The Great Escape

Diverting from an oceanic track to an alternate **requires a plan**

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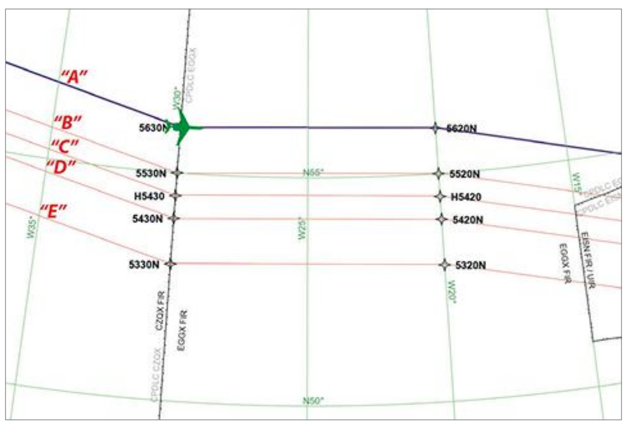
You can't always deal with your aircraft's problems without thinking about your neighbors first.

I've had a few jobs where one of my primary duties was to teach others how to fly internationally. I usually ended these training sessions with a favorite saying of mine: "The art of international flight operations includes the science of knowing how to pick up the pieces when they fall." And there are usually pieces to pick up on even the most routine ocean crossings. When things go very badly, we need to know how to escape the confines of an oceanic track and head to the nearest alternate. Of course, we devote a fair amount of time at international procedures courses talking about these things. If we are especially prudent, we also cover many of these same topics during our aircraft recurrent sessions. The problem is that the theories for the first set of courses don't work well with the theories from the second. And in both cases, you can argue that theory falls short of reality. You can fix this problem, but you have to know where it lies before you can fix anything.

The Faulty Theory of Aircraft Performance

In most parts of the world, an oceanic track is designed to keep you separated from aircraft on adjacent tracks. Spacing on these tracks can be at a minimum, as more and more aircraft are competing for the tracks with the most favorable winds and distances. In the North Atlantic, for example, you can have aircraft within 1,000 ft. above and below you as well as 30 nm left and right. You cannot turn off the track without first considering the possibility of a midair collision. Even if all of the competing tracks are on one side only, the only viable alternate may be on that same side. The geography of the track system itself flies in the face of the theory behind what the aircraft manufacturer intended or even what the regulatory authority envisioned for oceanic contingencies.

The aircraft manufacturer should have evaluated your aircraft's performance and figured out the best way to squeeze the most distance for the least amount of gas in the event of an engine failure. They will have made similar computations for a depressurization scenario and for a simple diversion while remaining at cruise altitude.



When flying within, on the edge, or even above an organized track system, divert options can be impacted by neighboring tracks.

In the case of an engine loss, for example, most manufacturers compute drift-down distances based on very specific procedures:

▶ Set your operating engine(s) to a specified setting (such as maximum continuous thrust), while turning directly to your alternate.

▶ Allow your speed to decay to drift-down speed while maintaining altitude (this may happen almost immediately or in a minute or so for most two-engine aircraft).

▶ As drift-down speed is reached, descend at that speed until at an optimal altitude for one-engine-inoperative operations, known as drift-down altitude.

For some aircraft, especially those with two engines, drift-down speed can be identical to cruise speed and the drift down must be started immediately to realize the promised performance. (Many Gulfstreams are like this.) For others, especially those with three or more engines, drift-down speed is much slower than cruise speed and the aircraft can spend 10, 20 or more minutes before needing to start down (such as many three-engine Falcons). In any case, deviating from the descent profile will decrease the aircraft's range and remaining fuel at the alternate.

This profile gets you to your en route alternate at the predicted fuel quantity, provided the winds, temperature and other considerations cooperate. In other words, it is a best-case scenario. You will have a limited number of alternate airports to choose from, usually because of limited fuel. When crossing an expanse of ocean, you are often called upon to stretch the distance between two alternates while figuring out which alternate is best for any given point along the route. The point at which you can get to either airport in the same amount of time is known as the Equal Time Point (ETP). It is important to note, however, that the ETP is a point (a location) along the route, not a time on your clock.

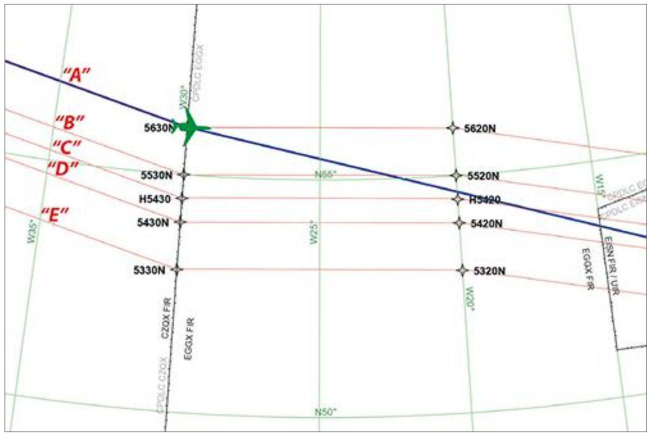
In its simplest form, you enter the formula with the total distance, the expected ground speed returning (GSreturn) to the alternate airport behind you, and the expected ground speed continuing (GScontinue) to the alternate airport in front of you. But the equation is based on flying a straight line from the ETP to either airport. Here again, it is a best-case scenario that isn't supported by regulatory airspace design.

In a typical North Atlantic scenario, an aircraft flying a direct line to an alternate airport can cross multiple tracks on either side of a cleared track. Even when flying above the North

$$\text{ETP (miles from "behind airport")} = \text{GSreturn}\left(\frac{\text{Total Distance}}{\text{GSreturn} + \text{GScontinue}}\right)$$

Atlantic Track System, a depressurization or engine loss may result in a loss of separation vertically as well as horizontally. Most aircraft will employ procedures to allow the aircraft to "drift down" to an optimal engine-out altitude by applying maximum continuous thrust on the operating engine(s), allowing the speed to decay to an optimal airspeed while holding altitude, and then descending at a minimum rate. Some two-engine aircraft will need to come down immediately to realize maximum forward distance. At normal crossing weights a Gulfstream G450, for example, cruises at the same speed as optimal drift-down speed and will therefore have to start down as soon as an engine fails. The resulting descent can take 250 nm or more to complete and will end up above 30,000 ft. This shallow descent can place the aircraft in the middle of many oceanic tracks and end up cruising at a competing track's altitude. This will result in a loss of separation and potential midair collision.

As pilots, we are worried about having enough fuel to make it to our alternate airports as well as the risk of a midair collision. But the computed ETP doesn't maximize fuel, it only



Basic oceanic divert performance depends on direct routing through adjacent tracks to the alternate, and may require an immediate descent through lower tracks.

ensures we have just enough. The fuel remaining at each ETP alternate airport provided by most flight planning providers is based on the perfect drift-down descent profile flown in a straight line. Unless you make specific allowances for extra fuel, your plan doesn't include deviations to avoid competing tracks, a steeper descent to fly below tracks, or even for an instrument approach.

The aircraft manual's promised performance for a "simple" engine-out drift down or decompression scenario may not consider multiple complications. Aircraft equipped with ram air turbines, which are little more than propeller-driven generators, will experience increased drag and fuel consumption. They could also restrict operations in icing conditions. Anti-icing may also increase fuel usage. A planned altitude where oxygen isn't required for the passengers but is for the crew may exceed an airplane's oxygen capacity. An altitude not requiring supplemental oxygen may be too cold for injured passengers or crew.

The ETP fuel calculations, even without the complications of a track system to avoid or other added complexities, can stretch fuel reserves to ridiculous levels. A Bombardier Challenger 601 flying from California to Hawaii, for example, can find itself on final approach with less than a thousand pounds of total fuel at its ETP alternate airport following a loss of cabin pressure. A Gulfstream GV flying the same route can land under the same scenario with enough fuel to make the return trip without any additional fuel. But that same GV flying from Eastern Europe to the U.S. West Coast can also end up with less than a thousand pounds of fuel at its ETP alternates. With either aircraft, having enough fuel to make the trip doesn't mean fuel at any ETP airport will be sufficient. The theory behind aircraft performance doesn't account for the design of oceanic airspace.

The Faulty Theory of Airspace Design

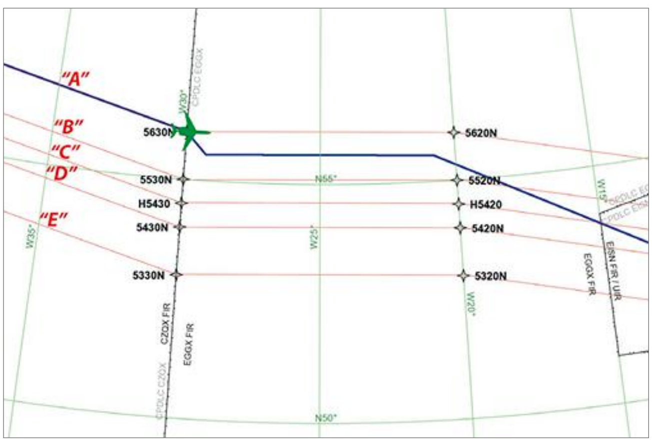
As big and wide as oceanic airspace may seem to the novice international flyer, experienced international pilots know the skies are crowded with other airplanes all competing for the best altitudes and winds. The International Civil Aviation

Organization (ICAO) attempts to bring order to the system through the Procedures for Air Navigation Services, Air Traffic Management (PANS-ATM) found in ICAO Doc 4444. PANS-ATM lays out specific procedures for situations where aircraft cannot continue flight in accordance with ATC clearances. ICAO Doc 4444, Paragraph 15.2.2 is worth bookmarking, and its procedures to leave an assigned route and level should be memorized:

▶ Turn 45 deg. away from track.
▶ Pick a direction based on alternates, nearby track, Strategic Lateral Offset Procedure (SLOP) and the desired altitude.
▶ Obtain a 15-nm offset.
▶ Pick an altitude that differs from those normally used by 500 ft. if at or below FL 410, or by 1,000 ft. if above.
▶ Broadcast to ATC and nearby aircraft.
▶ Light up the aircraft.

Pilots should also have regional requirements in mind. In the North Atlantic, for example, ICAO Doc 7030, Paragraph NAT 9.1.1.1 specifies that aircraft should proceed to a point midway between tracks and fly parallel to those tracks until below FL 280.

The ICAO Doc 4444 procedure has a distinct advantage in that it keeps you at least 15 nm from any competing tracks and reduces the chance of a midair collision. But the 45-deg. turns, the parallel tracks, the delayed descent and the possibly lower than optimal altitude will result in reduced range. At best you will end up at your ETP alternate with less fuel than predicted; at worst you will end up short of the airport.



An oceanic divert example using ICAO Doc 4444 procedures.

But you don't want to do that. Both the aircraft performance and the regulatory design theories involve too much risk. If you keep your wits about you and communicate your intentions, you can still work and play well with others even when diverting off an oceanic track.

The Optimized Reality of Good Situational Awareness

Let's say you are flying to Europe above the northernmost track of the Organized Track System over the North Atlantic. While crossing 56 deg. north/30 deg. west an engine quits, leaving you with one operable engine and no choice but to descend. Below minimums weather in Iceland means that your best option for a safe landing is at Shannon Airport, Ireland (EINN). You were cruising at Mach 0.80 and that is also your optimal drift-down speed. Your manual also tells you that if you push the operating engine up to maximum continuous thrust and fly a precise speed schedule, you will level off at 29,500 ft. after traveling forward 254 nm. Any variation to the speed, descent or level-off altitude will result in less fuel at Shannon. Because you were just beyond your engine-out ETP, your flight plan predicts you will have about 2,500 lb. of fuel if you do everything right. You've never landed the airplane with less than twice that amount.

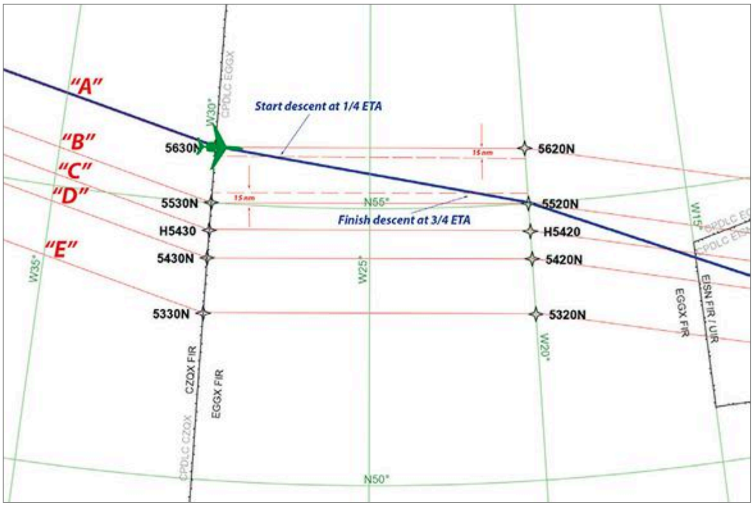
Flying directly to Shannon and using the manufacturer's drift-down procedure will fly you through one or maybe two of the tracks to your south. That is a possible option provided you can get the attention of every aircraft on those tracks. A "May Day" call to Shanwick Radio, and frequent broadcasts on the 121.5 MHz emergency channel as well as the 123.45 MHz air-to-air frequency will be needed. But the risk is unmistakable. You are relying on the pilots on every other aircraft to monitor these frequencies continuously. (How many of them are engrossed in conversation, a good book, their inflight meals or a DVD movie?) So, while it is an option, it isn't a good one.

Another option is flying the ICAO Doc 4444 procedure. If your FMS offers a "What if?" page, you might find out that you have just enough gas to make it while flying the parallel offset until you get to a lower altitude. But it may just as easily say you can't make it. Or the margin can be so small that you really don't know. Unless you've customized the math, your ETP fuel remaining figures don't allow for any of these variations.

While each situation is different, by looking at the big picture you can come up with a plan to maximize the use of "safe zones" between tracks. In our engine failure over the North Atlantic example:

▶ We can enter a direct leg to the next waypoint, one leg to the south (5520N).
▶ We can maintain altitude (and sacrifice drift-down speed) while making note of the Estimated Time En Route (ETE) to the next waypoint.
▶ At one-fourth of the ETE we can assume we are one-fourth of the total distance between tracks (60 nm in this example) and therefore beyond 15 nm; it will be safe to begin our descent.
▶ We realize that we must be below the tracks by three-quarters of our ETE so we can use our FMS vertical navigation mode to plan a descent that has us level when 15 nm of the next track.

This method isn't as efficient as the aircraft procedure but offers greater assurance of not encroaching on another aircraft's airspace. This method will, however, get us to the alternate with more gas than the ICAO Doc 4444 procedure. This could be a better option in this particular scenario. Each situation is different, and you could argue that having the presence of mind to come up with a "safe zone" for each situation while dealing with an engine failure or an explosive decompression will require superhuman intelligence, reflexes and presence of mind under



An example "safe zone" option for diverting from an oceanic track.

extreme pressure. No problem: With a little planning you can do this.

Improving Your Odds

It is considered a best practice to brief oceanic contingencies prior to entering oceanic airspace. These briefings usually include ETPs and alternate airport options. "If we need to turn back prior to ETP 1, we are heading to Gander. After that and before ETP 2, we are headed to Keflavik. After that, it's Shannon." While that satisfies the basic requirement of "what" to do and "when" to do it, it fails to address "how" to do it. It also ignores the fact that the emergency procedures change more often than only at each ETP. The situation is more fluid than that and should be re-briefed at each waypoint. Doing so will improve your odds, one waypoint at a time.

Prior to every waypoint, you should:

- ▶ Compute the aircraft's current weight.
- ▶ Look up and brief the aircraft's current drift-down speed, altitude and descent distance.
- ▶ Update the weather, as required, at every alternate and note which of them are still viable.
- ▶ Consider the proximity of nearby oceanic tracks.
- ▶ Devise an "escape plan" to get to the best alternate should a need arise between the next two waypoints.

The escape plan usually involves a binary choice of divert airports. As specified in the ETP computation, you usually have an airport behind you and another in front. The 180-deg. turn to the airport behind you introduces two more factors worthy of consideration. At typical speeds and altitudes, a 180-deg. turn will have a diameter of 20 nm or more. If you are on or over a track with only 30 nm of lateral separation, the turn can place you within 10 nm of the next track. A strategic lateral offset can reduce that farther by 2 nm. A second complication is that the turn itself consumes flight track distance. Your ETP doesn't factor the 30 nm consumed by the turn; your briefing should.

Your selection of alternates should also make note of the airport's capabilities. In some remote regions of the world, not every alternate is a good choice for a medical emergency. The MedAire kit on your airplane might just be better than what you can find within a few hours' drive of some alternate airports. You might be better off dialing the MedAire phone number placarded in your cockpit and seeing if your passenger would be better off with some of the drugs in the kit while just a few hours away from a city with a real hospital.

Sometimes you don't have an option, but you might be putting your airplane down someplace where it will have to remain for a few months. It could take a very long time to bring in a qualified mechanic due to immigration concerns, or parts because of customs rules. The time of year can be a factor if your passengers need to get out or your mechanic needs to get in. You could be placing your passengers and crew in medical jeopardy if landing in a cold, remote location without adequate lodging facilities. Some ETP alternates are only qualified because they are better than swimming. Commercial operators on planned routes that exceed 180 min. flying time from adequate airports face additional restrictions on what qualifies as an adequate alternate airport. While FAR Part 91 operators are not restricted by these Extended Operations (ETOPS) rules, knowing the capabilities of each alternate airport will improve situational awareness.

But you can further improve your situation even before you leave the ground. Some flight planning services will allow you to increase fuel reserves in an ETP situation by adding holding fuel or other adjustments. ARINCDirect, for example, will allow you to lower your maximum drift-down altitude so that it is beneath any oceanic tracks. You can increase your fuel reserves even without this level of customization with an iterative approach. If, for example, one of your ETP computations results in landing with 2,000 lb. fuel less than your comfort level dictates, you can raise your takeoff fuel by at least this amount. You will need more since, as your first international flight operations instructor told you in class, it takes gas to carry gas. The heavier weight could also mean you can't climb as high and may affect your coast-out flight level, which costs you even more gas. But your fuel computations need to be concerned with ETP alternate airports as well as the planned destination airport. There may come a point where you just can't go because the ETPs are no longer within comfortable reach.

If you are flying an airplane that requires you to do everything just right to make the jump over the pond possible, your ETP complications are probably considerable and you should pay close attention to the fuel remaining at every ETP airport. You might have a way of escaping the oceanic track system but just barely. But even if your high-altitude, ultra-long-range aircraft doesn't have a fuel problem for most of your oceanic crossings it doesn't mean you are OK for every situation. In either case, you have to remember the science behind the art of international flight operations. You will have to pick up the falling pieces no matter what you do; better situational awareness will reduce the number of falling pieces while improving your odds of doing so successfully. **BCA**