Water, water, everywhere

story & photography by David Sperry

Golden sand beaches, warm tropical breezes, hula girls, and fruity drinks with little umbrellas in them. The images conjured up by a mention of Hawai‘i are endless. Flying to the Islands has become a commonplace occurrence, yet few passengers give much thought to what is involved with making that journey.

The Central East Pacific (CEPAC) routes from the West Coast of the USA to Hawai'i are the longest in the world regularly flown by airliners that do not have an en route alternate. Yet every day several dozen jetliners make the journey easily and safely. It doesn't involve any black magic, but it does take planning and coordination between many different groups of people, from the rule-makers in government to the crews that fly the airplanes. The high level of safety displayed by the airlines in their long-distance flying comes from all that hard work and preparation. How the job is done is often a mystery to the flying public, because most of the work happens behind closed doors. But if the layers are peeled away, what becomes visible is a well-oiled machine that is devoted to flying across the vast expanse of the Pacific as safely and routinely as possible.

Which way do we go?

Travelling from point A to point B first requires deciding on a route. In the CEPAC region there is a fixed route structure because there is little variation in the normal winds. This is different to the North Atlantic track system that varies in location from day to day, based on where the most favorable winds are. In the Pacific there are nine routes, called tracks, between the West Coast and Hawai'i. Most have a starting point offshore California somewhere between San Diego and San Francisco, with two of them beginning near Portland, Oregon, and Seattle, Washington.

The flight used as an example here will go from Phoenix, Arizona (IATA: PHX/ICAO: KPHX) to Honolulu (HNL/PHNL), so there are a couple of choices of route. In the US airline world it is the dispatcher who makes most of the preflight planning decisions. Once the captain shows up at the airport for his flight he reviews the dispatcher's plan, and between the two of them they reach agreement on any remaining questions.

For the initial preparation the dispatcher uses a sophisticated flight planning software system that analyzes winds, weather, passenger and cargo loads, expected air traffic delays, and more, to decide on the best route for the flight. The primary basis for the decision is which route will have the lowest cost for the airline. Then adjustments are made for other items such as weather and delays, and to attempt to complete the trip on schedule. Based on the forecast winds the dispatcher can calculate how much fuel the flight will use at the planned altitude. From that number more fuel will be added to satisfy not only the basic en route and reserve requirements, but ETOPS (Extended Operations) rules as well.

Two engines, lots of water

Early in the Eighties, when the airlines wanted to use their new and more fuel-efficient twin-engine types across

A Hawaiian Airlines Boeing 767-300ER (Extended Range) at the gate in Phoenix.

Filling the tanks for the haul to Honolulu.

long open-water routes, they had a problem. Regulations prevented them from flying those aircraft more than 60 minutes from a suitable alternate airport. Only aircraft with three or more engines were allowed to fly more direct transoceanic routes.

Obviously, there isn't an airport every hour of the way to Hawai'i—or across the Atlantic either. However, the new generation of twin-jets began to prove themselves more reliable than any other type in history. After reviewing the data, the authorities grudgingly realized that they needed to begin making small extensions to that restrictive regulation.

At first there were many additional requirements for the aircrews, the airplanes, and the required maintenance procedures, yet these only provided a small increase in the allowed flight time away from an alternate. But over a few years the airlines and regulators learned what worked, and what was unnecessary. Today, because of the proven reliability of the aircraft, engines, and ETOPS regulations, airlines can earn the right to fly (in some cases) more than three hours from a suitable alternate airport in types such as the Boeing 767, 777, and Airbus A330. ETOPS doesn't specifically mean flying over water; rather, it means any flight that will be more than 60 minutes with a reduced number of engines operating from a suitable alternate airport. In the real world though, the oceans are where most of the ETOPS flights occur.

Feeding the engines

Fuel planning for these flights is an intricate mathematical dance to come up with the necessary amount to put into the tanks. Essentially, all flights that go outside US airspace are considered international flights, even though Hawai'i flights technically begin and end in the USA. The basic international requirements are for enough fuel to reach the destination and land there, plus fuel to the most distant alternate, plus an additional 10% of the en route fuel burn, plus holding fuel for 30 minutes over the alternate airport. These requirements are for the actual planned flight time, accounting for weather, wind, traffic delays, etc, not the published scheduled time. The regulations say nothing about flying over the water, but are merely for international flights.

ETOPS requirements then add a 'worst case' scenario to the mix. The idea is to find the point on the planned route where the aircraft would be an equal flying time, on one engine, from two alternate airports: one behind and one ahead, that are suitable for landing that type of aircraft. The maximum flying time allowed to either of these alternates is regulated by the FAA (Federal Aviation Administration), and for most airlines performing ETOPS flights can be no more than 180 minutes. In turn, that time limit dictates where the aircraft can fly, and how far from its alternate airport it can go. That halfway point is normally called the equal time point, or ETP.

The fuel consumption from the ETP is then calculated based on having to descend to 10,000ft—assuming a pressurization problem—using one or two engines (whichever method consumes more fuel), and flying to and holding over either one of the alternates at 1,500ft for 15 minutes, then landing. Several percentage points more fuel are then added for engine anti-ice, unforecast winds, airframe ice accumulation, and use of the APU (Auxiliary Power Unit). This 'ETP critical' amount of fuel must be planned to still be onboard when


Cockpit of the 767.

the flight reaches the ETP. In most cases this means more fuel has to be carried than would be required by the basic international flying rules, but it is one of the main reasons over-water flying in a twin-engine airliner has become so safe.

In the case of this flight from Phoenix, the two closest suitable airports to the ETP point are San Francisco, California (SFO/KSFO), and Hilo, Hawai'i (ITO/PHTO). Part of the preflight preparation includes ensuring the weather at those airports is forecast to be legal for use as an alternate. If not, another airport must be selected, which may then require a change in the ETP critical fuel.

Planning and preparation

It is a nice summer day for our flight, and the dispatcher has chosen the Delta track. The tracks are named alphabetically from north to south, not counting the two routes originating in the Pacific Northwest. Delta is an almost straight-line route between Los Angeles and Honolulu. Spaced along the track are waypoints that at normal cruising speed are crossed about every 35 to 50 minutes.

At the airport the captain picks up a copy of the flight plan, which includes most of the information he needs to complete the flight. The route with all waypoint information is on there, along with the fuel requirements, payload information, weather data, and anything else required or desired for the flight.

Once it is completed, the dispatcher files the flight plan with the FAA just as any pilot would for an IFR (Instrument Flight Rules) flight. Also included with the paperwork is a takeoff performance sheet, which shows the required engine power levels for the expected runway, takeoff weight, and weather conditions. It is an essential part of airline operations, and allows the pilots to ensure that they are able to depart and still have the legal single-engine performance available in case an engine quits as they lift off.

Onboard, one of the pilots calls Clearance Delivery to request departure clearance or, in some airplane types, requests the data over the ACARS (Aircraft Communications Addressing and Reporting System). This is a radio data receiver that acts like an email system for the airplane, allowing the pilots to request items from the dispatcher such as the current weather or their clearance, or have performance data (fuel, weight, payload, etc) sent directly into the airplane's FMS (Flight Management System) instead of having the pilots enter it manually.

The FMS is the computer 'brains' of the aircraft that takes all the data from the flight plan, performance information, radio navigation receivers, and aircraft sensors, and guides the aircraft through the sky. Whether the route and performance data are entered by hand or via ACARS, in the interest of accuracy the pilots check the route in the aircraft's FMS against what is printed on their flight plans. Once all that is done, the normal cockpit checks are completed, and the flight crew is ready to go.

Outside, the maintenance staff has been busy too. ETOPS flights require an additional layer of checks beyond the normal preflight inspections. Items that on domestic aircraft may be looked at every day or two are checked before each ETOPS flight. Oil quantities have higher minimum levels, as do the crew oxygen bottles. Inoperative items that could be 'deferred' on a domestic flight may not be deferrable when going ETOPS. Is one of the engine-driven electrical generators out of commission? It's OK if the flight is from Phoenix to Los Angeles, but not if it is headed out over the Pacific. Specific training is required for the maintenance technicians to sign off an ETOPS flight, and the special check must be completed and signed off in the aircraft's maintenance logbook before every ETOPS departure.

The long haul

Actually flying the takeoff and departure is like any other flight. When all the t's have been crossed and i's dotted, the crew makes sure the doors are closed, and the airplane is pushed back from the terminal. Once the engines are started and taxi clearance is received, the pilots run through the normal departure checklists. On the way to the runway the crew rechecks the performance data from the final payload information. If there were any changes, such as additional last-minute baggage, the numbers are rechecked for accuracy.

Operating a wide-body airliner is not that much different from flying any other aircraft, although the crew sits higher off the ground than most pilots do. Contrary to urban myth, however, it is not because they have fatter wallets! As long as the pilots remember that there are a couple hundred feet of aluminum, fuel, and people behind them while taxiing, they won't have a problem. When the takeoff clearance is received it's time to power up and go. Departing from PHX and climbing to cruise level over the Mojave Desert is like any other domestic flight. In this case, however, we pass over Los Angeles at altitude, and keep going westward.

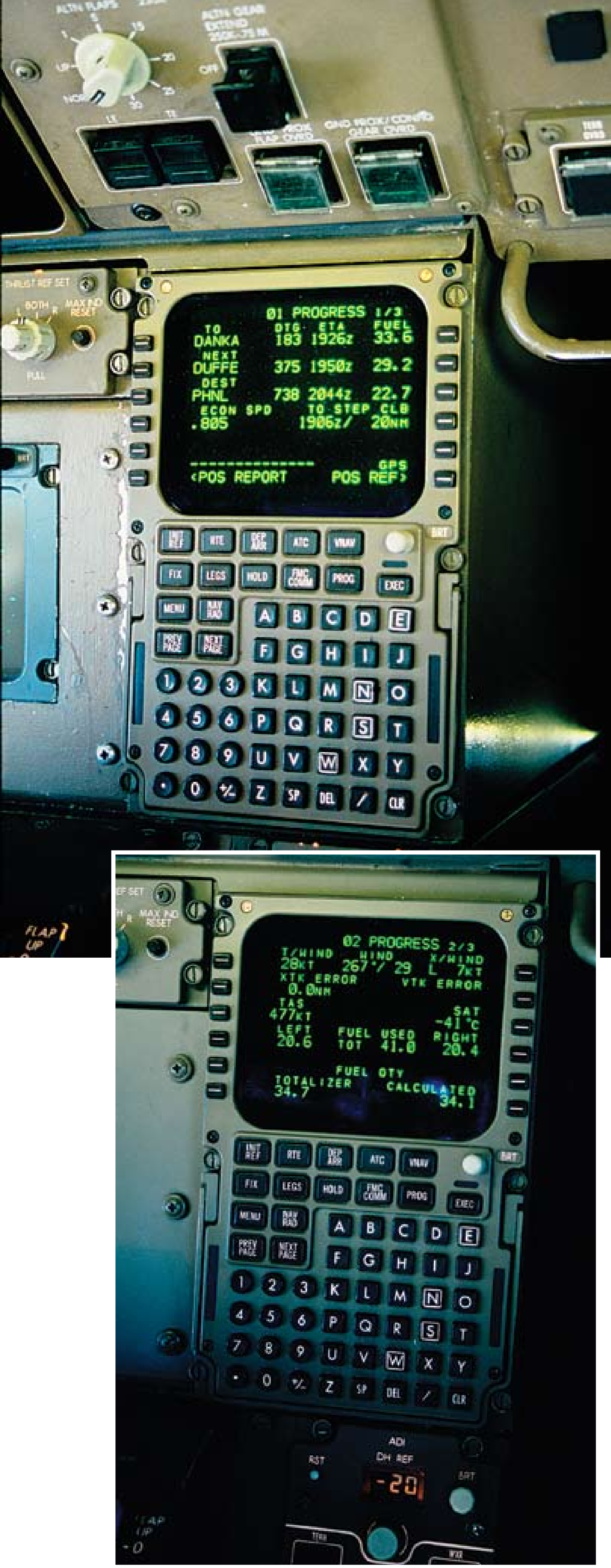
When the flight approaches the first waypoint of the track (called the gateway), the real differences begin. Over the ocean there aren't any ground-based navaids (navigation aids) to help guide the flight. Until recently most over-water navigation was done with IRUs (Inertial Reference Units). These compact little miracles of science keep track of where they are by being told where they started, then figuring in all the little accelerations experienced by the aircraft to calculate where it is and which way it's going, and how fast it is moving. They work quite well, although by the end of a long over-water flight without outside position updates, they could be off by several miles.

The PFD (Primary Flight Display) as we cross the Arizona-California border.

GPS (Global Positioning System) has changed all that and is now the primary over-water navigation aid, although IRUs are still aboard the aircraft as a backup to the satellite system. The GPS data, ground-based navaid signals (while they last), and IRU information are all brought together by the airplane's computer brain—the FMS—to give a constantly updated 'best guess' position for the flight. Before the aircraft heads too far from shore, though, that 'best guess' needs to be checked. Good old-fashioned raw bearing and distance data from the navaids back on shore are brought up by the pilots and compared to what the FMS is telling them. Despite having the latest in advanced avionics, it never hurts to check the basics, and if there is a problem with the FMS it is better to know while still close to land.

At the gateway, normal radio communications with local ATC (Air Traffic Control) ends, and the flight is put into the hands of Oceanic Control. Flights across the ocean are not 'on their own' for navigation and control, as many people assume. At higher altitudes, essentially the entire earth is covered by controlled airspace, so even across the middle of the Pacific the flight is under the thumb of ATC—in this case Oakland Oceanic, which oversees a vast slice of the Pacific Ocean air traffic.

Despite being hundreds of miles from land, the crew can still talk to the controllers, although not over the usual VHF (Very High Frequency) radios. Some of the



FMS Progress pages one and two, with a general overview of our flight and specific flight track and fuel information.

newest airplanes are equipped with satellite telephone systems, however the rest still use a very old-fashioned but serviceable HF (High Frequency) radio. These types of radios have been in use since the days of Amelia Earhart. They have a very long reception and transmission range, but at the expense of clarity. Imagine putting your head inside a large metal can, then having your friends rub sandpaper and rocks on the outside while another friend yells at you from about 50yd away. That is what using an HF radio is like. In the old days it was worse because one of the pilots had to constantly listen for their call-sign—a sure recipe for a headache by touchdown. Today we have what is called SELCAL (selective calling), a system that allows ATC (and the company) to send a special tone over the radio, which then sets off a chime in the cockpit. The pilots know that they've been called and turn up the volume.

Pilots can also use the HF radio—or the ACARS 'email' system if so equipped—to check the weather while en route. They not only check the weather at their destination, but the alternate airports designated in the ETP calculations too. This keeps them in the loop during a long flight, so there shouldn't be any nasty surprises, no matter where they end up landing.

They're still watching you

As the flight crosses each waypoint, a call is made to ATC and the crew makes a position report. With each contact to Oakland Oceanic, they give their current position, time over the waypoint, altitude, next position and estimated time over, next succeeding position, temperature, wind, and weather conditions; those items are what make up the position report. And that is how ATC keeps track of all the airplanes moving across the oceans of the world—the pilots tell them where they are, when they arrived there, where they're going, and how fast. ATC's computers crunch the data and come up with a picture of where everyone is.

Just like flying under IFR anywhere else, if a pilot wants to change altitude or deviate for weather, he calls ATC and makes the request. Because aircraft over the ocean are not being directly observed by radar, there is more space, or separation, required between each aircraft. If another airplane is at a different altitude, but too close horizontally, their request will not be granted even though there may be many miles separating the two.

Being that far from a place to land means there is more emphasis placed on monitoring the flight's fuel use too. At each waypoint the amount of fuel used and fuel remaining is noted, and compared to what was estimated for that position on the flight plan. The aircraft's FMS also calculates how much is onboard based on what the

Mid-Pacific: water, water everywhere.

Honolulu, and HNL.

pilots told the computer it started with, minus what it knows the engines have used. The total between this number and what the fuel gauges read is compared to ensure that there isn't a leak somewhere, removing fuel from the system before it is turned into thrust. Finally, an eye is kept on the estimated fuel that will be remaining at the ETP point. If that estimate falls below the 'ETP critical' fuel level, the flight must turn around.

An average, everyday flight

As the flight progresses, it goes along like most others these days. The autopilot follows the preplanned route, shown as a magenta line on the pilot's ND (Navigation Display). Whether flying a 767 or a two-seat trainer with a hand-held GPS unit, it seems pilots are all following that pink line across the ground these days. Flying across the ocean does have its perks though. The radios are mercifully quiet compared to the constant chatter of mainland flying. Weather across the CEPAC region is normally placid and predictable, and even a six-hour flight goes by quickly. When the flight reaches the gateway on the Hawai'i side of the track, the crew contacts Honolulu ATC on VHF radio and everything is back to normal, allowing the crew to use the same procedures as anywhere else in the USA. After landing, the passengers go and enjoy the tropical sunshine, while the aircraft is prepped for another ETOPS flight across the open ocean.

Welcome to paradise

Today's airline passengers take for granted the high level of safety expected of flights across vast stretches of ocean. It wasn't so long ago, though, that the image conjured by a trans-Pacific flight was more of John Wayne's heroic struggle in *The High and the Mighty* instead of the easy and safe flying we have today. It has taken many years of slow and steady implementation and growth for today's current ETOPS rules to come to fruition. It is those rules, however, that allow the safe, convenient air transport system we now have in place to whisk you from anywhere in the world to your own little corner of paradise. *Aloha!* ✈

Being readied for the return to the Mainland.