The Art Of Desktop INSTRUMENT Flying

Performing a STAR

Skill Level: Advanced

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"Foxtrot Lima Zulu clearance: track direct to the Lomar, Ballfor, Hallvale intersection, to the Browcat VOR, thence the two four seven Browcat radial to two zero DME Tobamore direct Georgetown. Enter on descent to flight level two one zero. Requirement: maintain flight level two five zero until crossing the three three one radial of the Goadie VOR". If you had trouble reading that, let alone remembering it in flight, then you will no doubt instantly appreciate the value of Standard Terminal Arrival Route clearance. Follow along as we perform a STAR arrival into Melbourne, Australia.

At 9:02am on the morning of September 25, 1978, the clear blue Californian skies were to bring the death of 44 people in a horrific mid-air collision between PSA Flight 182 (a Boeing 727) and a Cessna 172, N7711G. The 727 - while conducting a visual approach to San Diego's Lindberg Field at a time when the Cessna was departing following a practice ILS - lost sight of the traffic. It took less than 20 seconds for the flaming Boeing to plunge to the ground having impacted the climbing Cessna with the right inboard wing. Both aircraft were following verbal clearances; the Cessna assigned a departure heading of 070° while the jet was cleared

for a normal pattern entry. The fatal error was the fact that the 727 stated he had the Cessna in sight, and then subsequently lost that sighting. The Cessna's 070° heading would have had it harmlessly cross the arriving Boeing's downwind course from right to left, but then it makes an unauthorized turn to the right and ends up flying parallel to the jet and directly in front. Just over a minute after that fateful turn the two aircraft collide.

Had both aircraft had reliable, standardized departure and arrival clearances, the inbuilt separation standards between clearances could have assured safe travel for the Boeing and the Cessna alike. The more you rely on the human memory the more you introduce a weakness into the system. Perhaps if the Cessna pilot had been following a well-documented standard departure clearance he would have not strayed from his assigned heading into the path of the big jet.

Take a busy major airport at the hub of a complex airway system, with flight paths radiating outbound and inbound to destinations both far and near. Now, introduce about 200 aircraft movements from simultaneous departures to parallel arrivals in low ceiling and visibility conditions. The result is a deadly cocktail where the slightest navigational error or altitude infringement has the potential to trigger a mid-air collision over a typically vast populous area.

Standard Terminal Arrival Route (STAR) clearances are distributed to pilots and provide both a written and graphical representation of arrival clearances issued by ATC. By having them documented, controllers can rely on a common standard, a common arrival path and thus become familiar with the traffic flow. Graphical representation allows for a far greater complexity in approach and arrival design, allowing aircraft to track clear of noise-sensitive areas and the airport's many departure tracks. For the pilot, the need to memorize complex instructions shot at them like bullets from a machine gun is minimized, removing the human tendency to forget or misread the clearance details.

Chart Layout
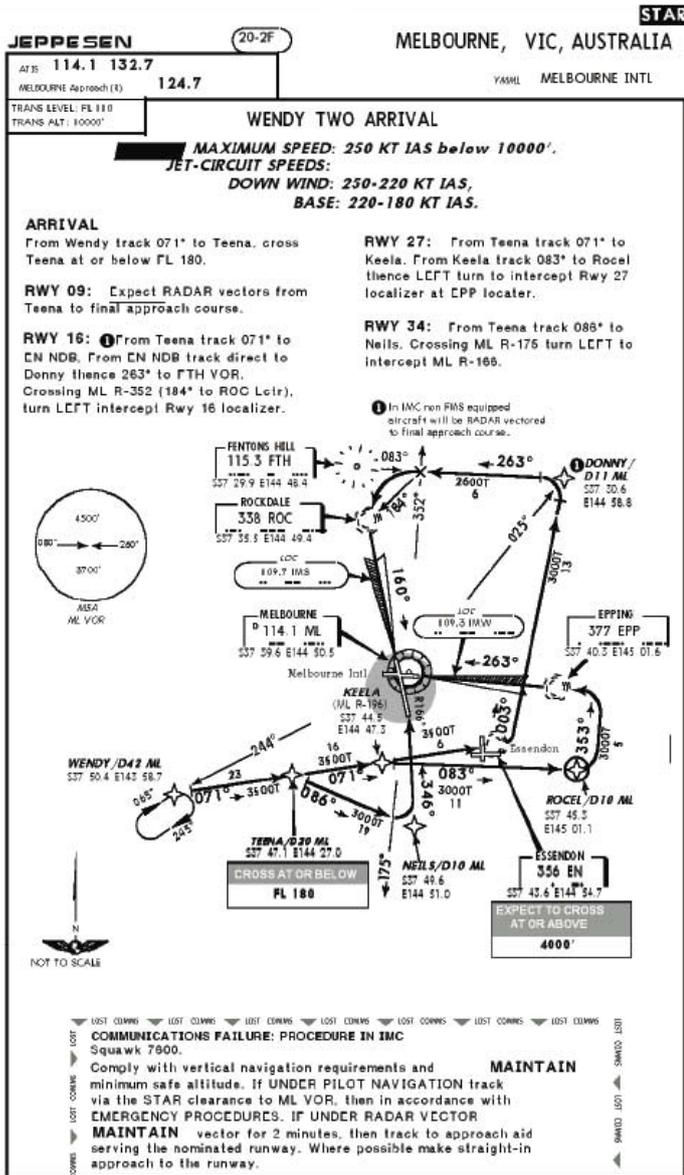
The 'Wendy Two' STAR. One procedure for each arrival runway is depicted in both textual and graphical form.

At the top of the STAR is the identification of the airport for which this STAR applies. In this case, it states Melbourne, but goes on to classify the particular Melbourne airport (of which there are 3 in fact; namely Melbourne, Essendon and Moorabbin).

The title of the STAR is found within the boxed section itself; 'WENDY TWO ARRIVAL' with some general restrictions published below that.

Next come the actual clearances in free-form text, beginning with the instructions common to each runway, and then for each runway the specific instructions for positioning onto that runway.

So, the common arrival clearance is:

ARRIVAL
From Wendy track 071° to Teena, cross Teena at or below FL 180.

Alright, that sounds simple enough; we track to Wendy then Teena, and the track is 071°. There is also an altitude restriction in that we must be at or below FL 180 (Flight Level 180) by the time we cross Teena. This is not a blanket clearance to just descend; you still require ATC descent clearance in conjunction with the tracking instructions published on the STAR. In our humble Cessna 182, we won't have any worries conforming to this restriction.

The remainder of the instructions are then stated for each runway. For runway 16 - our currently active runway - the instructions are as follows:

Rwy 16: ❶ From Teena track 071° to EN NDB, From EN NDB track direct to Donny thence 263° to FTH VOR. Crossing ML R-352 (184° to ROC Lctr), Turn LEFT intercept Rwy 16 localiser.

The little ❶ symbol is a reference to a note published somewhere on the main plan view. In this case the note appears at the top of the diagram stating that:

❶ In IMC non FMS equipped aircraft will be RADAR vectored to final approach course.

FMS is an abbreviation for Flight Management System where a computerized engine and navigation system is installed on the aircraft. Either GPS or other approved navigation systems feeds the FMS, providing accurate navigation to the waypoints contained on the STAR. The FMS even provides an autopilot interface that allows the aircraft to fly the STAR automatically. I want that!

Flight Management System (FMS)

We will have to fly the STAR manually in our 182, making use of the GPS as a tracking aid. We can, by coupling the Nav display with the GPS, display tracking displacement presented on the navigation instruments as if we were tracking to a VOR.

Take care to scan the entire chart for fragments of the clearance for your selected runway, as they may be segregated by warnings or other common procedures.

Plan View

Next comes the beauty of the whole concept; the ability to see - graphically - the clearance in diagrammatic form, including waypoints, track and distance references and lowest safe altitudes. Even frequencies of the relevant Nav Aids are shown on the chart.
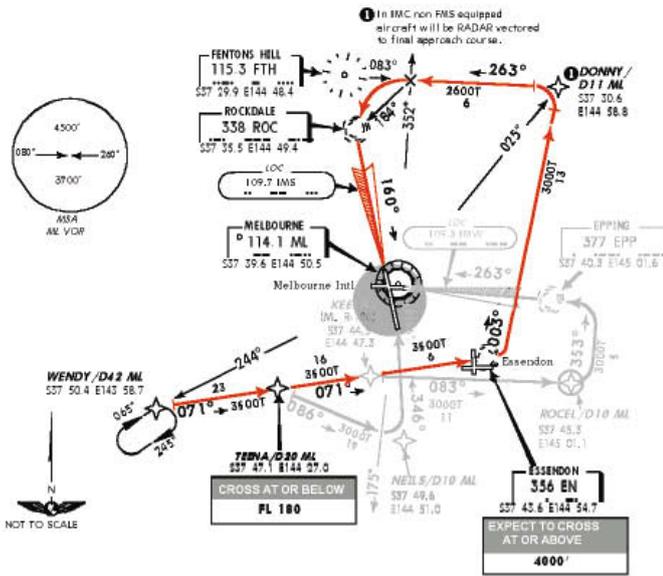
Plan view of the Wendy Two Arrival with the tracking for Rwy 16 highlighted.

Setting the Scene

We will be departing from Ballarat (YBLT) airport in central Victoria, tracking via Yarrowee VOR (114.3), then 109°/12nm to Wendy where our STAR takes over to guide us in for a landing on runway 16 at Melbourne (YMML). Set yourself up on runway 18 at Ballarat then use the Flight Planner option to enter each of the waypoints.

Open the Flight Planner and select the items as shown. Finally, click [Find Route].

The route generated will be direct YBLT to YMML, which is not really via the Low Altitude airways at all! Never mind, we can manually edit the route as follows:

1. **Click on the direct route shown in red and carefully drag it to the first waypoint, YWE. You may want to zoom in a little using the plus button at the top of the map;**

Drag the route to YWE and select the YWE VOR when prompted.

2. **Next click on the route YWE-YMML and drag it via Wendy;**
3. **Complete the route by dragging it via TEENA, EN, Donny and finally FTH.**
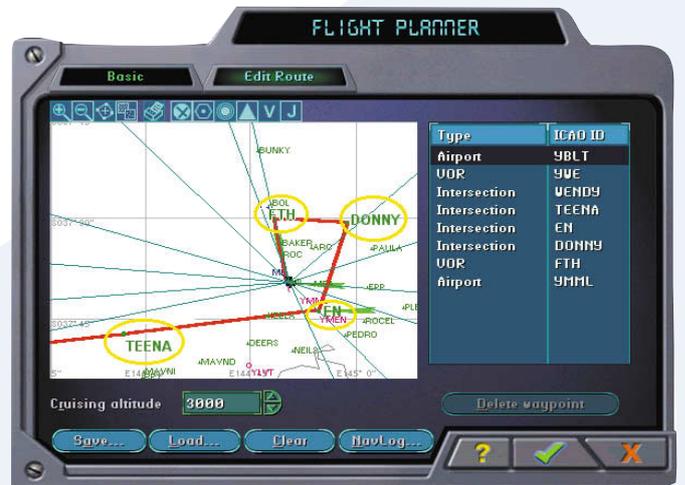
Completed route YBLT-YWE-Wendy-Teena-EN-Donny-FTH-YMML

Save the plan as IF0504 and set up your Cessna 182 and good weather conditions. If you're confident, set up some low cloud and visibility for a true IFR environment.

In the Briefing Office

Print the Flight Plan using the [Print] button on the planner. For our initial leg we will climb to 5000 feet as we track inbound to YWE VOR with 176° selected on the OBI. You can make use of BLT NDB for initial tracking, but transition over to YWE VOR a few miles south of Ballarat.

Once we reach YWE VOR, the next stage is to track to Wendy Intersection on the YWE 109 radial. From Wendy we can either track direct to the EN NDB (356 kHz) or use the GPS. Your GPS will be set up from the Flight Plan, so make use of the accuracy it provides to supplement the relatively inaccurate NDB.

As you overfly EN NDB, turn left and track 003° to Donny. This is where we get a little inaccurate compared to the FMS equipped aircraft. In truth, we are directed to track direct to Donny from the completion of the turn, not direct from the NDB to Donny. We can only track from the NDB on a line directly radiating from the NDB to Donny, but this will do for our training exercise. A similar problem applies to the turn at Donny. FMS equipped aircraft will begin the turn before Donny so as to roll out on the Donny to FTH track. This is instead of overflying the waypoint. Waypoints marked with a star enclosed in a circle are 'overfly' waypoints, while those without the circle are 'turn before' waypoints. We will do the best we can without the computer turn prediction software found in FMS equipped aircraft.

Once we are established on the 263° track Donny-FTH, we are looking to see when we cross the ML R-253 radial before we begin a gentle turn to establish ourselves on the ML Rwy 16 ILS. The ROC locator will help us here.

Ok, that's enough of a walkthrough for now. Let's go flying and I'll explain it in more detail at each step.

Let's go Flying!

Lined up on Runway 18 at Ballarat, navaids, autopilot and heading bug set.

When you complete your Flight Plan with the planner, you will be set up on Runway 18 at Ballarat. You need to set up the navaids as shown in this screen shot above.

Moving from left to right:

Set the heading bug to 176°

This is our outbound track to YWE VOR. While we may turn left or right to intercept 176° from the NDB, I always set the desired track on the bug simply as a reminder.

Set the Nav/GPS switch to Nav

For the exercise, leave this switch in its default 'Nav' position. This position is used to display the navigation information from the VOR selected on Nav 1 on its associated display. Switching to

GPS will display your off-track displacement from the current GPS track. We have a GPS track for the entire trip because we used the Flight Planner, but for the first stage we will use conventional Nav instruments to track to YWE.

Set 176° on the OBS for Nav 1 and 114.3 MHz (YWE VOR)

This is our track to YWE, and as you can see it has centred the needle on Nav 1 (Top Nav instrument) indicating we are on track at this point. Set 114.3 for YWE VOR on Nav 1.

Set 263° on the OBS for Nav 2 and 115.3 MHz (FTH VOR)

I'm setting this up very early. This is our track guidance for the leg Donny to FTH. We are in need of a third VOR here, we will need the ILS on Nav 1 and FTH as it is now on Nav 2, but how do we make use of ML VOR to pick up the crossing of R-352 as an early warning for the 16 ILS? The answer is that we simply don't have enough Nav's for that, so we use the alternative: 184° to Rockdale (ROC) NDB as the ADF will be free at that time. I'll talk you though this when we get there.

Set 239 kHz (BLT NDB)

This will help us to establish ourselves on track on departure. The departure will be simple enough, maintain runway heading until 500' AGL (2000 ft on the Altimeter) and turn left or right to intercept the 176° inbound track to YWE VOR. I doubt we'll even look at the ADF needle, but its there if we need it.

Set Code 2000 (IFR) on the Transponder

Set the Autopilot to hold heading and 5000 feet

Set ALT to 5000, our planned cruising altitude, and click on the [HDG] and [ALT] buttons in preparation for the Autopilot's use when we get airborne.

Depart now and track to the YWE VOR using the autopilot from 2000 feet. Track direct to the YWE VOR adjusting heading as required, then pause the sim when you are overhead YWE VOR as indicated by the To-From Flag changing to From.

Try it Now →

Tracking to Wendy

Turning over the top of Yarrowee VOR for Wendy. I have set 109° on Nav 1.

As you pass overhead Yarrowee VOR, the To-From Flag flicks to 'From' as shown in this screen shot. From this point, set up an

intercept onto the next track: YWE-Wendy (109°). I suggest you set 090° as an intercept heading. You should have 109° set on Nav 1 your primary tracking aid for this leg.

The hard part now is: How do we know when we are at Wendy? Wendy is an intersection between the 109° YWE track you are on now and 071° to EN NDB. You could select EN NDB and whilst maintaining 109° from YWE wait until the ADF needle shows you on 071° to EN. The problem with that is the two tracks are less than 45° displaced and as such this is a little too inaccurate.
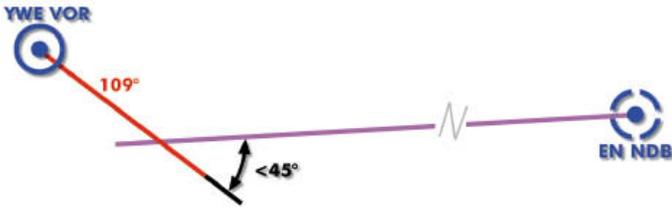
Wendy: 109° from YWE, 071° to EN NDB. This is not an accurate fix using VOR and NDB alone.

This is where I suggest you transition over to GPS for navigation, and the completion of our STAR. Switch the Nav/GPS switch to GPS enabling the display of your tracking on Nav 1. Next, bring up the display of the GPS map under the Views|Instrument Panel|GPS menu option, and click the [MENU] button to bring up the set-up menu.

Now, use the down arrowhead (in the four arrowhead cluster at the top of the GPS screen) to move the cursor to the 'Display Intersections' option, and then click the right arrowhead. This will set the display to show the name and location of intersections, such as Wendy. Click the [ENTER] button to process your selection. Finally, click the [MENU] button to return to the map view.
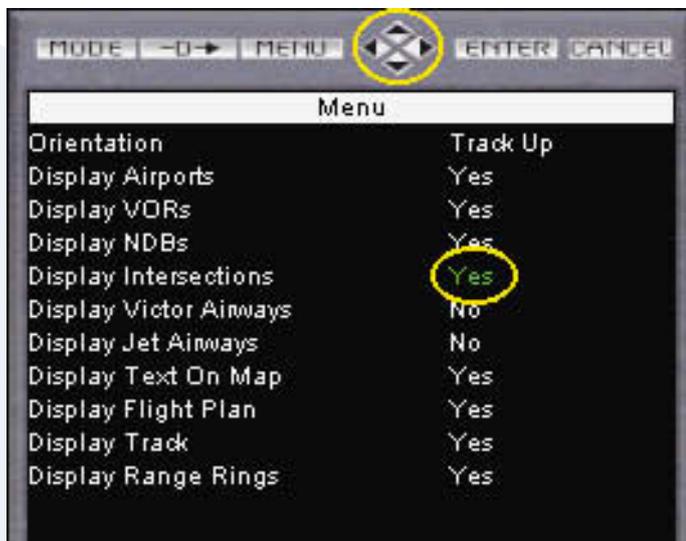
Select 'Display Intersections' to show Wendy, Teena, etc.

Before you get too close to Wendy, tune Essendon (EN) NDB on 356 kHz. This will provide supplemental tracking information on the leg Wendy to EN. In the screen shot below I have set up EN and have 3.6nm to run to Wendy. Adjust your heading to maintain track as closely as possible using the map display or the Nav 1 read out.

3.6 nm to run to Wendy.

Also along this track we would receive our clearance as follows:

> *"Kilo Delta Oscar, clearance: Enter control zone tracking Wendy, Essendon, planned route for the Wendy Two arrival, Runway one six. Enter at 5000"*

This is just what we expected, and so all we need to write down is:

    Wendy2
    Rwy 16
    5000

Flying the Wendy Two Arrival

Let's go through each stage of the procedure and look at the navigation considerations for the leg and the steps involved at each turn.

Wendy to Essendon
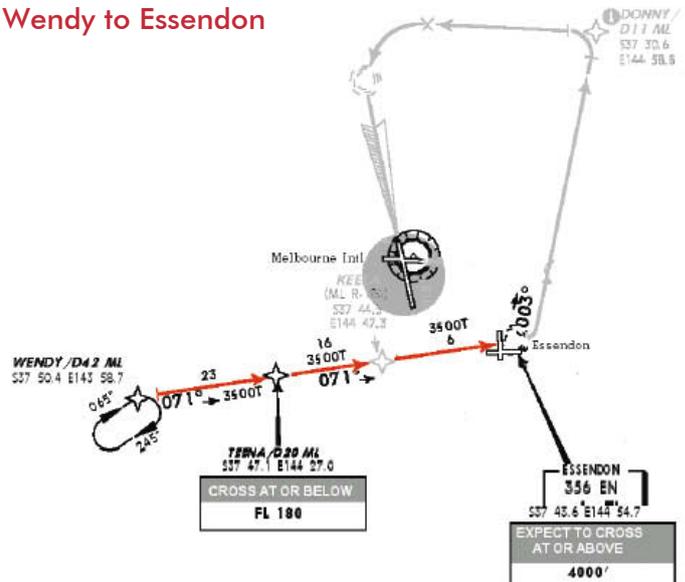
This leg could be referred to as the last of the en-route legs before we commence manoeuvring to position for the final approach. The tracking itself is simple in that we are maintaining a direct track to EN NDB using either the NDB or the GPS or both. Continue tracking to EN and descend when instructed by ATC. We should have EN NDB selected, and now that YWE is no longer being used for track guidance, we can preselect the Rwy 16 ILS (109.7 from the STAR Chart). You

won't see any indication from the ILS yet because you have selected GPS display. We must remember to flick that switch over prior to attempting an intercept of the Localizer.

We are definitely below the FL 180 required of us by TEENA. Note to the fact that we can expect to be at or above 4000 ft when crossing EN NDB. Also of note are the LSA (Lowest Safe Altitudes) along this track. They are shown as 3900 feet to Keela then 3500 feet from Keela to EN. This is handy to know in case you lose radio contact and need to descend on your own.

Adding up the distances Wendy-Teena-Keela-EN totals up to 23 + 16 + 6 = 45 nm. When we get station passage overhead EN, turn left and track direct to Donny (although in the real thing, we would track direct from the completion of the turn to Donny).

Coming up on position Teena. I have EN NDB on the nose and ML ILS is selected.

Essendon to Donny

Overhead EN, turn left and track direct to Donny (13 nm bearing 003°). We can expect to be descended on this leg down to about 3000 feet (LSA is 3000 feet).

On descent to 3000 en-route EN to Donny.

Donny to FTH

Commence turn onto 263° about a mile before Donny.

It's time now to prepare for the ILS if you have not already done so. You should have the ILS tuned on Nav 1 (109.7) and Rockdale (338 kHz) set up on the ADF to give us an indication of when to turn for the 16 ILS. Starting height of the ML Rwy 16 ILS is 2600 feet, so assume you have been cleared to descend to 2600 after turning onto your Donny-FTH track.

Now, flick the Nav/GPS switch to Nav to bring up the display of the ILS on Nav 1.

On descent to 2600 for the ILS. I have selected the ILS on Nav 1 while Nav 2 is providing guidance to FTH VOR.

Intercepting the ILS

About a mile to run to FTH, begin the turn left onto 160° to fly the ILS.

It's now a simple matter of turning left and flying the ILS down to the minima for Runway 16.

Summary

STAR clearances are a great way to ensure all aircraft conform to standard arrival path in the vicinity of an airport. This keeps the flow of air traffic both efficiently processed but most of all safely separated. If you enjoyed this little exercise, why not restart the whole thing again but introduce low cloud and visibility into the equation. When you are happy with the Wendy Two for Runway 16, try the Wendy Two for Runway 27.

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