ICEX 2018

Welcome Letter

WELCOME to ICEX 2018

DEPARTMENT OF THE NAVY
COMMANDER UNDERSEA WARFIGHTING DEVELOPMENT CENTER
DETACHMENT ARCTIC SUBMARINE LABORATORY
140 SYLVESTER ROAD
SAN DIEGO, CA 92106-3521

IN REPLY REFER TO:
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29 Jan 18

From: Director, Undersea Warfighting Development Center Detachment Arctic Submarine Laboratory
To: ICEX Distinguished Visitors and Guests

Subj: SUBMARINE ICEX 2018 AND ICE CAMP SKATE

Encl: (1) ICEX 2018 Visitor Briefing Book

1. Welcome to the Arctic and Ice Exercise (ICEX) 2018. I hope this trip will provide you with an understanding of the U.S. Navy and Submarine Force's Arctic interests and capabilities.

2. ICEX is a U.S. Navy Submarine Arctic Warfare Program sponsored by the Chief of Naval Operations, Undersea Warfare Division (OPNAV N97) and managed by the Undersea Warfighting Development Center Detachment Arctic Submarine Laboratory (ASL).

3. The Submarine Force has over 70 years of Arctic operational experience. On August 1, 1947, Dr. Waldo Lyon, the Arctic Submarine Laboratory's founder and original ice pilot, expertly guided the diesel submarine USS Boarfish (SS-327) as it conducted the first under-ice transit of an ice floe in the Chukchi Sea. Since then, ASL has supported the Submarine Force in over 120 operations near and under the ice.

4. In the attached briefing book, information is presented that will prepare you for the things you will see and the events in which you will participate over the next two days.

5. The Arctic remains the world's last frontier and every experience there is unique, even for those who have been operating there for years. No one can truly appreciate the Arctic without having actually been there. There are two elements that will help make this trip a positive and memorable experience: proper preparation and a constant awareness of safety. All ICEX 2018 participants have been trained in these precautions. They will be fully concerned for your safety and welfare while you are en route to, from, and at Ice Camp SKATE and while you are aboard one of the participating submarines. I encourage you to ask questions whenever and wherever they arise.

6. Once again, welcome and thank you for coming. Your excursion to the top of the world and under the ice will be a unique lifetime experience.

Larry Estrada

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What is ICEX

The 2018 Submarine Arctic Warfare Exercise (ICEX 2018) is part of the U.S. Navy Submarine Arctic Warfare Program sponsored by the Chief of Naval Operations, Undersea Warfare Division (OPNAV N97). ICEX 2018 is a biennial Submarine Force tactical development and torpedo exercise managed by the U.S. Navy Arctic Submarine Laboratory (ASL). Since 1947 when Dr. Waldo K. Lyon, the founder of ASL, made the first dive beneath the Arctic on a submarine, ASL has safely supported over 120 submarine operations near and under the ice.

The Arctic remains the world's last frontier and every experience there is unique, even for those who have been operating there for years. No one can truly appreciate the Arctic without having actually been there.

CURRENT ICEX FOCUS

The focus of ICEX is the continuation of a long-standing Submarine Force effort to ensure access to all of the world's oceans.

The ICEX program continues today as the proving ground for submarine Arctic operability and warfighting. Throughout the Cold War era, the STURGEON class fast attack submarine was the workhorse of the Arctic, participating in over a hundred ICEX missions. Since 2000, the focus of ICEX has shifted to ensuring the safe operation and tactical capability of four fast attack submarine classes. Any submarine may be called upon to fight in ice-covered waters or transit the Arctic and be required to make the arduous Bering Strait transit during a period of extensive ice cover. Therefore, LOS ANGELES (688), Improved LOS ANGELES (688I), SEAWOLF (21), and VIRGINIA (774) Class submarines have all conducted basic Arctic trials and all classes make routine Arctic deployments beyond those associated with ICEX.

The purpose of USS Connecticut's (SSN 22), USS Hartford's (SSN 788), AND HMS Trenchant's (S91) presence at the ice camp is to conduct a tactical development and torpedo exercise. With every ICEX, the submarine crews will be conducting training, testing new combat systems, and improving submarine operability and warfighting capabilities in ice covered and cold water arctic conditions. Upon completion of exercise operations , the submarines will transit to the North Pole for a joint surfacing before departing the Arctic and returning to port for their next assignments.

ICEX 2018 Participants

ICEX 2018 is being conducted under the operational control of Submarine Force U.S. Atlantic Fleet (COMSUBLANT) in Norfolk, Virginia.

ICEX PARTICIPANTS

- US Navy, USMC, US Air Force, US Army, US Coast Guard, Alaska Guard
- Royal Navy
- Royal Canadian Navy
- Royal Canadian Air Force
- Commander, Submarine Force, Atlantic (COMSUBLANT)
- Commander, Submarine Force, Pacific (COMSUBPAC)
- Royal Navy, Navy Command Headquarters (NCHQ)
- Undersea Warfighting Development Center (UWDC)
- UWDC, Detachment Arctic Submarine Laboratory (ASL)
- UWDC, Detachment Tactical Analysis Group (TAG)
- USS Connecticut (SSN-22)
- USS Hartford (SSN-768)
- HMS Trenchant (S91)
- Alaska Command (ALCOM), US Northern Command
- Special Operations Command North
- Royal Navy, Maritime Warfare Center (MWC)
- UK Ministry of Defense (MOD)
- Royal Navy, Joint Operations Meteorology and Oceanography Centre
- Royal Canadian Air Force 440 Transport Squadron
- Alaska Air National Guard 212th Rescue Squadron
- Alaska Air National Guard 176th Wing
- US Marine Corps Mountain Warfare Training Center
- USMC 3rd Battalion, 8th Marines Regiment
- USMC 1st Transportation Support Battalion
- US Air Force Operational Test Center
- US Army Cold Regions Research Lab
- US Coast Guard Dive Locker West
- US Coast Guard Air Station Kodiak
- Navy Explosive Ordinance Disposal Group 2
- Naval Construction Group, Underwater Construction Team One
- Navy Mobile Diving Salvage Unit (MDSU) 2
- Navy SEAL Delivery Vehicle Team 1
- Naval Research Laboratory (NRL)
- Commander Navy Meteorological Operations Center (CNMOC)
- Naval Postgraduate School (NPS)
- National/Naval Ice Center (NIC)
- Navy Undersea Warfare Center (NUWC)
- Office of Naval Research (ONR), Global
- Lead Development Test Organization (LDTO)
- Special Reconnaissance Team One
- Naval Submarine Support Center (NSSC) Pearl Harbor
- Commander, Submarine Development Squadron Five
- ARCO (ARDM 5)

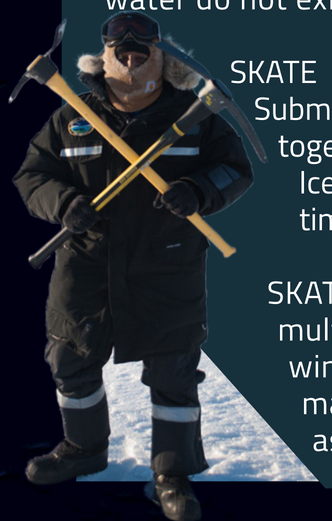
SHIP'S DESCRIPTION & VITAL STATISTICS

	USS CONNECTICUT	USS HARTFORD	HMS TRENCHANT
Builder:	General Dynamics Electric Boat Division	General Dynamics Electric Boat Division	Vickers Shipbuilding, Barrow-in-Furness
Keel Laid:	September 14, 1992	February 22, 1992	October 28, 1985
Launched:	September 1, 1997	December 4, 1993	November 3, 1986
Commissioned:	December 11, 1998	December 10, 1994	Janaury 14, 1989
Ship's Sponsor:	Mrs. Patricia L. Rowland	Mrs. Laura O'Keef	-
Class:	Seawolf	Improved Los Angeles	TRAFALGAR
Displacement	9138 tons	6900 tons	5300 tons
Length Overall:	353 Feet	360 Feet	280 Feet
Max Depth:	800 Feet	800 Feet	1000 Feet
Max Speed:	25 Knots	25 Knots	30 Knots
Crew Size:	140 Officers & Enlisted	141 Officers & Enlisted	130 Officers & Enlisted
Homeport:	Bremerton, WA	Groton, CT	Devonport, Plymouth
Squadron:	COMSUBDEVRON FIVE	Twelve	DEVFLOT
Namesake:	State of CT	The City of Hartford, CT	WWII T-Class Submarine

Location of ICEX 2018

ICE CAMP SKATE

Ice Camp SKATE is a small, complex, temporary outpost built on an drifting ice floe (frozen sea ice) north of Alaska. The purpose in building this camp is to support a submarine tactical development and torpedo exercise. A unique under-ice tracking range and torpedo recovery operations comprise a majority of the footprint and infrastructure. Since ICEX 2016, ASL has been able to incorporate other national and DOD Arctic strategic objectives at the same time as submarine operations. There are sufficient berthing tents to accommodate about 50 residents. There is a small electrical generator grid with power lines providing electricity to all of the buildings. There is a U.S. Navy Doctor and a Helicopter at the camp should any emergency arise. With a dynamic and unpredictable Arctic environment and changing sea-ice conditions, the Ice Camp is expeditionary in nature and accommodations like running water do not exist.

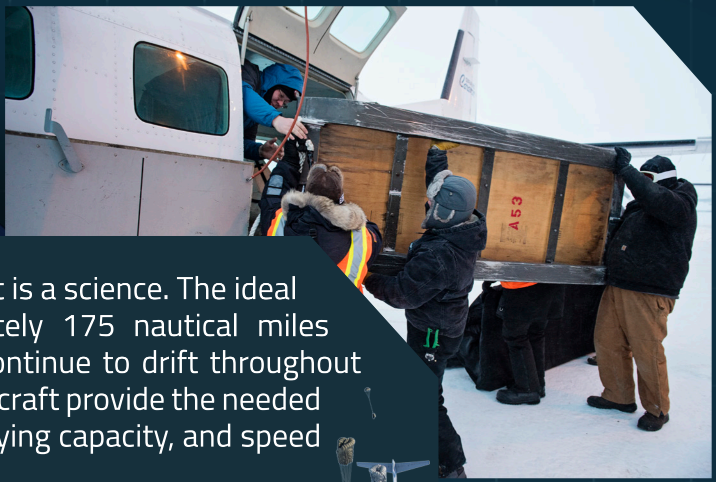


SKATE is staffed with experienced Navy civilian personnel from the Arctic Submarine Laboratory and a diverse group of military personnel who came together in the planning process to support or conduct operations from the Ice Camp. For many of the ICEX 2018 participants, this will be their first time in the Arctic and operating under and on-top of frozen sea ice.

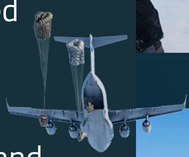
SKATE is built on a shell of thick ice that covers a deep ocean basin. It has multiple runways using sea ice that has grown over the first winter. Fixed wing aircraft conduct daily flights to maintain its connection with the mainland and people move about as often by snowmobile or helicopter as they do on foot.

At the heart of SKATE is the Command Center. From this nerve center, camp personnel keep tabs on all operations, personnel movements, monitor any changes in the weather or the ocean environment, control the movement of aircraft, and stay in touch with their lifeline back in Prudhoe Bay. Range Safety Officers (RSOs) monitor every movement of the submarines using an acoustic tracking range. The RSOs also employ underwater voice and digital communications to assist the submarines in positioning themselves relative to the camp sensors, coordinate the submarines' test activities with the personnel on the ice, and direct the submarines to safe areas of thinner ice when it is time to surface.

ESTABLISHING AN ICE CAMP



Building an ice camp is as much an art as it is a science. The ideal location of the ice camp is approximately 175 nautical miles offshore, however the chosen floe will continue to drift throughout the duration of the exercise. Fixed wing aircraft provide the needed camp support because of their range, carrying capacity, and speed when compared to those of a helicopter.



In order to land an aircraft on sea ice the pilot needs two things: ice thick enough to support the aircraft, but smooth enough to land on, and daylight. These two constraints, along with the required stability of the ice floe, define a narrow window for an ice camp to a few weeks in late winter/early spring. Establishing an ice camp outside these periods is risky and involves a larger investment in logistics. Setting up a camp in March has the added advantage of increasing amounts of daily sunshine.

Finding a suitable location for an ice camp requires an understanding of the Arctic Ocean and sea ice. Candidate floes must first be identified using satellite imagery analyzed by the Naval Ice Center (NAVICE). Camp personnel then utilize the imagery, which identify areas with candidate floes, and survey the prospective locations while onboard a U.S. Coast Guard Arctic Domain Awareness flights in late February. Within a few days, they had visited many of the candidate floes using lightweight aircraft and selected the site for constructing the ice camp. This team had an appreciation for what constitutes stable ice, the type of ice needed for landing aircraft, and the type of floe needed for the ice camp operations.

Once the site was identified, aircraft flights to the chosen floe made the maximum use of daylight to ferry out all of the necessary equipment for constructing a small encampment on the ice. The deadline for having a fully functioning camp and tracking range was the arrival of the submarines - less than two weeks after the first reconnaissance flight.

The camp can support a population of about 50 people with a mixture of full-time staff and various ICEX projects. Nothing about the camp is luxurious. But for three weeks, it will be a home, a submarine tracking station, an operational, test, and evaluation platform, a small airport, and the only source of shelter, heat, water, and a hot meal for 175 miles in any direction.

The Arctic Environment

Whether one looks at the Arctic Ocean from a military, geographic, or scientific perspective, it is truly unique. The Arctic remains one of the most challenging ocean environments on earth to observe, model and predict environmental conditions. A few facts will illustrate the distinctive nature of the Arctic Ocean.

Although the Arctic is only 3.6% of the total area of the world's oceans, it contains 25% of the world's continental shelf area - generally defined as water less than 100 fathoms (600 feet) deep. The Arctic Ocean also receives 10% of the world's total fresh water river runoff. It is also partially covered by sea ice throughout the year and almost completely in winter. The Arctic Ocean's surface temperature and salinity vary seasonally as the ice cover melts and freezes; its salinity is the lowest on average of the five major oceans, due to low evaporation, the heavy fresh water inflow from rivers and streams, and limited connection and outflow to surrounding oceanic waters with higher salinities. The combination of these factors causes Arctic Ocean salinity and density to vary dramatically. Because of the cold atmospheric temperatures, the ocean beneath the ice is coldest at the surface and warms at deeper depths – the inverse of more temperate oceans.

Both the Atlantic and the Pacific Oceans provide input to the Arctic. The water arriving in the Arctic from the Pacific must pass across hundreds of miles of the shallow Bering Strait region. As a result, it is very cold and extremely rich in nutrients. On the other hand, Atlantic water enters the Arctic mainly through the deep Greenland Sea. As a result, this water has fewer nutrients and is much warmer. Thus, the overall heat budget of the Arctic Ocean is driven not just by atmospheric temperatures and ice cover, but also by the balance between Atlantic and Pacific waters in the deep Arctic Basin. Data collected since the early 1990s (primarily by submarine launch of expendable oceanographic devices) indicate that this balance had swung in favor of the Atlantic waters, resulting in an overall warming of the Arctic Ocean.

ARCTIC ICE TYPES

There are actually two kinds of ice in the Arctic:

ICEBERGS

Icebergs are chunks of glaciers that have broken free ("calved") and are floating in the ocean. These are composed of fresh water ice that originated on land. The primary sources of icebergs are the glaciers in Greenland. Due to the absence of glaciers near Alaska's North Slope, and the general circulation pattern of the Arctic Ocean, you should not see any icebergs near Ice Camp SKATE.

ICE PACK

The primary form of ice in the Arctic Ocean is sea ice, which is in various stages of development throughout the year. Sea ice covers the majority of the Arctic Ocean and its peripheral seas in winter, and then recedes to its minimum extent during the summer melt season. Sea ice varies in thickness between a fraction of an inch to 10 or 12 feet, depending on how many melt seasons it has survived. When winds and currents cause interaction between different sections (floes) of ice, it is distorted into ridges (that extend above sea level) and corresponding keels (that extend below). The deepest ice keel observed to date was 189 feet deep. This was in the Lincoln Sea where ocean currents pile the ice against the north coasts of Greenland and Canada.

ICE FLOE RIDGES

REMEMBER

WHEN YOU ARE AT THE ICE CAMP,
YOU WILL BE WALKING ON FROZEN OCEAN.

Why do we need Subs in the Arctic

The Ice Exercise (ICEX) program is an important means by which our Submarine Force develops and hones its operational and warfighting skills in the challenging and unique Arctic environment.

The continents of the Northern Hemisphere - Europe, Asia, and North America - all share the Arctic Ocean. Yet, the Arctic region is primarily a maritime domain and a critical waterway that connects the Atlantic and Pacific Oceans. For that reason, freedom of the seas remains a top national priority. Preserving the rights and duties relating to navigation in the Arctic region supports our ability to exercise these rights throughout the world.

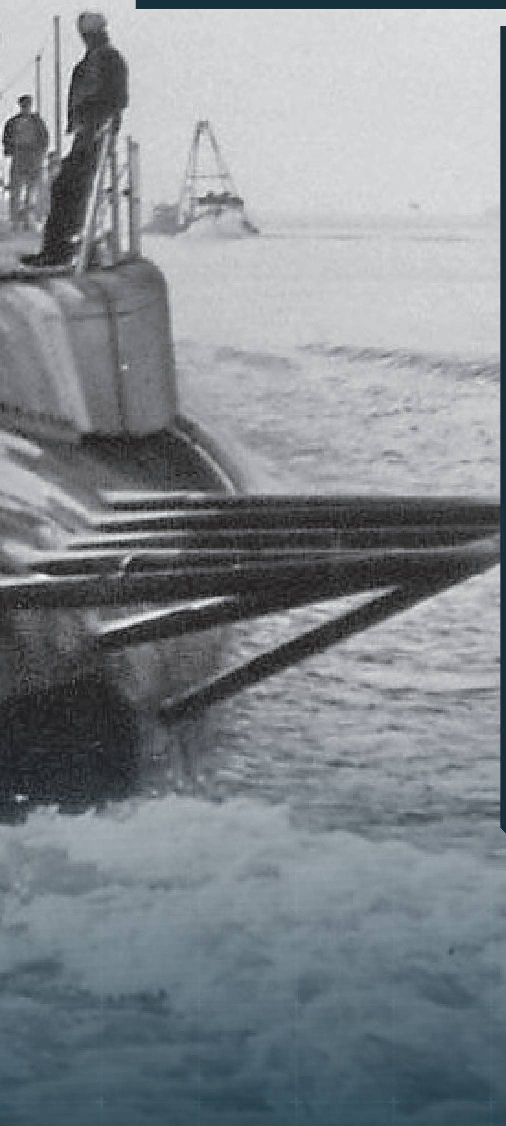
ARCTIC STRATEGY

The United States' strategy in the Arctic is codified in the documents described below, all of which highlight the important role of the Arctic in our national defense:

- National Security Presidential Directive-66/Homeland Security Presidential Directive-25 established the policy of the United States with respect to the Arctic region; which states the U.S. will, "Meet national security and homeland security needs relevant to the Arctic region."
- A National Strategy for the Arctic Region was released by the President in May 2013. It states that the United States will, "Seek to maintain and preserve the Arctic region as an area free of conflict, acting in concert with allies, partners, and other interested parties."
- The Department of Defense Arctic Strategy, released in November 2016, listed two objectives: Ensure security, support safety, and promote defense cooperation and prepare for a wide range of challenges.
- The February 2014 U.S. Navy Arctic Roadmap requires the Navy to be fully mission-capable in the Arctic.

The most recent statement of United States' strategy in the Arctic is presented in the 2016 Report to Congress on Strategy to Protect United States National Security Interests in the Arctic Region:

- The report, issued in December 2016, updated the DoD Arctic Strategy and states that DoD's strategic approach is guided by its main objectives of ensuring security, supporting safety, and promoting defense cooperation as it prepares to respond to a wide range of challenges and contingencies in the Arctic in the years to come. It is in the national security interest of the United States for DoD to strengthen partnerships with Arctic allies and partners. It is also in DoD's interest to shape military activity in the Arctic region to avoid conflict while improving its capability to operate safely and sustain forces in a harsh, remote environment in anticipation of increasing accessibility and activity in the Arctic in the coming years.
- The Arctic generally remains an area of cooperation, ranging from scientific, environmental, and economic collaboration under the auspices of the Arctic Council to military and coast guard cooperation to enhance maritime domain awareness and improve search and rescue (SAR) capabilities, exercise sovereignty, conduct bilateral and multilateral training and exercises, and develop Arctic transportation.
- ICEX and similar exercises maintain extreme cold weather operational skills and continue longstanding practices of regular military access to Arctic air, sea, and subsurface regions.



Through its ICEX Program, the Submarine Force supports these DoD strategy goals. At the same time, ICEX serves as a model and a potential springboard for other naval forces, DoD and interagency organizations, and partner nations to test and improve their own Arctic capabilities.

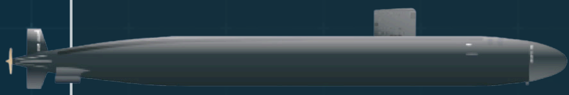
In order to meet these national objectives, the Submarine Force must overcome the operational challenges presented by the Arctic. These challenges impact many ways in which a submarine operates and fights. ICEX is part of the process by which we evaluate and improve our combat systems, sonar systems, communication systems, and navigation systems in this challenging operational environment.

The U.S. Navy's Arctic Submarine Laboratory (ASL) mission is to develop and maintain operational expertise for the Submarine Force and install special equipment on submarines used to enhance the safety and efficiency of under-ice operations. ASL provides the unique Arctic-specific skills, knowledge, equipment, and procedures for submarine Arctic operations and drifting ice stations. ASL's experienced Arctic Operations Specialists (AOS) embark on submarines that deploy under the ice and serve as advisors to the Commanding Officer and crew. ASL also serves as the lead technical agency for the biennial ICEX program and represents the continuity and core manpower for the Ice Camp and submarine exercise. ASL is one of only a few Arctic dedicated commands representing over 70 years of operational experience.

U.S. Sub Capabilities

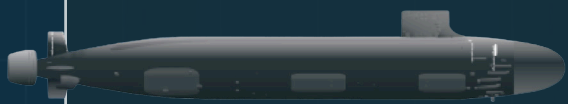
The United States Navy currently has three classes of fast attack submarines (SSNs), all of which are capable of operating in the Arctic.

LOS ANGELES CLASS



- The LOS ANGELES (688) Class, first introduced in the mid-1970's
- The Improved LOS ANGELES (688I) Class, first introduced in the mid-1980s. Among the improvements incorporated into these submarines were the structural strengthening and other modifications to give it a full ice-breakthrough capability.

SEAWOLF CLASS



- The SEAWOLF (SSN 21) Class, first introduced in the late 1990s. There are only three ships are in this class - USS SEAWOLF, USS CONNECTICUT, and USS JIMMY CARTER.
- Most Arctic capable

VIRGINIA CLASS

- The VIRGINIA Class, first introduced in 2005. USS TEXAS was the first of this class to operate in the Arctic during the fall of 2009.

BREAKTHROUGH CAPABILITY

All classes are capable of breaking through some amount of ice

- The 688 class is the most restricted because of their sail planes. Unlike earlier classes, 688s cannot rotate their sail planes to the full vertical position. As a result, this class is limited to less than about 1½ feet of ice breakthrough.
- Both the 688I and SEAWOLF classes have bow-mounted planes which eliminate this concern. They were designed to surface through at least three feet of ice and have repeatedly demonstrated this capability.
- The VIRGINIA class was designed to have similar breakthrough capability to the original 688 class. Although it is estimated that they could surface through at least 3 feet of ice, we limit the VIRGINIA class to surfacing through open water or slush because of fragile systems mounted atop their sails.

Ice Keel Avoidance (IKA) Sonars.

- All of our SSNs are equipped with high frequency sonars capable of detecting ice hazards protruding down into the water column.

TEMPORARY ALTERATIONS

The following special sensors - called Temporary Alterations, or TEMPALTs - are installed aboard submarines by the Arctic Submarine Laboratory to enhance their Arctic operability.

- **The Submarine Remote Video System (SRVS).** This is a low-light capable underwater camera, mounted flush with the top of the submarine's sail, which provides a view of the underside of the ice canopy. Relying entirely on natural sunlight, this camera allows the submarine to evaluate ice features and monitor its movement when preparing to surface. It also shows cracks in the ice, variations in the snow cover.
- **Environmental CTD sensor.** The acronym stands for the three parameters that it measures - Conductivity, Temperature, and Depth. From these, the system's computer can calculate other essential data, such as the speed of sound - needed for making sonar performance estimates - and density - needed to track the severe density gradients encountered in the Arctic Ocean, especially when surfacing through the upper, low salinity stratum.
- **The Side Scan Sonar System.** ASL uses commercial side scan systems and, after ice hardening, installs them on the sides of the submarine's sail. Pointed upward, these give a picture-like record of the underside of the ice canopy in a swath about a mile wide. The resulting image is similar to close-up pictures of the moon's surface. This tool is the primary means by which submarines search for thin-ice features that can be used to surface through the ice.

UK Sub Capabilities

The Royal Navy currently has two classes of Fleet Submarines, all of which are capable of operating in the Arctic.

ASTUTE CLASS

- The ASTUTE Class, first introduced in 2010 is the replacement for the TRENCHANT Class

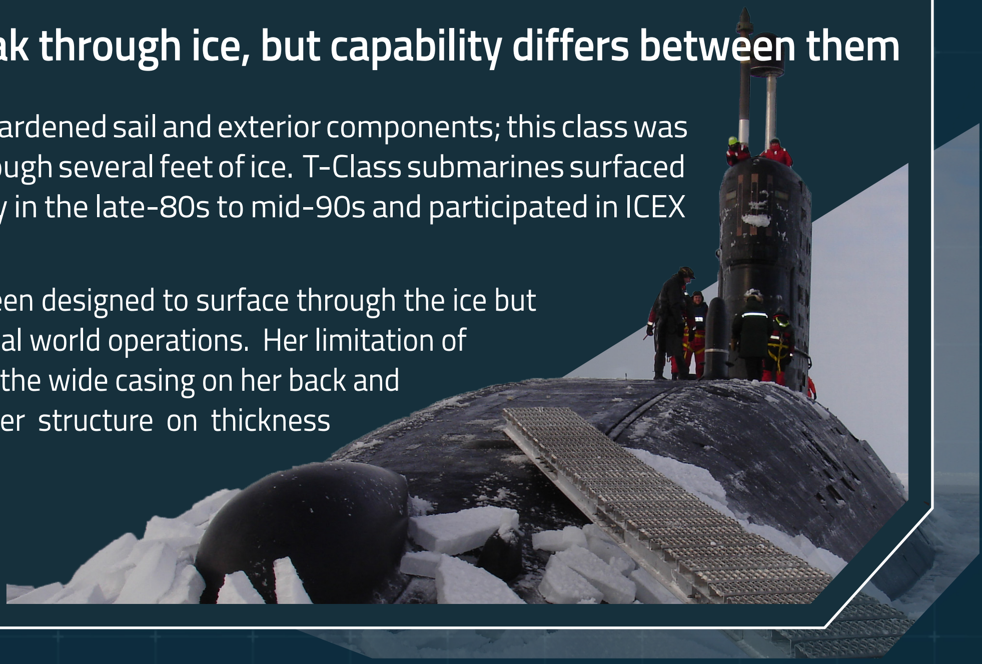
TRAFALGAR CLASS

- Capable of breaking through 0.6m of ice owing to the composite rudder, but could easily achieve similar to 688i accepting potential damage in emergency
- The TRAFALGAR Class, first introduced in 1983 as the replacement for the SWIFTSURE Class

BREAKTHROUGH CAPABILITY

All classes can break through ice, but capability differs between them

- The TRAFALGAR has a hardened sail and exterior components; this class was designed to surface through several feet of ice. T-Class submarines surfaced through the ice regularly in the late-80s to mid-90s and participated in ICEX until 2007.
- The ASTUTE Class has been designed to surface through the ice but has not been proven in real world operations. Her limitation of ice thickness is driven by the wide casing on her back and possible damage to super structure on thickness greater than 2 feet.



History of the UK in the Arctic

On March 3, 1971, Great Britain's first nuclear submarine, HMS DREADNOUGHT (S 101) became the first of several British submarines to reach the North Pole. Since then the British Navy has maintained an interest in under-ice capabilities and several additional British submarines have made voyages to the Arctic, often operating jointly with U.S. submarines.

OTHER NOTABLE ARCTIC OPERATIONS

- **1976 SOVEREIGN (S 108)** – October 20 – surfaced at the North Pole as part of 'Operation Brisk' in exercises designed to test the submarine's cold-water navigational, equipment, and operational capabilities.
- **1987 SUPERB (S 109)** – May 18 – surfaced at the North Pole in company with U.S. submarines BILLFISH and SEA DEVIL sending the signal 'On top of the world!' The reply from Operational Headquarters: 'Steer South.'
- **1987 TURBULENT (S 87)** – Conducted coordinated under-ice trials of the Tigerfish torpedo with SUPERB (S 109) . Afterwards, TURBULANT conducted a solo surfacing at the North Pole.
- **1989 TIRELESS (S 88)** – Conducted multi-submarine operations in the Arctic with HMS SUPERB.
- **1991 TIRELESS (S 88)** – Conducted joint Arctic operations with USS PARGO (SSN 650).
- **1996 TRAFALGAR (S 107)** – September – Scientists from Scott Polar Research Institute & Scottish Association for Marine Science on board for British version of American SCICEX.
- **2004 TIRELESS (S 88)** – April 19 – ICEX-04 with USS HAMPTON (SSN 767), 1st multi-national surfacing at the Pole since 1991.
- **2007 TIRELESS (S 88)** – ICEX(07) Conducted testing in the Arctic along with USS ALEXANDRIA (SSN 757). TIRELESS suffers the loss of two crewmen after an explosion on board the boat.
- **2018 HMS Trenchant (S91)** – ICEX(18) participant to re-establish under-ice capability following an 11 year hiatus from Arctic operations. The experience gained will be leveraged in establishing ASTUTE Class under-ice operations.

Operating Subs in the Arctic

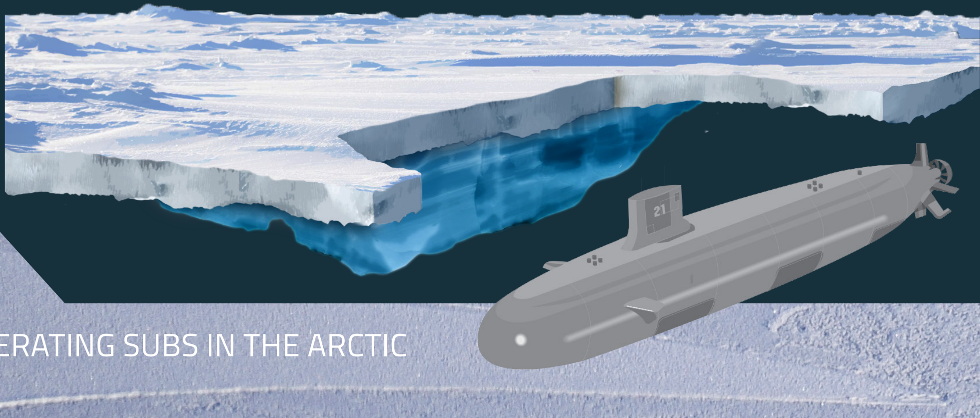
Experienced Arctic travelers know that nothing ever works the same in the Arctic as in warmer climates. This is very true for submarines. Because of the cold temperatures and the presence of ice, anything the submarine has or does that interfaces with the environment works or is performed differently in the Arctic.

One major impact on submarines is the variation in water density. Though the submarine will operate in the Arctic, it must transit through sub-Arctic waters. In order to maintain neutral buoyancy in these conditions, a submarine must be able to match the density of the surrounding water. The need to operate in both sub-Arctic and Arctic waters is just one of the design considerations on how much weight can be designed into a submarine.

The cold temperatures also impact the engineering of our submarines. Since normal shallow Arctic Ocean temperatures are about 29°F (below the freezing point of fresh water), no piping containing fresh water may come in contact with the ocean. Submarines also use seawater systems to remove heat from the ship's atmosphere, engineering plant, and auxiliary systems. Since the frigid Arctic's water is much more efficient at removing heat than the water in more temperate oceans, our submarines must be engineered to adapt to these differences.

While some of these factors are addressed in the design of our submarines, other factors can only be addressed by adapting the way in which our submarines are operated.

The most significant of these changes come about in response to the ice - seen by the submarine as an ice "canopy." Whenever a submarine is operating at a shallow depth - by choice or if forced to by being in shallow water - it must be constantly vigilant for threatening ice keels. This is done using high frequency Ice Keel Avoidance (IKA) sonar which is capable of detecting hazards at sufficiently long range to permit the submarine an opportunity to take avoiding maneuvers.



In normal conditions, if a submarine needs to update its location from a navigation (GPS) satellite, transmit a message, or take in fresh air, it simply drives up to periscope depth. Going to periscope depth is also the immediate response to most submarine casualties. Submarines cannot do this when operating beneath the ice. Instead, they must ascend through small areas of open water or find a large, thin, flat ice feature, hover beneath it, and break through the ice vertically using its strengthened sail. This through-ice surfacing requires a number of special preparations:

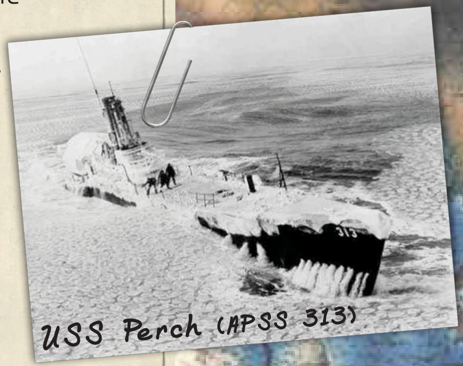
- The submarine's sail and topside superstructure must be designed to withstand the impact and loading of the ice.
- Prior to venturing to the Arctic, crews must practice the surfacing evolution until perfected.
- The Arctic Submarine Laboratory installs extra sensors aboard these submarines to assist in detecting, mapping, and monitoring surfaceable features.

Because of the unique density layers in the Arctic, sonars perform differently here than in other oceans. There is a tendency for sound to bend upward where it is scattered, weakened, and distorted by the irregular ice overhead. Submariners need to understand these differences in order to get the most out of our sonars and torpedoes.

The way that submariners (along with mariners, aviators, and researchers) normally monitor the ocean environment is to extend probes that provide a vertical temperature profile. Under standard ocean salinity conditions, this temperature profile may be converted easily into a sound speed profile (SSP). Here again, normal procedures must be adapted because the Arctic has highly variable salinities. For this reason, submarines deploying to the Arctic must carry special probes that measure sound speed more precisely and are designed to avoid impact with the ice.

History of ICEX

In order to support U.S. strategic objectives, our submarines need to maintain the ability to operate and fight in the Arctic. The Ice Exercise (ICEX) program, along with other routine Arctic transits, is the long-standing means by which our Submarine Force develops and hones its Arctic operational and warfighting skills in order to meet these challenges.



USS Perch (APSS 313)

The ICEX program was developed by ASL's founder, Dr. Waldo Lyon in the early 1940s. Dr. Lyon recognized the threat, the challenge, and operational need in the Arctic.

Starting in the late 1940s, the Submarine Force and ASL began exploring the potential for under-ice operations. Initially using diesel submarines, short excursions were made beneath the Marginal Ice Zone (MIZ) in the North Atlantic Ocean, the Bering and Chukchi Seas, and the waters off the Antarctic continent. The lessons learned from these cruises were put to outstanding use when, in 1958, the nuclear-powered USS NAUTILUS made the first crossing of the Arctic Ocean beneath the pack ice.

USS Nautilus (SSN-571)

The USS NAUTILUS cruise was followed in quick succession by other cruises using USS SKATE class submarines. These cruises, coupled with tests conducted in the Arctic Submarine Laboratory (ASL) Experimental Ice Pool, helped define the capabilities required to operate beneath the Arctic ice canopy. Starting in the late 1960s and running through the 1990s, the bulk of the ICEX missions were carried out by USS STURGEON class submarines. These ships were designed from the keel up to be fully Arctic capable and, as such, could prowl the front lines of the Cold War. In the mid-1980s, Great Britain's Royal Navy joined in the ICEX program, reflecting our nations' shared interest of maintaining Arctic/cold water operability.

USS Ray (SSN-653)
Sturgeon-class attack submarine

Throughout this period, at least one submarine deployed to the Arctic every year, with some years seeing five or six under-ice cruises. The purpose of these deployments was to maintain our submarines and crews ready to operate and, if necessary, fight in the Arctic.

What Subs are Doing during ICEX:

PRACTICING

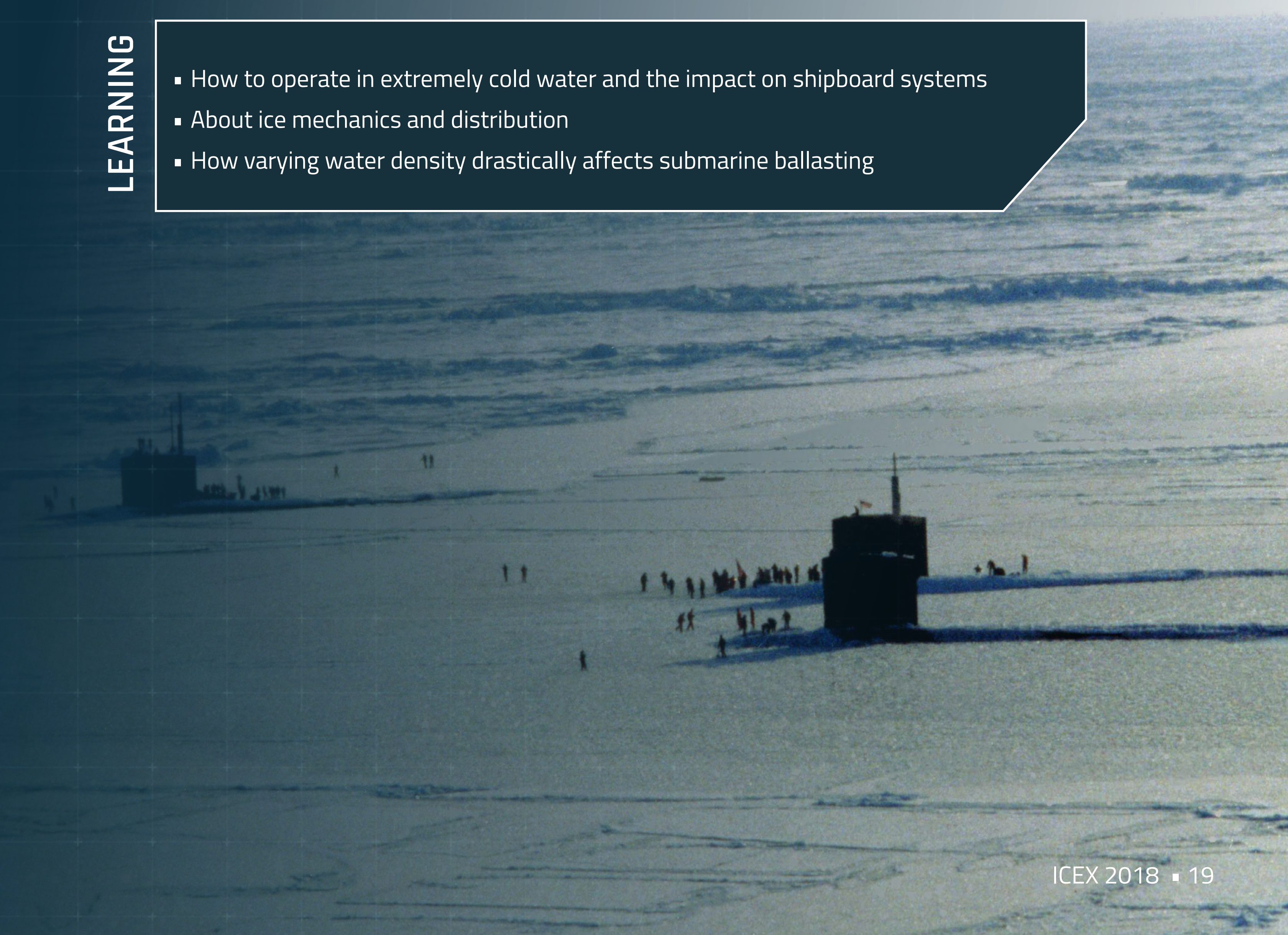
- How to surface through the ice
- How to find ice that a submarine could surface through
- How to navigate in high latitudes with no external references
- How to detect and avoid ice keels and icebergs which can extend hundreds of feet below the ocean's surface
- How to communicate when ice cover blocks most radio signals

OPERATING

- Sonar systems
- Weapons systems
- Developing tactics unique to the Arctic

LEARNING

- How to operate in extremely cold water and the impact on shipboard systems
- About ice mechanics and distribution
- How varying water density drastically affects submarine ballasting



ICEX 2018 is a multi-national exercise that includes a UK submarine and air assets from the Royal Canadian Air Force.

PARTNER NATIONS ARCTIC COOPERATION

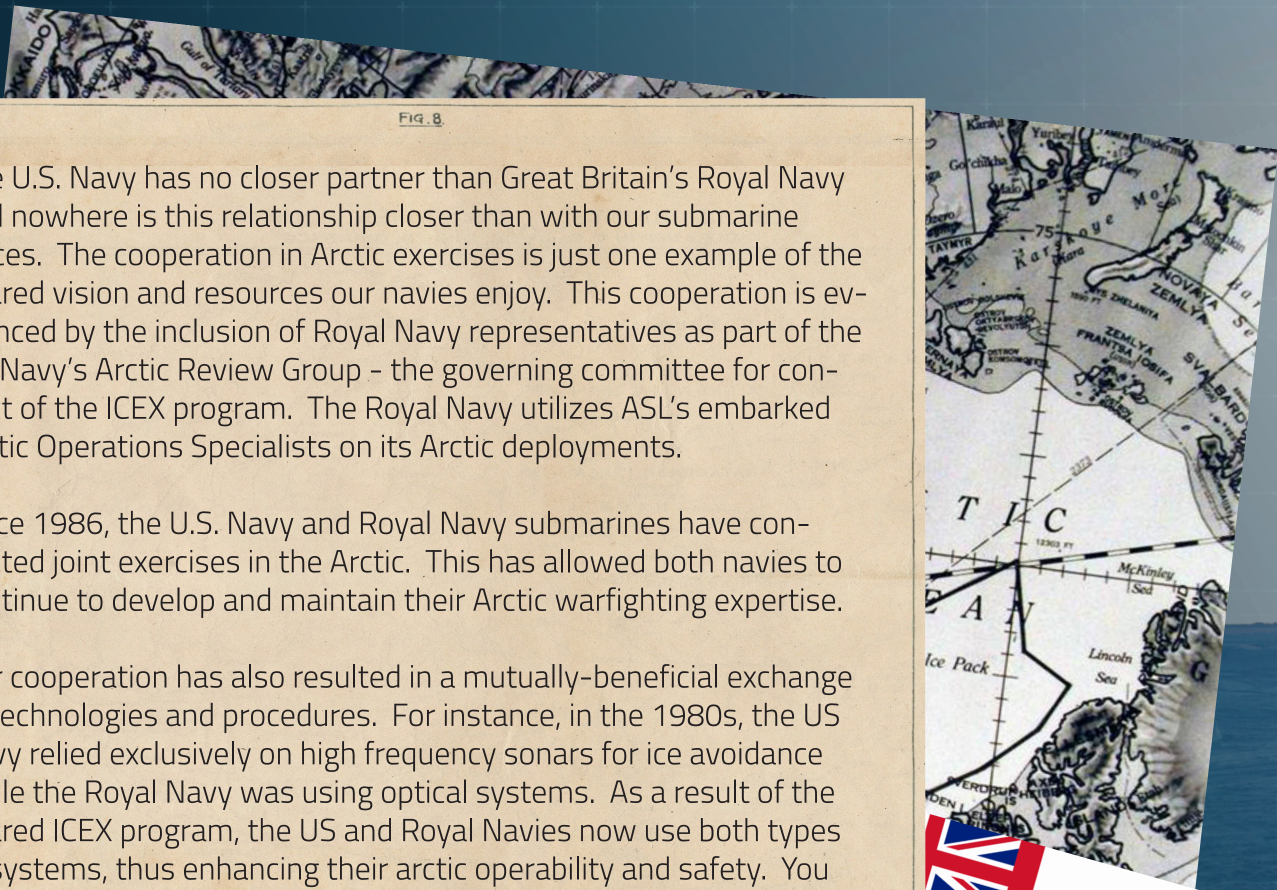


FIG. 8

The U.S. Navy has no closer partner than Great Britain's Royal Navy and nowhere is this relationship closer than with our submarine forces. The cooperation in Arctic exercises is just one example of the shared vision and resources our navies enjoy. This cooperation is evidenced by the inclusion of Royal Navy representatives as part of the US Navy's Arctic Review Group - the governing committee for conduct of the ICEX program. The Royal Navy utilizes ASL's embarked Arctic Operations Specialists on its Arctic deployments.

Since 1986, the U.S. Navy and Royal Navy submarines have conducted joint exercises in the Arctic. This has allowed both navies to continue to develop and maintain their Arctic warfighting expertise.

Our cooperation has also resulted in a mutually-beneficial exchange of technologies and procedures. For instance, in the 1980s, the US Navy relied exclusively on high frequency sonars for ice avoidance while the Royal Navy was using optical systems. As a result of the shared ICEX program, the US and Royal Navies now use both types of systems, thus enhancing their arctic operability and safety. You will see both of these in use while you are embarked. The participation of the Royal Navy in ICEX 2018 is the continuation of a long-standing, mutually beneficial relationship.

During the 1980s and 1990s, the US Submarine Force conducted numerous joint Arctic exercises with the Canadian military. The end of the Cold War reduced both nations' focus on northern affairs and our interactions with the Canadians slowed. Recent years have brought a renewed interest in the Arctic and our navies are now again cooperating in Arctic exercises. Starting with ICEX 2011, Canada has had a presence at our ice camps. In 2016, the Royal Canadian Air Force (RCAF) participated with transport aircraft assisting in personnel and equipment movement between Deadhorse and Ice Camp.

Glossary of Terms

- **ICEX:** A term used to describe the U.S. Navy Submarine Force exercise being conducted in the Arctic Ocean. The term is an acronym for ICE Exercise.

- **Navy Ice Camp SKATE:** One of the destinations is a temporary drifting ice station built on the Arctic Ocean sea ice about 175 nautical miles north of Deadhorse (Prudhoe Bay), Alaska. The camp is a small outpost, built especially for this naval exercise and entirely dependent upon aircraft support for its survival. The Arctic Submarine Laboratory provides the core team to build and staff essential functions to operate the camp.

- **Project Aircraft:** A mixture of fixed and rotary aircraft will be employed to ferry your party between Alaska and the ice camp. Fixed wing aircraft are equipped with larger than normal “tundra” tires to make smoother landings on sea-ice “runways” or skis. All aircraft were chosen for the cold and sea-ice environment to support personnel and logistics operations in and out of SKATE.

- **Prudhoe Bay, Alaska:** This term has many different meanings. Technically, Prudhoe Bay is an indentation along the north coast of Alaska, approximately 200 miles southeast of Point Barrow. “Prudhoe Bay” is also used to refer to the oil development region which has built up in the proximity of this bay. Additionally, it is sometimes used to refer to the most significant village in the region, also called Deadhorse.

- **Deadhorse, Alaska:** A village (also known as “Prudhoe Bay”) on the north slope of Alaska – the northern starting point of the Alaska Pipeline.

- **North Slope Borough:** Alaska is divided into boroughs that are similar to counties. Like everything in Alaska, the North Slope Borough is large – about the size of the state of Minnesota. Its offices are in Barrow (formerly changed to Utqiaġvik), about 200 miles up the coast from Deadhorse.

- **North Slope:** The North Slope of Alaska is the gently sloping coastal plain between the east-west tending Brooks Range and the Arctic Ocean. The term is also sometimes used to refer to the oil producing area of the coastline centered in the vicinity of Prudhoe Bay, the northern terminus of the Alaska Pipeline. The pipeline runs 800 miles south to the oil terminal of Valdez on the Gulf of Alaska.


ARCTIC SUBMARINE
LABORATORY