

51st IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE  
ACTIVITIES (D5)

Quality and safety, a challenge for traditional and new space (1)

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CHALLENGES FOR CUBESATS SAFETY DESIGN AND VERIFICATION TO DO LEAN  
SATELLITE DEVELOPMENT**Abstract**

Every satellite, regardless of its size, mission, value, capability or any other nature, shall comply with safety requirements. This statement applies even to a 1U or less CubeSat. CubeSats are good examples of lean satellites that utilize non-traditional, risk-taking development and management approaches to achieve low-cost and fast-delivery. Since 2012, the number of CubeSat launch has grown explosively, thanks to its nature of launch compatibility obtained by confining the satellite in a closed box, POD. Nowadays, various launch vehicles have options of certified PODs, giving the launch opportunity to the CubeSat developers worldwide. Since 2013, release of CubeSats from ISS has become a very attractive launch option because of its less-severe launch condition and routine launch opportunities. The recent diversity in the CubeSat launch options, however, has brought complication in satellite design and verification. The safety requirements differ among the launch vehicles. Even if a satellite is confined in a POD, the satellite still needs to comply with the safety requirements specific to each launch vehicle. The difference is particularly significant between the rocket launch and the ISS release. Satellite developers need to consider how to adapt their design to various safety requirements and how to verify their compliance from the early stage of satellite development, even before they decide on the launch option. Due to its limited volume, it is not always easy for a CubeSat to modify the design in the later phase. Sometimes, the design modification leads to significant schedule delay, which lessens the advantage of CubeSat, fast delivery, making the satellite no longer lean. Kyushu Institute of Technology (Kyutech) has operated Centre for Nanosatellite Testing (CeNT) in Laboratory of Spacecraft Environment Interaction Engineering (LaSEINE) since 2010. The satellite testing facility at CeNT is open to external use attracting users from worldwide. Kyutech assisted several non-Japanese CubeSats to be launched by Japanese rockets or released from ISS through JAXA. Those satellites that employed commercial-off-the-shelf (COTS) CubeSat components available on Internet had many safety-related issues to be resolved. Kyutech itself has developed nine satellites that were launched by rockets or released from ISS and experienced various issues related to safety. The purpose of the present paper is to review the safety issues encountered by various CubeSats for various launch options and how they were resolved with suggestions on how to minimize the troubles that delay the satellite delivery time.