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GENERAL DYNAMICS
Mission Systems

RASA Filter Jam Detection Algorithms

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OVERVIEW

General Dynamics Mission Systems (GDMS) operates, maintains, upgrades, sustains and recapitalizes the installed U.S. Radionuclide Particulate and Noble Gas systems and station infrastructure in support of the CTBTO International Monitoring System. GDMS also acts as station operator for the radionuclide station at Diego Garcia (RN66) and supports the CTBTO with data monitoring of ten additional Non-US Radionuclide Aerosol Sampler/Analyzer (RASA) systems; 21 stations in total.

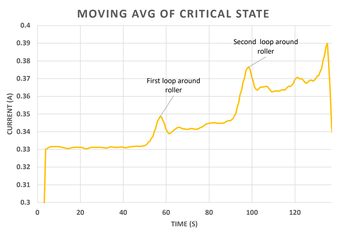
The RASA systems in the IMS operate unattended 24/7 and are required to maintain a data availability of at least 95%. One major contributor to downtime is filter jams. These occur when the filter media wraps itself around the rollers, eventually breaking the shear pin on the motor shaft.

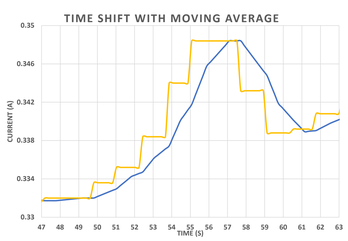
RASA Filter Jams – Wrapped around Rollers, Stuck inside Panels, and System Disassembly for Recovery

Recovery from a filter jam requires manual intervention, which can take up to several days; depending on personnel availability. GDMS has investigated new techniques for monitoring the motor electrical current to avoid severe jams/shear pin breakage and potentially take corrective action if an imminent filter jam is detected.

FILTER JAM ANALYSIS

To learn more about the electrical current of the filter advance motor during a filter advance, GDMS began recording and storing the filter advance current during its runtime at a much higher time-resolution than before.
A moving average window is applied to smooth the data and prevent noise from creating false positives.





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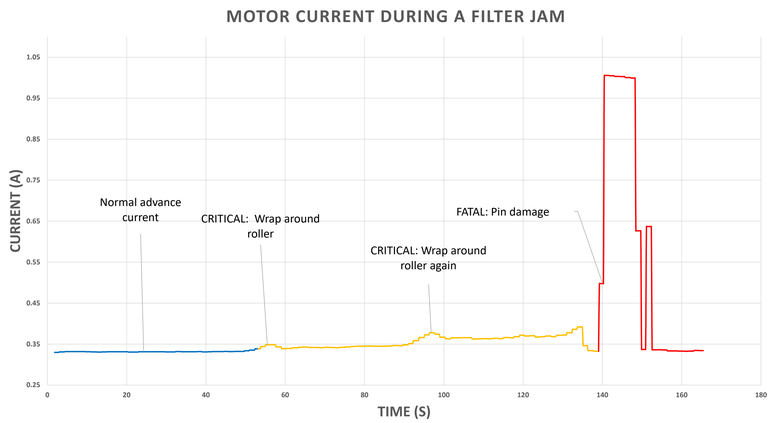
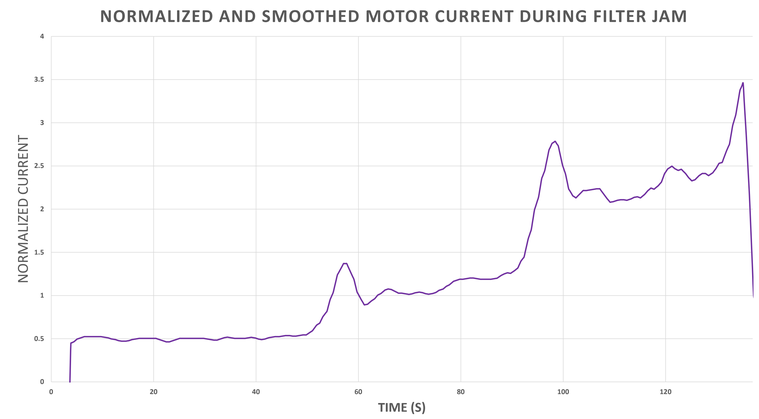
SOFTWARE DETECTION

The graph below illustrates the current progression during a typical filter jam. The area in blue represents a normal advance prior to a jam. As it begins to wrap around the roller, the current begins to increase (yellow) until the shear pin ultimately breaks (red).



To prevent any hardware damage and possible downtime, the RASA software should detect when it enters critical state and stop the motor to prevent shear pin breakage

Using minimum, maximum, and average of previous filter advance data, the current of an advance can be normalized to values between 0 and 1 for each station.

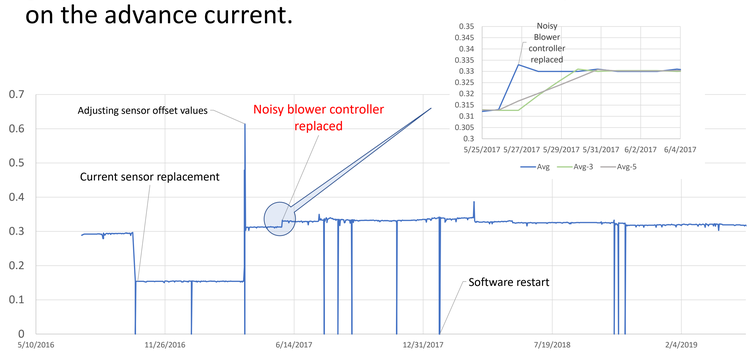


Under this algorithm, normalized filter advance current is around 0.5 and Critical State > 1. Anything over 4 risks possible hardware failure.

ANALYZING PAST DATA

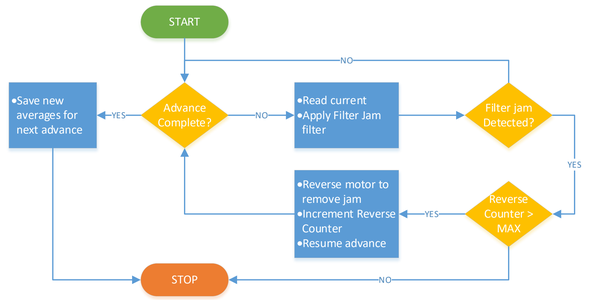
An analysis of historical data reveals other factors that can cause a dip or spike in the average current. The software, therefore, should handle non-filter jam abnormalities which can occur during normal operation.

The below graph shows the average filter advance current for USP74 from 2016-2019. Many of the abnormal events are a consequence of direct human actions performed on the filter advance subsystem or software. Other abnormities, however, are cause by unrelated components or events. Highlighted in the graph below, for example, is the effect of a faulty blower controller on the advance current.



Such event could trigger a false-positive in the algorithm. Further adjustments to the min and max values will prevent these events from creating false positives.

SOFTWARE CONTROL



CONCLUSION

- GDMS is using existing sensors and data in new ways to avoid downtime and enable faster system restoration
- An algorithm is in development to prevent filter jams in RASA systems
- Future is work needed improve the algorithm and/or apply machine learning models to improve robustness

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