CASE STUDY:
US NAVY

SNAPSHOT:

Challenge
Determine a means of identifying and solving issues in F-18 Environmental Control Systems that cause physiological events before they happen

Solution
Record and analyze vast amounts of pressure data with enDAQ sensors to catch problems before they occur. Every F/A-18 flight now records pressure with enDAQ sensors; over 2,000 sensors are in active circulation within the Navy for this purpose.

Results
- Development of a cockpit pressure monitoring and warning system
- Pressure-related PEs in F-18s are down 80 %

Large-Scale Condition Monitoring for F-18 Readiness and Safety

Challenge

When physiological events (PE) in naval aviators surged in 2017, the Navy's Physiological Episodes Action Team (PEAT), led by Rear Admiral Fredrick Luchtman, launched a multi-year investigation to determine the root cause. The situation had become untenable with flight instructors refusing to train new pilots in their jets. The safety of F-18 aviators and the readiness of the Navy's aircraft were at stake.

Early theories suggested that the PEs occurring in the aviators -- which were manifesting as hypoxia symptoms -- were due to air contamination; lack of oxygen; or an Environmental Control System (ECS) design unsuitable to protect humans, but extensive studies disproved each of these.

To further investigate the PEs, Naval Air Systems Command (NAVAIR) equipped F-18 aircrew with enDAQ sensors (formerly Slam Stick) to record cabin air pressure. After their flights, the air pressure data was downloaded and analyzed and compared with aircraft maintenance data from the jets. From the vast amount of data collected from the enDAQ sensors, PEAT determined that though the ECS design was suitable, certain system components were failing, leading to abnormalities in pressure that could cause severe PEs in aircrew.

Now that there was an established root cause of the PEs, it became imperative to determine a way to identify and solve ECS issues before they happened rather than relying on emergency or deferred maintenance of the ECS. Without a way to predict maintenance, aviator safety and aircraft readiness would remain a crucial and costly issue.

Learn More About enDAQ Sensors and the Navy's PE Mitigation Efforts

USNI News:

Navy Clear on Causes of Physiological Events in Pilots; Final Recommendations Released for PE Mitigation

NAVAIR News:

"Slam Stick" Helps NAVAIR Engineers Troubleshoot Aircraft

At Tailhook, Leaders Describe Efforts to Resolve Physiological Episodes

Solution

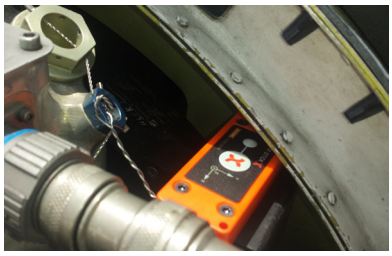
By using enDAQ's configurable sensors to investigate PEs, PEAT had collected a massive amount of air pressure data from the F-18 cabins. Because of their convenient size and rechargeable battery, enDAQ's sensors could be easily carried in an aviator's pocket while in flight, making data acquisition quick. From this enormous data collection effort, PEAT was able to build up a database that could then be analyzed in a number of ways.

> **"...we are almost to the point where we can get predictive with our data analytics, to the point where we receive information from the fleet, we analyze that information, and then we can tell the fleet, hey this particular aircraft is exhibiting signs that this particular part may be needing to be replaced pretty soon."**
>
> *- Rear Adm. Fredrick Luchtman*

From data analysis, PEAT could map the PEs alongside aircraft maintenance data and air pressure data from the enDAQ sensors to investigate changes in the ECS. Having the data on hand allowed the Navy to look back and identify component issues within the ECS and solve them before the parts failed. The pressure data collected from the sensors enabled the Navy to perform condition monitoring quickly, and on a large scale. Every F/A-18 flight now records pressure with enDAQ sensors and there are over 2,000 sensors in active circulation within the Navy for this purpose.

Date	A	B	C	D	E	F	G	H	I
5/5/2018	64	60	92	56	60	37	70	97	93
5/6/2018	94	69	77	86	93	15	85	96	82
5/6/2018	61	69	71	66	84	12	65	88	51
5/7/2018	73	74	100	58	85	44	81	61	52
5/8/2018	72	93	79	83	61	21	60	58	51
5/18/2018	7	34	30	40	6	34	79	73	74
5/19/2018	44	18	34	1	11	24	81	77	86
5/26/2018	35	6	13	32	13	7	23	9	36
5/27/2018	32	14	22	40	27	2	9	47	36
5/27/2018	5	35	35	44	26	1	48	22	31

Maintenance conducted between 5/8 and 5/18 that corrected identified ECS issues.



enDAQ sensor (formerly Slam Stick) in the engine housing of a C-2 Greyhound (Source: US Navy photo)

Results

Through accurate and reliable data provided by enDAQ's sensors, the Navy was able to develop the Hornet Health and Readiness Tool (or the HhART pilot program) -- a cockpit pressure monitoring and warning system that, through data analytics, can identify ECS components that are underperforming and may need replacement. Since the program's implementation in early 2019, pressure-related PEs occurring in F-18s have decreased by 80%.

> **"[This] is a tremendous paradigm shift in the way we do maintenance, we can actually identify parts that are sub-performing, replace those parts and prevent the PE from ever happening."**
>
> *- Rear Adm. Fredrick Luchtman*

Additionally, the Navy is installing cockpit pressure and onboard oxygen generating monitoring systems, also known as CPOMS, into their entire F-18 fleet. This system will record air-pressure and oxygen data and will send alerts to aircrew about aircraft problems, enabling proactive maintenance.

Noting the significance of using the enDAQ sensor data and aircraft maintenance data in concert to identify weaknesses in the ECS, Rear Adm. Luchtman remarked that this "...is a tremendous paradigm shift in the way we do maintenance, we can actually identify parts that are sub-performing, replace those parts and prevent the PE from ever happening."

Though the Navy was initially studying pressure data, enDAQ's recorders are equipped with a number of sensors that capture all of the information about an environment. This information allows for the development of a robust database that can be analyzed for shock events, vibration, and noise, among others. With enDAQ sensor data, analysts can study an enormous collection of reliable data to identify and solve problems within the ECS before they happen. enDAQ's sensors have provided the data needed for the Navy to conduct comprehensive condition monitoring on a large scale, and move toward the development of a predictive maintenance system powered by enDAQ sensor data.

The data provided by enDAQ's sensors enabled the Navy to develop a condition monitoring system that can identify and solve costly issues before they happen, ensuring a safe environment for pilots and readiness for aircraft.

Contact

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