Regional Aircraft and CDO Operations

Exploring solutions for enhanced safety and increased efficiencies

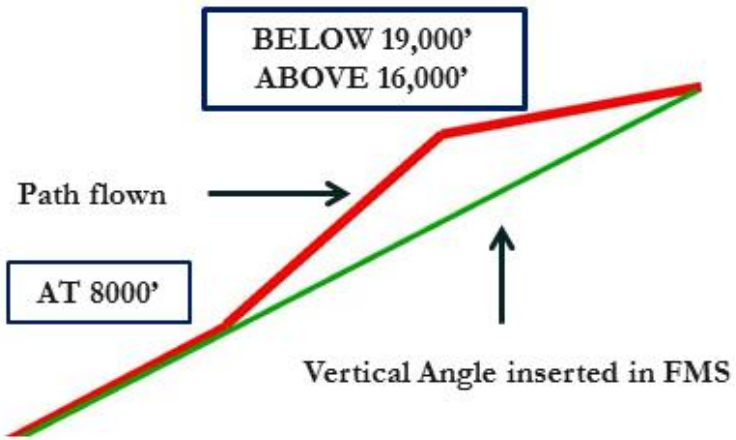
VNAV and CRJs

- Background
  - Most current CRJ aircraft do not have:
    - Autopilot coupled VNAV
    - Auto-throttles
    - FMS altitude / airspeed alerting

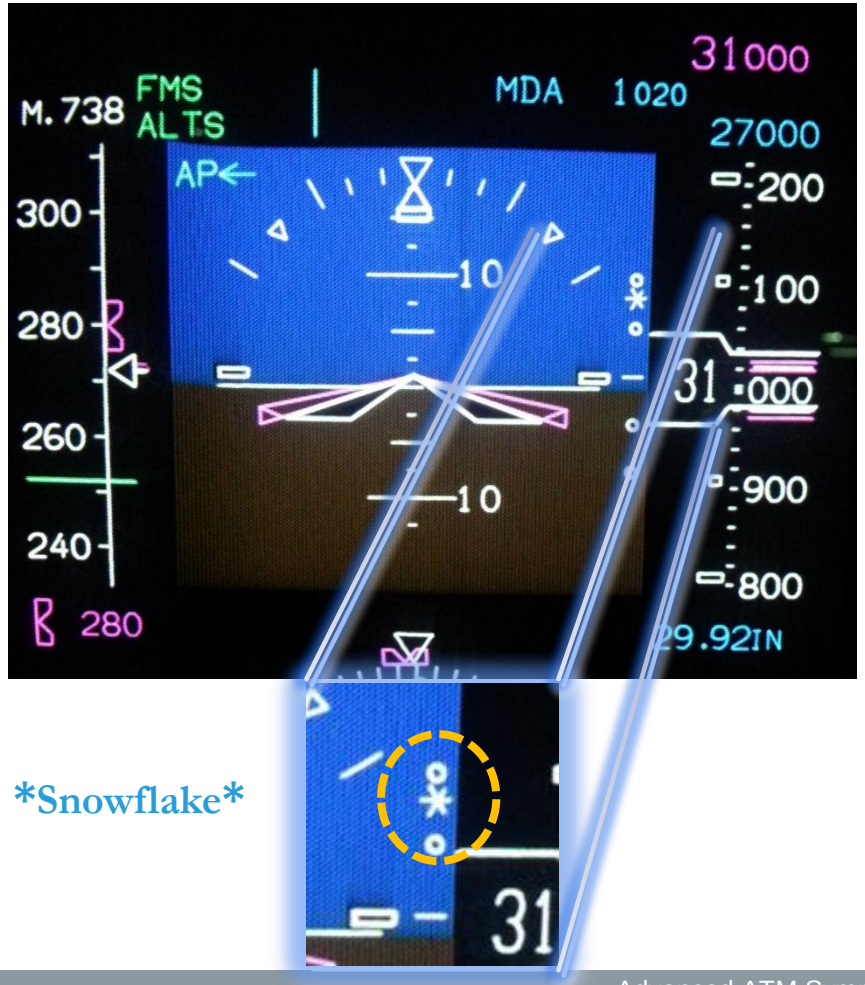
What the FMS does

- Uses a calculated vertical path angle.
- The angle comes from the defaults page (we set it to 3.0°).
- The angle can be changed by the flight crew.

- The FMS then creates a line from the first HARD altitude at the programmed angle.
- If the line does not fit an entered altitude limitation then the FMS adjusts the line to comply with the entered restriction.
- This is called “VNAV Smoothing”.



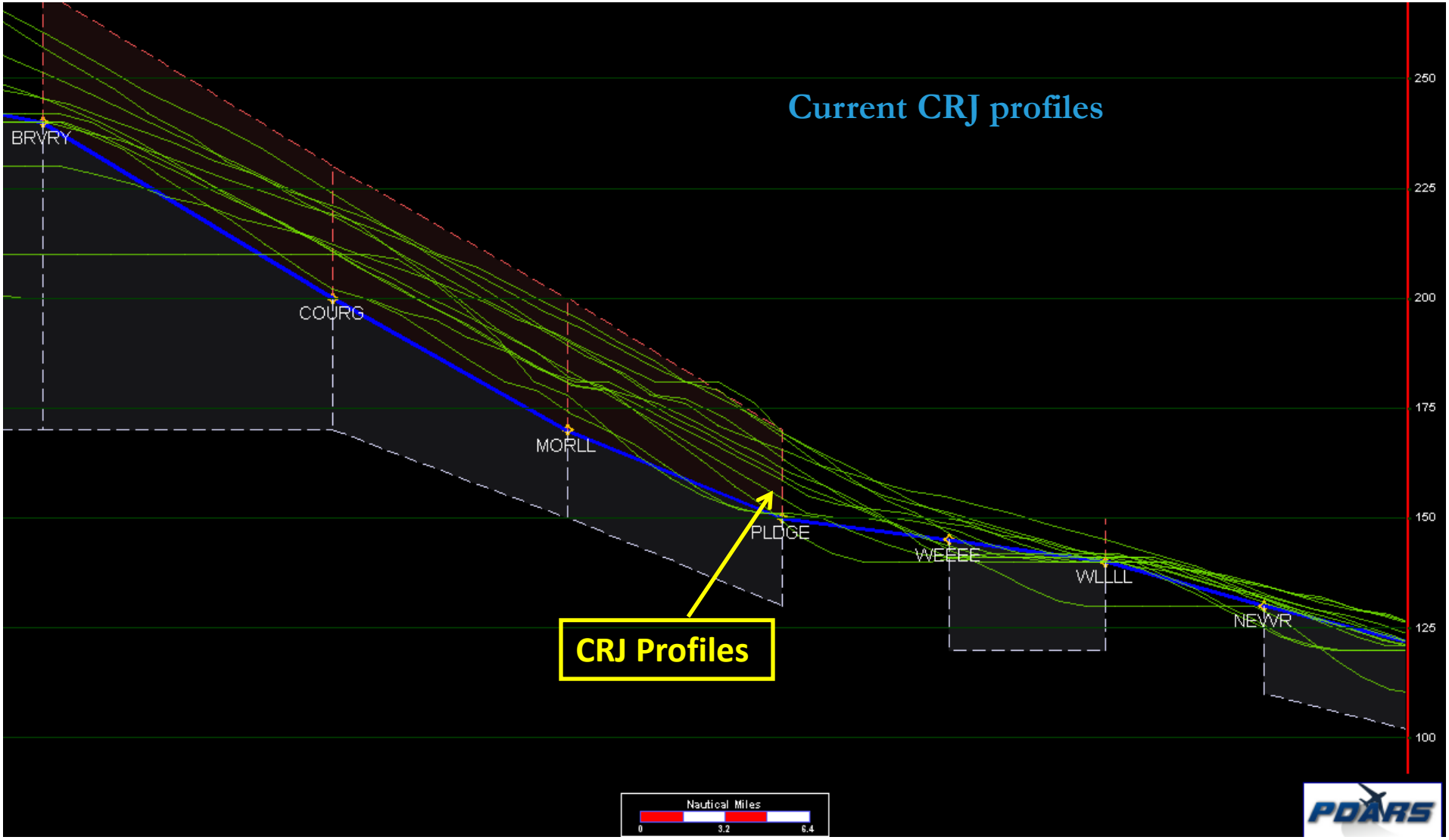
What the Crew Does



Snowflake

- Once the FMS is programmed the crew will manually fly the profile.
- The aircraft displays an ‘advisory VNAV’ on the PFD.
- When the aircraft is within 1/2 ° the advisory VNAV will display on the PFD.

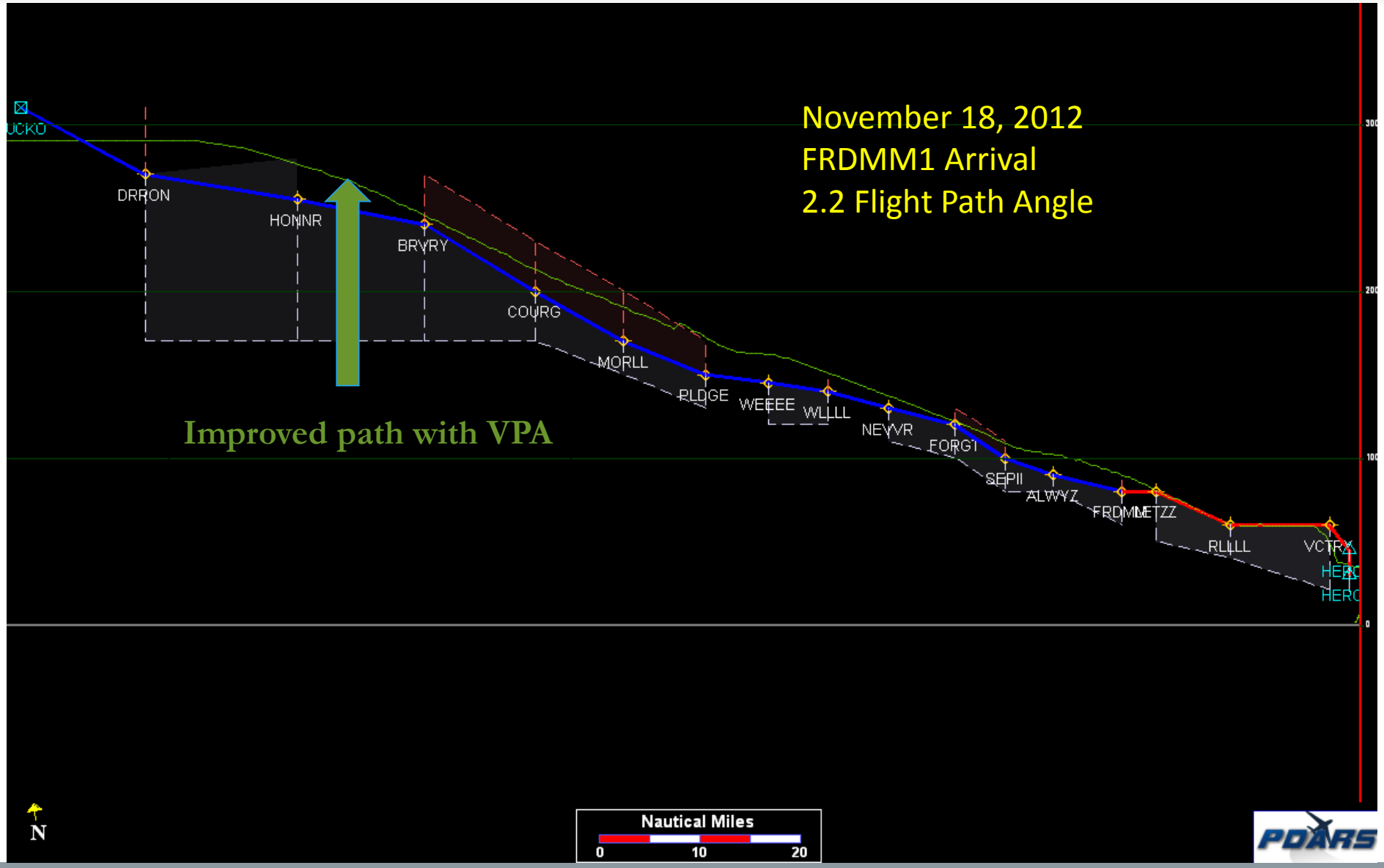
- The crew will then adjust vertical speed and thrust to maintain the programmed or adjusted vertical path and airspeed.


Current CRJ profiles
BRVRY
COURG
MORLL
PLDGE
WEEEE
WLLLL
NEWR
CRJ Profiles
250
225
200
175
150
125
100
Nautical Miles
0
3.2
6.4
PDARS

Differences in Flight Path Angle

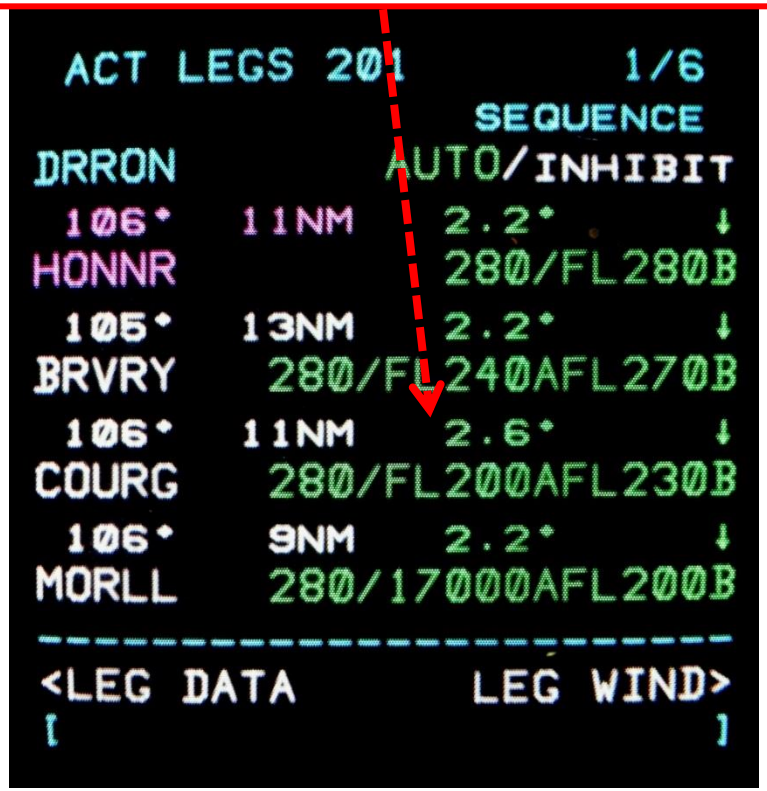
KDCA FRDMM 1

- Using default 3.0° flight path angle
  - Vertical speed changes from 1100 fpm to 2200 fpm along the arrival
  - There are three locations the FMS advises the crew to level off. (After WEEEE, NEVVR, and ALWYZ)
  - Thrust adjustment are necessary after most fixes due to changes in vertical speed.
- Using a calculated 2.2° flight path angle
  - Vertical speed changes from 1400 fpm to 1800 fpm along the arrival.
  - There are NO level offs.
  - Minimal thrust adjustments needed to maintain airspeed.

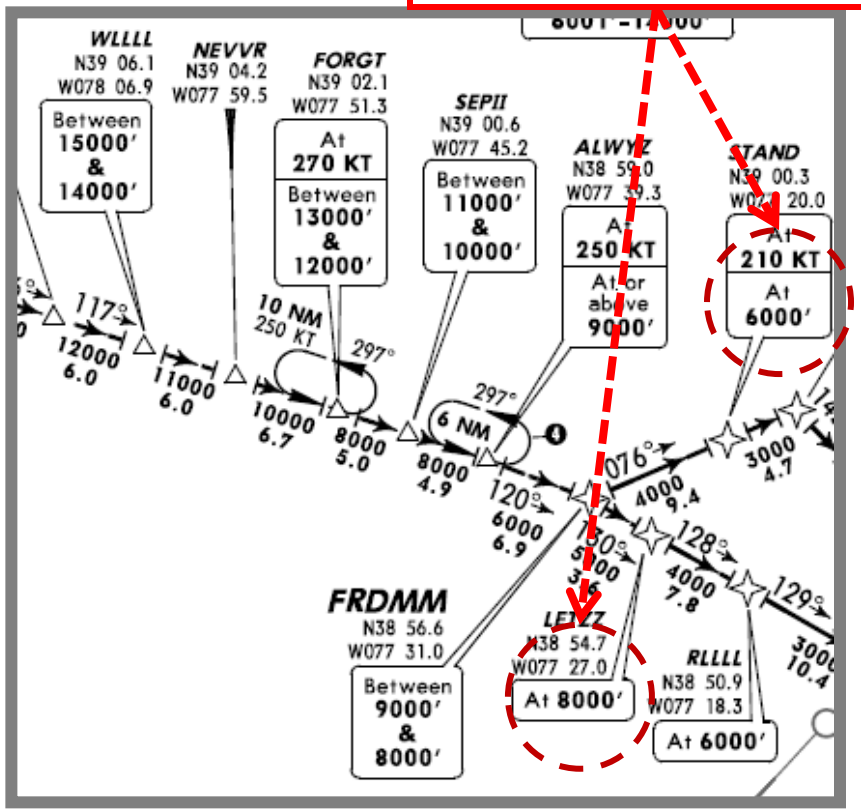

November 18, 2012
FRDMM1 Arrival
2.2 Flight Path Angle
Improved path with VPA
UCKO
DRRON
HONNR
BRVRY
COVRG
MORLL
RLDGE
WEEEE
WLLLL
NEVVR
EORGI
SEPII
ALWYZ
FRDMM
METZZ
RLLLL
VCTRX
HERC
HERC
N
Nautical Miles
0
10
20

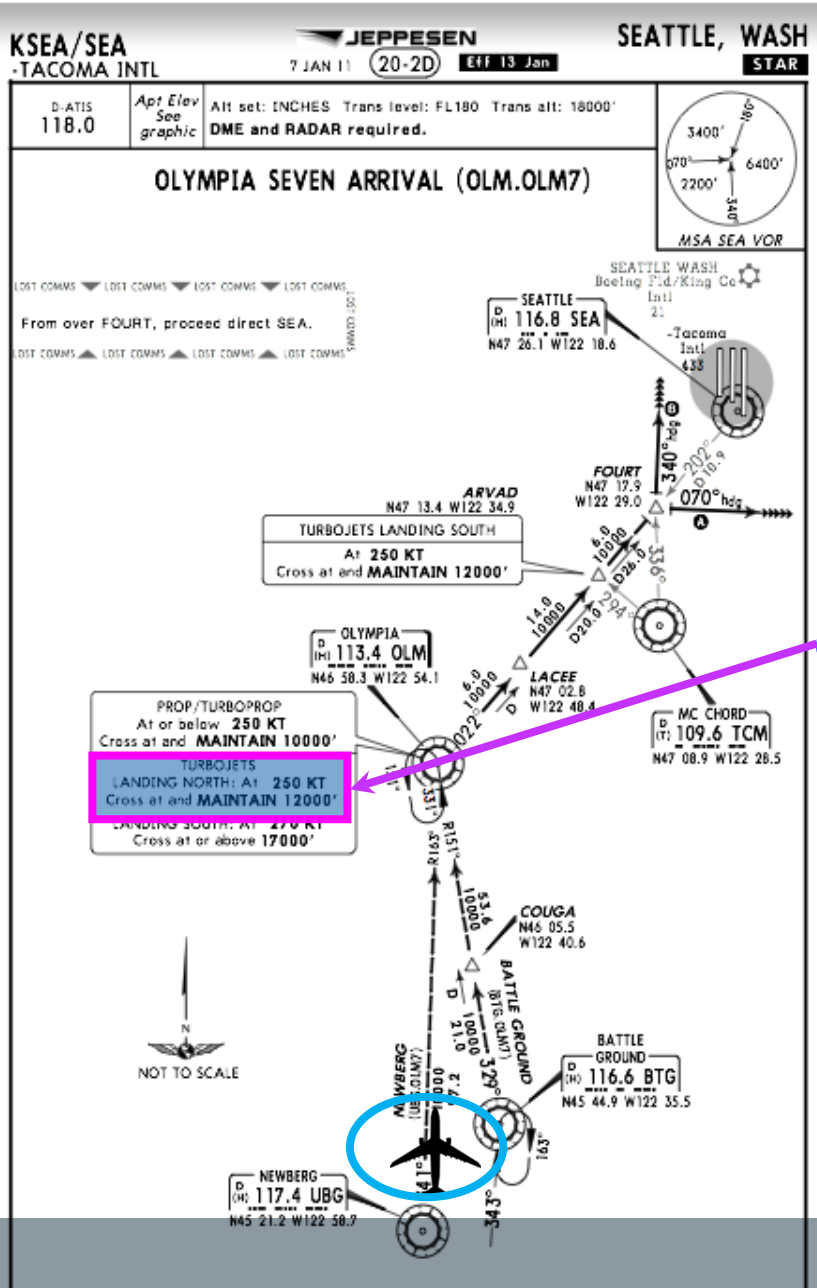
Lessons Learned

VPA increases between BRVRY and COURG. Pilot anticipates increased vertical descent



Hard altitude is set, based on runway transition in use



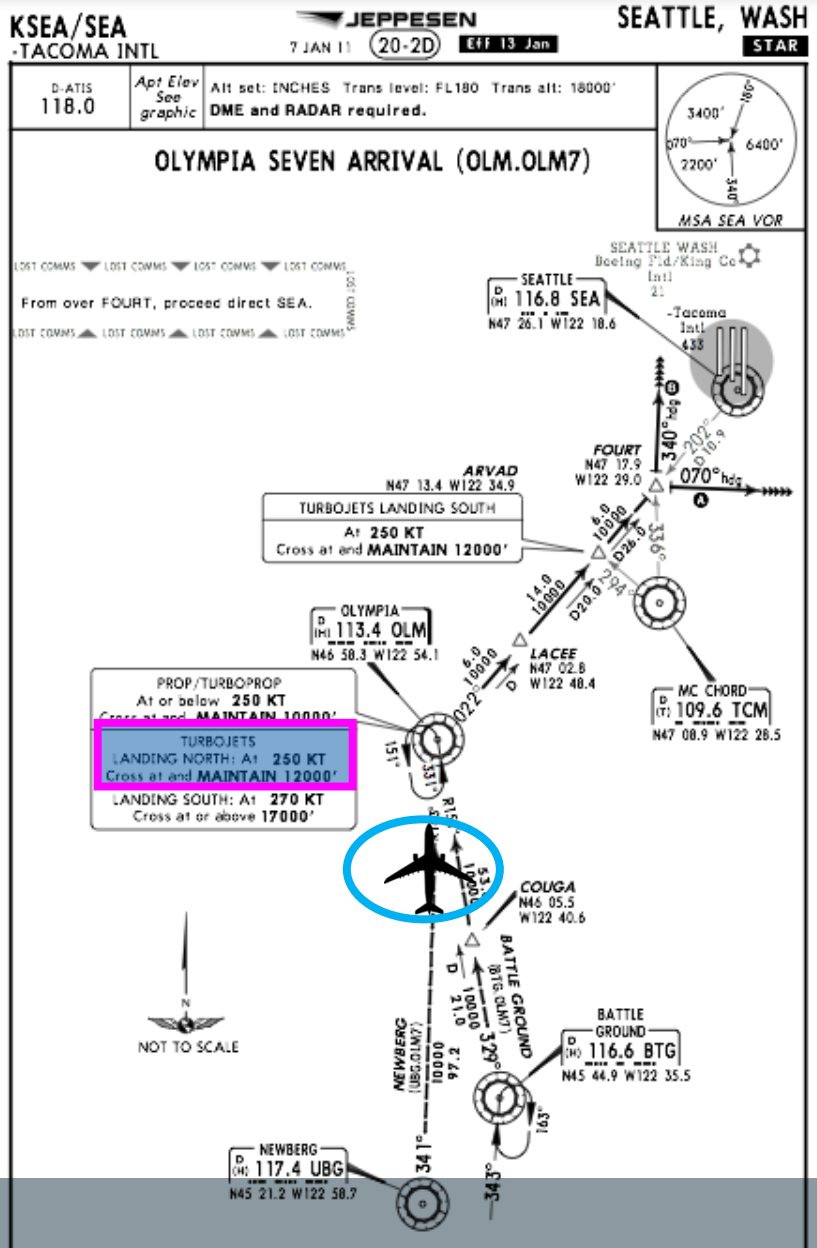


ATC: Bluestreak 223 contact center on 128.20

PILOT: Bluestreak 223, 128.20

PILOT: Seattle Center Bluestreak 223 leaving flight level 210 descending via the OLYMPIA 7 arrival; landing north

ATC: Bluestreak 223, Seattle Center



ATC: Bluestreak 223 contact Seattle approach on 128.3

PILOT: Bluestreak 223 128.3

PILOT: Seattle Approach, Bluestreak 223 leaving 13,000 descending via the Olympia 7 arrival; landing north information Kilo

PILOT: (takes breath)

ATC: Bluestreak 223, runway 34L

PILOT: Bluestreak 223, runway 34L

Guidance for CDO

- Pilot Preparation
  - Brief Arrival
  - Set VPA/FMS
  - Set the first hard altitude "at"
  - Fly the snowflake / make small adjustments
  - Monitor Altitude / Speed constraints
- Published VPA's on Station Bulletins for each arrival
- Published CDO Review Sheet

Crew Documents

- Station Bulletin
  - Quick review for crew
  - City, Arrival, Runway, Angle – All published.

KMEM/MEM **MEMPHIS, TN**
MEMPHIS INTL AIRPORT **1-2** **PSA STATION BULLETIN**

OPS FREQ	OPS PHONE	ATIS (Digital)

Runway 36C LOC unusable beyond 20° left and right of course.

RNAV OPD ARRIVAL:

Descending Via OPD arrivals:

1. Determine the direction of landing via ATIS.
2. Select the appropriate RNAV arrival, transition, and planned runway assignment.
3. Set the appropriate Vertical Path Angle (VPA) in the FMS on VNAV page 3.
   A. LTOWN6 – Runways 36L/C/R and 18L/C/R: enter 2.4°
   B. MASHH1 – Runways 36L/C/R and 18L/C/R: enter 2.4°
   C. MONAA1 – Runways 27/09: enter 2.8°
4. Confirm all FMS altitude and speed entries coincide with the Jeppesen Arrival chart.
5. When contacting ATC, be sure to state the runway or direction assigned for landing.
   A. Example: "MEM Approach, Bluestreak 202 at 15,000 feet descending via the LTOWN6 south/runway 36R transition, information Bravo".

Reference FOM section 5.9.3 for more detailed information.

PUSHBACK AND CLEARANCE:

Crew Documents

- Overview of the CDO in a 'Jeppessen' Size

Optimum Profile Descent (OPD) Arrivals

Setup

1. Brief the arrival and expected approach prior to the planned Top Of Descent. When briefing the arrival verify the altitude and speed constraints are entered into the FMS.
2. Ensure the appropriate transition and runway, if applicable is entered into the FMS.
3. Adjust the Vertical Path Angle (VPA) on VNAV page 3 to the VPA on the Airport Advisory page, if given.
4. When issued a "Descend Via" clearance from ATC, set the first HARD altitude on the arrival. This allows the FMS generated snowflake to calculate the best path for the arrival.
5. Follow the snowflake and ensure all restrictions are met. The opposite page shows the vertical speed needed based upon your vertical path and ground speed. This should only be used as a reference starting point.

Communications

1. You are cleared for the vertical portion of the arrival only AFTER ATC issues a "Descend Via" clearance.
2. When you check-in with a new controller be sure to give all relevant information. (i.e. "Charlotte Approach, Bluesteak 223 is descending via the IVANE1, landing south, information Bravo.)
3. If you are vectored off the arrival you will be issued an altitude by ATC to maintain.
4. If you are 're-cleared' to join the arrival, you need a new "descend via" clearance for the vertical portion.

Crew Documents

- Vertical Path Angle Descent Rates – for planning

VERTICAL PATH
DESCENT RATES

VPA	KNOTS 220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600
1.5	159	583	636	689	742	795	848	901	954	1007	1060	1113	1166	1219	1272	1325	1378	1431	1484	1537	1590
1.6	170	622	678	735	791	848	905	961	1018	1074	1131	1187	1244	1300	1357	1413	1470	1526	1583	1640	1696
1.7	180	661	721	781	841	901	961	1021	1081	1141	1201	1261	1322	1382	1442	1502	1562	1622	1682	1742	1802
1.8	191	700	763	827	890	954	1018	1081	1145	1209	1272	1336	1399	1463	1527	1590	1654	1717	1781	1845	1908
1.9	201	739	806	873	940	1007	1074	1141	1209	1276	1343	1410	1477	1544	1611	1679	1746	1813	1880	1947	2014
2	212	777	848	919	990	1060	1131	1202	1272	1343	1414	1484	1555	1626	1696	1767	1838	1908	1979	2050	2120
2.1	223	816	891	965	1039	1113	1187	1262	1336	1410	1484	1559	1633	1707	1781	1855	1930	2004	2078	2152	2227
2.2	233	855	933	1011	1089	1166	1244	1322	1400	1477	1555	1633	1711	1788	1866	1944	2022	2099	2177	2255	2333
2.3	244	894	976	1057	1138	1219	1301	1382	1463	1545	1626	1707	1788	1870	1951	2032	2114	2195	2276	2357	2439
2.4	254	933	1018	1103	1188	1272	1357	1442	1527	1612	1697	1781	1866	1951	2036	2121	2206	2290	2375	2460	2545
2.5	265	972	1060	1149	1237	1326	1414	1502	1591	1679	1767	1856	1944	2033	2121	2209	2298	2386	2474	2563	2651
2.6	276	1011	1103	1195	1287	1379	1471	1562	1654	1746	1838	1930	2022	2114	2206	2298	2390	2482	2573	2665	2757
2.7	286	1050	1145	1241	1336	1432	1527	1623	1718	1814	1909	2004	2100	2195	2291	2386	2482	2577	2673	2768	2863
2.8	297	1089	1188	1287	1386	1485	1584	1683	1782	1881	1980	2079	2178	2277	2376	2475	2574	2673	2772	2871	2970
2.9	308	1128	1230	1333	1435	1538	1641	1743	1846	1948	2051	2153	2256	2358	2461	2563	2666	2768	2871	2973	3076
3	318	1167	1273	1379	1485	1591	1697	1803	1909	2015	2121	2228	2334	2440	2546	2652	2758	2864	2970	3076	3182
3.1	329	1206	1315	1425	1535	1644	1754	1863	1973	2083	2192	2302	2412	2521	2631	2740	2850	2960	3069	3179	3288
3.2	339	1245	1358	1471	1584	1697	1811	1924	2037	2150	2263	2376	2490	2603	2716	2829	2942	3055	3168	3282	3395
3.3	350	1284	1400	1517	1634	1751	1867	1984	2101	2217	2334	2451	2567	2684	2801	2918	3034	3151	3268	3384	3501
3.4	361	1323	1443	1563	1683	1804	1924	2044	2164	2285	2405	2525	2645	2766	2886	3006	3126	3247	3367	3487	3607
3.5	371	1362	1486	1609	1733	1857	1981	2104	2228	2352	2476	2600	2723	2847	2971	3095	3219	3342	3466	3590	3714
3.6	382	1401	1528	1655	1783	1910	2037	2165	2292	2419	2547	2674	2801	2929	3056	3183	3311	3438	3566	3693	3820
3.7	393	1440	1571	1702	1832	1963	2094	2225	2356	2487	2618	2749	2879	3010	3141	3272	3403	3534	3665	3796	3927
3.8	403	1479	1613	1748	1882	2017	2151	2285	2420	2554	2689	2823	2958	3092	3226	3361	3495	3630	3764	3899	4033
3.9	414	1518	1656	1794	1932	2070	2208	2346	2484	2622	2760	2898	3036	3174	3312	3450	3588	3726	3864	4001	4139
4	425	1557	1698	1840	1981	2123	2265	2406	2548	2689	2831	2972	3114	3255	3397	3538	3680	3821	3963	4104	4246

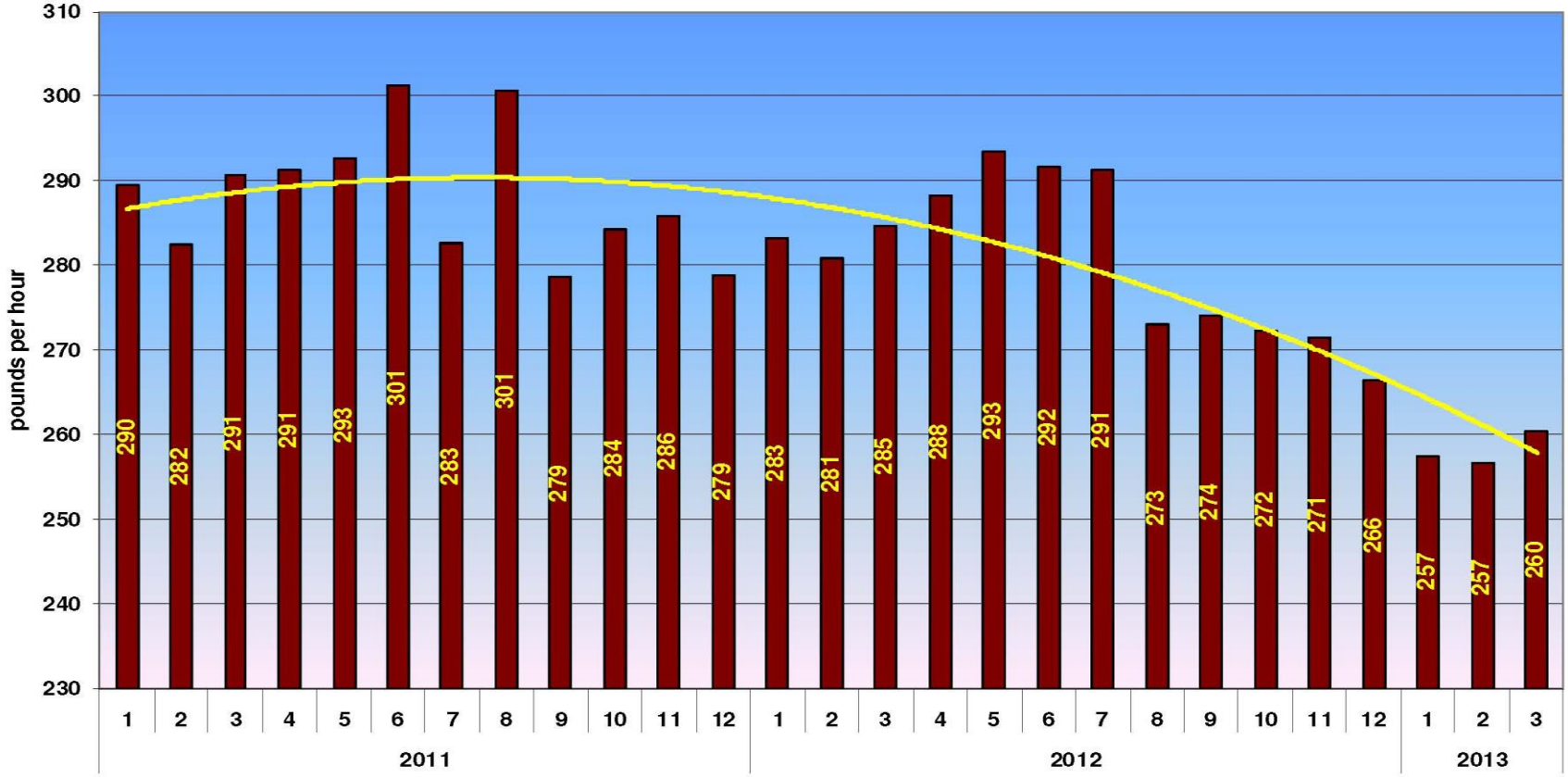
Fuel Savings

- Through FOQA we have determined a decrease of 8-10% fuel required for the descent into KDCA.
  - Fuel flow from TOD to flap extension

U·S AIRWAYS EXPRESS

PSA Airlines, Inc.

DCA All Runways Descent Fuel Burn
(pph per Engine)



Thank You