Flying the Cabin

Hello, and welcome back to the Advanced Pilot Program at Professional Flight Training. This time we are going to talk about Pressurization or “flying the cabin”. Probably the most difficult thing I experienced when moving up to jets from small, single-engine aircraft, was the assortment of systems one had to learn. Most real-life jet pilots feel that they are monitors of these various flight systems and just happen to be flying six to seven miles high above the earth.

Before I begin, we should be aware that real-world System Manuals could take up to a hundred pages or more. As you can see, to go into detail on all the different pressurization systems of each Aircraft would be a huge undertaking. What we can talk about more easily is the CONCEPT of these systems. That should work out OK for us. Real pilots, flying the real equipment, can make any necessary changes in pressurization that they may see fit.

All pressurized aircrafts are capable of flying above ten thousand feet. The human body, on the other hand, seems to function best when supplied with oxygen that maintains a pressure altitude of 10,000 feet or lower. Once a flight is above that pressure altitude, we must have an aircraft system that will do this for our passengers and us. How this is done is as follows. Air is “pumped in” to the cabin by tapping it off of the High-Pressure (HP) stage of a jet or turboprop engine. This is called High Pressure or HP Bleed. On some aircrafts, emergency pressurization is tapped off of the Low Pressure or LP Bleed of an engine. Next, this bleed air is cooled through some sort of heating and air-conditioning system before it enters the cabin or pressure vessel. Some of this cooled pressurized air is sent to the air-conditioning system and flows down ducts that are above your head. This air is called gasper air and is controlled by reaching up and turning it as you see fit. Gasper air works in both a pressurized and unpressurized state.

Once the pressurized air is in the cabin, the amount of it is controlled by one or more outflow valves. These valves open and close to maintain the correct amount of differential pressures that is required. On smaller aircrafts (turboprops) these outflow valves are spring controlled. When this type of aircraft is sitting out on the ramp and “powered down”, the outflow valves are closed by this spring loading. When the required amount of differential (diff) pressure is reached the spring opens to maintain this diff. Large aircrafts have their outflow valves controlled by Air Data Computers (ADC’s)

that are electrically operated.

When an aircraft is on the ground at the gate, it is not pressurized but receives air-conditioning through either an Auxiliary Power Unit (APU) or, in some cases, from an outside Air Cart. This Air Cart may be needed not only to maintain air-conditioning, but also to start the engines if the APU is not working.

Flight Pressurization begins when the aircraft's main wheels leave the ground. What happens is the main gear struts extend and allows a "squat" switch or "nutcracker" to start the system in motion. Please note: on some aircrafts when the cabin doors are closed and taxi power is applied - and (or) the crew selects the "Flight " option on the cabin controller - there may be a small degree of Ground Pressurization to commence in order to avoid a cabin bump once the aircraft lifts off its main gear on takeoff. Usually, the pressurization settings for the planed flight are done at the gate before the flight by adjusting the Cabin Controller.

Below is an example of the Cabin Controller of a Beech King Air set up for a flight. First, the planned flight is a takeoff and then a climb to 17,000 feet. At that altitude the cabin pressure of the King Air will be 1.000 feet above sea level. (Please note that the program model may be wrong according to the diff chart presented below.) Additionally, we have set the Cabin Rate of Climb to 500 feet per minute. We will use a Cabin Rate of Climb of 500 FPM and a Cabin Rate of Descent of 300 FPM as the Standard rates. In the real world if ATC gave you an unrestricted climb and you saw that you were outrunning the cabin then you would adjust the Cabin Climb Rate to a higher amount of pressurization per minute. This might be the case on turboprop equipment that does not have auto-schedulers on their Cabin Controllers.

Not shown on this example is the local altimeter setting (yes that is right) and the present field elevation. These two other factors would be set in before you took off. Please note that usually the Controller has the Field Elevation already set in from the previous landing. But if the aircraft just came out of maintenance, then it would be a good thing to check using the Before Start Cabin Preflight Checklist. Another thing to note is that on large jet aircrafts it is possible to get enough HP Bleed Air to maintain a sea level cabin up to FL 220. In this case, if you took off from KJFK (JFK Airport, NY, NY) and flew to KBOS (Boston Logan, Mass) at an altitude of 17.000 feet, then the Cabin Altitude would be pressurized to remain at sea level throughout the entire flight.

Earlier, we talked about Differential Pressure; I would like to go into more detail about this. The structure of the pressure vessel has to be built to withstand a certain amount of load at the various altitudes the aircraft is certified to fly. Also the amount of bleed air must be sufficient to allow full cabin pressurization if one engine is lost. The ratio of outside aircraft altitude verses inside cabin altitude is called Differential Pressure or “Diff” for short. Here are two charts, which are close enough for our purposes, to show the various cabin altitudes at the different aircraft’s altitudes.

FOR TURBOPROPS

Aircraft Altitude	***Cabin Altitude***	***Diff***
Sea Level to 4000	Sea Level	0 to 1.92
4,000 feet	145 feet	1.92
6,000 feet	350 feet	2.73
8,000 feet	570 feet	3.48
10,000 feet	790 feet	4.17
12,000 feet	1,040 feet	4.81
14,000 feet	1,290 feet	5.39
16,000 feet	1,555 feet	5.93
18,000 feet	1,840 feet	6.40
20,000 feet	2,125 feet	6.85
22,000 feet	2,460 feet	7.23
24,000 feet	2,795 feet	7.58
26,000 feet	3,165 feet	7.87
28,000 feet	3,575 feet	8.12
30,000 feet	3,980 feet	8.34

FOR JET AIRCRAFTS

Aircraft Altitude	***Cabin Altitude***	***Diff***
22,000 feet	Sea Level	0 to 7.23
24,000 feet	2,795 feet	7.58
26,000 feet	3,165 feet	7.87
28,000 feet	3,575 feet	8.12
30,000 feet	3,980 feet	8.34
35,000 feet	5,280 feet	8.65
40,000 feet	6,800 feet	8.72
45,000 feet	7,950 feet	8.77
		Redline 9.00

You would interpret these charts as follows. You are flying a 767 at FL350 what are the Cabin Altitude and Diff? By looking at the above chart the correct answer would be 5,280 feet with an allowable Diff. of 8.65.

Now there are some interesting things that can happen when you are “flying the cabin”. Take this example. You are flying a Beech 1900 at an altitude of 20,000 feet (FL200) and are going into the WTC at Denver. Before you begin your descent you set the field elevation (Denver Airport Reference Point Field Elevation) of 5,431 feet above sea level. As you begin you initial descent you should see the cabin climb from 2,125 feet to 5,431 feet even though the aircraft is descending. Here is another interesting example. Say you are at the WTC at Denver and have the field elevation set in. Your flight is to FL200 (20,000 feet). As soon as you are airborne after takeoff, and the landing gear starts to retract, you should see the cabin pressure descend from 5,431 feet to 2,125 feet even though the aircraft is climbing.

The charts, given above, show a normal max diff. of 8.77 and a Redline of 9.00. This redline would show up if the cabin was over pressurizing. The first thing to show this, in the cockpit, would be a Master Warning Light followed by a “Cabin Over Pressurizing” displayed on the enunciator panel (or EFIS). An enunciator panel is a series of lights on the main panel. If this were to happen then you would take over manual control of the pressurization and control the outflow valves yourself. Closing the outflow valve should increase you Cabin Pressurization while Opening the outflow valve should decrease your Cabin Pressurization. Different aircrafts have various ways to do this but the most important thing to do is follow the Emergency Checklist for your particular aircraft.

Another Emergency occurrence might be if you saw the Master Warning Light come on and a “Cabin Above 10,000 Feet” show up on the Enunciator Panel. In this case the Cabin has reached an unacceptable level above ten thousand feet and you would take over manual control of the pressurization to try and get the cabin within limits AFTER you first put on your oxygen mask. If all else fails you might have to do an Emergency Descent (which is covered within another of the Advance Pilot Program Posts).

OK, that is as far as we can go with this system at the moment. As Flight Sims become better we will be able to do more. If you have kept up and followed along you are to be congratulated.

Now!

I know what you have been waiting for, and here is Captain

Al's Ten Question Quiz.

1. NORMAL flight pressurization comes from?
   a) HP Bleed Air
   b) LP Bleed Air
   c) The APU
   d) The Ground Air Cart

2. On most Turboprop aircrafts the outflow valves are spring loaded?
   a) Closed or Shut in the unpowered state
   b) Open when sitting at the Gate unpowered
   c) Closed or Shut after the main landing gear struts extend
   d) A and C

3. The FIRST thing you should do if you saw "Cabin Altitude above 10.000" on the Enunciator Panel or EFIS is?
   a) Move the Pressurization Switch to Manual and attempt to close the outflow valves.
   b) Move the Pressurization Switch to Manual and attempt to open the outflow valves.
   c) Execute an Emergency Descent.
   d) Put on your Oxygen mask.

4. You are flying a Boeing 767 at FL350, what should be the Cabin Altitude and Diff?
   a) Sea Level and 0
   b) 10,000 and 4.17
   c) 5,280 and 8.65
   d) None of the above.

5. You see a "Cabin Altitude above 10,000" on the Enunciator Panel or EFIS, which of the following could cause this?
   a) The "Nutcracker" switch has failed and the aircraft thinks it is still on the ground.
   b) There is a leak or malfunction in the Heating and Air-Conditioning System.
   c) The Outflow Valves are stuck in the full open position.
   d) All of the above.

6. You are flying a Boring 767 at 16,000 feet. What should you see on the Cabin Altitude Controller for cabin altitude?
   a) Sea Level
   b) 1,555 Feet
   c) 16,000 Feet
   d) None of the Above

7. You are flying a Boeing 767 at FL350 and observe a

Cabin Altitude of 3,960 feet. The Cabin is?
a) Over Pressurized
b) Under Pressurized
c) Normal Pressurized
d) None of the above.

8. Based on your correct answer to question seven you would?
a) Move the Cabin Controller to Manual and attempt to Open the outflow valves.
b) Move the Cabin Controller to Manual and attempt to Close the outflow valves
c) Do nothing, as the Cabin will "catch up" in time.
d) Execute an Emergency Descent.

9. You are flying a Beech 1900 and are at FL220 enroute to the WTC at Denver, CO. On your descent you set the Denver Field Elevation in the Cabin Controller correctly. As you begin your descent you should see the Cabin Altitude?
a) Increase
b) Decrease
c) Remain the Same
d) None of the Above

10. Cabin Differential (Diff) is the difference between?
a) Outside Air Temperature and ISA
b) Density Altitude and Pressure Altitude
c) An increase in the normal lapse rate of 3 degrees F. per thousand feet.
d) Outside aircraft altitude verses inside cabin altitude

OK, now that was EASY wasn't it? Here are the correct answers.

1	a
2	d
3	d
4	c
5	d
6	a
7	a
8	a
9	a
10	d

I have enjoyed you dropping in to visit. Please come back again soon. .