

Tutorial A2A B377 Captain Of The Ship

Turbo Handling

First let's summarize a few things about the turbochargers on the B377. Generally turbochargers are used to supply more manifold pressure than the ambient air might deliver. In the B377 the turbochargers are kind of a „second stage“ on top of the internal geared blowers of the R-4360 engine. The geared blowers alone are capable of supplying the required MP of 60 in. at 2700 RPM for 100% power up to an altitude of approx. 4000 ft. This is called the engines critical altitude. With the turbos on top of that the critical altitude would rise considerably – however except for special operations on high altitude airports the turbochargers are not used for take-off. During climb the required MP for climb power is maintained by the turbochargers – again on top of the geared blowers. Max. Climb Power of 198 PSI torque at 2550 RPM can be maintained up to approx. 9000 ft. by the geared blowers alone whereas with the turbochargers this altitude rises far above the allowed power range of the R-4360. Contradictory to the geared blowers the turbochargers are exhaust-driven via a common-shaft exhaust turbine. The turbochargers are purely manually controlled through a wastegate with the exception of a safety circuit that will limit the max. RPM of the turbochargers. Manual wastegate control is achieved by the Turbo Control Lever.

So far for the power part of the turbochargers. A second – and of course not less important - task of the turbochargers is supplying pressurized air for Cabin Pressurization. This simply means that the turbochargers have to be used as soon as pressurization is required! For Airliners at that age usually pressurization was set to start approx. 1000 ft AAL and end again at 1000 ft AAL. This of course means that all provisions have to be set latest at that height - either during initial climb to be ready to use pressurized air or during final descent to be ready to cut pressurized air. There are three items that deal with pressurization on the turbo's side:

- 1) the Turbo Override Switches
- 2) the Turbo Bleeder Switches
- 3) the Cabin Differential Pressure Gauge

The **Turbo Override Switches** have two positions: „Take-off“ and „climb & cruise“. The „take-off“ position simply inhibits the use of the turbochargers by locking the wastegate open whereas the „climb & cruise“ position allows manual control of the wastegate by the Turbo Control Lever.

Furthermore there is a common pressure duct fed by the turbos directly through checkvalves and restrictor valves. These restrictor valves are controlled by the **Turbo Bleeder Switches**. They can be closed or open where open means that they have a restricting venturi that allows only a certain amount of air flowing into the common pressure duct and subsequently into the cabin.

The pressure measured before those venturis is a direct indication of airflow into the pressure duct. This airflow can be read as pressure on the **Cabin Differential Pressure Gauges**.

Enough of the theory, let's get practical now !

Two more notes though: For proper operation of the Cabin Pressurization System see my respective tutorial and make sure that we are talking here about a completely manual Turbo Handling !

Let's go through a normal routine take-off, climb, descent and landing.

Prior to take-off make sure that:

- the Turbo Override Switches are set to „take-off“
- the Turbo Lever is in 0 (Zero) position
- the Turbo Bleeder Switches are OFF

the following steps should be accomplished upon reaching 1000 ft AAL. This is the Target Altitude we have initially set for the cabin.

After climb power is set:

- set the Turbo Override Switches to „climb & cruise“
- set the Turbo Bleeder Switches to ON
- with the Differential Pressure Gauge in sight slowly advance the Turbo Lever
- aim for Cabin Differential Pressure of ~2 PSI
- correct the Climb Power as turbo pressure has now been added to the previous MP

Now we are set for Pressurization to work. As long as the Cabin Target is not moved the cabin rate should be zero or eventually slightly descending as the cabin might have been climbing a bit prior to the Pressurization becoming active.

During climb:

- make sure there is always at least 2 PSI Cabin Differential Pressure, nevertheless
- make only the necessary corrections on the Turbo Lever
- for decreasing MP with increasing altitude advance the throttles
- do not advance the Turbo Lever until the throttles have reached the full forward position unless required to maintain a minimum Carb Temp
- from now on increase the Turbo Lever to maintain necessary climb MP
- observe the limitations on the power output of the engines above 20'000 ft.

This part is not too complicated. The main target is to keep the turbos working on the lowest possible level in order to keep its bearings cool. That's why we advance the throttles to make maximum use of the geared blowers. However at a certain stage it might become necessary to increase the turbo boost prior to having the throttle firewalled. Remember: Carb Air Temp can only be kept above a certain level by turbo boost. It can be cooled however if necessary by the intercoolers.

During cruise: (high level)

- leave the throttles firewalled initially
- set Cruise Power initially using the Turbo Lever only
- observe the Carb Temp
- if Carb Temp cannot be maintained on a reasonable level:
- increase Turbo Lever and reduce throttles accordingly

During cruise: (low level)

- set Cruise Power initially using the throttles only

- observe the Cabin Differential Gauges to have min. 2 PSI
- if necessary advance Turbo Lever to maintain enough Cabin Differential Pressure
- if Carb Temp cannot be maintained on a reasonable level:
- increase Turbo Lever and reduce throttles accordingly

The cruise part is quite demanding initially. It's a „give and take“ between throttles and turbos. There are two parameters that have to be observed: Carb Temp and Cabin Differential Pressure. On high levels it is usually not a problem to maintain a reasonable Carb Temp with the required Turbo setting. However in extreme situations it might become necessary to increase the Turbo Boost and recude the throttles in order to keep the Carb Temp high enough. Using Carb Heat during cruise is not recommended.

During descent:

- reduce power initially using the throttles
- adjust the Turbo Boost to maintain min. 2 PSI Cabin Differential Pressure
- if necessary use Carb Heat to maintain a reasonable Carb Temp
- aim for lowest possible Turbo setting at Final Approach but still keep min. 2 PSI Cabin Differential Pressure

Now this part sounds simple but in fact is the most tricky one. Things are dynamic during descent. One thing that should be observed is the following: the Turbo boost is not only dependent on the setting of the Turbo Lever but also on the exhaust power produced by the engines. Simply reducing throttles and maintaining the Turbo Lever setting will definitely result in losing enough Turbo Boost to maintain Cabin Pressurization. You will also notice that depending on the A/C altitude there is a minimum MP that cannot be underrun in order not to lose Cabin Differential Pressure. You just need a certain exhaust pressure to run the turbos fast enough. This exhaust pressure can only be delivered by an engine producing a certain amount of power. Again here it's a „give and take“ between Throttles and Turbo Lever. Throttling back to idle and setting the Turbo Lever to max. position will not be a very good idea – neither will it be to use much throttle power and reduce Turbo Boost too much. This part is just a matter of practising and practising. However you will learn now why it is absolutely mandatory to use a shallow descent profile with the Strat ! There is simply no high rate descent possible when you need a certain power to maintain Cabin Pressurization.

On final approach:

- at around 1000 ft AAL check that actual Cabin Altitude is equal to Cabin Target
- set Turbo Lever to Zero and advance throttles to keep necessary approach power
- set Turbo Bleeder Switches to OFF
- set Turbo Override Switches to „take-off“

That's it, folks ! You're now ready to land or to go-around. Just be aware that you are now unpressurized for the last 1000 ft on final approach. The cabin will now follow the A/C's ROD. Keep it below 1000 FPM and no babies will ever start crying