

POLAR ROUTE OPERATIONS

The official opening of cross-polar routes in February 2001 marked an important step in air travel between North America and Asia. These new routes offer time, fuel, and environmental advantages over conventional routes and allow nonstop service between new city pairs. Operations are similar in many ways to conventional long-range routes. After two and one-half years and more than 650 demonstration flights, airlines have the experience and planning tools to make polar operations routine.

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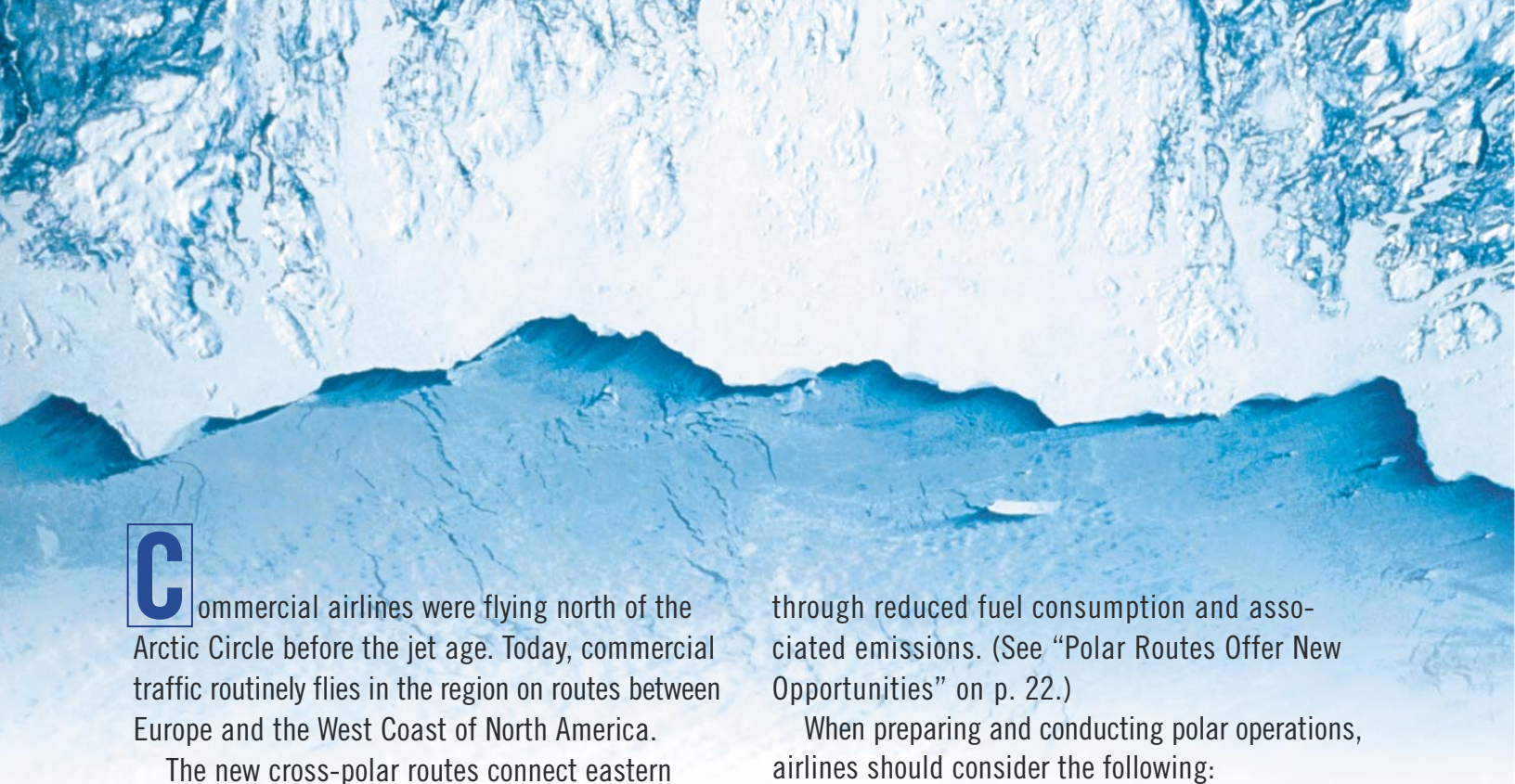
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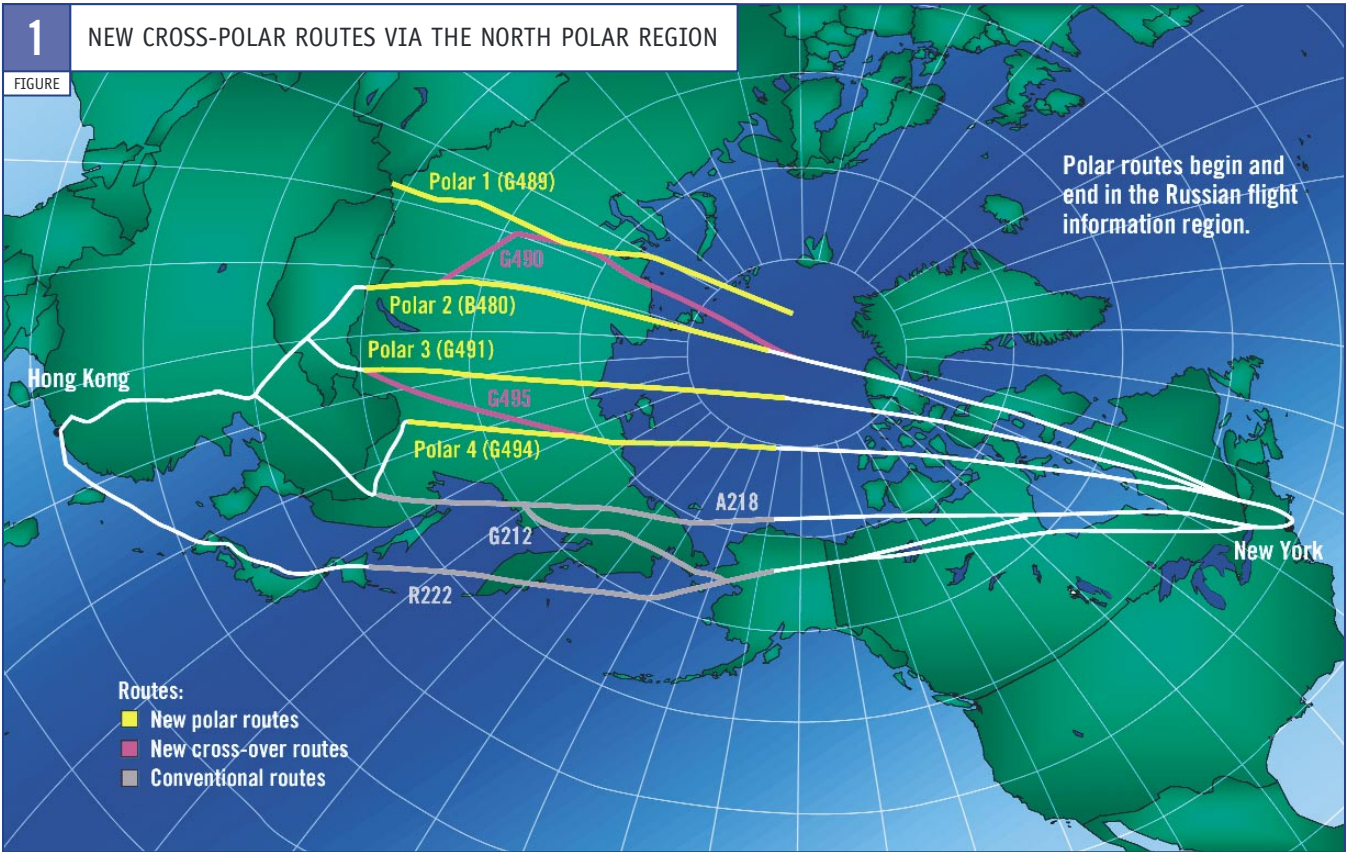
Commercial airlines were flying north of the Arctic Circle before the jet age. Today, commercial traffic routinely flies in the region on routes between Europe and the West Coast of North America.

The new cross-polar routes connect eastern and interior regions of North America to Asian cities via the North Polar region (fig. 1). These airways provide an attractive shortcut to Asia, which can open new air travel markets. These shortcuts also make service to existing city pairs more efficient

through reduced fuel consumption and associated emissions. (See “Polar Routes Offer New Opportunities” on p. 22.)

When preparing and conducting polar operations, airlines should consider the following:

1. Regulatory guidance.
2. En route alternate airports.
3. Cold fuel management.
4. Communication and navigation.



1 REGULATORY GUIDANCE

The U.S. Federal Aviation Administration (FAA) requires U.S. operators to obtain specific approval to conduct polar operations. The approval process validates airlines’ preparedness to conduct such operations. The FAA defines the North Polar area of operations as the area lying north of 78 deg north latitude (fig. 2, p. 14). The FAA information memorandum *Guidance for Polar Operations* (March 5, 2001) outlines 10 issues:

Airport requirements for designation as en route alternates.

All operators must define a sufficient set of alternate airports, such that one or more can be reasonably expected to be available in varying weather conditions. The FAA will assess the operators’ ability to safely land and maneuver airplanes off the runways at selected alternate airports. The selected alternates also must be able to provide for crew and passenger needs.

Airline recovery plan for passengers at diversion alternates.

All operators must have an FAA-approved recovery plan for unplanned diversions. The recovery plan should address the care and safety of passengers and crew at the diversion airport and provide a plan to transport passengers and crew from that airport. Operators should be able to demonstrate their ability to launch and conduct the recovery plan on their initial applications for polar route approval. Operators must maintain the accuracy and completeness of their recovery plans as part of their annual audits.

Fuel freeze strategy and monitoring requirements.

Operators can use a fuel temperature analysis and monitoring program in lieu of the standard minimum fuel freeze temperatures. In such cases, the program must be accepted by the FAA.

Communication capability.

Operators must have effective communication capability for all portions of the flight route. Operators accomplish this by using a combination of very-high-frequency (VHF) voice, VHF data link, high-frequency (HF) voice, HF data link, satellite communication (SATCOM) voice, and SATCOM data link systems.

Minimum equipment list considerations.

For polar operations dispatch, operators’ minimum equipment lists (MEL) must include the following:

- A fuel-quantity-indicating system that includes temperature indication.
- For two-engine airplanes, an auxiliary power unit (APU) that includes electrical and pneumatic supply to its designed capability.

- An autothrottle system.
- Flight crew communication systems that satisfy the FAA requirement for effective communication capability.
- An expanded medical kit with automated external defibrillators.

Airline training.

Operators must meet five requirements for their training programs:

- Training for flight crews and dispatchers on queen’s field elevation (QFE), queen’s normal height (QNH), and meter/feet altimetry as well as cold-temperature altitude correction procedures.
- Special curriculum segments on cold fuel management procedures for maintenance, dispatch, and flight crews.
- Route-specific training on weather patterns.
- Instructing maintenance personnel to provide information on airplane system capabilities to dispatch and flight crews, which will aid flight crews in diversion decisionmaking.
- The use of cold-weather antiexposure suits.

Long-range crew requirements.

Consistent with all long-range operations, operators must have approved crew rest plans and a clear progression of pilot-in-command authority.

Dispatch and crew considerations during solar flare.

Operators should be aware of the content of FAA Advisory Circular (AC) 120-52, *Radiation Exposure of Air Carrier Crewmembers*, and provide crew training as stated in AC 120-61, *Crewmember Training on In-Flight Radiation Exposure*.

Special equipment.

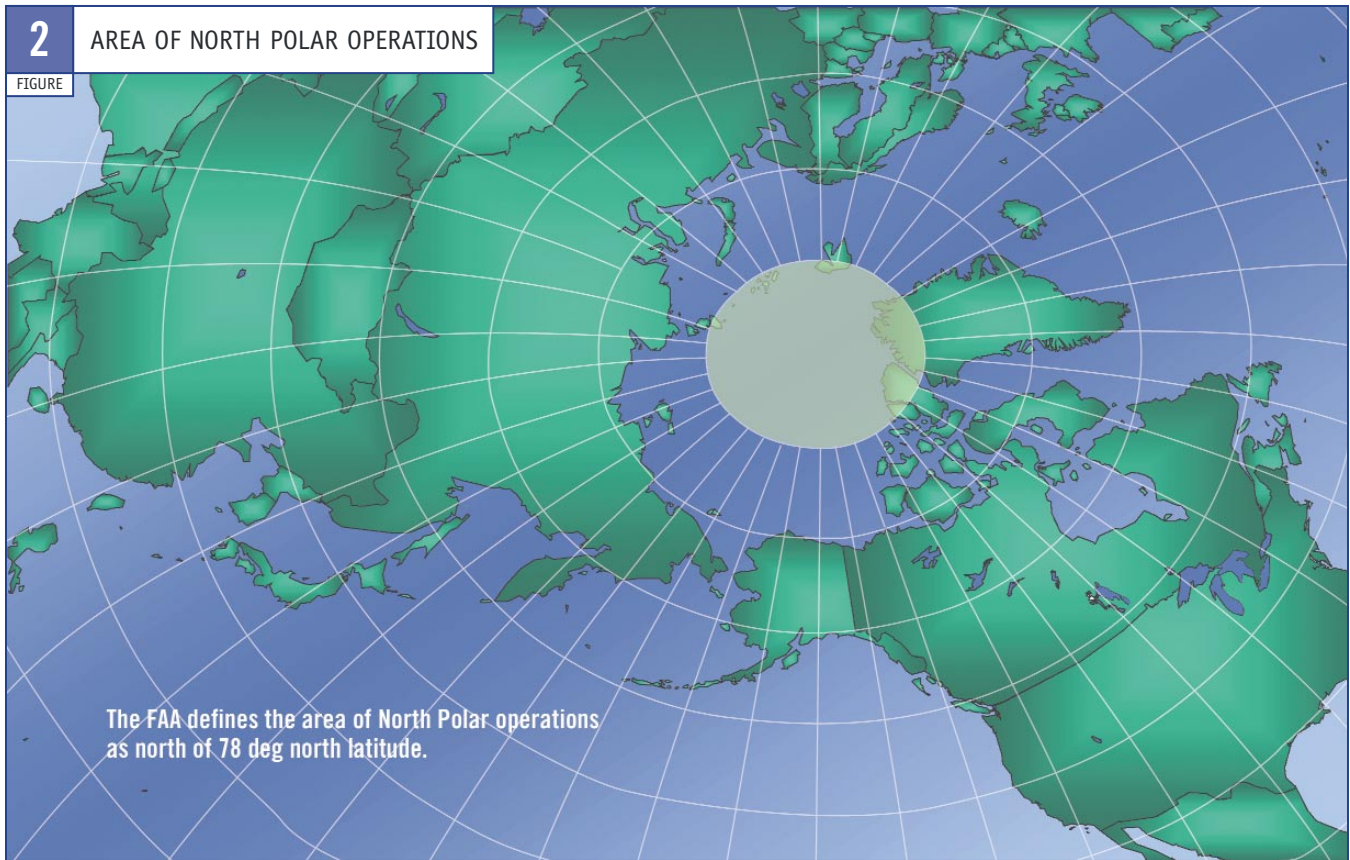
The FAA requires a minimum of two cold-weather antiexposure suits on board North Polar flights so that outside coordination at a diversion airport can be accomplished safely.

Validation requirements for area approval.

Operators are required to conduct an FAA-observed validation flight and reaction-and-recovery plan for a simulated airplane diversion at one of the designated en route alternate airports. The flight and plan implementation may be conducted together or separately. If the reaction-and-recovery plan is completed before the validation flight, the validation flight may be conducted as a revenue flight.

2 AREA OF NORTH POLAR OPERATIONS

FIGURE



2 EN ROUTE ALTERNATE AIRPORTS

The availability of alternate airports along a route is an important part of ensuring flight safety. Though much attention is paid to the very rare case of an in-flight engine failure, the vast majority of diversion causes are not engine related. It is very important, therefore, for all airplanes, regardless of the number of engines, to consider the availability and suitability of emergency alternate airfields. Considering this and the remote nature of cross-polar operations, the FAA has developed specific requirements regarding en route alternates on the polar routes.

Regulatory considerations for alternate airports.
The FAA *Guidance for Polar Operations* from the Flight Standards Service (AFS-1) requires airlines to define a sufficient set of alternate airports, such that one or more can be reasonably expected to be available in varying weather conditions.

The FAA looks for the following capabilities at alternate airports:

- A diverting airplane can land safely at the airport given the existing runway length, width, and load-bearing capacity.
- The diverted airplane can be cleared from the runway so that another airplane can land with maintenance personnel or depart with the passengers.
- Passengers and crew are able to deplane in a safe manner.
- Facilities at or near the airport can provide passengers with shelter and food while the airplane can be repaired or until alternate transportation can be provided.
- The recovery plan can be executed and completed within 12 to 48 hr after diversion.

Airport safety and operational assessments.
Boeing conducted airport safety and operational assessments (ASOA)



Yakutsk Airport Terminal
of 16 airports in Siberia and the Russian Far East from July 1998 to February 2001 with the Russian State Civil Aviation Authority, FAA, and airlines. The assessments examined the conditions of each airport and its capability to support flight diversions. In addition to onsite visits to facilities in the Russian Federation, three facilities in Alaska were assessed in support of North Pacific and Russian Far East tracks: Cold Bay, King Salmon, and Shemya Island/Eareckson Air Station (fig. 3). Although the capabilities of the airports varied, all were shown to be capable of supporting emergency diversions, and the majority were deemed adequate for use as alternates in

extended-range twin-engine operations. The ASOAs also identified how the airport infrastructures compared with the international standards of the International Civil Aviation Organization (ICAO).

Airlines preparing for polar operations should review the ASOAs to determine which airports suit the needs of their particular operational philosophies. Airlines also should contact the airports to assess changes that may have occurred since the assessments were conducted. Copies of the ASOAs are available to Boeing operators on line through MyBoeingFleet.com and on CD-ROM through their Boeing Field Service representative. (Note: Although the ASOAs are detailed assessments, they do not constitute certification of the individual airports.)

3 COLD FUEL MANAGEMENT

Because of the extended flight duration and the prevalence of very cold air masses on the polar routes, the

potential exists for fuel temperatures to approach the freezing point. However, current airplane systems and operating procedures provide confidence that fuel will continue to flow unobstructed to the engines in all plausible cold-weather conditions likely to be experienced on polar routes.

Properties of fuel at very low temperatures.

The *fuel freezing point* is the temperature at which wax crystals, which form in the fuel as it cools, completely disappear when the fuel is rewarmed. (This should not be confused with the fuel becoming cloudy upon cooling, which results when water dissolved in the fuel freezes, forming a suspension of very fine ice crystals. Airplane fuel and engine systems are designed to handle water ice crystals safely.)

The Jet A fuel specification limits the freezing point to a maximum of -40°C ; the Jet A-1 limit is -47°C maximum. In Russia, the fuels are TS-1 and RT, which have a maximum freezing point

of -50°C . (Note: Because specifications may vary by country, operators should ensure that they are using the appropriate fuel procurement specification for the fuel being dispensed.)

The maximum freezing point for some jet fuels can vary by the geographical region in which the fuel is refined or uplifted. Test methods for determining the fuel freezing point also introduce variability; reproducibility is approximately 2.5°C .

Some operators in the United States measure the actual freezing point of delivered Jet A fuel at the time of dispatch. Data show that the freezing point of delivered Jet A fuel is approximately 3°C lower than the specification maximum of -40°C . Table 1 (p. 16) shows the results of a study completed at several airports in the United States to verify the actual freezing point of Jet A fuel as delivered to the airplane. (An airline must verify the freezing point of the loaded fuel at dispatch if the airline uses a value other than the maximum specification.)

3 BOEING-CONDUCTED AIRPORT SAFETY AND OPERATIONAL ASSESSMENTS

FIGURE



1	FREEZING POINT OF DELIVERED JET A FUEL AT SELECTED AIRPORTS	
TABLE		
Airport location	Average freezing point (°C)	Range of freezing points (°C)
Atlanta	− 43	− 41.6 to − 46.6
Chicago	− 43	− 42.4 to − 44.7
Dallas–Ft. Worth	− 43	− 41.1 to − 45.9
Los Angeles	− 50	− 46.8 to − 58.2
Miami	− 47	− 41.0 to − 53.1
New York	− 45	− 44.0 to − 46.4
San Francisco	− 45	− 44.2 to − 56.1

However, the fuel freezing point is not what dictates fuel flow to the boost pumps. The critical condition of cold fuel in an airplane fuel tank, in terms of flight safety, is its propensity to flow toward and into the boost pump inlets. Pumpability, or flowability, depends on the pour point of the fuel, defined as the lowest temperature at which the fuel still flows before setting up into a semirigid state. Generally, the pour point

is approximately 6°C lower than the fuel freezing point. However, the exact relationship between freezing point and pour point depends on the source of the crude oil and the refining processes. Because jet fuel is a mixture of many different hydrocarbon molecules, each with its own freezing point, jet fuel does not become solid at one temperature as water does. As fuel is cooled, the hydrocarbon components with the

highest freezing points solidify first, forming wax crystals. Further cooling causes hydrocarbons with lower freezing points to solidify. Thus, as the fuel cools, it changes from a homogenous liquid to a liquid containing a few hydrocarbon (wax) crystals, to a slush of fuel and hydrocarbon crystals, and finally to a near-solid block of hydrocarbon wax. Because the freezing point is defined as the temperature at which the last wax crystal melts, the freezing point of jet fuel is well above the temperature at which it completely solidifies (fig. 4).

Refueling airplanes at different stations creates a blend of fuels in the tanks, each with a unique freezing point. The resulting fuel freezing point in each tank can vary widely. The flight crew must operate with caution and not automatically assume that the freezing point of the uplifted fuel is the actual freezing point of the fuel on board. Boeing published a procedure for estimating the freezing points of blends

of Jet A and Jet A-1 fuel in service letter 747-SL-28-68 (Nov. 4, 1991).

If the freezing point of the fuel on board cannot be determined using the published procedure, Boeing suggests using the highest freezing point of the fuel used in the last three fuel uplifts. For example, if Jet A-1 fuel was used for two uplifts and Jet A fuel was used for one uplift, then a −40°C freezing point would be used for the current refueling. If Jet A-1 fuel was used in three consecutive refuelings, then a −47°C freezing point may be used for the current refueling. In the 747-400 and 777, if the fuel freezing point is projected to be critical for the next flight segment, Boeing advises the transfer of wing tank fuel to the center wing tank before refueling. This makes it possible to use the freezing point of the fuel being uplifted for that flight segment.

Fuel systems and temperature measurement.

On the 747-400, the engine indication and crew alerting system (EICAS) displays the fuel temperature continuously on the upper CRT display except during jettison operations, when it is replaced by the FUEL TO REMAIN indication. The temperature signal originates from a single resistance-type temperature probe located within the no. 1 main tank. The temperature probe is mounted on the rear spar approximately 8.5 in off the bottom of the tank and approximately 40 in outboard of the aft boost pump inlet.

When the fuel temperature on the 747-400 reaches −37°C, a FUEL TEMP LOW message is activated, and the fuel temperature displayed on the EICAS changes color from white to amber. The 747-400 system automatically defaults to the limit associated with the highest freezing point of fuel approved for use on the 747, which is −37°C for Jet A fuel. When the fuel-temperature-sensing system is inoperative, the FUEL TEMP SYS message is displayed. The flight crew then is instructed to use total air temperature (TAT) as an indication of fuel temperature. (Instructions for this procedure are



contained in the master minimum equipment list.)

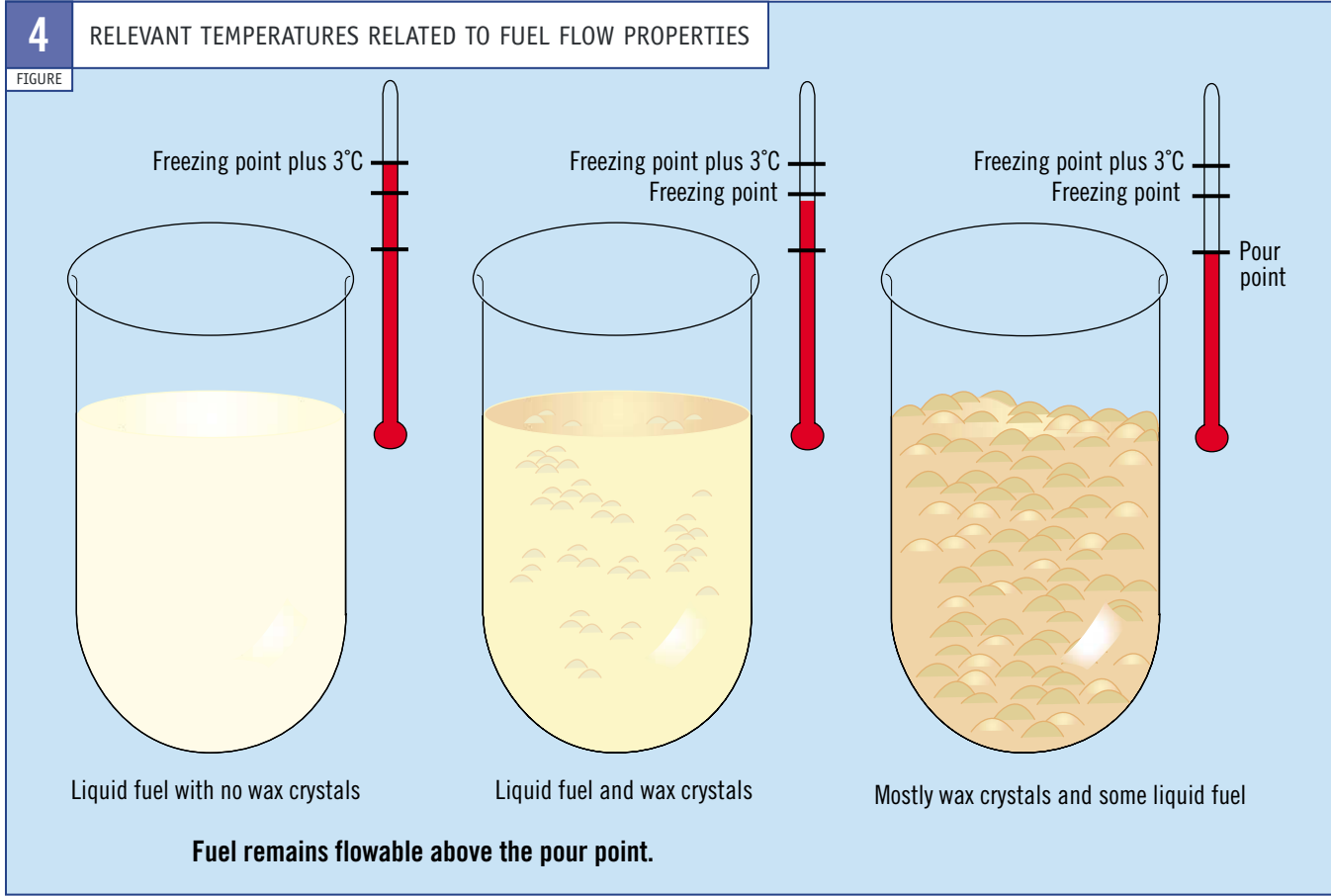
The 777 has a fuel temperature probe located between ribs 9 and 10 of the left main tank. The probe is approximately 12.6 in from the lower wing skin and is located one rib over, approximately 40 in outboard, from the aft boost pump inlet. Because the left wing tank contains a single heat exchanger, its fuel can be slightly colder than that in the right wing tank, which contains two hydraulic heat exchangers.

Fuel temperature on the 777 is displayed in white on the primary EICAS in the lower right corner. If the fuel temperature reaches the established minimum, the indication turns amber in color and the FUEL TEMP LOW advisory message is displayed (fig. 5). The 777 system automatically defaults to the limit associated with the highest freezing point of fuel approved for use on the 777, which is −37°C for Jet A

fuel. However, the EICAS message can be set to other values. For example, if Jet A-1 fuel is used, the message can be set to −44°C (fig. 6, p. 18).

On the 777, the fuel temperature can be entered in two ways: as the minimum fuel temperature or fuel freezing point. Both options provide an indication at 3°C above the fuel freezing point. Fuel temperature is not displayed during fuel jettison.

On the MD-11, a fuel temperature probe is located in the outboard compartment of tank no. 3 and another is in the horizontal stabilizer tank. At 3°C above the fuel freezing point, the probe in the no. 3 tank signals a FUEL TEMP LO message display in the flight deck. To establish when the message should be displayed, the flight crew can enter the freezing point of the fuel being carried or select the type of fuel being carried. When the crew does not enter a value or specify the type of fuel, the system defaults to Jet A fuel, which has a





freezing point of -40°C ; a message displays at -37°C .

The temperature probes in the 747-400, 777, and MD-11 are located where the bulk of the fuel is coldest. However, some fuel may be colder than the fuel measured by the probes, such as the fuel that is in contact with the lower wing skin. This creates a temperature gradient in the fuel tank from the wing skin to the location of the probe.

As fuel travels to the boost pump inlets, the bottom, cold layer flows through small flapper valves located on solid tank ribs next to the bottom wing skin. These valves are used to control fuel slosh. Thus, the cold fuel tends to flow toward the boost pump inlets. Because the probes are located near the bottom of the tank, the temperature reading is representative of the critical fuel temperature in the tank.

Factors affecting fuel temperature.

Factors that affect fuel temperature are the size and shape of the fuel tanks, fuel management, and long-range operations at high altitudes.

The size and shape of the tanks significantly affect how quickly the

fuel temperature is affected by wing skin temperatures. A tank with a high surface-to-volume ratio transfers heat through the wing surfaces at a higher rate than a tank with a low surface-to-volume ratio. Thus, fuel temperature is affected at different rates depending on the airplane model and tank design. For example, because the 747-400 outboard main tanks are long and narrow and have about half the total fuel volume of the 777 main tanks, the surface-to-volume ratio on the 747-400 main tanks is much higher. This means that heat transfer through the wing surfaces is greater on the 747-400, and the fuel temperature changes faster than it does on the 777. On the MD-11, the outboard compartments of tank nos. 1 and 3 have the highest surface-to-volume ratio. The next highest ratio is that of the horizontal stabilizer tank. These tanks are the most critical for fuel flowability at low temperatures on the MD-11.

Fuel is managed differently on the 747-400, 777, and MD-11, but in all cases, the wing main fuel tanks are the last to deplete. On some models, fuel in tanks with high surface-to-volume ratios is held until near the end of a flight.

Whether a tank is full or partially depleted of fuel alters the rate at which the fuel temperature changes.

During long-range operations at high altitudes, fuel tank temperatures can approach the freezing point of fuel. On long flights, the fuel temperature tends to adjust to the temperature of the aerodynamic boundary layer over the wing skin. This boundary layer temperature is slightly lower than the TAT because theoretical TAT is not achieved. Initially, TAT is much lower than the fuel probe temperature because of the thermal lag of the fuel. Thermal analysis of the 747-400, 777, and MD-11 airplanes shows that the fuel tank temperature is driven more by TAT than airplane configuration.

Operations and procedures with low fuel temperatures.

In flight, a temperature differential must be maintained between the observed temperature indication and the freezing point of the fuel. For the 747-400, 777, and MD-11, the observed fuel temperature must remain at least 3°C above the specified freezing point. (The actual fuel freezing point may be used if known.)

When fuel temperature decreases to 3°C above the freezing point, a message of FUEL TEMP LOW displays in the 747-400 and 777 flight decks; the message FUEL TEMP LO is displayed in the MD-11 flight deck. If this condition is reached, the flight crew must take action, as described below, to increase the TAT to avoid further fuel cooling.

In consultation with airline dispatch and air traffic control, the flight crew decides on a plan of action. If possible, the action should include changing the flight plan to where warmer air can be expected. Another action is to descend to a lower altitude. The required descent would be within 3,000 to 5,000 ft of optimum altitude. In more severe cases, a descent to 25,000 ft might be required. Recent experience on polar routes has shown that the temperature may be higher at higher altitudes, in which case a climb may be warranted. The flight crew also may increase airplane

speed; an increase of 0.01 Mach results in a TAT increase of 0.5° to 0.7°C . (It should be noted that any of these techniques increases fuel consumption, possibly to the point at which refueling becomes necessary.)

It takes approximately 15 min to 1 hr for a change in TAT to affect the fuel temperature. The rate of cooling of the fuel is approximately $3^{\circ}\text{C}/\text{h}$. A maximum of $12^{\circ}\text{C}/\text{h}$ is possible under the most extreme cold conditions.

A minimum in-flight fuel temperature advisory message provides a margin of safety under all atmospheric and operational conditions to ensure that the fuel will continue to flow to the boost pump inlets. Besides the 3°C margin between the advisory message temperature and fuel freezing point, there typically is a 6°C difference between the freezing point and pour point of fuels, which provides an additional margin. A review of the service history of transport airplane operations worldwide for the past 40 years does not show a single reported incident of restricted fuel flow because of low fuel tank temperatures. This service history affirms that the criteria used to establish the advisory message are adequate and conservative.

However, flight crews on polar routes must be knowledgeable about fuel freezing points. Flight crews also must be cognizant of the en route fuel temperature and the possible need for corrective action to ensure continued safe, routine polar operations.

Operational aids for flight planning.

Boeing has developed the Fuel Temperature Prediction Program (FTPP) for the 777 and is developing FTPPs for other airplane models. The FTPP assists operators in addressing fuel freezing point concerns during the flight planning process. The program is intended to interface with or be incorporated into an airline's flight planning system. The FTPP for the 777 has been calibrated with flight-test data obtained by Boeing and several airlines. The data are based on fuel temperature

indicated by the fuel tank temperature probe. Details on FTPPs are available to airlines through Boeing Field Service representatives.

Measuring the actual freezing point of the fuel being uplifted can be a valuable step in the flight planning process for flights during which fuel freezing point is a concern. In general, actual fuel freezing points tend to be about 3°C below the specification maximum requirement. Details on measuring the freezing point when fuel is being uplifted are available to airlines through Boeing Field Service representatives.

Before an airplane enters the polar region, the airline should provide the flight crew with the latest information on weather and en route alternate airports.

In addition to the general requirements for long-range operations, communication and navigation considerations unique to the polar region must be addressed in airlines' polar operations to ensure that flight crews have the information needed to conduct safe and efficient flights.

Communication.

Communication in the polar region should be handled according to the applicable procedures described on en route charts. Both VHF and HF equipment are needed to communicate with air traffic control (ATC). It is important to use only standard ICAO terminology for effective communication with ATC; nonstandard terminology or

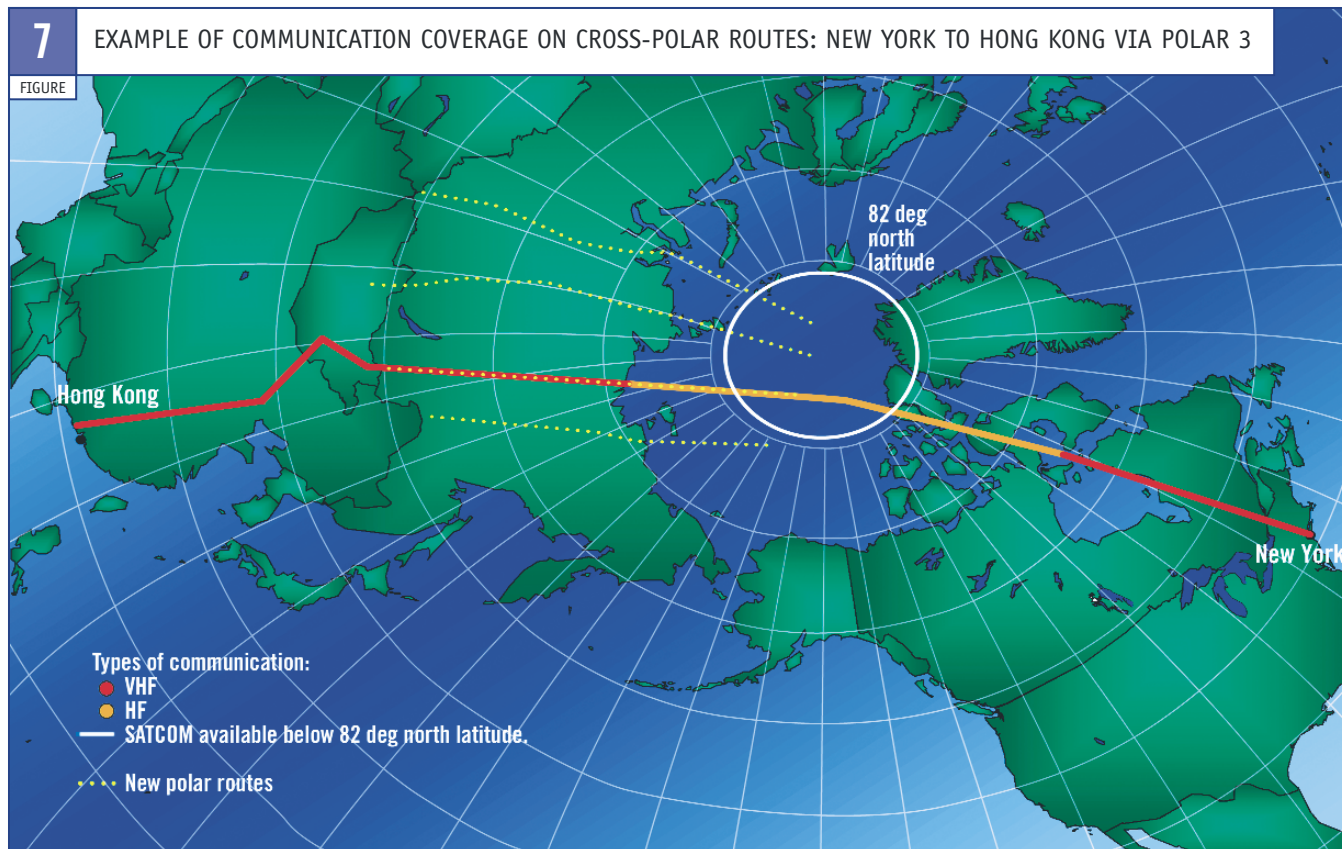
jargon may create confusion. SATCOM should be considered as a backup, although it is generally not available above 82° north latitude.

A typical polar flight initiated in North America has routine VHF communication with the various Canadian ATCs. As the airplane progresses north, the flight makes a transition to the Edmonton control center and then to Arctic Radio, a general-purpose communication provider that handles the interface between the airplane and controllers at the Anchorage and Edmonton control centers. Arctic Radio, which operates on HF frequencies and has several VHF remote sites, covers the northern flight information region (FIR) to the Russian FIRs (i.e., from Norway to Churchill, Canada, on its southern border and past the North Pole on the northern border).

The flight crew's first contact with Arctic Radio is made on VHF, and communication eventually switches to HF. On initial contact, the flight crew should request a primary and secondary frequency along with a selective calling (SELCAL) check. (Airlines provide crews with alternate contacts such as Iceland Radio, Bodo Radio, and Stockholm Radio to use in the event that crews cannot contact Arctic Radio.) Arctic Radio passes messages between the airplane and the airline's dispatch department. (Arctic Radio currently does not have the capability to provide a telephone patch. If a telephone patch is needed, airlines should consider Stockholm Radio, Rainbow Radio, Houston Radio, or San Francisco Radio.)

Communication with Russia begins before the airplane enters Russian airspace. Airlines should coordinate with air traffic management at the Russian State Civil Aviation Authority regarding specific contact procedures and locations.

Communication with Russian ATC is available on HF when operating beyond the VHF range of the ATC facilities (fig. 7, p. 20). In Russia, a call sign with the radio designator is



not a general-purpose communications service as it is with Arctic Radio. Instead, it indicates HF communications with an actual ATC center. Russian ATC centers usually list at least two HF frequencies; the higher frequency is used during the day, and the lower frequency is used at night.

Flight crews should be familiar with the following points of HF communications in Russia:

- An unused HF frequency may not be monitored.
- Russian HF stations are not equipped with SELCAL.
- Listening watches are required for HF frequencies assigned by ATC.
- Strong HF signals with distortion may require selecting the AM mode or requesting that the controller broadcast on the upper side band.

Before an airplane enters the polar region, the airline should provide the flight crew with the latest information on weather and en route alternate

airports. This ensures that the flight crew has the information needed to conduct safe, efficient operations. Airlines can update information using HF and SATCOM data links.

Airlines also need to consider the effects of solar activity on HF communication: poorer quality, a shift to lower usable frequency bands, and more noise or fading. During extreme solar activity, HF communications may not be available in the polar region. (Information on solar activity is available at the following web sites: www.sec.noaa.gov/SWN/ and www.hard-core-dx.com/solar/solarindex.shtml.)

SATCOM and SATCOM data links generally should be available south of 82 deg north latitude in the polar region. For SATCOM to be available on the ground, the inertial reference units (IRU) or air data inertial reference units (ADIRU) must be aligned.

Navigation.

The departure and initial cruise portions of a polar flight are routine operations.

But as the airplane nears the southern portion of the Canadian Northern Control Area (NCA), it approaches the area of magnetic unreliability.

In the polar region, magnetic heading is unreliable or totally useless for navigation. Magnetic variations typically are extreme, often are not constant at the same point, and change rapidly as an airplane changes position. Flight crews must ensure that the computer flight plan shows true tracks and headings. It is important to note that areas unmapped for enhanced ground proximity warnings systems (i.e., those areas beyond the limits of the terrain database) are displayed as magenta dots on the map display, regardless of airplane altitude.

The Canadian area of magnetic unreliability encompasses the NCA and the Arctic Control Area. The Russian area of magnetic unreliability is not formally defined. Russian airways south of 74 deg north latitude are referenced to magnetic north.

Flight crews should use caution when using automatic direction finders (ADF) or VHF omnirange navigation equipment (VOR), or both, because the heading reference in use will affect the display of data. With the heading reference in TRUE, ADF bearings are true and vice versa. VOR radials are displayed according to the orientation of the VOR station, either true or magnetic.

Crews should be prepared to operate in QFE and metric altitude where required. Some airports will provide QNH upon request even if their standard is QFE.

In the event of a diversion, the flight crew should leave the IRU and ADIRU on if SATCOM will be needed for communication. During preflight planning, extremely cold air masses should be noted and cold fuel temperatures considered. (See “Cold Fuel Management” on p. 15.)

If an active route takes an airplane over a pole, the preferred mode is



lateral navigation with the autopilot engaged. The flight management system (FMS) on the 747 and the 777 are operational in the polar areas with no restrictions. The 757 and 767 flight management computer (FMC) and the 757 and 767 Pegasus FMC are operational to 87 deg north latitude and 87 deg south latitude because of airplane certification restrictions. The MD-11 FMS is considered to be in the polar region when the airplane is above 85 deg north or south latitude. (See “Polar Route Navigation by Airplane Model” on p. 24.)

SUMMARY

The FAA requires operators to obtain specific approval to conduct polar operations. Current requirements for an airline to develop necessary plans in preparation for polar flights are contained in the FAA information memorandum *Guidance for Polar Operations* (March 5, 2001).

To determine which en route alternate airports suit the needs of their particular polar operations, airlines should review the airport safety and operational assessments available from Boeing. Airlines also should periodically contact their en route alternate airports to assess changes that may have occurred since the time of the assessments.

As for fuel temperature during polar operations, implementing a cold fuel management process allows airlines to address cold fuel temperatures during dispatch. Safety is ensured because of the conservative design of the fuel-temperature-indicating system, the corrective action available to the flight crew if required, and the dispatch aids available to more clearly identify the controlling variables.

Much of the material needed for communication and navigation on polar routes is contained in the operations and training manuals used for existing long-range operations. Additional crew and dispatch procedures needed for polar operations include cold fuel management, QFE/metric altimetry, cold-weather altitude correction, and FMC polar operations, limitations, and specifications.

Airlines should include the HF propagation forecasts as part of the dispatch process and ensure that flight crews are familiar with appropriate communication and navigation requirements in the polar region. Airlines also should provide flight crews with the latest weather and en route alternate airport information before a flight enters the polar region.