INCREASE SAFETY

AND REDUCE COST

THE RATIONALE FOR NEW PITOT COVER TECHNOLOGY FOR AIR DATA SYSTEM PROTECTION

From original white paper by Adam R. Thompson; CA. Stephen Walton(ret.)

New Technology Can Reduce Systemic Safety Concerns

A universal-fit pitot tube cover self-releases from the pitot tube, answering the call from industry for "fail-safe" protection of this critical system component.

By: Adam R. Thompson; CA. Stephen Walton (ret.)

SINCE *the earliest days of aviation, one of the most critical systems on any aircraft has been the pitot static system. While airframes and powerplants have evolved and speeds have made quantum leaps, this common component has remained. The technology of aircraft has developed and so have the somewhat simple tubes holding a calibrated orifice directly into the relative wind. These are no longer simple pipes connected to airspeed indicators. The output sends information to a host of equipment and sensors critical for the safe conduct of flight. The environmental demands on high performance aircraft have increased, the tube is heated to preclude blockage by ice and moisture. Critical to the tube's function, the opening must remain free of all manner of restrictions. This is important even when sitting static or in maintenance. Threats of contamination include insects, sand, dust, precipitation, and man-made obstruction.*

COVERING THE PITOT TUBE-CATCH 22

The traditional method to keep the tube protected has been a pitot cover. The cover most often consists of a fabric form-fitting sock-like envelope or plastic closed ended tube that slides into place as conditions warrant and is removed before flight operations or activation of the pitot heat. Most covers are equipped with red "Remove Before Flight" streamers to attract attention to their presence. This precludes operations that would hazard the airframe through the cover remaining in place during flight, and the potential melting or igniting of the cover during maintenance operations should heat be applied.

The principal danger of operating with blocked pitot tubes is in the realm of flight. The most hazardous operation of any flight is while the aircraft is low on energy and accelerating during takeoff. If a tube is blocked, the performance of the aircraft cannot be accurately gauged during this critical phase. This can potentially result in an aborted takeoff. Additionally, this can cause runway overruns, high-energy braking, and attendant stress on airframe components. If the aircraft becomes airborne with unreliable airspeed and associated systems, the hazards are many. Depending on conditions, the crew may become distracted or disoriented to the point of losing control of the aircraft and its occupants coming to grief.

Operations with the covers in place are grossly under-reported if no reportable incident occurs. The accident statistics over the years bear this out. The term “Pitot Cover Application Hesitancy” describes a phenomenon where operators do not apply covers out of fear that they will not be removed in a timely manner. Likewise, if maintenance personnel inadvertently activate the pitot system heat, melting a cover to the tube or otherwise damaging it, the action is quickly and quietly covered up. There have been examples of these problems on multiple continents. Immediately post 9-11, numerous operators had multiple RTO’s due to covers left in place or contamination after aircraft were out of service over many days without pitot covers. In 2018 a wide body operator attempted to leave an airport in North America with all the pitot tubes covered, also occurring in 2018 a widebody operator attempted to depart an Australian airport without first removing the pitot tube covers. The latter incident became public knowledge and resulted in multiple advisories. As recently as August 2021 a memo was disseminated from a commercial airframe OEM to its operators regarding a recent wide-body Rejected Take-Off due to two blocked pitot tubes following normal parking for six days without pitot covers in place. A government investigation of the incident was underway as of this writing. These are the incidents we have record of, we know others have happened. There are anecdotal tales from pilots and mechanics alike on this subject. There are others that believe that standard operating procedures will prevent an accident related to this issue. We know that procedures are not always followed, and accidents are the result.

THE HIGH COST OF HUMAN ERROR (see addendum)

When one of these instances occurs, there is a large financial cost to the operator and/or insurance companies. When the pitot tube heats up with a non-aramid cover on the tube the result is a melted cover. The pitot tube needs replaced, or extensive maintenance is required to clear it. The cost of replacing an airliner pitot tube is several thousand $USD for the part, approximately ten hours of labor and the operational cost of the delay. Additional costs include crew and passenger accommodations, as well as goodwill. In the case of the incident in mid-2018, the nation where it occurred impounded the airplane for an extensive investigation. This impoundment resulted in the cost due to the airplane being unavailable for use.

To be clear, it is ultimately the responsibility of the flight crew to ensure the cover is removed before flight. Safety Management Systems are built in by operators to provide a backup if the pilots fail to remove the cover. Unfortunately, the backup is also subject to human factors, as the backup for the pilots is ground staff. Over the years, this back-up has been shown, owing to a host of human or environmental factors, to be a potential point of critical failure. This has been proven in all manner of operations be they commercial airline, corporate, or defense flight operations.

Pitot tube covers have been in use for over one hundred years, but until recently the construction of pitot tube covers has remained largely unchanged, not for lack of need, but rather for a lack of technology. The need for a change has increased for various reasons. The cost of a mishap is not just measured financially. Even if no injuries or damage to the aircraft are incurred, there is often negative press and the demand by authorities for explanation, with possible disciplinary actions or penalties. The escalating costs of repair and operational compensation in terms of insurance and logistics are higher than historic averages. On the maintenance side, inadvertent damage to a pitot tube can be extremely expensive in terms of physical parts, logistics, labor and equipment substitution or flight cancelations.

ANSWERING THE CALL

Modern Safety Management Systems (SMS) function by identifying threats to safety and erecting multiple barriers against failures or errors. In normal operations those barriers against a failure of safety, as stated earlier, include the flight crew and ground staff.

After numerous inquiries from Air-Carrier representatives, DeGroff Aviation Technologies has developed a “fail-safe” pitot tube cover for turbine aircraft with pitot heat that automatically energizes on power-up. Using the Safety Management Systems approach, the PitotShield V2™ SmartCover™ Technology is a novel thermal-reactive pitot cover specifically designed and tested to self-remove from a pitot tube should heat be applied with the PitotShield V2™ still installed. Using first-in-the-US, state-of-the art additive manufacturing technology, the cover body consists of only five parts, and has only four materials. The pitot cover holds securely onto the pitot tube with heat-resistant, non-marring silicone baffles that tighten incrementally as wind and vibration try to move the cover as is normally found in the operating environment. The flexible baffle design provides for a universal fit-one size fits nearly every pitot tube on turbine aircraft. There are a few very large and very small pitot tubes for which there are non-standard sizes of PitotShield V2™. The cover slides on and off in a conventional manner and a telescoping installation/removal tool is available for operators that might need to reach pitot tubes up to thirteen feet (approx. four meters) above ground level.

Each PitotShield V2™ is also enhanced, vs prior pitot covers, with a bright orange “Remove Before Flight,” streamer with fluorescent yellow-green omni-reflective highlights. These are the two most visible colors to the human eye, much more so than red, thus reducing the risk of being overlooked during day and night pre-flight walk-around. The cover is also equipped with lanyard fittings should an operator wish to attach them to other component covers, static plugs and the like. In everyday operation, the PitotShield V2™ is intended to be deployed and removed in the conventional manner as with any other pitot cover. The self-release function is fail-safe should the cover be in place when heat is applied. Should the PitotShield V2™ self-shed, it will deploy in two halves. Being of low mass, it presents little FOD or ingestion hazard. An additional feature of this design is that one size fits nearly all pitot tubes. This will help assure that operators have available “safety” pitot covers to fit their aircraft wherever they fly.

CONCLUSION

The PitotShield V2™ SmartCover™ is novel technology developed in response to aerospace industry reaching out with long-recognized needs for prevention of potentially catastrophic failure modes in a critical system. DeGroff Aviation Technologies is the first to utilize a new additive manufacturing technology to develop and produce a simple answer to a complex problem. The PitotShield V2 SmartCover™ will break the accident chain while achieving a nearly universal fit to streamline the supply to the turbine aircraft market.

Addendum

Economic impact of Air or Ground interrupt
B-777-300 (Long Haul International)

Assumes four tubes fouled, no airframe damage or injuries to passengers or crew.

1. Passenger accommodation. *	300 x 900	= 270,000
2. Un-Airworthy pitot tubes.	4 x 2,500	= 10,000
3. Labor to remove install tubes.	4 x 4 x 80	= 1,280
4. Abort inspection.	4 x 80	= 320
5. Schedule Disruption.	Operator-dependent	
	TOTAL	**$281,600**

Economic impact of air or ground interrupt
Narrow Body (737) (Domestic Medium Haul)

Assumes four tubes fouled, no airframe damage or injuries to passengers or crew.

1. Passenger accommodation. *	150 x 300	= 45,000
2. Three fouled tubes replaced.	3 x 2,500	= 7,500
3. Labor to remove install tubes.	3 x 4 x 80	= 960
4. Abort inspection.	4 x 80	= 320
5. Schedule disruption.	Operator-dependent	
	TOTAL	**$53,780**

*IATA COST AVERAGE - $US

Costs include direct costs such as hotel, transportation, meals, regulatory compensation, rebooking and revenue displacement.

If schedule disruption is of sufficient length, passenger at intended destination may have to be accommodated incurring significant additional cost.

Economic Impact of Air or Ground Interrupt
70-Seat Regional

Assumes three tubes fouled, no airframe damage or injuries to passengers or crew.

1. Passenger accommodation *	70 x 300	= 21,000
2. Three fouled tubes replaced.	3 x 2,500	= 7,500
3. Labor to remove install tubes	3 x 2 x 40	= 240
4. Abort inspection	2 x 40	= 80
5. Schedule disruption	Operator-dependent	
	TOTAL	**$28,820**

Economic Impact of Air or Ground Interrupt
50 Seat Regional

Assumes three tubes fouled, no airframe damage or injuries to passengers or crew.

1. Passenger accommodation. *	50 x 300	= 15,000
2. Three fouled tubes replaced.	3 x 1,500	= 4,500
3. Labor to remove install tubes.	3 x 2 x 40	= 240
4. Abort inspection	2 x $ 40	= 80
5. Schedule disruption.	Operator dependent	
	TOTAL	**$19,820**

*IATA COST AVERAGE

All costs are in $US.
Costs include direct costs such as hotel, transportation, meals, regulatory compensation, rebooking and revenue displacement.

Economic impact of Air or Ground Interrupt
BizJet-Large

Assumes four tubes fouled, no airframe damage or injuries to passengers or crew.

6.	Passenger accommodation *	12 x 450 = 5,400
7.	Four fouled tubes replaced.	4 x 2,500 = 10,000
8.	Labor to remove/install tubes	4 x 2 x 80 = 640
9.	Abort inspection	2 x 80 = 160
10.	Schedule Disruption	Operator-dependent

TOTAL $ 16,200

Economic Impact of Air or Ground Interrupt
BizJet-Midsize/Super Midsize

Assumes three tubes fouled, no airframe damage or injuries to passengers or crew.

6.	Passenger accommodation *	8 x 450 = 3,600
7.	Three fouled tubes replaced.	3 x 2,500 = 7,500
8.	Labor to remove/install tubes	3 x 2 x 80 = 480
9.	Abort inspection	2 x 80 = 160
10.	Schedule disruption	Operator-dependent

TOTAL $ 11,740

Economic Impact of Air or Ground Interrupt

BizJet-Light

Assumes two tubes fouled, no airframe damage or injuries to passengers or crew.

1.	Passenger accommodation*	4 x 450	= 1,800
2.	Two fouled tubes replaced.	2 x 2,500	= 5,000
3.	Labor to remove/install tubes	2 x 80	= 160
4.	Abort inspection	2 x 80	= 160
5.	Schedule disruption	Operator-dependent	
		TOTAL	**$ 7,120**

* All costs are in $US.
Costs include direct costs such as hotel, transportation, meals. Costs vary with operator contracted rates.