinsk (70,000), and Igarka (30,000). These settlements, located at favorable sites along the littoral and rivers of the Arctic, function as important water and rail transshipment points serving large areas of the Arctic and sub-Arctic. The expanding mining and industrial centers of Noril'sk (92,000) and Vorkuta (60,000) are examples of more recent population and settlement growth. Many of the larger regional settlements have important fishing and lumbering industries or serve as political-administrative centers. In a large number of the Arctic settlements, isolation has stimulated the establishment of seaplane landing facilities as well as radio and polar weather installations; and the number of scheduled and nonscheduled polar flights, including those of a military nature, has increased.

On the Arctic Islands, where the population is extremely sparse, military and scientific installations and other government enterprises have formed the nuclei for settlements. Major airfields -- such as those at Belush'ya Guba (Bay) on Novaya Zemlya, Nagurskaya and Ostrov Gofmana on Zemlya Frantsa-Iosifa, Bukhta (Bay) Somnitel'naya on Ostrov Vrangelya, and the numerous polar stations scattered throughout the Arctic Islands -- form populated points in an otherwise desolate area of ice, rock, and water.

Although basic facilities such as schools, hospitals, clubs, and theaters have been built in a large number of the Arctic settlements, the harsh environmental conditions, generally inadequate housing, and relative isolation do not foster a normal population influx. The use of forced labor to meet the initial large industrial labor requirements of mining and construction contributed significantly to the original influx of population. Many large urban centers such as Noril'sk and Vorkuta were developed primarily by forced laborers, many of whom were subsequently released but forcibly retained in the areas as free workers. As a result of the amnesties issued between 1953 and 1957, large numbers of forced laborers were released and the Soviets have been placing increased emphasis upon the use of contract labor. Small numbers of forced laborers are still used in some mining areas.

Since 1932, the USSR has issued a number of announcements encouraging workers to migrate to the Arctic. The pay scales are generally higher than in more southern areas, the amount of pay increasing with the degree of isolation. In very isolated places, workers are given double allowances, special pension rights, and additional leave. The normal tour of duty at most polar stations appears to be 2 to 3 years, and at the end of each year of service the salary is increased 20 percent. At the more isolated places, however, the time is probably reduced to 1 year or even 6 months, thus allowing a more frequent rotation of personnel. 5/ Special privileges and inducements such as guaranteed housing are also used to attract free contract laborers to mining and other industrial centers in the Arctic. These inducements have met with only partial success, and labor shortages continue in many areas. In addition to free workers and some forced laborers, a relatively large number of exiles from the Baltic republics and from former German-occupied territories have been resettled throughout the Arctic. Although most of these people enjoy considerable freedom, they are not permitted to leave their assigned areas. The indigenous population, which is small in number, contributes little to the total labor force of the region.

B. Urban Settlements

1. European Arctic

Approximately two-thirds of the population is concentrated in the European part of the Soviet Arctic, chiefly on the Kola Peninsula and along the southeastern shore of the White Sea, where the important Murmansk and Arkhangel'sk trunklines and the Severnaya Dvina River terminate. The relatively high population densities of these areas are attributed to the large urban centers of Murmansk, Arkhangel'sk, and Severodvinsk and to a heavy concentration of military facilities, including airfields, naval bases, radar stations, and coastal defense installations. Many fishing villages are also scattered along the coast. In addition to their port and transshipment functions, Murmansk and Arkhangel'sk are important industrial centers, with about half of the total population consisting of civilian workers engaged chiefly in lumbering, wood-chemical, fishing, and shipbuilding activities.

Murmansk, along the ice-free Kol'skiy Zaliv, is the only major port in northern USSR that is accessible the year round, and consequently it is the focus of intensive merchant and naval activity. The port of Murmansk and the nearby Rosta naval shipyards together form the administrative headquarters and the major repair and supply base for the Soviet Northern Fleet. Murmansk is also the winter port for ice-bound Leningrad, with which it is connected by a double-track railroad. The port activities of Murmansk are equaled in importance by its role as the administrative and commercial center of the Kola Peninsula (Figure 1).

Figure 1. Lenin Avenue, one of the main thoroughfares of Murmansk.

Along Kol'skiy Zaliv to the north are the important naval bases of Severomorsk, Polyarnyy, and Guba Tyuva, which have sizable concentrations of both civilian and military personnel. In addition to maintenance and supply facilities, naval schools emphasizing specialist training, are operated at these bases. Severomorsk, with an estimated population of between 10,000 and 15,000 in 1951, is served by rail and road from Murmansk and is the site of one of the major airfields in the Soviet Arctic. Minor settlements along the northern coast of the peninsula include a number of fishing ports -- notably Pechenga, Port Vladimir, Sayda-Guba, Teriberka, and Ponoy -- and the minor naval base of Iokanga (5,000 in 1944). Military airfields have been constructed near most of these ports.

Pechenga, located on the deep-water and ice-free fiord of Guba Pechenga, is a fishing center of secondary importance. Its port at Linakhamari is 10 miles (16 kilometers) to the north on the western shore of the bay. The main function of Linakhamari before construction of the Nikel'-Murmansk railroad was the shipment of ore from the mines at Nikel' to Murmansk, but its most important activity is now fishing and fish processing. 6/ Pechenga and Linakhamari are on the Arctic Highway which extends northward from the Finnish-Soviet border and terminates at Linakhamari.

The sizable population on the southeastern shore of the White Sea is concentrated in the large urban centers of Arkhangel'sk and Severodvinsk. Arkhangel'sk, the largest seaport and urban complex in the Soviet Arctic, occupies both shores of the Severnaya Dvina and many islands in the estuary of the river. Arkhangel'sk is served by a double-track railroad line from Moscow and by the navigable Severnaya Dvina, which is connected by a system of canals with both the Baltic Sea and Volga River. The port is also a major Northern Sea Route base and a secondary naval base. Prior to World War II, it handled approximately 14 percent of all USSR shipments through ports, averaging more than 2,000,000 tons per year. The city is also the chief center of the USSR lumber industry and is a port of call for ships of several nations.

Approximately 17 miles (27 kilometers) west of Arkhangel'sk is the shipbuilding center and secondary port of Severodvinsk. Created in 1936 to meet the demand for a shipbuilding center with direct access to the open sea, Severodvinsk has rapidly become a sizable urban settlement and one of the largest shipbuilding centers in the USSR. A single-track railroad that connects with the Arkhangel'sk-Moscow trunkline at Isakogorka provides the city with most of its consumer goods, foodstuffs, and industrial materials for the shipyard.

Elsewhere in the European Arctic the population is restricted mainly to the river valleys and to isolated villages and installations along the coastline. Population density is relatively high along the Pechora River and its tributaries, where important reserves of coal, oil, and timber are being exploited. Vorkuta, in the upper basin of the Pechora, is the largest coal-mining center in the Soviet Arctic (Figure 2). The numerous mines of Vorkuta are a major source of coking coal for the industries of Leningrad. Coal is also shipped down the Pechora River to the port of Nar'yan-Mar, where it is used for bunkering and is exported to Murmansk, Arkhangel'sk, and other ports along the Arctic coast.

Figure 2. Main office of the Kapitalnaya Coal Mine in Vorkuta. (1957)

Figure 3. Snow-drifted streets in Amderma. (1956)

Figure 4. The town of Inta on the Kotlas-Vorkuta Railroad.

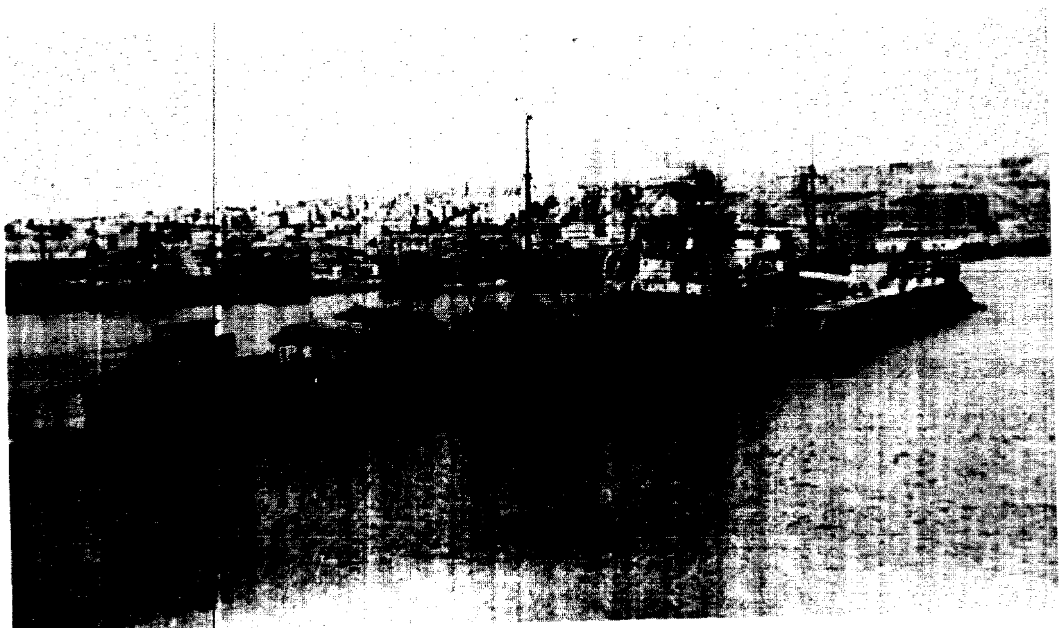

Figure 5. Freighters at anchor in Igarka.

Nar'yan-Mar, at the mouth of the Pechora River, is a loading point for ships and barges carrying coal, lumber, and fish to Murmansk, Arkhangel'sk, Leningrad, and other cities in European Russia. In addition, lumber is exported to Western European countries. The city is in the midst of an expansion program to enlarge and reconstruct buildings and residential areas in the city and its environs. Nar'yan-Mar is the administration center for the Nenetskiy N.O. and had an estimated population of 11,000 in 1956.

Mezen' (population 10,000) near the mouth of the Mezen' River and Amderma (2,000) on the Kara Sea coast are among the other populated places along the European Arctic coast. Amderma (Figure 3) is the site of a major airfield and is also the northern terminus of a railroad under construction from Khal'mer-Yu. Along the Kotlas-Vorkuta rail line are the small railroad and mining settlements of Inta (Figure 4) and Abez with 5,000 and under 5,000 population, respectively.

2. Siberian Arctic

Although the majority of the population of the Arctic is located in the European part, the post-World War II growth of ports, mining settlements, and airfields east of the Urals has been phenomenal, notably in the lower Yenisey Basin, on the Chukotsk Peninsula, and to a lesser degree in the Ob', Lena, and Kolyma River valleys. As is characteristic of most sparsely populated regions, the areas with the greatest population densities are concentrated chiefly along the major transportation arteries. Many of the principal settlements of the Siberian Arctic, like those in the European north, have developed as transshipment points.

The greatest density is in the lower Yenisey, where population is estimated to exceed 200,000. Most of this population is concentrated in the river ports of Igarka and Dudinka and in the rapidly expanding mining and metallurgical center of Noril'sk.

Igarka, located at the junction of river and ocean traffic, has become a major port of the Siberian Arctic and a leading lumber center of the USSR (Figure 5). Lumber from Igarka is exported to ports in both the Soviet Union and the countries of Western Europe. Igarka is the only Siberian Arctic port open to foreign vessels. The city is made up of an old and a new section, which are separated by a large timber storage area. In addition to its large lumber combine, Igarka contains a fish-curing plant, a ship-building yard that produces motor boats and launches, ship repair shops, and a brick plant. A sovkhoz on an island in the Yenisey River opposite Igarka provides the city with fresh vegetables, meat, and dairy products. Until recently all buildings were made of wood (Figure 6); and streets, sidewalks, and paths were planked. A reconstruction and

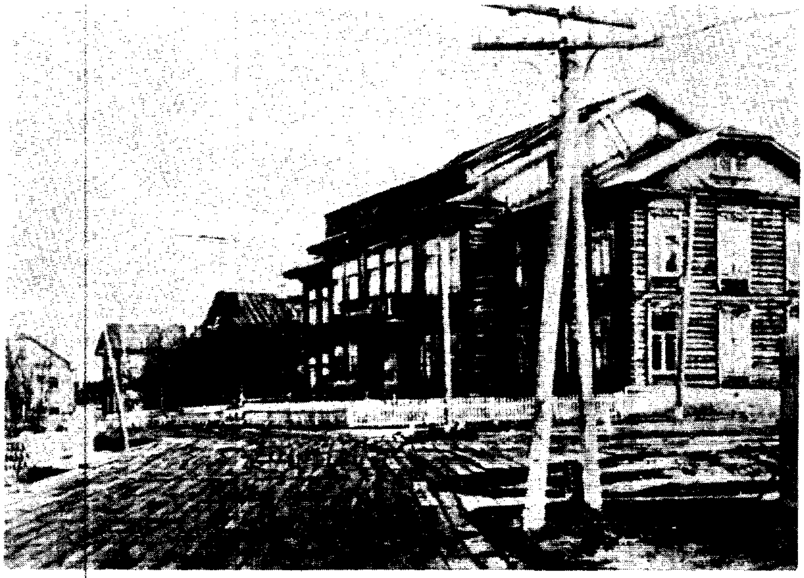

Figure 6. Wooden houses and planked streets in Igarka. (1955)

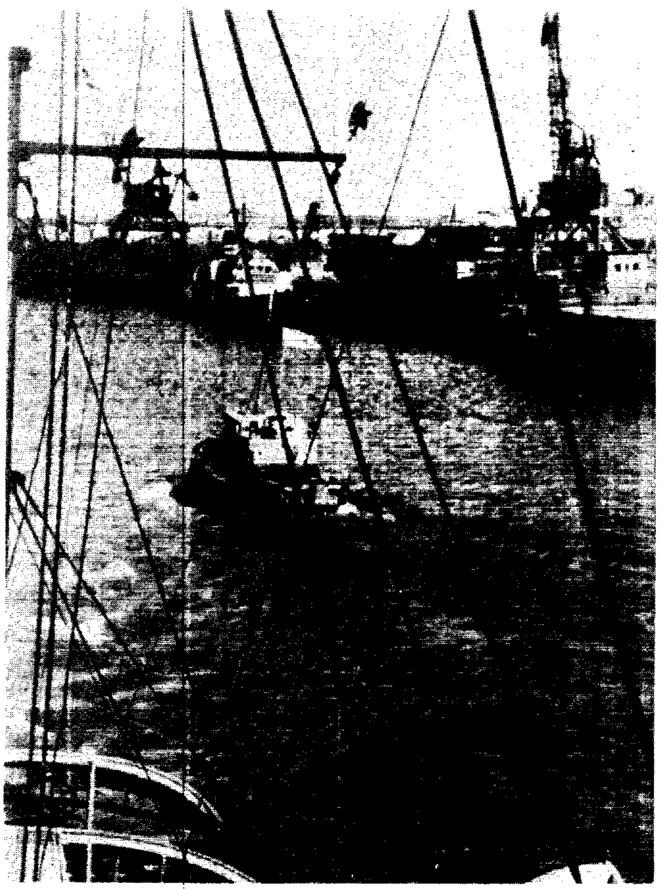

Figure 7. A part of the harbor complex at Dudinka.

development program, however, has been started, and the first stone building, a House of Culture, was being constructed as of 1957.

Dudinka, 134 miles (215 kilometers) downstream, functions primarily as the major outlet for the strategic minerals of Noril'sk. The port is equipped with cranes, conveyors, and numerous warehouses (Figure 7). It has considerable open storage area, and a tank farm is nearby. The streets of Dudinka are paved with stone and covered with asphalt. A busline connects the city with the railroad terminal in the suburbs. Most of the freight between Dudinka and Noril'sk is shipped over a narrow-gauge and a broad-gauge rail line. According to one report the broad-gauge line is being electrified; the section between Noril'sk and Kayerkan was to be finished in 1958 and the entire line by 1960. 7/ Large quantities of Noril'sk coal are shipped from Dudinka to Dikson, a bunkering station for the Northern Sea Route, and to other Arctic ports. During the navigation season on the Yenisey, freight and passenger service operates between Dudinka and Krasnoyarsk on the Trans-Siberian Railroad. In addition to the basic port activities, Dudinka also serves as the administrative center of the Taymyrskiy N.O. and includes regional and district offices, educational and medical facilities, and a number of other public and government buildings.

Noril'sk, with its exports of nickel, copper, and cobalt to industrial centers in various parts of the USSR, is the largest metallurgical center in the Soviet Arctic (Figure 8). The urban

Figure 8. Aerial view of Noril'sk, looking east. (1957)

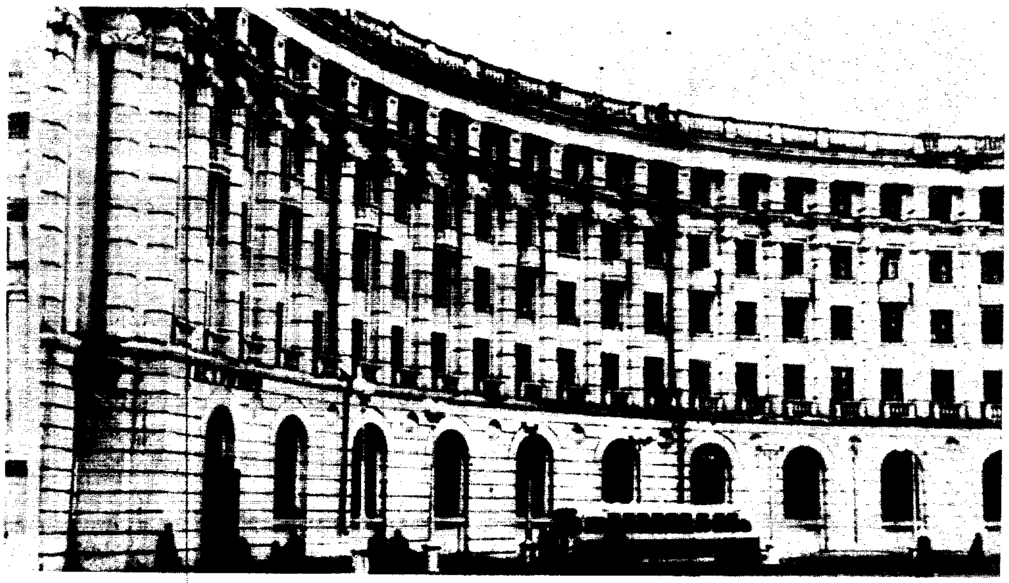

Figure 9. A multistoried building on Gvardeyskaya Ploshchad' in Noril'sk.

Figure 10. Apartment buildings in Gorstroy, a section of new apartment buildings in the northern part of Noril'sk.

area of Noril'sk is centered around the ore-concentrating plants, the nickel and copper refineries, and a number of repair and construction-materials plants, most of which have been developed since World War II. These plants have good rail and road connection with the nearby mines. Two powerplants, which operate on local coal, provide electric power for the industries and the city, as well as for distant Dudinka. Near the center of Noril'sk are a number of government offices, barracks, warehouses and other buildings (Figure 9). A new area of apartment buildings, Gorstroy, is located in the northern part of the city and houses much of the population (Figure 10). The Soviets plan to increase housing facilities further in 1959 through the construction of 2,300 apartments or of 695,000 square feet (65,000 square meters) of dwelling space.

Other minor populated places in the Yenisey Basin include Ust'-Port, a small fishing village, and Dikson, an important Northern Sea Route port (Figure 11). Bunkering facilities, a major airfield, a polar station, and an Arctic observatory are also located on Ostrov Dikson.

The population of the Ob' Basin is concentrated in Salekhard (18,000) and the adjacent settlements, such as Labytnangi. The population of Salekhard consists of Nentsy and Komi, as well as Russians, who predominate here as in most of the other principal settlements. The city serves as the administrative center for the Yamalo-Nenetskiy N.O. and has a number of cultural, educational, and medical facilities in addition to sawmills, fish canneries, and a leather factory. Salekhard also has storage facilities for fuel (coal and petroleum), equipment, and materials for the railroad, airfield, and local industry. The Seyda-Salekhard railroad serves the city, and river barges and ocean freighters call at the port. The port is under the administration of the Irtysh River Steamship Agency and during the 1958 navigation season handled approximately 1,150,000 tons of cargo (Figure 12). On the western shore of Obskaya Guba is Novyy Port, a small fishing settlement. According to one source the port is no longer used as a transshipment point for traffic on the Ob' River and has declined in importance. 8/

In the central part of the Siberian Arctic the population consists mainly of various indigenous nationalities who live mostly in small villages or on collectives along the Khatanga, Olenek, Lena, and other rivers or, occasionally, in scattered coastal areas (Figure 13). Most of the Russians are concentrated in a few large settlements, such as Khatanga and Tiksi, which are transshipment ports along the Northern Sea Route as well as sites of important airfields, telecommunications facilities, and polar stations.

Figure 11. New wooden houses in Dikson.

Figure 12. The port area of Salekhard. (1955)

Tiksi, near the estuary of the Lena River, is the principal settlement of the region. Since World War II, the port, adjacent air facilities, and the settlement have undergone considerable expansion (Figure 14). As in Dikson, an observatory of the Arctic and Antarctic Scientific Research Institute takes part in fleet planning and direction in cooperation with dispatchers and port workers. The observatory also participated in extensive scientific investigations of the Arctic during the International Geophysical Year.

With the development and expansion of mining activities in the upper Kolyma region, Ambarchik has become an important Arctic port despite certain site disadvantages. During World War II, lend-lease shipping was frequently routed here. Although the population of Ambarchik has been estimated at 15,000, this figure seems excessively high in view of its known facilities. 9/ Further development of Ambarchik will probably depend chiefly upon military considerations, since it could become a terminus of an important land-water route linking the Arctic Ocean with the Sea of Okhotsk at Magadan, thus bypassing the vulnerable Bering Strait.

Although the eastern Arctic accounts for only a small percentage of the total population, the intensification of mining and military activities since 1945 has resulted in the creation of a number of relatively new settlements -- notably Krasnoarmeyskoye, Iul'tin, and Egvekinot -- and the expansion of others, including Pevek, Mys Shmidta, and Provideniya. These developments have been paralleled by an increase in road construction and shipping activities within the area. At the mines in the Pevek-Krasnoarmeyskoye area and at Iul'tin, there are sizable concentrations of contract workers as well as some forced laborers.

Pevek, with a population of at least 1,000,* serves as the outlet for the extensive mining operations near Chaunskaya Guba. It has developed into an active port settlement that includes dwellings, a Soviet-established school, a hospital, and a club. In addition to port facilities, Pevek has wireless and radar stations, several repair shops, a powerplant, warehouses and petroleum storage tanks, and a number of GUSMP offices that operate the radio and polar stations, the port, and other public enterprises. Pevek is also the administrative center for Chaunskiy Rayon.

Egvekinot, located along the northern shore of Zaliv Kresta, has also become an active transshipment point for mining operations of the interior. As at Pevek, a large flow of construction and mining equipment as well as fuel and supplies passes through Egvekinot.

*PW population estimates range from 1,000 to 4,000.

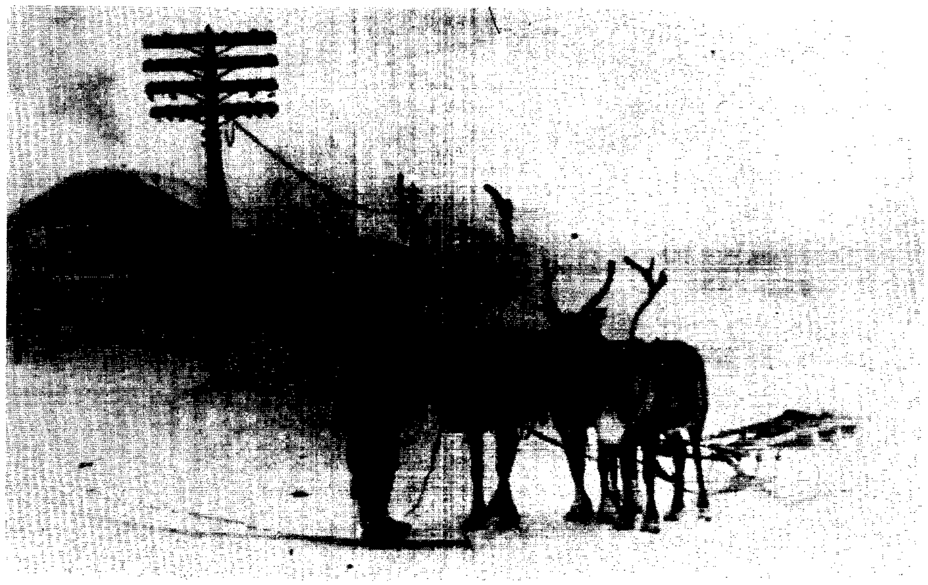

Figure 13. A Yakuti and his reindeer team in the settlement of Olenek on the coast of the Laptev Sea at the delta of the Olenek River. (1955)

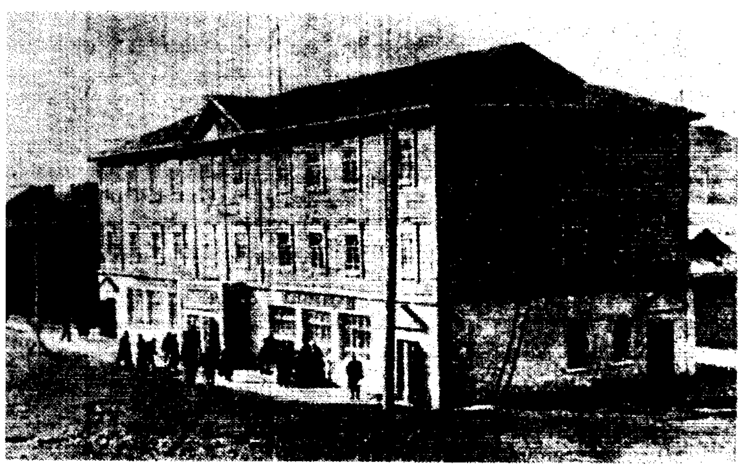

Figure 14. Three-storied Gosudarstvennyy Universal'nyy Magazin (GUM) or state department store in Tiksi. (1956)

Most of this material is transported by road to the mines at Iul'tin about 180 miles (290 kilometers) to the north. Tin and tungsten ore mined here is trucked to Egvekinot, where it is transferred to vessels and sent to refineries outside the Arctic. Several settlements have been noted along the Egvekinot-Iul'tin route. Little is known about the facilities at Egvekinot, except that they include a wooden pier, a meteorological station, and a nearby airfield.

Other settlements of the region have expanded greatly with the development of military establishments, chiefly airfields, along the coast of the Chukotsk Peninsula. Provideniya (4,500), 10/ on the southeastern coast of the peninsula, is the site of the largest military base in the area and one of the Soviet airfields nearest Alaska. The military base comprises over 600 buildings capable of accommodating an estimated 5,400 persons. 11/ The airfield has a permanent runway that was increased to 8,000 feet (2,440 meters) in 1954. The port of Provideniya is an important bunkering station and staging area for Northern Sea Route operations. During the navigation season, naval vessels operate out of Provideniya. The port also serves as a transshipment point for smaller settlements and installations along the coast. GUSMP and other government organizations maintain offices at Provideniya. Among the other small coastal settlements are Lavrentiya, Naukan, and Uelen.

C. Rural Population

In contrast to the predominantly urban population of the Arctic is the numerically small rural population, estimated at less than 150,000 and consisting chiefly of indigenes who represent numerous ethnic groups. The major racial groups -- Komi, Nentsy, Yakuty, and Chukchi -- have retained some degree of cultural unity through the formation of four national okrugs and two autonomous republics, which encompass most of the Soviet Arctic and parts of the sub-Arctic. These political-administrative divisions, however, are directly subordinate to the RSFSR and in reality provide the main racial groups with only a limited degree of autonomy.

The indigenes, like the Russians, are found largely along the river valleys where they have been settled either in small villages or on state or collective farms. Villages are usually located near the center of a kolkhoz and include a school, medical center, library, and club. Some villages are even electrified. In most villages, especially along the valleys, the people live in crude log houses. During the organized seasonal migrations of reindeer herds, the natives live in portable tents called *chums*, *yurtas*, or *yarangas*. In those coastal areas where fishing and pelagic hunting are the principal activities, many indigenes still live in tents. Many of the native villages, particularly on the Chukotsk Peninsula, are located in the vicinity of Russian settlements where the natives trade, occasionally engage in part-time employment, and avail themselves of Soviet-established educational and medical facilities. Occasional individual natives are selected for specialized training in Soviet institutions or, more frequently, receive political, technical, or some military training in the local Russian settlements.

In addition to reindeer herding, which is the principal occupation for most of the indigenes, many supplement their income by seasonal fishing, hunting, and trapping of fur-bearing animals. Despite Soviet educational, medical, and technical aid, the living standards of the indigenes remain low and their economy is near the subsistence level.

III. Economic Activities

A. General Characteristics

The economy of the Soviet Arctic is based principally on the extraction and processing of natural resources -- chiefly timber, minerals, fish, and furs. The construction of ships and food processing make up a smaller segment of the economy. (See Map 27361)

Most of the products of the Arctic are shipped from the area to foreign countries or to other parts of the Soviet Union. A large part of the lumber and other wood products are exported from Arkhangel'sk and Igarka to the United Kingdom, Netherlands, and Belgium. Large quantities of canned salmon, salted herring, and caviar are also shipped to Great Britain and other Western European countries. Minerals are used domestically, and the contribution of the Arctic to the national total is significant. In 1957, Noril'sk produced an estimated 18,000 tons of nickel and 50,000 tons of copper 12/; and the Pechora Basin produced 15,000,000 tons of coal.

The ship construction at Severodvinsk is the only fabricating industry of national importance. It contributes an estimated 7.5 percent of the combat-ship construction to the national total.

The products of herding and small-scale specialized farming are consumed within the region. The reindeer of the indigenes furnish meat, milk, and hides. Vegetables and fruits, frequently grown under glass, are sources of the antiscorbutic vitamins especially necessary in maintaining a balanced diet during the long winter period. Although the amount of food produced is a small part of the total for the nation, its local importance is significant.

The Soviet Arctic, together with the rest of the Soviet Union, has recently altered the organization and management of its industry, including construction. The change occurred in May 1957, when management was decentralized to the territorial level. At that time the country was divided into 105 economic-administrative regions, each headed by a sovnarkhoz (council of national economy). The Arctic includes the Murmansk, Arkhangel'sk, Komi, Tyumen, Krasnoyarsk, Yakutsk, and Magadan Sovnarkhozes; and the boundaries of these economic-administrative regions coincide with the corresponding administrative boundaries. The purpose of the reorganization was to remove bureaucratic "narrow-mindedness," cumbersome administrative apparatus, and poor organization of supply and marketing methods, and to improve the working conditions and efficiency of the scientific establishments and organizations serving industry. Apparently, however, the reorganization has had only partial success and in many instances has actually extended bureaucracy and increased mismanagement.

B. Wood Processing

The wood-processing industry of the Soviet Arctic is keyed largely to the production of lumber, with increasing emphasis on the output of wood-chemical, pulp and paper, and allied products. Big industrial combines -- including wood-processing, furniture, and prefabricated-housing factories -- have sprung up in the vicinity of large sawmills. Although the processed lumber supports important local construction, shipbuilding, and repair activities, it is chiefly a foreign-export item.

Most of the timber originates in the upper river basins of the sub-Arctic and is towed downstream in large sectional rafts to sawmills located at principal rail or water transportation terminals. Arkhangel'sk and Igarka, the leading sawmill and lumber export centers, obtain most of their timber from the forests along the Severnaya Dvina and in the upper Yenisey Basin. Logs are also rafted down the Mezen', Pechora, Ob', and Lena Rivers to the secondary lumber export centers of Mezen' (Figure 15), Nar'yan-Mar, Salekhard, and Tiksi. Log rafts are often

Figure 15. Lumber stacked on the shore and on the pontoon wharf at Mezen'. (1957)

damaged while moving downstream; and, in 1956, logs valued at 2,000,000 rubles were lost on the Lena River. Summer storms, fluctuations in water level, and poor handling techniques account for most of the losses. The summer losses occur largely because weather forecasts for a specific area are issued for 12-hour periods whereas the convoys often take more than 24 hours to pass through the area. Despite these limitations the rivers provide not only the most economical means of transporting timber but also the only means in most cases. Electricity provided by local powerplants is the chief source of energy for the wood industries. Although the wood industries employ a sizable labor force, the number of workers apparently varies with the seasonal supply of timber.

Arkhangel'sk produced 3.8 million cubic yards (2.9 million cubic meters) of coniferous lumber in 1955. In the same year the lumber exported amounted to 2.2 million cubic yards (1.7 million cubic meters) and represented 70 percent of the total Soviet lumber exports. It has been proposed that timber be exported from Arkhangel'sk on a year-round basis, using icebreakers to keep the White Sea open. At present, navigation in the White Sea is closed by ice from mid-November to mid-May. Since the southern part of the Barents Sea is ice free, European vessels would be able to call at Arkhangel'sk throughout the year. Four hundred foreign ships called there in 1957. 13/ Twenty-six sawmills 14/, 4 wood-processing plants, and 21 lumber and log-storage areas are located within Arkhangel'sk and its environs (Figure 16). 15/ The area is also the center of an expanding wood-chemical, pulp, and paper industry. Most of the mills and processing plants have good rail connection with nearby storage areas and piers (Figure 17).

The Kuznechevskiy mill, located north of Arkhangel'sk, is the largest sawmill in the USSR. It is equipped with 24 saw frames and employs over 1,000 workers. The waste products from the mill are used at the Arkhangel'sk pulp plant, Solombalskiy. Prefabricated houses, silos, and hothouse frames are also constructed in some of the local lumber mills. The Krasnyy Oktyabr' mill produces large numbers of prefabricated houses for lumber camps in the northern regions as well as for Arctic installations and settlements. Lumber, hothouse frames, and silo parts have been manufactured in Arkhangel'sk for use in regions as remote as the New Lands.

The Solombalskiy and the Voroshilov pulp plants are two of the most important in the Arkhangel'sk area. Both plants are served by their own heat and powerplants (TETS), which are a part of the Arkhangel'sk-Severodvinsk power network. The Voroshilov, located east of Isakogorka, is one of the largest pulp plants in the USSR. It produces pulp, newsprint, writing paper, and chemicals. In 1951, production was estimated at 250,000 metric tons of pulp, 90,000 metric tons of paper, and 16,000 metric tons of alcohol. 16/ The Solombalskiy plant supplies cellulose and pulp to explosive, plastics, and synthetic-fiber plants throughout the USSR and also makes brown wrapping paper, cardboard and soap (Figure 18). A large hydrolysis plant produces wood-chemicals, including xylose (wood sugar), ethyl alcohol, methyl alcohol, acetone, acetic acid, and turpentine. Several smaller cellulose and wood-chemical plants are also located in the area.

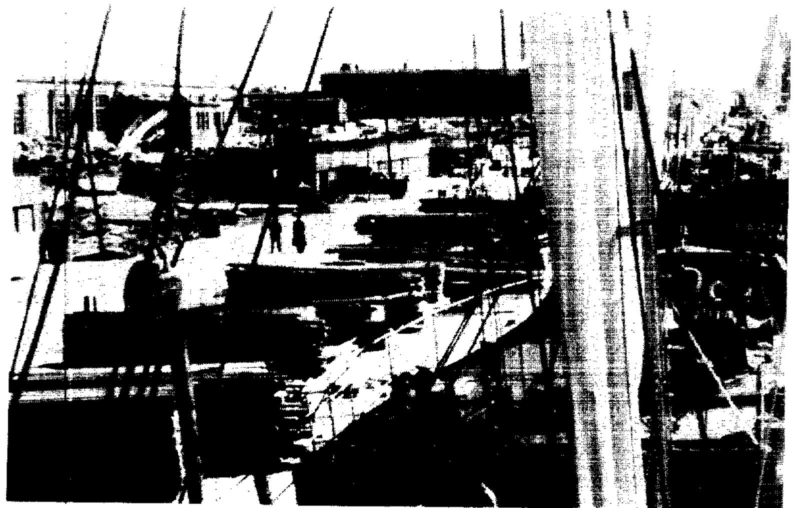

Figure 16. Lumber stacked at sawmill No. 3 on the Severnaya Dvina River, south of Arkhangel'sk. (1957)

Figure 17. Piles of lumber stored at Arkhangel'sk. (1957)

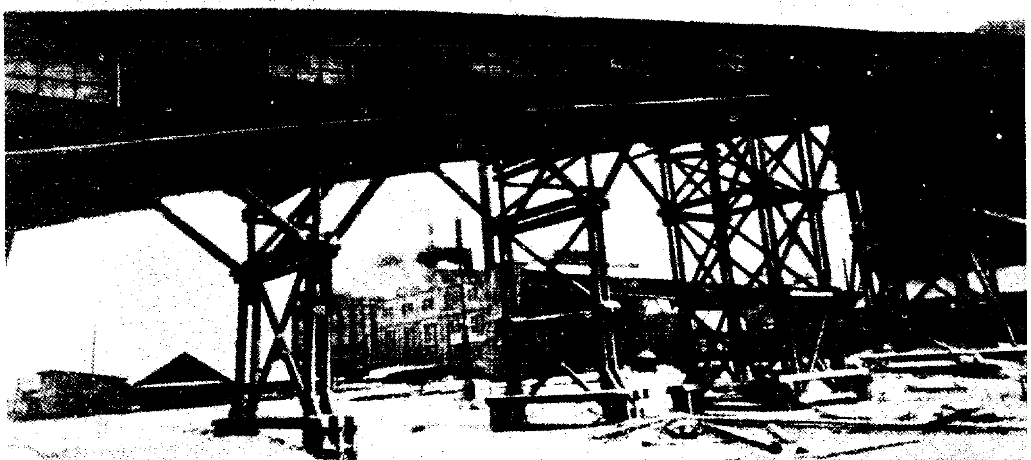

Figure 18. The Solombalskiy cellulose plant in Arkhangel'sk. (1958)

Igarka, the second largest sawmilling and lumber-export center in the Soviet Arctic is the site of a major lumber combine that includes 3 sawmills and extensive lumber yards. Rafts, which occasionally carry up to 44,500 cubic yards (35,000 cubic meters) of logs, are floated downstream to Igarka where they are stored, seasoned, and processed (Figure 19). A wooden wharf, with a total length of 2,100 feet (640 meters) can accommodate several vessels simultaneously. The lumber is hauled to the wharf by motorized fork-lift-type trucks, but it is transferred to the ships by their own gear because the wharf is not equipped with cranes (Figure 20). During the 1957 season, about 135,000 tons of timber were exported from Igarka by 50 foreign vessels. Most of these were of British, Norwegian, West German, Liberian, and Greek registry. Timber not exported is manufactured into prefabricated houses, furniture, other finished wood products, and wooden boxes and barrels for packing graphite and fish. Some timber is rafted beyond Igarka and is used in the sawmills at Dudinka and Noril'sk. Most of the products of these mills are used in local construction and mining activities.

Sawmills and associated industries are found in several other Arctic cities. Prefabricated houses are manufactured in Salekhard, and lumber is produced in neighboring Labytnangi. Logs for these mills arrive by rail from the Ural Mountains and by raft on the Ob' River. The several sawmills at Severodvinsk operate largely in support of local shipbuilding. Little is known of the wood-processing

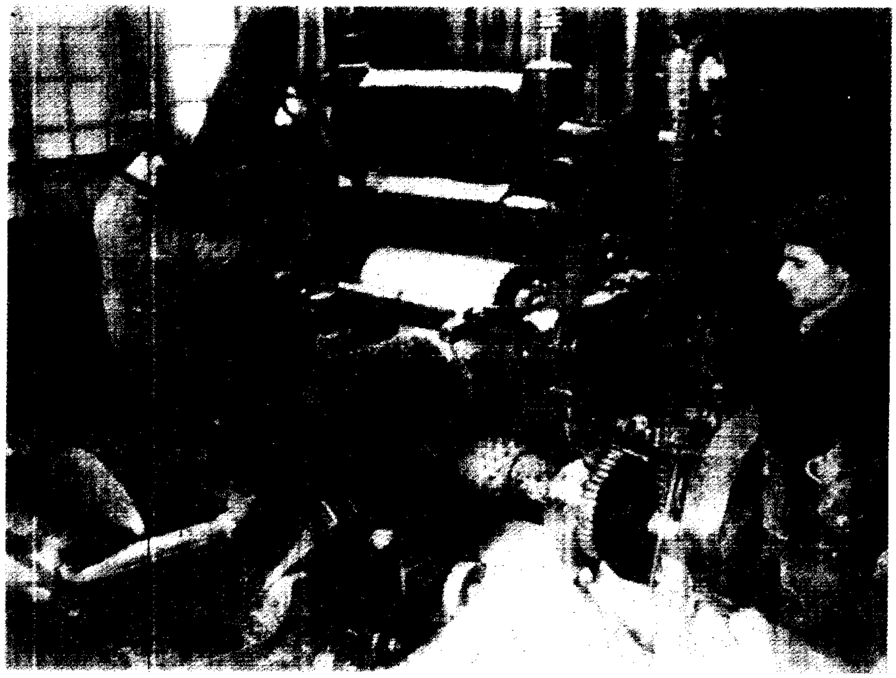

Figure 19. Milling operations at an Igarka sawmill.

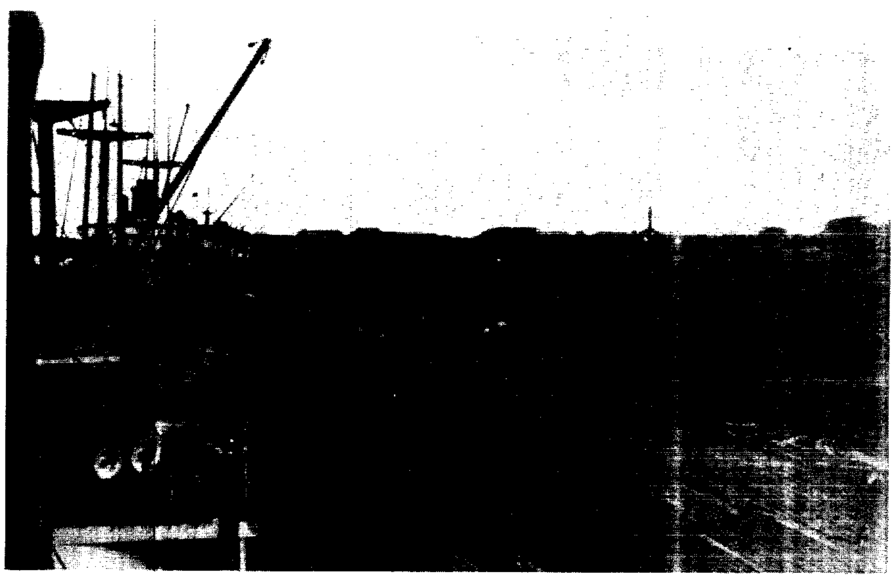

Figure 20. Freighters berthed at the lumber wharf in Igarka. Ramps connect the wharf with lumber storage areas on the top of the river bank. (1956)

industry at Murmansk; but a sawmill, plywood plant, prefabricated housing factory, and furniture factory are known to be in operation. A number of smaller sawmills have also been established throughout the Arctic -- notably at Vorkuta, Tiksi, Pevek, and Provideniya -- to support expanding construction and mining activities.

C. Fishing

The fishing industry of the Soviet Arctic comprises a large part of the region's economy and, in the Soviet Union, ranks second only to the Far East. Production is probably increasing and will continue to grow as the Northern Sea Route develops. At present the many small canneries along rivers in the Siberian Arctic process fish products for local consumption exclusively. Production in these canneries will probably increase greatly when better transportation to the populated centers in the south and west becomes available.

Research at ocean fishing grounds has been aided by the introduction of submarines. The research submarine Severyanka is equipped with windows, floodlights, and a television camera, and has been used to observe fish and their habitats regardless of weather or sea conditions. 17/ On its maiden voyage, the submarine made a 10-day cruise in the Barents Sea.

Cod, haddock, and herring make up the largest percentage of the total catch in the Arctic; and within the Arctic the Barents Sea is the largest producing area. Other species of commercial fish caught in the rivers and coastal waters include salmon, sea bass, and roach.

In the past, salting has been the most widespread method of preserving fish. Herring are still salted, and in many isolated areas this is the only practical method for preserving fish. Cod, haddock, and some salmon are canned, however, the percentage of the fish preserved in this manner has increased in recent years as the result of new cannery construction. The best grades are exported. Only a small percentage of the total catch is preserved by smoking or air drying. Dried fish is eaten by the native population and is used as dog food. Advances in sea and air transportation have made possible a wider distribution of fresh and frozen fish.

The length of the fishing season and the distribution of fish in the seas and rivers of the Soviet Arctic depends upon ice and climatic conditions. Ice cover on the seas and rivers during much of the year limits fishing to the summer season. Salmon and sturgeon, the most valuable river fish, do not appear in the rivers until after the spring breakup.

The southern half of the Barents Sea is not covered with pack ice because of the ameliorating effect of a branch of the Gulf Stream. Since this part of the sea remains ice free in winter, fishing fleets can operate without interruption throughout the year. Although herring, cod, haddock, and salmon are the principal species caught in the Barents Sea the warming of the water by the Gulf Stream has permitted the entry of numerous other species of fish. Cod, herring, mackerel, and haddock are found even along the western coast of Novaya Zemlya.

At sea the fish travel in schools near the surface when not feeding and are caught in large nets pulled by trawlers. When the fish feed, they move into coastal waters and estuaries, where they are caught in small nets -- often hand dip nets.

Murmansk is the most important fishing port and processing center in the entire Soviet Arctic. A fleet of 560 trawlers is based there and accounts for most of the fish taken in the Barents Sea (Figure 21). In addition to the trawlers, there are 14 floating canneries for processing fish (Figure 22). The catch amounted to nearly 500,000 tons in 1957, most of which was canned for export, chiefly to the United Kingdom.

Fish are brought into the port and processed the year round, since the trawler fleet is not restricted by winter ice. Several plants salt, can, and pickle the fish. The preparation of frozen fish, especially fillet of cod, has become important as a result of the development of rapid refrigerated transportation. Byproducts of fish processing include cod liver oil, vitamin A extracts, and fishmeal. Wooden barrels and tin cans are manufactured near most canneries.

Arkhangel'sk is an important fish processing center for the White Sea fishing fleet. Herring is the principal fish caught. Ice conditions in the White Sea limit the fishing season, and the canneries operate only 5 months during the year.

To the east of Barents Sea, fishing conditions rapidly become less favorable. Plankton is relatively abundant in these cold waters, but fish decrease both in number and species. In addition, the short ice-free season and the great distances from consuming centers limit the development of the fishing industry. Most fish are caught in river estuaries, and fishing collectives are found on all the major rivers. Part of the catch is canned for export, the remainder is smoked or air dried for local consumption.

Obskaya Guba is the second most important fishing area in the Soviet Arctic. The many factories around the bay can large amounts

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Figure 21. Trawlers of the Murmansk fishing fleet.

Figure 22. A floating fish cannery of the Murmansk fleet, with trawlers tied alongside the mother ship.

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of salmon, sturgeon, and whitefish. Products of the canneries reach the populated centers of the country via the Northern Sea Route and the Ob' River--Trans-Siberian Railroad network.

The slow-moving water of the estuary is rich in plankton and provides favorable feeding grounds for the fish as they move upstream to their spawning grounds. In addition to salmon, sturgeon, and whitefish, great numbers of pike and perch are caught. Salmon often weigh over 50 pounds (22 kilograms), and sturgeon may reach 200 to 250 pounds (90 to 112 kilograms). The fish reach great size since only a small portion are caught each year, and the remainder live to an old age.

A total of 10 fish-processing plants were scattered along the shores of Obskaya Guba in 1951, and several additional fish-packing plants are located along the shores of Tazovskaya Guba, an eastern extension of the bay. The Salekhard Canning Combine (Salekhardskiy Konservniy Kombinat) is the most important producer of fish products and includes plants at Kushevat, Shugin, Puyko, and Aksarka. The largest plant, which is in Salekhard, employed over 3,000 people in 1950. In 1946 the daily production of the combine amounted to 42,000 tins of fish. Salmon, sturgeon, and whitefish are canned, smoked, frozen, salted, and dried. Caviar is prepared from sturgeon roe. Waste products are converted into bone meal for fertilizer.

The delta of the Yenisey River north of Ust'-Port also supports a sizeable fish industry. The principal fish caught are three species of whitefish (Coregonus) -- sig, chir, and muksun. In 1955 the catch of sig and chir amounted to 424 tons and 24 tons, respectively; and in 1954 the muksun catch was 156 tons. The fish are procured with cast seine nets in the summer and with stationary nets during the remainder of the year. In winter the nets are placed under the ice. Fish too small to be processed in canneries such as that at Ust'-Port are used for dog food and as bait for white-fox traps. 18/

The Yenisey River upstream from the delta supports relatively few fish since the water is not rich in plankton and lacks protected spawning grounds. Fish that do live in the river grow slowly but reach great size. Salmon are canned and cod are salted at a small fish cannery and curing factory located on an island in the Yenisey near Dudinka.

A number of smaller canneries are scattered along the Arctic shore at various points, including Teriberka, Tazovskoye, Ust'-Port, Kazach'ye, and Ust'-Yansk. Their contribution to the total production of the Soviet Arctic is small. Most other villages along the coast and river deltas catch and process fish at least for their own consumption.

D. Shipbuilding

1. Extent of the Industry

The shipbuilding industry of the Soviet Arctic is keyed largely to the support of the Soviet Navy and the fishing industry of the region. In addition to outfitting and repairing ships of the Northern Sea Route and naval vessels of the Soviet Northern Fleet, the yards construct naval and fishing vessels. The majority of the yards are concentrated in the vicinity of Murmansk and Arkhangel'sk, which are connected by railroad with the principal industrial areas of the USSR. Direct year-round access to the open sea has been conducive to the expansion of shipbuilding and repair facilities within these areas. Although secondary and minor yards have sprung up in a number of ports along the Arctic coastline, the relatively short navigation season (except along the Kol'skiy Zaliv) and the lack of year-round supply routes preclude large-scale expansion of shipbuilding and repair activities elsewhere in the region.

Among the approximately 31 shipyards and boatyards in the Soviet Arctic, the most important are the Severodvinsk Shipyard Zavod Number 402 and the Rosta Naval Shipyard near Murmansk. These yards operate largely in support of the Soviet Northern Fleet; the former is the principal shipbuilding yard and the latter is the principal repair yard. The remaining shipbuilding and repair facilities in the Arctic consist of either secondary shipyards or minor boatyards. The secondary yards engage in the construction, maintenance, and repair of fishing vessels and patrol craft and perform limited repairs to ocean-going merchant vessels and naval ships up to destroyer size.

The shipyards in the Arkhangel'sk area include Isakogorka, Krasnaya Kuznitsa, and Morskoyflot as well as 5 smaller yards. Isakogorka does minor ship repairs. Krasnaya Kuznitsa overhauls submarines, merchant ships, and fishing craft; it has a graving dock that can accommodate 2 destroyer escorts simultaneously and 2 floating drydocks for destroyers [redacted] Morskoyflot shipyard repairs

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small destroyers, submarines, and commercial ships; its facilities include 2 installations that may be graving docks.

Shipyards in the Murmansk area, in addition to the Rosta Shipyard, include those at Murman-Ryba, Mys Khaldeyev, Chelnopushka, and 2 smaller yards. Murman-Ryba repairs fishing trawlers, utilizing 1 large and 2 small drydocks. Mys Khaldeyev builds and repairs local fishing vessels, and has facilities for constructing 12 ships simultaneously. Chelnopushka Shipyard, located in a small bay 5 miles (8 kilometers) northeast of Murmansk, has been constructed since World War II to take over small-repair work formerly done at Rosta. It has 2 floating drydocks 500 and 300 feet (152 and 91 meters) in length which can be joined to make one 800-foot (244-meter) drydock. The shipyard repairs submarines and destroyers and performs maintenance work on larger ships. 19/

Smaller boatyards, scattered throughout the region, are engaged chiefly in the construction and repair of fishing boats and barges and have limited repair facilities for small naval vessels only. In addition to those near Arkhangel'sk and Murmansk, yards are located at Nar'yan-Mar, Severomorsk, Polyarnyy, Iokanga, Mezen', Tiksi, and several other settlements. Although most of these yards have only limited equipment, they provide important construction, refueling, maintenance, and repair bases for river craft and fishing vessels operating in the region.

2. Severodvinsk Naval Yard, Zavod Number 402

The Severodvinsk Naval Yard, Zavod Number 402, is the largest and best equipped shipyard in the Soviet Arctic. It is located on the north side of the city along the Nikol'skoye Ust'ye (Estuary), a small inlet from the Dvinskaya Guba. A large ship basin is also located on Ostrov Yagry, an island forming the northern side of the harbor. The dockyard and associated shops are served by rail, water, and planked roadway and are equipped with electricity, heat, steam, and other utilities. Water access to the yard from the Dvinskaya Guba is through a dredged channel, 5 miles (8 kilometers) long and 180 feet (55 meters) wide. Rapid silting makes constant dredging necessary to maintain the 27- to 30-foot (8- to 9-meter) depths. Except in the severest winters, ice breakers are able to keep the harbor open to navigation most of the year. The bulk of the industrial materials, with the exception of lumber, arrives via a single-track railroad line that connects Severodvinsk with the Arkhangel'sk-Moscow trunkline at Isakogorka.

The yard has constructed tanker barges, submarines, destroyers, and 2 or possibly 3 cruisers. If an atomic-powered submarine were to be built, the covered construction docks of this shipyard would permit continuous construction with little danger of surveillance.

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The yard occupies an area of approximately 550 acres (220 hectares), with about 12,000 feet (3,660 meters) of water frontage. Facilities include (a) 2 covered graving-construction docks, each about 1,000 feet (305 meters) long and 150 feet (45 meters) wide and capable of building 4 destroyers simultaneously; (b) 2 transverse building ways; (c) a large transverse shipbuilding site for smaller vessels; and (d) a ship assembly shop 350 feet (107 meters) long and 80 feet (24 meters) wide for the construction of subchasers and small craft. Each graving-construction dock is served by a 25-ton and a 100-ton electric gantry crane and several lighter cranes. Since these docks and the ship assembly shop are covered, the shipyard is capable of year-round operations. Included in the yard are large multisectional plate, prefabrication, fabrication, and ship-assembly shops; a number of foundry, forge, and machine shops; a boiler shop; pipe and joiner shops; and extensive storage facilities. The Severodvinsk municipal powerplant supplies electric power to the yard and to the city as well as to part of Arkhangel'sk.

3. Rosta Naval Shipyard (Sevmorput)

The Rosta Naval Shipyard is located about 2.5 miles (4 kilometers) north of Murmansk and is the principal shipyard and supply depot of
25X1 the Soviet Northern Fleet [redacted] It has a total area of 80 acres

[redacted] 25X1

(32 hectares) and extends for about 3,000 feet (915 meters) along the eastern shore of Kol'skiy Zaliv. The shipyard is readily accessible from Murmansk by water, road, and an electrified railroad line. Most

of the materials and equipment for the shipyard arrive by railroad from the Leningrad and Moscow areas. Rosta has 2 graving docks 800 and 420 feet (244 and 128 meters) in length. In addition, there are 3 repair wharves that can accommodate the largest ships of the fleet. The wharves and graving docks are served by 7 cranes.

Some 60 barracks for naval personnel, several headquarters-type buildings, and a number of supply warehouses have been identified in the southeastern part of the dockyard. About 30 buildings believed to be used as quarters for civilian workers are also located in the vicinity. Current employment is estimated at 5,000 to 6,000 workers.

E. Mining

1. Mineral Resources

Minerals found in the Arctic region contribute significantly to the total mineral production of the Soviet Union. Nickel, copper, cobalt, tin, uranium, and coal are among the more important minerals; antimony, tungsten, platinum, gold, silver, and oil are also found. Although many of the mineral deposits of the Arctic are remote from consuming areas, transportation is not a prohibitive factor if the need for the mineral warrants its exploitation. The increasing need for nickel and copper prompted the development of the Noril'sk mines in western Siberia. The coal mines at Vorkuta are over 1,400 miles (2,250 kilometers) from Leningrad, but the urgency of the demand during World War II prompted their development. Uranium ore has been flown from distant mining centers to refineries in the interior of the country. The Kotlas-Vorkuta railroad, which connects the coal fields with the Leningrad rail lines, was completed in 2 years at a terrific cost in human lives. Nonstrategic minerals, such as rock salt and many ores of relatively low strategic importance, are delivered by ocean freighter, and their deposits have been less rapidly exploited.

The search for mineral deposits in the Soviet Arctic is carried out by the Scientific Research Institute for Geology of the Arctic (NIIGA) of the Ministry of Geology and Conservation of Mineral Resources, Leningrad. Every year, prospecting parties are sent into the field throughout the Arctic mainland and islands. Field parties usually begin work in April or May and return to Leningrad in September or October. A variety of transportation -- including aircraft, river boats, reindeer and dog teams -- is utilized to deliver the personnel, food, machinery, explosives and other equipment. Field parties of up to 80 people, including NIIGA geologists and technicians as well as indigenous natives, operate from expedition bases such as Khatanga, Tiksi, and Igarka. Surface and subsurface geology is mapped, drill cores are obtained, and test trenches are dug during the short summer season. The parties return to Leningrad with their field notes and samples at the end of the season, but small groups are often left at the prospecting sites during the winter.

Numerous mineral deposits have been discovered by NIIGA expeditions. Rare minerals, including columbium, lanthanum, and cerium, were found by the Kyndyn expedition; garnet and emerald deposits were found by the Biretka expedition; and chromium was discovered on Ostrova Izvestiy TsIK; west of the Taymyr Peninsula.

2. Major Deposits

Mineral production is centered in four major areas: Noril'sk (nickel, copper, cobalt, coal); Nikel' (nickel, copper, cobalt); Vorkuta (coal); and Pevek (tin, tungsten, gold).

a. Noril'sk

Metal refining and its associated industries have made the Noril'sk Mining and Metallurgical Combine the largest center of heavy industry in the Soviet Arctic (Figure 25). The mineral deposits

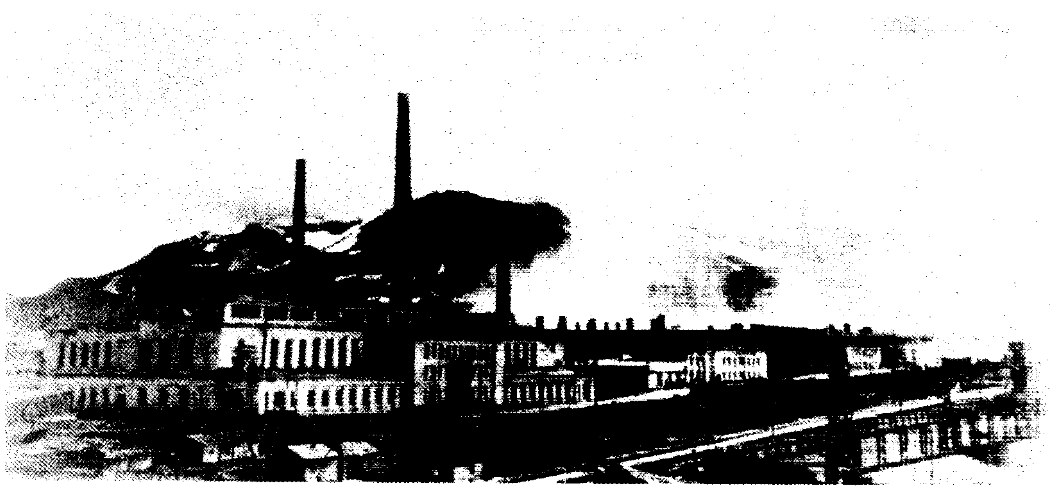

Figure 25. A part of the industrial complex in Noril'sk. The large building in the foreground is believed to be the locomotive repair shop. (1957)

were discovered in the late 1930's and large-scale mining operations began during World War II. The principal minerals are nickel, copper, cobalt, and coal; smaller amounts of silver, gold, platinum, and iron are also found. Metal production in 1957 was estimated as follows: copper 50,000 tons, nickel 18,000 tons, and cobalt 270 tons. Ore reserves have been estimated at 720,000 tons of copper, 200,000 of nickel, and 13,500 of cobalt. 20/

The Noril'sk ore contains 0.47 to 0.6 percent copper, 0.31 to 0.9 percent nickel, 0.1 percent cobalt, and smaller amounts of other metals. It is mined in the hills south and southwest of the city. Since the ore bodies are only 130 feet (40 meters) below the surface, open pit mining as well as underground methods are used (Figure 26). The ore is hauled by broad- and narrow-gauge railroads to concentrating plants where it is crushed, separated by selective flotation, and cencentrated. The copper and nickel ores are smelted, cast into electrodes, and electrolytically refined to pure metal (Figure 27). Cobalt and selenium are extracted as byproducts of the refining process. Platinum also is recovered during the refining, 2 grams of platinum being obtained from every ton of ore. The platinum concentrate is further processed to obtain palladium, osmium, irridium, and ruthenium. Platinum production began in 1940-41, and by 1947 Noril'sk produced 80,000 to 85,000 fine ounces a year or 30 percent of the Soviet output. Ferro-chromium and tellurium are also produced at the Noril'sk Mining and Metallurgical Combine.

Several industries are operated to support the refining operations. A coking plant prepares Noril'sk coal for use in roasting the ore. About 192,000 tons of coke were produced in 1955. The byproducts -- coal tar and coal gas -- are consumed in Noril'sk. Two thermalelectric powerplants located within the city supply power for electrolytic refining and for other industrial uses. The same installations furnish electricity, water, and steam heat to the city.

Both bituminous and anthracite coal are found in the Noril'sk area and enable the city not only to satisfy its own needs but also to ship large quantities to Dudinka. According to schedule, 2 million tons of coal are to be produced in 1959. Thirteen anthracite mines are located in the hills north and northeast of Noril'sk. The coal is in veins 13 to 16 feet (4 to 5 meters) thick and is produced at a rate of 2,000 tons per day. Numerous bituminous deposits of coking quality are scattered along both sides of Shmidt Gora (Mountain). Mines have also been reported at Kayerkan on the Noril'sk-Dudinka railroad about 19 miles (30 kilometers) west of Noril'sk. Only one mine in this area was worked in 1952, and it produced 2,400 tons a day.

Oil shale is also used as a fuel and is burned without prior processing. It is found in large, thick lenses in the poorer quality coal formations.

Other industrial installations associated with mineral refining include sulphuric- and hydrochloric-acid plants, a plant for manufacturing rubber-coating for lining pipes and barrels, brick factories, and a cement plant.

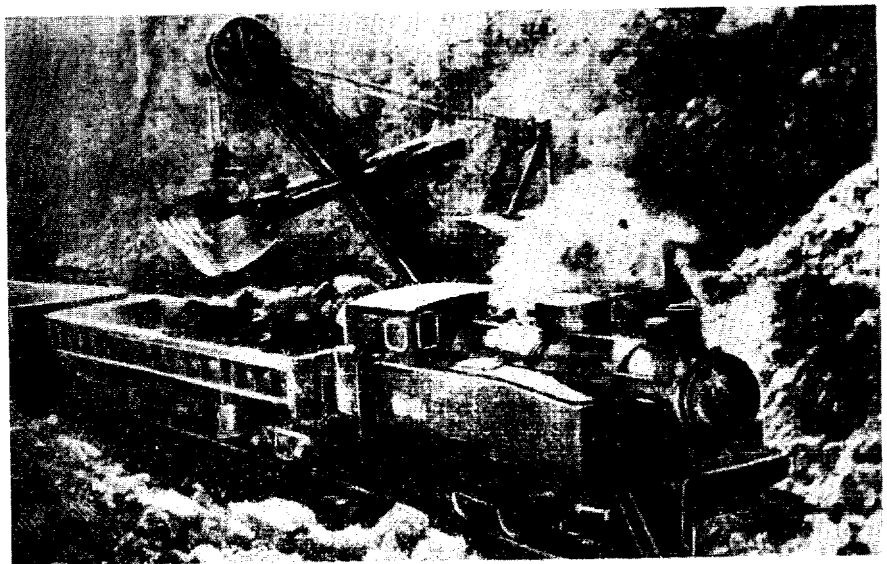

Figure 26. Loading ore on gondola cars at the strip mine near Noril'sk.

Figure 27. Interior of the electrolytic refinery of the Noril'sk nickel combine. (1956)

A heavy-water plant is reportedly located at Noril'sk, in the northeastern part of the city near one of the thermal powerplants. It consists of 6 buildings and 2 steel towers. 21/

Iron mines located near Noril'sk include one on Shmidt Gora, another north of the Noril'sk-Dudinka railroad and several 75 miles (120 kilometers) east of the city. 22/ Iron ore production is minor and is probably limited in use to local iron-foundry operations.

Small amounts of gold are produced at Noril'sk. The metal is recovered as a byproduct of nickel-copper refining and by dredging Ozero (Lake) Pyasino. A factor contributing to the small production from the lake is the short ice-free season.

b. Nikel'

The Pechenganikel Combine at Nikel' in the northwestern part of the Kola Peninsula produces nickel, copper and minute quantities of cobalt (Figure 28). When the mines were under Finnish jurisdiction they had an annual capacity of 10,000 tons of nickel contained in matte. Production has undoubtedly risen since then and may now be as high as 12,000 tons. The nickel-copper matte produced in the smelter is shipped by rail to Monchegorsk for electrolytic refining. The probability that Nikel' now has a refinery is indicated by the recent development of hydroelectric power in the area. Such a development would allow a great part of the matte produced by the smelter to be refined at Nikel'.

The mines are located in a mineralized zone southeast and east of Nikel', the original mine being southeast of the settlement. The ores contain 1.0 to 3.5 percent nickel and 1 to 2 percent copper. A new mining area, called Zapolyarnyy, is being developed about 12 miles (20 kilometers) east of Nikel' and will be operated by open-cast methods. Zapolyarnyy will no doubt replace the old mine, but the ore is of a lower grade, averaging 1 percent nickel. A high voltage powerline has been completed and an ore-processing plant is to be constructed along side it. 23/

c. Vorkuta

The Vorkuta area in the northeastern part of the European Arctic is the largest coal-mining center in the Soviet Arctic and produced an estimated 11,000,000 tons of coal in 1956 (Figure 29). Much of the coal is of coking quality and is expected to play a large role not only in the continued industrialization of Leningrad but also in the development of the Far North.

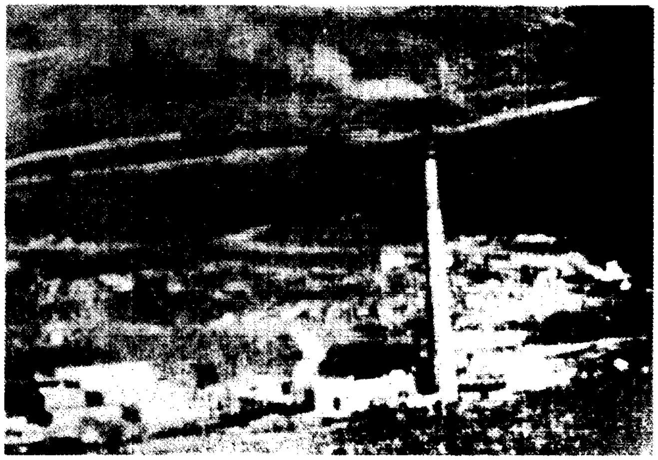

Figure 28. Buildings of the smelting and refining complex at Nikel'. (1956)

Figure 29. Vorkuta, the largest coal-mining center in the Soviet Arctic. On the left is a thermalelectric power-plant, and in the distance at the right is a mine and a pile of tailings. (1957)

Twenty-four mines were reported in Vorkuta in 1957. 24/ They are located north and west of the city, and most are of shaft type. Although the majority of the mines are mechanized, some cars are probably loaded by hand. The quality of Vorkuta deposits varies from lignite to bituminous. Coal of coking quality is also found here, but it is sent to industrial centers to be processed.

Coal is produced at several other places in the Vorkuta area. Khal'mer-Yu, 37 miles (60 kilometers) northeast of Vorkuta, has high-quality coking coal. Coal is also mined at Khanovey, 12 miles (20 kilometers) east of the city; at Abez and Inta, to the south of it, lignite is mined.

Several minerals including chromium, iron, gold, manganese, platinum, and uranium have been found north and east of Vorkuta but the present status of their exploitation is unknown.

d. Pevek

Mineral exploitation in the Pevek area is found in a broad zone surrounding Chaunskaya Guba in eastern Siberia. Geological exploration started in the 1930's, and mining operations began in 1948. The mines at present are important producers of tin. In addition, tungsten, copper, lead, zinc, platinum, silver, gold, and uranium are also produced in small quantities. It is possible that mining of the uranium ore has been abandoned in favor of more accessible deposits elsewhere in the Soviet Union. The ores produced at Pevek are graded and barreled for export since the isolated position and lack of a fuel base indicate that the construction of a refinery might be uneconomic. The ores are stockpiled in the winter and shipped out during the navigation season. Over 900 tons of tin ore and about 12 tons of tungsten ore were shipped from Pevek in 1957.

Mining is concentrated at several places near Pevek. Mt. Yandra-Paken, at the northern tip of Pevek Peninsula, contains deposits of tin and gold. The tin ore is found in thin seams several thousand meters in length and has a low metal content. Elsewhere on Pevek Peninsula, copper, lead, and zinc are found. The mountainous area 31 miles (50 kilometers) northeast of the peninsula contains shallow uranium mines, which were developed before World War II and were operated by hand labor. The valley of the Kuyveyem River along the eastern slopes of the mountains also has deposits of uranium and tin. The ore is found in alluvial deposits along the river and in veins in the surrounding hills. The largest mining area is 50 miles (80 kilometers) east-southeast of Pevek at Krasnoarmeyskoye, where more than 20 open-pit and shaft mines produce tin, tungsten, silver, and possibly uranium. 25/ Small amounts of tungsten, gold, silver, and platinum, are produced south of Krasnoarmeyskoye.

One of the newest mining areas near Pevek is located at Bilibino on a tributary of the Malyy Anyuy River southwest of Chaunskaya Guba. Equipment including a diesel-electric power unit and mining machinery was sent by tractor train to Bilibino to develop the gold deposit in the river. 26/

Prospecting for gold has been in active progress in the Pevek area for the past several years. Gold was found in the Ichuveyem River south of Pevek in 1956, and a placer mine was to start operation in 1957. In the Chaunskaya Guba area, prospecting parties have also been active on Ostrov Ayon, and on the Rauchevan, Gyrgychan, and Ichuveyem Rivers.

3. Minor Deposits

The minor mineral deposits of the Soviet Arctic are relatively small and include fluorspar at Amderma, oil in the Nordvik-Khatangskiy Zaliv area, iron ore near Murmansk, and tungsten and tin in northeastern Siberia.

a. Amderma

One of the largest fluorspar deposits in the USSR is found near the Amderma River at the settlement of Amderma. The ore body consists of 10 beds that cover 7 square miles (18 square kilometers) and contain veins up to 26 feet (8 meters) thick. The isolated far-northern position in the European Arctic and resultant high production costs have probably caused the mining operations to shut down. Since Amderma was a major producer of fluorspar, cessation of operations may be only temporary.

b. Nordvik-Khatangskiy Zaliv

The Nordvik-Khatangskiy Zaliv area is an oil-bearing region on the southeastern edge of the Taymyr Peninsula. Exploration began in 1935 and probably continued until 1953. During the exploration, more than 250 wells were drilled (Figure 30). The oil is found on the flanks of large salt domes. The first well struck oil strata at 2,000 feet (610 meters), and other wells were drilled at 6,000 feet (1,830 meters). The highest grade of oil, however, was found at 1,000 feet (305 meters). Most of the oil in this area is a sulfurous naphthenic base oil containing paraffin wax. In recent years, no information has been available on the region, and it is probable that prospecting and drilling have stopped.

The first area of exploration was on the Yurung-Tumus Peninsula near Nordvik. The oil flowed at a rate of 5 barrels a day. Exploration later shifted to the southwest, in the Bukhta Kozhevnikova area, and

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several refineries, apparently of the small pot-still type, were built on the north shore of the bay to process the oil. 27/ There are also known oil deposits at several other places in the Nordvik-Khatangskiy Zaliv area, including Ostrov Begicheva, the lower Anabar River, and the northwestern coast of Khatangskiy Zaliv.

Other minerals of the Nordvik-Khatangskiy Zaliv area include coal, salt, gypsum, and copper-nickel ore. Coal is produced in small amounts and used locally. At Bukhta Kozhevnikova, the coal varies in quality from lignite to bituminous and is produced from shaft mines 65 to 98 feet (20 to 30 meters) deep. Coal also outcrops in the hills at the confluence of the Khatanga and Khabydar Rivers. Ostrov Begicheva contains beds of bituminous coal 3 feet (1 meter) thick but they are probably not worked. At Nordvik, lignite is mined from open pits. A lignite bed at Bukhta Kulb'cha on the eastern shore of Khatangskiy Zaliv has been burning since 1932.

The salt dome south of Nordvik on the Yurung-Tumus Peninsula is an important source of rock salt (Figure 31). The deposits are 6,000 to 8,000 feet (1,830 to 2,440 meters) thick, and producing shafts were working at the 300-foot (91-meter) level in 1947. In that year, 100,000 tons of salt were produced. Since it contained little foreign matter, the salt was shipped directly from the mines to fish-processing plants along the Arctic Coast. No recent information is available on the status of production.

The gypsum deposits south of Bukhta Kozhevnikova near the settlement of Kozhevnikovo provide stone that is used locally for house construction. Sulfide ores containing copper and nickel are found near the confluence of the Khatanga and Kheta Rivers. The deposits, which are believed to be the eastern end of the Noril'sk ore body, have probably not been exploited. In 1944, diamonds were found near the town of Khatanga. An expedition was sent from Moscow to explore for other deposits, but the results were negative. A recent Soviet map indicates the presence of diamond-bearing deposits southwest of Khatanga; the stones found in 1944 were probably washed from this deposit. 28/

c. Murmansk

Iron ore deposits are found along the north coast of the Kola Peninsula near Murmansk. The ore bodies are lens shaped and contain 30 to 40 percent iron. Reserves of the area are estimated at from 60 to 100 million tons. The ore is found in two broad strips that extend from Kol'skiy Zaliv westward to the Norwegian border. 29/ The first strip is 4 to 6 miles (6 to 10 kilometers) wide and closely parallels the coast. The largest deposit is at Bolshaya Zapadnaya Litsa 40 miles (65 kilometers) northwest of Murmansk, where ore pockets

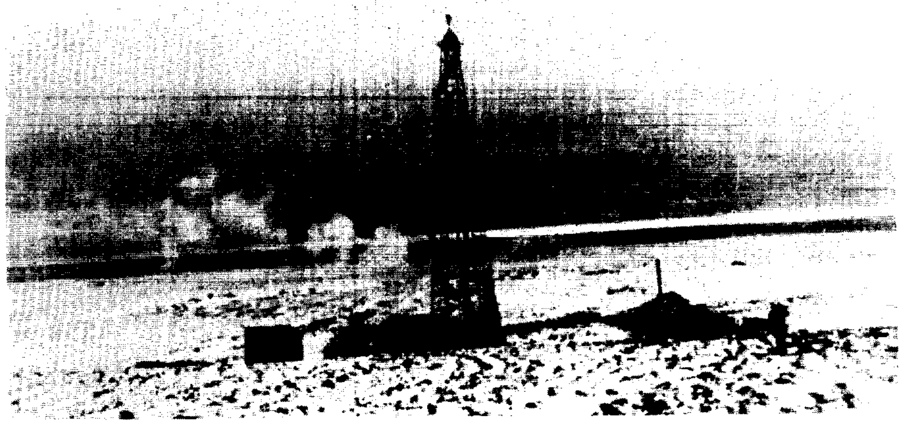

Figure 30. An oil derrick at Nordvik.

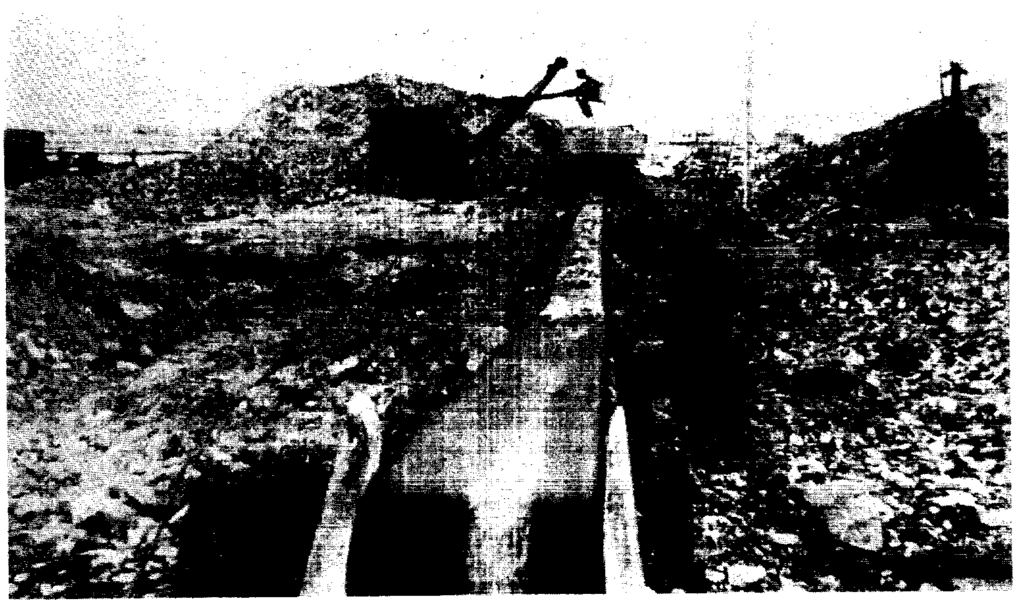

Figure 31. Mining operations at the salt dome in the Yurung-Tumus Peninsula.

are 1 to 2 miles (2 to 3 kilometers) in length. The second strip is discontinuous and lies 25 to 30 miles (40 to 50 kilometers) farther south.

The deposits apparently are not worked at present because of the presence of larger ore bodies in the central and southern Kola Peninsula. The deposits, located south of the study area, include Olenegorsk, Kovdorsk, Afrikanda, and Kirovogorsk and contain reserves of ore totaling nearly 900 million tons.

d. Iul'tin

The ore deposit on the western edge of the Chukotsk Peninsula north of the junction of the Chaantal'vegyrgyn and Amguyema Rivers appears to be an important source of tin and tungsten. The deposit was discovered in 1936, and exploration began the same year. The settlement of Iul'tin subsequently grew up nearby. World War II provided the impetus for a rapid expansion of mining operations. To facilitate the export of ore, a road was built from Iul'tin south to the port of Egvekinot. The port, located on Zaliv Kresta on the southern coast of the Chukotsk Peninsula, has a longer ice-free season than those along the northern coast. Bulldozers, steam boilers, air compressors, and pumps are shipped to Egvekinot and trucked from there to the mines at Iul'tin. Since diesel engines and electric equipment have been sent to Iul'tin, it is probable that electric power is generated there and that the mines are now mechanized.

Large deposits of tin have been found at Pyrkakai, about halfway between Pevek and Iul'tin. They occur as placer deposits and are estimated to contain 300,000 to 500,000 tons of ore. The present status of the deposits is unknown, but they are probably not being worked.

4. Additional Deposits

In the major ore producing areas of the Soviet Arctic several minerals are characteristically found in combination. A few minerals of strategic importance, however, including uranium, coal, and oil, occur in isolated deposits scattered throughout the region.

Uranium is in particularly high demand because of its many uses in times of both peace and war and has been searched for in a number of places. The Soviets were actively interested in deposits in the Arctic until 1953; but, with the development of southern deposits such as Krivoy Rog, Pyatogorsk, and the Fergana Valley, the Arctic sites were probably abandoned. Deposits have reportedly been found near Iokanga on the coast of the Kola Peninsula 186 miles (300 kilometers) southeast of Murmansk. Uranium is also found on Novaya

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Zemlya, but the deposits are probably not worth exploiting. Another deposit, 37 miles (60 kilometers) east of Vorkuta in the Polyarnyy Ural, is reportedly being worked. 30/ Although uranium has been reported on Ostrov Komsomolets in Severnaya Zemlya, it is doubtful if the deposits are workable. In 1946, ores were discovered at Mys Chelyuskin on the shore of Proliv Vil'kitskogo, but it is not known whether they are being worked at present. On Zaliv Lavrentiya at the eastern end of the Chukotsk Peninsula, uranium mines have been reported, but production, if any, is unknown.

Deposits of coal are scattered throughout the Soviet Arctic and serve as actual and potential fuel bases for the settlements. Except for the major fields at Vorkuta and Noril'sk the deposits are small, and they vary in quality. In most cases the deposits are actively worked to meet the local need for fuel. Mines 12 miles (20 kilometers) northeast of Murmansk produce 800 tons per day and supply a part of the city's coal requirements. Three surface mines on Novaya Zemlya are worked by hand labor and the coal is consumed locally.

Boghead coal is mined on the lower Olenek River and is used locally as a fuel. It is also refined to yield kerosene, benzine, and lubricating oils. Low-quality bituminous and small amounts of anthracite coal are mined in the bluffs along the Lena near Bulun. This coal is used locally for heating, bunkering fuel for the Lena River fleet being obtained from Sangar farther south.

A part of the coal supply of Tiksi is mined northwest and south of the town, but much of the coal used there comes from Sangar. Since the local coal is of glacial alluvial origin, the beds are thick (45 feet or 14 meters) and the moisture content is high. Mining operations at Tiksi began in 1945 and, by 1957 the coal shipments to nearby consumers exceeded 9,000 tons.

Although numerous coal deposits have been discovered in other parts of the Arctic, they have not as yet been worked because of their isolated position or small size. Seams in Zemlya Frantsa-Iosifa are 10 feet (3 meters) thick. A large anthracite field, reportedly covering 32,000 square miles (83,000 square kilometers) is centered south of Salekhard. Coal has also been found at Dudinka on the Yenisey, at Dikson, on the Yamal Peninsula west of Obskaya Guva, and in the lower and upper courses of the Pyasina River, where vast deposits are reported. On Ostrov Kotel'nyy in the Novosibirskiye Ostrova, coal deposits have been found in the vicinity of Guba Nerpich'ya and Guba Reshetnikova, and outcrops of coal occur on Ostrov Bennett in the Ostrova De-Longa. Other known deposits are located in the Chukotsk Peninsula at Mechigmenskaya Guba, north of Provideniya, and at Mys Serdtse-Kamen'.

Many settlements in the central and eastern Arctic are supplied with coal from 3 mines south of the study area. The mine at Kotuy, in the Evenkiyskiy N.O. apparently was scheduled to produce between 25,000 and 30,000 tons of coal in 1958. Coal from Kotuy was sent to Nordvik, Khatanga and other settlements on Khatangskiy Zaliv in 1957. The mine at Beringovskiy south of Anadyr' supplies coal to settlements on the coast of the Bering, Chukotsk, and East Siberian Seas. Planned production of coal for 1958 was 145,000 tons, with a minimum goal of 130,000 tons. The largest quantities of coal were sent to Provideniya (45,600 tons), Egvekinot (41,770 tons), and Pevek (20,200 tons).

Oil deposits other than those in the Nordvik-Khatangskiy Zaliv field are small in size and are concentrated in the western Arctic. They could serve as future fuel bases for ships of the Northern Sea Route, but at present the deposits remain undeveloped in favor of larger fields to the south. Oil seeps have been discovered near Zaliv Inostrantsev in Novaya Zemlya, but large accumulations of oil are unlikely because of the poor holding capacity of the rock. Oil has also been found in Zemlya Frantsa-Iosifa. In the lower Yenisey area, seepage and prospecting have indicated that oil deposits extend from Turukhansk north to the estuary of the river. The largest area of exploitation is at Ust'-Port, where many wells have been drilled. According to reports, however, operations at Ust'-Port were terminated in 1946. 31/

F. Herding

Reindeer herding is the principal occupation of the native population of the Soviet Arctic. Reindeer provide meat, hides, and milk for the natives, whose economy is at a near-subsistence level. Leather and preserved meat are exported in small quantities. Raising fur animals, fishing, and hunting are among the other occupations of the natives. Pelts are the only products of these minor activities that reach outside markets. There are about 2 million reindeer in the Soviet Union and about 300 to 400 thousand caribou or wild reindeer. In recent years the reindeer herds in the Siberian Arctic have increased, whereas the European herds have decreased -- a result of an expanding market in Siberia and depletion of pastures in Europe.

The nomadic herding tribes of the Arctic were collectivized in the 1930's. The resulting kolkhozes and sovkhozes cover large areas because vegetation in the pastures is scant and food requirements for the reindeer are great. One reindeer requires from 100 to 170 acres (40 to 70 hectares) of pasture during the year. 32, p. 21/ Kharp Kolkhoz in the Nenetskiy N.O. covers 3,860 square miles (10,000 square kilometers). The largest collective is the Kirov Kolkhoz, which includes 11,500 square miles (29,900 square kilometers) in an irregular area between Yeniseyskiy Zaliv and the Pyasina River. 33/ A kolkhoz herd may include up to 16,000 reindeer. In addition to these collectives, there are breeding and experimental stations for improving the quality of the herds.

One of the most important results of collectivization of the nomadic tribes has been the settling of people in villages. Formerly the entire tribe moved with the reindeer herds, but now only the herdsman and his immediate family migrate seasonally. Villages are usually found near the center of the kolkhoz area.

Tents are now used only during the migrations. Although pre-fabricated huts have been designed by the Scientific Research Institute of Agriculture of the Far North, they have not as yet been used in the tundra. In some parts of the Arctic, small groups of houses have been built along the routes and serve as temporary shelters during the migration.

The herdsman is paid wages in the form of meat, reindeer, or money according to the amount of labor furnished to the kolkhoz. When paid in reindeer, the animals are added to the family's private herd. Each family is allowed to own 250 reindeer. Annual wages of a herdsman are reported to average 8,000 to 15,000 rubles.

Supplementary activities of the herders change with the seasons. During the summer, when the reindeer are driven north, the herdsmen fish and hunt for birds in the numerous tundra lakes. In winter, when the herds are pastured in the south, the natives hunt and trap fur-bearing animals. During the 4-month trapping season of 1951-52, one hunter's catch in the Nenetskiy N.O. amounted to 30,000 rubles.

Many reindeer kolkhozes have organized fur farms and raise silver and blue fox (Figure 32). Both of these have been bred from the native

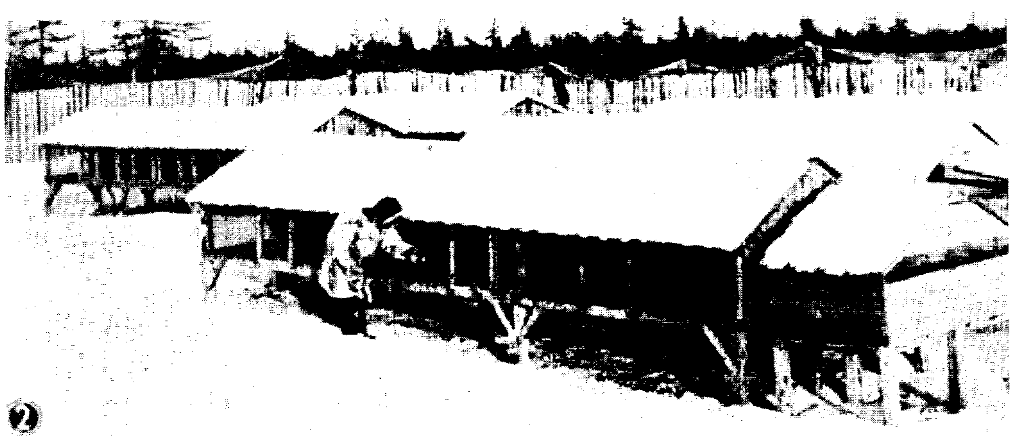

Figure 32. A fox farm on the Taymyr Peninsula.

arctic fox and red fox. Under controlled conditions the animals can be made to breed true and are raised in large numbers. One fur farm in the Nenetskiy N.O. produced pelts worth 100,000 rubles in 1952. 34/

The most significant feature of the herding economy is the seasonal migration of the reindeer. The herds winter in the wooded tundra where the trees afford shelter from the biting winds and the snow is not hard packed. By pawing through the snow the reindeer can find sufficient forage to last them throughout the winter.

When warm summer temperatures begin to melt the snow cover, herds are driven into the tundra pastures. The move is necessary to escape from insect pests and to find new pastures. Myriads of mosquitoes, gnats, and flies hatch in the southern tundra and wooded tundra and are a serious nuisance to men and animals. The insect most harmful to the reindeer is the botfly. It lays eggs in the hair of the animal; and when the larvae hatch they bore into the skin of the reindeer. Hides from such reindeer are full of holes and are worthless for leather. Herds on Novaya Zemlya produce hides of good quality since the climate is too cold for botflies.

Seasonal migrations of the herds involve great distances. The reindeer often move more than 300 miles (480 kilometers) to their summer pastures in the tundra. Some herds travel over the pack ice to summer pastures on nearby islands such as Ostrov Belyy and return to the mainland after the sea ice forms in the fall.

Migration routes to the pastures are planned in advance so that none will be grazed by more than one herd. The pasture areas are also assigned in order to prevent overgrazing. Because of the short summers and the slow rate of growth of mosses and lichens, an overgrazed pasture requires 20 years to recover fully.

The number of persons accompanying a herd is very small. Herdsmen are usually assigned at the rate of 1 person for every 200 to 300 reindeer. Veterinarians and husbandry experts also accompany the herds.

G. Hunting and Trapping

The Arctic region has been a rich hunting and trapping area since the early days of the Russian Empire, when Arctic fox pelts and seal skins were taken in large quantities. Today the Arctic continues to supply a significant portion of the furs, skins, and other products of hunting used in the Soviet Union. Arctic fox still accounts for most of the animals trapped (Figure 33). The ermine is also a leading fur bearer. Skins of leather quality are procured from reindeer, seals, and belukhas (white whales). Other products of hunting include oil, meat, down, and eggs.

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Figure 33. A fur warehouse on the Chukotsk Peninsula. Arctic fox pelts are hanging from the ropes.

The basic unit of the hunting economy is the artel. This type of collective has its own rifles, traps, and other gear. The hunters are organized into brigades of 50 to 100 men who operate from hunting stations scattered throughout the Arctic. These stations, or factories, serve as collecting and storage points for pelts and skins. Food supplies and equipment are purchased from the factories. Individual hunting and trapping are also carried on by natives, whose herding activities are curtailed during the winter season (Figure 34). In addition to pelts, trapped animals furnish the natives with meat.

Along the southern edge of the tundra where hunting and trapping do not predominate, hunters are attached to agricultural kolkhozes and forestry settlements. When the hunting season is closed the hunters work on the farms or in the forests.

The state has taken steps to control the size of the catch and to increase the animal population. Rigid laws limit the open season and the number of pelts that can be taken during this time. All hunters must be licensed, and poachers are severely punished. State breeding and experimental stations have been established to study fur-bearing animals so as to increase their number and the quality of their pelts. 35/ A 1957 decree of the RSFSR Council of Ministers imposed prohibitions and restrictions on the hunting and killing of arctic animals. Polar bear hunting is banned and walrus can be killed only by kolkhoz members or special expeditions. Caribou, also, may be hunted only by kolkhoz members, and eider duck colonies can be exploited only under license. 36/

Fur-bearing animals make up the largest part of the yearly catch. The arctic fox is found throughout the Arctic, and on Novaya Zemlya over 2,000 pelts were taken in one season. The fox's fur turns white in winter, and during this season the fox does not hibernate but roams over the land and far out on the pack ice in search of food. Ermine is also trapped in the winter when its coat, except for the tip of its tail, turns white. It lives throughout the Arctic mainland and islands. Ranking third as an important fur-producing animal is the otter, which is limited to the nearshore waters, rivers, and lakes along the coast of the Kola Peninsula.

Caribou provide both skins and meat for the indigenous hunters. Very few caribou are found in the European Arctic since most have been incorporated into domesticated herds.

Sea animals -- including seal, walrus, and belukha -- furnish leather, oil, and meat, all of which are important products of the hunting industry. The Greenland seals, and to a lesser extent the ringed and bearded seals, provide most of the skins. In 1938, some 850,000 seals were taken at the mouth of the White Sea. In recent years the catch has been smaller, amounting to about 146,000 seals from the entire White Sea in 1947. Only males and young pups are taken; the males provide skins and the pups furnish fleecy, white fur. Greenland seals congregate in large herds during the mating and pupping season. The White Sea herd, numbering many thousand, is the largest and gathers on the ice-covered shores of the White Sea entrance. The herd follows the receding ice pack to Zemlya Frantsa-Iosifa and Severnaya Zemlya when the pupping season is over. The seal remain at the high latitude for the rest of the summer and return south in the fall.

The belukha furnishes high-grade lubricating oil, leather, and meat. Although the meat is tough, it is canned for human consumption. Belukhas are found in large herds and live in the coastal waters. They feed in river estuaries and often travel far upstream in search of fish.

Wolves are hunted to reduce their depredations on reindeer herds. It is estimated one wolf eats 1.5 tons of meat a year and, during its lifetime of 10 to 15 years, destroys reindeer valued at 100,000 rubles. Wolves are trapped, poisoned, and hunted. Since 1951, aircraft have been used to hunt wolves, and the number of animals killed has increased greatly. 37/

Birds form only a small part of the hunting economy. Eider ducks furnish eider down, a valuable insulating material for high-latitude clothing and sleeping bags. The female duck lines her nest with down plucked from her breast. The nests are collected after the nesting season and the down is cleaned of dirt and grease.

Birds' eggs form an important part of the local native's diet. Guillemot eggs are the main species eaten, and in the late 1930's more than one-half million were collected. The birds live in large nesting colonies called bazars, which are located along the high, rocky coasts of the islands and mainland (Figure 35). Distribution of the bazars depends on hydrological conditions that favor the growth of rich marine fauna. The largest bazars are found along the western coast of Novaya Zemlya where the Nordkap Current of the Gulf Stream warms the water and permits the growth of abundant marine life. The Novaya Zemlya colonies are estimated to contain nearly 2 million birds. The principal species include guillemots, eider ducks, gulls, and mews.

H. Agriculture

Agricultural production in the Soviet Arctic satisfies only a small fraction of the local food needs. Although fodder for livestock is relatively abundant, only limited amounts of vegetables, fruit, and grain are produced. The goal of Soviet economic planners is to make the area supply its own food requirements in order to comply with the official dogma of regional self-sufficiency in food production. The pressure for agricultural development is justified on the basis that the northern limit depends not on physiographic conditions but on economic considerations. 38/ The determining factor for growing crops is the extent to which the Russians are willing to allocate funds for the subsidization of crop production. As a result, in most parts of the Arctic the cost of agricultural production far exceeds the value of the crops. The farm at Tiksi operates at a loss of 800,000 to 900,000 rubles per year because production costs are greater than consumer prices. 39/

By a decree of 26 March 1957, income, agricultural, and fishing taxes have been abolished for households of collective farmers in an effort to increase agricultural output and encourage free workers to settle and farm in the Arctic.

Physical conditions are severe for crop production. The growing season varies from 40 to 45 days along the littoral to 100 to 105 days near the Arctic Circle. Annual precipitation ranges from 3 inches (75 millimeters) on the northern islands to 16 inches (400 millimeters) at Igarka. The combination of cold temperatures with desert and semidesert moisture conditions is a serious handicap to agriculture.

The majority of the food consumed in the Arctic must be shipped into the region either by rail or water. Air transportation, since it is too expensive and limited for general use, is used primarily to supply the drifting stations with fresh vegetables. Railroads serve only the western part of the Arctic, and vegetables are

Figure 34. A kolkhoz member from the Bulun Rayon with his catch of arctic foxes.

Figure 35. A large nesting colony or bazar of shore birds on the rocky cliffs of Mys Karmakuly, Novaya Zemlya.

expensive if carried long distances, such as from Leningrad to Vorkuta (1,473 miles or 2,370 kilometers). Although shipment by water is the cheapest method, it is too slow for perishable items.

Since much of the population of the Arctic, particularly in the eastern part, can be reached only by water, the shipment of food is a seasonal operation. Supplies for the entire year in these areas must be stockpiled during the short summer season. In winter, vegetables may freeze unless they are properly stored. Meat products are canned or salted. A diet of canned goods, without a supplement of fresh vegetables, will result in avitaminosis. For this reason, fresh vegetables and milk must be produced within the Arctic.

As in areas farther south, farming in the Arctic is centered on sovkhozes, kolkhozes, and individual garden plots. The garden plots are cultivated by the urban population to supplement their diet. The sovkhozes and kolkhozes are the primary food producers and are of great size and are widely dispersed because of the difficult growing conditions.

Vegetable farms are concentrated in the western Arctic, since most of the population is found there. The farms vary in size; one of the largest is at Abez in northeastern Komi ASSR and covers 6,000 acres (2,430 hectares). Even in the western Arctic, only a small fraction of the area is cultivated because of the scarcity of suitable land. Factors such as soil composition, slope, exposure to sun and wind, snow retention, and permafrost limit agriculture to small, scattered fields.

The most productive soil is developed by draining marshes, since they contain the greatest amount of humus. Other soils must have large amounts of peat added to increase the humus content. Furthermore, all the soils require large applications of fertilizer and lime. To prepare the soil for cultivation, 44 to 66 tons of organic fertilizer and up to 1 ton of lime per acre are added.

Slope of the land is important in order to secure adequate soil drainage and a maximum amount of sunshine. South-facing slopes often warm up to 90°F (32°C) or higher during the long summer days. If the land is sheltered from the wind, crops can grow faster and the frost-free season is longer than on exposed fields. Long snow retention also affects the agricultural potential of land by shortening the time available for planting and growing crops. Permafrost, which underlies nearly all the Soviet Arctic, presents a serious drainage problem. Areas that have only a thin active soil layer lying over the permafrost are unsuited to farming. The permafrost layer gradually sinks, however, as repeated cultivation stirs up and thaws out the soil.

As the permafrost receds a serious soil moisture problem arises since the scant precipitation which falls is more rapidly absorbed.

Vegetables grown in the Arctic are acclimatized varieties of crops cultivated in lower latitudes. Root crops are the most widespread and include potatoes, turnips, parsnips, beets, carrots, and rutabagas. Other vegetables grown are cucumbers, cabbages, parsley, spinach, onions, tomatoes, peas, and cauliflower.

Crops are grown by three methods: greenhouses, hotbeds, and open fields. Greenhouses are used for starting seedlings, growing complete crops, and experimenting with new varieties. Seedlings grown in greenhouses are transplanted to open fields to mature, thus increasing the chances that the plants will complete their life cycles before fatal fall frosts occur. Crops such as tomatoes, cucumbers, onions, lettuce, and herbs that are sensitive to cold temperatures are grown exclusively in greenhouses. Although such facilities are limited, controlled conditions permit 2 to 4 crops to be grown in a year. At many settlements, greenhouses use electric lights to supplement the short winter daylight hours (Figure 36). To combat the cold climate the soil is heated by rows of electrodes and the plants are irrigated with warm water.

Hotbeds are also used to start seedlings and to produce mature crops. They are easier to construct and cheaper to heat than greenhouses and greatly increase the facilities for growing vegetables under glass. Plants can be started before the open-field season begins, and several crops can be raised before the season ends. Relatively high temperatures are maintained by insulating the frames with manure.

Open-field cultivation is limited to small, scattered plots that have favorable exposure, slope, and soil (Figure 37). New soil is prepared by plowing the land in spring and allowing it to remain fallow and thaw out during the summer. The following year it is ready for cultivation. Spring plowing begins in June or July, as soon as the snow has left the soil. Root crops are dug in August or September and other field crops are harvested in July or August (Figure 38).

Fruit forms a small but very important part of the local diet since it is a valuable source of Vitamin C. Fruit grown in the region consists of imported and indigenous species. Orchards of apples and cherries, established at Igarka in the mid-1930's, marked the beginning of fruit culture in the Arctic. Since that time, small orchards have been planted in several places in the western Arctic. The trees are pruned and made to trail along the ground in order to utilize the heat of summer and to receive protection against the cold

Figure 36. Electric lights supplement the short winter daylight hours in a greenhouse on the Taymyr Peninsula.

Figure 37. A cabbage field in an experimental station in Salekhard, with greenhouses in the background.

temperatures of winter provided by drifting snow. Trees grown in this manner produce fruit high in sugar, and damage by frost is reduced.

Wild fruit is widespread and consists chiefly of berries, such as black currant, serviceberry, whortleberry, bilberry, cowberry, blueberry, and raspberry. The fruit ripens in late summer and is eaten fresh or dried for winter use. Berries of some species are not damaged by freezing and can be gathered after the snow melts in the following spring.

Dairy cattle, though not numerous, are a source of fresh milk and meat for the population. Since milk is in short supply, it is given only to children and hospital patients. Milk yields are reportedly high. Annual production of the herd at Tiksi averages 1,300 gallons (4,900 liters) per cow. Some cows in this herd give as much as 2,300 gallons (8,700 liters) a year. 40/ The herds are turned out to pasture on the tundra during the summer from June through September. Wild tundra plants of the uplands and grasses and clover sown in river meadows provide rich pasture. In winter the cattle are fed hay and ensilage. Grain crops, such as barley, oats, and winter rye, seldom yield mature grain, but they are cut and stored for winter feed (Figure 39).

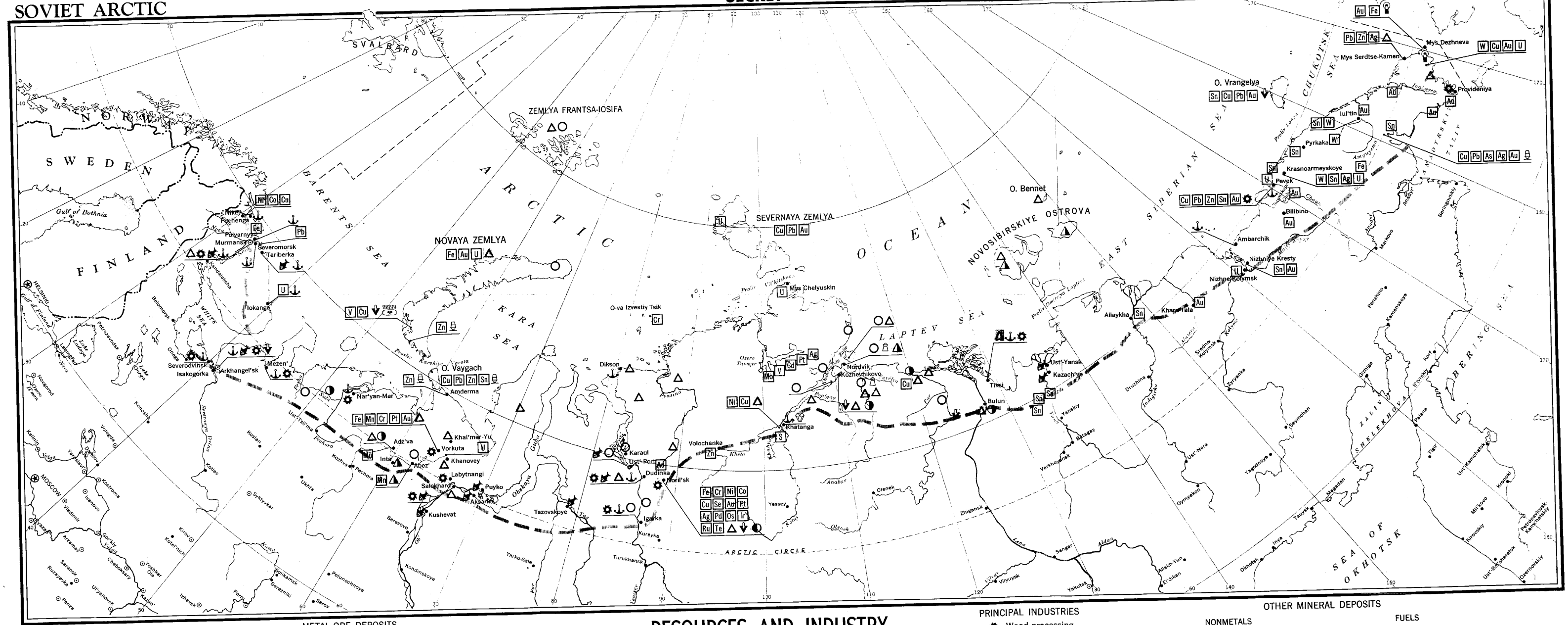
Attempts to raise milk cows where there is no adequate pasture have met with little success. A herd was started at Bukhta Tikhaya in Zemlya Frantsa-Iosifa, but the experiment was unsuccessful since the land supports very scant vegetation and all fodder had to be imported.

Some pigs are raised along with cattle and contribute a small amount of fresh meat to the diet. The farm at Tiksi produced 50 tons of pork in 1954. The pigs are fed sugar derived from wood waste products, root crops, and fodder. Reindeer provide a source of fresh meat in addition to beef and pork. Although reindeer would also furnish limited amounts of milk, most of it is probably consumed by the indigenous herdsmen.

Figure 38. A field of kohlrabi at Igarka. The crop will be dug in August or September.

Figure 39. A field of barley at the Igarka experiment station. The crop will probably be cut and stored for winter feed for cattle.

SOVIET ARCTIC



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RESOURCES AND INDUSTRY

METAL ORE DEPOSITS

IRON AND FERROALLOY METALS

- Fe Iron
- Mn Manganese
- Cr Chromium
- Mo Molybdenum
- W Tungsten
- V Vanadium
- Ni Nickel
- Co Cobalt

NONFERROUS METALS

- Cu Copper
- Pb Lead
- Zn Zinc
- Cd Cadmium
- Sn Tin
- Sb Antimony
- As Arsenic
- Se Selenium

Reported exploitation indicated by

PRECIOUS AND FISSIONABLE METALS

- Au Gold
- Pt Platinum
- Ag Silver
- U Uranium
- Pd Palladium
- Os Osmium
- Ir Irridum
- Ru Ruthenium
- Te Tellurium

Statute Miles: 0 200 400 600 800

Kilometers: 0 200 400 600 800

PRINCIPAL INDUSTRIES

- Wood processing
- Fish processing
- Shipbuilding and repair facilities

STUDY AREA BOUNDARY

OTHER MINERAL DEPOSITS

NONMETALS

- Salt
- S Sulfur
- Asbestos
- Fluorspar
- Graphite
- Gypsum
- Diamonds

FUELS

- Hard coal (anthracite or bituminous)
- Soft coal (lignite)
- Oil
- Oil shale

Reported exploitation indicated by

IV. The Development of Transportation in the Soviet Arctic

A. Air Transportation

1. Role of Air Transportation

Air transportation in the Soviet Arctic is characterized by a network of Polar Aviation air routes that largely parallel the northern coast. These are augmented by scheduled "All-Union" and regional Civil Air routes that operate directly between the Arctic settlements and Moscow and other major Soviet territorial-administrative, industrial, and transportation centers. The majority of these routes lie east of the Urals, where air transport -- because of vast distances, difficult terrain, and paucity of overland routes -- has become increasingly important for the penetration, economic development, and political unification of the Siberian Arctic. For most of the Arctic coastal establishments and mining centers, air transport provides the only means of year-round supply and communication. Airlift operations in support of the drifting stations and the Arctic Islands have been of major scientific and strategic significance. Hydrometeorological and ice-reconnaissance flights by Polar Aviation are also of utmost importance to successful maritime and naval operations along the Northern Sea Route.

The increase in air routes has been facilitated by the construction and improvement of air installations throughout the Arctic. Approximately 100 airfields and seaplane stations have been designated for military, civilian, or joint use. Several of these airfields -- including Mys Shmidta, Tiksi, Tiksi West, Amderma, Severomorsk and Mal-Yavr -- can be used for staging and refuelling heavy jet bombers and several others would be suitable for staging and refuelling medium jet bombers.

2. Polar Aviation

The Directorate of Polar Aviation plays a key role in the regional development of the Soviet Arctic. Its activities range from providing aerial ice reconnaissance in support of shipping along the Northern Sea Route to carrying mail, freight, and passengers to the numerous coastal settlements, mining centers, and isolated polar and radio stations that are dependent largely upon air transport for year-round supply and communication. Other functions performed by Polar Aviation, include meteorological work and aid to scientific expeditions. To assist in these functions, three Independent Air Detachments were created -- The Moscow Independent Air Detachment, with headquarters at Moscow; the Khatanga Independent Air Detachment, with headquarters at Igarka; and the Chukotsk Independent Air Detachment, with headquarters at Kresty Kolymskiye.

The activities of the Directorate of Polar Aviation date from the late 1920's, when it carried out sporadic missions and experimental flights to the European Arctic. During the period 1929-33, the principal aims of Polar Aviation were consolidated into two areas of responsibility -- scientific and economic. These activities were paralleled by an intensive effort to establish air-transport routes in the north. Not until 1933, however, when the newly organized Chief Directorate of the Northern Sea Route (GUSMP) acquired control of Polar Aviation, did the use of aircraft become particularly significant in the exploration and development of the Arctic. Since then the development of Polar Aviation has closely paralleled that of GUSMP and has become a major instrument in the economic and political unification of the Soviet Arctic.

In the past decade, the Soviets have made significant operational and technological advances in Arctic flying designed to correct earlier weaknesses and meet needs that may arise from the increasing economic and strategic importance of the Arctic. Postwar developments include (1) a significant increase in the number and capabilities of polar air facilities, (2) improvement of communication aids to assure better meteorological and navigational service for aircraft, (3) replacement of obsolete aircraft with newer types, including the helicopter, (4) improvement in the training of flight personnel, and (5) introduction of equipment and supplies designed specifically for use under Arctic conditions.

In early 1955, the organizational structure of the Directorate of Polar Aviation was changed to increase the efficiency of its aerial reconnaissance, supply, and communications missions in polar areas. An estimated 100 aircraft -- including Coaches (Il-12), Cabs (Li-2), Mules (Po-2), Colts (An-2), and Hounds (Mi-4) -- are now in service (Figures 40 and 41). Sightings of a Bull (Tu-4) 4-engine aircraft at Mys Shmidta and a similar plane at the Moscow/Vnukovo airfield, all with Polar Aviation markings, indicate that these ex-bombers are being used for long-range ice and weather reconnaissance (Figure 42). Polar Aviation has also received 4-engine turboprop Coot (Il-18) and Cat (An-10) aircraft. The Coot can carry up to 100 passengers; the Cat can carry 84 passengers and can operate from small unprepared airfields (Figures 43 and 44).

Although Polar Aviation provides timely and accurate weather and ice forecasts, its major functions are air transport and communications. The transport system of Polar Aviation consists chiefly of a network of routes confined largely to the Arctic rim with southward extentions of the net to Moscow and Krasnoyarsk
25X1 [redacted] Most of these routes radiate from the larger Arctic air terminals that serve as Polar Aviation operational and supply bases (Figure 45). Airlift operations to the Arctic Islands

Figure 40. A Coach (Il-12) being loaded and fueled for a flight to the drifting ice stations. (1955)

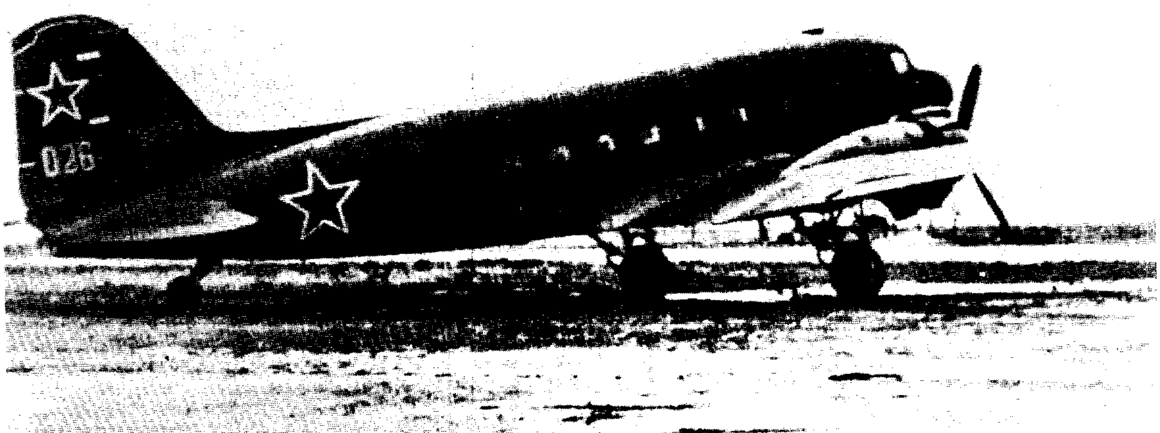

Figure 41. The twin-engine Cab (Li-2) has the smallest payload and range of any of the Russian transports.

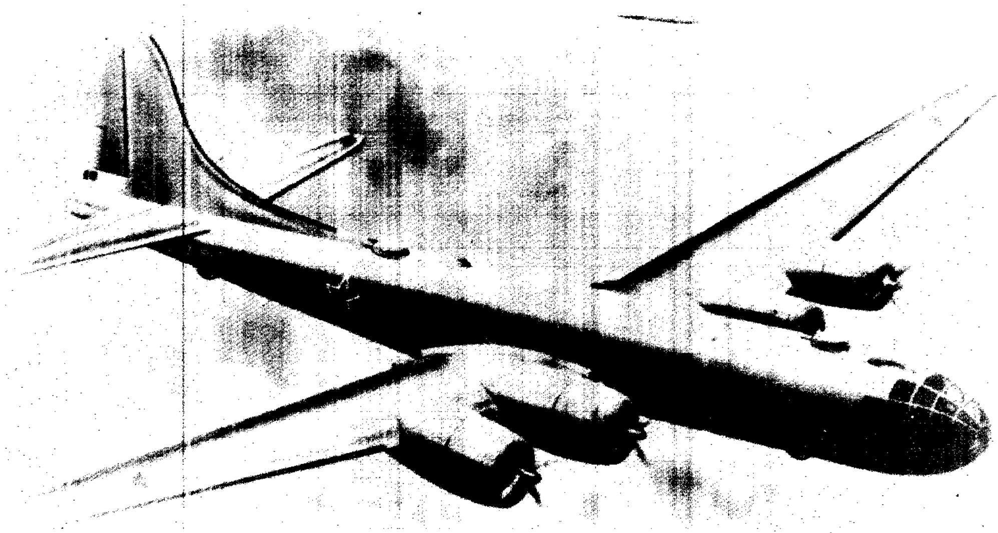

Figure 42. The Bull (Tu-4) is currently used for ice and weather reconnaissance.

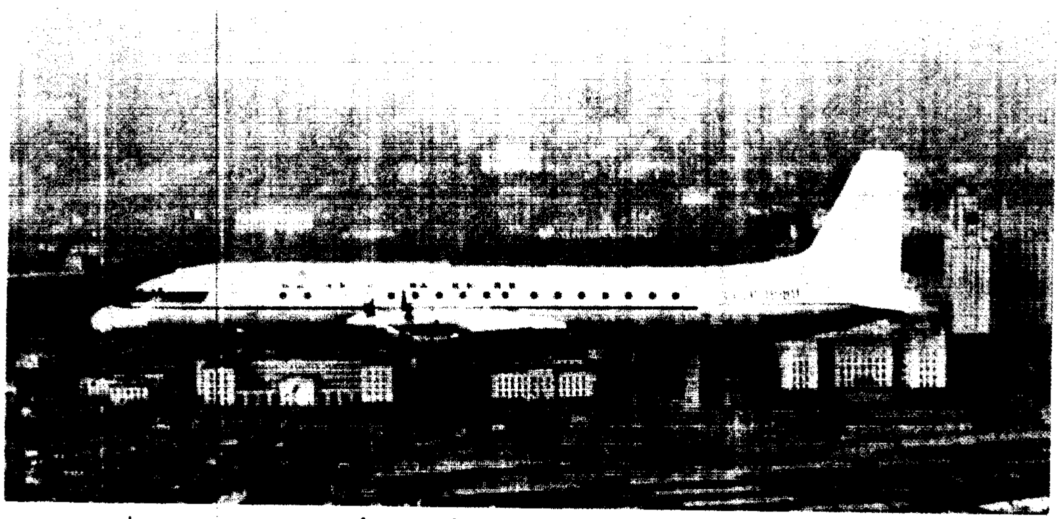

Figure 43. The Coot (Il-18), a four-engine turboprop transport can carry up to 100 passengers. (1958)

Figure 44. The turboprop Cat (An-10) can operate from small unprepared airfields. (1958)

Figure 45. The air terminal at Dikson, which serves as an operational and supply base for Polar Aviation.

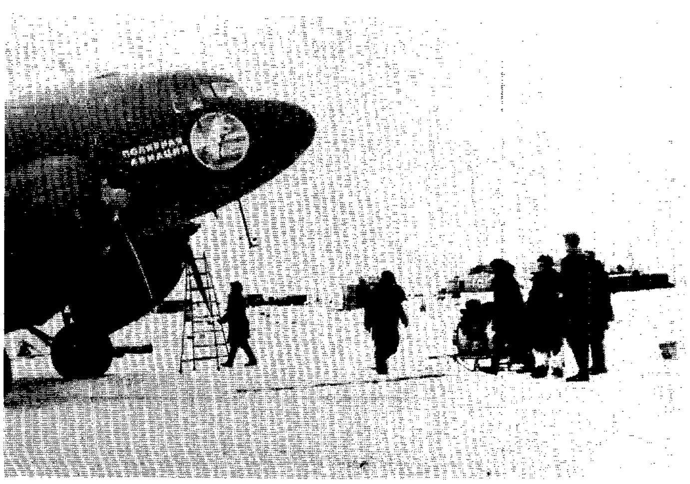

Figure 46. A Polar Aviation aircraft parked on Nagurskaya airfield on Zemlya Aleksandry, Zemlya Frantsa-Iosifa. (1956)

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and to Polar Basin activities also originate at these airfields (Figure 46). Probably only a few routes are operated on schedules; most of Polar Aviation's flying is believed to be on an "as required" basis. 41/ The main route, however, has regular service of undetermined frequency from Moscow to Anadyr' via the Arctic Coast with stops at major airfields along the way. Polar Aviation probably also operates secondary flights to smaller airfields where connections are made with Civil Air routes from the south.

Tons of freight -- including food and fuel supplies, scientific equipment, prefabricated houses, and motorized equipment such as a GAZ-69 automobile and a KD-35 tractor -- have been ferried to the drifting ice stations by transport and helicopter aircraft. Helicopters have actually been flown from Moscow to the drifting stations in the Central Arctic Basin. In 1956, 2 helicopters flew to the drifting stations Severnyy Polyus (SP)-3 and -4, stopping at Arkhangel'sk, Nar'yan-Mar, Amderma, and Mys Kamennyy for maintenance and refuelling. From Mys Kamennyy, one helicopter proceeded to Dikson and then to SP-3 and another to Ostrov Vrangelya and then to SP-4. Other Polar Aviation flights from Moscow have also been noted along similar routes. It is doubtful whether Polar Aviation operates west of Arkhangel'sk. All Polar Aviation long-range Arctic operations as well as local operations in the western half of the polar region are conducted by the Moscow Independent Air Detachment.

The Directorate of Polar Aviation, in addition to its increasing air-logistic capabilities and sizable cadre of trained and experienced Arctic personnel, serves as a potential adjunct to Soviet military operations in the Soviet Arctic. Many of the current Polar Aviation airfields could readily be made available for refuelling, servicing, and staging various types of military aircraft. Polar Aviation aircraft could also be diverted to transport and reconnaissance use in support of military operations. In addition to the airlift potential of Polar Aviation, the ice reconnaissance essential to successful shipping operations along the Northern Sea Route would also be significant. The larger transports and Bull aircraft currently used for long-range ice and weather reconnaissance could perform vital photoreconnaissance missions or serve as troop carriers for airborne operations.

The cadre of Polar Aviation personnel, including fliers, navigators, technicians, and administrators, has gained a vital know-how in Arctic operations, which could be made available on demand to the Soviet military forces. Since 1946, active officers of the Red Army have been assigned to duty in Polar Aviation. The tendency toward militarization, which is evident within Polar Aviation, indicates that the Soviet Air Force is probably studying closely the operational techniques of Polar Aviation.

3. Civil Air Fleet

A number of Civil Air routes -- scheduled "All-Union" and regional -- have been established to facilitate rapid movement of mail, freight, and passengers between Arctic centers and major air-traffic hubs to the south. Many of these routes follow the principal north-south river valleys and are closely integrated with the transportation networks of the Northern Sea Route, the inland waterways, and Polar Aviation. The major scheduled air routes are supplemented by a network of regional routes, both scheduled and nonscheduled, operated under the jurisdiction of various Territorial Directorates of the Civil Air Fleet. The administration of the scheduled air lines as well as the territorial routes is carried out by the Chief Directorate of the Civil Air Fleet (Glavnoye Upravleniye Grazhdanskogo Vozdushnogo Flota -- GUGVF), which maintains control over all civil aviation in the USSR and operates under the trade name Aeroflot.

Aeroflot flights to the Soviet Arctic branch off the southern transcontinental routes and terminate on the Arctic coast. Five daily flights by Crate (Il-14) and Cab transports originate in Moscow and terminate in Noril'sk, Vorkuta, Arkhangel'sk and Murmansk. 42/ Arctic routes east of the Urals usually follow the principal rivers, the Ob', Yenisey, Lena, and Kolyma and terminate at Salekhard, Dudinka, Tiksi, and Kresty Kolymskiye, respectively. Several routes radiate from Anadyr', and serve Pevek, Ostrov Vrangelya, and the north coast of the Chukotsk Peninsula. Flight schedules for the Siberian Arctic are not available, and service is probably less frequent than in the European Arctic.

Although Polar Aviation will undoubtedly continue to operate territorially within the Arctic, the development program in progress in the Soviet polar region indicates that the Polar Aviation system may be in process of realignment. If the 25-year pattern for Polar Aviation development continues, Aeroflot seems likely to take over any of its operations that are placed on a regularly scheduled basis.

The numerous scheduled and nonscheduled regional routes as well as "special purpose" operations are controlled mainly by the local Territorial Directorates of the GVF, subject to approval by the GUGVF in Moscow. Although a number of the regional routes flown may have the same alignment as scheduled Aeroflot routes, many others undoubtedly serve areas that do not generate sufficient traffic to warrant service on a regular basis. Nonscheduled services may be devoted primarily to freight lifts associated with high-priority construction and mining projects. These activities would support the USSR claim of having the largest air-freight lift in the world, even though it is not reflected in published timetables of scheduled routes alone. "Special purpose" operations are apparently those designed to support the activities of nonaviation government agencies such as the Ministry of Geology and Mineral Conservation, which uses transports for aerial exploration and geological surveying missions.

4. Military Air Forces

The recent development of major airfields and the utilization of inflight refuelling, together with improved logistic support by air, water, and rail, have significantly increased Soviet military air power in the Arctic.

The Long Range Air Force is active in the Arctic and conducts training exercises in order to (1) familiarize air crews with the problems of Arctic navigation, including flights in total darkness, (2) practice bombing at northern ranges, (3) test navigational and direction-finding equipment, and (4) train radar ground crews. These exercises indicate a well-developed logistics system including adequate fuel storage facilities, the existence of a number of forward staging bases, and a network of radar, navigational, and communication facilities.

All types of aircraft -- including the heavy bombers Bear and Bison and the medium bomber Badger, together with auxiliary aircraft such as transports -- operate in the Arctic (Figures 47, 48 and 49).

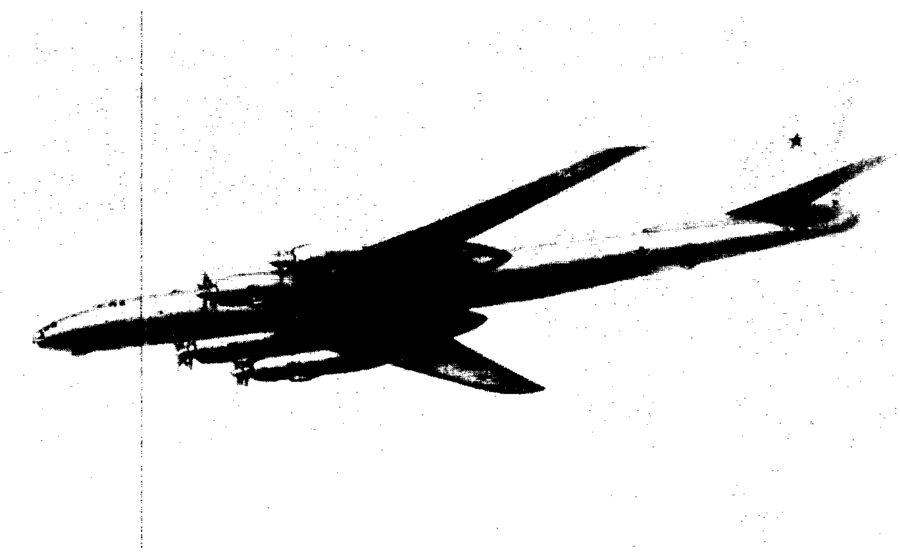

Figure 47. The four-engine turboprop Bear is capable of reaching any target in the United States.

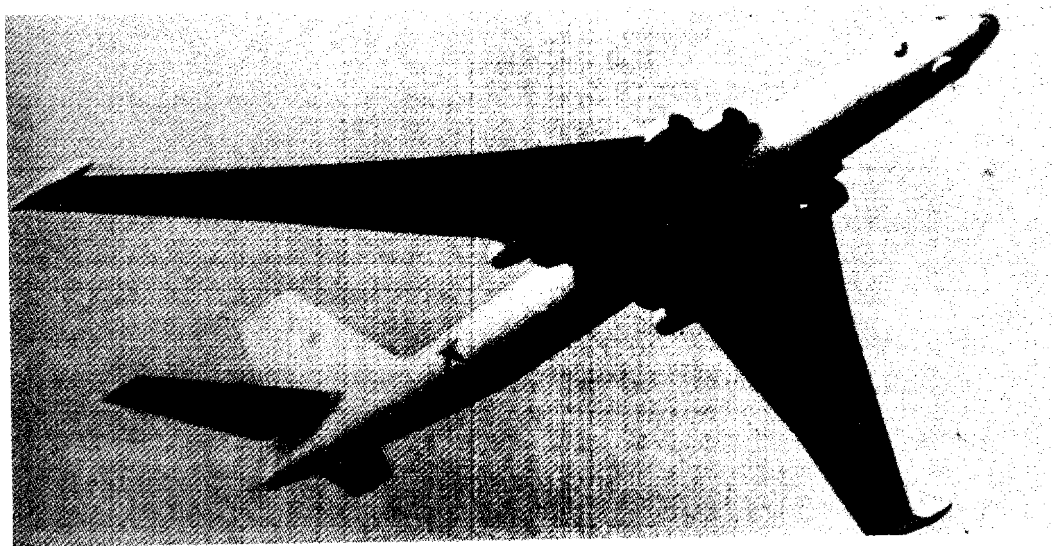

Figure 48. The Bison, a four-engine jet bomber, could reach Chicago and El Paso.

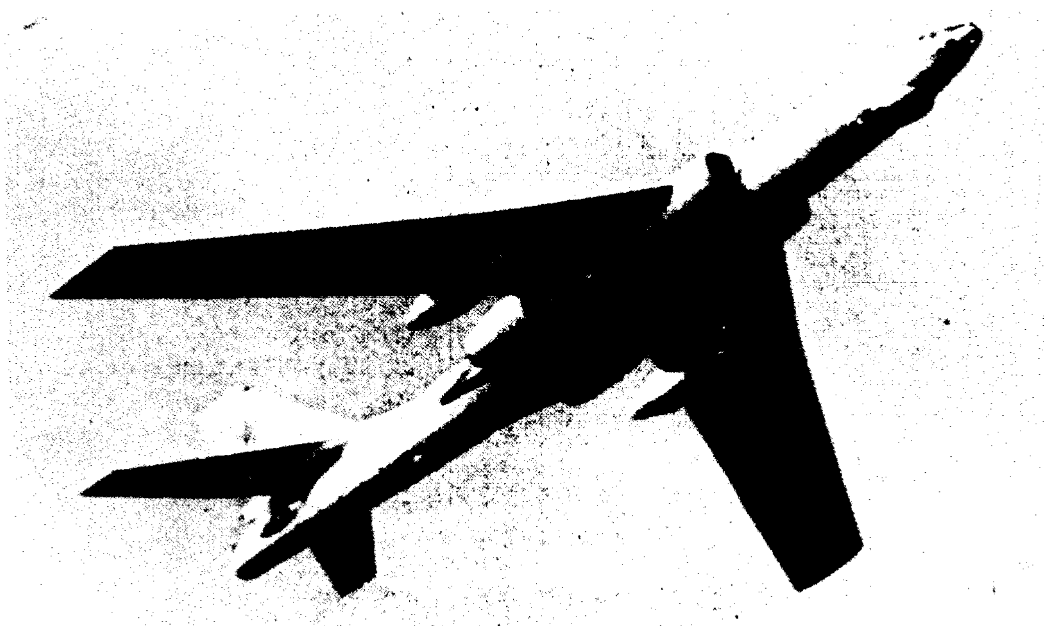

Figure 49. The Badger, a medium jet bomber, is assigned to the Long-range, Tactical, and Naval Air Forces.

Flights are most frequent in late winter and early spring, the best seasons for flying. Summer activity may indicate, however, that the Soviets have a nearly year-round capability. The aircraft originate from home bases deep within the Soviet Union and fly to staging bases along the Arctic periphery such as at Severomorsk (south of Murmansk), Olenya, Amderma, Tiksi, Mys Shmidta, and Anadyr'. Some of the aircraft do not land at the airfields but continue on round-robin flights to the Arctic islands or over the pack ice before returning to their southern home bases. Other aircraft remain at the staging bases for a short time only unless detained by unfavorable flying conditions. From these airfields flights are made to points within the Arctic before the aircraft returns to the south. Heavy bombers flying from bases on the Kola and Chukotsk Peninsulas could cover much of the United States. The turboprop Bear, with a radius/range of 4,400/8,700 nautical miles, is capable of reaching any target within the United States; and the Bison, with a radius/range of 2,950/5,800 nautical miles, could reach Chicago and El Paso* (see Map 25221). With one inflight refuelling the basic radius/range of an aircraft could be increased approximately 35 percent. The estimated number of Long Range Air Force bombers in military units varied from 50 to 100 heavy bombers and 800 to 925 jet medium bombers. 44, 45/

The strength of the Soviet Navy Northern Fleet Air Force was estimated to be 530 aircraft in 1957. The largest number of aircraft were day and all-weather jet fighters. Recently, a significant change in aircraft elements has taken place; the number of Badger bombers has increased, and the number of light bombers has decreased. This change has added to the reconnaissance and offensive capabilities of the Northern Fleet Air Force, which operates from bases at Murmansk and Arkhangel'sk. Extended operational flight exercises are conducted in the European Arctic and involve torpedo drops, mine laying, and long-range reconnaissance. 46/

After World War II the Soviet Tactical Air Force was expanded to protect the exposed and vulnerable Arctic coastline from attack. Air units were stationed at Murmansk, Arkhangel'sk, and on the Chukotsk Peninsula. The expanse lying between these two extremities may also contain Tactical Air Force elements by now. The aircraft consist of fighters (Fagot and Fresco), light bombers (Beagle), medium bombers (Badger) and transports (Cab and Coach).

5. Facilities Available for Air Transport

a. Airfields

The network of approximately 70 airfields in the Arctic is almost equally divided between the European and Siberian sections. In

*All radius/ranges based on optimum conditions under Optimum Mission IV. See source 43, Appendix B.

addition to these airfields, many other airstrips under 2,000 feet (610 meters) or of unknown length and status are located within the Soviet Arctic, the vast majority east of the Urals [redacted] 25X1

Most of the airfields have been built on the better drained gravel terraces found chiefly along the coast and in the principal river valleys of the Arctic. Most of these installations have been collocated with polar stations and are relatively accessible to supply by river and Northern Sea Route vessels. Many coastal airfields are on barrier bars or spits consisting of sand and gravel. These spits commonly enclose lagoons that can serve as seaplane landing areas in summer. With proper drainage and insulation of the permafrost layer to prevent disturbance of the temperature region of the frozen ground, many inland areas could provide sites suitable for natural-surfaced and permanent runways. Unimproved snow and ice surfaces can be used by aircraft during the cold season.

Runways are surfaced with a variety of materials. Many have concrete, macadam, or asphalt surfaces; but most runways have graded natural surfaces. Airstrips of compacted snow and ice can be constructed on any level surface in the tundra during the cold season. Compacted snow and ice are also used to extend runway lengths of permanent airfields in winter. Landing strips can also be made on the frozen surfaces of lagoons, rivers, and lakes. Several methods are used to construct ice runways. An ice milling machine has been used to level ice hummocks and form a layer of pulverized ice which subsequently freezes into a hard surface. Another method uses a machine to drill a hole through the ice and pump water over the surface of the ice, which freezes into a smooth surface. River-ice runways can also be made by forcing water from a channel on to the surface of the ice, where it freezes and forms a level surface.

Soviet airfields are grouped into 3 classes according to their use (military, civil, and joint), but military aircraft probably use airfields designated as civilian at present and would use airfields of all types in time of war.

Although information regarding runways, parking, and ancillary facilities is inadequate for many areas of the Soviet Arctic, the majority of the airfields are known to have runways or take-off runs of 4,000 feet (1,220 meters) or more in length. Most of these have permanent-surfaced runways that are operational the year round. The majority of the natural-surfaced airstrips range in length from 3,000 to 4,000 feet (915 to 1,220 meters) and are operational only seasonally.

The airfields are supported by various navigational aids, POL storage, maintenance facilities, and miscellaneous buildings used as hangars, shops, and billets. Although a number of airfields are equipped with station-to-station (code) facilities, the most common type of navigational aid is air-to-ground radio (voice). Most of the airfields have been collocated with polar stations that provide navigational information for both air and maritime operations. The Arctic coastline is also reportedly provided with a system of radio beacons and direction-finding stations, the latter being installed at intervals of approximately 270 miles (435 kilometers). The larger Arctic airfields have air-to-ground and station-to-station radio facilities, weather stations, control towers, radar, and in many cases telephone and telegraph communications and direction-finding equipment. Many of the smaller airfields have at least some of these aids.

Bulk POL (petrol, oil, and lubricants) storage is available at most of the permanent and temporary runways as well as at many of the natural-surfaced airstrips. Known repair facilities are limited chiefly to preventative maintenance. Barracks and various other installations such as workshops, storage, and administrative buildings are usually found only at the military airfields in the European Arctic. The lack of hangars or shelters at most of the airfields east of the Urals, coupled with the low temperatures of the Siberian Arctic, imposes numerous aircraft maintenance problems. Most airfields are equipped with some type of lighting to facilitate operations during darkness. Lighting facilities include searchlights; runway, boundary, and obstruction lights; or, more commonly, flares and fire pots.

(1) Airfields of Major Significance

Airfields that fall into the Air Force catagory of Class 2 or 1 (6,000 to 6,999 feet and 7,000 feet or over in length; 1,830 to 2,130 meters and over 2,130 meters) are concentrated in the European Arctic, with others scattered throughout the Siberian Arctic.

On the Kola Peninsula airfields are grouped around Murmansk and include the major airfields at Severomorsk, Mal-Yavr, Kulp-Yavr, Kildin, Murmansk/Northeast, and the minor airfields at Murmansk/Kola, Ura Guba, and Murmashi. Severomorsk and Mal-Yavr have 8,200-foot (2,500-meter) concrete runways and are staging bases for heavy bombers. Kildin and Kulp-Yavr have 6,600-foot (2,000-meter) runways and probably have limited staging capability. All these airfields have the advantage of year-round logistic support by water and rail.

A major airfield is located south of the study area at Olenya, 55 miles (90 kilometers) south of Murmansk. It is capable of staging heavy bombers and has an 11,500-foot (3,500-meter) concrete runway.

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The Pechenga airfield near the USSR-Norwegian border has two parallel northeast-southwest runways, one 6,600 by 200 feet and the other 6,500 by 375 feet (2,000 by 60 meters and 1,980 by 114 meters). The airfield is supplied by sea through the ice-free port of Linakhamari, 19 miles (30 kilometers) north-northeast at the mouth of Guba Pechenga, and by land over the Murmansk-Pechenga railroad. Eighteen miles (28 kilometers) south of Pechenga is Pechenga South airfield, which has a 6,600 foot (2,000 meter) hard-surfaced runway.

Six airfields and 2 seaplane stations are located in the vicinity of Arkhangel'sk. Arkhangel'sk airfield, 7 miles (10 kilometers) south-southwest of the city, has 2 gravel runways 6,600 feet (2,000 meters) in length. Arkhangel'sk/Bakaritsa has a graded earth runway 4,000 by 750 feet (1,220 by 228 meters) in extent. The main civil airfield for the city, Arkhangel'sk/Keg Ostrov, is also used as a training base for the Soviet Air Force. Arkhangel'sk/Talagi and Arkhangel'sk/Yagodnik have sod runways 6,600 and 4,000 feet (2,000 and 1,220 meters) in length, respectively. A seaplane station is located in a channel of the Severnaya Dvina River southwest of the Arkhangel'sk/Yagodnik airfield. During the summer a 9,000-foot (2,700-meter) landing and takeoff area is marked by bouys and in winter aircraft can land on an ice runway. Arkhangel'sk/Kholm is located northeast of Ozero Kholm, 10 miles (16 kilometers) south-southeast of the city. The airfield has a 6,600-foot (2,000-meter) concrete runway, and jet fighters are probably based at the airfield. Nearby is the Arkhangel'sk/Kholm seaplane station which is used by seaplanes in summer and by land planes in winter, when a 10,000-foot (3,000-meter) runway is made on the ice.

Other sizable airfields of the European Arctic include Iokanga, Belush'ya Guba, and Amderma, all of which may have undergone considerable expansion since 1950. Iokanga has a paved-surface runway 6,600 feet (2,000 meters) in length and can accommodate jet fighters. Belush'ya Guba has a 5,700-foot (1,700-meter) natural-surfaced runway oriented north-south.

Amderma, the largest and most active of these airfields, has a hard-surfaced runway 9,200 feet (2,800 meters) long. In addition to probable use by ice-reconnaissance aircraft, Amderma serves as an air-supply point for Novaya Zemlya and Zemlya Frantsa-Iosifa. The military as well as economic significance of the airfield will be greatly increased when the railroad line, currently under construction from Vorkuta, is completed to Amderma.

Airfield development has also been active in the Siberian Arctic. On the Chukotsk Peninsula, an 8,000- by 500-foot (2,440- by 152-meter), hard-surfaced runway capable of staging medium and heavy bombers was completed at Provideniya/Urelik during 1954 [redacted] This is the 25X1

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nearest of the very large Soviet airfields to continental United States and serves currently as a base for a Soviet Air Force jet-fighter unit. A taxiway approximately 65 feet (20 meters) wide parallels the runway and is joined to it by 4 access tracks. There are no large hangars or workshops on the airfield, but several small buildings to the east appear to serve as maintenance and storage facilities and barracks. A POL storage area, located about 4 miles (6 kilometers) to the north along the eastern shore of Bukhta Emma, is connected with the airfield by a road and reportedly by a narrow-gauge railroad line. Logistic support for the airfield is provided by the limited port facilities at Urelik, supplemented by somewhat larger facilities at Provideniya on the opposite shore of the bay.

Air activity in the Chukotsk area, [redacted] 25X1
25X1 [redacted] has increased steadily since 1953. The latest data available -- July to December 1956 -- indicate an increase over 1955 was due to an unusual amount of activity by low performance aircraft, i.e., transports. From 20 July to 27 September 1956, air activity almost ceased, which may indicate a temporary shortage of POL supplies. During December 1956 the number of high speed (jet) tracks was abnormally large. About one-third were made at night, which suggests an increased capability for night flying. 47/

The airfield at Uel'kal' has a runway 6,600 feet (2,000 meters) in length and is fairly well equipped with ancillary facilities, including navigational aids, fixed installations (hangars, quarters, etc.) and maintenance facilities [redacted] During World War II, 25X1

[redacted] 25X1

Uel'kal' served as a major stop for lend-lease aircraft ferried from Alaska. It is currently a civil air route stop.

One of the most important Soviet Arctic bases is located along the northern coast of the Chukotsk Peninsula approximately 3.5 miles (5.6 kilometers) southeast of Mys Shmidta. In addition to serving as an important Northern Sea Route base for ice and weather reconnaissance flights, it has recently become capable of staging medium- and heavy-bomber operations, with a consequent increase in its military potential. A concrete 9,300-foot (2,800-meter) runway is paralleled by a compacted-snow landing strip 4,300 feet (1,300 meters) in length. Support facilities include two medium-sized POL tanks, warehouses, repair shops, a Token radar, and a radio station with an antenna farm of 14 antennas.

Tiksi, farther west, has also developed into one of the most important air centers in the Siberian Arctic. Two runways, 9,500 feet (2,900 meters) and 10,500 feet (3,200 meters) long, were completed in 1955 and 1956, respectively. The latter runway, designated Tiksi West, is located about 4 miles (6 kilometers) west of the port. Facilities at Tiksi West include 1 parking apron and 2 alert ramps. Those at Tiksi include a POL storage area, 3 taxiways, 1 parking apron, 1 alert ramp, radar, warehouses, and barracks. Both runways are hard surfaced and are suitable for jet fighters and medium or heavy bombers. Logistical support is provided by the port facilities at Tiksi, which is an active river-ocean transshipment point and major supply base for the region. Although the airfields at Tiksi are several hundred miles farther from key United States target areas than either Provideniya/Urelik or Severomorsk, they are potential forward staging areas. Their significance in offensive air operations could be greatly increased by inflight refuelling over the Polar Basin or by one-way missions.

Two long gravel runways have been constructed on the Arctic Islands. A runway on Ostrov Gofmana in Zemlya Frantsa-Iosifa has a length of 13,000 feet (4,000 meters). Mys Molotova on the northern tip of Ostrov Komsomolets in Severnaya Zemlya has a runway 15,300 feet (4,600 meters) in length.

South of the study area is the important Siberian Arctic airfield at Anadyr'. The Anadyr'/Leninka airfield has 2 runways, one 13,000 feet (4,000 meters) long with a hard surface and the other 8,000 feet (2,440 meters) with a graded-earth surface. The airfield is served by an extensive POL storage area and at least 1 early-warning radar.

(2) Airfields of Secondary Significance

In addition to the major airfields suitable for staging long-range bomber operations, the Soviet Arctic contains numerous smaller airfields that are currently used for civil or joint operations. In the event of hostilities, many of these could be improved to support staging operations of heavy transports, medium bombers, and jet fighter aircraft. Airfields such as at Dikson, Kosistyy on Khatanskiy Zaliv, and Chokurdakh near the mouth of the Indigirka River could readily be improved for military use. Although the Chukotsk area is vulnerable to attack, airfields such as that at Lavrentiya could, if the runway were lengthened, be used for staging airborne attacks on Alaska in addition to serving a defensive role.

The airfield at Bukhta Somnitel'naya on Ostrov Vrangelya has a natural-surfaced runway 7,000 feet (2,000 meters) in length. A second landing strip is to be constructed at Bukhta Somnitel'naya during 1959. Supplementary ice strips 7,000 and 4,500 feet (2,130 and 1,370 meters) in length have been noted on aerial photographs.

Drifting ice islands and floes provide other potential sites for advance airstrips, refuelling bases, and direction-finding equipment. Being far removed from the Soviet mainland, many of these islands or floes in the Arctic Basin could serve as advanced bases for small mobile striking forces consisting of long-range fighter aircraft.

b. Seaplane Stations

In addition to airfields, numerous inlets, bays, and lagoons along the coasts and rivers of the Soviet Arctic provide favorable sites for seaplane operations. An estimated 27 seaplane stations with complete or partial facilities have been established within the Arctic. Twenty of these stations are located in the Siberian Arctic and operate in conjunction with local airfields in making ice reconnaissance, supporting polar expeditions, and servicing radio and weather stations and settlements along the coasts [redacted] 25X1

[redacted] 25X1

The use of seaplanes, however, is limited to summer, when most coastal areas are relatively free of floating ice but often enveloped by coastal fogs. Improvements in coastal airfield facilities and increased use of helicopters have resulted in an apparent decrease in the use of seaplanes.

The seaplane stations within the European Arctic are under military operation and are used by both the Soviet Air Force and the Soviet Naval Air Force for ice reconnaissance and for patrol missions in the Kol'skiy Zaliv and the Barents Sea. The seaplane stations of Murmansk/Gryaznyy and Arkhangel'sk/Kholm have been used by Catalina-type aircraft. The only known seaplane stations with adequate shelter and complete facilities are the two bases mentioned and the seaplane station at Provideniya in the eastern Arctic. These stations are capable of major repairs and are equipped with beaching gear and refuelling services. The strategic location and ice-free water of the Kol'skiy Zaliv make the Murmansk/Gryaznyy seaplane station the most important in the Soviet Arctic.

Navigational aids at seaplane bases are like those of the airfields and generally include air-to-ground radio facilities and weather stations. Most of the operational facilities are probably used jointly by airfields and seaplane bases. Little is known about most of the seaplane stations that have only partial facilities. In most cases, however, POL supplies and navigational aids are available from nearby settlements or airfields.

B. Water Transportation

1. The Northern Sea Route

a. Historical Background

The Chief Directorate of the Northern Sea Route (GUSMP) was established in 1932 to develop, equip, and maintain a safe shipping lane along the Arctic coast of the Soviet Union. In its early days GUSMP controlled all activities on the mainland, seas, and islands north of 62°N. GUSMP reached its peak of power and influence in 1936, when it ruled an area of over 2,200,000 square miles (5,700,000 square kilometers). 48/

By 1938, it was realized that GUSMP was involved in too many activities and was neglecting its primary duty -- operating the Northern Sea Route. As a result of a decree in 1938, cultural and educational work was transferred to the republics, krays, and okrugs; and fisheries, mines, airlines, and river shipping were transferred to other agencies. To carry out its duties of planning and coordinating traffic along the Northern Sea Route, GUSMP established extensive weather- and ice-forecasting facilities, formed an ice-breaker fleet, and developed staging, dispatching, and controlling procedures for shipping. GUSMP maintains its own research installations and educational organizations, including the Arctic and Antarctic Scientific Research Institute and the Hydrographic Institute.

Additional changes in the functions of GUSMP were made in 1957. Prior to the start of the navigation season the administrative control over Arctic ports and shipping was transferred from GUSMP to the Murmansk Arctic Steamship Agency and the Far Eastern United Steamship Agency in order to improve the organization and timing of shipping operations. The meridian of 140°E has been established as the boundary between the eastern and western sectors of the Northern Sea Route. The Murmansk Agency has control of the western sector, and the Far Eastern Agency has control of the eastern sector. The latter agency supervises and escorts ships through Proliv Lapteva, which lies adjacent to the boundary. The Far Eastern Agency also acquired control of the former Dalstroy (Chief Directorate of Far Northern Construction) ports of Pevek and Egvekinot.

GUSMP continues to direct and assist shipping on the Northern Sea Route and retains control of its air arm -- Polar Aviation -- as well as polar stations, observatories, drifting stations, and construction and hydrographic enterprises. The political organizations of Arctic enterprises were liquidated, and their records were turned over to local organizations. The GUSMP coal mines at Beringovskiy and Sangar were transferred to Magadan and Yakutsk Sovnarkhozes, respectively.

b. Economic Significance

The establishment of a Northern Sea Route started with the need for provisioning settlements along the coast and lower river areas and for bringing out raw materials from the hinterland. Before the route became a regular transportation line, supplies for the Arctic settlements were sent over the Trans-Siberian Railroad and shipped down the major rivers. Little freight could be transported in one season because of the limited size of the river fleets and the short navigation period. Shipments to the central Arctic, however, are still sent via the Trans-Siberian Railroad and the Lena River, which may indicate the Northern Sea Route is not yet able to provide a sufficiently reliable supply.

Lumber, which probably comprises the largest part of the exports via the Northern Sea Route, is carried chiefly by foreign ships to Western European ports. Additional cargo sent over the route includes minerals, fish products, coal, construction materials, and general supplies.

In quantity, passenger traffic makes up only a small portion of movement on the Northern Sea Route and is concentrated west of Proliv Karskiye Vorota. During the navigation season, which extends from about 1 July to 15 October; scheduled passenger service varies from daily sailings to 5 trips per month, depending on local ice conditions. Most passenger routes originate at Arkhangel'sk and terminate at ports on the White and Barents Seas, such as Onega, Mezen', Nar'yan-Mar, and Beluzh'ye. Other routes originate at Murmansk and Kandalaksha. An Arctic Freight-Passenger Line (Arkticheskaya Gruzo-Passazhirskaya Liniya) has infrequent service from Arkhangel'sk to Dikson and Tiksi from late July to early October. In August, one round trip with numerous stops is made between Arkhangel'sk and Dikson; the journey takes 12 days in each direction. On the three trips in July, August, and October, the number of stops is limited; and the travel time between terminal points is 6 days. One ship making regular calls and another stopping only at selected points sails from Arkhangel'sk to Tiksi in September. The former requires 18 days each way; the latter is an express steamer that takes 12 days.

Passenger service in the eastern sector of the Arctic is limited. One trip is made between Vladivostok and Provideniya during July and one during September; the trip requires 14 days. Service between Vladivostok and Mys Shmidta is limited to one 21-day trip during the navigation season. The ship touches the mainland first at Beringovskiy and then stops at numerous settlements on the Chukotsk Peninsula before arriving at Mys Shmidta. The return trip to Vladivostok takes 19 days. 49/

Since operations are limited by a short navigation season, the Northern Sea Route is not a serious competitor of other transportation routes in the Soviet Union. Although the sea route carried more than 1 million tons of freight during the 1958 navigation season, the Trans-Siberian Railroad moves an equal amount in a few weeks and operates the year round. Little of the 1 million tons was through freight. An additional factor unfavorable to the Northern Sea Route is the long time spent in transit, since sea transport is much slower than rail.

Of the estimated 512 vessels that sailed on the Northern Sea Route during the 1957 navigation season, 62 were naval vessels and 450 were merchant-type ships, including 15 icebreakers and 50 non-Communist freighters. These freighters were among the 79 vessels that were convoyed up the Yenisey River to Igarka. According to A. Afanas'yev, Chief of GUSMP, 170 vessels on the Northern Sea Route required assistance from icebreakers or reinforced diesel-electric ships. 50/

c. Military Significance

Although establishment of the Northern Sea Route was prompted by economic considerations, the military significance of the route cannot be overlooked. The value of a northern route was realized during the Russo-Japanese War, when the Russian Baltic Squadron was forced to sail around Southern Asia to reach the Far East. If a northern route had been available to the fleet, many months of sailing time could have been saved and the naval defeat in the Tsushima Strait might possibly have been averted.

No information is available on the military use of the route in World War II, but German vessels operated in the western seas. On 27 August 1942 the German pocket cruiser Admiral Scheer shelled the harbor, polar station, and settlement on Ostrov Dikson. A German meteorological unit operating on Zemlya Frantsa-Iosifa in 1943-44 was visited by submarines. Submarines were also used at the northern tip of Novaya Zemlya to launch automatic weather transmitting buoys.

The most important military use of the Northern Sea Route at present is the annual transfer of units from the Northern Fleet to the Pacific Fleet. It is also the principal route for deploying naval forces between the two areas, although a few vessels have moved to the Far East via the Suez Canal and the Indian Ocean. Of the naval vessels that reinforced the Pacific Fleet in the 1957 navigation season, 62 arrived via the Northern Sea Route, but approximately 19 of these units had wintered in the Nizhniye Kresty area at the close of the 1956 navigation season because of severe ice conditions. The vessels making the transit included 24 "W" class submarines, 4 destroyer escorts, 4 submarine tenders, and additional smaller vessels. 51/ The 1958 naval convoy encountered severe ice conditions at the western entrance to Proliv Vil'kitskogo and was forced to return to Northern Fleet waters in the Barents Sea.

The movement of troops and materiel over the Northern Sea Route during a war would probably not be practical except in case of an emergency since trains on the Trans-Siberian Railroad require only half as long (9.2 days) to cross the country from Moscow to Vladivostok and can move throughout the year.

The military use of the route is limited by the short navigation season. During the greater part of the year, no naval ships except possibly submarines could cross, and they would be limited to deep water beyond the continental shelf. The Soviet hints concerning under-ice navigation accomplished during World War II may have referred to only the peripheral probing of the ice pack. Navigation along the entire route would have to take into account the extreme shallowness of the water in many places and, unless atomic-powered submarines were used, the problem of replenishing the air supply through the pack ice.

d. Physical Aspects of the Route

The Northern Sea Route extends from Murmansk to Provideniya, a total of 3,375 nautical miles (6,250 kilometers). At its eastern end, extensions lead to Anadyr', Magadan, Petropavlovsk-Kamchatskiy, and Vladivostok. The major part of the passage is within sight of the mainland or islands. Entrance to the Kara Sea is provided at four points -- around Mys Zhelaniya at the northern tip of Novaya Zemlya and through Proliv Matochkin Shar, Proliv Karskiye Vorota, and Proliv Yugorskiy Shar. The last two passages are most commonly used. The route then passes through Proliv Vil'kitskogo, Proliv Lapteva or Proliv Sannikova, and Proliv Longa (see Map 27359).

In the early days of the Northern Sea Route, a "Northern Variant" passing north of the islands to the Bering Sea was proposed. This route was pioneered and occasionally used by ships that had found the more southern route blocked by ice. In 1940 the Arctic Scientific Research Institute studied the variant and decided to build a series of polar stations along the northern shores of the islands to assist in navigation. A few of these stations have been established. A recent map of the Northern Sea Route traces the alignment of the Northern Variant and gives its length as 3,000 nautical miles (5,560 kilometers). 52, p. 10/ Hydrographic expeditions studying the variant route were active in the area of Severnaya Zemlya during late 1957 and early 1958. An expedition of the Hydrographic Directorate of GUSMP based at Mys Vatutin was scheduled to chart Proliv Krasnoy Armii between Ostrov Komsomolets and Ostrov Oktyabr'skoy Revolutsii and to make astronomic, geodetic, and hydrologic observations. In addition, 5 hydrographic ships made extensive depth soundings between northern Novaya Zemlya and Severnaya Zemlya. In early 1958, a crew from the Arctic and Antarctic Scientific Research Institute of GUSMP planned to conduct explorations in the strait between Ostrov Shmidta and Ostrov Komsomolets and in the waters surrounding Ostrov Shmidta. Severe ice conditions in mid-1958, however, evidently prevented the continuation of the hydrographic work in the waters adjacent to Severnaya Zemlya.

Ice conditions on the Northern Sea Route vary from year to year, and changes frequently occur within a single navigation season. Variations in atmospheric and climatological conditions have a great influence on the location of the pack ice, and the position of the southern ice limit fluctuates many degrees of latitude. During the navigation season, the position of the pack ice varies from day to day with changing winds. Narrow channels (leads) and wide areas (polyn'i) appear and disappear, forcing ships to follow an erratic course through the ice. The pack ice often closes in completely, and much time is lost in spite of icebreaker assistance.

Ice conditions during the 1956 navigation season were particularly severe and very few merchant ships traversed the entire route. Many vessels, including naval units, were either forced to turn back or winter along the route. Navigation in 1957 was also unusually difficult, especially in the Laptev Sea. North winds drove the pack ice far into the shipping lanes and obstructed navigation. Icebergs appeared in the northern part of Khatangskiy Zaliv for the first time in many years. The icebreakers Sibiryakov, Kapitan Voronin, and Kapitan Belousov suffered considerable damage during the navigation season and wintered at Tiksi (Figure 53). A shaft and other propeller parts were brought in by air, and repairs were completed before the opening of the 1958 navigation season.

Figure 53. Icebreakers wintering in the ice at Tiksi. The ships -- (1) Sibiryakov, (2) Kapitan Voronin, and Kapitan Belousov -- were marooned here throughout the winter of 1957-58.

According to the Soviet press, ice conditions in the Western Arctic at the beginning of the 1958 navigation season were the worst in 40 years, and icebreakers -- including the Yermak, Sibiryakov, Kapitan Melekhov, Kapitan Voronin, and Kapitan Belousov -- were assigned to assist convoys. 53/ The ice not only disrupted shipping schedules and caused congestion in the ports but also delayed ships moving eastward and may have caused a shortage of supplies for polar stations and other installations. The departure of the first convoy from Dikson to the eastern Arctic was delayed by unfavorable ice conditions until mid-August. Ice conditions were most serious in the central sector at Proliv Vil'kitskogo. In late August, a total of 6 icebreakers were escorting convoys in the area, whereas only one icebreaker was escorting vessels in the Kara Sea and in the East Siberian Sea. On 30 August the Sevan, a small merchant vessel, sank in the ice while under icebreaker escort in Proliv Vil'kitskogo. By mid-September, ice conditions west of Khatanga became even more serious. Ships at Khatanga, after completing their loading and unloading operations, proceeded eastward rather than attempt passage to the west through the strait. Foreign vessels loading timber at Igarka left the port by 25 September in order to avoid worsening ice conditions. At the same time, ice conditions in the Eastern Arctic were unusually favorable. A convoy sailed from Provideniya to Pevek in 5 days, a record time for transit of the difficult Proliv Longa.

Annual variations in the position of the ice determine the dates for the opening and closing of navigation, but in general the season lasts 135 days with icebreaker support and 97 days without it, provided ice conditions are favorable. Under extremely unfavorable ice conditions, navigation may be possible for as few as 42 days with icebreakers or completely impossible without their assistance. 54, p. 184/ The narrow strait areas are navigable for much shorter periods than are the seas.

Experiments to increase the melting rate of ice have been conducted in an attempt to (1) lengthen the navigation period of the Northern Sea Route and Arctic rivers, (2) clear ports and harbors, (3) prevent ice jams at river estuaries, and (4) free ice-bound vessels. The accelerated melting of ice has been accomplished only on a small scale in selected areas such as Arkhangel'sk and Tiksi, and ice in most areas is still removed by icebreakers and explosives. The materials that have been used most effectively to accelerate melting are salvaged foundry sand and diesel-oil wastes; coal cinders and coal dust have also proved effective. Approximately 50 days before the normal ice breakup, aircraft fly 15 feet (4 meters) above the ice and spread the materials, which darken the surface of the ice and increase the rate at which it absorbs the sun's heat. 55/ The treated ice disappears 15 to 20 days earlier than untreated ice. Ice on the Severnaya Dvina at Arkhangel'sk was treated in this manner at one-sixtieth the cost of renting icebreakers to remove it. 56/ Ships that wintered in Khatangskiy Zaliv were freed from the ice at the beginning of June 1958 after a Polar Aviation aircraft scattered coal dust on the ice surrounding the ships in order to accelerate the melting of the ice.

During the winter, navigation is limited to the southern half of the Barents Sea where the warm Nordkap Current of the Gulf Stream keeps the sea free of ice. By July or early August the river ice goes out and the discharge of the rivers melts the adjacent pack ice. In early September the ice has retreated farthest northward, but several areas along the route remain choked with ice. These congested areas include the Arkhipelag (Archipelago) Nordenshel'da, Proliv Vil'kitskogo, and sections of the East Siberian and Chukotsk Seas in the region of Proliv Longa.

Summer ice conditions in the straits are governed by winds. When the winds blow from the northwest, Proliv Vil'kitskogo is jammed, and ships cannot enter from either direction. Even under normal conditions the strait contains some pack ice, but it can be negotiated for 5 to 7 weeks in late summer. Proliv Longa becomes ice blocked when winds blow from the east. The strait is seldom ice free. When the ice does disperse, it retreats northward to the vicinity of Ostrov Vrangelya.

Icebergs are encountered in summer in the western part of the Laptev Sea and around the northern tip of Novaya Zemlya. They are formed from fragments separated from the lower ends of the glaciers that cover large parts of Severnaya Zemlya and Novaya Zemlya.

Fog, another restriction to navigation, reaches its greatest intensity during the navigation season. Fogs occur from 15 to 25 days per month during July and August. The fogs are of short duration, lasting from 12 to 24 hours, but occasionally they remain for several days. There are records of ships sailing from Murmansk to Dikson without sighting land. 57, p. 10/ These ships used radio navigation beacons to guide them along the route.

Shoal areas along the route are also a navigational hazard. They are encountered from Proliv Yugorskiy Shar to the Kolyma River and are a limiting factor to the size of vessels that can sail the route. Most ships have a draught of 22 to 26 feet (7 to 8 meters), which enables them to navigate nearly all sections of the route.

The first shallow area encountered in a west to east passage is at Proliv Yugorskiy Shar. The water here is 32 feet (10 meters) deep. Another shoal area extends from Ostrov Belyy to Ostrov Dikson, where depths reach a minimum of 10 feet (3 meters). Tiksi is located in a shoal area on the eastern side of the Lena Delta. Although depths vary from 10 to 27 feet (3 to 8 meters), a dredged channel enables ocean vessels to dock at Tiksi. The two entrances to the East Siberian Sea -- Proliv Sannikova and Proliv Lapteva -- are both shallow. The former is 36 feet (11 meters) deep, whereas the latter and more frequently used strait has several areas only 21 feet (6 meters) deep. Shoals are also found off the Indigirka and Kolyma River deltas. Ambarchik, an important port at the mouth of the Kolyma, has a depth of 3 to 10 feet (1 to 3 meters), and ocean vessels must anchor several miles offshore.

e. Shipping Procedure

Shipping procedure on the Northern Sea Route is controlled by the short navigation season. To reduce travel time and ice danger, most ships start from either the eastern or western end and move toward the center, unloading cargo along the way; cargo for the remaining half of the route is unloaded at Tiksi to be picked up by ships returning to their home ports of Murmansk, Arkhangel'sk, or Vladivostok. Tiksi was chosen as the turn-around point on the route and has subsequently developed into an important transshipment and bunkering port. Often the cargo space of ships is not fully utilized. Vessels in the western sector usually sail back from Tiksi to Arkhangel'sk in ballast after delivering cargoes whereas ships in the eastern sector often sail in ballast from the Chukotsk Peninsula to Tiksi, where they take on timber for the return voyage.

Through the turn-around method, travel time for a ship is reduced, although added time is spent transshipping cargo. At ports that are short of lightering equipment or docking facilities, freighters may have to wait several days before unloading. During the latter part of the 1955 navigation season, ships were forced to wait 2 to 3 weeks at Arkhangel'sk before unloading and loading cargoes. Freighters often must anchor as much as 15 miles (24 kilometers) offshore and be unloaded by small lighters. Since these craft, may have only 1- or 2-ton capacities and can make only 2 or 3 trips a day, unloading is a lengthy procedure.

By traveling only part of the route, many ships are spared the passage through ice-choked Proliv Vil'kitskogo. In the early 1930's an alternate to this part of the route was proposed, which would have bypassed the strait to the south. The plan entailed sailing up the Pyasina River to a canal connecting it with the Kheta River and then following this river to Khatangskiy Zaliv and Nordvik. This route would have required an extensive system of locks to make it navigable. The difficulties of constructing and maintaining such a system would have been enormous, and the project presumably never proceeded beyond the planning stage. 58/

Sailing time required to cross the route -- 20 to 25 days under favorable conditions -- depends not only upon ice conditions, but also upon the number and type of ships making the voyage. Convoys move slower than individual ships and spend about 60 days sailing from Murmansk to Provideniya. The shortest crossing by an individual ship was made in 1940, when the German auxiliary cruiser Komet, favored by optimum ice conditions, completed the trip in 21.5 days of which only 14 days were spent under way. Since then Russian freighters have made the trip in 22 to 27 days. The standard oil- or coal-burning freighter, which must stop many times to unload and load cargo, could make only one trip across the entire route during the navigation season. The turnaround system was adopted for this reason. Few ships make the complete passage, and only vessels being reassigned or carrying special cargo travel the whole length. The turnaround system has the advantage not only of reduced travel time but also of increased use of each vessel.

Ships sailing eastward from Murmansk or Arkhangel'sk normally travel singly to Dikson. Ice conditions in the Barents and eastern Kara Seas are usually such that no difficulties are encountered. When assistance is needed, the vessel contacts Dikson; and, if ice conditions are not serious enough to warrent the use of an icebreaker, an aircraft is sent to investigate the area and direct the vessel to clear water. Foreign ships sailing eastward to Igarka must carry provisions for 60 days as well as emergency repair equipment, including wooden girders, quick-setting cement, and oakum, since neither materiel nor bunkering facilities are available to them between Murmansk and Igarka. 59/

East of Dikson, ice conditions and shoal areas make navigation hazardous and ships usually travel in convoys. During the severe ice conditions of the 1957 navigation season, one convoy of 5 vessels sailing from Dikson to the Laptev Sea was accompanied by 4 icebreakers -- Kapitan Voronin, Admiral Makarov, Kapitan Belousov, and Sibiryakov.

The size of the convoy depends upon the severity of ice conditions and the horsepower and strength of the icebreakers and freighters. The average convoy consists of about 10 freighters led by an icebreaker. If ice conditions are particularly bad, 2 or more icebreakers will accompany the ships. Slow freighters are formed into small convoys of only 3 or 4 vessels. The most powerful icebreaker leads the convoy and is followed by the broadest beamed freighter. When several icebreakers are used they are scattered throughout the convoy, and one also serves as a rear guard to assist stragglers. The interval between ships is decided by the convoy captain and varies with ice conditions and the speed of travel.

f. Scientific Support

Many scientific services contribute to a successful voyage on the Northern Sea Route. The need for such support was clearly demonstrated in 1937, when 26 ships, including 7 of the 8 icebreakers in the Arctic, were trapped in the pack ice as a result of poor information on ice. Present day scientific support includes, in addition to ice reconnaissance, weather reporting and hydrographic information. Hydrographic vessels are responsible for charting tides, currents, and depths and for establishing navigation aids including markers, lights, and radio beacons (Figures 54 and 55).

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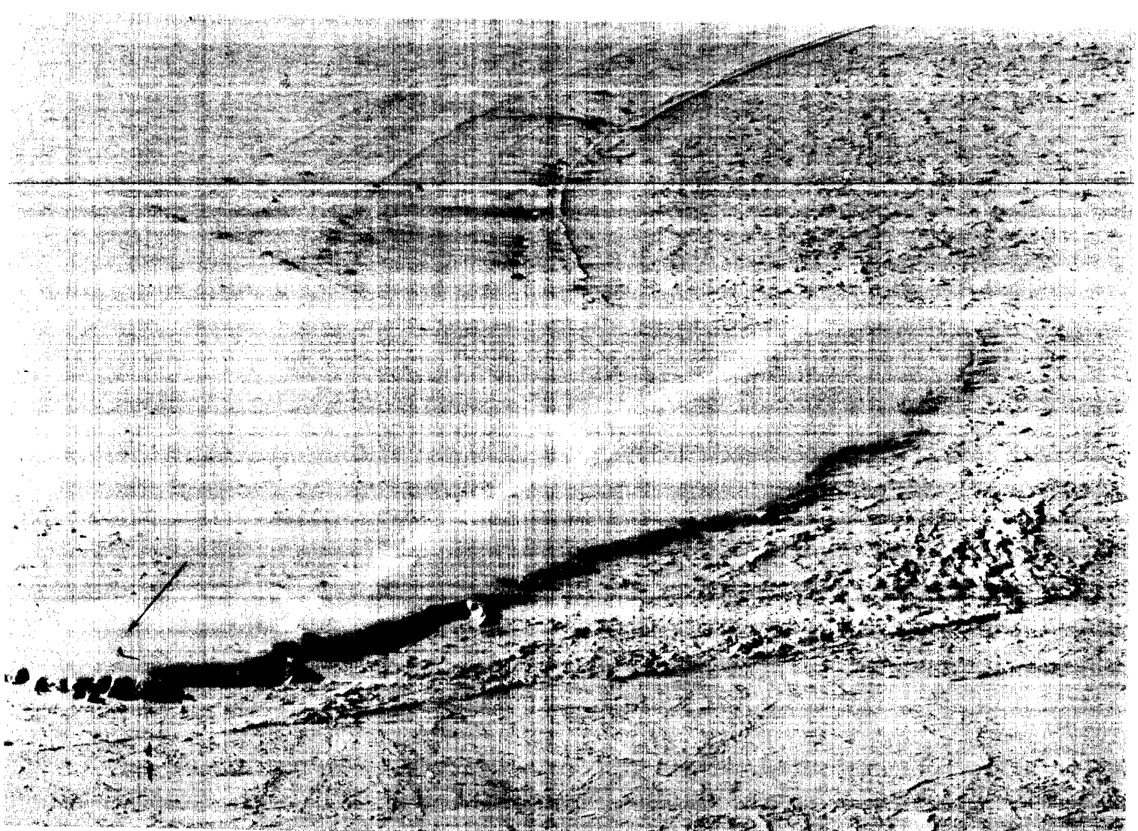

Figure 54. Mys Vankarem on the northern coast of Chukotsk Peninsula is marked by a pyramidal wooden tower (arrow). A light is shown atop the tower at night. The Vankarem Polar Station is in the background. (1951)

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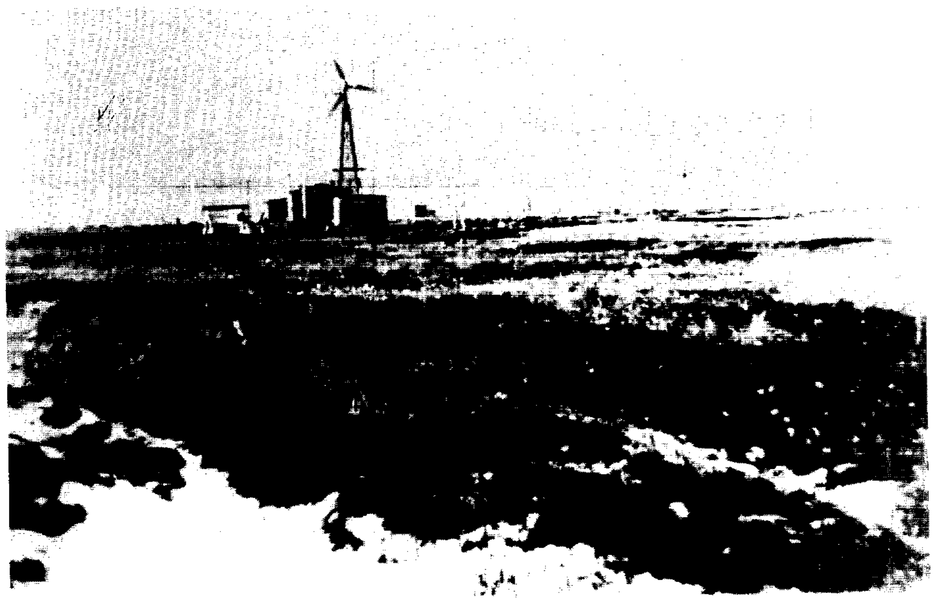

Figure 55. A radio beacon at Mys Kosistyy. The windmill generates power for the beacon.

Ice reconnaissance, the most important support function, is provided in several ways. Some data are collected by drifting stations, flying observatories, and high-latitude air expeditions. These groups, however, devote only a small portion of their time to the collection of ice data; and the information is not so detailed as that provided by air reconnaissance, which accounts for the major part of the information collected. The ice charts and other data supplied are used for reports on the current situation as well as for long-range forecasts.

Aircraft used for the reconnaissance are under the Directorate of Polar Aviation. In 1956, 59 aircraft flew 6,700 hours and covered 1,032,000 miles (1,665,000 kilometers). In 1958 about one half as many aircraft flew 5,000 hours. The aircraft usually fly at an altitude of 2,000 feet (610 meters), and the ice charts are compiled during the flight. Maps at a scale of 1:3,000,000 or 1:1,500,000 are used over the sea; maps at 1:500,000 are used near land, and maps at 1:200,000 are used for critical areas. Standard symbols have been adopted; and colors indicate the amounts of ice and clear water, age and shape of the floes, amount of hummocking, and many other features. The information is radioed to all ships and ports within the sector mapped. All shipmasters beginning a voyage or enroute rely on such information to guide their ships. If a ship or convoy is in distress or if winds and currents cause rapid changes in ice conditions, reconnaissance aircraft assist them by dropping large-scale charts to the vessels. These charts, however, often miss the ships or fall where they cannot be retrieved from the ice.

Photofacsimile apparatus for the transmission and reception of ice charts has been installed on aircraft; 2 icebreakers, the Yermak and Mikoyan; and at 11 polar stations -- Amderma, Dikson, Mys Chelyuskin, Mys Kosistyy, Tiksi, Kresty Kolymskiye, Pevek, Appapel'khin, Mys Shmidta, Provideniya, and Beringovskiy. Reconnaissance aircraft can transmit ice charts to the icebreakers or the shore stations. The photofacsimile equipment can also be used to transmit weather charts.

Reconnaissance flights are carried out during all seasons of the year, but winter flights are infrequent since the pack ice is more stable then than in other seasons. The first reconnaissance of 1959 took place on 11 February. Ice reconnaissance flights are termed strategic or navigational, depending on their purpose and the season of the year. Strategic reconnaissance is carried out over the ice of the Arctic Seas and adjacent Arctic Basin areas. The flights follow predetermined routes and enable studies to be made of ice variations in a specific area. Bull aircraft are used for these surveys because of their great range.

Pre-navigational reconnaissance in May is coordinated with observations conducted during the high-latitude air expeditions; the result is a composite picture of ice conditions over the entire Arctic Basin obtained in a minimum period of time.

Navigational reconnaissance flights begin before ships start moving on the Northern Sea Route and end at the conclusion of the navigation season. Flights are frequent since the ice situation changes rapidly. Coach and Cab aircraft are used for reconnaissance in the Arctic Seas, whereas Colts and helicopters are used in coastal areas. The number of aircraft used for reconnaissance varies with the number of ships sailing on the Northern Sea Route and the severity of ice conditions. The greatest number of flights are made in Proliv Vil'kitskogo and Proliv Lapteva since they are the areas of greatest ice hazard. 60/

Ships sailing on the Northern Sea Route also provide data on ice conditions. Since 1955, all ships in Arctic waters have made ice and hydrometeorological observations and transmitted the data to regional forecasting centers.

Experiments are being conducted on other methods of ice reconnaissance. Television provides a continual view of ice conditions confronting a convoy. The camera, with a vision angle of 45 degrees, is carried in an aircraft; and the screen is placed on the captain's bridge of the icebreaker. The image transmitted from the aircraft, which has a width of about 3 miles (5 kilometers), assists the vessel in picking its way through the ice. According to one report, fog and darkness do not restrict operations since the camera has special instruments, probably infrared, adapted for night observations. 61/ Radar ice reconnaissance that would permit observations through fogs, snow storms, and clouds is under consideration. Such a system will be difficult to perfect since water and ice have very similar radar reflections. Aerial photography has also been used by icebreakers to guide vessels through the Northern Sea Route.

Drifting radio beacons (DARB's) and automatic radiometeorological stations (DARMS's) are employed in the Arctic Basin to facilitate operations along the Northern Sea Route. DARB's emit a scheduled radio signal that enables polar stations to plot their positions and trace the direction and rate of ice movement. (Figures 56 and 57).

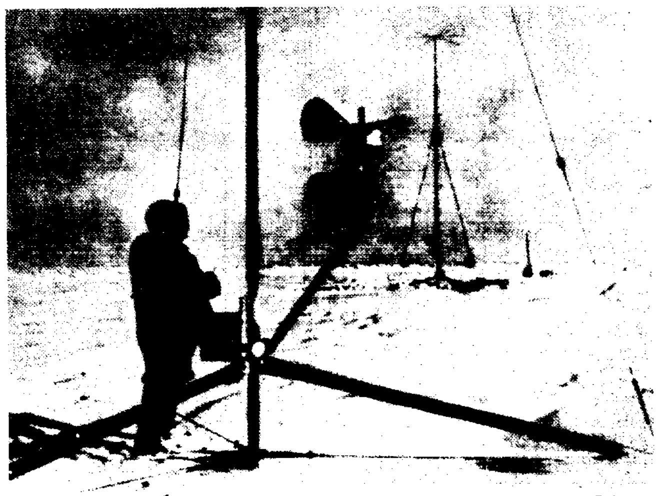

Figure 56. A drifting automatic radio meteorological station (DARMS) set up on pack ice. (1958)

DARMS's transmit information four times a day on air pressure and temperature, wind velocity and direction, and ice direction and rate of movement. DARM signals can be received at distances up to 930 miles. If a DARM receives a special signal from a coastal station or passing aircraft, it immediately and automatically transmits weather information throughout its vicinity. 62/ A DARM continues to operate until it is destroyed by the shifting pack ice or its battery fails. The battery, although designed to function for a year, seldom lasts that long. Complaints have been made that the stations cease working in the fall, the most difficult season for navigation on the Northern Sea Route. To ensure continuous operation in the fall, it has been suggested that new DARMS's be established in late summer. Since they are not prohibitively expensive and are probably regarded as expendable, it is undoubtedly cheaper and easier to establish new DARMS's than to spend time and effort searching for and reactivating silent stations.

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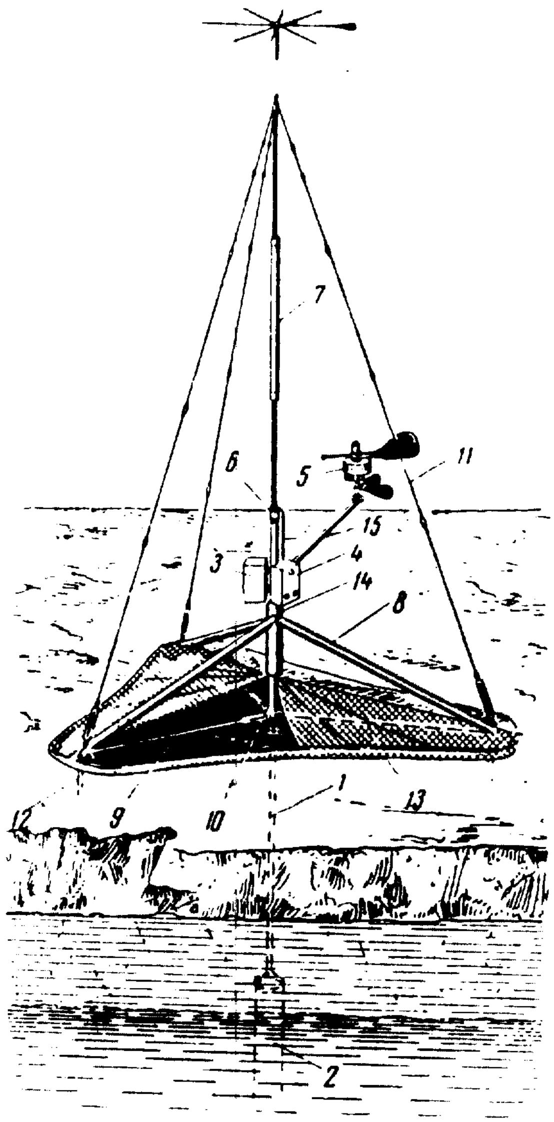

Legend

(1) Underwater extension of mast
(2) Underwater housing for battery
(3) Radio transmitter
(4) Radio receiver
(5) Meteorological instruments
(6) Isometer
(7) Antenna mast
(8) Support
(9) Brace
(10) Collar
(11) Wire brace
(12) Wooden anchor
(13) Screen cover
(14) Rubber cushion for supports
(15) Bracket for meteorological instruments

Figure 57. Sketch of a DARMS.

DARB's have been used every year since 1952, and the number established in a given year has varied from 2 to 17. DARMS's were first used in 1956, when 2 stations were set up on the ice. For the 1957 navigation season the "Sever 9" High-Latitude Air Expedition of the Arctic and Antarctic Scientific Research Institute set up 14 DARMS's and 11 DARB's within the 4 major ice masses -- Novozemel'skiy, Severozemel'skiy, Taymyrskiy, and Ayonskiy -- as well as in the area of SP-6. A total of 20 DARMS's and DARB's were set up on the pack ice by the 1958 High-Latitude Air Expedition in 1958. By the fall of 1958, all of the DARMS's and all but 1 of the DARB's had ceased to function. However, 8 new DARMS's were established in the eastern Arctic during the fall resupply operations for the drifting stations.

Stationary automatic radiometeorological stations (ARMS-54's) that operate on land are under development. They will perform the functions of a standard meteorological station but without operating personnel.

The data collected by aerial reconnaissance, DARMS's, DARB's, drifting stations, and other methods are analyzed; and reports are prepared at regional centers and at the Arctic and Antarctic Scientific Research Institute in Leningrad. Forecasts are of 2 types -- short term, which cover from 1 to 10 days in advance; and long-range, which cover several weeks to 1 year. Short-term forecasts are usually limited to a particular area and include an evaluation of local hydrologic, cryologic, and atmospheric conditions. They are produced at field stations, such as Dikson and Tiksi. Long-range forecasts are released by the Arctic and Antarctic Research Institute twice a year, in winter to cover the first half of the navigation season and again in summer for the remainder of the navigation season. They include the following: (1) extent of ice cover for each individual sea; (2) area of the principal floating ice masses; (3) periods of disintegration of fast ice in the vicinity of important ports, straits, and bays; (4) beginning of navigation with and without icebreakers on the main sectors of the route, and (5) beginning of new ice formation. Attached to the forecast is a chronological schedule indicating changes in ice conditions to be expected from the moment of breakup of the fast ice until the final freezing over. These forecasts serve as a basis for planning maritime operations, especially for determining the traffic capacity of the route. According to the Soviets, the reliability of these long-range forecasts has been 70 to 80 percent correct during the past few years. 63/

Copies of the reconnaissance maps are sent to the Arctic and Antarctic Scientific Research Institute to be consolidated and published as a series called Ledovyye Yezhegodniki (Ice Yearbooks). Such yearbooks were published regularly up to 1945; their present status is not known.

g. Types of Ships

Most vessels sailing the Arctic seas are freighters and icebreakers and, to a lesser extent, tankers and passenger ships. Ocean-going lighters and barges are used extensively in the Barents Sea and also between ports along the central Arctic coast. The Northern Sea Route is occasionally used by river vessels sailing from European shipyards (East Germany, Czechoslovakia, and Finland) to ports on West Siberian rivers.

Although shoals limit the size of the vessels along the route, they average 1,500 to 2,000 displacement tons and 22 to 26 feet (7 to 8 meters) draught. Lend-lease Liberty ships, which are still in use, are much larger. Since they average 10,000 tons and have a draught of 28 feet (8 meters), they are excluded from many stretches of the route.

Freighters are classified according to their ability to navigate in ice-infested waters. Icebreaking steamships belong to the first class and include ships that can sail unaided in compact ice and can lead other vessels through light ice. A ship of this type has a reinforced hull, special rudder, changeable propeller blades, and diesel-electric engines. For a given weight of fuel, propulsion of this type will carry a ship 3 times as far as coal-fired steam engines. Six ships of this class -- the Ob', Yenisey, Lena, Indigirka, Angara, and Baykal -- have been constructed (Figure 58). Defects became apparent when these ships sailed in fast ice, and an improved version has been designed. The construction of a prototype was scheduled to begin in 1957 at Nikolayev. 64/

Vessels of the ice-going class are freighters of a more vulnerable type. They have reinforced hulls and powerful engines, but they cannot navigate alone in compact ice. Ordinary freighters such as the Liberty ships are the most vulnerable since they have no reinforcement or special equipment. They cannot navigate in ice more than 4 inches (100 millimeters) thick.

The Soviet Union has the largest icebreaker fleet (35 ships) in the world because most of its ports are ice-bound during the winter. Nearly half (15) of the icebreakers are stationed in the Arctic. Most of them are seagoing vessels, and the remainder are river icebreaking tugs. The Soviet Government considers many types of ships as icebreakers, among them capital and auxiliary icebreakers, expedition ships, port icebreakers, and icebreaking freighters. The largest ships are the capital icebreakers, which include the Stalin, Admiral Lazarev, Admiral Makarov, and Yermak (Figure 59). The capital icebreakers lead convoys and clear lanes through the ice. They carry surplus fuel and food supplies for marooned vessels and have workshops

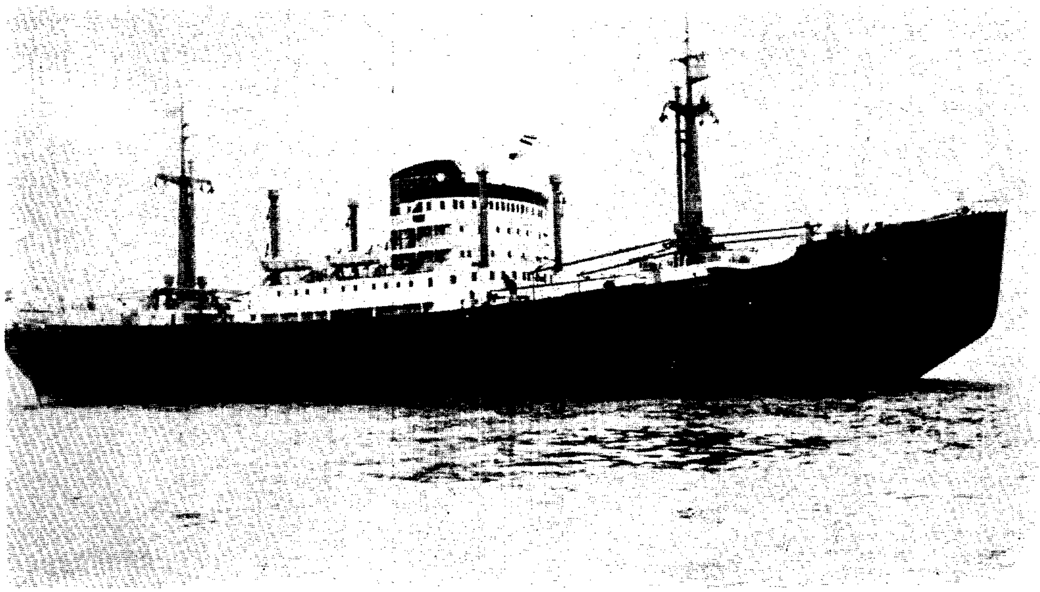

Figure 58. The diesel-electric ship Lena. The sharply undercut bow is similar to that of an icebreaker and enables the ship to navigate in heavy ice.

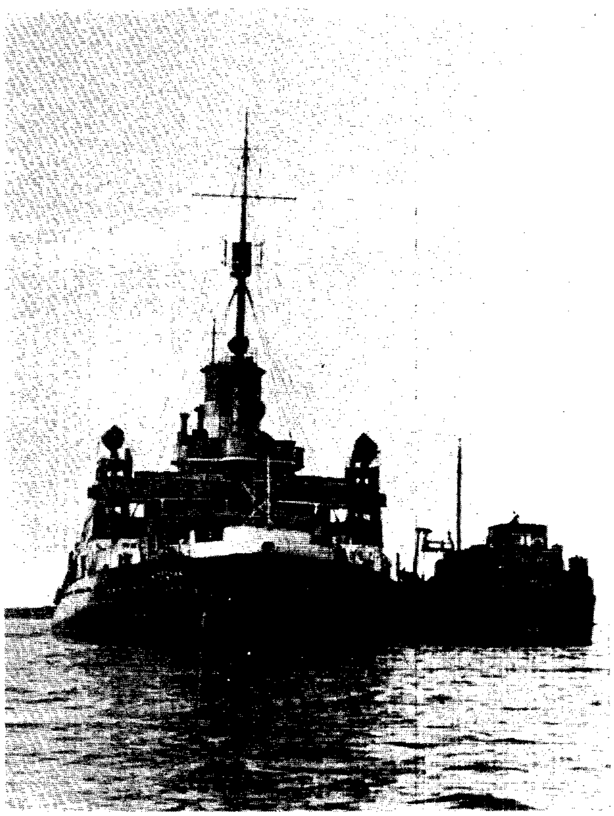

Figure 59. The icebreaker Iosif Stalin loading supplies at Ostrov Dikson.

for minor repairs. The Stalin and Admiral Makarov have diesel-electric engines and develop up to 20,000 horsepower. The other icebreakers burn coal, have a limited range, and require frequent refuelling.

Auxiliary icebreakers are used to free individual ships and to assist stragglers in convoys. They are more maneuverable than capital icebreakers but cannot work in heavy ice that must be cleared by impact. Expedition ships, such as hydrographic vessels, can move unaided in heavy ice but cannot assist other ships. Icebreaking freighters, such as the Ob' class ships, are also reinforced and powered to sail unaided in compact ice. Port icebreakers are stationed at the main harbors along the route to keep the ports clear of ice and assist vessels when docking or departing.

Icebreakers are scheduled to escort vessels through difficult portions of the Northern Sea Route, which is divided into eastern and western sectors at 140°E. On reaching the terminus of a sector, a convoy takes on a new icebreaker. The relieved icebreaker then waits to pick up a new convoy for its return trip. Foréign ships requiring assistance must pay for this service.

An atomic-powered icebreaker, the Lenin, is currently under construction. Work began on the icebreaker in the spring of 1956 at the Admiralty Shipyard, Leningrad. Although it was launched on 5 December 1957, the Soviet press stated that the ship would not be completed until April 1959 (Figure 60). It is 439 feet (134 meters) long and 88 feet (27 meters) wide and has a displacement of 16,000 tons. The 44,000 horsepower developed for the main propulsion utilizes about two-thirds of the output of the 3 atomic reactors. The Lenin is equipped with a double bottom, water tight compartments, side surge tanks, heavy framing and plating, bow and stern propellers, a helicopter, a small cutter, and torpedoes. The last are to be used to break up pack ice. The Lenin will carry a year's supply of food and fuel and will be able to navigate in unexplored areas of the Arctic Basin.

According to a trade agreement, Finland is building 2 icebreakers (the Moscow and Leningrad) of 13,200 tons displacement for the USSR. The diesel-electric engines will develop 22,000 horsepower and will power 3 stern propellers. 65/ The ships will have over twice the displacement and horsepower of the 3 icebreakers of the Kapitan Voronin class built for the Soviet Union in 1954 (Figure 61).

h. Availability of Fuel

Coal and oil are available for fuel at the terminal ports of Murmansk, Arkhangel'sk, and Provideniya and also at Dikson and Tiksi. Ships usually carry sufficient fuel for their voyage on the Northern

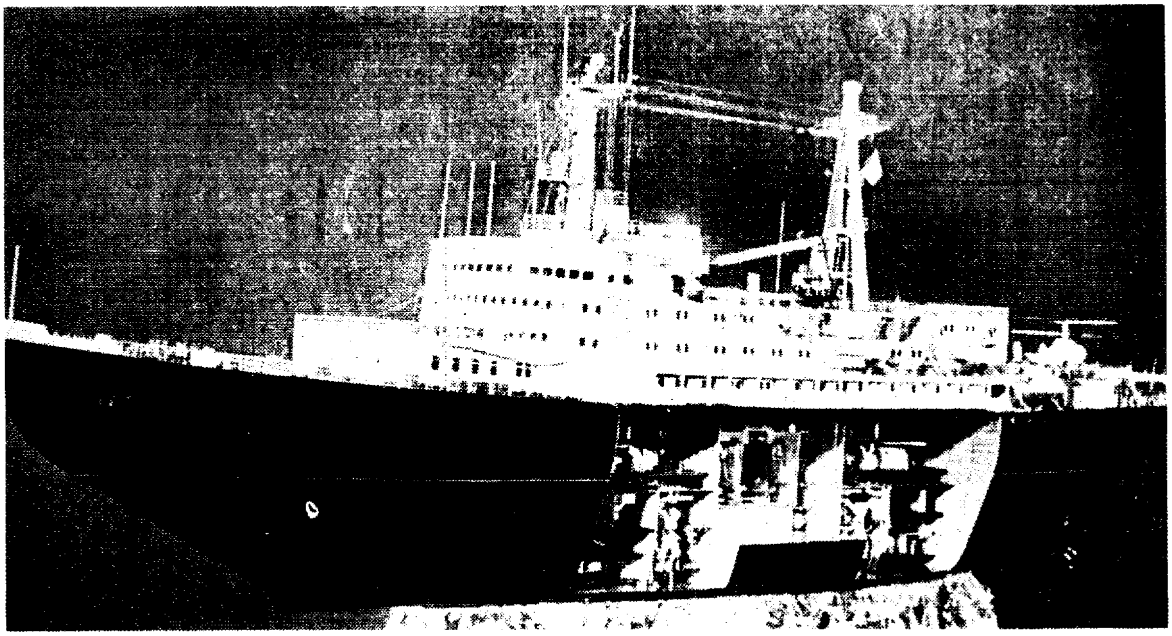

Figure 60. Model of the 16,000-ton atomic-powered icebreaker Lenin.

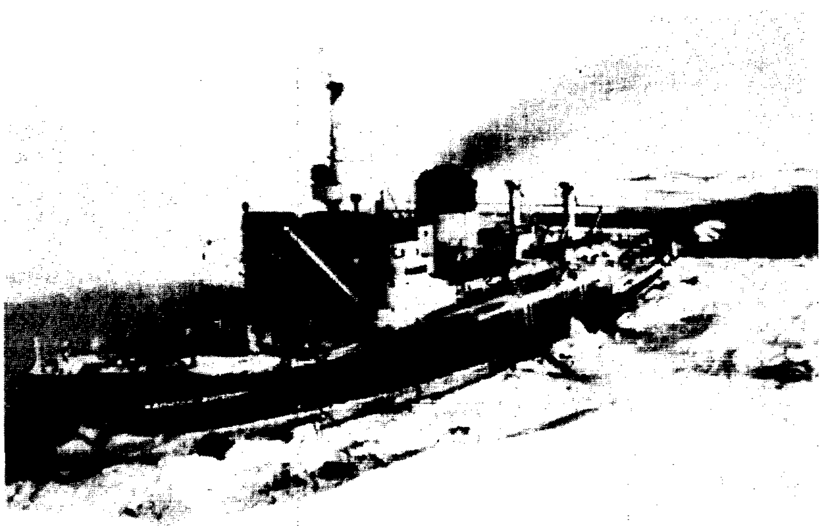

Figure 61. The Kapitan Voronin, an icebreaker of 5,360 tons displacement and 10,500 horsepower. (1958)

Sea Route; but, in an emergency, additional supplies could probably be obtained from bunker ships or ports along the route.

Murmansk and Arkhangel'sk obtain coal from Vorkuta. Prior to World War II, Spitzbergen supplied their coal, but during the war the vulnerability of the supply line was recognized and the Vorkuta fields were developed. Dikson, the bunkering station for the Kara Sea, receives its coal from Noril'sk. Before the Noril'sk-Dudinka Railroad was completed, coal was sent down the Pyasina River to Dikson. Since 1938, coal has been moved over the railroad to Dudinka and then by barge down the Yenisey River to the port. Ships in the Laptev Sea bunker at Tiksi. Local coal on the Sogo River and at Bulun is unsatisfactory for ship fuel, and supplies are brought from Sangar, 750 miles (1,200 kilometers) up the Lena. In 1957 the mine at Sangar delivered 24,000 tons of coal to Tiksi for use by GUSMP. Provideniya services ships in the eastern part of the route. Coal was formerly imported from Vladivostok. With the development of the deposits at Beringovskiy, 150 miles (240 kilometers) south of Anadyr', a more convenient source was established. Provideniya received 45,600 tons of coal from Beringovskiy during the 1957 navigation season.

Oil is used as a fuel by relatively few of the Russian ships on the Northern Sea Route, chiefly by the most recently constructed freighters and icebreakers and lend-lease Liberty ships. Oil is not produced locally in the Arctic, and the ports are supplied by river barges and tankers and by ocean tankers (Figure 62). A number of

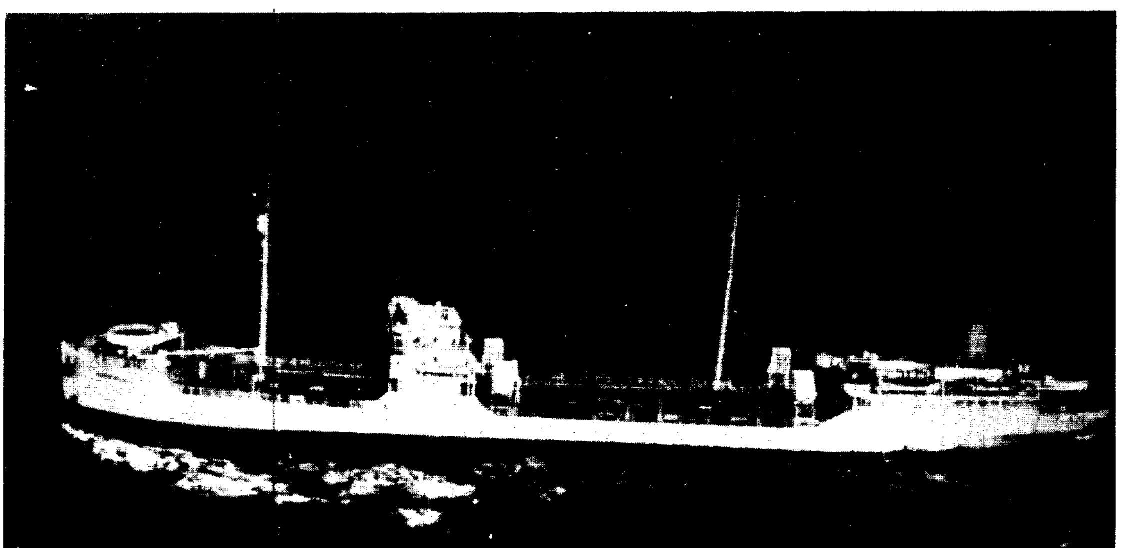

Figure 62. The oil tanker Azerbaydzhan (6,000 GRT) in the Arctic. (1956)

tankers with reinforced hulls are being built for the Soviet Union by Finland and will probably be put into service on the Northern Sea Route.

During the 1958 navigation season a minimum of 100,000 tons of fuel and lubricants was delivered to Arctic ports. Vladivostok shipped most of the bulk and barreled POL; lesser amounts originated at Batumi, Murmansk, Arkhangel'sk, Severodvinsk, and the Lena River. POL is stored in bulk tanks that range in capacity from 10 to 600 tons and are placed either above or below ground. Non-metal underground storage facilities may be used at some ports. The largest bulk storage facilities are at Provideniya (estimated 20,000 tons) and Pevek (estimated 10,000 tons). Where bulk storage is not available, barrels are used; and approximately 125,800 barrels would be required to handle the 18,500 tons of packaged POL delivered in 1957.

i. Ports Along the Route

When GUSMP was founded, ports along the Northern Sea Route were almost nonexistent, except for the terminal ports of Murmansk and Arkhangel'sk. Elsewhere along the coast, there were only small fishing villages and the harbor at Dikson. In establishing its ports, GUSMP attempted to select bases that would be suitable for provisioning ships and could also be used for developing the hinterland. The ports that were founded did not always serve both of these functions. Currently the more important ports include Arkhangel'sk, Murmansk, Dikson, Dudinka, Igarka, Tiksi, Ambarchik, Pevek, and Provideniya.

Arkhangel'sk is the largest port in the Soviet Arctic. In addition, it is the biggest lumbering center in the USSR and an important transshipment point for ocean and river vessels. The port area, which extends for 20 miles (32 kilometers) along the lower Severnaya Dvina River and its estuary channels, has about 75,000 feet (2,300 meters) of wharfage. Wharf cranes are adequate for general-cargo transfer, but ship's gear must be used for loading at timber wharves. Storage facilities include covered storage space with a floor area of 1,340,000 square feet (123,280 square meters), 3 petroleum terminals with a total capacity of over 400,000 barrels, and 3 coal terminals with a storage area of 14 acres (6 hectares). Most of the wharves are cleared by rail lines which feed into a doubletracked line to Vologda. Freight moving over this line must be ferried across the Severnaya Dvina River. The port has 7 shipyards, which repair large ships such as destroyers and commercial vessels and construct small tugs, fishing boats, and lighters. 66/

Murmansk, the second largest port in the region, has a harbor that extends for 7 miles (11 kilometers) along the eastern side of Kolskiy Zaliv. Grain, petroleum products, and coal are the chief imports; and ores, fish, and lumber products are the most important exports. The port has approximately 25,000 feet (7,600 meters) of wharfage, of which 3,000 feet (915 meters) is used by the Soviet Navy. Most of the cargo wharves have rail clearance, covered storage buildings, and cranes. Special equipment is used in handling petroleum, coal, ores, and fish. The more important of the general-cargo and fish wharves have covered storage buildings with a floor space of about 500,000 square feet (46,000 square meters). POL storage is estimated at 87,500 barrels, and coal storage yards cover a total area of 20 acres (8 hectares). Rail lines clearing the port lead south to Kandalaksha, north to Severomorsk, and west to Pechenga. Murmansk has 5 shipyards engaged in construction and repair of ships varying in type from fishing vessels to destroyers. 67/

East of Arkhangel'sk and Murmansk the size and number of facilities at ports decrease markedly. The ports to the east have been developed by GUSMP in the past few decades, and many are still inadequately equipped for handling the large amounts of shipping that arrive and depart during the short navigation season. Dikson, however, is an important fueling base for the western section of the Northern Sea Route as well as an important transshipment point for Yenisey River traffic. After unloading their cargo, most ships bunker with coal and proceed in ballast to Igarka to load timber. At Dikson pilots are provided for vessels proceeding up the Yenisey River. The Chief of Staff of Maritime Operations in the western sector of the Northern Sea Route is stationed here and supervises all shipping operations in this sector.

The harbor at Dikson consists of outer and inner roads. The outer road, south of Ostrov Dikson, has an area of 15 square miles (39 square kilometers) and a depth of 40 to 100 feet (12 to 30 meters). The inner road, between Ostrov Dikson and the mainland, covers 3 square miles (8 square kilometers) and has a depth of 25 to 45 feet (8 to 14 meters). Seven wooden wharves with a total length of about 1,200 feet (3,600 meters) are located in the inner road. Cargo cranes, including portal cranes, gantry cranes and possibly a caterpillar steam crane have been installed at the port to facilitate cargo movement. Conveyors for handling coal are available at 2 coal wharves and 1 coal pier. About 4 acres (2 hectares) of coal storage space are located on Ostrov Konus and petroleum tanks with an estimated capacity of 22,000 barrels are situated on Ostrov Sakhalin and Ostrov Dikson. 68/

Dudinka serves as the port for the mining and metallurgical center of Noril'sk. Large quantities of machinery, construction materials, and food stuffs enter the port; and coal, copper, nickel, and cobalt are shipped out. Because the port is located at the junction of the Dudinka and Yenisey Rivers, spring ice jams are likely to raise the water level more than 50 feet (15 meters) and cause extensive damage to port facilities. Approximately 7,000 feet (2,130 meters) of wharfage are available for general cargo in addition to specialized berths for handling petroleum, coal, and lumber. The wharves contain several cranes, conveyors, and ore loaders and are served by rail spurs. Storage facilities include 70 covered storage buildings with a combined floor area of 1 million square feet (92,000 square meters), which are located near the main wharf; a 50 tank petroleum terminal of 250,000-barrel capacity; and a coal yard covering nearly 4 acres (2 hectares). 69/

Igarka, the second largest lumber center in the Soviet Arctic, is located on the high northern bank of the Yenisey, where the river for a short distance flows westward. Several planked ramp roads provide access to the main wharf (see Figure 20). This wharf and an industrial wharf, with a combined length of 2,150 feet (655 meters), are rebuilt each spring after the ice has moved out and the flood has passed. Four standard ocean-type vessels can berth at the main wharf, and limited additional anchorage is available in the river channel. Ships must use their own gear to load lumber since the wharves have no facilities for loading large ships. An area of about 245 acres (100 hectares) is available for storing lumber and logs. Storage for petroleum, consisting of 5 tanks with a total capacity of about 45,000 barrels, is located west of the main wharf. Bunkering coal is stored to the east of it. 70/

Tiksi was developed to serve as a transshipment point for Lena River traffic, a coaling station for the middle stretches of the Northern Sea Route, and a turnaround point for ships arriving from both ends of the route. Port facilities have undergone repair and expansion since 1955. Wharves and moorings are being repaired and gantry cranes, portal cranes, and scraper hoists have been installed. The portal cranes make possible a considerable saving of ship-hours for cargo ships and river craft while in port. The speed with which ships are cleared depends on the number of ships in the harbor and the type of cargo being handled. Coal is loaded rapidly, which suggests the extensive use of mechanized conveyors. General cargo is sometimes handled slowly and up to 3 weeks may be required to complete the operation, possibly when ships unload their cargo in the harbor by lighters rather than at piers. The port is located on the southern shore of Zaliv Bulukan, an indentation on the western shore of Bukhta Tiksi. Six piers serve the port, three of which -- a main pier, lighter pier, and petroleum pier -- have been identified. The main pier, which can accommodate 2 small ocean freighters, has a dredged channel and an along-side depth of 22 feet (7 meters). It is served by 2 locomotive cranes and 2 portal jib cranes. Other vessels can anchor in the inner portion of the harbor, where they are loaded and unloaded by lighters and barges (Figure 63).

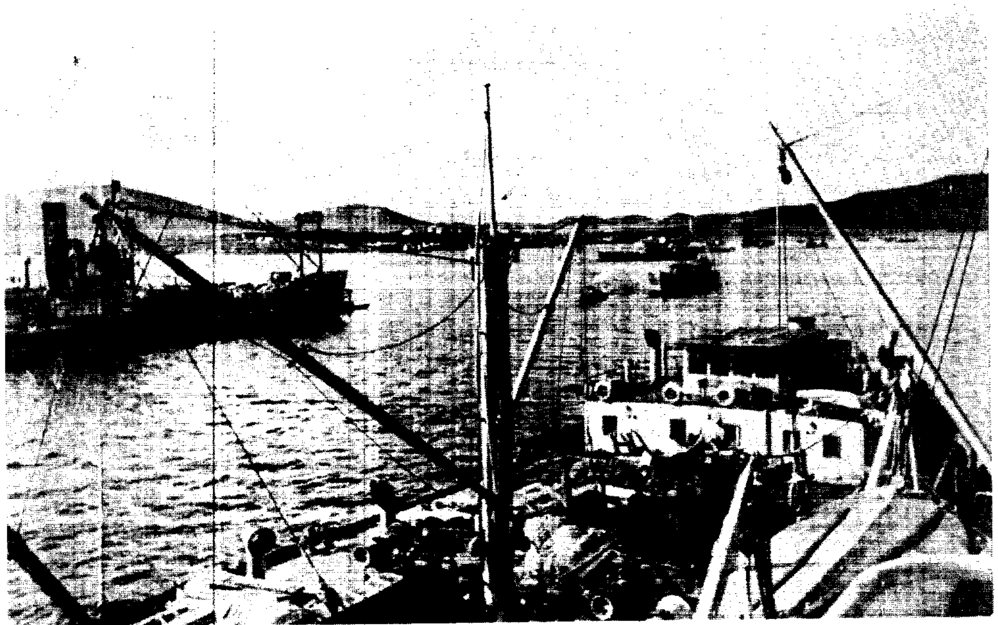

Figure 63. Freighters anchored in the harbor at Tiksi.

These boats dock at the pier west of the main pier. Storage facilities in the port include several warehouses, 4 petroleum tanks of 40,000-barrel capacity, and bunkering-coal dumps. 71, p. 318/ The manufacture of oxygen gas and cylinders at Tiksi has enabled the port to produce 40 cylinders of oxygen per day.

Ambarchik, located east of the main channel of the Kolyma River, has developed as a transshipment point for river traffic. Minerals from the upper Kolyma River and supplies for the mining areas make up the greatest part of the cargo handled. As a port, Ambarchik has serious drawbacks, but no alternative site is available. Landing facilities consist of 3 wharves that have alongside depths of only 10 feet (3 meters). Consequently, all ocean vessels must anchor in the bay and lighter their cargoes to shore. Cargo must be unloaded by the ship's own gear, thus increasing the turnaround time in port. The bay is not sheltered, and ships are exposed to winds that may vary the depth of the bay by more than 5 feet (1.5 meters) and prevent the handling of cargo.

Pevek has developed from a small Chukchi settlement to an important port serving the nearby mining region. Lumber, logs, grain, coal, petroleum, and machinery for the mines are imported; and bulk or barreled ores are shipped out. Two wharves, totaling 1,500 feet (4,750 meters), are available and may be extended during the navigation season by the use of pontoon wharves. At least six cranes were assembled and possibly put into operation at the port during 1958. Their installation involved repairing the wharves and moorings, laying crane tracks, and general repair of port facilities.

The largest crane had a lifting capacity of 30 to 40 tons. An anchorage area 3 miles (5 kilometers) wide and 8 miles (13 kilometers) long is available in Proliv Pevek west of the port, but strong southerly winds frequently interrupt cargo-handling operations. Depths in the strait vary from 30 to 100 feet (9 to 30 meters), whereas Bukhta Pevek is limited to craft drawing 4 feet (1 meter). 72/

Provideniya is the focal point for shipping at the eastern end of the Northern Sea Route. It is a refuelling station, staging area for convoys, and distribution point for supplies destined for smaller ports along the coast. Approximately 25,000 tons of cargo were loaded and 150,000 tons were unloaded in the port during the 1957 navigation season. The number of small craft used for harbor work and delivery of cargo to roadsteads along the Chukotsk Peninsula, however, was inadequate. Although Provideniya is an important coal bunkering port, only one vessel at a time can unload coal or be bunkered at its single coaling berth. The harbor, located in Bukhta Emma, an eastern arm of Bukhta Provideniya, has all the necessary requirements for an ideal port site -- the area is sheltered by surrounding mountains, the harbor is deep enough for ocean vessels (30 to 100 feet or 9 to 30 meters), and a mud bottom provides excellent free swinging anchorages. The port has a total of 2,200 feet (670 meters) berthing space and 15 ships can be accommodated within the harbor area. Mechanical handling devices include 1 coal loader, 3 automotive cranes, and probably several other cranes. A 5-acre (2-hectare) storage area for bunker coal, which accommodates 25,000 to 50,000 tons of coal, is located near the quays at Provideniya. Four oil tanks of 25,000 barrels capacity are situated on the northwestern shore of Bukhta Emma, and an aviation-gasoline storage area of more than 3,500-barrel capacity is situated on the southeastern shore of the bay. In addition, several smaller drum storage areas are located at various other port facilities. 73/

2. Inland Waterways

The northward-flowing rivers of the Soviet Arctic connect the Northern Sea Route with the Trans-Siberian Railroad and are the most important inland transportation arteries serving the region. Only one Arctic river, the Severnaya Dvina, is linked by canals and locks with other regions in the USSR. The Mariinsk Waterways connects the Sukhona, a tributary of the Severnaya Dvina, with rivers emptying into the Baltic Sea and with the Volga, which provides access to the Black and Caspian Seas. A second factor contributing to the importance of the rivers is that, in most parts of the Siberian Arctic, they provide the only transportation routes available. Since the distribution of railroads and roads is sparse, freight must be moved on the rivers. The Severnaya Dvina flows through vast forests and carries timber to the sawmills at Arkhangel'sk. Coal from Vorkuta and oil from Ukhta are carried down the Pechora River to Nar'yan-Mar. The upper Ob' and its tributaries tap the resources and industries of the Kuznetsk Basin (Kuzbas). The Yenisey carries timber from its upper reaches to the mills at Igarka. The Lena is the main traffic route in East Siberia and carries a variety of freight. Minerals and mining supplies are shipped on the Kolyma River.

River transportation is affected by several physical factors including winter ice, ice jams, and fluctuations in water level. Ice forms on lower reaches of the rivers in early October and on the upper parts by mid-November. Floating drift ice preceeds the formation of a permanent ice cover. The thickness of the ice cover is greater in the Siberian Arctic than in the European part. In winter the Severnaya Dvina at Arkhangel'sk freezes to a maximum of 2 feet (0.6 meters) and railroad tracks are laid across the ice. Ice on the Lena River at Bulun attains a thickness of 8 feet (2 meters), and many channels of the delta freeze to the bottom. Widespread floods occur from mid-May to early June, when swollen waters from the upper parts of the rivers reach the icebound lower stretches. Local floods develop when the outgoing ice jams and temporarily dams the rivers. Spring floods reach their greatest intensity along the lower parts of the rivers. The Yenisey has risen 70 feet (20 meters) at Igarka, and the Lena has risen 60 feet (18 meters) at Kyusyur. At flood stage the discharge at the mouth of the Kolyma reaches 565,000 cubic feet per second (cfs), whereas it amounts to only 35,000 cfs in late summer. 74, p. 958/

During the short summer season the rivers reach their lowest level, and numerous sandbanks and shoal areas appear. These obstructions, together with the rapidly shifting river channels, are a hazard to navigation. The low-water period continues until the autumn rains begin, usually in late September. These rains cause a small, secondary high-water period that makes normal navigation possible again until the winter freeze-up begins.

The administration and operation of the rivers is directed by the Ministry of the River Fleet. Shipping lines are organized for each major river, such as the Lena River Steamship Agency, and are subordinate to the Ministry.

Freight is the principal commodity carried on the inland waterways and consists chiefly of bulky low-priority goods such as timber, POL supplies, grain, ores, and construction materials. Smaller quantities of food products, machinery, and manufactured goods are also shipped on the rivers.

Timber is the largest single freight commodity transported and log rafts are floated downstream to mills on the Severnaya Dvina

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(Arkhangel'sk), Pechora (Nar'yan-Mar), Yenisey (Igarka), and Lena (Tiksi). Timber is also shipped on other rivers but the amounts are relatively small. The Yenisey carries the greatest amount of timber, which comprises 65 to 70 percent of the total freight of the river (Figure 64).

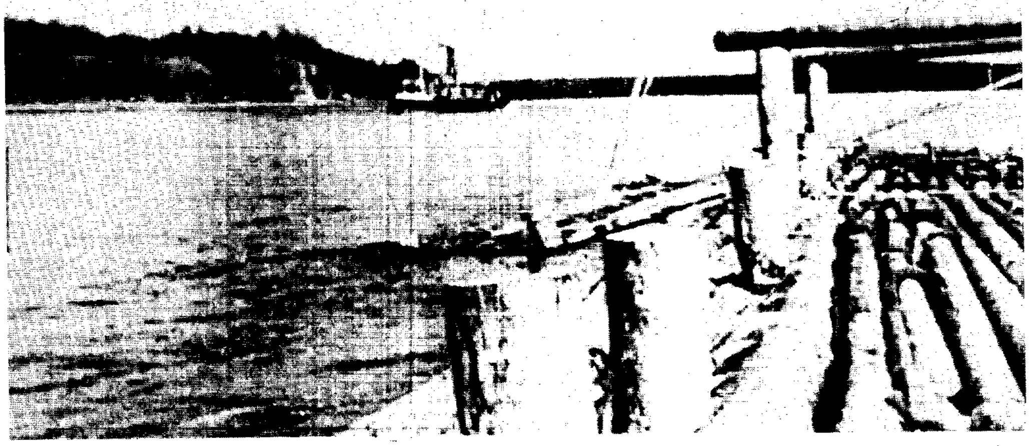

Figure 64. Timber raft on the Yenisey River en route to Igarka.

Log rafts reach large proportions, depending on the width, depth, and speed of the rivers. Rafts on the Yenisey occasionally carry 1 million cubic feet (28,000 cubic meters) of logs. The rafts are launched in the upper reaches of the rivers during the spring flood in order to take advantage of the high water level. In the summer low-water season the rafts are exposed to shoal areas which often ground or damage them. Summer storms frequently strike the rafts and cause great damage unless the rafts can tie up in sheltered spots along the river.

POL supplies destined for the Arctic are shipped over the Northern Sea Route and also over the Trans-Siberian Railroad to the rivers, where they are transshipped to barges for distribution along the rivers. Drums are still used in great numbers to carry the POL supplies, but tanker shipments are increasing as bulk storage facilities are constructed at the airfields and settlements. River tankers have shallow drafts to enable them to navigate shoal areas and reach the upper stretches of the rivers.

Much river freight is carried in barges. They are made of wood or metal and generally carry from 300 to 800 tons, although some of the larger barges have a capacity of 4,000 tons. The barges are grouped into trains of 10 to 20 vessels, which are pushed by a tug.

The pusher method has been used instead of towing since 1951 because it furnishes greater control and more barges can be handled. The tugs, which are driven from the stern or side by paddle wheels, have not yet been replaced by more modern screw-driven tugs.

The remaining freight items include coal, grain, machinery, ores, and foodstuffs. Coal from mines on the Pechora, Yenisey, Lena, and Kolyma Rivers is distributed to seaports and settlements throughout the Arctic. Ores and metal shipments are concentrated on the Yenisey and Kolyma Rivers. Foodstuffs from the southern agricultural areas are carried downstream in large quantities. Lighters are used for hardy vegetables such as potatoes, cabbages, cucumbers, and onions; more perishable vegetables are sent downstream in refrigerated ships. These ships carry frozen fresh fish upstream on their return voyages. Refrigerated ships, however, are in short supply; and much of the perishable food carried by unrefrigerated vessels spoils en route.

A large number of river craft were scheduled for transfer to the Arctic to increase the amount of river-borne cargo. Eighty-four craft from White Sea ports were to go to the Ob', Yenisey, and Lena Rivers; and several others were to go from Tiksi to the Indigirka and Kolyma Rivers.

Passengers make up a small part of the traffic on the rivers. Passage can be obtained on barges and packet vessels (Figure 65). Many of the poorer people travel on the barges, which furnish little or no shelter and comforts. Accommodations on passenger vessels are at times heavily overloaded in spite of the increasing number of ships on the rivers. The Ordzhonikidze, sailing on the Yenisey in 1952, carried 700 passengers instead of the 360 it was designed to accommodate (Figure 66). The three double-deck and two triple-deck vessels that were added to the Yenisey fleet in 1954 have probably helped to alleviate the crowded conditions. These ships have restaurants, reading and music rooms, and cabins with showers, telephones, and radios. In 1956, new diesel passenger ships were scheuled to sail the Northern Sea Route and begin service on the Siberian rivers. They were to supplement 4 ships of the same type already in the Arctic. 75/

Passenger traffic schedules vary from daily to monthly service. The Severnaya Line, operating on the Severnaya Dvina River, has daily trips between Arkhangel'sk and Kotlas, a 2-day trip. Ships on the Pechora River leave Nar'yan-Mar and Pechora on odd-numbered days for trips which take 4 days downstream and 5 days upstream. The latest available information on the Ob' River (1950) indicates that traffic moves from Salekhard to Tobol'sk, Tyumen', and Omsk via the Ob' and Irtysh Rivers but that no direct passage is available from Salekhard

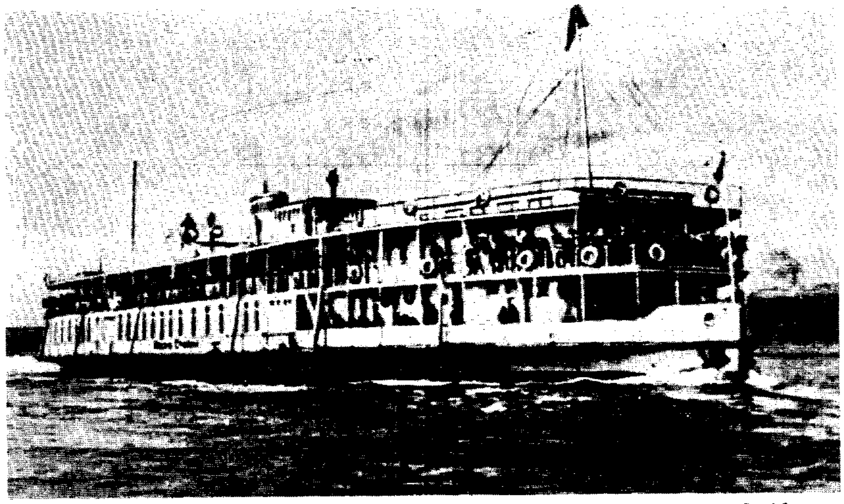

Figure 65. The packet vessel Iosif Stalin of the Krasnoyarsk-Dudinka line.

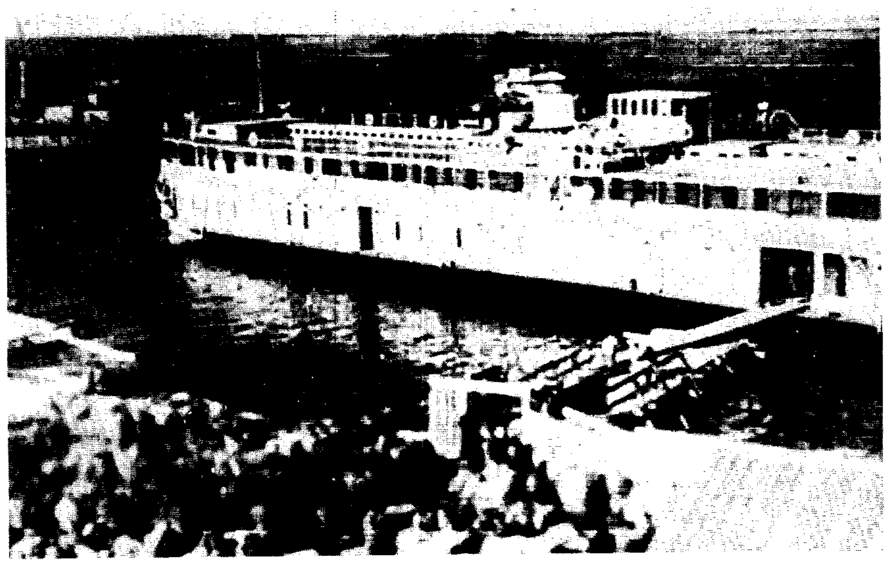

Figure 66. The Ordzhonikidze taking on passengers at Dudinka.

to Novosibirsk. 76, p. 593-613/ Only three round-trips are made between Salekhard and Omsk during the navigation season.

Passenger traffic is heaviest on the Yenisey. The Yenisey Steamship Line controls operations and dispatches vessels from June through September. The journey from Dudinka to Krasnoyarsk by passenger ship takes 7 days and 10 hours and the return trip 4 days and 18 hours. Four or five passenger ships a month, as well as a number of other vessels carrying both passengers and freight, operate between these ports. In 1950, an express line operated between Dudinka and Krasnoyarsk. and both upstream and downstream trips were made in 6.5 days. In 1958, regular passenger service was inaugurated between Krasnoyarsk and Dikson. The diesel ship Valeriy Chakalov was scheduled to make four round trips during the navigation season.

Little information is available on passenger traffic on the Lena and Kolyma Rivers.

3. Submarine Activities

Submarines of the Northern Fleet are active in the Arctic, but their operations extend throughout the Atlantic Ocean. The fleet comprises an important segment of the Soviet submarine forces and constitutes a potential threat to shipping lanes of the Atlantic Ocean. Submarines assigned to the Northern Fleet include the long-range "W" and "Z" classes as well as the smaller, older "S-1" and "L-III" types. Their activities include annual passage over the Northern Sea Route to the Pacific and participation in naval manuevers such as the massive exercise that took place in the fall of 1957 in the southern Barents Sea.

Most of the submarines for the Northern Fleet are constructed at shipyards in more southern parts of the Soviet Union. Submarines, however, have been constructed at Severodvinsk.

Submarine facilities in the western Arctic are located principally in the ice-free areas of the Kol'skiy Zaliv and, to a lesser extent, along the northern coast of the Kola Peninsula. The Kol'skiy Zaliv is the nearest Soviet naval complex to the US and contains ice-free, protected harbors that have access to the open sea through Soviet-controlled waters. Submarine facilities in the central and eastern Arctic sectors are not known.

Polyarnyy, the principal submarine base in the Soviet Arctic is located on the western side of Kol'skiy Zaliv about 8 miles (13 kilometers) south of the entrance to the Barents Sea. Three piers provide berths for 6 submarines, and a wharf provides fixed mooring for 14 submarines. In addition, destroyers, destroyer escorts, minesweepers, and motor torpedo boats operate from the base [redacted] 25X1

25X1

[redacted]

East of the wharves, fuel oil is stored underground on the southern shore of Ostrov Yekaterininskiy; west of the base, it is stored above ground. A graving dock can accommodate the largest class of submarine, and facilities are also available for the repairing of periscopes, instruments, and batteries. 77/

Two smaller ports at Guba Olen'ya and Guba Sayda serve as auxiliary bases to Polyarnyy. The base in Guba Olen'ya is located in a small cove 3 miles (5 kilometers) northwest of Polyarnyy. Berthing space for 2 submarines is provided at each of 2 piers, and up to 10 submarines can be accommodated by nesting. A submarine training school has probably been constructed at Guba Olen'ya since World War II. Guba Sayda, located 8 miles (13 kilometers) northwest of Guba Olen'ya, has 2 submarine piers, the longest measuring 450 feet (137 meters). Both piers can accommodate submarines, and an additional 10 submarines can be nested. 78/

In addition to these major facilities, several other submarine bases are located along the northern coast of the Kola Peninsula. Teriberka, 43 miles (70 kilometers) east of the entrance to Kol'skiy Zaliv, is an operating base for submarines as well as submarine chasers, patrol craft, and minesweepers. It serves primarily as a supply depot where batteries are charged and ammunition, torpedoes, and mines are stored. Iokan'ga, 150 miles (240 kilometers) east of Teriberka, may be a submarine operating base, possibly capable of performing repairs on even the largest types of submarines. Vaydaguba, on the northwestern tip of Poluostrov Rybachiy, is reportedly a submarine and torpedo-boat base. 79/

S-E-C-R-E-T

C. Land Transportation

1. Railroads

a. The Role of Railroads in the Soviet Arctic

Railroad transportation in the Soviet Arctic, though comparatively recent, is already contributing significantly to the economic and military build-up of the area. The penetration of key railroad lines into the Arctic regions of European and West Siberian USSR has facilitated the establishment of strategic airfields and the exploitation of natural resources.

From a strategic point of view, the development of railroads within and south of the Arctic Circle opens up vast possibilities for Soviet military build-up in the area. Many of the important new airfields constructed in the western Arctic are located at sites made accessible by new railroads. As the railroad system penetrates deeper into the permafrost belt, more installation sites will become available. The potential effectiveness of new air installations and the operational capabilities of military and commercial aircraft depend in large measure on the year-round supply of fuel, equipment, and personnel brought in by railroads.

The development of natural resources such as the copper-nickel ores from Nikel' and Noril'sk and the coal from Vorkuta has been given great impetus by the availability of railroad transport.

Railroad facilities in the European Arctic are focused primarily at the industrial and maritime centers of Murmansk and Arkhangel'sk and at the mining center of Vorkuta. In the West Siberian Arctic, railroad construction is more recent and is closely linked with the rise of Salekhard and Dudinka as important river ports and of Noril'sk as a major industrial complex. (See Map 27362).

b. Railroad Development in the European Arctic

(1) The Murmansk Railroad Complex

Murmansk, located near the western extremity of the region, is currently the major railroad center in the Soviet Arctic. It is the terminus of a trunkline from Leningrad that serves as the principal supply route for the Soviet Northern Fleet and the Northern Sea Route. In addition, this line is one of the main channels for routing the flow of Soviet exports and imports. It is a single-track, broad-gauge line with a second track projected; the stretch between Murmansk and Kandalaksha is electrified. At the main railroad station in Murmansk, connection is made with a number of spur lines leading to a classification yard in the northern part of the city. Spurs radiating from this yard serve the Murmansk waterfront. Industrial and commercial spurs lead to all the principal wharves, including the Murman-Ryba and Rosta shipyards; the fishing, commercial, and military ports; and the coal and oil storage areas. Operational and rolling-stock repair facilities are located within the classification-yard area. Among these are an enginehouse for electric and steam locomotives and a railroad-car repair shop. A branch line continues northward from the classification yard to Rosta and Severomorsk. At Rosta, which is a major repair station for the Northern Fleet, a rail line serves a large oil storage area and the naval base. The terminus of the line is Severomorsk, which is some 15 miles (24 kilometers) north of Murmansk proper and the site of a major airfield.

The Murmansk-Pechenga railroad is an important branch of the Leningrad-Murmansk trunkline (Figure 68). Construction of the 112-mile

Figure 68. A distant view of the Murmansk-Pechenga railroad at a point east of the Pechenga River. (1955)

(180-kilometer) line began in 1950 and was completed in 1955. The railroad begins at Kola, 7 miles (11 kilometers) south of Murmansk, and extends southwestward along the Tuloma River to Murmashi. From there the route continues northwestward, passing between Kulp Yavr and Ura-Guba, to Luostari and the terminus at Pechenga.

The line is steam operated and single tracked, but several short sidings provide passing stops for two-way traffic. Passenger trains reportedly consist of a steam locomotive and 10 or 12 two-axle passenger cars. The embankment is of sand and gravel construction and is about 13 feet (4 meters) wide and 7 feet (2 meters) high.

Along some stretches where the route crosses marshy terrain, the embankment is of poor construction, and trains must travel at relatively slow speeds. Wooden poles, earmarked for a telephone line, parallel the western side of the embankment. The Pechenga railroad station is located on the east bank of the Pechenga River, approximately 1 mile (2 kilometers) south of Pechenga proper. A bridge across the river was completed by 1955, and rails had been laid.

A branch railroad has been constructed from Luostari westward to Nikel' and permits year-round transport of the nickel matte from the smelter at Nikel' to the refineries at Monchegorsk. Another branch line is under construction from Pechenga to Linakhamari, its deep, ice-free ocean port.

The Murmansk-Pechenga railroad is the main supply route for airfields in the Murmansk and Pechenga areas. Its construction has increased the importance of the Kola Peninsula as an operational area for jet bombers and fighters.

(2) The Arkhangel'sk-Severodvinsk Railroad Complex

The Arctic seaport of Arkhangel'sk, located at the mouth of the Severnaya Dvina, is the terminus of an important trunkline from Moscow. The single-track railroad line enters the metropolitan area from the south, passes through the railroad junction and yards at Isakogorka, and terminates at the Arkhangel'sk railroad station and yards, which are located on the left bank of the Severnaya Dvina River across from the main port and city area.

The terminal station and the city proper are connected by railroad-ferry service. A ferry terminal north of the railroad station serves the ferries that carry freight cars to the main port. A second railroad ferry terminal south of the station connects the Isakogorka railroad junction and yard (south of Arkhangel'sk) with various port and lumberyard installations scattered throughout Arkhangel'sk proper, as well as with the harbor area of Solombala and the port of Ekonomiya.

Ekonomiya is located at the extreme northern tip of Ostrov Povrakul'skiy, at the confluence of the Maymaksa and Kuznechikha River channels. An important multispan, deck-type bridge carries the Isakogorka-Ekonomiya line over the Kuznechikha Channel. Just beyond this crossing the railroad divides into two main branches. One serves the waterfront area of the Maymaksa Channel, where there are a number of sawmills, lumberyards, boat repair yards, a chemical plant, and a woodworking plant. The second branch runs farther inland and connects directly with the harbor installations at Ekonomiya.

A number of smaller multispan bridges, most of wooden construction, carry the two branches over small tributaries of the Maymaksa Channel.

The major railroad facilities within the Arkhangel'sk complex are located at the main Arkhangel'sk railroad station and yards and at the Isakogorka railroad junction and yards. The former includes a passenger station and a storage area connected with the freight yard by a railroad spur. The yard area has 13 tracks and several freight and fuel storage buildings and repair shops. Among the railroad facilities at Isakogorka are a freight and passenger station, main relay and servicing yards, a 12-track holding yard, a 15-engine roundhouse with turntable, a 3-engine roundhouse, 5 workshops, a railroad-car servicing shop, and some 50-odd maintenance buildings. 80/

A single-track railroad line leads from the Isakogorka junction to the ship-building center and naval base of Severodvinsk. The line enters the Severodvinsk complex from the south-southeast and forms a large loop around the east side of the city proper. Spurs leading northward from the loop form a network of lines that serve the harbor and industrial sections of the city. The main line terminates at the Severodvinsk railroad station, yards, and shops. From here, a local line runs some 9 miles (14 kilometers) westward from Severodvinsk, terminating at the east bank of the Solza River. Terminal railroad facilities include a passenger station, a railroad-car repair shop, five smaller workshops, a boilerhouse, an enginehouse, an outdoor gantry crane, a coaling and storage area, and a number of miscellaneous sheds. The railroad shops reportedly perform only minor repair and servicing functions, but they probably produce some machinery for the Severodvinsk shipyard. A four-span, deck-type bridge carries the Severodvinsk-Isakogorka line over the Laya River, a lesser tributary within the Severnaya Dvina estuary. 81/

(3) The Vorkuta Railroad Complex

Since World War II the coal-mining city of Vorkuta has developed into an important railroad center on the Pechora (Kotlas-Vorkuta) trunkline. Originating at Kotlas, the Pechora trunkline was hurriedly constructed during World War II to haul coal from the Pechora River basin for the Soviet war industries. In recent years the Kotlas-Vorkuta line has been the sole rail link and supply route for railroad construction penetrating toward the Kara Sea and deeper into the west Siberian Arctic. This construction effort consists mainly of a northward advance from Vorkuta to Khal'mer-Yu, Kara, Amderma, and possibly Khabarovo. An eastward extension has been built from Seyda (located a short distance southwest of Vorkuta) to Labytnangi and Salekhard on the Ob' River and on to Igarka on the Yenisey.

The Kotlas-Vorkuta trunkline, covering a distance of 970 miles (1,560 kilometers), crosses difficult terrain consisting mostly of extensive areas of coniferous forest and tundra partially underlain by permafrost. Although the line is reported to be carrying heavy traffic, operations are frequently handicapped by difficult climatic conditions. During the winter, heavy snowstorms and fogs often seriously reduce visibility and the speed of travel. Even in summer, cold winds of high velocity often create traffic problems. The entire railroad is to be double-tracked to alleviate traffic congestion, and portions of the line have already been improved. Passenger traffic on the line consists of two daily passenger trains in each direction as well as an unscheduled fast train for special occasions. 82/ Trains are generally made up of a steam-operated locomotive and 18 or 20 coaches of both 2- and 4-axle types. Freight traffic is heavier, reportedly 12 or more trains a day in each direction. Freight trains are up to 50 cars in length and consist of an assortment of gondola, hopper, box, platform, refrigerator, and tank cars. Northbound freight includes mainly provisions, mining machinery, rails, and construction materials. Between 1949 and 1953, shipments of rails were frequently observed. Coal, oil, and timber are the principal items carried by southbound trains.

Railroad installations of the Pechora trunkline within the Arctic sector are located at Inta and Vorkuta, and at the intervening stations of Kochmes, Abez, Sivaya Maska, and Seyda. Facilities at Inta consist of a railroad station, a railroad maintenance shop, and a small marshalling yard. The station is located on the main line and has two sidings. Short spurs lead from the main line to a number of local coal mines in the Inta area. The maintenance shop reportedly produces railroad equipment and parts and also repairs coal-mining machinery. 83/ Railroad facilities at Kochmes are less extensive, including a small railroad station, a steam-locomotive enginehouse, and a water-supply station. The station area has a number of short sidings for freight-shipping purposes. Abez is a main stop on the Kotlas-Vorkuta line. The town is located on the Usa River and consists of two parts, "Old" Abez and "New" Abez which are connected by a new steel-girder railroad bridge some 2,600 feet (790 meters) long that rests on 5 concrete piers. Installations at the Abez station, also known as the Usa station, include 7 or 8 siding and shunting tracks, a watering and coaling station for locomotives, and a small repair shop for locomotives, cars, and trucks. Railroad spurs reportedly lead to an airfield, a wagon factory, grain elevators, and storage depots. 84/ Sivaya Maska, about 29 miles (46 kilometers) northeast of Abez, is a minor stop on the line but has a turnaround enginehouse and a small locomotive repair shop.

Seyda is a more important railroad junction located 60 miles (96 kilometers) southwest of Vorkuta. It serves as the turnoff point for railroad traffic routed over the branch line to Labytnangi on the Ob' River. Construction of the Seyda-Labytnangi line was completed during the period 1947-48. It is a single-track, broad-gauge line and is steam operated. Following an easterly direction from Seyda, the line proceeds through tundra terrain, crosses the Polyarnyy Ural Range, and then continues over the boggy ground of the Ob' River flood plain. Most of the roadbed is of sand and gravel, but stone and crushed-rock supports are used where soft, wet ground might otherwise cause roadbed sinking. Fences along both sides of the roadbed protect it against severe snow drifting. Railroad stops on the Seyda-Labytnangi branch line include the settlements of Ust'-Vorkuta, Nikita, Yeletskiy, Polyarnyy Ural, Sob', and Krasnyy Kamen'. Krasnyy Kamen', Yeletskiy, and Nikita have minor railroad repair facilities. Krasnyy Kamen' and Nikita also have short sidings for local traffic transactions. Two to four freight trains operated daily in each direction between Seyda and Labytnangi in 1949, and traffic is probably heavier now. The chief commodities transported are food, construction materials, machinery, and motor vehicles. Passenger traffic is relatively light and is probably carried on trains consisting of mixed freight and passenger cars.

Railroad facilities at Seyda proper are fairly extensive. The railroad station is served by the main Kotlas-Vorkuta trunkline and by a long siding. The station has two storage yards, one with 5 or 6 shunting tracks about 1,600 feet (490 meters) long. Several wooden locomotive sheds, a railroad repair shop, and a coaling and watering area are also located near the station. The locomotive repair shop has a hand-operated turntable. 85/

As the result of extensive mining operations and new railroad construction in the area, Vorkuta is becoming an increasingly important center of railroad activity. It serves as the terminus of the Pechora trunkline and of the new railroad which is under construction to Kara and Amderma and, according to plans, will continue to Khabarovo on Proliv Yugorskiy Shar. Vorkuta is also the focal point of a network of narrow-gauge industrial lines leading to various mines in the area. At present, railroad facilities include 2 transloading stations for the transfer of coal shipments from narrow- to broad-gauge carriers, a small railroad yard, a repair shop capable of handling 10 to 15 locomotives, and a steam-locomotive enginehouse. 86/

Since 1946, construction has been underway on an Arctic railroad connecting Vorkuta with Amderma and Khabarovo. Plans for this railroad apparently were made in the early 1930's. According to an article published in 1933 in the Byulletin' Arkticheskogo Instituta (Bulletin of the Arctic Institute), a railroad line between Vorkuta and the Arctic Ocean had been projected at that time. The terminus proposed for the new line was to be located near the settlement of

Khabarovo on Proliv Yugorskiy Shar. 87/ The route was to follow a general north-northeasterly course from Vorkuta to Khal'mer-Yu, continue to the north and northwest to Kara, and from there run northwestward along the coast to Amderma and Khabarovo.

The first section of the railroad, from Vorkuta to Khal'mer-Yu, was constructed to transport the bituminous coal from the mines in the Khal'mer-Yu area. The line has a single track and broad gauge. Its embankment is constructed of a mixture of sand, earth, and crushed rock. Wooden ties are laid on coarse broken stones, and rails are fastened to the ties by means of spikes and screws. Much of the terrain traversed by the railroad is marshy during the summer. As a result, numerous drainage conduits and cuts have been constructed to prevent deterioration of the roadbed. The railroad between Khal'mer-Yu and Amderma is under construction and the line further west to Khabarovo is projected.

(4) Planned Railroad Construction

A railroad line from Mikun' on the Kotlas-Vorkuta railroad to Mezen' on the Barents Sea has been planned, and short stretches near both terminals have been completed or are under construction. A major freight item on the railroad will be timber from the forests of the Mezen' River basin, which will be shipped to the sawmills at the port as well as to other consumer centers located along the Kotlas-Vorkuta line. The railroad will make possible the development of Mezen' into a major Northern Sea Route port serving the Mezen' River basin area. A further aid in the development of the port will be tidal electric stations (PES). Three stations, utilizing the tides of Mezenskaya Guba will be constructed and will provide power to the port.

c. Railroad Development in the West Siberian Arctic

(1) The Salekhard Railroad Complex

The Salekhard railroad complex consists essentially of terminal facilities at Labytnangi (across the Ob' River from Salekhard), which serve the Seyda-Labytnangi line, and terminal facilities at Salekhard proper, which serve the usable portion of the Salekhard-Igarka line.

Labytnangi is an assembly point for railroad traffic earmarked for Salekhard and for limited traffic farther east. Railroad facilities include a fairly large passenger station, which is connected with a freight and shunting yard that parallels the local harbor installations. Labytnangi also has locomotive sheds, small repair shops, a switching station, coaling and watering facilities, and a number of storage sheds with loading ramps. 88/ Railroad traffic is carried across the Ob' River to Salekhard by ferry during the summer and by tracks laid over the ice during the winter. The railroad ferrys are reportedly diesel-powered iron pontoons on which two broad-gauge track sections are mounted lengthwise. The ferry service, which handles both passengers and freight, is discontinued from the end of October to the middle of March. During this period the river freezes to a depth of approximately 8 feet (2 meters), which permits the laying of railroad tracks across the ice. The first successful crossing over the ice was made in February 1948. 89/ Tracks are laid on a foundation of wooden logs, with the bottom logs solidly frozen into the ice. In crossing the ice, trains of not more than 6 to 8 cars are pulled by steam locomotives. An average of 1 to 3 trains cross the river daily in each direction. Information as of 1948 indicates that the Soviets had originally planned to build a ferroconcrete bridge over the Ob' River between Salekhard and Labytnangi. In 1950, some bridge-construction material was reportedly stored along the west bank of the Ob' near Labytnangi. 90/ To date, however, there is still no evidence that construction is under way.

Railroad facilities at Salekhard serve both the local port area and the part of the line extending eastward toward Igarka that is still usable. Facilities include a main railroad station, a freight station and marshalling yard (consisting of 10 to 12 shunting tracks), a locomotive and railroad-car repair shop, a roundhouse, switching towers, and locomotive water-supply tanks. Spur lines lead to a railroad-ferry terminal and to port installations scattered along the Ob' waterfront. 91/

The Salekhard-Igarka line, 620 miles (1,000 kilometers) of broad-gauge, single-track railroad between the Ob' and Yenisey Rivers, was completed between 1951 and 1953. The line may have been used for a short time after its completion, but no information is available to confirm the fact that the line is currently in operation. It is probable that most of the trackage has been allowed to fall into disrepair. According to one report, only about 150 miles (240 kilometers) of track east of Salekhard is now usable, the remainder having sunk into the tundra. 92/ The speed and weight of trains on the usable section of the railroad would be limited by the condition of the roadbed.

The alignment of the Salekhard-Igarka railroad can be traced on the basis of PW reports and, although it is not used in its entire length at present, it may be repaired and used in the future.

The railroad follows roughly an east-southeasterly course from Salekhard to the small settlement of Aksarka on the right bank of the Ob' River. The terrain here is largely tundra and marsh, except in the area directly east of Salekhard, which is thinly forested.

At Aksarka the route turns southeastward for 37 miles (60 kilometers) to Yangiyugan on the right bank of the Poluy River. This stretch of the route crosses flat tundra interspersed with small stands of scraggy trees. Beyond Yangiyugan the railroad follows a southeasterly course for approximately 100 miles (160 kilometers) through the settlement of Orlin to Nadym, which is located on the Nadym River. Here the railroad follows a circuitous alignment in order to bypass swamps, small hills, and a number of rivulets. Several short sidetracks lead outward from the railroad station at Orlin. Eastward from Nadym the railroad enters a region of dense swamps and many rivers, rivulets, and lakes before reaching the settlement of Urengoy near the Pur River. The Pur River is reportedly crossed by a multispan steel bridge.

Information on the railroad alignment between Urengoy and Igarka is indefinite but the railroad apparently approaches Igarka by a circuitous route. It probably leads eastward from Urengoy to the Taz River opposite Krasnosel'kup, then parallels the left bank of the Taz River to a point some 25 miles (40 kilometers) north of Krasnosel'kup, where it crosses the river and leads eastward to Yanov Stan on the Turukhan River. Construction of this section of the railroad was reported as underway in 1949. From Yanov Stan the line follows a generally northeast course to the settlement of Yermakovo, located on the Yenisey River some 62 miles (100 kilometers) south of Igarka. This section of the line was reported as under construction in 1951. 93/

There is no recent evidence of construction or traffic on the section between Yermakovo and Igarka. In 1951, railroad installations at Yermakovo included a railroad station, some minor storage and repair facilities, and at least 1 or 2 shunting tracks. At that time a short stretch of the line north of Yermakovo along the left bank of the Yenisey had been completed, and the construction of a railroad bridge across the river in the vicinity of Ostrov Berezovyy was planned. Penal laborers camped along the right bank of the Yenisey from Yermakovo to Igarka were at the time engaged in clearing and leveling ground preliminary to railroad construction.

(2) The Noril'sk-Dudinka Railroad Complex

The Noril'sk-Dudinka railroad complex consists of the rail lines between the urban areas and the network of industrial lines within Noril'sk. The first railroad between Noril'sk and Dudinka was a narrow-gauge line built before World War II. A broad-gauge line, which roughly follows the same route, was completed in 1952 (Figure 69). Both lines are probably still in use since there are no indications that the narrow-gauge line has been abandoned. The broad-gauge line is being electrified; electrification of the section from Noril'sk to Kayerkan, 15 miles (24 kilometers) to the west, was scheduled for

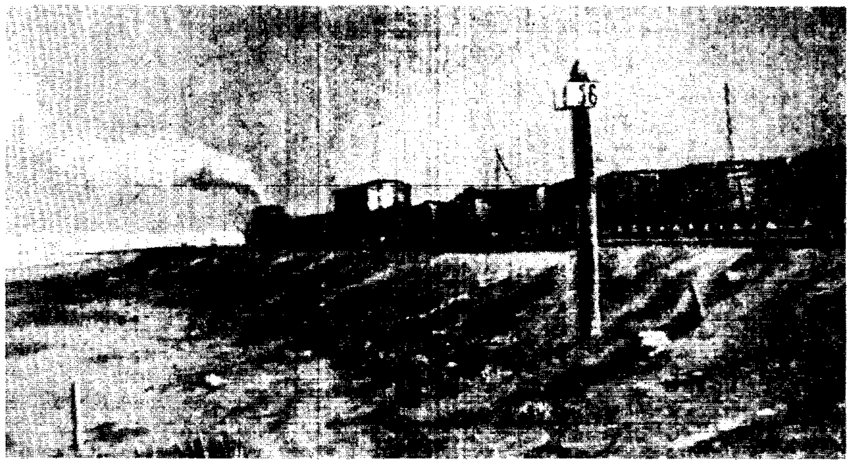

Figure 69. A freight train on the Noril'sk-Dudinka railroad passing the 56-kilometer marking.

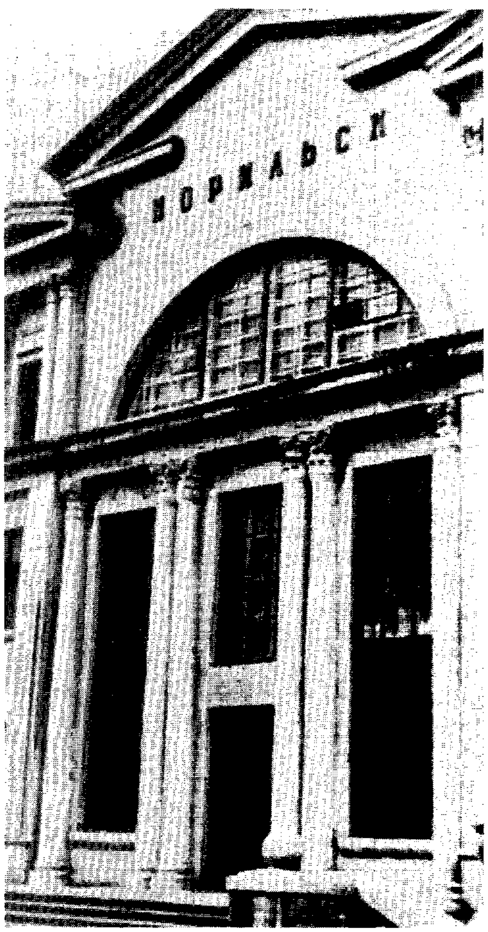

Figure 70. Facade of the railroad station at Noril'sk.

completion in 1958 and the entire line by 1960. 94/ In 1953, nine electric locomotives made in Novosibirsk were sent to Noril'sk. The broad-gauge line is poorly built, with ties set directly on leveled ground. As a result, many accidents occur as a result of the thawing of the ground in spring and the overloading of track and breaking of rails during severe winter frosts.

As of 1954, coal-burning locomotives were used, chiefly freight and switching engines. Of the latter, 8 are reported to be in operation at Dudinka and 8 more were stationed at the Noril'sk yard. Rolling stock consists mainly of old 12-ton freight cars and some tank and ore cars. According to reports, some 40- and 60-ton freight cars have arrived from Czechoslovakia.

Within the city of Noril'sk the network of broad- and narrow-gauge lines is relatively dense and will probably be completely electrified by 1960. The network consists of short spurs and branch lines that serve the various industrial and mining installations in the area. On some lines, 3 tracks have been laid to permit the operation of both broad- and narrow-gauge rolling stock.

From the Noril'sk station, both broad- and narrow-gauge lines lead to the industries within the city and to various nearby mines (Figure 70). A single-track, broad-gauge line leads to Gorstroy, a multistory housing development in the northern part of the city. A locomotive and car repair shop is located in the center of the town; and several railyards and service facilities are in the outskirts of the city, particularly in the mining sections.

A 7-mile (11-kilometer) narrow-gauge railroad leads from Noril'sk northeastward to Valek, a small port and fishing settlement on the Noril'sk River. The line was used to bring supplies to Noril'sk during the initial development of the city before the Noril'sk-Dudinka line was built, but it has since lost its importance and has probably been abandoned.

(3) Planned Railroad Construction

Plans call for a railroad that will parallel the eastern slopes of the Ural Mountains and connect Polunochnoye and the Ural industrial centers to the south with the Seyda-Labytnangi line. The railroad will permit the transport of coal from the Pechora Basin to industrial cities on the eastern slopes of the Urals and so reduce the amount of coking coal imported from the Kuzbass. Material will also be able to move northward to Salekhard for export via the Northern Sea Route. An article published by Soviet academician V. Nemchinov in Izvestiya of 3 February 1956 might be considered as partial Soviet endorsement of this new railroad development. Nemchinov proposes that a railroad be built from Polunochnoye to Salekhard via Nyaksimvol' during the period 1956-60. 95/

Plans have also been made for a broad-gauge railroad that will follow the Yenisey River from the Trans-Siberian Railroad at Achinsk to Igarka and Dudinka. The portion of the railroad from Achinsk to Maklakovo is under construction. The remainder of the line will follow the left bank of the Yenisey to Yermakovo, where it will cross the river, and continue to Igarka and Dudinka.

2. Road Systems

a. The Character of the Overland Traffic

Year-round road transport in the Arctic regions of the USSR is virtually restricted to a number of scattered motor roads in the European Arctic, and to a few isolated roads in the Siberian Arctic. Roadbeds and road surfaces, however, require a large amount of maintenance every year after the spring thawing begins. The year-round roads are supplemented by seasonal roads, which are generally in poor condition and permit only a limited amount of truck traffic. Dirt roads can be used for 40 to 80 days during the summer, depending on the date of the spring thaw and the amount of rainfall. In large areas of the Arctic, overland travel is still primitive in character. During the summer, such travel is limited to pack transports drawn by dogs, horses, or reindeer. In winter, movement by dog- or horse-drawn sleds along established winter trails or reindeer migration routes is common.

Winter automobile and tractor roads are a characteristic feature of the Soviet Arctic. In timber areas, such as those around Arkhangel'sk and Igarka, winter roads consist of artificially created ice tracks. These tracks, also known as ice-roads, are surveyed and prepared prior to the advent of autumn frosts. In areas north of the timber zone, the winter roads are established cross-country routes laid over compacted snow. Traffic over winter roads is usually by tractor-hauled sled trains. Along a marked route, 100 miles (160 kilometers) or more can be covered in 24 hours. Because sleds weighing up to 100 tons or more when loaded are used, much freight can be carried by a single train. Ice and snow roads in the Eastern Arctic can be used on an average of 110 days during the cold season.

Another method of winter travel in the Arctic is over the frozen surfaces of major rivers. These rivers, particularly in the Siberian Arctic, provide excellent avenues for motor traffic. On the Yenisey, trucks travel from Igarka as far south as Krasnoyarak. On the Lena and Kolyma Rivers, trucks travel as far south as Yakutsk and Seymchan, respectively.

A new method of road building in timbered areas has been developed in the USSR. Logging roads are paved with pre-cast concrete slabs which can be picked up and relaid when timber operations are moved. Such a road 25 miles (40 kilometers) long has been constructed in the Arkhangel'sk area (Figure 71).

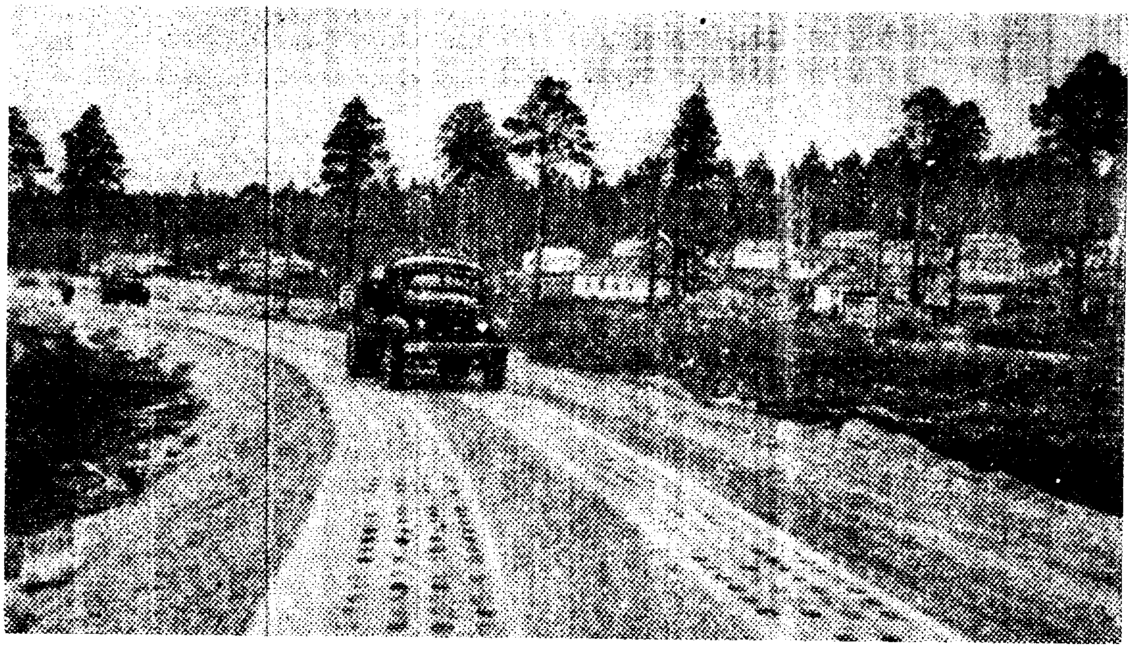

Figure 71. Logging road of pre-cast concrete slabs in Arkhangel'sk Oblast'. (1957)

b. Roads in the European Arctic

Most of the motorable roads in the European Arctic are located in the vicinities of Murmansk, Pechenga, Arkhangel'sk, and Vorkuta and in the Mezen' River basin. With the exception of the Arctic Highway at Pechenga, the Murmansk-Pechenga Highway, and short stretches of improved roads from Kola and Murmansk, existing roads are largely seasonal and in poor condition. Most of them are little more than unimproved dirt tracks that are capable of handling limited truck traffic only during the summer season.

The Arctic Highway, located in the extreme western part of the Arctic, connects Pechenga with Virtaniemi on the Finnish-Soviet border. The highway, which was built by the Finns before the Soviet occupation of the Pechenga (Finnish: Petsamo) area, runs from the Soviet border to Rovaniemi in north-central Finland. The Arctic Highway has a uniform width of about 13 feet (4 meters) and is metaled but not macadamized. Because of its limited width, heavy vehicles frequently have difficulty in passing each other. Along most of its course the road is paralleled by drainage ditches and telephone lines. An electric power line from Nikel' to Nautsi and Yaniskoski follows the highway most of the way. The road is kept in a good state of repair. Since the area traversed is a frontier zone, MVD Border Guards (Pogranichniki) maintain a number of check and control points along the route. Motor traffic on the Arctic Highway section adjacent to the Finnish border consists mainly of military transports. Important branch roads lead to Nikel', Yaniskoski, and Rayakoski. The latter two branch roads are in a state of poor repair that permits truck traffic only.

The Murmansk-Pechenga Highway covers a distance of approximately 71 miles (115 kilometers). Judging by known patterns of Soviet road construction, this highway is probably 20 feet (6 meters) wide with an improved surface (probably packed gravel) that should permit active bus and truck service between Murmansk and Pechenga. The highway probably crosses the Kol'skiy Zaliv somewhere between Murmansk and Kola. It then veers northward and follows the western bank of the Kol'skiy Zaliv to Min'kino, northwest of Murmansk. From Min'kino it winds northwestward to Pechenga. The alignment of the highway follows the contour of the terrain, bypassing hilly or mountainous areas; and apparently no great effort has been made to straighten the route. Several roads branch off the highway, the most important terminating at Ura-Guba and Titovka, farther west.

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Improved motor roads also lead northward and southward from Murmansk. One road runs along the east bank of the Kol'skiy Zaliv and connects Murmansk with Severomorsk. It has a gravel surface with a stone roadbed and is capable of withstanding the heaviest traffic. An extension northward from Severomorsk has been planned and will lead to Teriberka via Tyuva-Guba and Maloye Olen'ye. A second road follows the Murmansk railroad southward to Pulozero, and then turns southeastward to Lovozero in the central part of the Kola Peninsula. The section of the road extending from Murmansk to Kola and Kil'dinstroy is paved and in very good condition. It has an average width of 23 feet (7 meters) and is heavily traveled. The remainder of the road is reportedly in poor condition but is passable for automobiles. At Kola a branch road leads across the Kola River to Murmashi. This road is in good condition, and telephone and

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telegraph lines run alongside it. As of 1943 the road bridge over the Kola River had not been completed. Automobiles cross the river by way of the railroad bridge of the Kola-Murmashi line. An improved branch road also connects Kil'dinstroy with Murmashi. This road passes through a predominantly forested area and generally parallels the electric power lines from the Tuloma GES (Hydroelectric Station).

A number of seasonal motor roads connect larger populated centers in the Severnaya Dvina and Mezen' River basins. Some of these roads are referred to on recent Soviet maps as main traffic routes. A road of this type leads southeastward from Arkhangel'sk along the Severnaya Dvina to the river anchorage point of Kholmogory, where it divides into two main branches. One follows the Pinega River northward to the rayon center of Pinega. Across the river from Pinega, at the village of Vonga, the road connects with a timber road that follows the Pinega River southward (upstream) through the settlement of Karpogory to Okulovskaya. This road is 30 to 40 feet (9 to 12 meters) wide and is constructed of tree trunks felled from the adjacent forest. The second branch road leads southward from Kholmogory along the left bank of the Severnaya Dvina to Kotlas on the Pechora railroad.

Motor roads in the Mezen' River Basin follow the river and its main tributary, the Vashka. A seasonal road originates at the port of Mezen' and follows the Mezen' River for some 250 miles (400 kilometers), terminating at Zheleznodorozhnyy on the Pechora trunkline. During the winter the road is used for sledge traffic. A seasonal road also follows the course of the Vashka River from its confluence with the Mezen' at Leshukonskoye southward for a distance of over 118 miles (190 kilometers). Near the rayon center of Koslan it joins the Mezen' River road. Winter traffic is limited to sledge transport.

Short stretches of motor road in the Vorkuta area have been reported. They were built by PW and penal labor and connected the city of Vorkuta with various mining settlements and penal camps in the surrounding area. Roads lead northward to the nearby settlements of Gornyatskiy, Oktyabr'skiy, Sedlovaya, and Poselok 37 Km; northwestward to Komsomol'skiy; and southward to station Ust'-Vorkuta on the Seyda-Labytnangi railroad. In addition, a road encircles the coal basin of Vorkuta and provides access to the mines in the area. Apparently the roads are well built. At least one reportedly has a crushed-rock base topped with rolled gravel and sand and has drainage ditches along the road to prevent waterlogging in spring and summer. 96/

In addition to the motor roads in the European Arctic, there are a number of unimproved wheel tracks, trails, and winter paths that connect scattered coastal and river settlements. Trails lead northward into several of the large peninsulas along the Arctic coast, including the Kanin, Yugorskiy, and Onezhskiy. One of the more important trails skirts the northern coastline of the Kola Peninsula and provides the only land communication between the isolated rayon center of Gremikha (just west of Iokanga) and numerous small fishing settlements located along the coast.

c. Roads in the Siberian Arctic

In the Siberian Arctic, motor roads are rare. With few exceptions, they are seasonal in character and short in length, having been built to connect inland mining centers with sea and river ports. Noril'sk has an extensive road network that serves the mines and other industries in the area. The main roads have asphalt surfaces and are 20 to 26 feet (6 to 8 meters) in width.

On the Chukotsk Peninsula, a major road has been constructed from the mines at Iul'tin to the port of Egvekinot on Zaliv Kresta. The road is about 180 miles (290 kilometers) in length and 20 feet (6 meters) in width, and has a rolled gravel surface. On both sides the road is paralleled by shallow drainage ditches. Although wooden and concrete bridges have been built across the larger streams and rivers, many of the smaller streams must be forded. The road can be used only from July to October, when its surface is free of snow. During the remainder of the year, sled trains travel cross country between Egvekinot and Iul'tin. The travel time between these points averages 2 weeks for trucks and 4 weeks for sled trains. 97/

There are a number of roads in the Pevek area. One leads from Pevek southeastward to Krasnoarmeyskoye and serves various mines along the route. It has a crushed-stone surface and is approximately 10 feet (3 meters) wide. Road-maintenance stations manned by 1 or 2 officers and 20 to 40 prisoners were reportedly located at various points along the route. Other roads in the Pevek area extend eastward to ore deposits in the Koyveyem Valley and southward for 11 miles (18 kilometers) to an unidentified mine. 98/

Short stretches of roads are found in the vicinity of various settlements, including Tiksi, Ambarchik, Lavrentiya, and Provideniya-Urelik. In the last of these areas the road extends from Provideniya around the northern end of Bukhta Emma to Urelik and continues southwestward to Plover. Near the Soviet military installations in the Provideniya-Urelik area, there are evidences of relatively heavy motor traffic. In addition to these few established roads, cross-country movement in the Siberian Arctic follows trails and reindeer-migration routes, which can be used throughout the year.

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SOVIET ARCTIC

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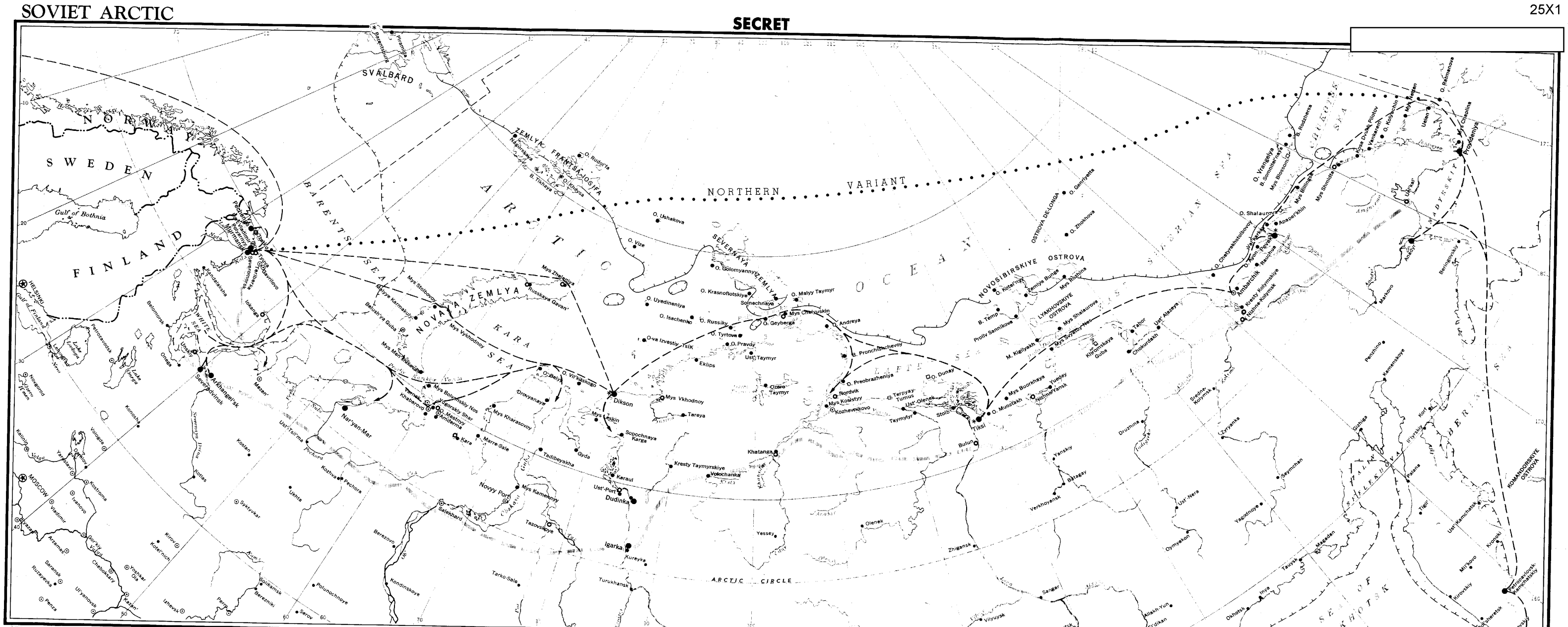

AVERAGE EXTENT OF UNNAVIGABLE SEA ICE

- Summer (August and September—months of maximum withdrawal)
- Winter (February and March—months of maximum extent)

ARCTIC PORTS

- Major importance
- Minor importance
- Other anchorages and landings

NORTHERN SEA ROUTE
(Including Ports and Polar Stations)

Statute Miles: 0 200 400 600 800

Kilometers: 0 200 400 600 800

— — — NORTHERN SEA ROUTE

STUDY AREA BOUNDARY

POLAR STATIONS

- Standard observations
- Observatory
- Manned only during navigation season

SECRET

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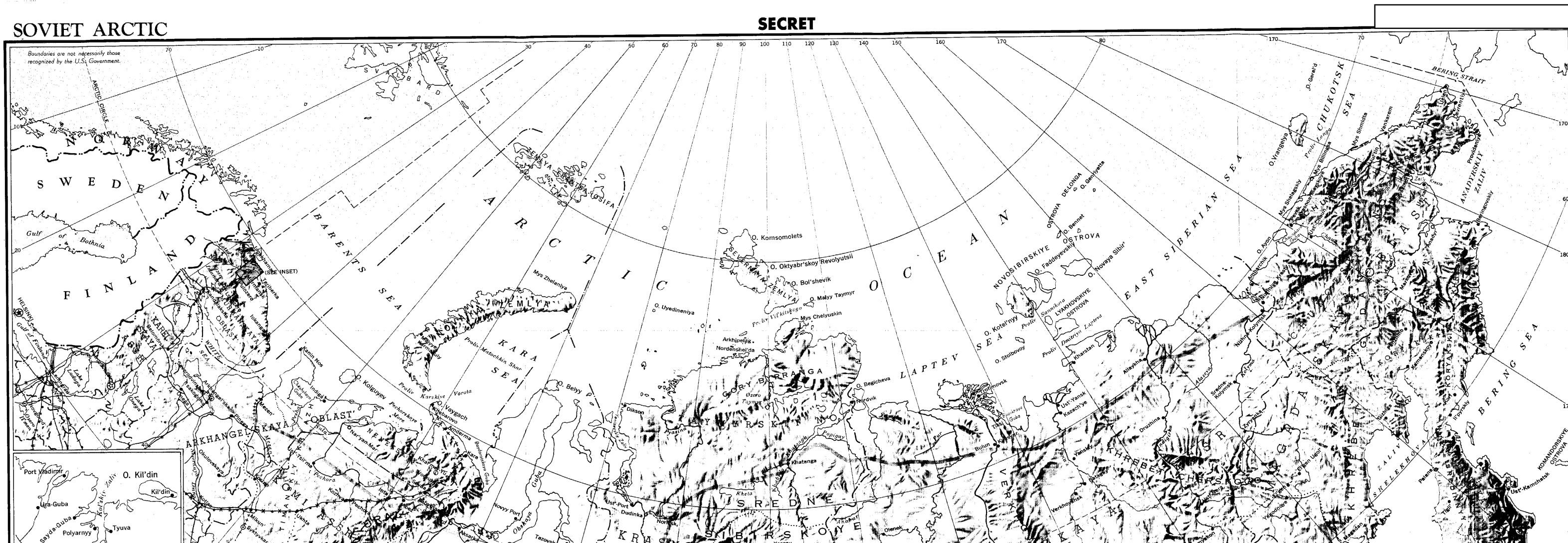
SOVIET ARCTIC

SECRET



27362 4-59

TRANSPORTATION AND ADMINISTRATIVE DIVISIONS

ADMINISTRATIVE DIVISIONS (1959)

CENTER		BOUNDARY
⊛	Union Republic (S S R)	— ·· —
⊙	Oblast, Kray, or Autonomous Republic (A S S R)	— · — · —
○	National Okrug (N O)	....

0 200 400 600 800 1000 Statute Miles

0 200 400 600 800 1000 Kilometers

RAILROADS

- Double track
- Single track (second track under construction)
- Single track
- Narrow gauge
- Single track under construction
- Single track projected

RAILROAD ELECTRIFICATION

- Existing
- Under construction
- Projected

Main road

Study area boundary

SECRET

V. Telecommunications

Telecommunications service in the Soviet Arctic include telegraph, telephone, and radiobroadcasting and a ground controlled intercept (GCI) radar net. Transmission facilities for all are being developed and expanded to provide quick, reliable, secure service between this strategic region and the remainder of the country (see Map 27363).

A. Telecommunication Methods

1. Telegraph

Telegraph is the most widely used system of telecommunications in the Arctic and is accomplished by several methods. Point-to-point radio telegraph is the primary means of communicating between populated places within the region and between the Arctic and major centers to the south. The radio-telegraph network centers that connect with the Arctic include Moscow, Krasnoyarsk, Yakutsk, Magadan, and Anadyr'. 99/ Radio communications, using primarily medium frequency and high frequency Morse, which are available in practically every populated place along the Arctic littoral and in the river valleys, are used for shipping, aircraft, and meteorological traffic as well as domestic point-to-point messages.

Telegraph communications are also carried over wire lines in the European and Central Siberian sectors of the Arctic. Wire lines are a relatively secure means of transmission, but facilities will probably not be substantially extended because of severe weather conditions, lack of alternate wire-line routes, and the extreme distances between inhabitated points. In the European sector, wire lines connect many of the large settlements with Leningrad and Moscow. A line also extends from Krasnoyarsk to Yermakovo, Dudinka and Noril'sk. A wire line from Aksarka to Yermakovo apparently parallels the Salekhard-Igarka railroad, but its present status is unknown. Wire lines between Leningrad and Murmansk and between Moscow and Khal'mer-Yu have carriers that enable the circuit to be divided into portions which can be used independent of or simultaneously with all other portions. High priority traffic, such as aircraft control and warning (AC and W) information, is being diverted from high frequency radio to land lines as the network of wire lines is expanded. The radio continues to transmit low-grade traffic and to serve as an emergency telecommunication system in the European and Central Siberian Arctic.

Additional telegraph facilities include the microwave radio relay lines. They are better developed in more southern parts of the country than in the Arctic. A line from Moscow to Kostroma, however, is to be extended and completed to Arkhangel'sk by 1960. Additional microwave lines will probably be introduced to replace present point-to-point facilities, which will be kept for emergency standby use. Microwave is much more useful than other communication systems since it provides a high degree of security from interception, offers great freedom from jamming, has an economy of frequencies and a broad band width, is unaffected by atmospheric and weather disturbances, and provides economy of operation. 100, p. 21/

Atmospheric scatter is a technique that offers great promise for point-to-point communications in the Arctic since it is not affected by magnetic disturbances. In this method, a radio signal is scattered at a predetermined angle into the ionosphere or troposphere and is reflected to a specific receiving station. An experimental ionospheric scatter circuit is in operation between Leningrad and Murmansk, and tropospheric scatter is expected to be a primary system in the Arctic in the future.

2. Telephone

Telephone communication is limited largely to urban and interurban service for large cities. Murmansk has an automatic telephone system with facilities in the main post office and branch buildings. There are no public phone booths on the streets, and only prominent persons have telephones in their homes. 101/ Noril'sk has both automatic and manual telephone exchanges. Arkhangel'sk has an automatic exchange and is connected with Murmansk by a submarine telephone cable. Other means of interurban telephone communication are by point-to-point radio and, to a lesser extent, by microwave radio relay networks.

3. Broadcasting

The broadcasting system of telecommunications includes radiobroadcasting, wire-diffusion, and television networks. The number of receivers for radiobroadcasting in the Arctic is small, and most broadcasts are received through wire-diffusion, using wired loudspeakers. Government propaganda and entertainment programs are disseminated by this method.

Television is a recent innovation in the European Arctic, but facilities are now being extended into the Siberian sector. The major stations now in operation are at Murmansk and Vorkuta. Television broadcasts from Vorkuta are received at a distance of 50 miles (80 kilometers), making the use of television sets possible throughout the entire mining basin. Other television stations are located in Arkhangel'sk and Noril'sk. A major station is planned for Arkhangel'sk in addition to its local station. In Noril'sk, a television center has been constructed on one of the hills near the city.

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Unusual television reception has been experienced on drifting station SP-6. In November 1957, shows originating in Vladivostok, 2,500 miles (4,000 kilometers) to the south, were received there. The high degree of ionization in the ionosphere due to high solar activity, in addition to the fact that Vladivostok and SP-6 were on the same meridian, are said to account for the phenomenal reception distance. 102/

4. Radar

The radar net in the Soviet Arctic provides continuous coastal coverage from the Norwegian border to the Bering Strait, with extensions north from Zemlya Frantsa-Iosifa, and SP-6. Early warning (EW) coverage reaches points 100 to 125 miles (160 to 200 kilometers) from the coast. Details are lacking concerning the number and location of the radar sites, but concentration is heaviest at the eastern and western extremities of the Soviet Arctic and relatively sparse between. The areas from the Norwegian border to Dikson and from Mys Shmidta to Provideniya are under surveillance by two or more radars simultaneously. The danger of undetected penetration into the interior of the mainland is greatest in the Central Arctic, but radar coverage is being improved in this area.

The present communications net that serves the Air Defense Districts (ADD's) is believed to be a mixture of low-power transmitter stations and civil air, administrative, and general communication circuits. More powerful transmitters and exclusive AC and W channels are needed if operating proficiency is to equal that of other areas of the Soviet Union.

Control of air defense communication facilities has apparently been placed under temporary control of the ADD's. The districts are aligned in a north-south direction, probably to provide a greater depth of warning and to utilize existing communication channels. The Novosibirsk ADD may have been extended northward to include Ostrov Vize and Severnaya Zemlya. The Chita ADD may have been extended laterally to include the coast from Mys Kosistyy to Nizhniye Kresty and northward to the Novosibirskiye Ostrova. Radars on Zemlya Frantsa-Iosifa and Novaya Zemlya are probably subordinate to the White Sea ADD, whereas the Chukotsk ADD probably controls Ostrov Vrangelya and the northern Chukotsk Peninsula. The Northern ADD includes Murmanskaya Oblast'.

The future development of the Arctic radar net will probably include the introduction of jet fighters and the installation of improved radars. Fighter aircraft will no doubt be based at Tiksi to supplement those now at Severomorsk, Amderma, Provideniya/Urelik and other bases. The use of improved EW and GCI radars, especially in the Novosibirskiye Ostrova, will substantially increase the capability of the radar system of the central sector of the Arctic. 103/

B. Regional Difficulties in Construction and Operation

The high latitudinal position of the Soviet Arctic produces construction and operational problems peculiar to the region. Permafrost presents difficulties in constructing wire lines, antennas, and towers. High winds occasionally blow down wire lines and also damage towers and antennas. During the cold season, hoarfrost and ice form on wire lines; and, unless removed, the accumulated weight is sufficient to break the wires. A simple wooden scraper has been devised to remove frost and ice, but its effectiveness is limited by the number of personnel available for such work and the distance they can walk in one day.

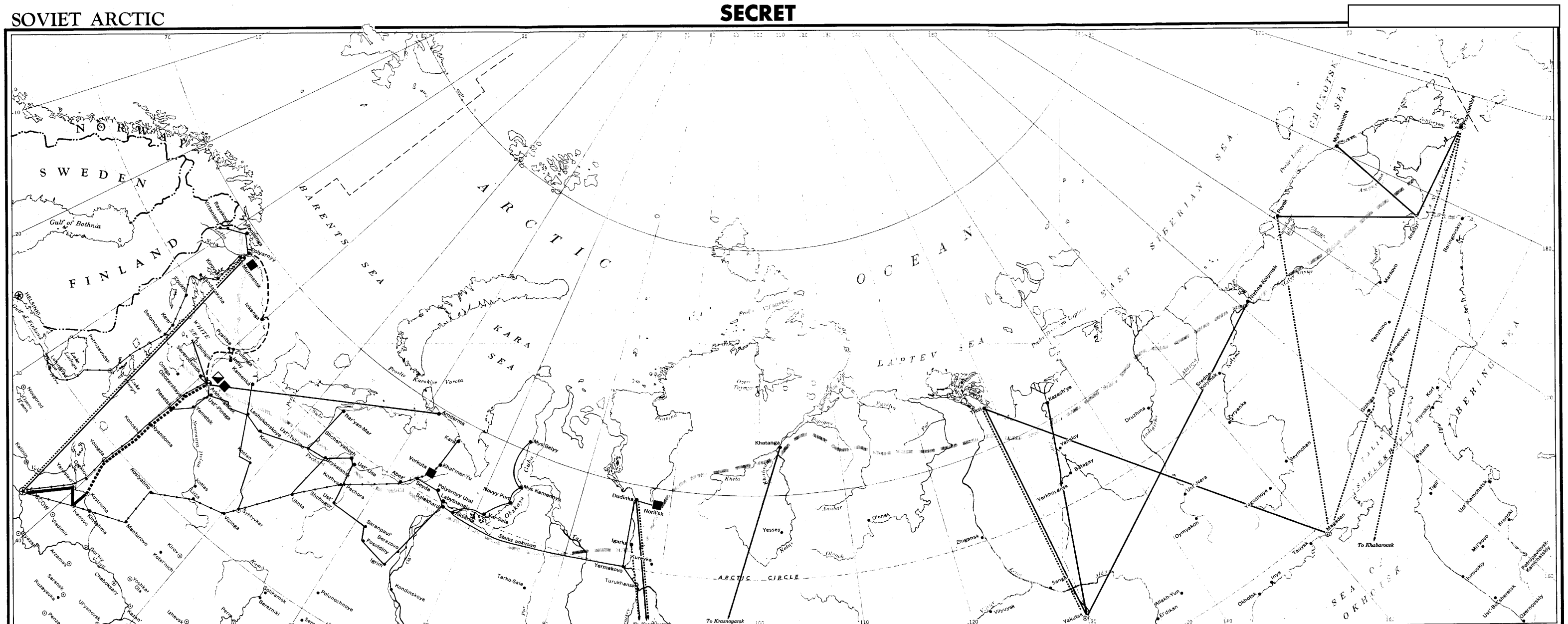
Radio "blackout" or disruption of communications is prevalent throughout the Arctic region and occurs when the earth's magnetic field is highly disturbed. A byproduct of the magnetic disturbance is the aurora borealis or northern lights. The Soviet Arctic lies within the zone of maximum auroral activity, which extends from the northern tip of Norway through the center of Novaya Zemlya and then south of Ozero Taymyr, the Novosibirskiye Ostrova, and Ostrov Vrangelya. To the north and south of this zone the number of displays and consequent communication disruptions decreases, but to the north the lights can still be seen on almost all clear nights. 104/ Radio links oriented north-south are less affected by blackouts than those with east-west orientation since the signal has to pass through the auroral zone only once and at its narrowest dimension. When adverse weather and ionospheric disturbances occur, however, east-west communications can be successfully transmitted by zig-zag routing.

During periods of great auroral activity, point-to-point and air-ground communications are affected and may be disrupted for several days. Since the low-frequency radio systems (up to 300 kcs) are less affected by magnetic disturbances than those with high frequencies, the Russians have adopted low-frequency systems for air-ground communications. 105/

Communications are also affected by factors associated with the winter and summer seasons. Operating conditions are relatively good in winter, when the nights are long and the cold is severe. During the long summer days, however, signal efficiency, effective antenna radiations, and transmissions via the ionosphere layers are reduced and wire resistance and the possibility of solar-flare "blackouts" are increased.

SOVIET ARCTIC

SECRET



27363 4-59

TELECOMMUNICATIONS

WIRELINES*
- Wireline with carrier
- Wireline
- Submarine cable
- Repeater Station

*Only selected lines are shown south of study boundary.

MAIN DOMESTIC RADIOTELEGRAPH CIRCUITS
(observed during 1953-57)
- Teletype
- Morse

Statute Miles: 0, 200, 400, 600, 800

Kilometers: 0, 200, 400, 600, 800

MICROWAVE RADIO RELAY LINES
- In operation
- Planned *(completion by 1960)*

STUDY AREA BOUNDARY

TELEVISION STATIONS
- Major - in operation
- Major - planned
- Local - in operation

SECRET

VI. Arctic Scientific Activities

The present extensive program of geophysical research in the Soviet Arctic includes studies of the entire Polar Basin environment from the ocean bottom to the upper atmosphere. The research undertaken by the Soviet Union has both economic and strategic implications. The benefits to shipping on the Northern Sea Route and to internal air traffic are obvious, but the same information also has a bearing on military polar flights, submarine operations, and guided-missile flights. Launching sites designed for high-altitude research and meteorological rockets may also be used to launch guided missiles. For any flights along polar routes, weather forecasts are necessary. Submarine operations are dependent upon a knowledge of underwater topography, sea currents, and ice movement, all of which are emphasized in the present research program. Gravity observations have particular significance for Soviet capabilities in positioning and navigational control of long-range missiles since information of this type is necessary to compute the earth's exterior gravity field along the missile flight path.

The organized study of the Arctic began in 1882, when 13 polar stations were established for the First International Polar Year. During the Second International Polar Year (1932-33), 24 polar stations were established, and the marine expeditions of the Knipovich, Persey, and Sibiryakov were carried out. The drift of the Sedov in 1937-40 and the Papanin expedition on SP-1 in 1937 also added to Soviet data on the Arctic Basin. Since 1954, the program of scientific study has been greatly expanded and now includes observations made for the International Geophysical Year. The chain of polar stations on both the mainland and offshore islands together with drifting stations, flying observatories, oceanographic expeditions, and high-latitude air expeditions are used to collect data on the vast area of the Arctic Basin and its littoral areas.

A. Polar Stations

Approximately 100 polar stations are in operation in the Soviet Arctic (see Map 27359). The polar stations are under the Department of Polar Stations, GUSMP; and their operations are directed by regional centers at Amderma, Dikson, Tiksi, Pevek, and Provideniya. The stations are located along the coast, in the interior of the mainland, and on the offshore islands. Most are at settlements, but some are situated on deserted expanses along the coast. A typical polar station consists of several wooden structures -- including a meteorological building, radio hut and masts, a generator hut, living quarters, and a storehouse. An airstrip serving the polar station is usually located nearby on a gravel bar or on the tundra.

The polar stations vary greatly in size and function. Some of the smaller stations have 3- or 4-man crews and operate only during the navigation season; others have staffs of 20 or more and operate the year round. Nearly all stations conduct meteorological observations, including radiosonde, radiowind, pilot ballons, or solar radiation measurements. These data, together with hydrological and cryological observations, are forwarded to the regional centers. Information is also disseminated to ships and aircraft in the immediate vicinity of the stations. Incidental activities at a polar station include the study of the local area and the native population and rescue work and aid to seamen, trading agents, and others among the local population.

In addition to their regular observations, 4 polar stations -- Barentsburg, Dikson, Tiksi, and Pevek -- together with the observatory at Ostrov Kheysa serve as major observatories (Figure 72). They are engaged in more extensive geophysical programs, including upper air research, ionospheric work, and the continuation of special IGY activities. These observatories also serve as regional centers for surrounding polar stations and receive data from them to be relayed to Moscow and Leningrad.

B. Drifting Stations

The first drifting station was established in 1937. Since then, 7 others have been set up; but, at present, only 2 of the stations are active (see Map 27669). SP-1 was set up under the direction of Papanin on pack ice at a point near the North Pole. Four men remained at the station for 274 days and covered a distance of 1,305 miles (2,100 kilometers) during a 1,555-mile (2,500-kilometer) drift. SP-2, under the direction of M. Somov, was launched north of Alaska in 1950. It was abandoned after 1 year; the ice floe on which it was located continued to drift in a large arc for 3 years and returned to its approximate starting point. Drifting stations were again established in 1954 with the founding of SP-3 and SP-4. SP-3 was abandoned in May 1955 when it drifted to within 100 miles (160 kilometers) of Greenland. SP-4 was abandoned in April 1957 after operating for 1,075 days and traveling over 4,000 miles (6,500 kilometers). In April 1955, SP-5 was established, but it was abandoned in October 1956 because the ice floe on which it was located was drifting out of the Arctic Basin.

SP-6 was set up in April 1957 on an ice island 6 by 9 miles (10 by 14 kilometers) in extent and up to 130 feet (40 meters) thick. This was the first station to be established on an ice island and may have been an experiment to find platforms more suitable than ice floes for station locations. On 27 December, a piece of ice 0.7 square miles (2 square kilometers) in area broke from the island, but apparently

Figure 72. Buildings of the polar station at Dikson. (1956)

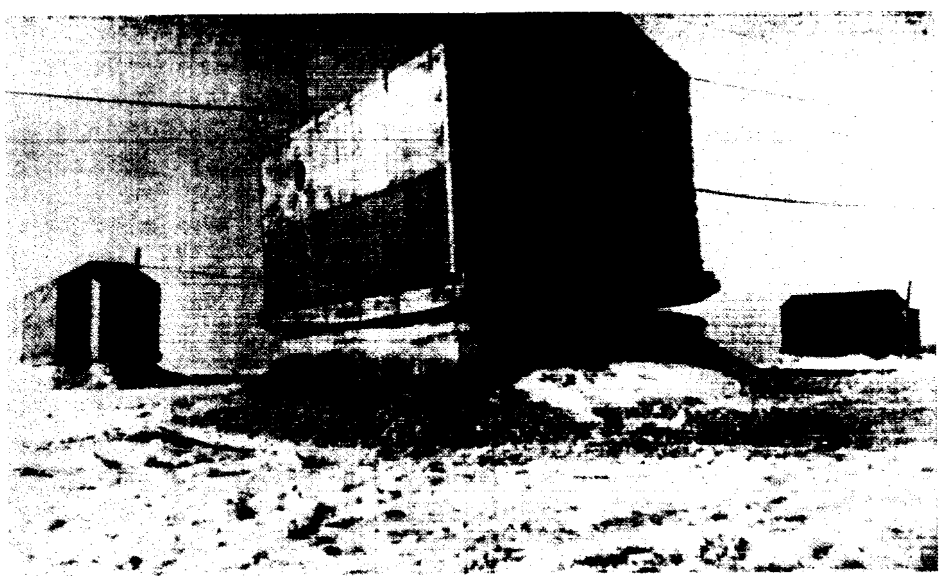


Figure 73. Prefabricated buildings on SP-6. The buildings have prevented the ice beneath them from melting, whereas seasonal melting has lowered the surrounding surface of the ice island. (1957)

25X1 the damage did not disrupt activities at the camp. [redacted] 25X1

In May 1957, SP-7 was set up near the drift of SP-3 and was expected to follow the course of the former. Since SP-3 was in operation during a period of minimum solar activity and SP-7 operated during maximum solar activity, a comparison of the two sets of data

25X1 will provide new information on the sun. [redacted] 25X1

In November and December 1958 the ice floe on which SP-7 was situated was damaged by severe winds and hummocking, which caused the ice to crack in several places and a portion of the ice floe to break off. In late December, cracks 16 feet (5 meters) wide developed within the camp site, causing the loss of tents and equipment and disruption of the airstrip. Fuel, ionospheric and hydrologic equipment, and a helicopter were moved to new locations. By the end of December the airstrip had been repaired and camp activities were back to normal. Observations on SP-7 ceased and the station was abandoned at the beginning of April 1959.

The most recent drifting station, SP-8 was established in April 1959 on the pack ice northeast of Ostrov Vrangelya; it replaced SP-7, which in 2 years had drifted across the Arctic Basin to a point north of Greenland.

25X1

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Drifting stations are manned by about 20 scientists and support personnel and carry a large amount of equipment, which enables them to make observations in the field of geophysics, including meteorology, oceanography, and terrestrial geophysics (Figures 76, 77 and 78).

Figure 76. Preparing a platform for scientific observations on SP-4. The winch is used for taking water and biological samples and temperature readings. (1955)

Meteorological observations consist of surface, upper-air, and ionospheric conditions; ice, snow, and water temperatures; and solar radiation measurements. Oceanographic observations include water temperatures, water samples, speed and directions of currents at various levels; depths soundings; and ocean bottom, plankton, and bottom-fauna sampling. Cryological investigations include the formation, melting, texture, structure, mechanical properties, and thickness of the ice as well as aerial ice reconnaissance. Terrestrial geophysical observations include geomagnetic, aerial magnetic, seismological, and probably gravity surveys and recordings.

According to the Soviets, investigations by the drifting stations have revealed the existence of a seismic zone, including an active volcano, in the Arctic Basin. The zone nearly parallels the submarine Lomonosov Range, and the volcano is located near the junction of the zone and the range (88°16'N-65°36'W). The presence of volcanism was indicated by the recovery of bottom sediments, particularly volcanic glass, and by the experiences of SP-3 when it drifted near the area in November 1954. At that time, strong shocks were felt, the ice floe cracked, rumbling noises were heard, and hydrogen sulfide gas was detected in the air. Further study may reveal additional volcanoes in the Arctic Basin. 108/

Figure 77. An instrument used for making actinometric measurements on SP-4. (1955)

Figure 78. Scientists filling a balloon with hydrogen prior to launching radiosonde instruments. (1955)

C. Flying Observatories

Flying observatories are planes used for nonstop roundtrip flights from coastal locations to the North Pole and back for the collection of weather and ice data. The aircraft fly over predetermined routes to prevent flights from overlapping and to insure that the area is evenly covered. The method was used first in 1945 and again in 1954. It has probably been used since then, but no information is available.

D. Oceanographic Expeditions

Oceanographic expeditions by icebreakers and icebreaking freighters are conducted in the Soviet Arctic Seas and more recently have been undertaken beyond the limits of the Soviet territorial seas. In 1946 the icebreaker Severnyy Polyus conducted observations in the Chukotsk, East Siberian, and Laptev Seas. No new major Arctic oceanographic expeditions were initiated until 1955, when the icebreaker Litke sailed in the Greenland Sea and in the area north of Zemlya Frantsa-Iosifa and Spitsbergen to study water and drift-ice movement in these areas. The Litke sailed through the pack ice to 83° north latitude, which the Soviets claim is the most northerly point reached by any ship sailing under its own power.

The icebreaking freighter Ob' has been outfitted with laboratories for a full range of continuous oceanographic observations extending from portions of the Arctic Basin and peripheral seas during the northern summer to the Antarctic waters during the southern summer. In 1956 the Ob' sailed in the area north of Spitsbergen and Zemlya Frantsa-Iosifa and in the northern part of the Greenland Sea to study water and heat exchange between the Arctic and Atlantic Oceans. Another icebreaking freighter, the Lena, continued the study of water and heat exchange in the same area in 1957. One of the significant results of this voyage was the measurement of the depth of the Nansen Porog (Shelf), which lies between Greenland and Spitsbergen. The shelf was found to lie at 9,842 to 16,404 feet (3,000 to 5,000 meters) below sea level, with a deeper channel intersecting it near the middle. 109/ The depth of the shelf is much greater than previously supposed, which will necessitate a revision of the calculated amounts of water exchanged between the Arctic Ocean and the Greenland Sea.

In 1957, a hydrographic expedition was engaged in geodetic surveying on Ostrov Kheysa and at additional points in Zemlya Frantsa-Iosifa, and also made observations on Severnaya Zemlya. Another hydrographic expedition took part in the 1957 exploration of new high-latitude sea routes to be developed after the atomic-powered icebreaker Lenin is put into service. The program included charting Proliv Krasnoy Armiya in Severnaya Zemlya and making depth soundings of the Kara Sea between Novaya Zemlya and Severnaya Zemlya.

During the first half of 1958 the Hydrographic Institute of GUSMP had stations and expeditions based at Arkhangel'sk, Ostrov Kheysa, Dikson, Igarka, Mys Kosistyy, Mys Vatutin, Tiksi, Pevek, and Provideniya. Soundings were made by all the expeditions and, except for Arkhangel'sk, all were conducting astrogeodetic surveys. At the end of the second quarter of 1958, the mainland bases terminated their observations in order to prepare for their usual activities of repairing and establishing navigational aids along the Northern Sea Route; and only the two island bases -- Ostrov Kheysa and Mys Vatutin -- were continuing their soundings and geodetic work. During August and September, 25 ships of the Hydrographic Institute were active in the Arctic seas and the lower Yenisey River, where they conducted depth soundings, serviced signal beacons, and constructed new markers. The severe ice conditions in the central Arctic prevented a four-ship depth-sounding expedition from operating in the Severnaya Zemlya area. After their activities north of Novaya Zemlya were completed, the ships were sent to the southern Kara Sea instead of proceeding to Severnaya Zemlya.

One result of the oceanographic investigations is the compilation of a bottom-sediments map of the Arctic Basin and adjacent seas. The geological history of the ocean bottom was worked out by an analysis of bottom-sediment cores 10 to 23 feet (3 to 7 meters) deep, which were obtained by using special sampling tubes.

E. High-Latitude Air Expeditions

High-latitude air expeditions (1) conduct geophysical observations from temporary camps on the pack ice; (2) establish, resupply and evacuate drifting stations; (3) set up DARMS's and DARB's; and (4) conduct ice reconnaissance. On the first expedition to the Arctic in 1937, SP-1 was established; since 1954 the expeditions have become annual affairs.

The 1958 High-Latitude Air Expedition brought supplies and new personnel to the drifting stations, set up a total of 20 DARMS's and DARB's, and conducted ice research on SP-7. The expedition was reactivated in the fall of 1958, when 8 DARMS's were established and the drifting stations were resupplied. An additional feature of the fall expedition was a visit to SP-7 by a group of Soviet and foreign correspondents.

The 1959 High-Latitude Air Expedition, which operated in March and April, had as its main objectives the resupply of SP-6, deactivation of SP-7, establishment of SP-8, and setting up DARMS's and DARB's. SP-8 was established on the pack ice northeast of Ostrov Vrangelya, and much of the scientific equipment from SP-7 was probably transferred to it. DARMS's were set up in the vicinity of the abandoned station so that weather and ice-drift records would continue. These automatic instruments are part of a total of 30 DARMS's and DARB's, that were set up in 1959 on the pack ice of the Central Arctic Basin. 110/

A high-latitude air expedition usually consists of 3 detachments, 2 to service the drifting stations and 1 to carry out geophysical observations. The expeditions are usually conducted in early spring (March, April, and May) and are completed in about one month. As many as 30 aircraft are used during the operations. Tons of equipment and food, together with new personnel, are sent to the drifting stations. If a new station is to be established, extensive reconnaissance flights are made to find a suitable ice floe. The detachment conducting geophysical observations is composed of several mobile teams that operate from fuel bases on the pack ice. The teams of scientists fly to predetermined locations to conduct observations for periods ranging from a few hours for depth measurements and bottom samples to a day for more extensive observations. At the conclusion of the observations the team either flies to another location or returns to the fuel base.

The magnitude of the observations conducted by high-latitude air expeditions was shown on a map published by the Soviets in 1957 (see Map 27375). 111/ A total of 579 landings are indicated, varying from 7 in 1937, which were concentrated at the North Pole and north of Zemlya Frantsa-Iosifa, to 214 in 1956, which were grouped north of Siberia and Alaska between 140°E and 120°W. 112, 113/ The actual number of landings probably greatly exceeds the 579 plotted on the map, since Soviet authors mention "some hundreds of landings" on the drifting ice. [redacted]

25X1

25X1

F. International Geophysical Year Activities

The extensive IGY plans of the Soviet Union supplemented the already existing Arctic research program (see Table 1). The Arctic research program was modified somewhat to fit the IGY plans, but in general the objectives of the two programs were similar. Most of the activities are being continued although the IGY has officially terminated. In most fields the IGY program is comparable to those of Western countries, but some fields are more comprehensively covered and others are totally lacking. The following disciplines are included: meteorology, aurora, cosmic rays, geomagnetism, ionosphere, oceanography, seismology, and glaciology. Specific observations in fields having military implications such as oceanography and rocket flights have not as yet been released by the Soviets for international exchange.

Table 1

Locations of Soviet Arctic Research Activities for The International Geophysical Year

Location	Coordinates		Standard meteorology	Radiosonde	Radiowind	Pilot	Solar radiation	Ozone	Chemistry of precip.	Geomagnetism	Earth currents	Aurora	Airglow	Ionosphere	Cosmic rays	Glaciology	Oceanography	Seismology
	° '	° '																
1. Ambarchik	69 34 N	162 18 E										X						
2. Amderma	69 46 N	61 41 E	X															
3. Arkhangel'sk	64 35 N	40 30 E	X	X	X		X		X			X						
4. Barentsburg	78 04 N	14 13 E	X	X	X		X				X	X						X
5. Belyy, Ostrov	73 20 N	70 02 E	X															
6. Bolvanskiy Nos, Mys	70 27 N	59 04 E										X						
7. Chaplino, Mys	64 24 N	172 14 W										X						
8. Chelyuskin, Mys	77 43 N	104 17 E	X	X	X		X			X	X	X					X	
9. Chetyrekhstolbovoy, Ostrov	70 37 N	162 24 E	X	X	X		X					X					X	
10. Chokurdakh	72 38 N	147 55 E	X															
11. Dikson	73 30 N	80 24 E	X	X	X		X	X		X		X		X				
12. Dudinka	69 24 N	86 10 E	X	X		X												
13. Golomyannyy, Ostrov	79 30 N	91 08 E	X									X						
14. Igarka	67 30 N	86 34 E	X															
15. Kamennyy, Mys	68 28 N	73 36 E	X	X		X						X						
16. Kanin Nos	68 39 N	43 18 E	X															
17. Khatanga	71 59 N	102 28 E	X	X	X							X						
18. Kheysa, Ostrov	80 37 N	58 03 E	X	X	X		X	X		X	X	X		X	X		X	X
19. Khoseda-Khard	67 05 N	59 23 E	X															
20. Kolyuchin, Ostrov	67 28 N	172 14 W										X						
21. Kotel'nyy, Ostrov	76 02 N	138 02 E	X	X			X											
22. Kresty Kolymskiye	68 48 N	161 17 E	X									X						
23. Malyye Karmakuly	72 23 N	52 37 E	X	X		X						X						
24. Muostakh, Ostrov	71 33 N	130 02 E										X						
25. Murmansk	68 58 N	33 05 E	X	X	X					X		X		X	X		X	X
26. Nagurskaya	80 46 N	46 39 E										X						
27. Nar'yan-Mar	67 40 N	53 05 E	X	X		X						X						
28. Pevek	69 42 N	170 16 E	X	X			X					X						
29. Polyarnyy Ural	67 36 N	66 05 E														X		
30. Preobrazheniya, Ostrov	74 40 N	112 50 E	X	X	X	X	X					X						
31. Provideniya	64 23 N	173 18 W	X	X		X								X				
32. Pyramida	78 11 N	15 08 E										X						
33. Rauchua	69 30 N	166 35 E										X						
34. Russkaya Gavan'	76 11 N	62 57 E	X													X	X	
35. Salekhard	66 35 N	66 40 E	X									X		X				
36. Saskylakh	71 58 N	114 05 E	X															
37. Severnyy Polyus 6	86 30 N	56 30 E	X	X	X	X	X			X		X		X			X	
38. Severnyy Polyus 7	86 00 N	53 18 W	X	X	X	X	X			X		X		X			X	
39. Shalaurova, Mys	73 11 N	143 13 E	X	X		X						X						
40. Shmidta, Mys	68 55 N	179 29 W	X	X	X		X					X		X	X		X	
41. Taymylyr	72 36 N	121 55 E										X						
42. Tazovskoye	67 28 N	78 44 E	X															
43. Tiksi	71 33 N	128 54 E	X	X	X		X			X	X	X	X	X	X			X
44. Tikhaya, Bukhta	80 20 N	52 48 E	X	X		X				X		X				X		
45. Uelen	66 10 N	169 53 W	X	X		X	X			X		X						
46. Ust'-Port	69 39 N	84 24 E										X						
47. Ust'-Yansk	70 56 N	136 10 E	X	X		X	X			X								
48. Uyedineniya, Ostrov	77 30 N	82 14 E										X						
49. Vankarem, Mys	67 50 N	175 36 W	X									X					X	
50. Vize, Ostrov	79 50 N	76 59 E	X	X	X		X					X						
51. Vrangelya, Ostrov	70 58 N	178 32 W	X	X		X	X					X					X	
52. Zhelaniya, Mys	76 57 N	68 33 E	X									X						
53. Zhokhova, Ostrov	76 07 N	153 55 E	X	X								X						

The Soviets are using polar stations, drifting stations, observatories, and oceanographic expeditions to carry out their program of IGY research and observations. Although various reports differ as to the number of polar stations and observatories that are gathering data during the IGY, about 50 of the approximately 100 polar stations are included in the program. The Soviet Arctic is covered by a net of observation points extending from Zemlya Frantsa-Iosifa in the west to Uelen in the east, and the types of observations range from standard meteorologic measurement such as that done at Ostrov Golomyanny to the comprehensive program of meteorologic, geomagnetic, auroral, ionospheric, cosmic ray, glaciology and seismic observations conducted at Tiksi.

A new ionospheric station was established on Ostrov Kheysa in Zemlya Frantsa-Iosifa. The settlement, called Druzhnyy (Friendly) is built in a semicircle around a fresh water lake and consists of an eating hall, living quarters, radio station, buildings housing geophysical instruments, and a rocket launching site. 114/ A total of 25 meteorological rockets were scheduled to be launched during the IGY; the first was fired on 4 November 1957 and a total of 14 had been launched by 29 May 1958. The meteorological rockets, which reach altitudes of 50 to 56 miles (80 to 90 kilometers), carry electric resistance thermometers as well as thermal and membrane monometers for measuring air temperature and pressure. Other observations conducted at Druzhnyy included seismology, variations in sea level, cosmic rays, aurora, and geomagnetism.

The two drifting stations, SP-6 and SP-7, are probably the stations that were designated for the IGY as Arctica I and Arctica II and made meteorologic, geomagnetic, auroral, and ionospheric observations. However, the most important observations of the drifting stations -- oceanographic and ice data -- were not included in their IGY commitment. These functions were probably omitted to forestall an exchange of these data on the Arctic Basin with Western countries.

Oceanographic surveys in the Soviet Arctic are limited to peripheral areas. The research ships Toros and the Polyarnik conducted observations in meteorology, bottom relief, temperature, chemistry, currents, waves, and plankton in the Chukotsk Sea and Norwegian and Greenland Seas. The Lena has also worked in the Norwegian and Greenland Seas. The icebreaking freighter Ob', which has been used for oceanographic work in the Soviet Arctic, was not listed for IGY surveys in this region, this ommission also suggests unwillingness to exchange data with other countries.

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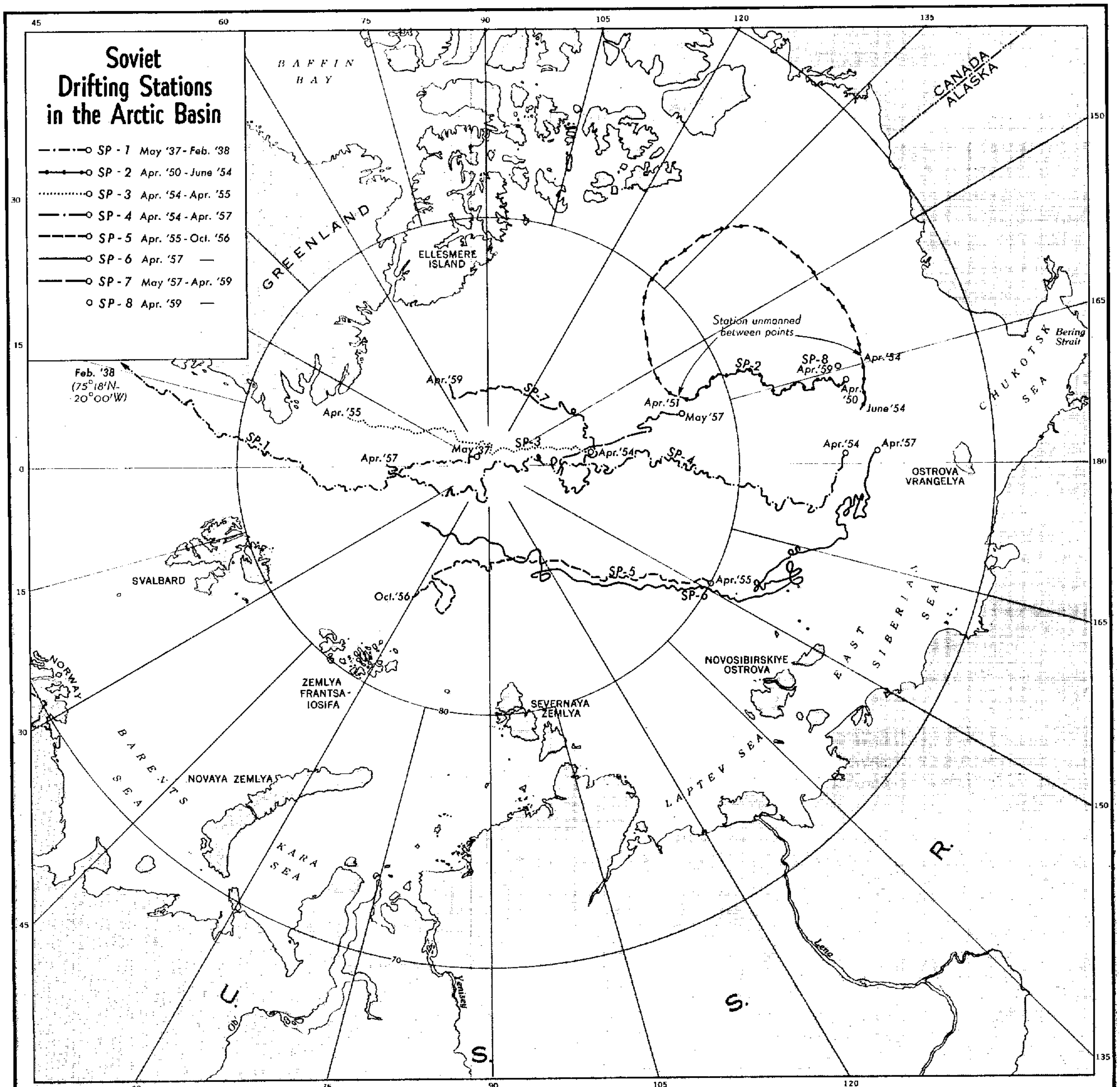
Soviet Drifting Stations in the Arctic Basin
SP - 1 May '37 - Feb. '38
SP - 2 Apr. '50 - June '54
SP - 3 Apr. '54 - Apr. '55
SP - 4 Apr. '54 - Apr. '57
SP - 5 Apr. '55 - Oct. '56
SP - 6 Apr. '57 —
SP - 7 May '57 - Apr. '59
SP - 8 Apr. '59 —
BAFFIN BAY
GREENLAND
ELLESMERE ISLAND
CANADA
ALASKA
Station unmanned between points
Bering Strait
CHUKOTSK SEA
OSTROVA VRANGELYA
Feb. '38 (75°18'N-20°00'W)
SVALBARD
NORWAY
ZEMLYA FRANTSA-IOSIFA
SEVERNAYA ZEMLYA
NOVOSIBIRSKIYE OSTROVA
EAST SIBERIAN SEA
LAPTEV SEA
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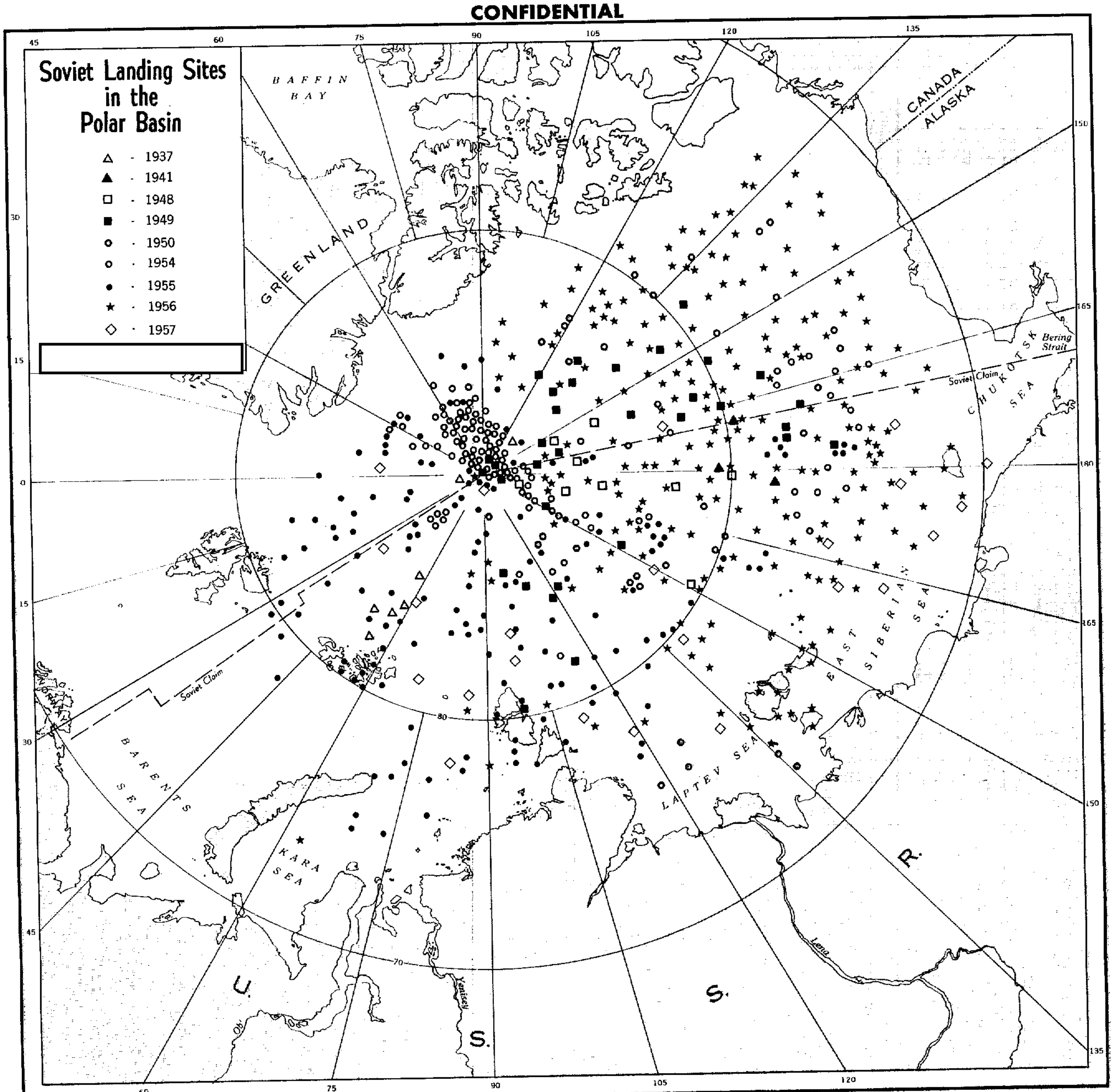

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VII. Relation Between Physical Environment and Arctic Operations

A. Climate

Climate is the factor that exerts the greatest influence on the progress of air, land, and sea operations in the Soviet Arctic. Factors of major importance affecting air and land operations are cold winter temperatures and strong surface winds. Sea operations are also seriously affected by summer ice and fog conditions. In the following discussion of air, land, and sea operations, climatic factors are presented in order of their importance to these operations.

1. Effect on Air Operations

Air operations, the major means of exploration and of offensive and defensive warfare in the Soviet Arctic, are especially dependent upon favorable climatic conditions. To reduce the dangers of flying in inclement weather the present meteorological activities in the Arctic are directed toward both long- and short-range weather forecasting.

a. Temperature

The extremely low winter temperatures create airplane maintenance and operating difficulties not encountered at lower latitudes. The scarcity of adequate hangars and shelters for parking and servicing aircraft is a particularly serious problem. Currently, cloth covers are commonly used to protect aircraft from snow, frost, and ice accumulations. Fighters and light bombers are completely covered in some cases, whereas larger bombers and transports have only their engines covered. During maintenance and repair work, permanent and portable shelters, warmed by ground heaters, are used. 116/

Without protection from low temperatures and strong winds, a parked aircraft soon becomes "cold-soaked"; that is, all of its parts become as cold as the surrounding air. Cold-soaked aircraft present many maintenance and operational problems unless they are adapted to weather conditions and special procedures are used.

Tests conducted in the United States at temperatures as low as -65°F (-54°C) on a Russian jet fighter cold-soaked for 48 hours showed that its hydraulic and pneumatic systems were practically trouble-free and that the engine started on the first attempt. Russian maintenance handbooks suggest, however, that jet engines should be started without preheating or oil dilution only at temperatures above -40°F (-40°C). At lower temperatures the engine and the oil and fuel lines are heated by hot air, and preheated oil is put into the oil system. 117/ Aircraft with reciprocating engines use an oil dilution system to facilitate engine starting. Gasoline is used to thin oil when air temperatures drop to -40°F (-40°C) or lower. At lower temperatures the oil is preheated and poured into the engine, or the entire engine is warmed by an external heat source (Figure 79). During Arctic operations, drained oil would be

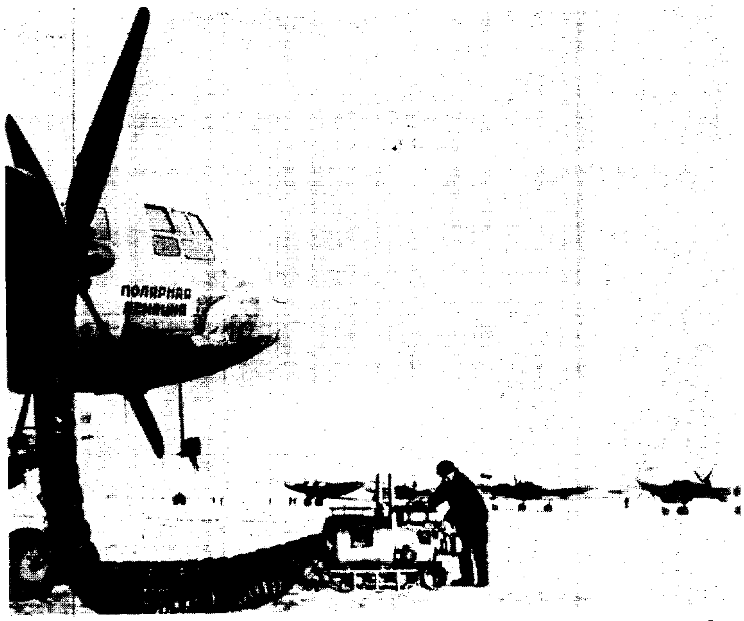

Figure 79. Preheating the engine of a Coach before taking off from Arkhangel'sk. The aircraft of Polar Aviation can be distinguished by the insignia "Polyarnaya Aviatsiya." (1955)

preheated if there were any danger that the dilution procedure would restrict flying capability.

Cold temperatures also cause ice crystals to form in fuel tanks, clogging fuel lines and carburetors. Diligent effort is required to prevent snow from entering the tanks and to filter out existing moisture in the fuel during fueling operations.

b. Winds

Arctic winds have a relatively high velocity as compared with those in more southerly latitudes. The high winds of the winter seriously affect air operations. Surface winds are particularly strong during this season and often prevent aircraft from taking off or landing. On Novaya Zemlya, gusts have reached 132 miles (212 kilometers) per hour. Although this is a record speed, winds of 88 miles (142 kilometers) per hour are not uncommon at Uelen and on Ostrov Vaygach, Ostrov Dikson, and Ostrov Vrangelya.

The weather becomes worse when snow accompanies the high winds, since visibility is then reduced to a few feet and all outside activity ceases. In addition to snow, sand and small pebbles are carried by the wind and can damage the aircraft.

Winds aloft have no seriously adverse effect on air operations. Upper air currents might even be an advantage to planes flying in the same direction, as could be the case in the event of an air attack on the United States. Narrow bands of upper air currents known as "jet streams" blow from west to east at high speeds, occasionally reaching 275 miles (443 kilometers) per hour. 118/ They form numerous interrupted belts that are flattened in cross section and vary from day to day in speed, altitude, and location. Jet streams are found at all latitudes from the Equator to the North Pole, but they are concentrated chiefly between 30°N and 40°N. Although the streams in general migrate northward in summer and become weaker, there is evidence of a midwinter jet stream in the vicinity of the Arctic Circle. The core of this stream is at an altitude above 65,000 feet (20,000 meters). Since the maximum altitude of Soviet bombers is less than this (60,000 feet for the Backfin), the usefulness of the jet stream in the near future is doubtful. 119/

Many problems would be encountered in using the jet streams. Up-to-the-minute detailed weather information would be needed to plot the shifting wind belts. Since the altitude, position, and speed of the winds change rapidly, aircraft planning to utilize them would be required to change course frequently, formation flying would be impractical, and simultaneous arrival over a target would be highly unlikely. 120/

c. Visibility

Visibility during air operations is reduced by fog, cloud, and to a minor extent by smoke. Fog and smoke lie close to the ground and are hazards in takeoffs, landings, and bombing runs. Clouds, which are usually in the form of stratus decks up to 25,000 feet (7,600 meters), are a hindrance to high-level bombing.

Fog is produced by the cooling effect of the coastal water and ice floes upon the winds that blow over them. Summer is the worst season for fogs since large areas of water along the coast are ice free at this time. During the winter, when the seas are frozen and the land is covered with snow, temperature differences are slight, and fogs are rare. Warm-season fogs commonly last about 12 hours, but fogs of longer duration are not unusual. Ostrov Vaygach, which averages 123 days of fog per year, has experienced single fogs that last up to 9 days.

The areal distribution of fogs follows a distinct pattern. The central section of the Soviet Arctic from Novaya Zemlya eastward to Novosibirskiye Ostrova has the greatest number of fogs. Ostrov Belyy has a maximum of 228 per year; and Mys Chelyushkin, on the northern tip of the Taymyr Peninsula, has 136 foggy days per year. At Mys Chelyushkin, 25 days per month are foggy during the navigation season. To the west and east the number of foggy days decreases rapidly. The western coast of Novaya Zemlya has only 55 to 60 days with fog per year and Murmansk only 57. Along the East Siberian and Chukotsk Sea coasts, an average of 80 to 100 foggy days occur during the year. The frequency of fogs declines rapidly with distance inland from the coast, depending on local topography. Inland towns located in river valleys often have fogs resulting from radiational cooling. These fogs are not a serious hindrance to air operations, since they are of short duration, usually burning off by midmorning.

Cloud conditions have little effect on air operations. Both the Soviet jet and conventional aircraft have been known to carry on operations when the ceiling was below 1,000 feet (300 meters). In general, skies are clear in the winter and cloudy in summer. Winter clouds are usually in the form of flat stratus decks up to 10,000 feet (3,000 meters) in altitude. In Central and Eastern Siberia the layers are frequently so thin that objects on the ground can be identified through them. On cloudy days, air operations would be limited to low-level flights, whereas the numerous clear days of winter would permit high-level flights.

In summer the clouds in the European Arctic are generally low stratus decks that would restrict operations to high-level instrument bombing. In Central and Eastern Siberia the clouds form in thick decks extending upward to 25,000 feet (7,600 meters). Both low-level visual bombing missions below the cloud deck and high-level instrument bombing missions above it are possible.

On days with a high overcast sky, the phenomenon of "whiteout" develops. Under such conditions the sky blends in with the snow- and ice-covered land and the horizon disappears. Since there are no shadows, it is impossible to distinguish variations in elevation. Flying under such conditions is hazardous and has been compared to "flying inside a bottle of milk."

Smoke is a minor obstruction to air operations. Towns located in valleys may often be obscured by a smoky layer of air. This is caused by temperature inversion and is of a temporary nature.

d. Light Conditions

Great annual variations in the length of daylight and darkness, a characteristic of high latitudes, have little effect on air operations. In general, maintenance and flight operations can be carried on during the winter season without many additional problems. [redacted] The planning and execution of strategic flights, however, is affected by the length of daylight and darkness, especially along trans-Polar routes. The utilization of darkness as a cover in approaching or leaving a target would depend in part on the time of year, since at high latitudes the summers have unusually long days and the winters have unusually long nights. If an aircraft is navigating along a parallel of latitude it can remain under the cover of darkness by flying at a speed equal to the peripheral velocity of the sector of darkness at this latitude. 122/ At 60°N this speed is about 575 miles (925 kilometers) per hour, which is within the speed range of most Soviet long-range bombers.

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The Arctic as defined in this study covers approximately 30 degrees of latitude and has a variety of daylight and darkness conditions. Arkhangel'sk (64°34'N-40°32'E), which lies in the extreme south, has no period of complete darkness during the winter but experiences decreasing amounts of daylight until a minimum of 4 hours and 12 minutes is reached on 22 December. From the end of May to the end of July the darkness of night is replaced by twilight.

Dikson (73°30'N-80°24'E), a representative station, experiences periods of complete light and darkness. At this latitude the sun remains above the horizon from early May to early August. Before and after these dates, there is a period of several weeks during which the sun dips below the horizon at night but a twilight condition remains. From the middle of December until the end of January the sun never rises above the horizon, and complete darkness prevails.

Ostrov Rudol'fa (81°45'N-58°30'E), in Zemlya Frantsa-Iosifa, is one of the most northern island possessions and has a period of complete darkness lasting from the middle of October to the end of February. During the summer the sun remains above the horizon from early April until the beginning of September. 123/

e. Precipitation

The total annual precipitation in the Arctic is very small and occurs chiefly as snow. Rain occasionally falls during the short summer season, but thunderstorms are rare. Snow takes the form of small, needle-shaped crystals that are easily drifted by the wind. They are blown from level areas and windward slopes and are drifted on lee slopes and in depressions. For this reason the amount of precipitation is difficult to measure, but in general it diminishes from south to north. Igarka and Provideniya average 16 and 14 inches (400 and 350 millimeters), respectively, while on the northern islands the amount decreases to 4 inches (100 millimeters) at Ostrov Domashniy (Severnaya Zemlya) and 3 inches (75 millimeters) at Mys Shalaurova (Lyakhovskiye Ostrova). 124/

Snow and ice are the most important factors affecting runway maintenance during the cold season. The present procedure is to clear permanently paved and natural-surfaced runways and to compact snow only on runways with temporary natural surfaces. Runways cleared of snow are not affected by unseasonal thaws or annual spring thaws, and the resulting year-round accessibility is especially important at military airfields. Blade and rotary plows work from one edge of the runway toward the center. This usually allows aircraft the continued use of the uncleared half of the airstrip while the other half is being scraped. The runway and adjacent dirt strips are cleared to a width of 500 feet (152 meters). The final step in clearing involves sweeping away residual snow with rotary brushes. These are made of rubber strips cut from discarded tires rather than of wire because steel bristles break off and cause jet engine ingestion damage. 125/

Maintenance of temporary natural-surfaced runways starts as soon as the snow begins to fall. The snow is rolled and packed in thin layers to produce a uniform strong surface. These airstrips, however, cannot be used during periods of thaw.

Icy areas on cleared runways or glazed packed strips cause aircraft to skid. Several methods of preventing this have been tested. The addition of warm or moist abrasives to the snow surface did not prove satisfactory. The treatment of a runway 6,600 by 200 feet (2,000 by 60 meters) required about 45 cubic yards of sand heated to 113°F (45°C) or 45 cubic yards of sand plus 45 cubic yards of water. The sand, however, is blown away by jet or propeller blasts or is covered by subsequent snows. Chemicals were also used to melt the ice, but they corroded the aircraft metals. A new method for treating glazed surfaces has been developed, however, which is said to have solved the skidding problem. A mixture of water and foaming chemical fluid is sprayed on the runway. The foam freezes in a few minutes and gives a high coefficient of friction that lasts 1 to 2 days, depending on the amount of use the runways receive. The entire airstrip is not treated -- only the turnoffs and curved sections of taxiways, taxiing and turning areas of the aprons, and the starting and touchdown areas of the runway.

During all seasons, hoarfrost and rime or clear ice may form on aircraft. Aircraft that are parked in the open collect needles of hoarfrost as the temperature drops and the moisture in the air freezes. The deposit must be removed before the aircraft can be flown, since it often accumulates to such a thickness that the stalling speed is dangerously increased (Figure 80). Rime or clear ice may form on

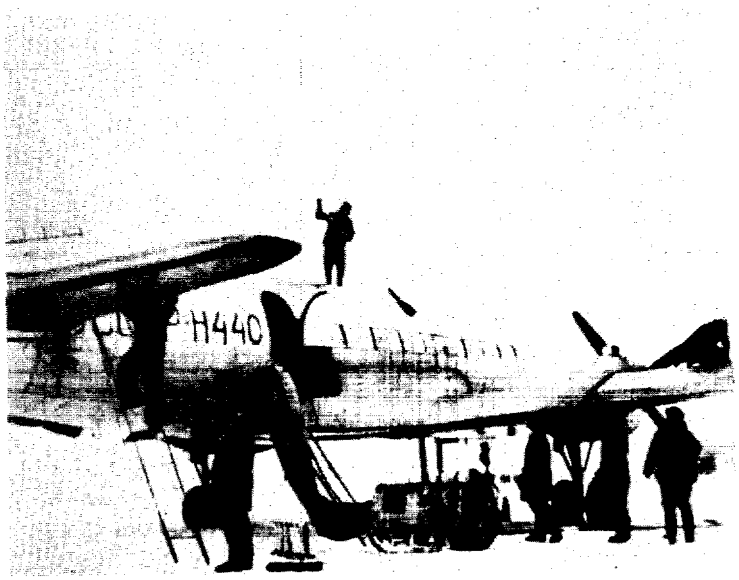

Figure 80. Preparing a Coach for takeoff. The body, tail, and wing surfaces are cleared of frost; and the interior of the plane is heated. (1955)

aircraft when they fly through super-cooled fogs or clouds. The worst season for rime-ice formation is the summer, when fog is at a maximum. Ice that accumulates in flight can increase stalling speed of the aircraft, decrease efficiency of propellers, and cause dangerous vibrations in helicopter rotors. The ice can be removed by several methods while the aircraft is in flight. One method is to force compressed hot air through tubes on the leading edges of the plane's wings, stabilizer, and rudder. Another method of melting ice consists of spraying chemicals -- usually alcohol or alcohol-glycerine mixture -- from the leading edge of the wings and propellers. This method is impractical for long-range bombers because of the great quantity of fluid needed on long missions. The most effective method of ice removal is by electric heating. Wires are imbedded in the leading edge of the wings, stabilizer, and rudder, as well as in the propellers. The turbo-prop Bear is thought to have such a deicing system. Windows and canopies can be made icefree by installing a thin layer of transparent, semi-conducting material over the glass. 126/

2. Effect on Land Operations

Operations on land, in addition to the activities in cities and ports, include the maintenance and operation of airfields, radar posts, and polar stations scattered along the Arctic Coast. Military units are stationed in the region and according to one report include 8 or 9 infantry divisions and 3 airborne divisions. Each division consists of 6,500 to 7,000 men and is armed with light weapons. 127, p.4/ The largest contingent in the Soviet Arctic is undoubtedly at Provideniya/Urelik, where the military personnel numbers 5,400. In February 1955, large-scale maneuvers in which both ground and air forces participated were undertaken from Novaya Zemlya to the Kolyma River. In the event of war, additional personnel would be brought into the Arctic to bolster present positions and establish new ones, but their total number would not be great. Large deployments of troops, a regular feature of more temperate latitudes, would be impossible in this region because of the severe living conditions and the difficulties of logistic supply.

a. Temperature

Severe winter temperature is the greatest deterrent to land operations. Even though most Russians are accustomed to living in a cold environment, the combination of low temperatures and high winds makes outdoor operations extremely difficult or impossible. Motor vehicles and other rolling stock are particularly effected by the harsh conditions. Engines may take 1 to 4 hours to start, requiring heaters for batteries and fuel lines. Special cold-weather types of oil, brake fluid, gasoline and deisel mixes, and cooling system fluids are needed. In the Arctic, air-cooled engines are preferred to liquid-cooled types. Truck and tractor cabins and automobiles are insulated against the cold. Special frost-resisting rubber is used for tires to prevent cracking and loss of elasticity. Strong winds during storms drive snow into the most minute cracks; and cabins, hoods, and bodies of cars and buses are hermetically sealed. Where covered garages are unavailable, vehicles must be widely spaced on elevated parking lots to prevent the snow from drifting around them. 128/

In the Soviet Arctic the temperature varies from the relatively warm Murmanskiy Bereg (Coast) to the frigid east Siberian area. The Nordkap Current of the Gulf Stream ameliorates the climate along the shore of the Murmanskiy Bereg and to a lesser extent the western coast of Novaya Zemlya. The average monthly temperature for February is 16°F (-9°C) at Teriberka and 9°F (-13°C) at Malyye Karmakuly. When the Nordkap Current reaches Mys Zhelaniya, at the northern tip of Novaya Zemlya, it is much cooler and the mean temperature for February averages 1°F (-17°C).

East of Novaya Zemlya the land becomes increasingly cold as the "cold pole" of Siberia is approached. Monthly temperatures within the study area reach a minimum at Kazach'ye, which averages -42°F (-41°C) for January; the "cold pole" south of the area at Verkhoyansk-Oymyakon averages -58°F (-50°C) for the same month. Temperatures rise again near the Bering Strait and at Uelen average -13°F (-25°C) during February. Absolute minimum temperatures drop much lower than monthly averages and vary from -30°F (-34°C) at Ostrov Kolguyev to -76°F (-60°C) at Igarka and Bulun.

During the short Arctic summer, temperatures are cool and monthly averages range from near freezing (34°F or 1°C) on the northern islands to the low 60°'s at the southern edge of the tundra. Since the islands are usually low in elevation, contain many glaciers, and are surrounded by floating ice, summer temperatures are never high. An absolute maximum of 52°F (11°C) has occurred in Zemlya Frantsa-Iosifa in July. Contenintal temperatures are much higher; at Igarka it has reached 88°F (31°C) in July. 129/

b. Winds

Winds are one of the greatest factors in limiting outdoor activity. When winds of 20 to 30 miles (32 to 50 kilometers) per hour sweep across the land and the temperatures are low, work becomes secondary to the struggle of keeping warm and alive. This combination of wind and temperature has been named "windchill" by Western scientists. It is calculated from the number of calories lost from 1 square meter of surface at skin temperature (91.4°F; 33°C). Exposed flesh will freeze in a windchill of 1,500, and in a windchill of over 2,000 prolonged exposure becomes critical.

The windstorms are known by various local names. The buran is a south wind that blows in Central and Eastern Siberia and is accompanied by low temperatures and blowing snow. East of Chaunskaya Guba a south wind, the yuzhak, occurs in both summer and winter. The yuzhak is strongest in winter, when winds reach 90 miles (145 kilometers) per hour and windstorms last 3 to 4 days. They can carry away all unsecured equipment and destroy buildings. During one storm, fuel drums were blown several miles over the sea ice.

In Central and Eastern Siberia the bora is a north wind that often continues for days. Novaya Zemlya experiences a western bora during the winter. Winds of 90 miles (145 kilometers) per hour with gusts up to 132 miles (212 kilometers) per hour are accompanied by blowing snow, sand, and small pebbles. The purga is a general name given to strong north winds occurring throughout the Arctic. Severe windstorms are called "black purgas" because the dark, overcast skies and blowing snow almost completely destroy visibility. Winds increase to 90 miles (145 kilometers) per hour and last 2 or 3 days before diminishing. Outside work is impossible and ropes are strung between buildings to prevent personnel from becoming lost in the storm. After the storm passes the skies clear and the temperature rises.

Foehns occur at various places throughout the Arctic and give a short respite to the normally harsh, cold winds. Towns near mountains or other heights experience these winds, which are warmed as they blow down to the lowlands, melting the snow and bringing higher temperatures.

c. Precipitation

The major part of the precipitation in the Arctic falls as snow and remains on the ground for long periods. Although maximum depth is reached at most stations in April, some places may have their deepest snow in December, January, or March. The depth of the snow varies from 20 inches (500 millimeters) at Mys Leskina west of Yeniseyskiy Zaliv to 11 inches (280 millimeters) at Malyye Karmakuly on Novaya Zemlya. These figures are only approximate, since winds frequently blow the snow out of the measuring gauges.

Movement over the snow-covered land is difficult. According to Soviet winter warfare manuals, the rates of march vary from 1 to 2 miles per hour (2 to 3 kilometers per hour) for infantry in snow over 12 inches (300 millimeters) deep to 2.5 to 4 miles per hour (4 to 6 kilometers per hour) for a small ski unit. The speed of vehicles equipped with extra wide tracks is approximately the same as that for ski troops. Infantry troops can cover 11 to 15 miles (18 to 24 kilometers) in a day's march (6 to 7 hours), whereas a ski unit can move 18 to 25 miles (30 to 40 kilometers) and a motorized sled can travel 62 to 68 miles (100 to 110 kilometers) a day. 130/

d. Visibility

Ground visibility is restricted most often during the summer, when fog and whiteout occur frequently. Coastal regions experience dense prolonged fogs during the summer; inland stations have occasional fogs even during the colder seasons. Along the coast and in the river bays, offshore summer winds bring relatively warm air in contact with cold water, and dense fog results. Occasionally the fog will burn off for a few hours in midday, but it forms again in the afternoon. Most coastal stations experience fog or more than half the days during summer. These fogs usually last up to 12 hours, but they occasionally persist as long as a week. Inland stations experience radiational fogs that form during the night in river valleys and other low places; such fogs dissipate during the day.

When whiteout conditions occur and there is no shadow or discernible horizon, travel overland is difficult. What appears to be a small hump on the ground might in reality be a nearby snow drift or a large hill several miles away. Travel is difficult not only because of the deceptive appearance of the topography but also because navigation by visual methods is restricted. Movement overland can be aided by radio homing devices.

3. Effect on Sea Operations

Sea operations in the Soviet Arctic are dependent upon favorable ice and fog conditions. Sea ice is the biggest problem, since all navigation ceases with the advent of winter and the advancing pack ice.

a. Ice

Pack ice covers the Arctic seas for 8 or 9 months a year. During this time, navigation is limited to a small area in the southern half of the Barents Sea which remains ice free because of the Nordkap Current. By August the Barents Sea is completely clear, as are the southern half of the Kara Sea, the mouths of the Khatanga and Lena Rivers, and the Bering Strait. In September the ice has reached its minimum extent, but two large sections of the Northern Sea Route are still blocked by ice. These sections can be navigated only by heavily reinforced vessels. The first area includes Proliv Vil'kitskogo and extends from Mys Oskara eastward to Khatangskiy Zaliv. The second area is in the East Siberian and Chukotsk Seas from Ambarchik to Kolyuchinskaya Guba. The pack ice is made up of floes 7 to 10 feet (2 to 3 meters) thick, but they occasionally reach 30 feet (9 meters) as a result of shelving. Currents and winds influence the drift of the floes, and stretches of open water are widened or closed by the movement of the floes.

b. Fog

Fog is a serious hazard to sea operations, since it reaches a maximum during the navigation season. The greatest danger is the restriction of vision, which increases the chance of collision. Often the occurrence of fog is a warning of approaching ice floes. The dangers of navigation during fog have been reduced considerably by the use of radar.

Fog occurs most frequently during July and August and usually lasts from 12 to 24 hours. Ostrov Belyy is one of the worst areas, averaging 15 to 20 days per month with fog. Fogs, together with shallow water, make this area one of the most hazardous parts of the Northern Sea Route. Mys Chelyushkin averages 136 foggy days a year and is the second worst area along the route.

4. Effects of Climatic Change

The climate of the Arctic has become increasingly warmer during the past 30 years. This represents one phase of the cyclical progress of climate. Evidence of previous warm periods is seen in the numerous coal and animal-bone (mammoth, rhinoceros, and tiger) deposits found throughout the Arctic. The retreat of sea ice and glaciers and the northward advance of animals and plants are indications of the present warm-up. 131/ The average thickness of the pack ice has decreased from 12 feet (4 meters), as measured during the Fram Expedition of 1893-96, to 7 feet (2 meters), as measured during the drift of the Sedov of 1937-40. The areal extent of the pack ice is estimated to have decreased by some 386,000 square miles (1,000,000 square kilometers) between 1924 and 1944. The southern part of the Kara Sea now remains ice free until September, whereas 30 years ago there was a 30 percent chance it would be ice covered before that date. The ice-free season in Proliv Yugorskiy Shar has been lengthened by 2 months. At present, it is possible for unreinforced vessels to round the northern tip of Novaya Zemlya; 20 years ago it was a difficult task for an icebreaker. 132/

Further evidence of the warming climate is found on the land. Glaciers on Novaya Zemlya and Zemlya Frantsa-Iosifa have been retreating and some islands of Zemlya Frantsa-Iosifa that previously were joined by ice are now separated. Two islands of very ancient ice in the Laptev Sea have melted, and only submarine shoals mark their former position. Throughout the Arctic the extent and thickness of the permafrost layer is decreasing.

Animals and plants are migrating northward as a result of the warmer climate. Birds are also moving to higher latitudes because of the improving nesting and feeding conditions. Flowers bloom earlier, and berries ripen earlier than in the past.

In the sea, many species of fish are found farther north and east than previously. Herring are now caught in the Barents Sea, and the fishing season in the northern half of the sea has been lengthened by 3 months. Cod have appeared in increasing numbers along the shores of Novaya Zemlya since 1921. Mackerel are now found in the Barents Sea and occasionally in the Kara Sea, and lamprey are found from the Barents Sea to the mouth of the Ob' River.

A continuation of the warming climatic cycle would affect the strategic and economic development of the Soviet Arctic. A lengthened navigation season would be of greatest importance since this would permit greater use of the Northern Sea Route. Agriculture would also benefit from a warmer climate. Varieties of crops that at present cannot grow or mature in the region could be introduced to help increase the amount of locally grown food. The total acreage in crops would also be increased, since they can now be grown out of doors only in small isolated field plots. A warmer climate would reduce the extent and depth of permafrost, and the construction of buildings and railroads would become less difficult.

The Russians have proposed a fantastic scheme which would melt the pack ice, eliminate ice-bound rivers, and turn the tundra into lush pastures and fertile fields. Their plan is to build a dam 50 miles (80 kilometers) long across the Bering Strait between Mys Dezhneva on the Chukotsk Peninsula and Cape Prince of Wales in Alaska. The original plan envisioned hundreds of giant pumps, powered by a 2,000,000-kilowatt atomic power station, that would transfer relatively warm Pacific water into the cold Chukotsk Sea. However, because of the Coriolis force which diverts horizontal motions to the right in the northern hemisphere, the influx of warmer water would move toward Alaska and the Canadian Arctic Archipelago and not toward Siberia. A later scheme planned to reverse the original flow and pump the water from the Chukotsk Sea into the Bering Sea. This plan, aided by the Coriolis force, would increase the movement of warm Gulf Stream water into the Arctic Basin and move it eastward, warming the land and melting the ice. The most recent plan for a Bering Strait dam did not mention atomic-powered pumps. According to this scheme the dam would stop Pacific currents from entering the Chukotsk Sea, thereby causing a drop in sealevel and an increasing flow of warm Gulf Stream water into the Arctic Basin. 133/

B. Terrain

The Soviet Arctic can be characterized as a low plain crossed by numerous rivers and interrupted by several mountainous areas. The coastline is indented by many bays and estuaries, and for most of its 14,000-mile (22,500-kilometer) length the coast is backed by abrupt, low cliffs.

The plain has an elevation of 330 to 660 feet (100 to 200 meters) and slopes gently toward the Arctic seas. The surface is flat to rolling and is dotted by a myriad of lakes. Rivers crossing the plain are generally slow moving and have developed meandering, braided channels (Figure 81).

The principal mountains within the Arctic are the Urals, the Byrranga, and the complex of mountain chains in northeastern Siberia. Extensions of the Urals can be traced northward into Novaya Zemlya. The Polyarnyy Ural, a northern continuation of the Urals, averages 3,600 to 4,300 feet (1,100 to 1,300 meters) in altitude and extends to about 68°N. North of this point the mountains decrease in elevation

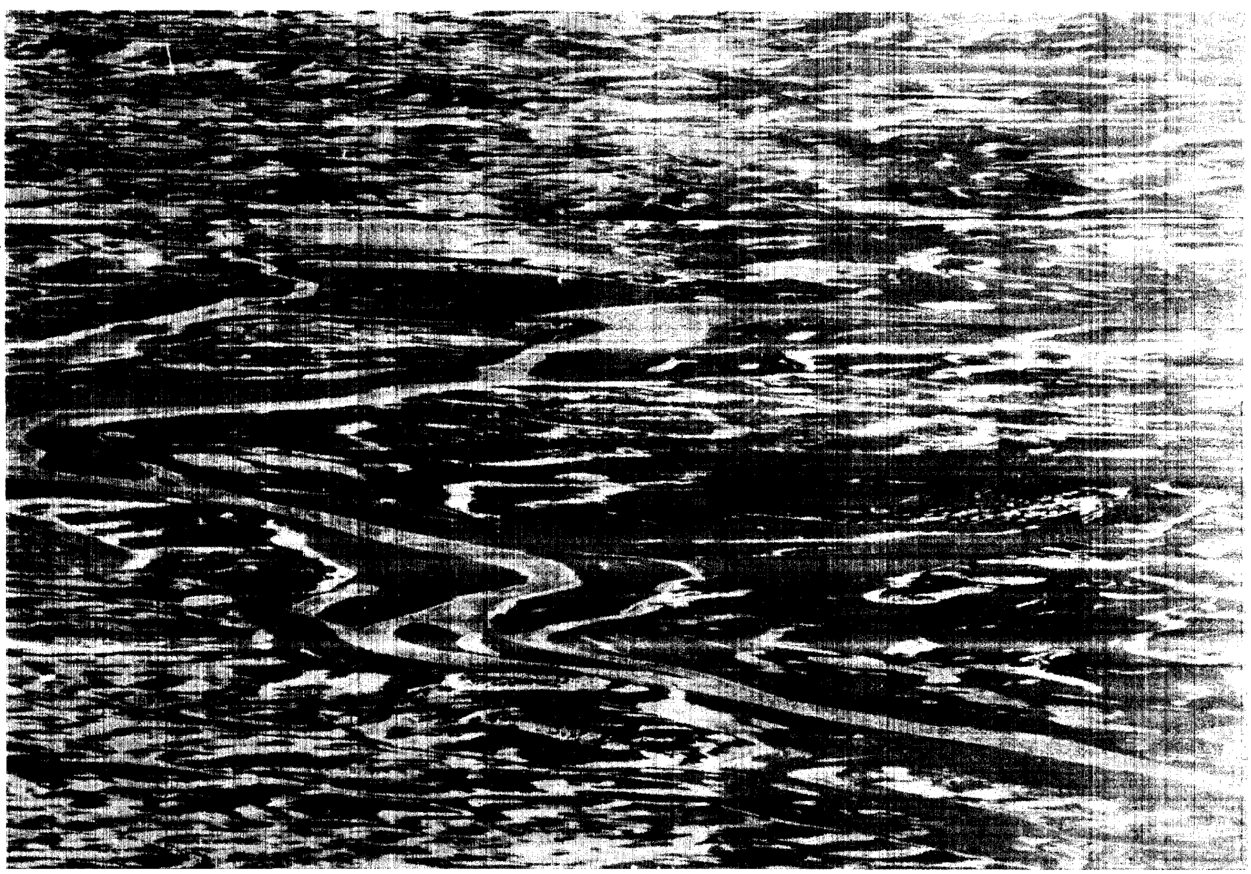

Figure 81. A meandering stream with braided channels crossing the coastal plain near Mys Vankarem on Chukotsk Peninsula. (1952)

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to 660 feet (200 meters), veer to the northwest, and are called Khrebet (Range) Pay-Khoy. The northwest trend is continued on Ostrov Vaygach where the elevations decrease, forming low hills. On Novaya Zemlya, the mountains again appear and rise in altitude to about 3,500 feet (1,000 meters) in the central part of the island.

Farther east the Gory (Mountains) Byrranga extend in an east-west direction across the center of the Taymyr Peninsula. They consist of ancient pre-Cambrian rocks that form a narrow chain about 620 miles (1,000 kilometers) in length and 2,400 to 4,900 feet (750 to 1,500 meters) in elevation.

The mountains of northeastern Siberia extend from the Verkhoyanskiy Khrebet, which parallels the Lena River, eastward to the Chukotskiy Khrebet. They reach elevations of 6,500 to 9,800 feet (2,000 to 3,000 meters) and have rounded summits. Valleys between the mountains are broad and marshy.

For much of its length the coast of the mainland is bordered by rocky cliffs (Figure 82) with elevations ranging up to 200 feet

Figure 82. Low coastal cliffs near Onega. Cliffs like these are characteristic of much of the Arctic littoral.

(60 meters). The offshore depths are usually shallow and contain shoal areas. Although portions of the coast between Obskaya Guba and Khatangskiy Zaliv and much of the coastline of the Chukotsk Peninsula have deep offshore water, approaches are obstructed by rocks. Sections of low coast are scattered and are usually located at river mouths.

Most of the larger rivers, with the exception of the Lena, Yana, and Indigirka, have deeply indented estuaries. Obskaya Guba, the largest of the estuaries, extends inland for over 500 miles (800 kilometers). It varies in depth from 60 to 120 feet (18 to 36 meters) and becomes very shallow at the mouth, where a submerged bar almost reaches the surface.

A distinctive feature of the northern part of the Chukotsk Peninsula is the series of coastal lagoons that occur in an area extending from Mys Billingsa eastward to the settlement of Uelen. Bars and spits that have formed along the shore impede the natural drainage of the rivers, thus forming shallow lagoons. Some of them parallel the coast for more than 20 miles (32 kilometers) (Figure 83).

The surface of the land in the Arctic is covered with a mixture of glacial, marine, and river sediments; in scattered areas, igneous and sedimentary rocks outcrop. Glacial sediments consisting of boulders, gravel, and sand are found in the areas between the Urals and the Khatanga River and between the Yana and Kolyma Rivers, as well as in the mountains of the Chukotsk Peninsula. Marine sediments cover extensive areas of the European Arctic between the White Sea and Khrebet Pay-Khoy, scattered spots along the Siberian coast, and the Novosibirskiye Ostrova, with the exception of one island, Ostrov Kotel'nyy. River sediments of sand, silt, and clay are found in all river valleys but reach their greatest extent in the valleys of the Ob', Yenisey, and Lena Rivers. The Yamal Peninsula is built of sediments carried downstream by the Ob', and parts of the Gydansk Peninsula are formed from deposits of the Ob' and Yenisey. Outcrops of igneous rock are limited to the mountainous areas. Sedimentary rocks are found between Khatangskiy Zaliv and the Lena River and along the western side of Chaunskaya Guba.

Low tundra plants form the characteristic vegetation of the Arctic landscape. The southern areas support a mixture of stunted trees, grasses, mosses, and lichens. To the north the trees become smaller and gradually thin out. Near the tree line, even dwarf forms are barely able to survive in stream valleys and other sheltered spots. In the remainder of the Arctic, vegetation is limited to mosses, lichens, grasses, and low flowering plants. The flowering plants form a carpet of vivid colors during the short summer season.

Several distinct types of tundra are found in the Arctic. Hillock tundra (kochkarnaya) is formed on plains and low plateaus and in river valleys. In tundra of this type, up to 50 percent of the surface is covered with small hillocks 12 to 20 inches (300 to 500 millimeters) in height. In marshy areas these hummocks are covered with moss; lichens predominate in the open, better drained areas. Marshy areas are also underlain by great thicknesses of moss, which make the surface

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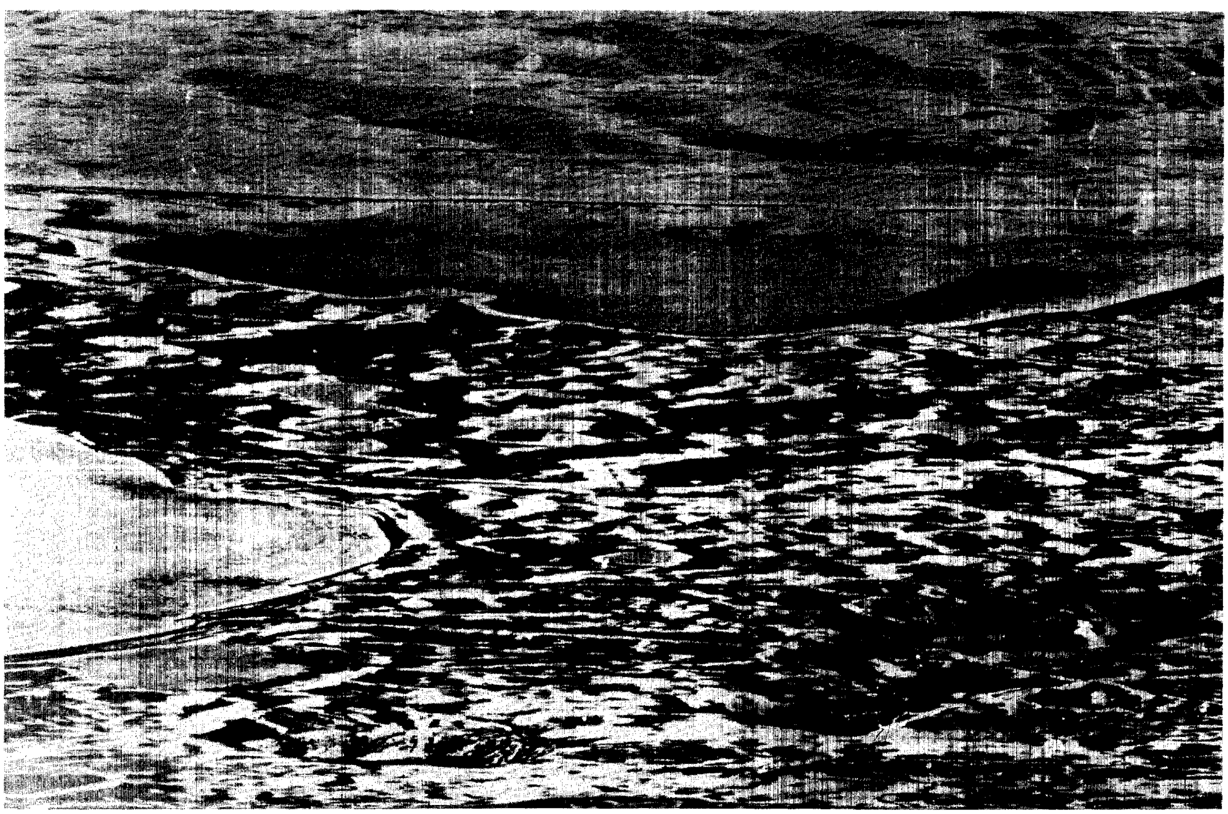

Figure 83. Two small coastal lagoons west of Mys Vankarem on the northern coast of Chukotsk Peninsula. (1951)

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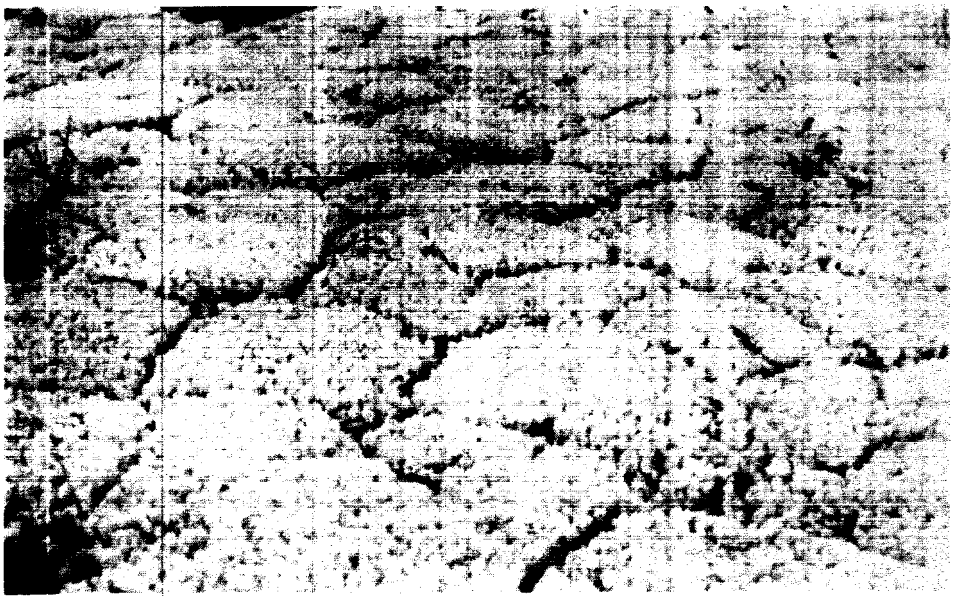

Figure 84. Reindeer moss growing on polygonal tundra.

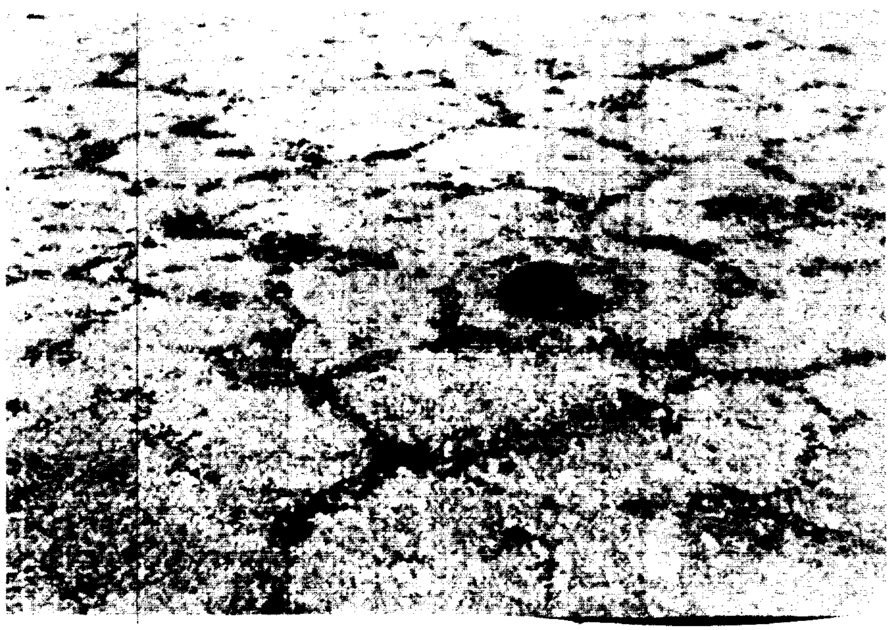

Figure 85. Polygonal tundra developed on dry, stony soil.

spongy and unstable. Vehicles cannot operate in these areas, and walking is dangerous and slow. The mossy vegetation, however, furnishes excellent winter pasture for reindeer.

Spotted or medallion tundra develops on mountain sides or other steep slopes where the snow cover is blown away. Here bare, rocky spots 3 to 5 feet (1 to 1.5 meters) in diameter are surrounded by growths of low mosses and lichens. The total area of the bare spots exceeds that of land covered with vegetation.

A variation of the spotted tundra has also developed on the summits of coastal foothills of the Chukotsk Peninsula, where the winds are very strong and of long duration but the climate is not sufficiently harsh to form true polygonal tundra characteristic of the Arctic.

Polygonal tundra develops in coastal areas of the mainland from Proliv Yugorskiy Shar to the Kolyma River and on the northern islands. The polygons have 4 to 6 uneven sides and vary in size from a few feet to over 65 feet (20 meters) in diameter. As a rule the size of the polygons increases toward the north, where the climate is colder. The freezing and thawing of the ground causes the sorting of surface material, with coarse stones on the periphery of the polygon and finer stones, sand, and clay in the center. Where soil is available the polygons are vegetation covered, but those formed on beach gravel or glacial debris or in areas of soil creep are devoid of any plant life (Figures 84 and 85).

Permafrost underlies most of the Soviet Arctic and extends southward into Mongolia. Continuous permafrost is found from the Chukotsk Peninsula westward to the Yenisey River. Permafrost interrupted by occasional islands of unfrozen ground continues to the Pechora River; beyond this the amount of unfrozen ground increases toward the White Sea. On the Kola Peninsula, permafrost is found only in small isolated areas such as peat mounds. Permafrost varies in thickness from a few feet in the south to over 600 feet (180 meters) along the northern coast. Borings at Amderma indicate permafrost extends to a depth of 752 feet (230 meters). The active layer that is subject to seasonal freezing and thawing varies in thickness up to several feet, being deeper in the south than in the north. The layer is also thicker in sandy ground than in peat or marshes.

Cross-country movement and construction are the two activities most affected by terrain. The ease of movement across the tundra depends upon the season. When the ground surface is frozen during the cold season, it is possible to move unhindered over the tundra. During the summer, permafrost prevents moisture from draining through the soil, and much of the area turns into a soggy quagmire. Mechanized amphibious vehicles on land and boats on rivers and lakes are the only practical means of transportation in large areas. Movement on foot over any great distance is difficult and is limited to gravel terraces in stream valleys or to reindeer trails. Paths made by reindeer herds follow lines of least resistance from one firm area to another; they seldom follow the most direct route between points.

Construction of buildings, airfields, roads, and railroads is limited materially by permafrost. Through trial and error and research, the Russians have gained much construction experience and have amassed a great amount of information on the subject. Active and passive construction methods have been developed and their use depends on the type of permafrost encountered. In areas of discontinuous permafrost the active method is used, whereby the permafrost is thawed prior to construction. The passive method is used where the permafrost is continuous, the ground being insulated to prevent the permafrost from melting.

Damage to buildings occurs most frequently when the permafrost beneath a building melts and the structure settles unevenly into the active layer. To prevent the permafrost from melting, buildings are constructed on gravel pads or on piles. The Russians prefer the latter, and multistoried brick and wooden buildings have been successfully constructed on piles. Since the piles cannot be driven into the frozen ground, the permafrost must first be melted. The ground refreezes around the piles after several months, and they form a solid base for the building. The piles are shielded and lubricated where they pass through the active layer so that it can swell and contract without disturbing the piles. To remove heat radiated from the structure an airspace is left beneath the building. If the piles or pads are not of sufficient depth the construction work can be damaged when the active layer refreezes differentially at the beginning of winter.

In large cities the installation of sewer pipes, water mains, and steam pipes -- once a great construction problem -- has now been satisfactorily worked out. In Noril'sk the following methods are used: above ground the pipes are placed in architecturally designed structures or in insulated tubes attached to tops of the ventilated sub-floor space; and below ground, they are laid in ventilated, reinforced-concrete conduits or in artificial foundations of clay-concrete that have replaced the soil as far down as the bottom of the active layer. 134/

Construction of airfields in permafrost areas involves extensive surveys and special construction techniques. Preliminary air and ground surveys of the area are made; and provide data for maps of soil and vegetation and for studies of water supply, prevailing winds, availability of construction materials, and possibility of flooding. A detailed analysis of the permafrost is made, which includes depth, type, temperature, and composition; thickness of the active layer; soil sampling; and investigation of associated relief features. When the site is selected construction proceeds according to the passive method of construction. The active layer is removed and an insulation pad of peat or moss is inserted. A layer of sand or gravel is placed over this and, if the airstrip is to be hard surfaced, a final surface of asphalt, macadam, or concrete is added. Alternating strips of sand and peat parallel the runway and protect it from expansion and contraction of the adjacent active layer. Adequate drainage of surface and subsurface water is provided in the ground surrounding the air strip. 135/

Similar problems are encountered in the construction of roads and railroads. Their beds should follow the natural contours of the land as closely as possible to avoid the necessity for any grading or filling that might disturb the permafrost. Road cuts expose the permafrost, subsequently causing it to melt and slump. Alteration of the natural drainage frequently results in flooding on the uphill side of the roadbed and slumping on the downhill side. 136/ Subsurface disturbance is usually least when roadbeds are laid over tundra vegetation.

Icing creates a critical construction problem in the Arctic. In icing, water under hydrostatic pressure emerges from a weak zone in the ground, a spring, or an ice-covered river and forms successive sheets of ice. On rivers, icing is destructive to bridges; and water squeezed between the permafrost layer and the freezing active layer can build up sheets of ice capable of disrupting traffic on roads and airfields. Buildings can also be damaged by water emerging from thawed ground beneath their foundations.

APPENDIX A

GAPS IN INTELLIGENCE

Although Russian publications on the Arctic have increased in number during the past few years, detailed information concerning some phases of the development is lacking. Map coverage, particularly for the area east of the Urals, is limited.

Most population figures in terms of settlement and regional distribution have been derived from Soviet estimates in statistical handbooks or approximated from electoral districts. In many cases, specific information on various aspects of industry within individual settlements is lacking. Statistical data on economic activities, especially mining, are for the most part meager or unavailable.

There are a considerable number of gaps in information concerning the transportation network. Statistical data on the nature, volume, and movement of traffic by air, water, and rail are limited. Information on the progress of current railroad construction and the alignment of planned railroad lines is meager. Data on roads and other means of overland transportation were limited.

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