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COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE
PRESENTATION TO THE SUBCOMMITTEE ON READINESS
COMMITTEE ON ARMED SERVICES
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SUBJECT: PHYSIOLOGIC EPISODES UPDATE

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Introduction

Chairman Turner, Ranking Member Tsongas and distinguished members of the subcommittee, thank you for the opportunity to provide you an update on aircraft physiologic events within the United States Air Force. This written statement addresses recent historical trends in aircraft physiologic events in addition to how the Air Force is responding to physiologic events by assessing trends and utilizing lessons learned. For seventy years the United States Air Force has provided combat air power for the joint force to deter and decisively defeat our nation's enemies. Airmen continue to fly, fight and win today, in combat missions in Afghanistan, Iraq and Syria, as well as over our skies in defense of the homeland.

Operating combat aircraft to their maximum performance will always carry inherent risk, but it is our solemn duty as a service to provide the best equipment and training for our Airmen to ensure their safety is never placed in unnecessary jeopardy. The Air Force takes flight safety seriously. The service investigates every accident, every mishap, and any issues that impact the presentation of airpower to the joint force. The extensive aviation history of the Air Force gives the service a wealth of data to draw from when assessing physiologic events that occur in flight. Investigations and resolutions to physiologic events are shared across multiple agencies within the Air Force to ensure a holistic approach to solutions.

The Air Force has a robust and extensive process to respond to physiologic events. Investigations into physiologic events are shared between Air Force Material Command, Air Force Flight Safety, Air Force Research Lab, the 71lth Human Performance Wing, our sister services and other government agencies. While this federated process ensures a holistic approach, the Air Force recognizes that process improvements can still be made. In Nov 2016, the Air Force stood up a joint research effort called "Characterizing and Optimizing the

Physiologic Environment in Fighters" or COPE-Fighter. Their mission is to identify solutions for high performance aircraft that optimize human performance in tactical aviation, and eliminate or minimize the impact of unexplained physiologic incidents. Membership in the team is both multi-service and inter-agency. Additionally, I have appointed a General Officer, Brigadier General Bobbi Doorenbos to be the singular point of contact on the Headquarters Air Force Operations staff to integrate our efforts.

Definitions

A physiologic event occurs when aircrew are physically impaired, experiencing decreased performance due to a variety of factors. There are three types of possible physiologic events referenced in this testimony. Hypoxia related events, which occur when there is a lack of oxygen delivered to the body, hypocapnea which occurs when there is reduced carbon-dioxide in the blood stream due to hyperventilation, and hypercapnia which is the opposite of hypocapnea, in which there is too much carbon-dioxide in the blood stream.

Historical Trend Rate Data

Despite the serious nature of physiologic events, the overall rate of hypoxia-like physiologic episodes occurring across the Air Force fighter and trainer fleet remains incredibly low. In fact, the probability of a fighter pilot experiencing a physiologic episode remains less than 1% per year.

Table 1 shows hypoxia-like events for the eight Air Force fighter and trainer aircraft in the service's fleet over the past ten years. It is challenging to pinpoint exact trends across air frames. The occurrence of these events seem to have no correlation or causation with the rollout of new technology or increased flight hours. Evident are the spikes which occur surrounding the

F-22A and F-15C/D. Several studies show the tendency for increased reporting and awareness alongside high profile events, like that of the F-22A in FY12 or the F-15C/D in FY16.

Hypoxia-like Events									
	F-22A	F-15C/D	F-15E	F-16C/D	A-10C	F-35A	T-38C	T-6A	Totals
FY08	2	1	0	2	1	N/A	0	2	8
FY09	2	0	0	7	3	N/A	1	3	16
FY10	2	3	1	4	1	N/A	0	5	16
FY11	10	1	5	6	0	N/A	1	3	26
FY12	15	2	3	10	2	1	1	4	38
FY13	5	3	3	7	2	1	0	3	24
FY14	2	2	2	11	2	1	1	2	23
FY15	2	12	1	13	3	1	5	4	41
FY16	5	20	2	12	1	2	3	3	48
FY17	1	1	2	12	6	6	2	4	34
FY18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22	N/A
Totals	46	45	19	84	21	12	14	55	296

No Common Root Causes Identified

Multiple agencies in the Air Force are responsible for addressing physiologic events. Air Force Flight Safety is the lead for the flight investigation assessing probable causes of a flight mishap, while also making recommendations to prevent future issues. The Air Force Life Cycle Management Center provides equipment solutions, training experts, and liaisons across military services to share expertise and lessons learned. Finally, the aircraft program offices have the

ultimate control on developing and fielding material solutions for the aircraft if deficiencies or improvements are found.

According to extensive analysis by Air Force Flight Safety and the Air Force Life Cycle Management Center, there is no single root cause tied to a manufacturing or design defect that would explain multiple physiologic event incidents across airframes or within a specific airframe. Some events are due to issues outside the aircraft or equipment, and some physiologic events remain unexplained and cannot be replicated.

The Air Force rigorously investigates each event, and has implemented multiple solutions and advancements. Where applicable, the Air Force installs systems to prevent future recurrences. For example, in response to the F-22A physiologic events from 2010 to 2012 we installed a backup oxygen system and additional sensors to allow pilots increased awareness of cabin pressure and oxygen quality. Not all events result in material solutions, often procedural or training changes remain sufficient. Solutions prescribed differ widely across airframes and situation. I will now give specific examples and resolutions related to incidents surrounding the F-15C/D, F-22A, F35A and T-6A.

F-15C/D

The F-15C/D fleet experienced an increase in the number of physiologic events in late FY15 and throughout FY16. This spike was highlighted by several incidents involving failures of the cockpit pressurization system and/or perceived failures of the oxygen system. It should be noted that the F-15C/D does not use an onboard oxygen generating system found in other fighter and trainer aircraft models. Instead, the F-15C/D uses a liquid oxygen system to supply aircrew with oxygen.

Following extensive investigation of the physiologic events, the Air Force developed additional cockpit instrumentation within the F-15C/D that will be fielded starting in FY18. The instrument, called a Cockpit Pressure Indicator, will give aircrew an audible and visual warning if the cockpit pressurization schedule deviates from the desired range. Additionally, the F-15C/D/E flight manuals have been updated with guidance on hypocapnia at altitude with functioning oxygen systems, time of useful consciousness, and improved emergency procedures for physiologic events.

F-22A

Physiologic events with the F-22A generated very high profile coverage and attention between 2010 and 2012. The Air Force testified before Congress and this committee, regarding the extensive investigation the service conducted to identify root causes and corrective actions. The F-22A's onboard oxygen generation system was extensively evaluated by multiple agencies to include the National Aeronautics and Space Agency and the Air Force Scientific Advisory Board. The system was determined not to be a cause in any of the physiologic events reported during that time frame; however, based on recommendations from the investigations, material solutions, and training and procedural changes were made to the F-22A, such as the addition of the automatic backup oxygen system.

Since 2016, the F-22A has had four discrepancy reports related to degraded partial pressure oxygen sensors, a component of the environmental control system within the aircraft. This is a known issue with degraded oxygen sensors, according to the F-22A program office and Air Force Life Cycle Management Center. The supplier has been made aware of the deficiency and has implemented a design improvement to address the issue.

F-35A

Within five weeks, from May 2017 to June 2017, there were five airborne physiologic events with the F-35A at the 56th Fighter Wing, Luke Air Force Base, Phoenix, Arizona.

The Air Force investigation into the issue determined that the onboard oxygen generation system was not at fault for any of the airborne related events. Investigators noted possible causes could have been attributed to:

a) Ingestion of increased carbon monoxide during ground operations
b) Rate and depth of breathing exacerbated by positive pressure flow from the onboard oxygen generation system
c) Procedural and systems knowledge
d) Psychological factors

Despite no mechanical faults being presented, recommendations have been made to change the algorithms that deliver oxygen and changes to training and maintenance have been put in place.

Following the initial five physiologic events listed above, there were four additional airborne events between July and November 2017. Of these nine total events at the 56th Fighter Wing, only one appears to have a definitive root cause related to a loss of cabin pressurization caused by a mechanical malfunction. The other eight events do not have a definitive root cause – these are referred to as unexplained physiologic events.

In addition to the above, the 56th Fighter Wing has revised training and aircrew procedures to further decrease the risk of physiologic events. New procedures require aircrew to wear oxygen masks on the ground once the system is operational and through engine shutdown.

Annual physiologic training is conducted to educate aircrew on symptoms and responses to hypoxia, hypocapnia, and hypercapnia, as well as training on rate and depth of breathing. The Air Force is confident that these actions taken by the 56th Fighter Wing and actions by the F-35A Physiologic Event Team, will ensure an extremely low likelihood of future events.

T-6A

The T-6A fleet has suffered from a recent rash of unexplained physiologic events beginning in 2018. Since the start of the New Year, there have been twenty-one physiologic events reported. The Air Force was already in the process of investigating the onboard oxygen generation system of the aircraft due to two physiologic events experienced at the 71st Flying Training Wing at Vance Air Force Base, Oklahoma during November of 2017. The events at Vance Air Force Base resulted in a forty eight hour operational pause of T-6A flying sorties locally while flight safety agencies within the Air Force convened to investigate the issue. Inspections on the remaining aircraft tested at Vance found nothing unusual, and normal flight operations resumed.

The most recent events involving the T-6A have occurred at Columbus Air Force Base, Columbus, Mississippi. Immediate testing of the equipment has been inconclusive, and the human factors involved, such as the symptoms reported by the aircrew, have varied greatly. Following these events, 19th Air Force commander Major General Patrick Doherty directed an operational pause in the T-6A flying operation to allow them to study the problem and devise mitigating or corrective measures.

While the investigation continues, the T-6A unexplained physiologic event investigation is a proving ground for the Air Force's cross-service, multi-agency top down approach to quickly

address and resolve these issues. Major General Doherty has traveled to all the Undergraduate Pilot Training bases to meet with student and instructor pilots, as well as wing leadership and apprise them of details learned so far in the investigation, procedures for moving forward, and to listen to their concerns. The Air Force is also trying to address a pilot production problem, the service is not producing enough to meet demand, so the lost training sorties for the stand down doubles the pain inflicted on operations due to these events. Nevertheless, aircrew safety is paramount, so we will double our efforts to return to flying operations as soon as possible.

Sharing Lessons Learned

The Air Force and the Navy are committed to working together to find solutions to the causes of physiologic events in our aircraft, ensuring that our pilots are not exposed to unnecessary risk, and restoring confidence in our aircraft. We have engaged a broad range of internal and external partners, including subject matter experts from the Air Force and Navy, National Aeronautics and Space Administration (NASA), Federal Aviation Administration (FAA), industry, academia, medical, and dive communities to resolve these issues.

Headquarters Air Force has appointed a General Officer to lead an Unexplained Physiologic Event Integration Team, which will serve as the Air Force's focal point for recommending actions to prevent future physiologic events. Similarly, the Navy has stood up a General Officer-led Physiological Episodes Action Team (PEAT), and both teams work closely together to investigate in a complimentary manner. By providing senior leadership, the services seek to ensure all physiologic event investigations receive the appropriate level of advocacy for resources and assistance required for timely resolution, and that recommendations from these investigations are fully implemented.

In addition to these headquarter-level initiatives, multiple joint forums are working at the Action Officer level to identify and implement efforts which will mitigate the risk and impact of physiologic events. Examples include aeromedical expertise as part of the COPE-Fighter physiologic team, program office/engineering expertise as part of AFLCMC and NAVAIR Oxygen System Cross Talk, and the upcoming 19AF-hosted senior leader cross-talk meeting to ensure senior leaders and decision makers from both services have a common understanding of the problem and are working together to solve it.

Conclusion

The safety of Air Force aircrew is tantamount to the execution of the service's mission to deter and decisively defeat the nation's enemies in air, space and cyberspace. Operating high performance combat aircraft, especially as aircraft age, will always carry some inherent risk. The Air Force takes every mishap or event seriously, and investigates to the furthest extent possible these events to determine root causes. Increased awareness of physiologic events has led to increased reporting of possible episodes, which in turn is driving aggressive response actions from the Air Force and its joint partners to address these events and implement recommendations that make air operations safer.