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GEOGRAPHIC INTELLIGENCE REPORT

THE SOVIET ARCTIC

CIA/RR-G-15

December 1956

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CENTRAL INTELLIGENCE AGENCY

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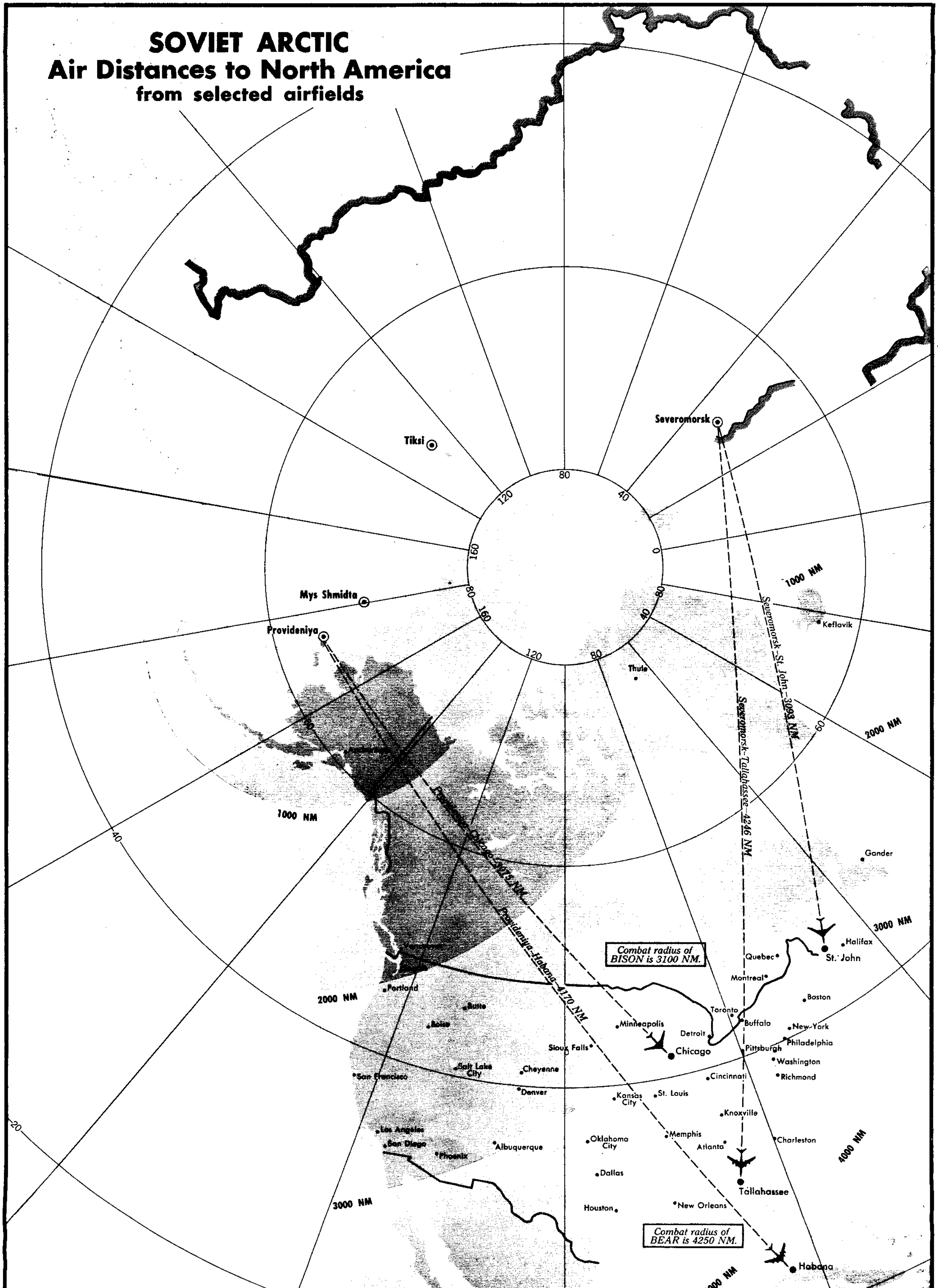

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ERRATA

On pages vi and 42, in the caption for Figure 22 "oil refinery" should read "nickel refinery".

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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, airplanes 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 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 only a small part of the Soviet mineral production; but nickel, copper, cobalt, tin, uranium, and coal are mined in significant quantities. 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 Molotovsk.

The population of the Arctic has been greatly increased 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 settlements and takes out mineral ores, timber, and other products. Naval vessels, some carrying troops, have followed the sea route, but its military use and commercial use are limited by the short navigation season. 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 over 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, Salekhard-Igarka, and Noril'sk-Dudinka lines provide limited east-west transport.

Scientific activity in the Soviet Arctic entered its era of greatest intensity with the founding of drifting stations in the Polar Basin. Observations from the drifting ice floes, together with information from polar stations along the coast, flying observatories, mobile research teams, and oceanographic expeditions, have supplied a vast amount of hydrographic, atmospheric, gravimetric, and magnetometric information of great value for economic and military operations.

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 urgency and secrecy of recent Soviet scientific activities, in addition to the magnitude of effort involved, suggest that economic as well as military considerations have been initiated at a high government level. Further indication of the importance attached to the Arctic is revealed in the Five-Year Plans, 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 (hydrometeorological 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. Over 100 polar stations of various sizes are located along the coast, most of which are currently in operation on either a seasonal or 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, Molotovsk, and Igarka -- as well as the mining developments of

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

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.

In spite of the large gaps in the geological exploration of the Soviet Arctic, valuable mineral deposits are currently being exploited throughout the region. Mining activities centered at Noril'sk, Vorkuta, and Nikel', and more recently in the Pevek area and at Iul'tin in the eastern Arctic, have become foci of Soviet economic activity. These mining centers are important sources of nickel, copper, coal, tin, and tungsten in addition to uranium, cobalt, and other strategic minerals essential to Soviet industries. Many of the mines as well as other projects are worked by forced labor, which initially added considerably to the population growth of the region. Noril'sk, with the nearby reserves of copper-nickel ores 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. Over 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 the support of extensive scientific operations. The successful year-round operations of the drifting ice 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 Molotovsk as well as to strategic airfields on the Kola Peninsula. Among the more recent railroad developments are the Murmansk-Pechenga and the Vorkuta-Amderma lines. Recent railroad construction in the Siberian Arctic is primarily a penetration into the permafrost region between the Ob' and Yenisey Rivers. This construction is focused on a new rail access between Salekhard and Igarka that will facilitate year-round transport in support of economic and military developments of the area. Additional lines have also been projected along the Yenisey River to provide a future link between the Northern Sea Route ports of Dudinka and Igarka and the Trans-Siberian Railroad at Achinsk.

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 the Soviet Arctic, major airfields capable of staging medium and heavy bombers have been constructed and expanded since 1950. The build-up of military air facilities has been noted particularly on the Kola and Chukotsk Peninsulas, which lie closest to the United States. Operating from the larger known airfields -- notably Severomorsk, Tiksi, Mys (Cape) Shmidta, and Provideniya/Urelik -- the Soviet heavy turboprop bomber, the Bear (Tu-34), could reach virtually any target in the United States. The reported 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.

In spite of the proximity of these airfields to North America the potential air capabilities of the region are probably limited by its adverse climate, which imposes (1) seasonal flying restrictions, (2) logistic problems, and (3) numerous aircraft- and runway-maintenance difficulties. Although these factors impose operational limitations, many air and guided-missile bases could be remotely located deep within the Soviet Arctic and consequently would be subject to minimum damage from retaliatory measures.

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) permit year-round operation of submarines and other naval vessels. The possibility of the development of an atomic-powered submarine for operation below ice might permit year-round naval activities throughout the region, including the deployment of submarines 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 region.

From the point of view of defense the coastal installations could serve as an early-warning line to detect enemy planes approaching the mainland since the major polar stations and the larger airfields are commonly equipped with both radar and radio facilities. The number and disposition of radar sites at other points along the coast is unknown, but they are probably sparsely distributed except in the European Arctic. The radar net is most closely spaced in the area extending from the USSR-Norwegian border eastward to approximately 50°E, particularly along the northern coast of the Kola Peninsula.

With the rapid growth of polar scientific activity, 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, seismology, and gravimetry) and upper-air physics. Only recently, the Barents Sea near Novaya Zemlya was the scene of an underwater nuclear explosion. 1/ This comprehensive program may well give the Soviets a 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. The emphasis upon geomagnetism and gravity has particular significance in relation to Soviet capabilities for positioning long-range missiles. Aside from the obvious contributions to military capabilities, this Arctic superiority will give the Soviet Union 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 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. Most of this area lies north of the tree line, which is generally regarded as the 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 Nizhnie-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.

The traditional boundary of the region has been the Arctic Circle at 66°33'20"N. This line is not satisfactory since it either combines Arctic and temperate conditions on the basis of vegetation and wildlife or excludes regions such as the Chukotsk Peninsula, which on the basis of climate and other characteristics is largely Arctic. Köppen in defining climatic regions 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 degree the southern boundary of the Far North (Kraynyy Sever) region appeared to follow, in general, the northern limit of relatively continuous population. 2,p.28-38/ At that time the European Arctic included Murmanskaya Oblast' and the northern portions of Arkhangel'skaya Oblast' and Komi ASSR, and 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) 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 until this time 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. Soviet publications in the post-World War II period indicate once again that the GUSMP operates through a system of territorial administrations. 3/ Although the GUSMP continues to function as the principal government agency within the Soviet Arctic, neither its overall responsibilities nor the status of its current territorial administrations are fully known.

In contrast to a somewhat arbitrary southern boundary, the northern limit of the Arctic is sharply defined on the basis of the so-called "sector theory" that was established in a Soviet decree of 15 April 1926. 4,p.5/ Under this decree the Soviet Union claims unlimited sovereignty over all lands, islands, and seas south of the North Pole that lie between 32°04'35"E and 168°49'30"W as well as the air space above this sector. Within this sector the USSR considers the Arctic Ocean as a territorial sea. Although this view has not become officially recognized, the Kara, Laptev, and East Siberian Seas are generally accepted unofficially as Soviet territorial waters. In addition the Soviets claim a 12-mile limit in territorial waters along all coasts of the USSR. In the Barents Sea, this has the effect of closing Proliv (Strait) Karskiye Vorota, the entrance to the Kara Sea. In Bering Strait, where the territorial waters of the USSR and U.S. overlap, namely between Ostrov Ratmanov (Big Diomede Island) and Little Diomede Island, the international boundary has been fixed at the center of the mid-channel. 5/

Although the Arctic 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 an administrative oblast or kray.

The only recent change in the administrative structure of the Arctic has been in the Far East. In December 1953 the Kolyma-Magadan area, including the Chukotskiy N.O., was removed from Khabarovskiy Kray and was made into an independent oblast of the RSFSR. The creation of the Magadanskaya Oblast' emphasizes the increasing economic and military importance of the Far Eastern Arctic. The move may also be viewed as a possible lessening of MVD authority in the region -- presumably by transferring control to the new oblast government directly responsible to Moscow. 6,p.18/

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 supply 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, excluding forced labor, probably 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 (168,000), 7/ Molotovsk (60,000), and Igarka (22,000). 8/ 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 (85,000) and Vorkuta (55,000) 9/ 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. On Novaya Zemlya and Severnaya Zemlya the growth of some settlements has been attributed to the sizable numbers of forced laborers sent there to work in the mines. Belush'ya Guba (Bay) on Novaya Zemlya and Bukhta (Bay) Rodzhersa on Ostrov Vrangelya are the sites of 2 principal island settlements. Each of these settlements have an airfield, seaplane station, and polar station. The Bukhta Rodzhersa settlement is also a staging base for drifting ice stations.

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 has contributed significantly to the total 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. Since the special amnesties in 1953 and 1955, when large numbers of forced laborers were released, the Soviets have been placing increased emphasis upon the use of contract labor.

Since 1932, the USSR has issued a number of decrees governing workers in the "Far North." Special privileges and inducements such as higher pay scales, additional leave, and guaranteed housing have been offered to increase the voluntary labor supply, especially in the mining areas east of the Urals. 10;11,p.11/ These inducements have met with only partial success, and labor shortages continue in many areas. In addition to free workers and 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 and receive higher pay than the forced labor population, 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 terminate along the Baltic-White Sea waterway. The relatively high population densities of these areas are attributed to the large urban centers of Murmansk, Arkhangel'sk, and Molotovsk and 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 (Figure 1). 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. 12,p.70-19/ 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 by its importance as the administrative and commercial center of the Kola Peninsula (Figure 2).

Along Kol'skiy Zaliv to the north are the important naval bases of Severomorsk (formerly Vayenga), Polyarnyy, and 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 under the direction of the Ministry of Navy. Severomorsk, with an estimated population of between 10,000 and 15,000 in 1949, 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.

X1 [redacted] Pechenga, a center of fishing activity on the deep-water and ice-free fiord of Guba Pechenga, is also being developed as a naval base for submarine operations. It is possible that this naval installation may be located farther north along the bay at Linakhamari, which serves as the deep-water port for Pechenga as well as for the more southerly town of Nikel'. Both of these settlements are on the Arctic Highway, which terminates at Linakhamari. A railroad recently completed from Kola on the Murmansk railway to Pechenga should greatly increase the military and economic importance of the port and its naval facilities, as well as the development of the nearby Pechenga airfield and the Nikel' mines.

The sizable population on the southeastern shore of the White Sea is concentrated in the large urban centers of Arkhangel'sk and Molotovsk. Arkhangel'sk, the largest seaport and urban complex in the Soviet Arctic, occupies both shores of the Severnaya Dvina and

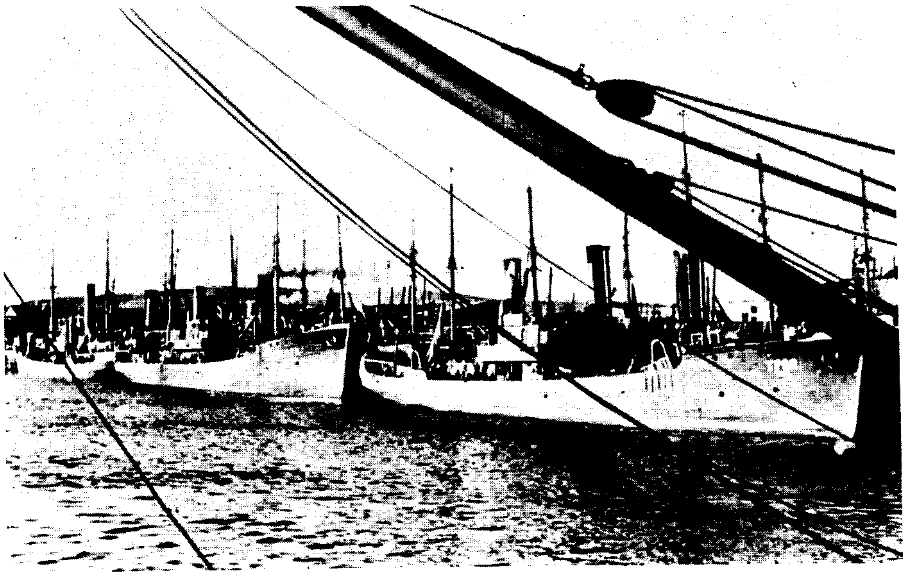

Figure 1. Freighters in the harbor of Murmansk.

Figure 2. Lenin Avenue, one of the main thoroughfares of Murmansk.

many islands in the estuary of the river. A large percentage of its population consists of exiles from the Baltic area and forced laborers who are employed in the port, shipyards, and numerous saw-mills and related industries. In 1953, 12 labor camps were reportedly located at Arkhangel'sk, 13/ but many of these camps may have been abolished following the recent amnesties. 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 short tons per year. 14,p.2/ The city is also the chief center of the USSR lumber industry and is a port of call for ships of several nations. 15/

Approximately 17 miles (27 kilometers) west of Arkhangel'sk is the shipbuilding center and secondary port of Molotovsk. Created in 1936 to meet the demand for a shipbuilding center with direct access to the open sea, Molotovsk has rapidly become a sizable urban settlement and the third largest shipbuilding center in the USSR. 16,p.1/ 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 3). 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.

With the development of oil in the Ukhta area in the upper Pechora basin, Nar'yan-Mar has developed into an important refueling base for both naval and merchant vessels operating in the northern sea area. The Fifth Five-Year Plan (1951-55) included provisions for the enlargement and reconstruction of the Nar'yan-Mar and Murmansk seaports. Nar'yan-Mar also serves as the administrative center for the Nenetskiy Natsional'nyy Okrug. The population of Nar'yan-Mar on the eve of World War II was estimated at 10,000. 17,p.18/

Mezen' (10,000 pop.) near the mouth of the Mezen' River and Amderma (25,000) on the Kara Sea coast are among the other

Figure 3. Vorkuta, the largest coal-mining center in the Soviet Arctic. In the foreground is Komsomolskaya Street, a paved and lighted thoroughfare.

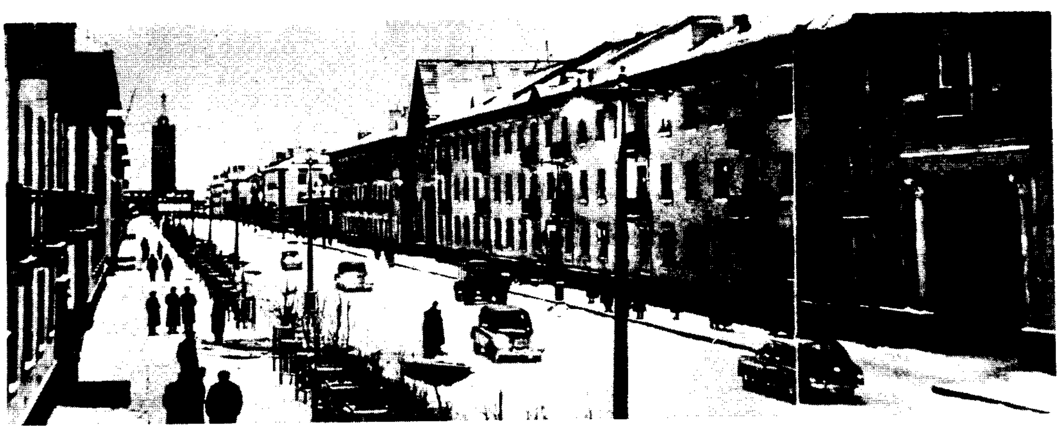

Figure 4. The town of Inta on the Kotlas-Vorkuta Railroad.

concentrations of population along the European Arctic coast. 18/ Although the population figure for Amderma seems high, local mining and recent construction activities have probably created a sizable labor force in the area. Amderma is the site of the largest fluorspar deposits in the USSR and of a major airfield that is believed to have been extensively enlarged. It is also probably the northern terminus of a railroad line currently under construction from Vorkuta. Along the Kotlas-Vorkuta trunkline are the small railroad and mining settlements of Inta and Abez. According to various PW reports, the population of Inta is about 15,000 to 20,000 (Figure 4).

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 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 the major port of the Siberian Arctic and a leading lumber center of the USSR (Figure 5). It is also the eastern terminal of a rail line from Salekhard. The port serves as the northern outlet for Yenisey Basin lumber, which is exported to Murmansk, Arkhangel'sk, and Western European ports. Igarka is the only Siberian Arctic port open to foreign vessel. 19/ A sovkhoz and several Arctic stations are also located at Igarka. Because of the swampy terrain of the area, streets, sidewalks, and even paths are planked. Most of the buildings also are constructed of lumber produced locally (Figure 6).

Dudinka, 134 nautical miles 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

Figure 5. Freighters at anchor in Igarka.

with asphalt. A bus connects the city with the railroad terminal in the suburbs. Most of the freight between Dudinka and Noril'sk travels over a 70-mile (112-meter), narrow-gauge rail line that has been either supplemented or replaced by a broad-gauge line. 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 Natsional'nyy Okrug 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. The urban area of Noril'sk is centered around the ore-concentrating plants, the several nickel and copper refineries, and a number of repair and construction-materials plants, most of which have been developed since World War II by the Ministry of Nonferrous Metals. These plants have good rail and road connection with the nearby mines. It is possible that the industrial facilities at Noril'sk could support guided missile activities in the Noril'sk-Taymyr Peninsula

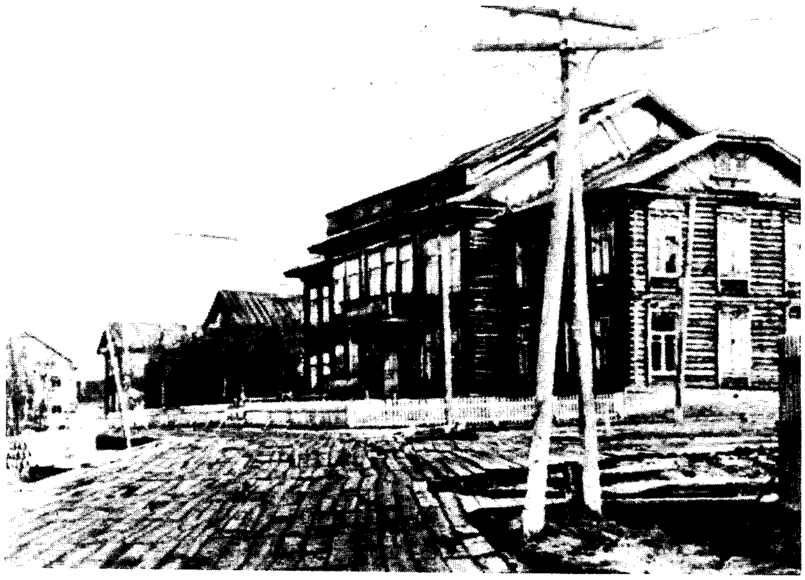

Figure 6. Wooden houses and planked streets in Igarka.

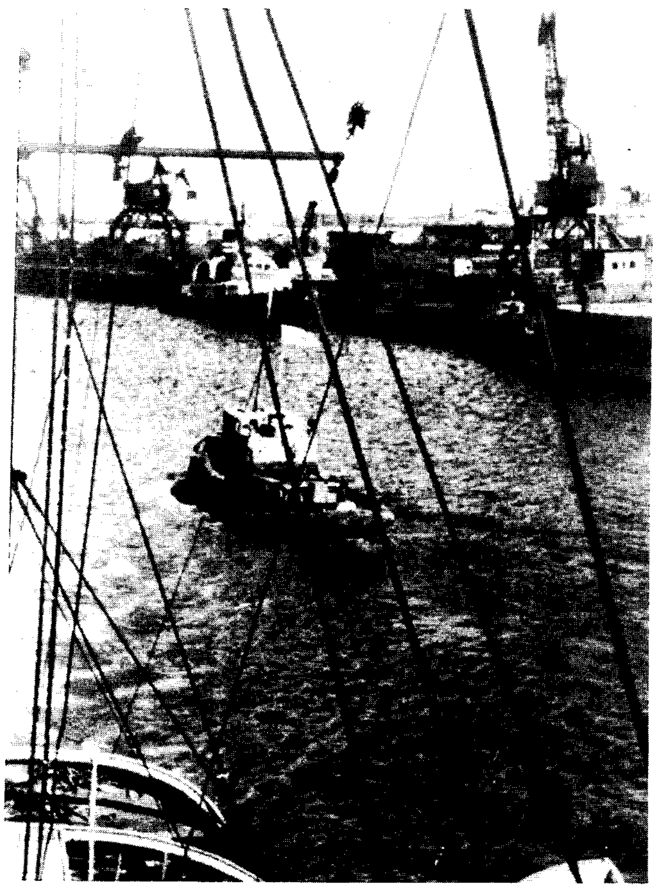

Figure 7. A part of the harbor complex at Dudinka.

area. Infrequent reports of low reliability indicate such activity on the Taymyr Peninsula. A sizable powerplant, which operates on local coal, provides 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* (Figures 8 and 9). A new area of apartment buildings, Gor-stroy, is located in the northern part of the city and houses much of the free population (Figure 10). Although free workers and government employees form the majority of the population, many prison camps located in the outskirts of the city continue to house large numbers of forced laborers.

Other minor population concentrations in the Yenisey Basin include Ust'-Port, a small fishing village, and Dikson, which has a major airfield and polar station in addition to bunkering facilities (Figure 11). The Dikson station is one of the major observatories of the Arctic Institute, as are also Mys Chelyuskin, Tiksi, Pevek, Mys Shmidta, and Uelen on the mainland; Barentsburg on Spitsbergen (Svalbard); Bukhta Tikhaya on Zemlya Frantsa-Iosifa; and Matochkin Shar on Novaya Zemlya (see Map 25348).

The population increase in the Ob' Basin has been confined chiefly to Salekhard (15,000) and the adjacent settlements, which have expanded with the construction of the Vorkuta-Salekhard line and, more recently, the Salekhard-Igarka railroad. The population of Salekhard consists of Nentsy, and Komi as well as Russians, who predominate here as in most of the other principal settlements. At Salekhard, storage facilities for fuel (coal and petroleum), equipment, and materials for the railroad, airfield, and local industry have been expanded recently. The city serves as the administrative center for the Yamalo-Nenetskiy Natsional'nyy Okrug and has a number of cultural, educational, and medical facilities. The labor forces employed by the several government enterprises -- including sawmills, fish canneries, and a leather factory -- are small. Since the Ob' River can be ascended to Salekhard only by small sea-going craft, Novyy Port on Obskaya Guba has become the focal point for the transshipment of cargo between ocean-going vessels and river craft. Novyy Port serves also as a base for fishing and whaling operations. A number of small fishing villages are also scattered along the shore of the bay.

*Most of the information on Noril'sk is based on Source 20, Appendix B.

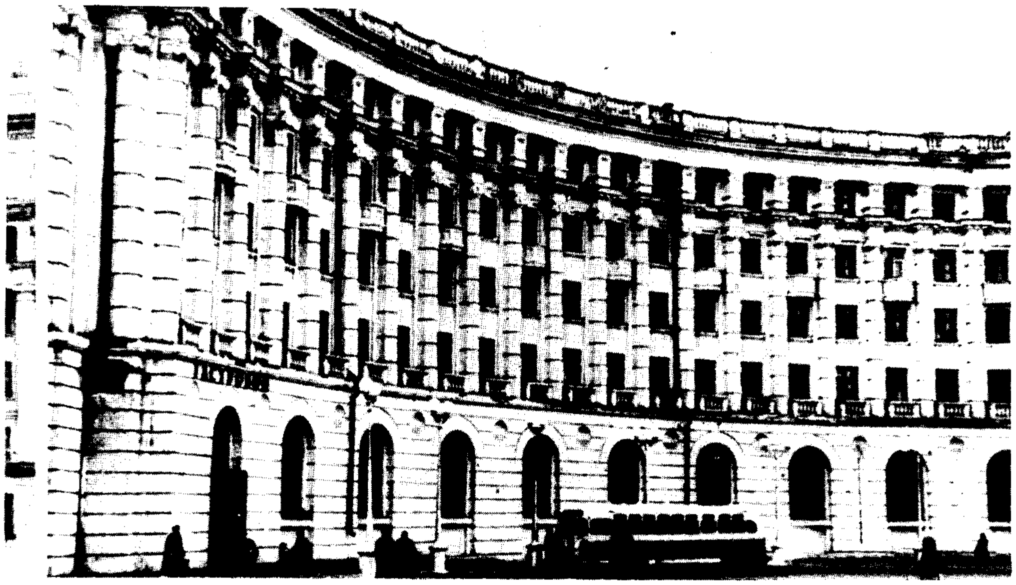

Figure 8. A multistoried stone building on Gvardeyskaya Square in Noril'sk.

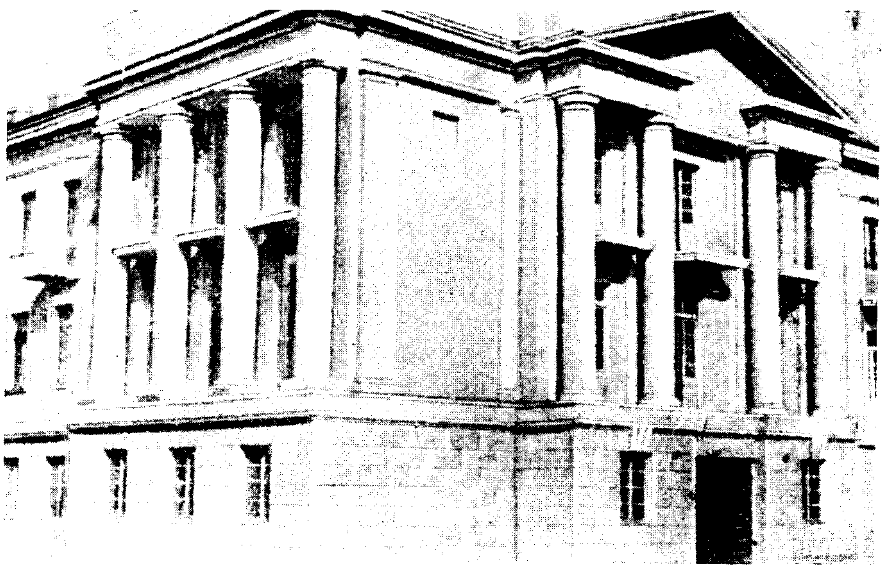

Figure 9. A hotel in Noril'sk.

Figure 10. Apartment buildings in Gor-stroy, a new section of Noril'sk.

Figure 11. New wooden houses in Dikson.

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, Lena, and Kolyma Rivers or occasionally in scattered coastal areas. Most of the Russians are concentrated in a few key settlements, notably Khatanga, Nordvik, Tiksi, and Ambarchik, which are bunkering and transshipment ports along the Northern Sea Route as well as sites of important airfields, telecommunications facilities, and polar stations.

Tiksi, near the estuary of the Lena River, is the principal settlement of the region. Since World War II, the port and adjacent airfield have undergone considerable expansion (Figure 12). As in Dikson, a local observatory of the Arctic Institute takes part in fleet planning and direction in cooperation with dispatchers and port workers. The Tiksi observatory receives weather and ice

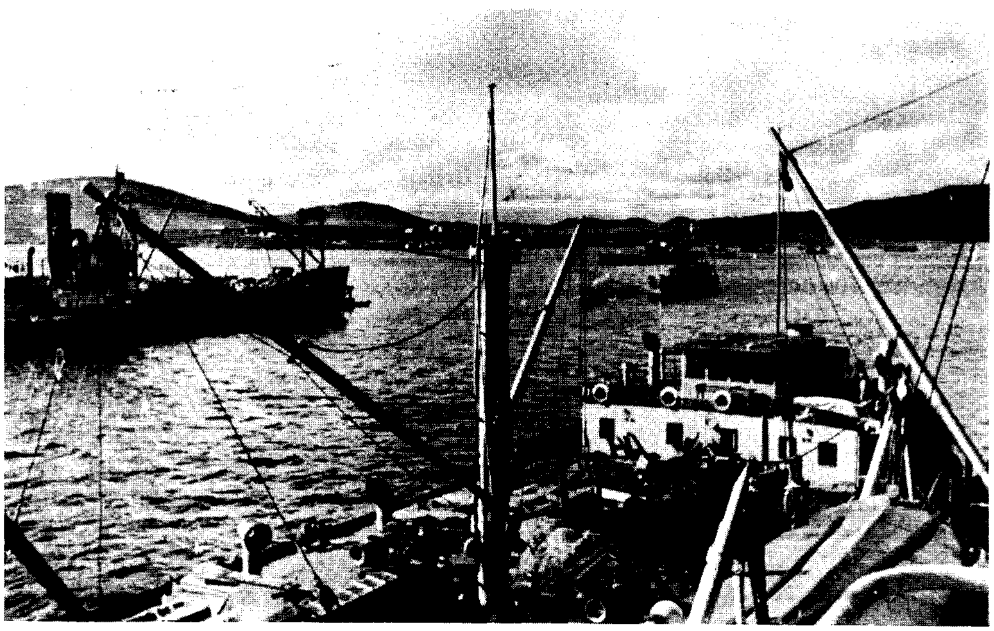

Figure 12. The harbor area at Tiksi.

reports several times a day from 23 polar stations located on the islands and on the shore of Laptev Sea. 21/ The Tiksi observatory in conjunction with those at Barentsburg, Bukhta Tikhaya, Dikson, and Pevek and three drift stations is scheduled to participate in extensive scientific investigations of the Arctic during the International Geophysical Year (1957-58). 22,p.4/ A cosmic ray station is to be established at Tiksi. This station along with two others now operating at Bukhta Tikhaya and Mys Shmidta and a fourth station to be established at Murmansk will also take an active part in IGY activities. 23/

With the development and expansion of the Dal'stroy mining activities in the upper Kolyma region, Ambarchik has become increasingly important as an 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. 24,p.5-2,5-3/ 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. 25/

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 forced laborers and of contract workers who come to the area on 3-year contracts.

Pevek, which serves as the outlet for the extensive mining operations centered at Krasnoarmeyskoye, has developed into an active port settlement, with an estimated population of at least 1,000 inhabitants.* In addition to minor port facilities, dwellings, a Soviet-established school, a hospital, and a club, 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. A number of intelligence reports based on the interrogation of PW's also indicate the presence of a military garrison at Pevek. It has been reported that this unit was assigned coast-guard duties along the northern coast of the Chukotsk Peninsula from Pevek to Mys Dezhneva (formerly East Cape). A network of coastal fortifications as well as food and other storage facilities were to be constructed by this garrison. 26/

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

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. 27/ Most of this material is transported by truck over a newly constructed road to the mines at Iul'tin about 180 miles (290 kilometers) to the north. In 1950, Iul'tin reportedly had a labor force of 1,200 workers. 28/ Tungsten ore mined here is trucked to Egvekinot, where it is transferred to vessels and sent to refineries outside the Arctic. Several settlements and numerous forced labor camps have been noted along the Egvekinot-Iul'tin route. Other than a wooden pier, a meteorological station, and a nearby airfield, little is known about the facilities at Egvekinot.

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), 29/* on the southeastern coast of the peninsula, is the site of the largest military base in the area and of the Soviet airfield nearest Alaska. The military base comprises over 600 buildings capable of accommodating an estimated 5,400 persons. 30/ The airfield has a permanent runway that was increased to 8,000 feet (2,440 meters) in 1954. 31/ The port of Provideniya is an important bunkering station and staging area for Northern Sea Route operations. During the navigation season, naval vessels have reportedly operated out of Provideniya. 32/ 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 with 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 RFSFR and in reality provide the main racial groups with only a limited degree of autonomy.

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*This source also gives the population of Pevek as 1,500.

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 the 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. Some 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. On Novaya Zemlya the natives obtain the major part of their income from birds. Guillemots provide over a half million eggs, and ducks are an important source of eider down and meat. 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 the production of food products make up a smaller part of the economy. (See Map 25351.)

Most of the products 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. Although the mineral contribution of the Arctic is small when compared with producing areas farther south, the amounts are significant. In 1945, Noril'sk produced an estimated 2,000 tons of nickel as compared with 11,000 tons for Monchegorsk. 33,p.75/ An estimated 10,000,000 tons of coal was mined in the Pechora Basin in 1950, while the Donets Basin produced 85,000,000 tons. 34/

The ship construction at Molotovsk is the only fabricating industry of national importance. It contributes an estimated 14 percent of the submarine construction and 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 the source of 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.

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 shipbuilding, construction, 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 rafted downstream 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, and Ob' Rivers to the secondary lumber export centers of Mezen', Nar'yan-Mar, and Salekhard. Despite heavy losses and operational limitations due to fluctuations in water level and the short navigation season, 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 handles approximately one-third of the Soviet Union's export of timber products (Figure 13). Some 20 independent sawmills,* 4 wood-processing plants, and 21 lumber and log storage areas are located within the Arkhangel'sk complex (Figure 14). 35/ It is also the center of an expanding wood-chemical, pulp, and paper industry.

Figure 13. The freighter Budennyy loading logs at Arkhangel'sk.

*Includes 1 sawmill located outside the target complex.

Most of the mills and processing plants have good rail connection with nearby storage areas and piers (Figure 15).

The Molotov mill, located northeast 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," which produces wood pulp and chemical products in addition to heavy brown wrapping paper, cardboard, black soap, and alcohol. 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, 36/ as well as for Arctic installations and settlements. Thirty-two carloads of lumber and 18,000 parts for hothouse frames have been sent to the New Lands. The Lenin Sawmill recently manufactured the parts for 27 silos for sovkhozes in Krasnodarskiy Kray and Rostovskaya Oblast'. 37/

The "Solombalskiy" and the "Arkhbumstroy" are two of the most important pulp plants in the Arkhangel'sk area. Both plants are served by their own heat and powerplants (TETS), which are a part of the Arkhangel'sk-Molotovsk power network. The "Arkhbumstroy," 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. 38/ The "Solombalskiy" plant at the southern end of Solombala Island supplies cellulose and pulp to explosive, plastics, and synthetic-fiber plants throughout the USSR. A large hydrolysis plant produces wood-chemicals including xylose (wood sugar), ethyl alcohol, methyl alcohol, acetone, acetic acid, and turpentine. Several other cellulose and wood-chemical plants are also located in the area.

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 (Figure 16). Logs, amounting to many millions of board feet, are annually rafted downstream to Igarka, where they are processed, stored, and seasoned (Figure 17). The labor force includes forced and voluntary workers. During the navigation season, ships from various European nations call at the port for lumber. In 1954, approximately 100,000 cubic meters of Angara timber passing through Igarka was shipped via the Northern Sea Route to Murmansk, Arkhangel'sk, and foreign ports. 39/ Much of the finished lumber is hauled to a wooden loading jetty by motorized fork-lift-type trucks. Manufactured items produced by combine are prefabricated houses, furniture, other finished wood products, and boxes and wooden barrels for packing graphite and fish.

Figure 14. Logs stored at a sawmill in Arkhangel'sk.

Figure 15. Freighters loading lumber at a dock in Arkhangel'sk, with stacks of stored lumber in the foreground.

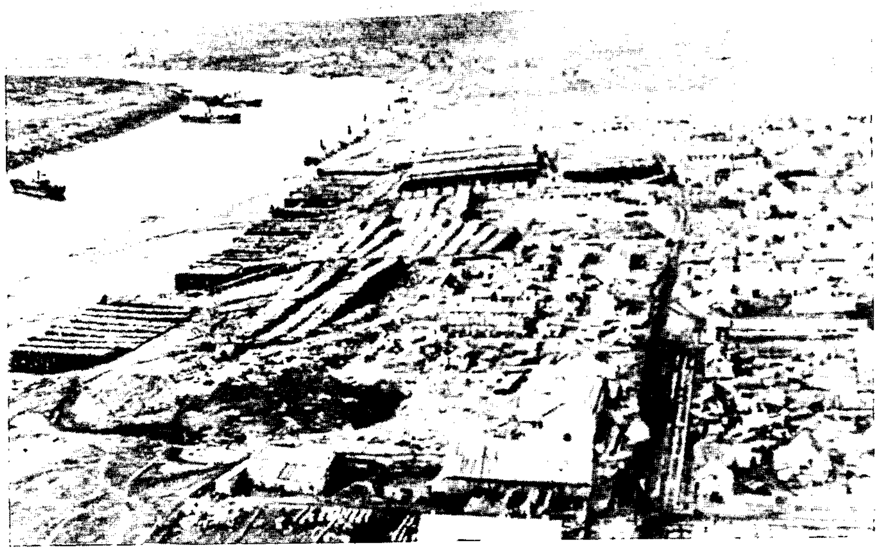

Figure 16. Aerial view of Igarka showing logs stacked near the shore. (1940)

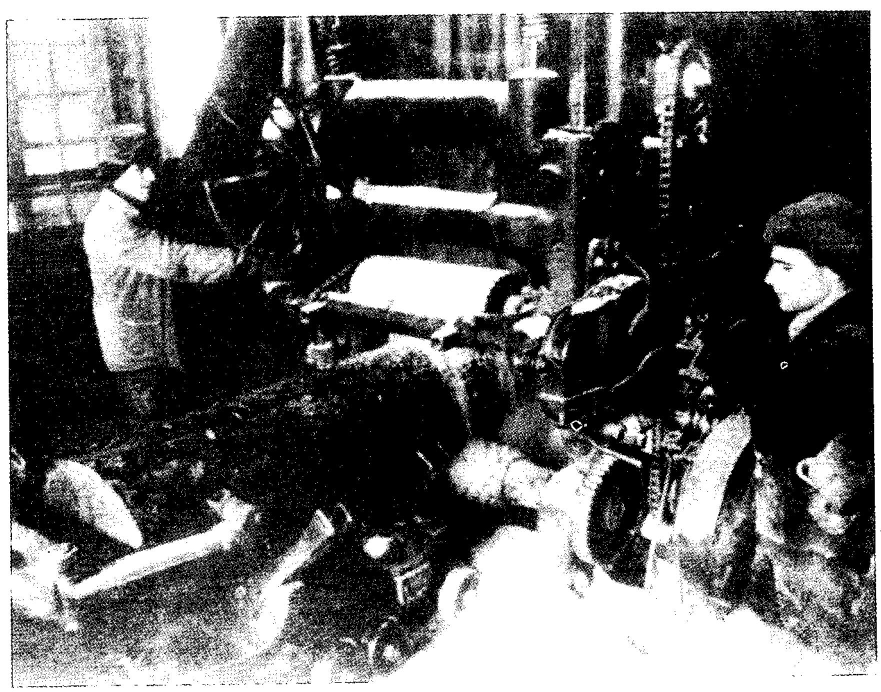

Figure 17. Milling operations at an Igarka lumbermill.

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.

Lumber for export is also milled at the river ports of Salekhard, Nar'yan-Mar, and Mezen'. The ports of Nar'yan-Mar and Mezen' are also open to foreign vessels. Prefabricated houses are reportedly manufactured at Salekhard. 40/ Although a sawmill at Labytnangi on the opposite banks of the Ob' River also produces some lumber for export, most of its output is used in construction projects within the area. Logs for this mill are said to arrive by rail from the Ural Mountains. 41/

The several sawmills at Molotovsk operate largely in support of local shipbuilding. Little is known of the wood-processing 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 provides much of the fish consumed in the Soviet Union. The total catch of the region was estimated at 750,000 tons in 1953; ranking second only to the Far East. 42,p.68/ Production has probably increased since then 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 only for local consumption. Production in these canneries will probably increase greatly when better transportation to the populated centers in the south and west becomes available.

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

In the past, salting has been the most widespread method of preserving fish. 43/ Herring are still salted, and in many isolated areas this is the only practical method for preserving fish. The percentage of the fish canned has increased in recent years as the result of new cannery construction. Cod, haddock, and some salmon are preserved in this manner, and the best grades are exported. Advances in sea and air transportation have made possible a wider distribution of fresh and frozen fish. 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.

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 limits fishing to the summer season. Salmon and sturgeon, the most valuable river fish, do not appear in the rivers, however, 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. Because this part of the sea remains ice free in winter, fishing fleets can operate without interruption throughout the year. Herring, cod, haddock, and salmon are the principle species caught there. The warming effect of the Gulf Stream has allowed numerous species of fish to enter Arctic waters; and cod, herring, mackerel, and haddock are found even along the western coast of Novaya Zemlya. 44,45/

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. 46/

Murmansk is the most important fishing port and processing center in the entire Soviet Arctic. A fleet of approximately 350 trawlers is based here and accounts for most of the fish taken in the Barents Sea (Figure 18). In addition to the trawlers, there is at least one floating cannery for processing herring (Figure 19). Recent figures are not available, but 135,000 tons of fish were caught in 1947. 47/ Most of the catch is canned for export to foreign countries, chiefly the United Kingdom.

The Murmansk Fish Combine (Rybokombinat) processes all the fish brought into the port. It operates the year round, since the trawler fleet is not restricted by winter ice. The combine consists of several plants that 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. By-products of fish processing include cod liver oil, vitamin A extracts, and fishmeal. Wooden barrels and tin cans are manufactured near most canneries. 48/

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.

Figure 18. Trawlers of the Murmansk fishing fleet.

Figure 19. A floating fish cannery of the Murmansk fleet, with trawlers tied alongside the mother ship.

Conditions favoring the propagation of fish decline rapidly to the east of the Barents Sea. Cold water reduces the growth of plankton, and the number and species of fish decline proportionally. Fish are found in large numbers only in river estuaries where the water is warm and rich in food. Part of the catch is canned for export, and the remainder is smoked or air dried for local consumption. Fishing collectives are found on all the major rivers.

The Ob' Estuary (Obskaya Guba) is the second most important fishing area in the Soviet Arctic. The many factories around the bay can large amounts of salmon, sturgeon, and whitefish. 49/ 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, and sturgeon may reach 200 to 250 pounds. 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 largest producer of fish products and includes plants at Kushevat, Shugin, Puyko, and Aksarka. The largest plant, which is in Salekhard, employs over 3,000 people. 50/ 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 Yenisey River supports relatively few fish since the water is too pure for a rich growth of plankton and too swift for good breeding grounds. Fish that do live in the river grow slowly but reach great size. 51/ A small fish cannery and curing factory is located on an island in the Yenisey near Dudinka. Salmon are canned and cod are salted at the factory. 52/ A cannery north of Dudinka on the right bank of the river has also been reported. 53/

A number of smaller canneries are scattered along the Arctic shore at a number of 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. The yards have a major responsibility for equipping both naval and merchant vessels for early sailing over the Northern Sea Route. 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 ship building 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 26 shipyards and boatyards in the Soviet Arctic, the most important are the Molotovsk Shipyard No. 402 in Molotovsk and the Rosta Naval Shipyard near Murmansk. These yards operate largely in support of the Soviet Northern Fleet and employ an estimated total of 12,000 to 20,000 workers. The Molotovsk yard is the third largest in the Soviet Union and engages chiefly in construction of new vessels. The yard's maximum annual construction capability is estimated to be 282,000 gross tons (GRT) or 224,000 naval standard displacement tons (NSDT). During the period from 1949 through 1953, the yard completed 22 destroyers of the Skoryy class and an unknown number of minesweepers, motor torpedo boats, patrol vessels, and other craft.

The shipyard at Rosta, which is equipped only for repairs, is rated as the second most important yard in the Soviet Arctic. Because of the relatively ice-free condition of the harbor, it has become the major repair base of the Soviet Northern Fleet. The shipyard is capable of repairing naval ships, including cruisers and merchant ships up to 15,000 gross tons. During World War II the yard was used for repairing destroyers, submarines, and small ships.

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

*Based primarily on Source 54, Appendix B.

ocean-going merchant vessels and naval ships up to destroyer size. The most significant of these yards are the Rybprom (Glavryb) and Sudna shipyards in Murmansk and the Krasnaya Kuznitsa shipyard in Arkhangel'sk, which have a combined annual shipbuilding capacity* estimated at 52,400 GRT or 51,700 NSDT. An estimated total of 4,500 to 9,000 workers are employed in the 3 yards. Four other secondary yards are located in the Arctic; two in the vicinity of Arkhangel'sk, one at the Iokanga Naval Base, and one at Igarka. The yard at Igarka builds seiners, motor boats, and launches in addition to making repairs to river and Northern Sea Route vessels. 55/

An estimated 17 small boatyards, located throughout the region, engage chiefly in the construction and repair of fishing boats and barges and have only limited repair facilities for small naval vessels. The majority of these boatyards are concentrated in the vicinity of Arkhangel'sk, the focus of intensive shipping activities. In addition to the 8 yards at Arkhangel'sk, 4 others are located along the Kol'skiy Zaliv -- two at Murmansk and one each at Severomorsk and Polyarnyy. Pechenga, Mezen', Salekhard, Tiksi, and Ambarchik also have one boatyard each. Although most of these yards are equipped with only limited facilities, they provide important refueling, maintenance, and repair bases for submarines, destroyers, and small ships operating in the region. Most of the yards are also served by rail and maintain facilities for storing large quantities of fuel as well as naval stores and munitions.

2. Molotovsk Shipyard Number 402

The Molotovsk Naval Yard, Zavod Number 344, 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, 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 nautical miles long and a 180 feet (55 meters) wide. Rapid silting makes constant dredging necessary to maintain the 27 to 30 foot (8-9 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 Molotovsk with the Arkhangel'sk-Moscow trunkline at Isakogorka.

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*Capacity based on one-shift operation.

The civil labor force of Molotovsk is estimated at 35,000, with the shipyard and related activities employing the largest percentage of the workers. In 1949, an observer estimated that 6,000 persons were employed on a three-shift operation, but more recent estimates place the number of shipyard workers at 15,000. 56/ However, with production per person equal to that of US workers, an estimated 21,000 workers would be required to operate the yard on a full three-shift basis.

The yard occupies an area of approximately 550 acres, with about 12,000 feet (366 meters) of water frontage. Facilities include (1) two covered graving-construction docks, each about 1,000 feet (305 meters) long and 150 feet (45 meters) wide and capable of building the largest of vessels; (2) two transverse building ways; (3) a large transverse shipbuilding site capable of simultaneous construction of 10 destroyers; and (4) a ship assembly shop 350 feet (106 meters) long and 80 feet (24 meters) wide for the construction of subchasers and smaller 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 and prefabrication, fabrication, and ship-assembly shops; a number of foundry, forge, and machine shops; a boiler shop; pipe and joiner shops; and large storage facilities. The Molotovsk municipal powerplant supplies electric power to the yard and to the city.

3. Rosta Naval Shipyard (Sevmorput)

The Rosta shipyard is located about 2.5 nautical miles north of Murmansk. An important function of the yard is the preparing of both naval and merchant vessels for the eastward trip over the Northern Sea Route. Although strictly a ship repair yard, it is reportedly being developed into a first-class shipyard that may possibly build submarines and destroyers. 57/

The yard has a total area of approximately 80 acres and extends for about 3,000 feet (915 meters) along the eastern shore of the Kol'skiy Zaliv. It is readily accessible from Murmansk by water, road, and an electrified railroad line. Most of the materials and equipment for the shipyard arrive via the railroad from the Leningrad and Moscow areas. Yard facilities include two graving docks 656 feet (200 meters) and 328 feet (100 meters) long, and a floating drydock reportedly of 3,000-ton lifting capacity. The graving docks are served by three 15-ton-capacity derricks. Among the other facilities are three machine shops; a sheet-metal, foundry, and forge shop; and a number of supplemental shops. A 36,000-kilowatt powerplant at Murmansk and a

48,000-kilowatt hydroelectric plant at Tuloma supply electric power to the Rosta dockyard.

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. 58/ In 1943, some 10,000 workers were reportedly employed in the yard, of whom the majority were convicts. 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 some of the more important minerals; antimony, tungsten, platinum, gold, silver, and oil are also found. Exploitation depends upon the strategic importance of the mineral. The increasing need for nickel and copper prompted the development of the Noril'sk mines. Since tungsten is a necessary ingredient for high-speed tool steels and armor-piercing ammunition, deposits of the mineral are being developed rapidly. The growth of Iul'tin, in the isolated northeastern part of Siberia, is a further indication of this need. 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. The strategic significance of uranium has caused a widespread search for deposits, and the mineral is mined wherever it is found, even in distant, isolated areas such as Severnaya Zemlya.

Transportation is not a limiting factor if the need for the mineral warrants its exploitation. Uranium and tungsten ores are 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 that do not have such high priority, are delivered by ocean freighter.

2. Major Deposits

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

a. Noril'sk

Metal refining and its associated industries have made Noril'sk the largest center of heavy industry in the Soviet Arctic. The mineral deposits 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 platinum; but smaller amounts of coal, silver, gold, iron, vanadium, tungsten, molybdenum, and chromium are also found. Ore reserves (in metric tons) have been estimated at 720,000 of copper, 500,000 of nickel, and 10,000 of cobalt. 59/ Although these amounts are outranked by deposits in the Urals and Central Asia, they contribute significantly to the economy of the Soviet Union.

The Noril'sk ore contains 0.47 percent copper, 0.31 percent nickel, 0.1 percent cobalt, and smaller amounts of platinum, gold, and silver. It is mined in the hills surrounding the town on the north, east, and south. Ore is found in greatest quantity in the Shmidt and Medvezkha Hills southwest and southeast of Noril'sk. Since the ore bodies are only 130 feet (40 meters) below the surface, strip mining is used (Figure 20). Three mines are in operation on Medvezhka Hill and two on Shmidt Hill.

The ore is hauled by broad- and narrow-gauge railroads to the concentrating plants, where it is crushed, washed, and graded. An estimated 2,500 to 3,000 workers are employed in these plants. After concentration, the ore is smelted to separate the copper and nickel components. These are cast into anodes and electrolytically refined to pure copper and nickel. The nickel process takes about a week and the resultant plates weigh 8 pounds. Copper is formed into much larger plates which weigh 352 pounds. 60/

Several industries operate to support the refining operations. A large coking plant prepares Noril'sk coal for use in roasting the ore. The byproducts, coal tar and coal gas, are consumed in Noril'sk. A thermoelectric powerplant located within the city supplies power for electrolytic refining and for other industrial uses (Figure 21). The same installation furnishes electricity, water, and steam heat to the city.

Both anthracite and bitiminous coal are found in the Noril'sk area and enable the city to be self-sufficient in meeting its power needs. 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. 61/ Numerous bituminous deposits of coking quality are scattered along both sides of Shmidt Hill. Mines have also been reported at Kayrkan

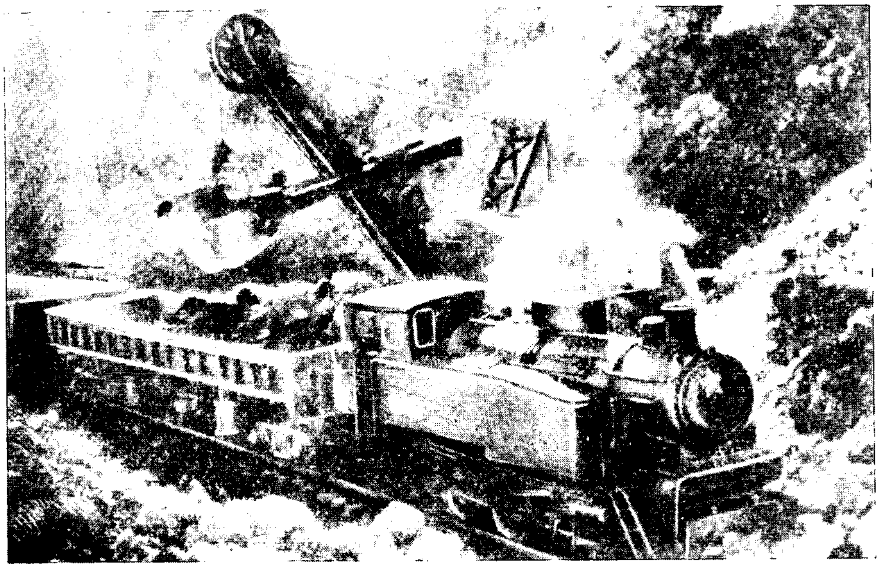


Figure 20. Loading ore on gondola cars at the strip mine near Noril'sk.

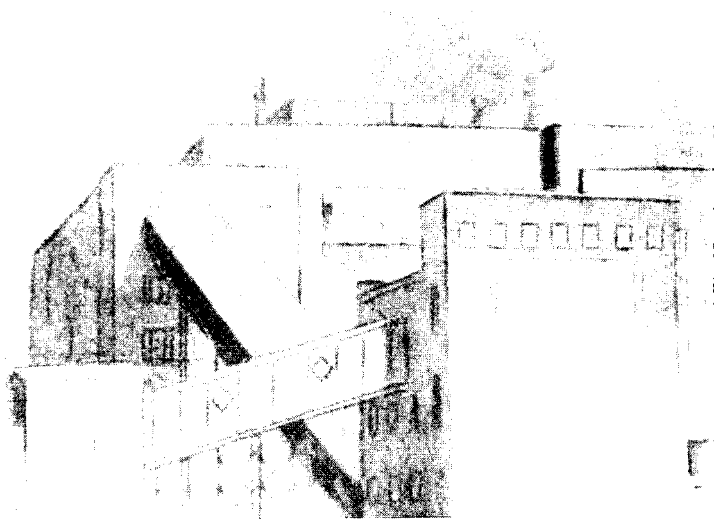


Figure 21. The thermoelectric powerplant at Noril'sk.

(Kaerukan)* on the Noril'sk-Dudinka railroad about 19 miles (30 kilometers) west of Noril'sk. Only one mine was worked in 1952, and it produced 2,400 tons a day. 62/

Oil shale is also used as a fuel and is burned without prior processing. 63,p.2/ It is found in large, thick lenses in the poorer quality coal formations. Shale is sometimes saturated with liquid oxygen and used in blasting when regular types of explosives are in short supply.

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

According to PW reports, three plants in the Noril'sk complex are engaged in secret work. 64/ They have been described as a cobalt or platinum refinery, an atomic- and hydrogen-bomb plant, and a poison-gas plant. Platinum production began in 1940-41; by 1947, Noril'sk produced 80,000 to 85,000 fine ounces or 30 percent of the Soviet output. Platinum is obtained as a refining byproduct of nickel-copper ore, by stream panning, and by mining. The metal is recovered at a rate of 2 grams of metal from every ton of nickel-copper ore. Many streams are panned for platinum, but no production figures are known. One platinum mine is known to have been in operation at Noril'sk, but it has reportedly been closed. 65/

Iron ore is mined at several places in the vicinity of Noril'sk, but the total production is unknown. A strip mine was started in 1947 on Shmidt Hill, and an iron mine north of the Noril'sk-Dudinka railroad is producing small amounts of ore. Several mines are reportedly located 75 miles (120 kilometers) east of Noril'sk. 66/

Small amounts of gold are produced at Noril'sk. The metal is recovered as a byproduct of nickel-copper refining and by dredging Lake Pyasino. Production from the lake is small since operations can be carried on only during the short ice-free season.

b. Nikel'

The Nikel' area in the northwestern part of Kola Peninsula also produces nickel and copper. No reliable production figures are available. However, when the mines were under Finnish jurisdiction, they had an annual capacity of 10,000 tons of nickel and 3,000 tons of

*Confirmed spelling unknown.

copper. 67/ Estimates of ore reserves vary from 230,000 to 5,000,000 tons. 68,69/

The mines are located near the town of Nikel' in the extreme northwestern corner of Murmanskaya Oblast' (Figure 22), and the ore contains 1.5-3.0 percent nickel, 1-2 percent copper, 1 percent cobalt, and minute quantities of platinum. 70,71/ The ore is concentrated to matte at Nikel' and is then sent to Monchegorsk for further refining. The furnaces at Nikel' are electric and receive their power from the hydroelectric station at Yaniskoski, 43 miles (70 kilometers) to the southwest. 72/ When concentrated into matte the ore contains 30-60 percent nickel and copper. Until recently the matte from Nikel' was first trucked to Linakhamari, the deep-water, ice-free port for Pechenga; then the matte was shipped to Murmansk; and from there it was sent by rail to Monchegorsk. In late 1955, a railroad from Pechenga to Murmansk was completed, and now most of the ore probably moves over this route.

c. Vorkuta

The Vorkuta area is the largest coal-mining center in the Soviet Arctic and produced an estimated 12,850,000 tons of coal in 1952. This amount, however, represents only 4.3 percent of the total USSR production. 73/ 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.

Soviet sources state there were 28 mines at Vorkuta in 1950 74/ and claim that the present total is 40. 75/ The mines are located north and west of the city and are mostly of shaft type (Figure 23). X1 [redacted] some of the mines are highly mechanized, but [redacted] by hand. 76,77/ The quality of Vorkuta coal 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 surface mines. Coal is also mines at Khanovey, 12 miles (20 kilometers east of Vorkuta. Abez and Inta, both south of Vorkuta, produce coking coal and anthracite.

Several minerals of minor importance are mined in the Vorkuta area. Chromium, iron, gold, and platinum are found 10 to 20 miles (16 to 32 kilometers) north of the town. In 1950, gold and platinum were mined, and the ore was sent downstream by barge to be processed. Manganese deposits were developed east of Vorkuta in 1945, and the ore was shipped to Kozhva for refining.

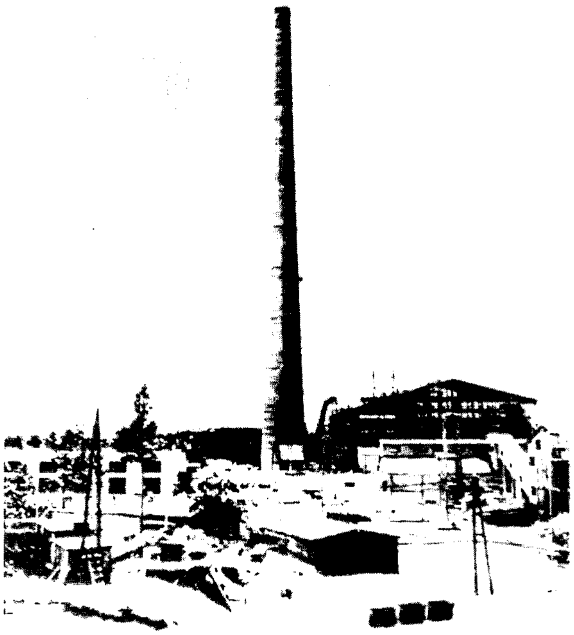
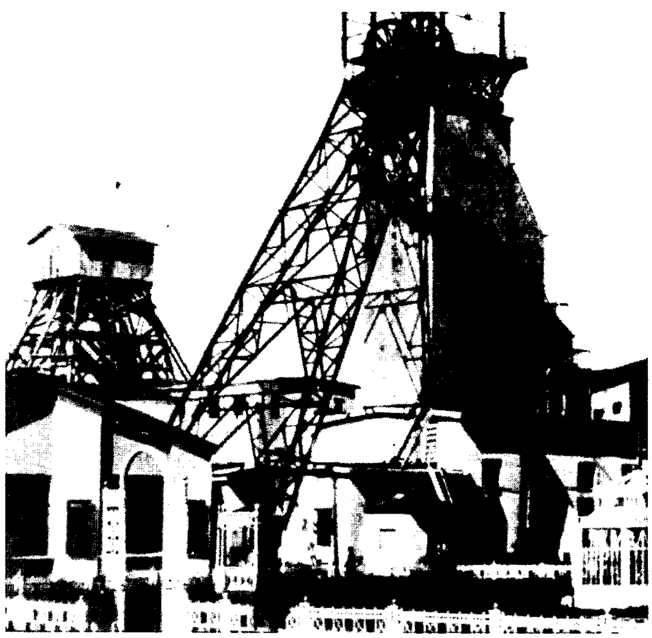


Figure 22. Buildings of the oil-refinery complex at Nikel'.

Figure 23. A coal shaft at Vorkuta.



d. Pevek

Mineral exploitation in the Pevek area extends from Chaunskaya Guba northeastward to the Koyveyem River and southeastward to Krasnoarmeyskoye. The area was explored in the 1930's but mining operations did not begin until 1948. At present the area is an important producer of tin. Uranium, iron, tungsten, vanadium, copper, antimony, lead, zinc, platinum, silver, and gold are mined in small quantities. Since the isolated position and lack of a fuel base preclude the possibility of refining ores at Pevek, they are graded and barreled for export. The ores are stockpiled in the winter and shipped out during the navigation season.

Mining is concentrated at four places in the Pevek area. Mt. Yandra-Paken, at the northern tip of Pevek Peninsula, contains deposits of tin and gold. 78,p.1,078/ The tin ore is found in thin seams that extend for several thousand meters and have 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, 79/ which were developed before World War II and are operated by hand labor. The valley of the Koyveyem River along the eastern slopes of the mountains also has rich deposits of uranium and tin. The ore is found in alluvial deposits along the river and in veins in the surrounding hills.

Ore deposits extend from Pevek southeastward to Ust'-Chaun. The largest mining area is 50 miles (80 kilometers) southeast of Pevek at Krasnoarmeyskoye. More than 20 open-pit and shaft mines produce uranium, tin, tungsten, and silver. 80/ Small amounts of antimony, tungsten, gold, silver, platinum, iron, molybdenum, and vanadium are mined south of Krasnoarmeyskoye.

3. Secondary Deposits

The secondary 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 (Figure 24). The ore body consists of 10 beds that cover 7 square miles (28 square kilometers) and contain veins up to 26 feet (8 meters) thick. 81/ The ore is refined at Amderma, and the fluorspar is shipped to Arkhangel'sk for distribution. Zinc is obtained as a byproduct of the refining.

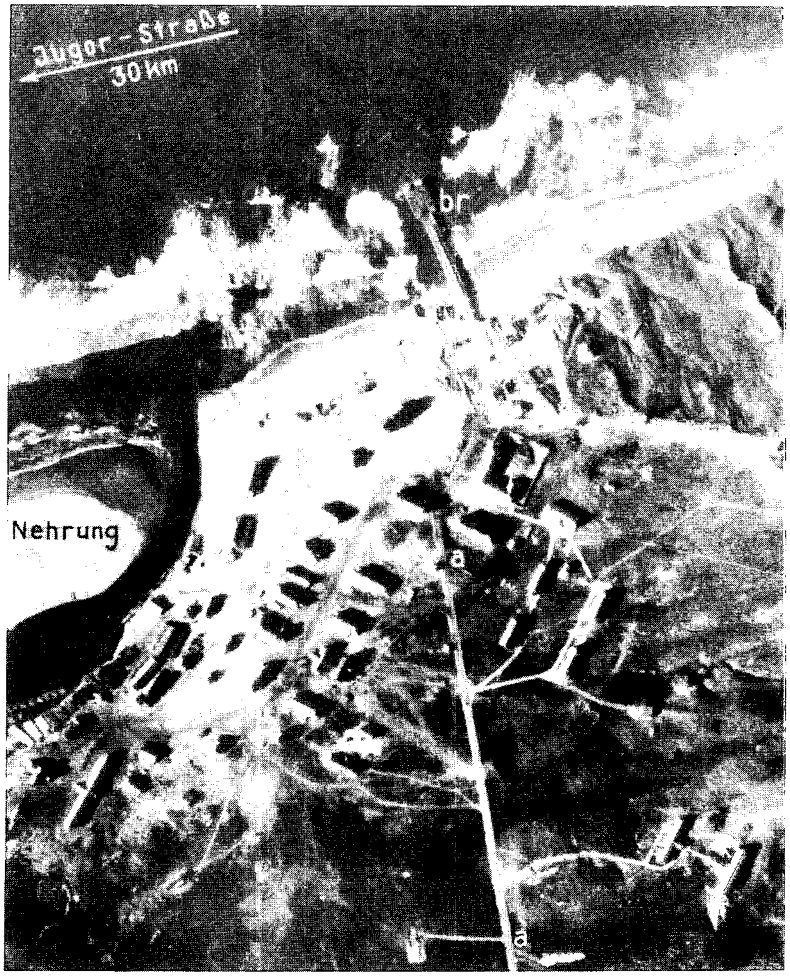


Figure 24. Amderma in 1943. The spur "a-a" brings ore from the fluorspar mine to the pier "br."

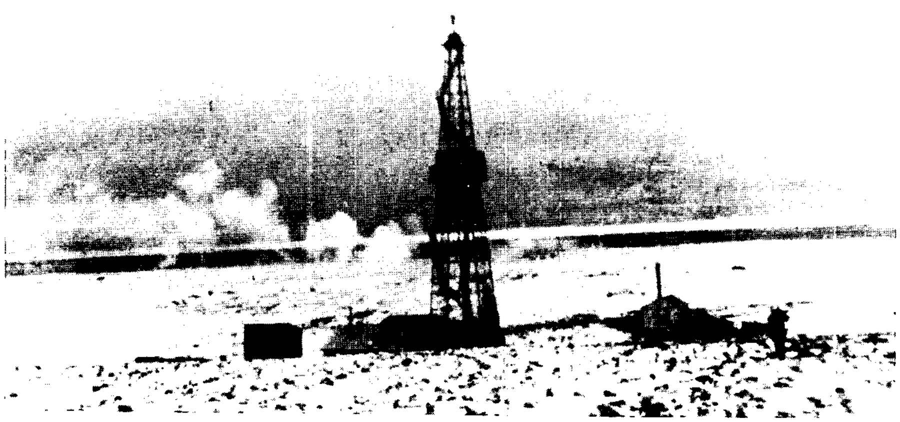


Figure 25. An oil derrick at Nordvik.

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 1946. 82/ During the exploration, more than 250 wells were drilled (Figure 25). 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 to 6,000 feet (1,830 meters). The highest grade of oil was found at 1,000 feet (305 meters). Most of the oil in this area is of a resinous paraffin type with a high sulphur content. 83/ No reliable production figures are available for the region. On the basis of the small yields obtained during the exploratory drilling, it is probable that there is little or no production at present.

The first area of exploration was on the Yurung-Tumus Peninsula, an eastward extension of the Khara-Tumus Peninsula. The oil flowed at a rate of 5 barrels a day. Exploration later shifted to the south, near Mys Ilya in Bukhta Kozhevnikova, and several small refineries were built on the north shore of the bay to process the oil. 84/ 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. 85/

Other minerals of the Nordvik-Khatangskiy Zaliv area include coal, salt, gypsum, and copper-nickel ore. Coal in the Nordvik-Khatangskiy Zaliv region is produced in small amounts and used locally. At Bukhta Kozhevnikova it 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 has been burning since 1932.

The salt dome on the Yurung-Tumus Peninsula is an important source of rock salt (Figure 26). 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 contains little foreign matter, the salt is shipped directly from the mines to fish-processing plants along the Arctic Coast. 86/

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

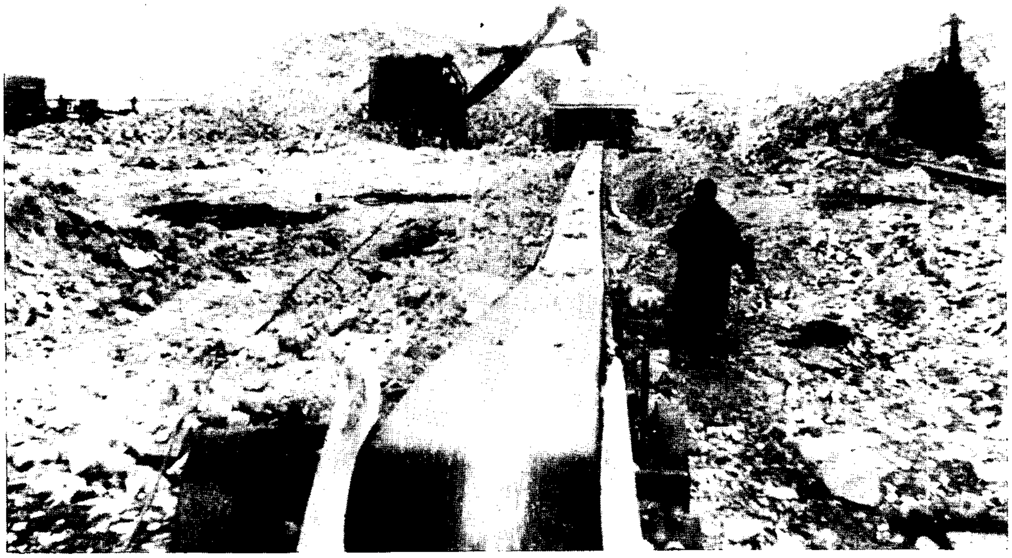


Figure 26. Mining operations at the salt dome on the Yurung-Tumus Peninsula.

are believed to be the eastern end of the Noril'sk ore body and 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. 87/

c. Murmansk

Important iron ore deposits have recently been developed among the north coast of the Kola Peninsula near Murmansk. The ore is sent by water to the new steel mills at Cherepovets (Vologodskaya Oblast'). Here it is combined with Vorkuta coal to produce steel for the industries of Leningrad. The ore bodies are lens-shaped and contain 30-40 percent iron. Reserves of the area are estimated at from 60 to 100 million tons. 88/ The ore is found in two broad strips that extend from Kol'skiy Zaliv westward to the Norwegian border. 89/ 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, where ore pockets 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.

d. Iul'tin

The tungsten ore deposit on the western edge of the Chukotsk Peninsula north of the junction of the Chaantal'vegyrgyn and Amguyema Rivers appears to be one of the largest in the USSR. Discovery and exploration of the deposit began in 1936, and the settlement of Iul'tin subsequently grew up nearby. World War II provided the impetus for a rapid expansion of mining operations. The need for tungsten has remained acute, and Iul'tin has continued to grow. In 1950, some 1,200 PW's were reportedly working in the mines. 90/ 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 shipped 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. 91/ The present status of the deposits is unknown, but they are probably not being worked.

4. Minor Deposits

Uranium, coal, and oil have a strategic significance that makes them more valuable than any of the other minerals found in the Soviet Arctic. In addition to the major deposits of these minerals that have previously been described, minor deposits are scattered throughout the entire Arctic Sector.

Uranium is in particularly high demand because of its many uses in both peace and war. It is, therefore, being searched for and mines in a number of places. Iokanga, on the coast of the Kola Peninsula 186 miles (300 kilometers) southeast of Murmansk, produces uranium ore, which is shipped to southern refining centers. Uranium is also mined on Novaya Zemlya but the exact location is unknown. The ore is stockpiled during the winter and sent to Murmansk when the seas become ice free. Another deposit 37 miles (60 kilometers) east of Vorkuta in the Polyarnyy Ural is reportedly being exploited. 92/ The ore is processed at the mines and then sent by rail to southern consuming centers. The uranium deposits of Ostrov Komsomolets in Severnaya Zemlya are on the southwestern coast. 93/ The mines cover a square kilometer and are 33 to 66 feet (10 to 20 meters) deep. After the ore has been separated from the waste, it is flown to the mainland. In 1946, deposits were discovered at Mys Chelyuskin but it is not known whether they are being worked at present. On the Chukotsk Peninsula uranium is being mined at Zaliv Lavrentiya [redacted] and from there is sent to southern processing centers by ship and aircraft. 94/

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 coal 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. The coal is shipped out, probably to Nar'yan-Mar.

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. Although it is used locally for heating, bunkering fuel for the Lena River fleet is imported from Sangar.

Coal for Tiksi is mined northwest and south of the town. Since the coal is of glacial alluvial origin, the beds are thick (45 feet or 14 meters) and the moisture content is high. Mining was started in 1945 and production reached 50,000 tons in 1947. 95/ Small mines at Ambarchik and Pevek are also being worked.

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 (80,000 square kilometers) is centered south of Salekhard. Coal has also been found at Dudinka and Dikson, on the Yamal Peninsula, and in the lower and upper courses of the Pyasina River are reported to contain vast deposits. 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 and Mys Serdtse-Kamen'.

Oil deposits other than those in the Nordvik-Khatangskiy Zaliv field are small in size and are concentrated in the western Arctic. They

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could serve as future fuel bases for ships of the Northern Sea Route. For the most part the deposits remain undeveloped in favor of larger fields to the south. Oil seeps have been discovered near Zaliv Inostrantsev in Novaya Zemlya, 96/ 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. 97/

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 which reach outside markets. There are 2 to 3 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. 98/

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. 99,p.21/ Kharp Kolkhoz in the Nenetskiy Natsional'nyy Okrug (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. 100/ 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. 101/

Tents only are now used during the migrations. Although prefabricated huts have been designed by the Institute of Polar Agriculture and Cattle Breeding, 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. 102/

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. 103/

Many reindeer kolkhozes have organized fur farms and raise silver and blue fox (Figure 28). Both of these have been bred from the

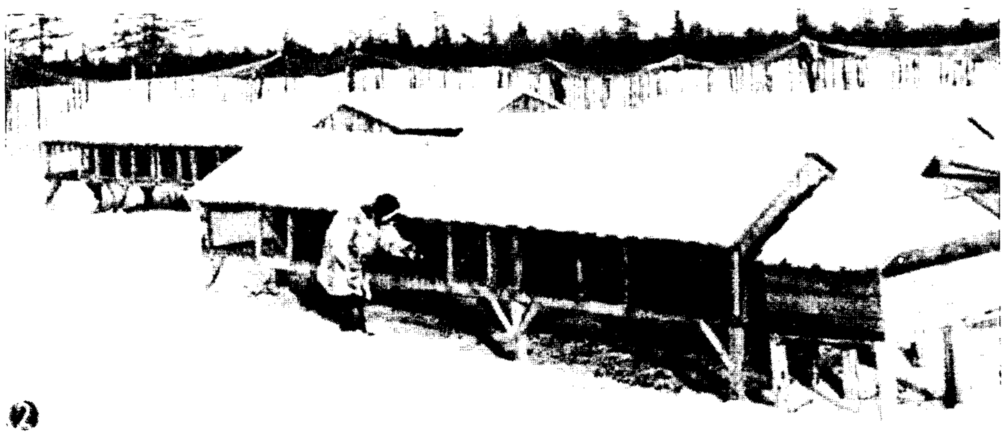

Figure 28. A fox farm on the Taymyr Peninsula.

native 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. 104/

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 gadfly. It lays eggs in the hair of the animal; and when the larvae hatch they bore into the reindeer's skin. 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 gadflies.

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 they will not be grazed by more than one herd. The pasture areas are also assigned 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 furs trapped (Figure 29). 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.

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. 105/ Individual hunting and trapping are also carried on by natives whose herding activities are curtailed during the winter season (Figure 30). 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. 106/

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. 107/ 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 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 only 146,000 seals from the entire White Sea in 1947. 108/ 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

Figure 29. A fur warehouse on Chukotsk Peninsula. Arctic fox pelts are hanging from the ropes.

Figure 30. A kolkhoz member from Bulun Rayon with his catch of arctic foxes.

receding ice pack to Zemlya Frantsa-Iosifa and Severnaya Zemlya when the pupping season is over. The seal remain at this high latitude for the remainder of the summer and return south in the fall.

The belukha furnishes high-grade lubricating oil, leather, and meat. The meat is tough, but 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.

Walrus is hunted for its skin and meat. It is seldom found in the European Arctic, and its numbers have been reduced to such an extent elsewhere that it is probably not widely hunted commercially.

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. 109/

Birds eggs form a large part of the local native's diet. Guillemot eggs are the main species eaten, and more than one-half million are collected yearly (Figure 31). The birds live in large nesting colonies called "bazars," which are located along the high, rocky coasts of the islands and mainland (Figure 32). 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 over 1.5 million birds. The principal species include eider ducks, guillemots, 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. 110/ 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

Figure 31. Packing guillemot eggs on Novaya Zemlya.

Figure 32. A large nesting colony or bazar of shore birds on the rocky cliffs of Mys Karmakuly, Novaya Zemlya.

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. 111/

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 (76 millimeters) on the northern islands to 16 inches (406 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 floating scientific stations with fresh vegetables. Railroads serve only the western part of the Arctic, and vegetables are 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 slow -- especially for perishable items.

Since most of the area can be reached only by water, the shipment of food is a seasonal operation. Supplies for the entire year are stockpiled during the summer. 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 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 and covers 6,000 acres (2,430 hectares). 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. 112/

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 more 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 layer lying over the permafrost are unsuited to farming. The permafrost layer gradually deepens, however, as repeated cultivation stirs up and thaws out the soil.

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. 113/

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 transplated 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 completely in greenhouses (Figure 33). 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 34). 114/ 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 produce mature crops. They are easier to construct 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 lining the frames with manure.

Open-field cultivation is limited to small, scattered plots that have favorable exposure, slope, and soil (Figure 35). New soil is prepared by plowing the land in spring and allowing it to remain

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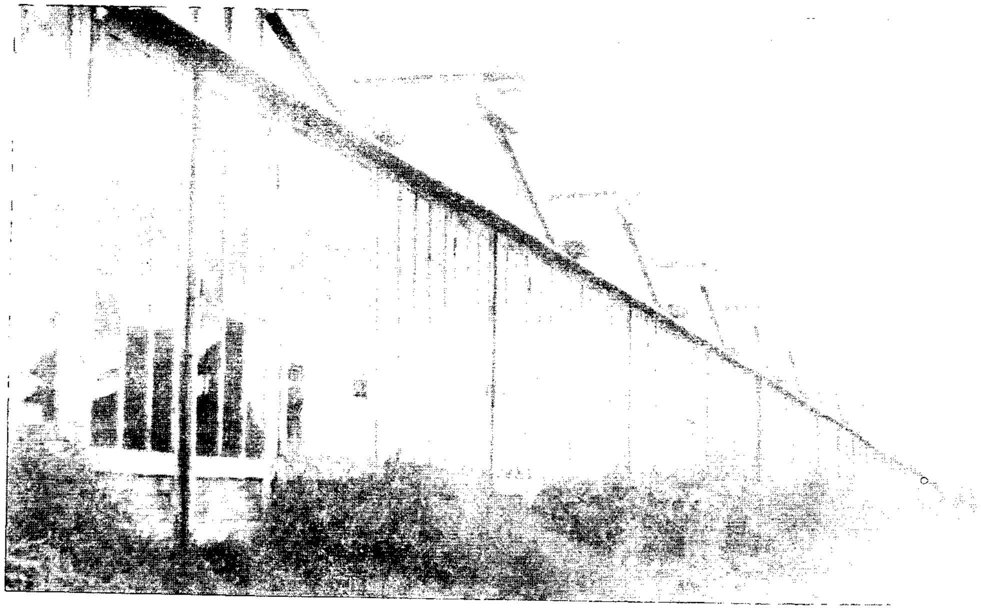

Figure 33. Greenhouses on Kola Peninsula.

Figure 34. Cucumber plants growing in a greenhouse on Taymyr Peninsula. Electric lights supplement the short winter daylight hours.

Figure 35. A cabbage field in an experimental station in Salekhard, with greenhouses in the background.

Figure 36. A field of kohlrabi at Igarka. The crop will be dug in August or September.

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. Field crops are harvested in July or August and root crops are dug in August or September (Figure 36).

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 be protected by drifting snow from the cold temperatures of winter. Trees grown in this manner produce fruit high in sugar, and damage by frost is reduced. 115/

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 usually eaten fresh. 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 per cow. Some cows in this herd give as much as 2,300 gallons per year. 116/ 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 are cut and stored for winter feed (Figure 37).

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. 117/

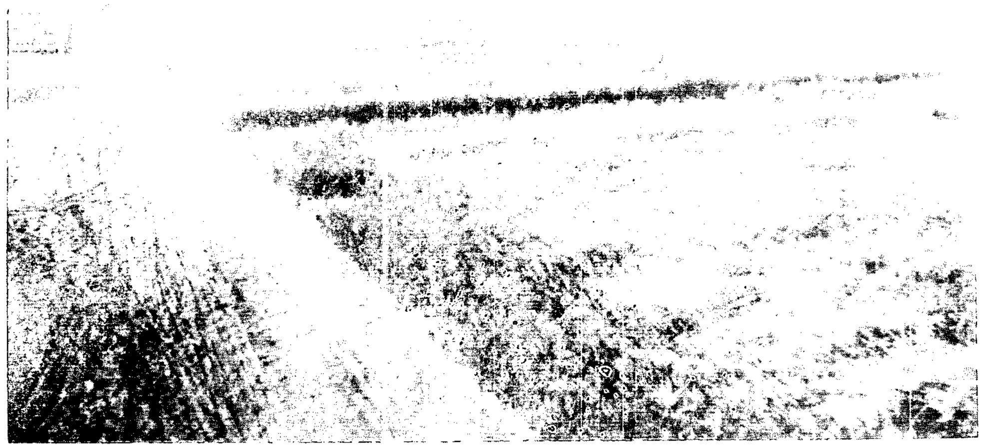

Figure 37. A field of barley at the Igarka experimental station. The crop will probably be cut and stored for winter feed for cattle.

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. 118/

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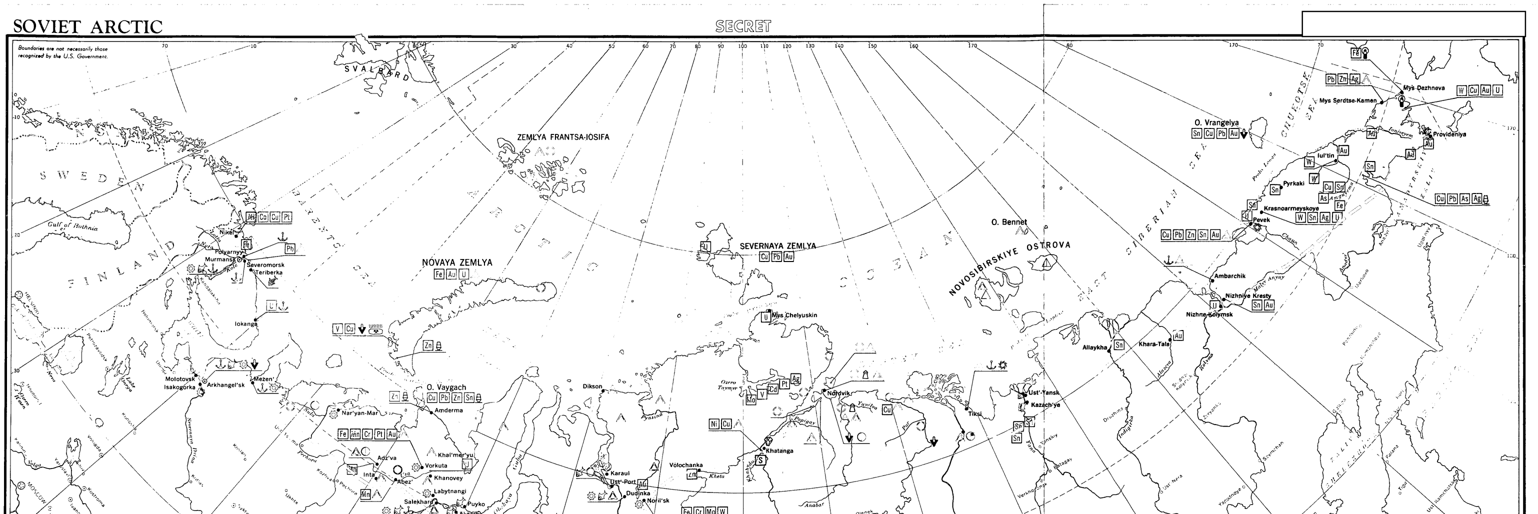

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RESOURCES AND INDUSTRY

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

PRECIOUS AND FISSIONABLE METALS

- Au Gold
- Pt Platinum
- Ag Silver
- U Uranium

Reported exploitation indicated by

Statute Miles: 0 200 400 600 800

Kilometers: 0 200 400 600 800

PRINCIPAL INDUSTRIES

- Wood processing
- Fish processing
- Shipbuilding

STUDY AREA BOUNDARY

OTHER MINERAL DEPOSITS

NONMETALS

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

FUELS

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

Reported exploitation indicated by

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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 relatively dense 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 are concentrated 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 ice stations and the Arctic Islands have been of major scientific and strategic significance. Hydrometeorological flights by Polar Aviation are also of utmost importance to successful maritime and naval operations along the Northern Sea Route.

The expansion of air routes throughout the polar region has been facilitated by the construction and improvement of air installations, chiefly along the Arctic littoral. Along the littoral there are 67 airfields and 27 seaplane bases, as well as a number of others whose exact status has not been established. 119-123/ Although these installations are used chiefly by civil aircraft, many of the airfields lend themselves to military operations. In the peripheral areas of the Soviet Arctic, major airfields devoted primarily to military operations have recently undergone considerable expansion. These developments reflect an increasing emphasis on the strategic significance of transpolar air routes.

2. Polar Aviation

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. A wide range of auxiliary functions is also performed by Polar Aviation, including meteorological work, aid to scientific expeditions, aerial assistance to hunting patrols on land

and sea, and aid in locating reindeer pastures, as well as propaganda work under the Political Directorate of the GUSMP. To assist in these functions, four regional air groups were created -- the Igarka Air Group, Lena Air Group, Chukotsk Air Group, and Moscow Special Purpose Air Group. 124/ Since 1955 the headquarters group based at Moscow has assumed control of the regional air groups. 125,p.59/

The activities of Polar Aviation date from the late 1920's when it carried out sporadic missions and experimental flights to the European north. 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 associated with the establishment of air-transport routes in the north. Not until 1933, however, when the newly organized GUSMP acquired control of Polar Aviation, did the use of aircraft become particularly significant in the exploration and development of the Arctic. 126/ Since then the development of Polar Aviation has closely paralleled the growth of its parent organization and has become a major instrument in the economic and political unification of the Arctic region.

In the past decade, the Soviets have made significant operational and technological advances in Arctic flying in order to correct earlier weaknesses and meet needs arising 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, 127,p.405/ and (5) introduction of equipment and supplies designed specifically for use under Arctic conditions.

In early 1955, Polar Aviation was apparently assigned an expanded mission that resulted in some realignment of its operating structure. Although the new mission of Polar Aviation is not known, it undoubtedly calls for utilization of the experience of the past 25 years in the conduct of aerial reconnaissance, supply, and communication missions in polar areas. In any event, the new Polar Aviation operating structure is not likely to be extensive since its aircraft complement in the past has never exceeded 5 percent of the major nonmilitary transport aircraft strength of the USSR. 128/ It is estimated that about 75 Coach (Il-12) and Cab (Li-2) aircraft and an additional 75 smaller planes, such as the Mule (Po-2), Colt (An-2), and Hound (Mi-4) helicopter, are now in service. 129/ Recent 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 and possibly for freight shipments (Figures 38 and 39).

In addition to providing timely and accurate weather and ice forecasts, the major functions of Polar Aviation are air transport and communications. The transport system of Polar Aviation consists chiefly of a relatively dense network of routes confined largely to the Arctic rim. Most of these routes appear to radiate from the larger air terminals that serve as Polar Aviation operational and supply bases (Figure 40), notably Amderma, Dikson, Igarka, Khatanga, and Tiksi. These bases, along with Mys Chelyuskin, Pevek, and Mys Shmidta, have become important staging areas for airlift operations to the Arctic Islands and in support of current Polar Basin activities. Probably only a few routes are operated on schedules; most of Polar Aviation's flying is believed to be on an "as required" basis. 130/ The main route, however, has regular service of undetermined frequency from Moscow to Anadyr' via the Arctic Coast. Apparently this route connects the intervening points of Arkhangel'sk, Amderma, Dikson, Khatanga, Tiksi, and Pevek.

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. 131/ Helicopters have actually been flown directly from Moscow to the drifting stations in the Central Arctic Basin. 132/ On the flight from Moscow the helicopters made maintenance and refueling stops at Arkhangel'sk, Nar'yan-Mar, Amderma, and Mys Kamennyy. From Mys Kamennyy, one helicopter proceeded to Dikson and then to Severnyy Polyus-3 and another to Ostrov Vrangelya and then to Severnyy Polyus-4. On the flight to Ostrov Vrangelya, stops were made at Dudinka, Tiksi, Chokurdakh, Nizhniye Kresty (Kresty Kolymskiye), Pevek, and Mys Shmidta. 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 Special Purpose Air Group. 133/

The network of Polar Aviation air facilities, 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 polar region. Many of the current Polar Aviation airfields could readily be made available for refueling, 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

Figure 38. A Coach (Il-12) being loaded and fueled for a flight to the drifting ice stations.

Figure 39. The twin-engine Cab (Li-2) is the Soviet version of the DC-3 transport supplied to the USSR under lend-lease during World War II.

successful tactical operations along the Northern Sea Route would also be significant. The larger four-engine transports and Bull (Tu-4) aircraft currently used for long-range ice and weather reconnaissance could perform vital photo-reconnaissance missions or serve as troop carriers for airborne operations (Figure 41).

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. 134/

3. Civil Air Fleet (GVF)*

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. Most 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 connect Moscow with Murmansk, Arkhangel'sk, Vorkuta, and Noril'sk. These 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.

According to the 1954-55 winter timetables, the network of scheduled Arctic routes of the GVF, which operates under the trade name Aeroflot, consists of five airlines. 135/ These routes are primarily carriers of mail and passengers, but sizable amounts of air freight are included in air shipments to the Siberian Arctic, where other means of surface transportation are notably lacking. Operating from Moscow, the Aeroflot routes include the northern segments of the following lines: (1) Moscow-Vologda-Arkhangel'sk, (2) Moscow-Leningrad-Petrozavodsk-Arkhangel'sk, (3) Moscow-Leningrad-Petrozavodsk-Murmansk, (4) Moscow-Gor'kiy-Syktyvkar-Vorkuta, and (5) Moscow-Krasnoyarsk-Noril'sk. Except on the Syktyvkar-Vorkuta line, which operates three round trips per week, Aeroflot maintains daily round-trip service between the terminal cities on each of these lines.

*For additional information, see page 143.

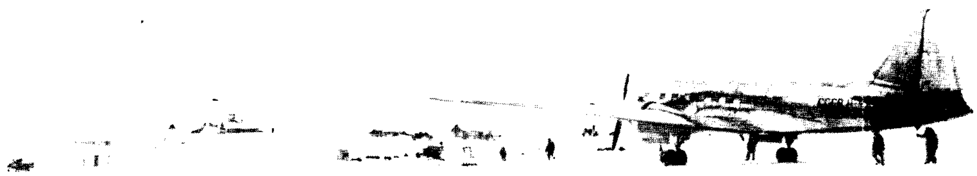

Figure 40. The air terminal at Dikson, which serves as an operational and supply base for Polar Aviation.

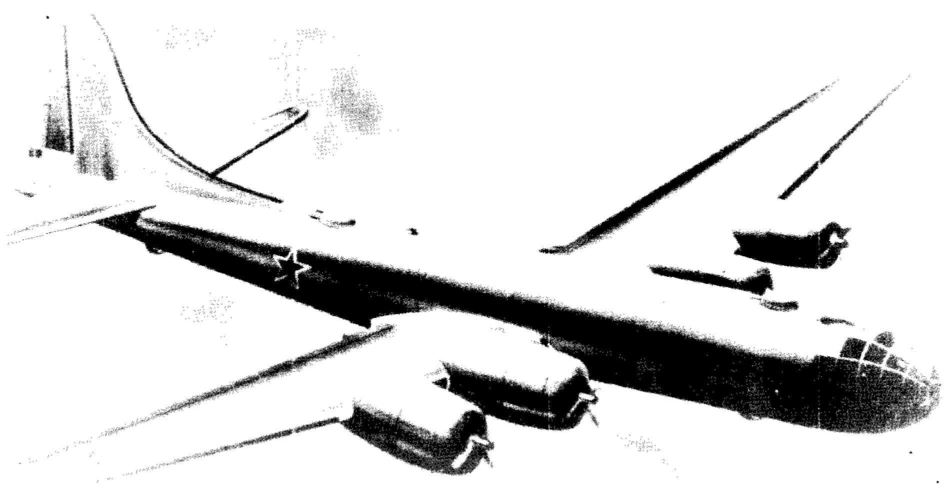

Figure 41. The Bull (Tu-4), a copy of the U.S. Superfortress, is currently used for ice and weather reconnaissance.

An additional insight into the possible extension of GVF routes northward into the Arctic is provided by a Soviet postwar map of regular and irregular civil air routes of Aeroflot.* Most of the routes are located east of the Urals and originate at Headquarters of the Territorial Directorates of the Civil Air Fleet. They follow the courses of the Ob', Yenisey, and Lena Rivers and lead northeastward to the Chukotsk Peninsula. A recent USAF report on Polar Aviation indicates that these routes, along with several others, were transferred from Polar Aviation to the authority of the GUGVF during the reorganization of the GUSMP in 1938 on the grounds that they were "in normal operation." 137/ The north-south lines appear to be feeder routes for scheduled transcontinental services.

The Ob' route begins at Sverdlovsk and follows the Irtysh and Ob' Rivers northward to Salekhard via the principal cities of Tyumen', Tobol'sk, Samarovo, and Berezovo, a total air distance of 1,104 miles (1,777 kilometers). From Salekhard, an irregular route is shown connecting Novyy Port with Tazovskoye (formerly Khal'mer-Sede), an additional air distance of 340 miles (550 kilometers). In 1947, an airline reportedly linked Tazovskoye with Khanty-Mansiysk and Tyumen'. 138/

The Yenisey route extends from Krasnoyarsk northward to Igarka, with irregular service continuing farther north to Dudinka. Stops are made at Strelka, Yeniseysk, Yartsevo, Podkamennaya Tunguska, Verkhne-Imbatskoye, and Turukhansk. The total air distance from Krasnoyarsk to Igarka is 865 miles (1,392 kilometers). The air distance to Dudinka is an additional 133 miles (215 kilometers).

The Aeroflot route along the Lena River and to the Chukotsk Peninsula begins at the GVF headquarters at Yakutsk. The Lena route connects the river settlements of Sangar, Zhigansk, Dzhardzhan, and Bulun and terminates at the Northern Sea Route port of Tiksi, a total air distance of 880 miles (1,415 kilometers). However, for the section between Bulun and Tiksi, a distance of 124 miles (200 kilometers), irregular air service only is shown on the Aeroflot map. The recent construction of a 9,500-foot (2,895-meter) hard-surfaced runway at Tiksi indicates plans for increased air traffic, including landings by multiengine heavy transports. The route to the Chukotsk Peninsula terminates at Uel'kal', a military airfield on the west coast of Zaliv Kresta. In view of the increased transshipment, Aeroflot service probably has been extended to the rayon center of Egvekinot on the northern shore of the bay and perhaps to other points along the coast of the Chukotsk Peninsula. This development is generally associated

*The map, source 136 in Appendix B, also shows air distances between terminal points.

with the increasing activities and airfield construction that have been noted on the peninsula since World War II. In 1947, bimonthly passenger and mail service was inaugurated between Provideniya and Moscow. 139,p.20/ This service, however, may have been a Polar Aviation operation. Along the Yakutsk-Uel'kal' route, an air distance of 1,610 miles (2,591 kilometers), the map shows stops at Oymyakon, Seymchan, Markovo, and Anadyr'. According to the Alaskan Air Command, Ambarchik is also the northern terminus of the Kolyma air route from Magadan. Since Magadan is a major northeast Siberian civil air terminal, it is provided with Aeroflot connections to all major Soviet cities. 140/

The map of Aeroflot airlines also shows a route from Arkhangel'sk to Nar'yan-Mar via Mezen', an air distance of 416 miles (670 kilometers), as well as irregular operations along the Petrozavodsk-Murmansk and the Syktyvkar-Vorkuta air routes.

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 should take over any of its operations that have been 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. Although the USSR claims to have the largest air-freight lift in the world, this is not reflected in published timetables of scheduled routes.

"Special purpose" operations are apparently those designed to support the activities of nonaviation government agencies such as the Ministry of Health, Ministry of Agriculture and Procurement, and Ministry of Geology. Several other Soviet agencies operating in the Arctic region, notably the MVD and MGB, also utilize civil aircraft and at times flight personnel assigned to them by the GUGVF to carry out their specific responsibilities. These organizations have been assigned 50 transport aircraft, of which a substantial number may currently be based in the northern areas of Yakutsk or in the Far Eastern Territorial Directorate of the GVF to service construction and mining projects. These security organizations also conduct coastal patrol flights from Polar Aviation and military airfields and maintain surveillance of ports and military installations. The GUGVF has also provided the Ministry of Geology with 20 transports for use in aerial exploration and geological surveying missions. A sizable number of these aircraft may also be based currently in the Arctic. 141/

4. Military Air Transport

a. Current Status

The recent development of major airfields, combined with improved logistic support by air, water, and rail and the reported development of inflight refueling techniques, has significantly increased Soviet strategic air power in the Arctic region. An estimated 35 airfields and 12 seaplane stations are currently utilized by military aircraft. The most important of these are located on the Kola and Chukotsk Peninsulas, where hard-surfaced runways are suitable for staging long-range turboprop and jet heavy bombers. Operating from these stations, Russia's only truly intercontinental bomber -- the turboprop Bear with a radius/range of 4,250/8,300 nautical miles -- would be capable of reaching virtually any target within the United States* (Figure 42). The Bison jet bomber, with a radius/range of 3,100/6,100 nautical miles, provides additional striking power to the Soviet Long Range Air Force (Figure 43). With one inflight refueling, the basic radius/range of an aircraft could be increased approximately 35 percent. 143/ As of January 1956, the estimated number of bombers in military operational units was 36 Bear and 38 Bison, with the estimated total authorized strength placed at 64 aircraft of each type. 144/ An arc with a 3,100-nautical-mile radius from the Chukotsk Peninsula passes through Chicago, Illinois, and El Paso, Texas (see Map 25347).

Recent runway developments in the Central Arctic, combined with Soviet capabilities in the construction and use of compacted snow-and-ice airstrips, have added appreciably to Russia's military air potential in the polar region. In addition to their role as strategic air bases, many of the airfields already have or could readily assume a defensive role as fighter-interceptor bases. A large number of such readily adaptable facilities are found in the vicinity of Murmansk and Arkhangel'sk, the two key ports and naval bases of the Soviet Arctic.

*All radius/ranges based on optimum conditions under Basic or Cruise Mission III. See source 142, Appendix B.

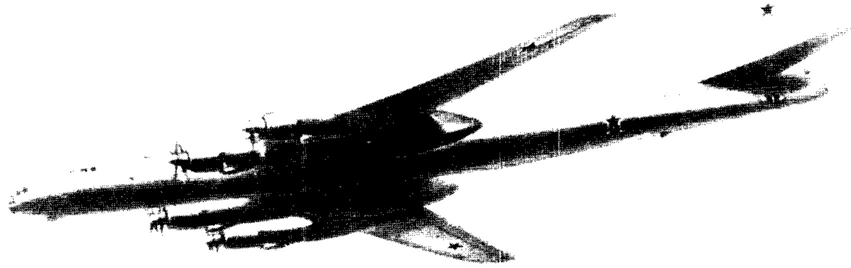

Figure 42. The four-engine turboprop bomber Bear (Tu-34) has a radius/range of 4,250/8,300 nautical miles and is capable of reaching nearly any target in the United States.

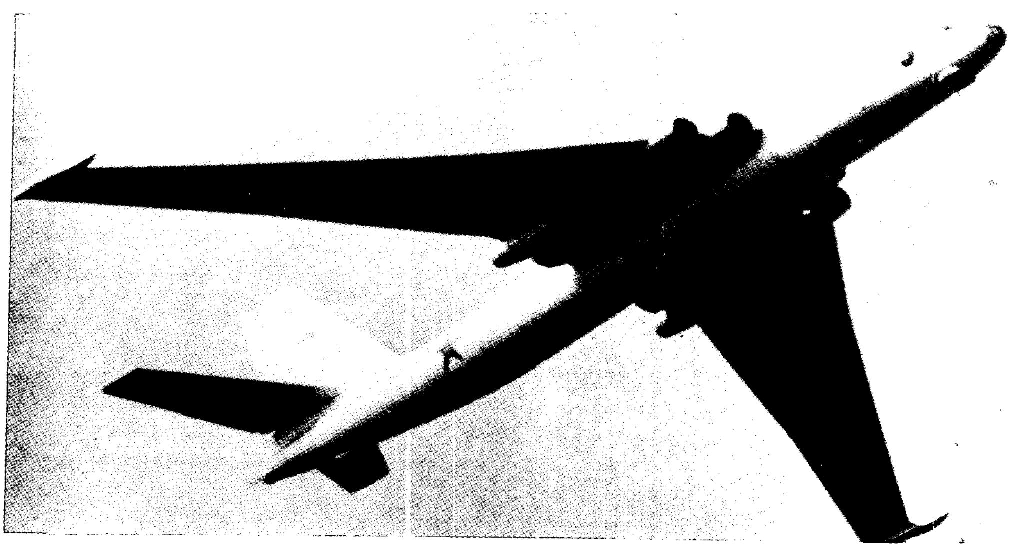

Figure 43. The Bison, a four-engine jet bomber, has a radius/range of 3,100/6,100 nautical miles.

b. Airfields of Major Military Significance

The major airfields on the Kola Peninsula include Severomorsk and Pechenga and a number of others within the Murmansk Complex -- Murmansk, Murmansk/Northeast, Murmansk/Kola, Kulp-Yavr, and Kildin -- that have recently become significant as bases for jet fighter aircraft operations. On the basis of the estimated lengths of the runways, most of these airfields are currently capable of staging medium and possibly heavy bombers and have the advantage of year-round logistic support by water, rail, and road. Extensive underground storage facilities have been constructed throughout the area. The Severomorsk airfield, which measures an estimated 7,000 by 260 feet (2,130 by 80 meters) is the most important military airbase in the European Arctic. It is approximately 7 miles (11 kilometers) northeast of Murmansk and is used by both the Soviet Air Force and Soviet Naval Air Force.* It is also an important fighter and bomber training base that has been used by Beagle and Bull aircraft. The concrete runway has been enlarged and hard-surfaced since the war; and new hangars, barracks, and other facilities have probably been constructed. 145/

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 (2,010 by 60 meters and 1,980 by 114 meters). The longer runway is supplied through the ice-free port of Linakhamari (19 miles north-northeast at the mouth of the Guba Pechenga), by an improved dirt road from Pechenga to Murmansk, and by a railroad line that was completed in 1955. Up to 30 Fagot fighter aircraft have been based at the airfield. Both runways could be extended an additional 6,000 and 5,000 feet (1,830 and 1,525 meters), thus making Pechenga a potential base for heavy bombers. 146/

Other sizable airfields of the European Arctic include Ioganka, Belush'ya Guba on Novaya Zemlya, and Amderma, all of which are believed to have undergone considerable expansion since 1950. Amderma, the largest and most active of these airfields, has an estimated minimum runway length of 8,200 feet (2,500 meters). The use of the field by Bull aircraft in 1955 seems to substantiate this estimate. 147/ In addition to probable use by ice-reconnaissance aircraft, Amderma serves as an important civil air route stop and air supply point for Novaya Zemlya and Zemlya Frantsa-Iosifa. Although no military planes are known to operate from Amderma, the military as well as economic significance of the airfield has been greatly enhanced by its recent expansion and by a railroad line currently under construction from Vorkuta northward to Amderma.

*Although the Bear and Bison require 9,000- and 8,200-foot runways, respectively, with a 50-foot clearance they are capable of taking off on 6,000- and 5,300-foot runways at sea level.

Airfield development has also been extremely active in the Far East. On the Chukotsk Peninsula, an 8,000- by 500-foot (2,440- by 152-meter) hard-surfaced runway capable of supporting medium and heavy bombers was completed at Provideniya/Urelik during 1954 [redacted] 25X1
X1 [redacted] This is the 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 taxi 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 (petrol, oil, and lubricants) 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. Radar trackings show that air activity in the Chukotsk area has increased greatly since 1953. During the first 6 months of 1955, radar trackings were more than double the number for the same period in 1954. 150/ The increase in air activity is believed to have followed the introduction of the Falcon aircraft, which currently operate from the Provideniya/Urelik and probably from the Lavrentiya airfields. In 1954 the stockpile of fuel supplies appeared to be adequate to service intensified air activity from February through May. 151/ An increase in night trackings also indicates that both of these airfields are probably equipped with lights. Since the Lavrentiya runway is used by jet fighter aircraft, it is estimated to be at least 6,000 feet (1,830 meters) long.

In view of runway construction taking place elsewhere on the Chukotsk Peninsula, the runway at Uel'kal' airfield along the west shore of Zaliv Kresta has probably been lengthened to 8,000 feet (2,440 meters). 152/ Although this development has not been confirmed, Uel'kal' is known to be fairly well equipped with ancillary facilities, including navigational aids, fixed installations (hangars, quarters, etc.) and maintenance facilities. During World War II, 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 3-1/2 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 supporting medium- and heavy-bomber operations, with a consequent increase in its military potential. In 1955, a 9,000-foot (2,740-meter) runway was under construction. This permanent runway is paralleled by a

25X1

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northwest-southeast strip made of ice and compacted snow approximately 8,500 feet (2,590 meters) long, which has been used by Bull aircraft for reconnaissance patrols.

In the Soviet north the longest known hard-surfaced runway, 9,500 by 500 feet (2,895 by 152 meters), has recently been completed at Tiksi. 153,154/ It is one of the few Arctic airfields currently capable of supporting any type of Soviet aircraft. The runway is equipped with hard-surfaced taxiways that connect it with a large parallel parking ramp that has a hard surface. Although Tiksi has no hangars or workshops, large warehouse facilities and barracks have been noted near the field. POL is stored in drums on the field and in a nearby storage area consisting of four above-ground tanks. A parabolic radar antenna is located on top of the control tower adjacent to the parking ramp. Logistic support is probably provided by the port facilities at Tiksi, which is an active river-ocean transshipment point and major supply base for the region. Although the Tiksi airfield is several hundred miles farther from key United States target areas than either Provideniya/Urelik or Severomorsk, it serves as a potential forward staging area. The significance of Tiksi in offensive air operations could be greatly improved by in-flight refueling over the Polar Basin or one-way missions.

c. Airfields of Secondary Military Significance

In addition to the airfields suitable for staging long-range bomber operations, the Soviet Arctic has a network of temporary and natural-surfaced runways that currently serve as bases for fighters, transports, and various types of reconnaissance aircraft. In event of hostilities, many of these military airstrips, as well as numerous civil airfields, could easily be improved to support staging operations of heavy transports, medium and heavy bombers, and jet fighter aircraft.

With the current improvement of air facilities along the Arctic littoral, many of the present runways have probably undergone expansion. The civil airfields of Dikson, Khatanga, and Kosisty, which have permanent runways estimated at 6,000 feet (1,830 meters) each, and the recently hard-surfaced 5,500-foot (1,675-meter) runway at Nizhniye Kresty* could readily be used for military purposes. Although the airfields in the Chukotsk area are vulnerable to attack, Uel'kal', Provideniya/Urelik, Lavrentiya, and Chaplino could be used for staging airborne attacks on Alaska, as well as serving a defensive role
X1 [redacted] On the basis of AAC intelligence estimates, the

*A nearby 6,000- by 400-foot clearing appears to be a second airstrip in the early stages of development. 155/

Providenia/Urelik, Lavrentiya,* and Chaplino airfields could support a total of 32 jet light bombers, 74 jet fighters, and 150 transports. 156/ Several ice strips 7,000 and 4,500 feet (2,130 and 1,370 meters) in length were noted on recent aerial photographs of Ostrov Vrangelya; these also could support seasonal air operations. 25X1

[redacted]

Drifting ice islands and floes provide other potential sites for advanced airstrips, refueling bases, and direction-finding equipment. Having the advantage of remote locations, 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.

Although infrequent reports of low reliability refer to numerous strategic air and guided-missile bases at a number of selected sites throughout the Soviet Arctic, no intelligence available substantiates the existence of developments other than those already noted.

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*Based on 5,000-foot and 3,500-foot runways at Provideniya/ Urelik and Lavrentiya, respectively, that have subsequently been extended to 8,000 feet and 6,000 feet.

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5. Facilities Available for Air Transport

a. Airfields

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. The majority of these installations, most of which are east of the Urals, have been collocated with polar stations and are relatively accessible to supply by river and Northern Sea Route vessels. Many of these coastal airfields are on barrier bars or spits consisting of sand and gravel. A number of these spits enclose lagoons that serve as seaplane landing areas in summer and as ice strips in winter. During the winter the rivers and numerous lakes of the Arctic region also provide suitable ice strips for ski- or wheel-equipped aircraft.

Among the network of approximately 67 Arctic airfields, 33 are located in the European Arctic and 34 east of the Urals. Of these, 21 are equipped with permanent hard-surfaced runways; 13 have temporary runways of pierced steel, wood, or graded earth; and 33 are classed as natural-surfaced runways. In addition to these airfields, 37 other airstrips either of unknown status or under 2,000 feet (610 meters) in length are located within the Soviet Arctic. The vast majority of these are located east of the Urals (see Map 25349). Through proper drainage and the insulation of the permafrost layer, many areas within the frozen tundra could be converted into temporary or natural-surfaced runways. Recent experiments in Alaska have proved that it is feasible to build quickly and inexpensively landing areas of compacted snow capable of supporting gross weights in excess of 148,000 pounds. 157/

Although information regarding runways, parking, and ancillary facilities is inadequate for many areas of the Soviet Arctic, over 50 percent 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 are either permanent or temporary runways that are operational the year round. The only permanent runway less than 5,000 feet (1,525 meters) in length is at Dudinka. The majority of the natural-surfaced airstrips range in length from 3,000 to 4,000 feet and are generally operational only seasonally.

The airfields are supported by various navigational aids, POL storage, maintenance facilities, and miscellaneous buildings used as hangars, shops, and billets. The most common type of navigational aid is air-to-ground radio (voice), although a number of airfields are equipped with station-to-station (code) facilities. Most of the airfields have been collocated with polar weather stations that provide

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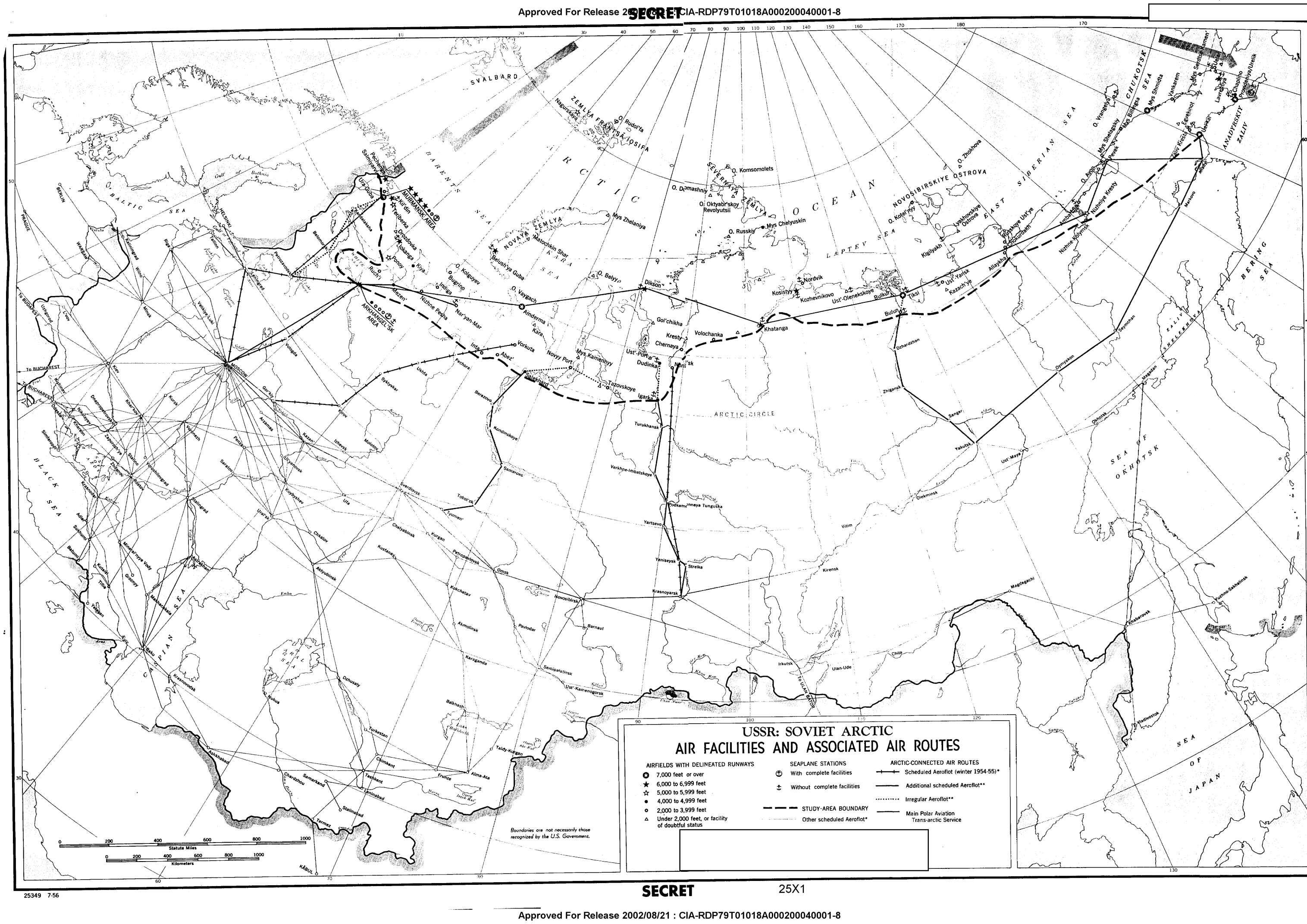
25X1


USSR: SOVIET ARCTIC
AIR FACILITIES AND ASSOCIATED AIR ROUTES
AIRFIELDS WITH DELINEATED RUNWAYS
7,000 feet or over
6,000 to 6,999 feet
5,000 to 5,999 feet
4,000 to 4,999 feet
2,000 to 3,999 feet
Under 2,000 feet, or facility of doubtful status
SEAPLANE STATIONS
With complete facilities
Without complete facilities
STUDY-AREA BOUNDARY
Other scheduled Aeroflot*
ARCTIC-CONNECTED AIR ROUTES
Scheduled Aeroflot (winter 1954-55)*
Additional scheduled Aeroflot**
Irregular Aeroflot**
Main Polar Aviation Trans-arctic Service
Boundaries are not necessarily those recognized by the U.S. Government.
ARCTIC OCEAN
BARENTS SEA
KARA SEA
LAPTEV SEA
EAST SIBERIAN SEA
CHUKOTSK SEA
BERING SEA
SEA OF OKHOTSK
SEA OF JAPAN
BLACK SEA
CASPIAN SEA
BALTIC SEA
ARCTIC CIRCLE
SVALBARD
ZEMLYA FRANTSA IOSIFA
NOVAYA ZEMLYA
SEVERNAYA ZEMLYA
NOVOSIBIRSKIYE OSTROVA
MURMANSK AREA
ARKHANGEL'SK AREA
MOSCOW
Statute Miles
Kilometers
25349 7-56

25X1

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). 158/ Airfields in Class 1 or Class 2 categories of the Arctic 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.

Bulk POL 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 organizational maintenance. Hangars, barracks, and various other facilities such as workshops, storage, and administrative buildings are generally found only at the military airfields of 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 lubrication and maintenance problems. Most of the Class 1 and Class 2 airfields and a number of other military and civil installations that support special operations are probably equipped with some type of lighting to facilitate night operations. Lighting facilities include either runway, boundary, and obstruction, lights or searchlights. Little information, however, is available concerning lighting, and it is doubtful whether night flying has been developed to any great extent as yet.

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. The majority of these stations (20) 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. The use of seaplanes, however, is limited to summer, when most coastal areas are relatively free of floating ice. Offshore rocks and small islands (such as those at Tiksi), nearby cliffs or hills, and the frequency of coastal fogs during the summer are major obstacles to seaplane operations.

The seven 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

*Nar'yan-Mar is the only known seaplane station in the European Arctic that is used for civil operations.

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 refueling services. Strategic location and the 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 (5,750,000 square kilometers). 159/

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 icebreaker fleet, and developed staging, dispatching, and controlling procedures for shipping. GUSMP maintains its own research installations and educational organizations, including the Arctic Scientific Research Institute and the Hydrographic Institute.

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. This method was arduous and little freight could be sent in one season.

Lumber, which probably comprises the largest part of material exported 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.

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. The cost of icebreaker assistance and other services along the route eliminates any saving in cost over land routes. The sea route carries more than 2 million tons of freight during the 2-1/2 month navigation season. 160/ The Trans-Siberian Railroad, on the other hand, moves an equal amount of freight in only 30 days and operates the year round.

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 in 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. 161/ 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. 162/

Since the Soviet Union was at war with Japan for only a few days during World War II the Northern Sea Route was never put to the test of moving large amounts of supplies to the Far East. The route is used for military purposes, however, and at least 55 vessels -- including cruisers, destroyers, and submarines -- were moved to the Far East in late August and early September 1955. 163/ Two divisions of Chinese troops are reported to have crossed the route aboard

Russian destroyers and participated in Soviet autumn maneuvers in the Pechenga region of the Kola Peninsula. 164/ During a war the movement of troops by this method would probably not be practical except in an emergency, since the Trans-Siberian Railroad could transport them across the country from Moscow to Vladivostok in approximately one-half the time (9.2 days). 165/

The military use of the route is limited by the short navigation season. During the greater part of the year, no naval ships except submarines could traverse the route. A submarine equipped with a device that could be extended through the ice from time to time to replenish its air could navigate submerged over the entire route.

Another limitation to the route is its exposure at Bering Strait. Ships traversing the strait enroute to Anadyr', Magadan, and Vladivostok would be subject to attack from Alaskan airbases. As an alternative to transport over this section of the route, cargo could be transferred to river vessels and shipped up the Kolyma River to Seymchan and then sent by truck to Magadan. Elsewhere along the route, vessels are immune to attack by all foreign naval ships except submarines. Convoys keep within sight of the mainland for the majority of the route and would also be under the protection of shore batteries.

d. Physical Aspects of the Route

The Northern Sea Route extends from Murmansk to Provideniya, a total of 4,600 miles (7,400 kilometers). At its eastern end, extensions lead to Anadyr', Magadan, Petropavlovsk-Kamchatskiy, and Vladivostok. The majority 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 Matochkin Shar, Proliv Karskiye Vorota, and Proliv Yugorskiy Shar. The last two straits are most commonly used. The route then passes through Proliv Vil'kitskogo, Proliv Lapteva or Proliv Sannikova, and Proliv Longa. (See Map 25348.)

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 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. The Northern Variant has not been mentioned in recent years and the status of this route is unknown. 166/

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. 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. Statistics for 1940 indicate that 23 percent of the total time lost in voyage was due to ice conditions. 167/

Ice is the principal hindrance to shipping along the route and governs the length of the navigation season. Annual variations in the position of the ice determine the dates for the opening and closing of navigation, but in general the season lasts 2-1/2 months, from about mid-July to the end of September. 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 to its minimum size, 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. 168/

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. 169/ There are records of ships sailing from Murmansk to Dikson without sighting land. 170,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 (6 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 Velyy 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 channel dredged to the port 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 (6.5 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.

Through the turn-around method, travel time for a ship is reduced, although time spent transshipping cargo is often increased. 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. 171/

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. 172/

Sailing time required to cross the route 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. 173/ 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 18-1/2 days. 174/ In 1955 the diesel-electric freighter Lena sailed from Arkhangel'sk to Nagayevo in 27 days. 175/ 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. For this reason few ships make the complete passage, and only vessels being reassigned or carrying special cargo travel the whole length. The advantage of the turn-around system lies not only in reduced travel time but in 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. If assistance is required, icebreakers are sent from Dikson or Novaya Zemlya. East of Dikson, ice conditions and shoal areas make navigation hazardous and ships usually travel in convoys.

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 3 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. 176/

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, 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 research. The latter charts tides, currents, and depths and establishes navigation aids

X1 [redacted]

Ice reconnaissance, the most important support function, is carried on by several methods. Data are collected by drifting stations, flying observatories, and mobile research teams. These groups devote only a small portion of their time to the collection of ice data, and the information is not so detailed as that performed by aerial-reconnaissance planes. The latter account for the majority of the information that is collected and the ice charts, and resulting reports give a detailed picture of current ice conditions. Aircraft used for these surveys are under the direction of Polar Aviation.

Reconnaissance flights take place throughout the year, and their total flight distance exceeds 310,000 miles (500,000 kilometers). The flights are grouped into four seasonal types -- winter, prenavigation (spring), navigation (summer), and fall -- and occur during the following periods:

Season	Beginning	Ending	Average Duration
Winter	Feb 20-28	May 5-15	2.5 months
Prenavigation	Jun 10-20	Jul 10-20	1.0 months
Navigation	Jul 10-20	Oct 1-10	2.5-3.0 months
Fall	Oct 1-10	Nov 1-10	1.0 month

During the winter, flights are of a strategic nature, and the data collected are used for long-range planning. During the flights the edges of the pack and fast ice are mapped, and the amount of hummocking and the condition of the ice masses are noted. By analyzing and mapping these data, long-range forecasts are made for the coming navigation season. The Soviets claimed that the forecasts were 75 percent correct in 1940.

The aircraft follow predetermined flight patterns, which extend to high latitudes including the central regions of the Polar Basin.

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Although only 2 or 3 flights are made during the winter because of the brief periods of daylight, their total length exceeds 18,600 miles (30,000 kilometers). No reconnaissance is flown in December and January since most of the region is in total darkness at this time.

When the ice begins to break up in the prenavigation season the number of reconnaissance flights are increased. Since some sections of the route become clear of ice before others, reconnaissance at this time determines routes for the first convoys of the navigation season.

The number of flights increases further during the navigation season. Depending on flying conditions, they may be made every 5 to 10 days or whenever a convoy requires assistance. The greatest number of flights are made in Proliv Vil'kitskogo and north of Ostrov Ayon, since the ice hazard is greatest in these areas. Most observations are visual, but radar can be used to locate edges of the pack ice during periods of poor visibility. Aerial photography was first used to plot ice condition in 1945.

Ice charts are compiled during the reconnaissance. Standardized symbols are used, and colors indicate the amount 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 in the mapped sector. All shipmasters beginning a voyage or enroute use the information to guide their ships. If a ship or convoy is in distress or when winds and currents cause rapid changes in ice conditions, the reconnaissance aircraft assist them by dropping large-scale charts to the vessels. After an aircraft has returned to its base, a report is written describing the ice chart which was compiled during the flight. Copies of the charts and reports are sent to the Ice Service Office of the Arctic Scientific Research Institute to be consolidated and published in the Ice Annals.

Fall reconnaissance begins at the close of the navigation season. Two or three flights are made at this time to determine where coastal waters have become blocked with ice. The distribution of old and new ice is mapped in an effort to prolong the navigation season. Planes are occasionally used in this season to guide tardy vessels through the rapidly closing channels.

Drifting radio beacons also are used in plotting ice drift. The beacons are established at various places on the pack ice, and their battery-powered signals enable shore-based stations to determine by triangulation each beacon's position. Their successive positions are plotted, and the total picture of ice movement can be studied.

A new type of beacon now being used also transmits weather data. Daily broadcasts made by each beacon include air temperature, atmospheric pressure, and wind speed and direction. If the beacon receives a special signal from a coastal station or passing aircraft, it will transmit the weather information in its vicinity as of that particular moment. 178/

g. Types of Ships

Most vessels sailing the Arctic seas are freighters and icebreakers. A small number of tankers and passenger ships also follow the Northern Sea Route, but river barges, lighters, and tugs venture onto it only in the vicinity of river estuaries. The route is occasionally used by river vessels sailing from European shipyards (East Germany, Czechoslovakia, and Finland) to West Siberian rivers. 179/

A total of 47 freighters was reported on the route in 1954. 180/ Although shoals limit the size of the vessels, they average 1,500 to 2,000 displacement tons and 22 to 26 feet (7 to 8 meters) draught. Lend-lease Liberty ships, which still sail the route, are much larger. Since they average 10,000 tons and have a draught of 28 feet (8.5 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, unusually powerful engines, a special rudder, and changeable propeller blades. Three of the newest freighters on the Northern Sea Route, the sister ships Ob', Yenisey, and Lena, belong to this class (Figure 47). They are powered by diesel-electric engines which, for a given weight of fuel, will carry them three times as far as coal-fired steam engines.

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 in the world because most of her ports are ice-bound during the winter. The majority of the icebreakers are stationed in the Arctic. About 20 of them are seagoing vessels, and an equal number are river icebreaking tugs. In 1955, a total of 8 icebreakers was assigned to the Northern Sea

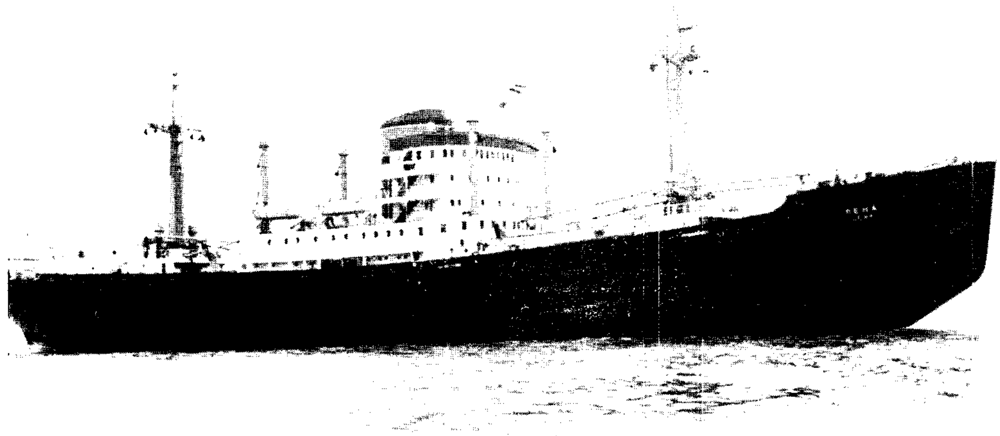

Figure 47. The diesel-electric freighter Lena. The sharply undercut bow is similar to that of an icebreaker and enables the ship to navigate in heavy ice.

Route, but only 4 were in actual operation. 181/ According to a recent trade agreement, Finland will build 2 super-powered icebreakers for the USSR between 1958 and 1960. These will resemble the 3 icebreakers of the Kapitan Belousov class built for the Soviet Union in 1954. 182/

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, Kaganovich, Molotov, and Yermak (Figures 48 and 49). The capital icebreakers are employed in leading convoys and clearing lanes through the ice. They carry surplus fuel and food supplies for marooned vessels and workshops for minor repairs. The Stalin and Molotov have diesel-electric engines and develop up to 20,000 horsepower. The other icebreakers burn coal, have a limited range, and require frequent refueling. The Russians have recently announced plans for an atom-powered icebreaker with a capacity of 44,000 horsepower. Such a ship would be able to travel 10 to 12 times as far as conventionally powered icebreakers without refueling. The space normally used for coal or fuel-oil storage could hold cargo. 183/

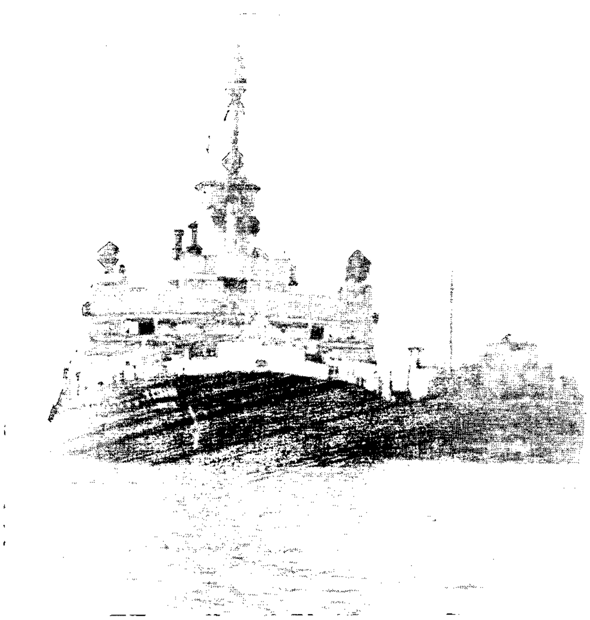

Figure 48. The icebreaker Iosif Stalin loading supplies at Ostrov Dikson.

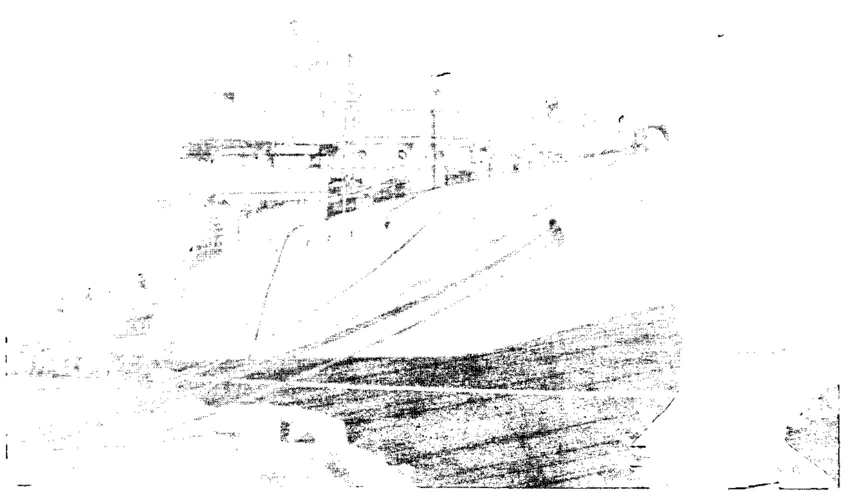

Figure 49. The icebreaker Yermak. The ship was built in 1898 and is the oldest large icebreaker in the Soviet fleet.

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.

Capital and auxiliary icebreakers operate from summer stations scattered along the Northern Sea Route. These stations are located at Belush'ya Guba in Novaya Zemlya, Dikson, Mys Chelyuskin, Novosibirskiye Ostrova, Ostrov Vrangelya, and Provideniya. 184/ The route is divided into sectors whose end points are Ostrov Dikson, Lena River, and Kolyma River, and the icebreakers operate within these sectors. An icebreaker escorts vessels through its specific sector. On reaching the terminus of a sector, a convoy takes on a new icebreaker. The relieved icebreaker than waits to pick up a new convoy for its return trip. Foreign ships requiring assistance must pay for this service.

h. Availability of Fuel

The availability of fuel is a critical factor for ships sailing the Northern Sea Route. Before the formation of GUSMP the vessels had to carry sufficient fuel for the entire journey and cargo space was severely restricted. Now bunkering stations are more numerous, and ships can carry greater pay loads.

Coal is the principal type of fuel used on the route. The main fueling points are located at Murmansk, Arkhangel'sk, Dikson, Tiksi, Ambarchik, and Provideniya. 185/ No coal is available locally, and all fuel supplies must be brought in from the south. Murmansk and Arkhangel'sk obtain coal from Vorkuta. Prior to World War II, Spitzbergen supplied their coal, but during the war the vulnerable nature of this supply line was recognized and the Vorkuta fields were developed.

Dikson is the bunkering station for the Kara Sea and 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.

Ambarchik is the coaling station for the East Siberian Sea. Its coal is mined at Zyryanka on the Kolyma River, 350 miles (560 kilometers) from Ambarchik.

Provideniya services ships in the eastern part of the route. Coal was formerly imported from Vladivostok. With the development of the deposits at Bukhta Ugol'naya, 150 miles (240 kilometers) south of Anadyr', a more convenient source was established.

Oil is used as a fuel in only about one-third of the ships on the route. Only the most recently constructed freighters and icebreakers and lend-lease Liberty ships use this type of fuel. Bunkering oil is available at Dikson, Tiksi, Ambarchik, and Pevek, as well as at the terminal ports of Murmansk, Arkhangel'sk, and Provideniya. Oil is not produced locally in the Arctic, and supplies for these ports are delivered by river barges and tankers and by ocean tankers (Figure 50). A number of tankers with reinforced hulls are

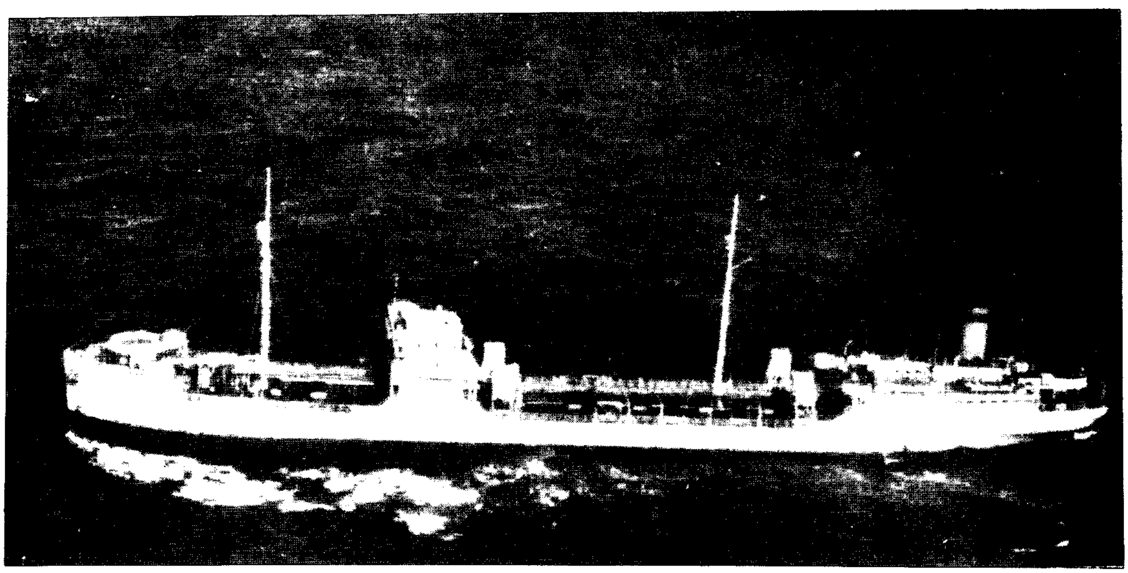

Figure 50. The oil tanker Azerbaydzhan (6,000 GRT) in the Arctic.

being built for the Soviet Union by Finland and will probably be put into service on the Northern Sea Route. 186/

i. Ports Along the Route 187/

When the 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, Tiksi, Ambarchik, and Provideniya.

Arkhangel'sk, with its suburbs of Solombala, Ekonomiya, and Bakaritsa, is the largest port on the Northern Sea Route. Its principal export is lumber, and its imports include hardware goods and general supplies. It has 35 wharves that have a combined length of 49,000 feet (15,000 meters) and provide berthing space for 150 ships. The numerous cranes and conveyors in the harbor can handle 28,000 to 30,000 tons of cargo per day. Storage facilities include 48 warehouses and 1 refrigeration plant. Oil and coal storage capacity amounts to 22,000 barrels and 70,000 tons, respectively.

Murmansk is the second largest port and exports ores, fish, and lumber products. Imports include grain, petroleum products, and coal. The commercial wharves total 16,000 feet (4,875 meters) in length and can accommodate 64 ships. The naval wharves provide 1,200 feet (365 meters) of berthing space and accommodations for miscellaneous naval craft. Storage is available for 270,000 barrels of oil and 50,000 tons of coal.

East of Arkhangel'sk and Murmansk the size and facilities of the ports decrease markedly. These ports have been developed by GUSMP in the last two decades, and many are still inadequately equipped for handling the large amounts of shipping that arrive and depart during the short navigation season. Further development would probably be economically unfeasible since the ports are active for only a short period during the year.

Dikson has developed into the principal fueling base for the western section of the Northern Sea Route and an important transshipment point for Yenisey River traffic. Deep-draught ocean vessels can anchor at Ostrov Konus, a small island between Ostrov Dikson and the mainland. A 30-foot (9-meter) dredged channel leads to the wharves, which provide 1,830 feet (557 meters) of berthing space. Additional ships can anchor at the inner roadstead between Ostrov Dikson and the mainland. The port area covers 3 square miles (7.8 square kilometers) of water, which averages 15 to 33 feet (4.5 to 10 meters) in depth and provides fair shelter. Shallow-draught lighters, fishing boats, and other small craft have docking facilities adjacent to the settlement of Dikson. Four traveling cranes and four conveyors assist ships in unloading their cargoes. In 1946, over 1,000,000 tons cleared the port.

Tiksi was developed to serve as a transshipment point for Lena River traffic, a coaling station for the central part of the route, and a turn-around point for ships arriving from both ends of the route. A mole extending into the bay provides docking facilities for shallow-draught river vessels, which must traverse several miles of open sea to reach the port. Berthing space for ocean vessels is sufficient to allow 4 ships to dock simultaneously. Additional ships can anchor 5 miles offshore in Bukhta Tiksi. Lighters and barges are used to transfer the cargoes to the port (Figure 51).

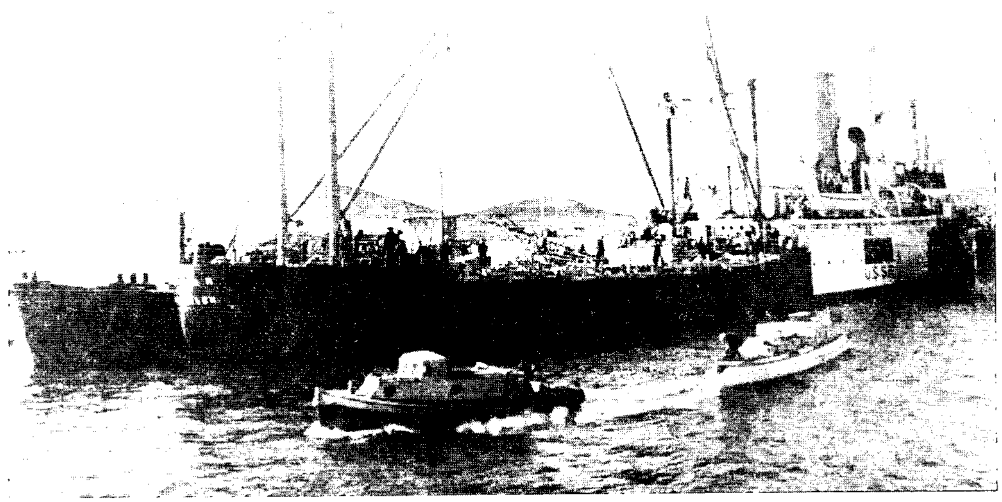

Figure 51. Lighters in the harbor at Tiksi carrying cargo from freighters to the dock.

Ambarchik, located east of the main channel of the Kolyma River, has developed as a transshipment point for river traffic and a coaling station for ships in the East Siberian Sea. Minerals from the upper Kolyma River and supplies for these mining areas make up the greatest part of the cargo handled. As a port, Ambarchik has serious drawbacks, but no alternative site is available. The wharves have an alongside depth of only 10 feet (3 meters). Consequently, all ocean vessels must anchor in the bay and lighter their cargoes to shore. Most cargo must be unloaded by the ship's own gear, thus increasing the turn-around 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).

Provideniya is the focal point for shipping at the eastern end of the Northern Sea Route. It is a refueling station, staging area for convoys, and distribution point for supplies destined for smaller ports along the coast. 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, and a mud bottom provides excellent free-swinging anchorage. 188/ The port has a total of 750 feet (230 meters) of berthing space, and 15 ships can be accommodated in the harbor area. A large coal dump and oil storage area is located at the port. Oil tanks are also located along both shores of Bukhta Emma.

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 Waterway 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 precedes 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. 189/ Ice on the Lena River at Bulun attains a thickness of 8 feet (2.4 meters) and many channels of the delta freeze to the bottom. 190/ Widespread floods occur from mid-May to early June, when swollen waters from the

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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 (21 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. 191/

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 through September and is relieved by autumn rains. These showers cause a small, secondary high-water period and normal navigation is again possible until the winter freeze-up begins.

The administration and operation of the rivers is directed by the Ministry of Inland Waterways of the RSFSR. Vessels sailing on the rivers are formed into shipping lines and are subordinate to the Ministry. Traffic on certain rivers such as the Aldan, Anabar, Anadyr', Indigirka, Khatanga, Kolyma, and the Lena north of Yakutsk is under the control of the Chief Directorate of the Northern Sea Route. Several organizations -- including the Ministries of Nonferrous Metal, Fur, Timber, and Agriculture and various individual industrial enterprises -- also operate their own vessels. Traffic on minor rivers is controlled by Chief Directorates for Transport Development of Small Rivers, which is responsible to the council of ministers of the various republics, krays, and oblasts. 192/

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 large rafts are floated downstream to mills on the Severnaya Dvina (Arkhangel'sk), Pechora (Nar'yan-Mar), and Yenisey (Igarka). Timber is also shipped on other rivers but the amounts are relatively small. The Yenisey carries the greatest amount of timber, and it comprises 65-70 percent of the total freight of the river (Figure 52).

Timber rafts reach large proportions, depending on the width, depth, and speed of the rivers. Rafts on the Yenisey carry 1 to 1.4 million cubic feet (30 to 40 thousand cubic meters) of logs. The rafts are launched in the upper reaches of the rivers during the

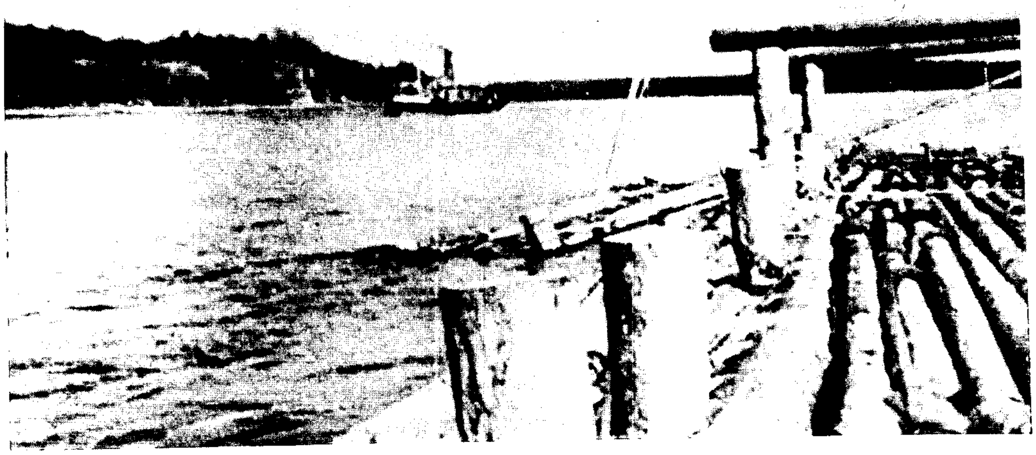

Figure 52. Timber raft on the Yenisey River en route to Igarka.

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 the Trans-Siberian Railroad to the rivers and are then 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. 193/ 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 carry from 300 to 800 tons, but 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 used are driven from the stern or side by paddle wheels and 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. In 1954, seed grain and agricultural machinery were shipped upstream on the Ob' River to the New Lands areas. Foodstuffs from the southern agricultural areas are carried downstream in large quantities. Hardy vegetables such as potatoes, cabbages, cucumbers, and onions are shipped in lighters, while more perishable vegetables are sent in refrigerated ships. These ships carry frozen fresh fish upstream on their return voyages.

Passengers make up a small part of the traffic on the rivers. Passage can be obtained on barges and packet vessels (Figure 53). 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 54). 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 are reported to contain restaurants, reading and music rooms, and cabins with showers, telephones, and radios. 194/

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. Latest available information on the Ob' River (1950) indicates 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 to Novosibirsk. 195,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. 196/ An express line operated between Dudinka and Krasnoyarsk in 1950, and both upstream and downstream trips were made in 6-1/2 days. 197/

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

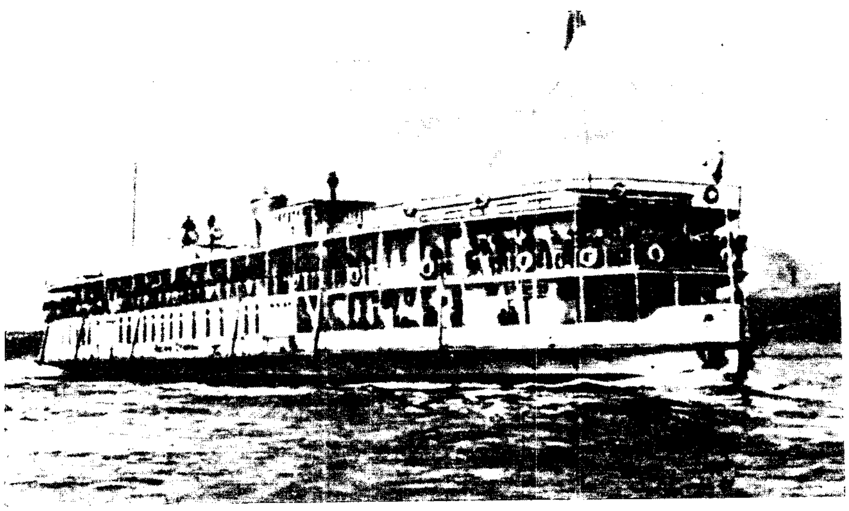

Figure 53. The packet vessel Iosif Stalin of the Krasnoyarsk-Dudinka line.

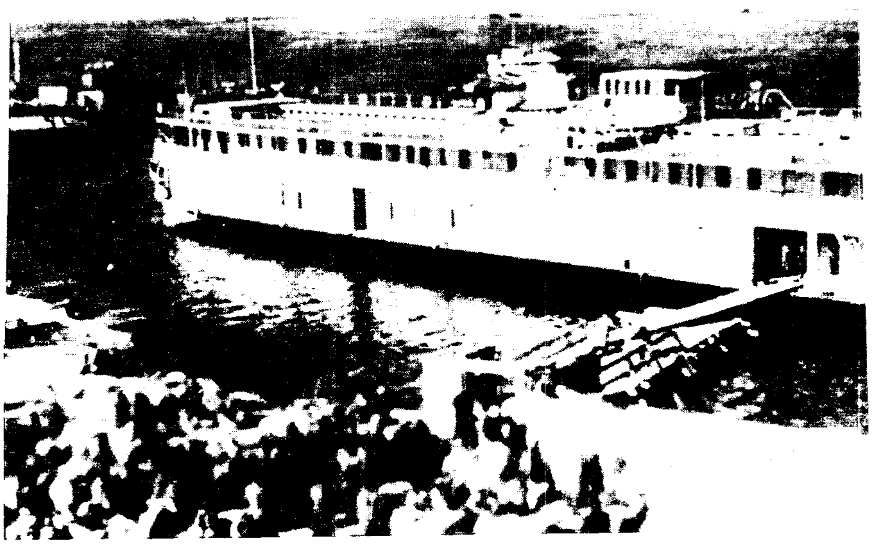

Figure 54. The Ordzhonikidze taking on passengers at Dudinka.

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SOVIET ARCTIC

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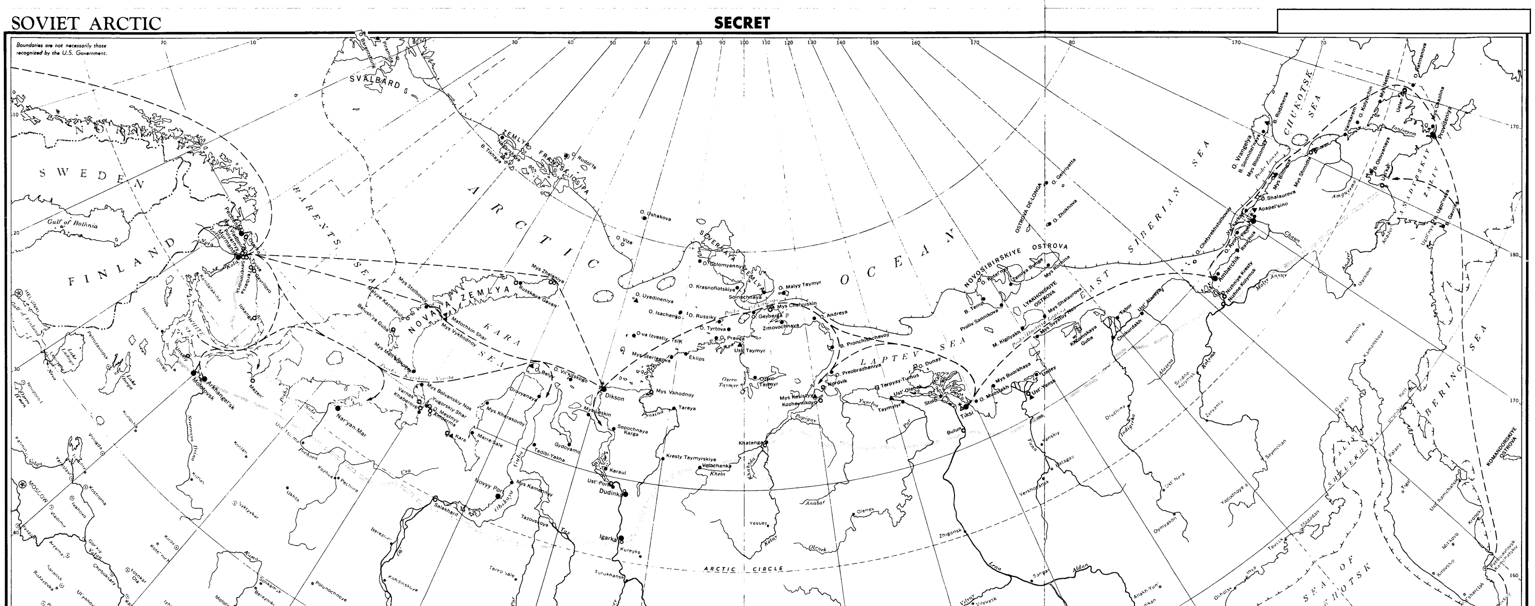

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NORTHERN SEA ROUTE

(Including Ports and Polar Stations)

AVERAGE EXTENT OF UNNAVIGABLE SEA ICE

Summer (August and September—months of maximum withdrawal)

Winter (February and March—months of maximum extent)

● Arctic ports of major importance

○ Other anchorages and landings

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

Kilometers: 0, 200, 400, 600, 800

— — — NORTHERN SEA ROUTE

STUDY AREA BOUNDARY

POLAR STATIONS*

- Hydrological and meteorological observations
- Radiosonde observations
- Pilot balloon observations
- Magnetic observations
- Observatory
- Manned only during navigation season

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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. 198/

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 on the industrial and maritime centers of Murmansk and Arkhangel'sk, and on the recently developed mining center of Vorkuta. In the West Siberian Arctic, railroad construction is more recent and is closely linked with the rise of Salekhard, Igarka, and Dudinka as important river ports and of Noril'sk as a major industrial complex. (See Map 25352.)

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, and 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 Rybprom (Glavryb) and Rosta (Sevmorput) 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. 199/ 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 military airfield.

Two important branch lines join the Leningrad-Murmansk trunkline at Kola, 7 miles (11 kilometers) south of Murmansk proper. One leads southwestward along the Tuloma River to Murmashi and serves as the main supply route to an important military airfield. The second line is of more recent construction and provides direct access to Pechenga, its port at Linakhamari, and the nearby nickel deposits (Figure 55).

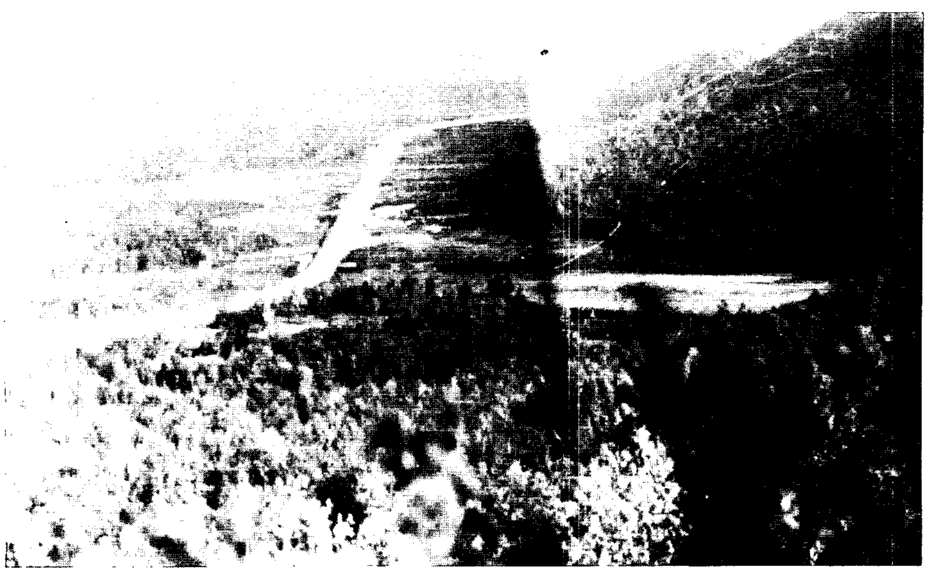


Figure 55. A distant view of the Murmansk-Pechenga railroad at a point east of the Pechenga River.

Construction of the 130-mile (210-kilometer) Murmansk-Pechenga line began in 1950 and was completed sometime in 1955. The alignment of this new railroad is not known in detail. After crossing the Tuloma River at Kola, it turns northward and follows the left bank of Kol'skiy Zaliv to Polyarnyy. From there the route continues in a north-northwest direction, eventually touching the heads of Guba Ura and Guba Zapadnaya Litsa. The line then leads to the Titovka River and continues to Luostari on the Pechenga River, the site of the Pechenga military airfield. 200/ From Luostari the railroad runs northward to Pechenga and possibly terminates some 8 miles (13 kilometers) north of the town proper at its port at Linakhamari, which is open to maritime shipping all year round. 201/

The line is steam operated and single tracked, but several short sidings provide passing stops for two-way traffic. 202/ 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 (1.6 kilometers) south of Pechenga proper. A bridge across the river was completed by 1955, and rails had been laid. A siding from the Pechenga station to Nikel', some 25 miles (40 kilometers) to the southwest, was also under construction at that time. 203/

With the completion of the new line, ore from the mines at Nikel' can now be transported by rail to the refinery at Monchegorsk, south of Murmansk. 204/ The year-round transportation provided will also facilitate the exploitation of nickel, iron ore, and timber. 205/ Extension of the railroad system to Pechenga, the site of a medium- or heavy-bomber base, has increased the importance of the Kola Peninsula as a staging area. The logistic support provided by the new railroad would make possible the dispersion of air units along the northern rim of the Kola Peninsula, whereas they are now concentrated in the Murmansk area. 206/

(2) The Arkhangel'sk-Molotovsk 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. Arkhangel'sk is the chief Soviet base for lumber exports and a major staging area for convoys of the Northern Sea Route. The double-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 near the railroad station serves the river ferries that carry freight cars to the main port. A single-track railroad line is served by a second railroad ferry farther upstream. This ferry 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 Povrakulskiy, at the confluence of the Maymaksa and Kuznechikha Rivers. An important multispan, deck-type bridge carries the Isakogorka-Ekonomiya line over the Kuznechikha River. Just beyond this crossing the railroad divides into two main branches. One serves the waterfront area of the Maymaksa River, 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 River. 207/

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 by a railroad spur to the freight yard. 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. 208/

A single-track railroad line leads from the Isakogorka junction to the ship-building center and naval base of Molotovsk. The line enters the Molotovsk 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 Molotovsk railroad station, yards, and shops. From here, a local line runs some 9 miles (14 kilometers) eastward from Molotovsk, 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 probably produce some machinery for the Molotovsk shipyard. A four-span, deck-type bridge carries the Molotovsk-Isakogorka line over the Laya River, a lesser tributary within the Severnaya Dvina estuary. 209/

(3) The Vorkuta Railroad Complex

Since World War II the coal-mining settlement of Vorkuta has developed into an important railroad center of the European Arctic. It is the terminus of the now famous 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 new railroad construction penetrating toward the Kara Sea and deeper into the west Siberian Arctic. 210/ This construction effort consists mainly of a northward advance from Vorkuta to Khal'mer'yu, Kara, and possibly Amderma; and of an eastward advance from Seyda (located a short distance southwest of Vorkuta) to Labytnangi and Salekhard on the Ob' River and east 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, tundra, and 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. 211/ To alleviate traffic congestion the current, or Sixth, Five-Year Plan calls for the double-tracking of the entire Kotlas-Vorkuta trunkline. 212/ Passenger traffic on the line consists of 2 passenger trains daily in each direction. 213/ Trains are generally made up of a steam-operated locomotive and 18 or 20 coaches of both the 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. 214/ 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. 215/

Railroad installations of the Pechora trunkline within the Arctic sector are located at Inta, Kochmes, Abez (Usa), Sivaya Maska, Seyda, and Vorkuta. 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. 216/ Railroad facilities at Kochmes are less extensive, including a small railroad station, a steam-locomotive enginehouse, and a water-supply station. 217/ 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 used for locomotives, cars, and trucks. 218/ Railroad spurs reportedly lead to an airfield, a wagon factory, grain elevators, and storage depots. 219/ Sivaya Maska, about 29 miles (46 kilometers) northeast of Abez, is a minor stop on the line but has a turn-around enginehouse and a small locomotive repair shop. 220,221/

Seyda is a more important railroad junction located 60 miles (96 kilometers) southwest of Vorkuta. It serves as the turn-off point for railroad traffic routed over a newly constructed 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, and then continues over the boggy ground of the Ob' River flood basin. 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 are located at the settlements of Ust'-Vorkuta, Nikita, Yeletskiy, Polyarnyy Ural, Sob', and Krasnyy Kamen'. Krasnyy Kamen', Yeletskiy, and Nikita reportedly have minor railroad repair facilities. Krasnyy Kamen' and Nikita reportedly also have short sidings for local traffic transactions. Two to four freight trains operate daily in each direction between Seyda and Labytnangi. The chief commodities transported are food, construction materials, machinery, and motor vehicles. Passenger traffic is relatively light, with passenger trains operating approximately every 2 or 3 days. 222,223,224/

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. 225/

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 under construction to Kara and possibly Amderma on the Kara Sea. 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 10-15 locomotives, and a steam-locomotive enginehouse. 226,227,228/

Since 1946, construction has been underway on a new Arctic railroad connecting Vorkuta with the port of Amderma on the Kara Sea. Plans for this railroad apparently were made in the early 1930's. According to an article published in 1933 in the Byulleten' 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 the Barents Sea. 229/ From reports of German PW's and Soviet defectors, the line has apparently been completed to Kara and possibly beyond it to a point some 31 miles (50 kilometers) south of Amderma. 230/ The route follows a general north-northeasterly course from Vorkuta to Khal'mer'yu, continues to Kara, and from there runs northwestward along the coast to Amderma.

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. 231/ 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 section from Khal'mer'yu to Kara also appears to have been completed. The Swedish Communist newspaper Ny Dag announced the completion of the line as early as 4 November 1949. 232/ [redacted] at the 25X1

Vorkuta railroad station the arrival of several trains destined for Kara. 233/ The status of the last section of the route, extending from Kara to Amderma, is still somewhat of a mystery. A number of reports suggest that construction has already reached the vicinity of Amderma, but most of them are based on hearsay. Several stops and sidings along the route provide for passing. They are generally spaced 6 to 12 miles (10 to 19 kilometers) apart. A telephone line runs along the entire course of the railroad. It is quite likely that the railroad will be used to transport coal mined in the area south of Amderma. 234/

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 at Salekhard proper, which will serve the new trunkline to the Yenisey River port of Igarka.

Labytnangi, located on a channel of the Ob' River, is an assembly point for railroad traffic earmarked for Salekhard and destinations 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. 235,236,237/ 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 passenger and freight traffic, 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 (2.4 meters), which permits the laying of railroad tracks across the ice. The first successful crossing over the ice was made in February 1948. 238/ 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. 239/ 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. 240/ To date, however, there is still no evidence that construction is under way.

A few miles east of Labytnangi, according to PW sources, a branch line leads northeastward to the small shipping port and naval base of Novyy Port on the west shore of the Obskaya Guba. Reports from 1946 to 1949 stated that this line was then under construction, but its present status is not known. 241/

Railroad facilities at Salekhard serve both the local port area and the new trunkline to Igarka. Facilities include a main railroad station, a freight station and marshalling yard (consisting of 10-12 shunting tracks), 242/ 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. 243/ In addition, there are indications that Salekhard may soon develop into an important railroad junction point. [redacted] X1 official Soviet press releases, reveal plans to construct a new railroad connecting Salekhard with the railroad network of the Ural industrial area. This line will proceed northward from Polunochnoye (on the east side of the Urals) to Burmantovo and Nyaksimvol', swing northeast to Berezovo on the Severnaya Sos'va River, then follow the course of the Severnaya Sos'va northward to its junction with the Malaya Ob', and continue along this river to its confluence with the Bol'shaya Ob'. The railroad will cross the Ob' River before reaching Salekhard. Railroad ties were laid for a single-track line during the period from 1945 to 1952. 244/ 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. According to the article, the railroad would permit metallurgical plants in the northern and central Urals to receive coal from the Pechora Basin. 245/

The Salekhard-Igarka line, 620 miles (998 kilometers) of broad-gauge, single track between the Ob' and Yenisey Rivers, is the most significant and most recent railroad undertaking in the West Siberian Arctic. It was reportedly completed between 1951 and 1953, mainly through the use of PW and slave labor. If completed, it is strategically important as a year-round transportation and supply route to the lumber center at Igarka and to various airfields serving the Soviet Air Force, Polar Aviation, and territorial directorates of the Civil Air Fleet. Severe climatic conditions, and the difficulty of constructing a good roadbed on soft ground along much of the route would restrict both the size of trains and the volume of traffic that could be handled. [redacted] eastbound 25X1 traffic apparently will be largely coal, petroleum, foodstuffs, and penal laborers. 246/ Return cargo will probably be mainly lumber from the Igarka region.

Information on the alignment of the Salekhard line, based on reports from PW's who were stationed in the area between 1948 and 1953, indicates that the railroad follows roughly an east-southeasterly course from Salekhard to the small settlements of Kamenyy and 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 to Yangiyugan on the right bank of the Poluy River. This stretch of the route is approximately 37 miles (60 kilometers) long and crosses flat tundra interspersed with small stands of scraggy trees. Beyond Yangiyugan the railroad follows a southeasterly course for approximately 100 miles (160 kilometers) to the settlements of Orlin and Nadym, which is located on the Nadym River. Here the railroad has a circuitous alignment in order to bypass swamps, small hills, and a number of rivulets. Several short side tracks reportedly lead outward from the railroad station at Orlin. 247/ 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 still indefinite. According to an earlier interpretation of sources the route led directly to Igarka, following a northeasterly direction from Urengoy through the settlement of Sidorovsk on the Taz River. More recent reports of railroad construction south and southwest of Igarka -- specifically between the settlements of Krasnosel'kup, Yanov Stan, and Yermakovo -- have altered the interpretation somewhat. It now appears that the railroad has a more circuitous approach to Igarka. 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. 248/

Railroad construction between Yermakovo, the administrative center for the penal-labor district of the lower Yenisey region, and Igarka is believed to be completed, or at least in its final stages of completion. Railroad installations at Yermakovo include a railroad station, some minor storage and repair facilities, and at least 1 or 2 shunting tracks. As of 1951, a short stretch of the line north of Yermakovo along the left bank of the Yenisey was completed. The construction of a railroad bridge across the river was planned for the vicinity of Ostrov Berezovyy. Penal laborers camped along the right bank of the Yenisey from Yermakovo to Igarka were at that time engaged in clearing and leveling ground preliminary to railroad construction. 249/

(2) The Igarka Railroad Complex

Igarka seems to be the focal point for planned railroad construction in the West Siberian Arctic. A projected broad-gauge line will lead northward from Igarka along the Yenisey River to Dudinka. Here it will connect with broad- and narrow-gauge lines currently operating between Dudinka and Noril'sk. Almost all German PW's interned in the Salekhard-Igarka region speak of frequent claims made by Soviet penal laborers and camp guards that a connection between Igarka and Dudinka has been planned, and that construction may already be in progress. 250/ Railroad transportation to Dudinka would certainly serve as an impetus to the increased exploitation of rich mineral resources in the Noril'sk area. Current exploitation is limited to some extent by the short navigation season on the Yenisey. During the winter, small quantities of coal and nickel are shipped southward by truck along the frozen waterway. 251/

A second projected line is to connect Igarka with the Trans-Siberian Railroad. The route will probably branch off the Salekhard-Igarka line at Yermakovo and follow the left bank of the Yenisey River. Construction of a section of the line leading south from Yermakovo to Staryy Turukhansk is reported completed for a distance of 12 miles (19 kilometers). In 1951, freight trains were said to move daily over the completed section of the line, carrying provisions to be distributed to penal camps along the construction route.

Only recently, the Soviet Sixth Five-Year Plan announced the planned construction of a line from the Trans-Siberian station of Achinsk to Abalakovo on the Yenisey River. 252/

A third projected line was to lead from Igarka eastward to Yakutsk. Although some construction was reported in the early 1950's, the project now appears to have been dropped.

(3) The Noril'sk-Dudinka Railroad Complex

Railroad operations between Noril'sk and Dudinka are confined to a broad- and a narrow-gauge line connecting the two settlements (Figure 56). The narrow-gauge line was laid some time before World War II and is believed to be still in operation. The broad-gauge line, which roughly follows the same route as that of the narrow-gauge, was completed in 1952. By July 1954, a broad-gauge network had been developed in the industrial area of Noril'sk. The network consists mainly of short spur and branch lines that serve the various industrial and mining installations in the area. Apparently the narrow-gauge lines in Noril'sk and Dudinka were not completely removed and still are being used to some extent. 253/

Noril'sk has a station from which both broad- and narrow-gauge lines lead into the city proper and to various nearby mining installations (Figure 57). A single-track, broad-gauge line leads to Gor-stroy, a multistory housing development under construction 6 miles (10 kilometers) north of the city limits. 254/ The main line to Dudinka is poorly built, with ties set directly on leveled ground. As a result, many accidents occur during the thawing of the ground in spring, overloading of track, and breaking of rails during severe winter frosts. Traffic is moderately heavy and consists of a variety of materials. Items shipped from Dudinka to Noril'sk include lumber, steel plates and rods, and various types of machinery, as well as foodstuffs such as wheat, millet, macaroni, canned and salted fish, and small amounts of fresh meat. Material shipped from Noril'sk to Dudinka is chiefly coal, ores, and metals.

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
X1 tank and ore cars. [redacted] some 40- and 60-ton freight cars have recently arrived from Czechoslovakia. There are indications that the entire route is to be electrified by 1957. 255/ In 1953, nine electric locomotives made in Novosibirsk were sent to Noril'sk.

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. 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 following reindeer migration routes is common. 256/

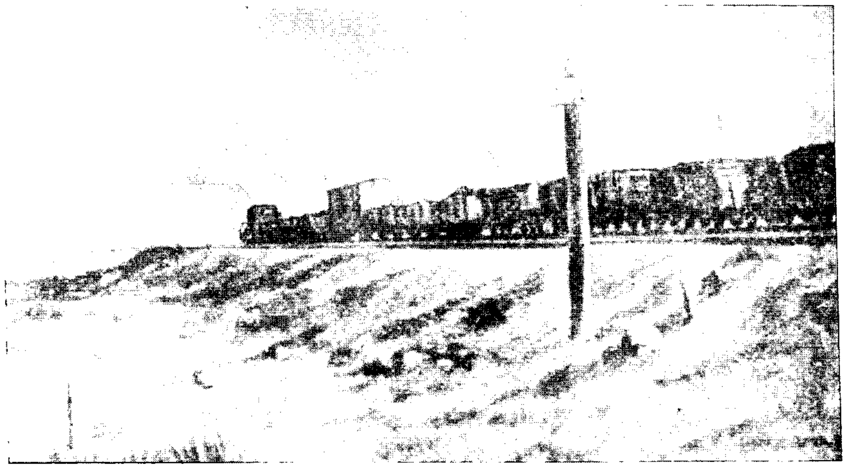


Figure 56. A freight train on the Noril'sk-Dudinka Railroad passing the 56-kilometer marking.

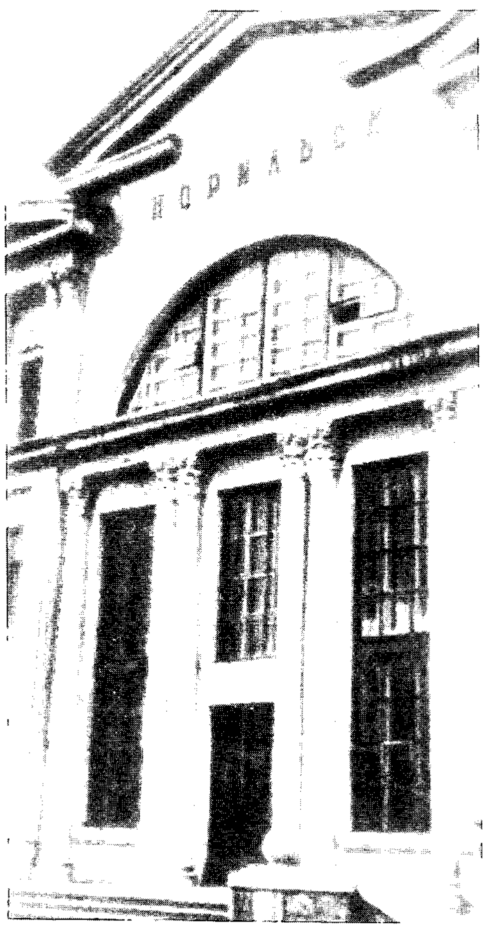


Figure 57. Facade of the railroad station at Noril'sk.

A characteristic means of overland travel in the Soviet Arctic is by winter automobile and tractor roads. 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. 257/ 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 a 24-hour period. Because sleds weighing up to 100 tons or more when loaded are used, much freight can be carried by a single train.

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 Krasnoyarsk. On the Lena and Kolyma Rivers, trucks travel as far south as Yakutsk and Seymchan, respectively.

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 newly constructed Murmansk-Pechenga Highway, and short stretches of improved road from Kola and Murmansk, existing roads are largely seasonal and in poor condition. Most of them are little more than unimproved dirt tracks and 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 Virtanieni 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. 258/ Motor traffic on the Arctic Highway section adjacent to the Finnish border consists mainly of military transports. 259/ 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 recently completed Murmansk-Pechenga Highway covers a distance of approximately 87 miles (140 kilometers). Judging by known patterns of Soviet road construction, this highway is probably 20 feet (6 meters) wide with an improved surface (probably gravel packed) 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 to the south. It then veers northward and follows the western bank of the Kol'skiy Zaliv to Min'kino. From Min'kino it winds northwestward, passing through the fishing settlement of Ura-Guba, and then roughly parallels the coast to Pechenga. The alignment of the highway is approximately the same as that of the new Murmansk-Pechenga railroad and generally follows the contour of the terrain, bypassing hilly or mountainous areas. It appears that no great effort has been made to straighten the course of the highway. Several secondary roads appear to branch off the highway at intervals. At the Titovka River crossing, a road of greater importance than the secondary roads is shown as winding northward to the northern tip of the Rybachiy Peninsula. 260/

25X1

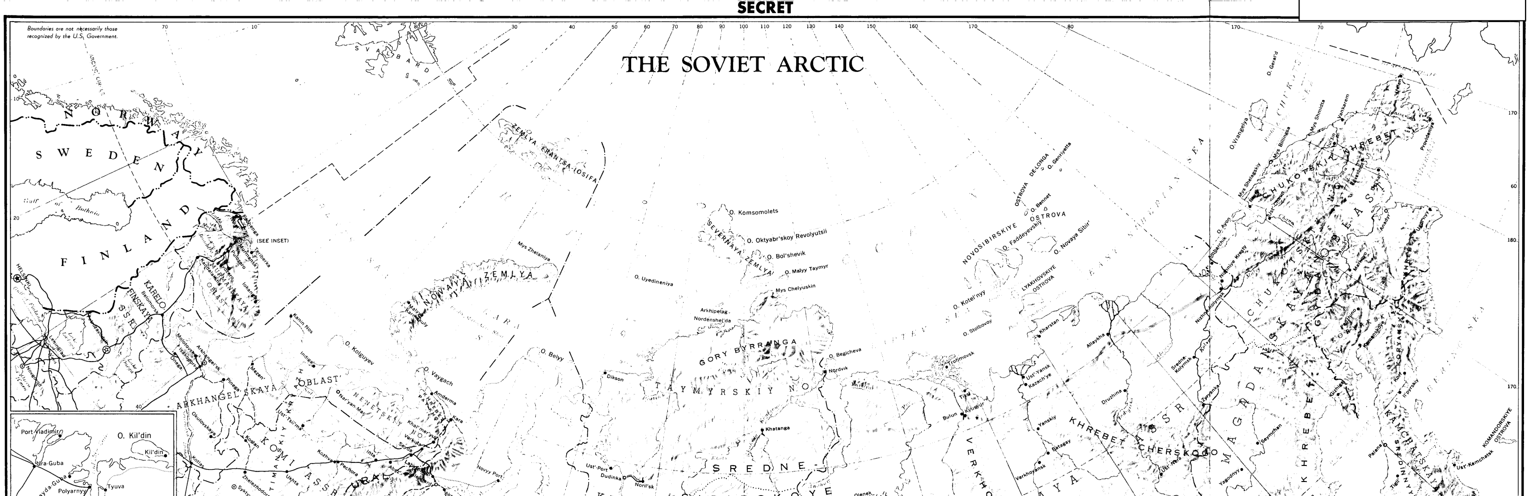
Improved motor roads also lead northward and southward from Murmansk. One road runs along the east bank of the Kol'skiy Zaliv and connects Murmansk with Severomorsk. It has a gravel surface with a stone roadbed and is capable of withstanding the heaviest traffic. An extension northward from Severomorsk has been planned and will lead to Teriberka via Tyuva 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 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 passed through a predominantly forested area and generally parallels the electric power lines from the Tuloma GES (Hydroelectric Station). 262/

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) to the settlements of Karpogory and 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 trunk-line. During the winter the road is used for sledge traffic. 263/ 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 have been reported in the Vorkuta area. They were built by PW and penal labor, and connect the city of Vorkuta with various mining settlements and penal camps in the surrounding area. 264/ Roads lead northward to the 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. 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. 265/

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



Study-area boundary

ADMINISTRATIVE DIVISIONS (1956)

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

Statute Miles: 0 200 400 600 800 1000

Kilometers: 0 200 400 600 800 1000

RAILROADS

- ——— Existing
- – – – Under construction or possibly completed*
- ········ Proposed, possibly under construction*

ROADS

- ——— All-weather
- – – – Seasonal
- ········ Proposed*

*(Exact alignment unknown)

Peninsula and provides the only land communication between the isolated rayon center of Gremikha 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. The largest road network surrounds Noril'sk and connects the nickel combine with other parts of the urban area. The main road within the combine has an asphalt surface and is 20-26 feet (6-8 meters) wide. 266/ The other roads of the area are unsurfaced and average 20 feet (6 meters) in width. There are indications that a motor road may parallel the Noril'sk-Dudinka railroad.

On the Chukotsk Peninsula, a major road has been constructed from the tungsten mines at Iul'tin to the port of Egvekinot on Zaliv Kresta. The road is about 180 miles (290 kilometers) in length and 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. 267,268/

X1 [redacted] 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 are 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. 269/

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. A road 9 miles (14 kilometers) long crosses the easternmost extremity of the Chukotsk Peninsula and connects the settlements of Uelen and Dezhnev. 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.

V. Arctic Scientific Activities

The present extensive program of research in the Soviet Arctic includes studies of the entire Polar Basin environment from the ocean bottom to the upper atmosphere. The study of the Arctic began in 1882, when polar stations were established for the First International Polar Year. Beginning at this early date, Arctic research and exploration have been associated with economic activities and have been centered in the western Arctic. Research activities have included the exploration of the northern waters, islands, and coast and the first attempts at ice reconnaissance.

During the Second International Polar Year (1932-33), 24 polar stations were established, and marine expeditions in the Knipovich, Persey, and Sibiryakov were carried out. The drift of the Sedov (1937-40) and the Papanin expedition Severnyy Polus (North Pole) (1937) also added to the Soviet data of the Arctic. These periodic programs of research had only limited value since the atmospheric, terrestrial, and oceanographic observations did not cover suitable periods of time or significant areas. To correct this the Soviets have gradually established a program in which observations of these phenomena are collected from a number of widely scattered points throughout the Polar Basin and are integrated with observations taken at the vast network of land-based polar stations. Under this program, observational data have been collected from about two-thirds of the total area of the basin, the remaining area being largely in the sector from 70°W to 160°W.

Four methods were evolved to cover the vast area of the Arctic Ocean with facilities for the desired observations: drifting stations, flying observatories, icebreaker oceanographic expeditions, and mobile research teams. The investigations included studies of (1) the physical and chemical characteristics of the Arctic Ocean, (2) the dynamics of ocean currents and their circulation, (3) solar radiation and the associated interaction between the hydrosphere and the atmosphere, and (4) the character and distribution of the ice and of the upper air. Astronomical fixes were made to pinpoint terrestrial locations and measure ice movement. Other geophysical observations, including magnetism and gravimetry, were also undertaken.

Papanin's drifting station Severnyy Polus, subsequently renamed Severnyy Polus I (SP-I), was launched by air in 1937. A station was established on pack ice at a point near the North Pole, and four men remained at the station for 274 days and covered 2,100 kilometers (1,305 miles) during a 2,500-kilometer (1,555-mile) drift. SP-2, under the direction of M. Somov, was launched north of Alaska in 1950. It was abandoned after 1 year; and the ice floe, drifting in a large arc, returned after 3 years to its approximate starting point. Drifting stations were again established in 1954 with the founding of SP-3 and SP-4 (Figure 58). SP-3 was abandoned in May 1955, when it drifted to within 100 miles of Greenland. SP-5 was established in April 1955; and the newest drifting station, SP-6, was set up during April 1956. At present, these 3 stations are active in the Arctic Basin.

The drifting stations are manned by 30 to 40 scientists and carry a large amount of equipment, which enables them to carry out virtually any type of geophysical observation and biological research (Figure 59). Among the investigations are determination of ocean depth, sampling of the sea bottom and different layers of the ocean, measurement of the speed and direction of drift, studies of ice and heat balance, gravity and magnetic-component determinations, and collection of biological specimens (Figures 60 and 61).

The flying observatories used in the Soviet Arctic are large transport aircraft that make roundtrip flights to the Pole for the collection of weather, ice, and magnetic data. The aircraft fly over predetermined routes to prevent the flights from overlapping and insure that the area is evenly covered.

Icebreaker operations for exploration have been used from time to time for hydrographic and oceanographic purposes. The Soviets claim the distinction of having increased use of specially outfitted icebreakers or vessels reinforced for ice duty in a planned program for broadening the network of simultaneous observations over water areas. Recently, voyages by the Litke have been undertaken to penetrate as far as possible into pack ice, and record penetrations have been claimed. According to Burkhanov, areas of significant size (reportedly as much as 15 percent of the total area) near the Pole are ice free. The plan is to continue a northward expansion of navigation. The Ob' has been outfitted with six laboratories for a full range of continuous oceanographic observations from the Arctic Basin in the northern summer to the Antarctic waters in the southern summer.

One of the most significant Soviet achievements is the development of mobile research teams, which consist of small groups of scientists who fly to assigned points and set up temporary bases on the pack ice. The scientists obtain a complete set of geophysical data at each base before moving on to the next. By the end of 1950 about 200 points had been established and 500 more are planned for the coming program of the International Geophysical Year (1957-58). Most recently the Soviet Union established a temporary air base

Figure 58. A part of the drifting station SP-3. The hemispherical tents are used for housing personnel and sheltering observational instruments. The large building in the center is the mess hall.

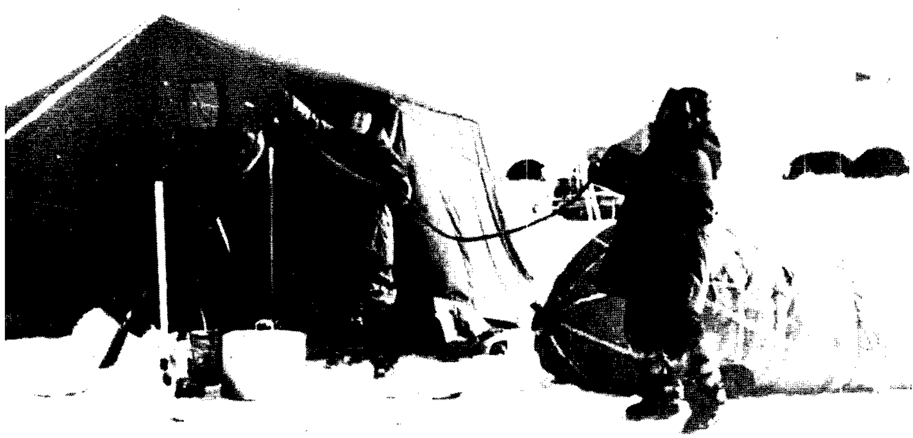


Figure 59. Scientists filling a balloon with hydrogen prior to launching radiosonde instruments.

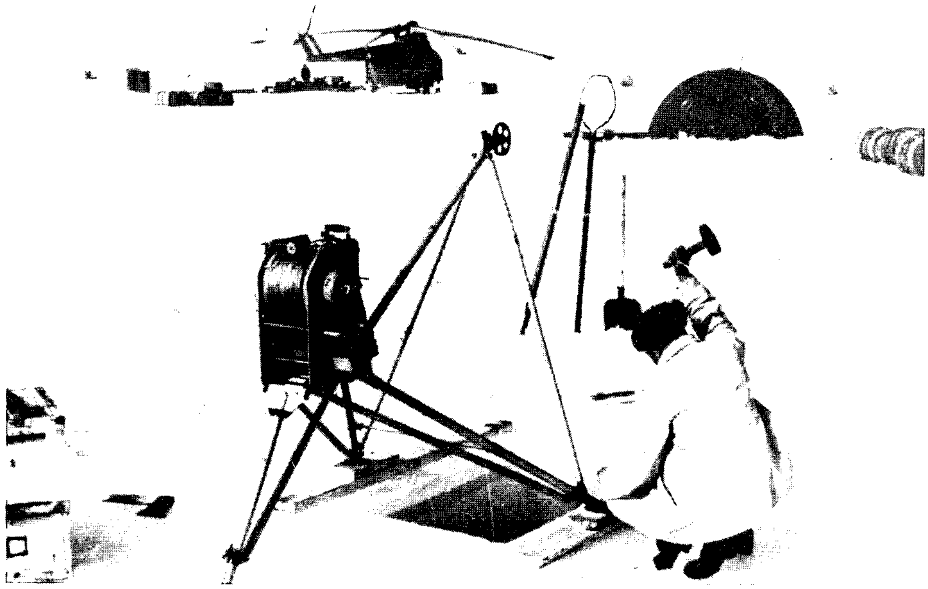


Figure 60. Preparing a platform for scientific observations on SP-4. The winch is used to obtain water and biological samples and temperature readings.

Figure 61. An instrument used for making actinometric measurements on SP-4.

about 200 miles northwest of Canada. The operation, which lasted about 10 days, was undertaken by 8 aircraft with 50 people who fanned out to predetermined points for oceanographic, surface, air, and upper-air observations. It was a mobile research team that first detected the existence of the Lomonosov Ridge, which divides the Polar Basin into two distinct sub-basins.

The extensive program of research undertaken by the Soviets has many applications of both an economic and a strategic nature. The benefits to shipping on the Northern Sea Route and to internal air traffic are obvious, but the same information can also be used for polar air flights, submarine operations, and guided-missile flights. Weather conditions and their forecast are necessary for any flight via polar routes. 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 long-range missiles. Gravity information is necessary to compute the earth's exterior gravity field along the missile flight path, which affects both bearing and range.

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Relation Between Physical Environment and Arctic Operations

A. Climate

Climate is the single element exerting 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 affected by summer ice and fog conditions. In the following discussion of air, land, and sea operations, climatic factors are represented 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, are especially dependent upon favorable climatic conditions. The present meteorological activities in the Arctic enable the Russians to make both long- and short-range weather forecasts, thereby reducing the dangers of flying in inclement weather.

a. Temperature

Cold is one of the greatest obstacles to air operations. The extremely low winter temperatures create maintenance and operating difficulties not encountered at lower latitudes. The scarcity of adequate hangars and shelters for parking and servicing aircraft is a serious problem. Without protection from the 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. Contraction of metal parts causes leakage of fluids around the gaskets of landing gear and other parts. Oil and grease become stiff and do not lubricate properly until sufficiently warmed. To counter this the Russians are reported to have developed greases and lubricants especially suited for polar conditions. Condensation of moisture in fuel tanks causes ice crystals to form in the gasoline, clogging the fuel lines and carburetors. Aircraft engines, especially the internal-combustion type, are difficult to start when cold-soaked and must be warmed by portable heaters (Figure 62).

Summer temperatures have much less influence on air operations than do winter temperatures. Although temperatures often drop below freezing during the short summer, outdoor activity can be carried on without too much discomfort. The greatest difficulty associated with warmer weather occurs when the spring temperatures rise and the

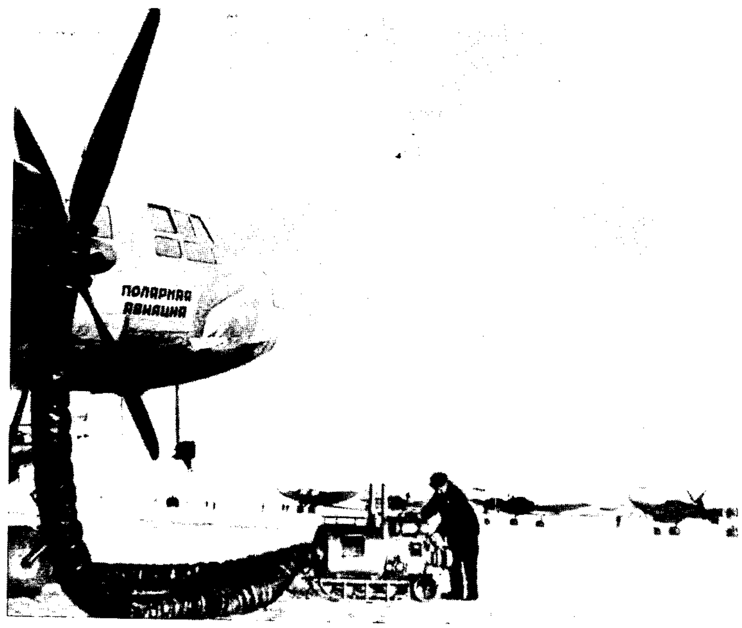

Figure 62. Preheating the engine of a transport before taking off. Aircraft of Polar Aviation can be distinguished by the insignia "Polyarnaya Aviatsiya."

runways thaw. Since many of the runways are constructed of gravel, they become soft and unusable when the frost leaves the ground. Several methods are employed to insure continuous operation during this period. 270/ The most common involves clearing one runway or half a runway of snow and ice and allowing the sun to dry out the gravel. Snow left on the remaining runway surface is rolled and compacted to enable aircraft to continue to operate during the drying-out period. By the time the snow cover finally melts away and the soggy gravel surface is exposed, the previously cleared area is comparatively dry and ready for use.

b. Winds

Winds of the Arctic have a relatively high velocity as compared with those of more southerly latitudes. High winds often occur during the winter and seriously affect air operations. Surface winds are particularly strong during this season and often prevent aircraft from taking off or landing. Gusts have reached 132 miles per hour on Novaya Zemlya. While this is a record speed, winds of 88 miles per hour often occur 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. Sand and small pebbles, as well as snow, 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 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. 271/ They form numerous interrupted belts that are flattened in cross section and vary in speed, altitude, and location from day to day. Jet streams are found at all latitudes from the Equator to the North Pole, but are concentrated chiefly between 30°N and 40°N. 272/ The streams migrate northward in summer and become weaker. There is evidence, however, 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 (19,800 meters). Since the present estimated ceiling of Soviet bombers is reported to be only 42,000 to 54,000 feet (13,000 to 16,500 meters), there is some doubt as to whether this jet stream could be utilized in the near future. 273/

Many problems would be encountered in using the jet streams. Current detailed weather information would be needed to plot the shifting wind belts. In order to make best use of the winds, a pilot would have to change his course repeatedly. As a result, close-formation flying would be difficult. On the return flight a different course would have to be followed to avoid the jet streams, which would then become strong headwinds. 274,p.28/

c. Visibility

Visibility during air operations is reduced by fog, cloud, and to a minor extent by smoke. Fog and smoke are 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 rarely occur. Warm-season fogs 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. 275/

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. 276/ 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 and high-level instrument bombing missions are possible.

On days with a high overcast sky, the phenomenon of "whiteout" develops. 277/ 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. Analysis of radar tracks in the Provideniya-Urelik area has shown that night flights continue throughout the winter season. 278/ 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. 279/ 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.

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 Rudolf (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. 280/

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 which are easily drifted by the wind.

Level areas and windward slopes are usually blown clear, while lee slopes and depressions become drifted. 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 (1,002 millimeters) at Ostrov Domashniy (Severnaya Zemlya) and 3 inches (75 millimeters) at Mys Shalaurova (Lyakhovskiye Ostrova). 281,p.57/

Snow affects both runway maintenance and flying conditions. Permanent runways are usually constructed slightly above the surrounding ground so that snow blows clear instead of drifting over them. When strong winter winds are blowing, the snow is whipped into blizzard conditions and air operations are usually grounded.

During all seasons, hoarfrost and rime ice 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. 282/ 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 63). Rime ice forms on aircraft when

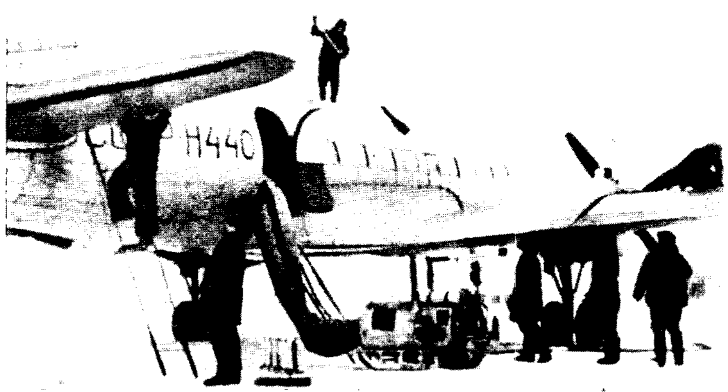

Figure 63. Preparing a Coach (Il-12) for take-off. The body, tail, and wing surfaces are cleared of frost and the interior of the plane is heated.

they fly through under-cooled fog or cloud. The worst season for rime-ice formation is the summer, when fog is at a maximum.

f. Aurora Borealis

The Soviet Arctic lies within the zone of maximum auroral activity. This zone extends from the northern tip of Norway, through the center of Novaya Zemlya, and south of Ozero Taymyr, Novosibirskiye Ostrova, and Ostrov Vrangelya. To the north and south the number of displays decreases, but in the north they can still be observed almost every clear night. 283/ Auroral activity is greatest when the earth's magnetic field is highly disturbed, that is, when there is a magnetic storm. During such periods, high-frequency wireless communication is disrupted or "blacked out" and contact between flying aircraft and their bases is difficult. These blackout periods often continue for several days. Since low-frequency radio systems (up to 300 kilocycles) are less interrupted by magnetic disturbances than the high-frequency, the Russians have adopted such systems for air-ground communication. 284;285,p.37/

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. 286,p.4/ In February 1955, large-scale maneuvers in which both ground and air forces participated were undertaken from Novaya Zemlya to the Kolyma River. 287/ 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 dangers of outdoor work -- such as frostbite and freezing of bare flesh to metal -- are ever-present. The effect of cold on motor vehicles is similar to the effect on aircraft in that water vapor in fuel freezes and oil and grease become stiff. Cold temperatures also affect ammunition, making the range much shorter than in temperate latitudes. 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. Minimum monthly temperatures for January average 16°F (-9°C) at Murmansk and 5°F (-15°C) at Malyye Karmakuly. When the Nordkap Current reaches Mys Zhelaniya, at the northern tip of Novaya Zemlya, it is quite cool and the coldest winter month averages 11°F (-18°C). 288/

East of Novaya Zemlya the land becomes increasingly cold as the "cold pole" of northeastern Siberia is approached. Monthly temperatures reach a minimum at Kazach'ye, which averages -42°F (-41°C) for January. Temperatures rise again near the Bering Strait and at Uelen average -13°F (-24°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. Inland temperatures rise much higher; at Igarka it has reached 88°F (31°C) in July.

b. Winds

Winds are one of the greatest factors in limiting outdoor activity. When winds of 20 to 30 miles (32 to 48 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. 289/ 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. 290/ 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. It can carry away all unsecured equipment and destroy buildings. During one storm, fuel drums were blown several miles over the sea ice. 291/

The bora is a north wind of Central and Eastern Siberia 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 rise 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. 292/ 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. Snow compacted by the wind will support the weight of a man, but loose snow in excess of 24 inches (600 millimeters) will immobilize him. With snowshoes, a man can travel slowly over snow of all depths; by using skis his speed can be doubled. Wheeled vehicles cannot move in snow deeper than 12 inches (300 millimeters). Tracked vehicles can operate in depths up to 24 inches (600 millimeters) but at much reduced speeds. 293,p.11/

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 on 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 topography but because navigation by visual methods is restricted. Movement overland can be aided by radio homing devices. 294,p.204/

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. 295/ During this time, navigation is limited to a small area in the southern half of the Barents Sea which is kept ice free by 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 and extends 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 the movement of the floes widens and closes stretches of open water.

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. 296/ 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. 297,298/ The average thickness of the pack ice has decreased from 12 feet (3.6 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. 299/

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. 300/ 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 more favorable nesting and feeding conditions. Flowers bloom earlier and berries ripen sooner 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. 301/ Lamprey are now found from the Barents Sea to the mouth of the Ob' River. The catch of commercial fish in the Barents Sea increased from 30,000 tons in 1924 to 97,000 tons in 1930.

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 would also be increased, since crops 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 for speeding up the warming cycle by constructing a Bering Strait dam. Under this scheme, a dam would be built across the Bering Strait and the warmer Pacific waters would be pumped into the Arctic Ocean. According to the Russians, this would lengthen the navigation season on the Northern Sea Route and ameliorate the climate in the Arctic sectors of both the USSR and North America.

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 64).

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 4,265 feet (1,100 to 1,300 meters) in altitude and extends to about 68°N. North of this point the mountains decrease in elevation 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.

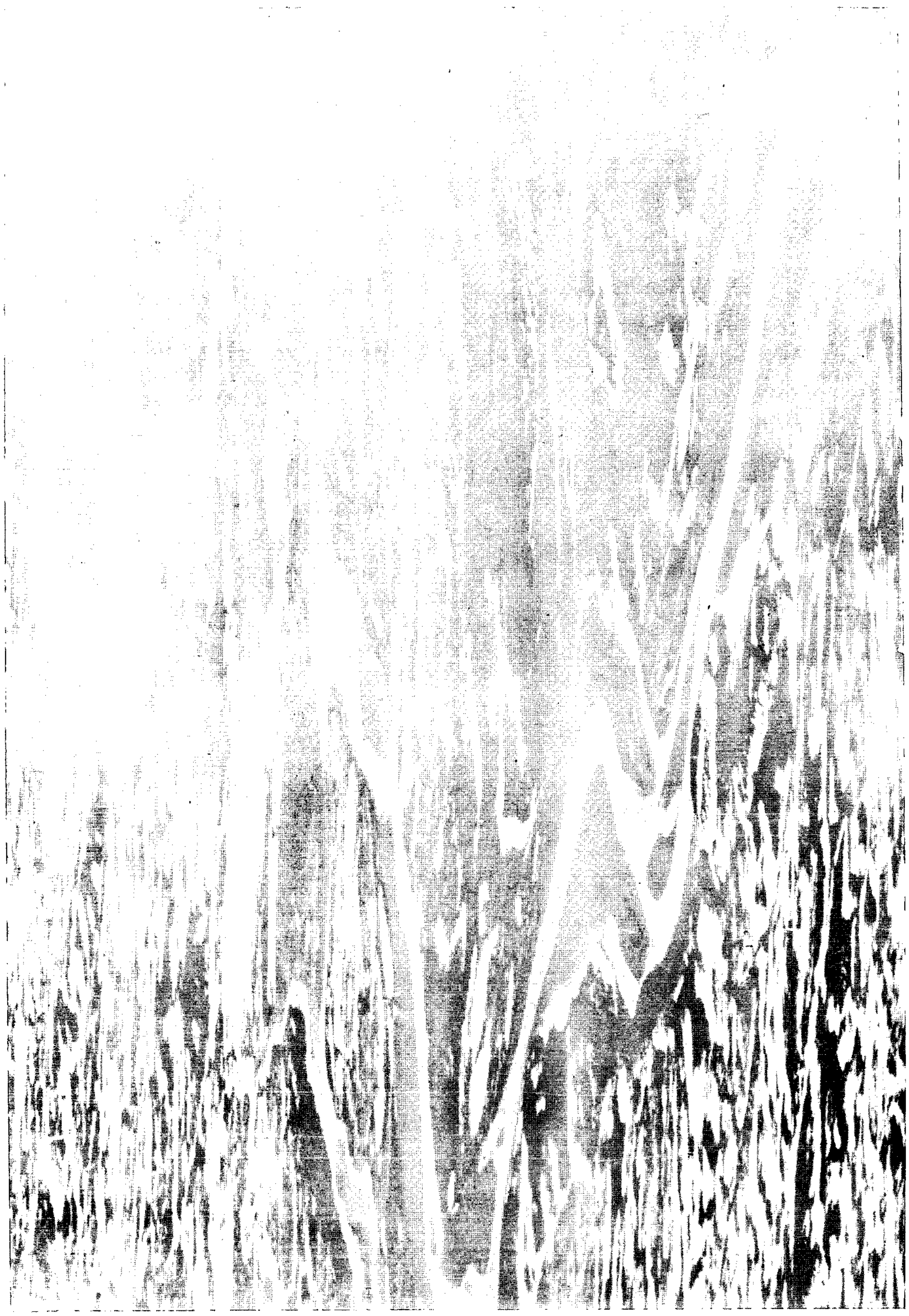

Figure 64. A meandering stream with braided channels crossing the coastal plain near Mys Vankarem on Chukotsk Peninsula.

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On Novaya Zemlya, the mountains again appear and rise in altitude to 3,300 feet (1,000 meters) on the northern tip 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 1,650 to 3,300 feet (500 to 1,000 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 6,560 to 9,840 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 65) with elevations varying up to 200 feet (60 meters). The offshore depths are usually shallow and contain

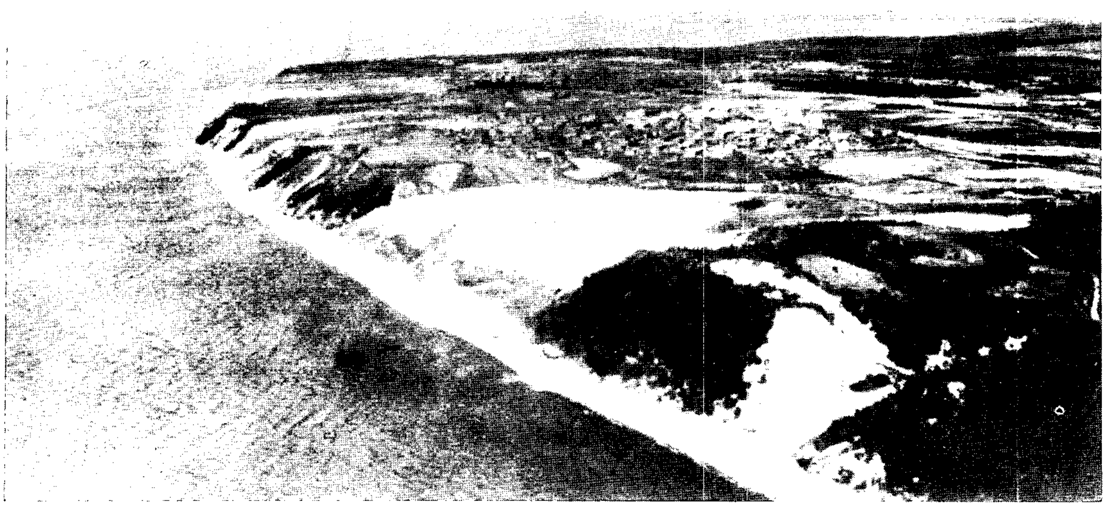

Figure 65. Low coastal cliffs near Onega. Cliffs like these are characteristic of much of the Arctic littoral.

shoal areas. Although 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 these 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 of the gulf, 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 (130 kilometers) (Figure 66). 302/

The surface of the land 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. 303,304/ 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 roaks are found between Khatangskiy Zaliv and the Lena River and along the western side of Chaunskaya Guba.

Low tundra plants form the characteristic vegetation cover 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)

Figure 66. Two small coastal lagoons west of Mys Vankarem on the northern coast of Chukotsk Peninsula.

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in height. In marshy areas these hummocks are covered with moss; in the open, better drained areas, lichens predominate. Marshy areas are also underlain by great thicknesses of moss, which make the surface 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. 305/

Polygonal tundra develops in coastal areas of the mainland from Proliv Yugorskiy Shar to the Kolyma River and on the northern islands. The freezing and thawing of the ground causes cracks that divide the surface into polygonal blocks. The polygons vary in size from a few feet to over 600 feet (180 meters), and as a rule the size increases toward the north, where the climate is colder. 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 67 and 68). 306/

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 (229 meters). The active layer 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.

Movement and construction are the two activities most affected by terrain. The ease of movement through the tundra depends upon the season. When 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

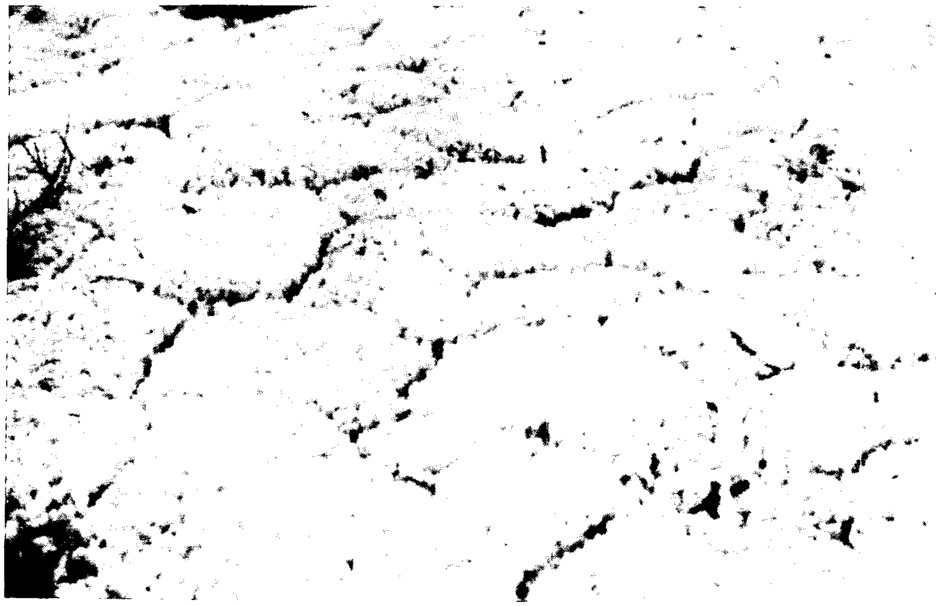

Figure 67. Reindeer moss growing on polygonal tundra.

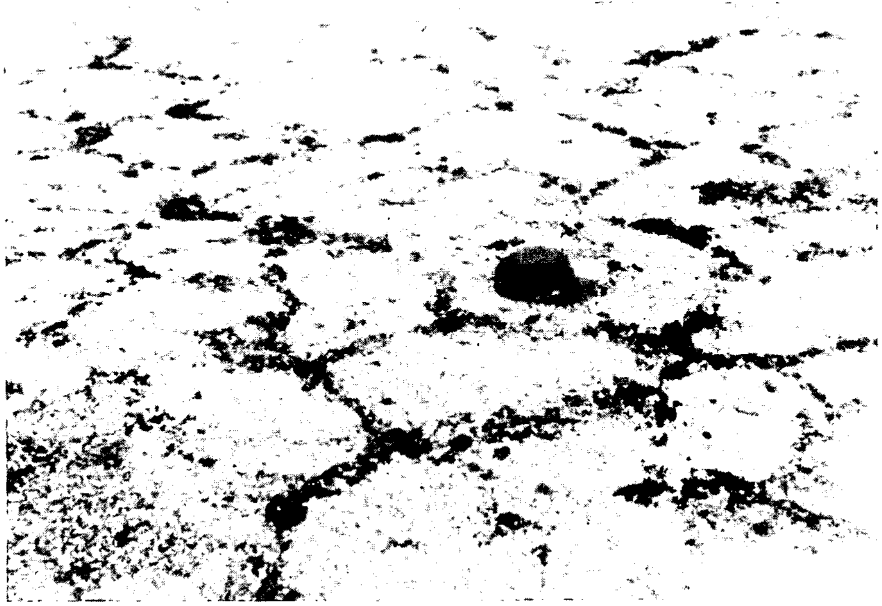

Figure 68. Polygonal tundra developed on dry, stony soil.

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 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 the Russians have gained much construction experience and have amassed a great amount of information on the subject. 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.

The physical conditions determining the location of airfields are terrain, surface material, and permafrost. The site must be level and composed of homogeneous material. Since most of the recent airfields built in the Soviet Arctic are large, varying in length from 8,000 feet (2,440 meters) at Provideniya to 9,500 feet (2,895 meters) at Tiksi, sites for runways are difficult to find. If the area is not level the grading should not interfere with natural drainage, or the field may become flooded and the permafrost balance may be disturbed. Channels must be dug and pipes must be laid to facilitate drainage. After the strip is graded and leveled, it is usually left unsurfaced, although a few of the larger runways are surfaced. Macadamized sand is often used, since this nonrigid material can easily be repaired if the surface becomes warped or develops frost boils. If concrete runways are built, the ground is first covered with a low heat conducting material such as pumice, slag, or porous lava rock. This layer is slightly thicker than the active layer and insulates it from heat absorbed by the concrete. If extensive grading and filling is required, tile drains must also be laid.

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. 307/ Roadbeds laid over the tundra cover usually cause the least subsurface disturbance.

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ADDENDUM

Subsequent to the completion of this study, a 1956 summer (June-September) Aeroflot timetable was received. According to this timetable, four air routes are scheduled in summer between Moscow and the key Arctic centers of Arkhangel'sk, Murmansk, Vorkuta, and Noril'sk. These routes operate under the Severnaya Territorial'naya Upravleniye (Northern Territorial Directorate) of the GVF, which is one of 15 (formerly 18) Territorial Directorates now carrying out scheduled Aeroflot flights. The routes shown are (1) Moscow-Cherepovets-Vologda-Arkhangel'sk, (2) Moscow-Cherepovets-Arkhangel'sk-Murmansk, (3) Moscow-Syktyvkar-Pechora-Vorkuta, and (4) Murmansk-Syktyvkar-Pechora-Vorkuta-Noril'sk. During the summer, an Li-2 airplane departs daily from each of the terminal cities bound for the opposite terminus. 308/ The most noticeable difference between the winter and summer routes is in the flights to Murmansk and Noril'sk. Summer flights to these two cities are more direct, resulting in a reduction of the total flight time. Scheduled winter flights, however, will undoubtedly continue to follow north-south routes along the Yenisey and possibly along other Siberian Rivers, since during this season aircraft are the most reliable means of transportation between the river settlements and the larger supply centers to the south.

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APPENDIX A

GAPS IN INTELLIGENCE

Although an increasing number of articles and reports are being published on the Soviet Arctic, reliable and detailed information concerning numerous phases of development are notably lacking. Despite Soviet publication of their extensive Polar Basin activities, a high degree of secrecy surrounds most of the economic and military developments.

Changes in governmental agencies having specific responsibilities within the region have been fairly frequent and are difficult to ascertain. Detailed map coverage, particularly for the area east of the Urals, is also limited.

Most population figures in terms of settlement and regional distribution are either estimates or approximations. Current population estimates were derived from the latest United States and Soviet sources, which have varied considerably from year to year. Since the last Soviet census was taken in 1939, most of these estimates are based primarily on electoral districts and considerable allowance should be made for error. In many cases, specific information on various aspects of industry within the individual settlements is lacking. Statistical data concerning the principal economic activities -- lumbering, fishing, and mining -- were for the most part meager or unavailable. Reports on mining activities were frequently conflicting, which made it difficult to assess the mineral wealth reliably.

There were 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 were extremely limited. The alignments given for the most recently constructed and planned railroad lines are only approximate, since little information on this subject has appeared in Soviet literature. Information on the progress of current railroad construction is also meager, and data on roads and other means of overland transport were almost nonexistent. The territorial jurisdiction over and alignment of air routes was also difficult to determine on the bases of available reports.

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