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## WHAT UKUBE-1 OPERATIONS TAUGHT US

**Abstract**

UKube-1 was the UK Space Agency's first cubesat and it was a 3-unit cubesat with six payloads. It was launched on 8 July 2014, and operations were conducted using the Ground Station at Chilbolton Observatory, and a custom-built Ground Segment. Operations ceased after 14 months, on 8 September 2015, when the Mission Manager decided that the goals of the technology demonstrator satellite had been achieved, as far as was possible. The satellite licence has now been transferred to AMSAT-UK for their outreach activities with schools. Some of the lessons learned from the operations, and the operations rehearsals before launch, are now considered. They have a lot in common with larger satellite missions! One of anything is more expensive, and for UKube-1 an Engineering Model of the platform module for the cubesat (or even a Flight Spare) would have been incredibly helpful for trouble-shooting, even if EMs were not available for the payloads. The Ground Segment was started too late, and the satellite operational requirements were only considered when the payloads and platform had been integrated and the on-board software virtually completed. The operations rehearsals were a very useful exercise, allowing all the operations and support teams (from RAL Space, Clyde Space Ltd and Bright Ascension Ltd) to exercise much of the functionality of the platform, payloads and software. The operations rehearsals were conducted using low-level interactive commands, most of which were still available post-launch for diagnostic purposes. The operation of the satellite was automated after the operational rehearsals, and higher level scripts provided. A software simulator of the satellite was also built, using the on-board software as the basis. This was a very useful tool for testing new procedures, practising the uplinking of on-board software patches, and checking procedures for errors before use. After launch, several issues became apparent: the two main ones were that the on-board computer frequently reset, resulting in the loss of command sequences, and once telemetry had been requested the downlink carrier signal interfered with the receipt of the uplink command signals. One problem which had not been considered (in common with many other missions), what happens if something goes wrong?