

High Altitude Testing

Many, if not most, FAA Part 25 (Transport) aircraft want to get certified for high altitude airport operations. These operations put challenges on the aircraft in various ways that need to be tested and certified. This includes mainly pressurization systems and engine operations (starting and thermal issues). The FAA allows for 3000' extrapolation of flight test data. The highest commercial airport is approximately 14,500' so testing is desired at 11,500 or above. A commonly used major airport test location is at La Paz, Bolivia (13,325'). Testing at high altitudes presents some unique safety issues, mainly physiological, that I will discuss below.

Several Approaches to Testing

Depending on the scope of your program, there can be several ways to approach this testing. One manufacturer has based their operations out of a lower altitude airport and then flown to the higher airport for the testing and returned the same day. If your test program can support this, it is the least invasive to the team from a physiological point of view, since the crew don't necessarily have to become "acclimated" to the full target altitude. But has its downsides too. There is the added travel time to and from the test site (and associated costs), and often you may need to stop and do the customs, both of which eats into your test day. You may also suffer from weather changes enroute. Finally, if something should go wrong, you may not have the right maintenance people/equipment there and then there would be the burden of last minute travel issues (hotels, transportation, visas, etc.).

However, if you have tests such as cold engine starts that require an overnight cold soak, then you may have to deploy and operate at the higher altitude airport. Advantages include no travel time to the test site, no risk of failures stranding you away from support and no risk of weather issues popping up that aren't easily waited out. However, this approach puts the entire test team under the most physiological stress and they need to be acclimated to be in peak performance. This may extend your deployment by several days.

Physiology

With either approach the main concern is physiology issues related to the high altitude. The body doesn't like it at that high altitude (low pressure and lack of oxygen) and can cause several different medical conditions, with hypoxia on the top of the list. Extended time in hypoxic conditions can also lead to what is called "Acute Mountain Sickness" (AMS). This can be a life threatening condition if not diagnosed and treated in a timely fashion. The cause of AMS is the lower level of oxygen available at altitude. With a few hours of exposure to low oxygen levels, without sufficient acclimatization, this lack of oxygen can lead to a condition known as pulmonary edema, where the lung tissues become stiff and full of fluid. Your risk of experiencing acute mountain sickness is greater if you live near sea level and are unaccustomed to higher altitudes. Anyone who makes a rapid ascent and has a prolonged stay at altitudes greater than 10,000 feet above sea level is subject to AMS.

The very first and foremost mitigation is that **ALL** flight test crewmembers have gotten education in flight physiology, to include a high altitude chamber ride. Everyone needs to know how this affects you and what your hypoxia symptoms are. Believe it or not, this training is FREE! The FAA's civil aeromedical institute (CAMI) in Oklahoma City, OK conducts a one-day physiology class that includes ground school and an altitude chamber ride (or new nitrogen enriched chamber that simulates the low oxygen partial pressure). You just need to get there to take the class.

Symptoms:

Some early symptoms you may experience with hypoxia or AMS:

- Dizziness
- Headache
- Feeling unusually hot (flushed)
- Disturbed vision (blurry or tunnel)
- Confusion
- Muscle aches
- Tingling in extremities
- Insomnia
- Nausea and vomiting
- Irritability
- Loss of appetite
- Swelling of the hands, feet and face
- Rapid heartbeat
- Shortness of breath with physical exertion

If any of those symptoms appear, some interventions include:

- Stop any physical activity and rest
- Ensure well hydrated
- Return to a lower altitude if possible (or re-pressurize the aircraft)

Symptoms of severe altitude sickness, requiring immediate medical attention may include:

- Uncharacteristic coughing
- Chest congestion
- Pale complexion and skin discoloration
- Inability to walk or lack of balance
- Social withdrawal

Coughing up blood, or loss of consciousness are late signs of AMS that may indicate a fatal outcome.

Mitigations

Some or all of the below mitigations can be used to help acclimate to the high altitude or mitigate the dangers. Whether it is hypoxia or AMS, most mitigations are the same.

- It is recommended to allow at least 1-2 days to allow your body to acclimate to the higher altitude. Of course longer is better, but most physicians recommend at *least* 48 hours.
- If you have choices in personnel, take the more physically fit people and non-smokers if possible. If you have any significant medical issues (such as heart/lung disease or anemia), see your doctor before going.
- Abstain from any significant physical activity. Nothing more than normal walking is recommended. Even walking stairs can be tough. Take the elevator if you can. (I can attest that just climbing the flight stairs at 13K' will wind you!). You may run at home, but at 13K' it can put major stress on your body. Don't be lulled by seeing locals jogging around, they are acclimated!
- Abstain from alcohol intake.

- Medications: Like alcohol, sleeping medications such as Ambien, and some Anti-Hypertensive medications will slow your rate of breathing in your sleep and make you more susceptible to AMS, and render you more likely to experience the serious consequences associated with the disorder. Check with your doctor if you're taking any medications.
- You may have trouble sleeping and from my experience in La Paz, the better hotels offered oxygen to use in your room to help with sleeping and acclimation and to address symptoms like headaches.
- Keep yourself well hydrated and nourished (frequent high carb meals recommended).
- Crewmembers participating in the test need to wear oxygen whenever the cabin altitude is above 8,000 feet (typical pressurized cabin). This could be an extended period so care needs to be taken to ensure enough oxygen is onboard, whether it is in onboard systems or separate bottles.
- Return to lower altitudes to sleep (first scenario described above).

There are a medication you can take that will help with acclimation and lessen altitude sickness. You start taking it several days before you leave. Its generic name is **Acetazolamide** (common brand name: Diamox). It is a prescription drug so you need to see a doctor to get it. There are some side effects as it is a diuretic, so the doctor can analyze whether the benefits outweigh the risks in your particular case. Pilots should contact their doctor to document that they are on this medication for prevention of altitude sickness (not some other condition which may be disqualifying) and it is recommended they send an email to their regional flight surgeon stating this in case anything should happen.

This short article was put together with inputs from several members of the Flight Test Safety Committee and reviewed by an FAA aeromedical examiner. If you have anything to add, please email me at: john.hed@faa.gov or phone me at 425-917-6518

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