Flight Test Data Recording Guidance:

A reference provided by the Flight Test Safety Committee (Dec 2018)

Background: Following the fatal mishap involving a Bell 525 flight test aircraft in Italy, TX on 6 July 2016, the NTSB in its subsequent investigation recommended that the Flight Test Safety Committee develop and issue guidance on the use of recording devices during flight test.

NTSB Safety Recommendation A-18-1: Develop and issue guidance for the use of recording devices for parametric data, cockpit audio, and cockpit images during experimental flight test activities.

The NTSB determined that the Cockpit Voice Recorder (CVR) (required for Part 29 certification) was not operational during the accident flight, and absence of data from the CVR impeded a more thorough analysis of the accident sequence. The NTSB thus concluded "that recorded cockpit audio and images, whether recorded on flight recorders or ground-based telemetry systems, from experimental flight test aircraft would help give manufacturers more information about experimental flight tests and would also help manufacturers and investigators better understand the circumstances of an accident. This understanding could be used to develop improvements to the aircraft and/or procedures." In separate correspondence, the NTSB issued the above recommendation. The FTSC developed this guidance in response to this recommendation.

Discussion and Recommended Practices: Real-time parameter monitoring and recorded test data offer tremendous benefits to test programs including execution safety, post-flight analysis, demonstration of compliance, as well as event root-cause determination for non-normal performance or incident/accident events. *Test team involvement in the very early stages of program development can ensure that telemetered data (TM) and recording capabilities are expressly defined as a test data capture requirement and equipment procurement, installation and testing are accommodated in the program budget and integrated master schedule*. Crash-survivable recorders such as Cockpit Voice Recorder/Flight Data Recorder (CVR/FDR), can aid accident causality determination, and many programs likely consider that the sole purpose. For those aircraft types that require CVR/FDR for certification, consideration should be given to prioritizing the testing (operational functionality validation) of these components earlier in the program but not solely for accident cause determination purposes. Although data extraction can be more complex for those units, they may still provide valuable data resources to complement other data recording sources or provide backup. Arguably, they could be used as a substitute for flight test specific recorders but they generally lack the data capture rate and parameter library necessary for sophisticated flight test vehicle or systems testing. Programs for small/light aircraft without inherent CVR/FDR still have viable and commercially available recording devices that have demonstrated crash-resistance capabilities. These lightweight/miniature recorders offer audio, video and flight parameter data with easy data extraction and playback. *Test teams should explore available data recorder hardware and real-time/playback capabilities to meet necessary critical parameter monitoring as well as post-flight data capture and analysis requirements*.

Parametric Data: Data requirements, methods and equipment for flight test are generally well understood for research, development, and certification activities. Preservation and archive of data are crucial to data reduction and analysis as well as any post-event anomaly root cause determination. Because many test events are conducted away from primary site, consideration for a TM trailer and/or portable servers should be considered. In any case, *parametric data gathered while flight testing should always be recorded on crash/fire survivable devices on board or streamed to and recorded by ground based systems*. In the case of aircraft that are being provisioned with a flight data recording system (FDR), this system should be qualified early and fully operational during the entirety of the flight test program. While Quick Access Recorder (QAR or mini-QAR) or Aircraft Health and Trend Monitoring System (AHTMS) recording devices are not typically certified as being "crash survivable," they may still offer considerable crash-resistance and capability to record relevant flight data.

At a minimum, it is recommended to record as many of these critical parameters as practicable: time, aircraft states (airspeed, altitude, temperature, rates, accelerations), configuration (flaps, landing gear, instrument settings, pitch, collective, stores), mass properties (gross weight or fuel state, center of gravity), power states (thrust, powerplant temperatures/pressures/ratios, rpm, pitch), control system states (control positions, control surface deflections, control law modes), automatic flight modes/states/commands (climb, cruise, approach, landing, augmentation/reversion mode), precise position (latitude, longitude, navigation fix distance & bearing). Where it is not normally in the parametric data stream, aircraft basic weight, balance, crew compliment, configuration (including software revisions), inspection and discrepancy status should be kept in ground based records readily available to the test team or/and investigators. Test teams may consider other parameters to be important for safe, efficient and thorough flight testing or/and root cause analysis.

Flight Deck Audio Recording: Vocalized human observations provide the basis for sensed or qualitative information and are complementary to parametric data capture. For aircraft that are being provisioned with a cockpit voice recorder (CVR), this system should be activated for the entirety of the flight test program. CVR or other voice system equipage, *the test aircraft data acquisition system should have a voice recording channel for each test participant as well as a background sound channel*. It is recognized that not all parametric data systems have sufficient sample rate to capture cockpit voice (85-255 Hz) and anticipated background noises. In such cases, it is recommended that the aircraft be equipped with a separate audio recording system (preferably with a timestamp feature to synchronize with other data sources). It is recommended that this record each test participant, each external radio source being monitored and cockpit background noise. Additionally, if streaming telemetry data is planned, including the same voice channels on the downlink stream is recommended. Participant voice recording (including ground/control room participants) provides a means of providing time synchronized, relevant comments to augment parametric data.

In the event such systems are inoperative for scheduled testing, test teams may elect to pre-plan acceptable/alternative means of recording, e.g. portable digital audio recorders that can be mounted or carried in crew pockets (again, with time stamp features desired). Using alternative methods should be time/flight limited (e.g., 2 days or 2 flights) in a fashion similar to Minimum Equipment List (MEL) operations.

Flight Deck Video Recording: *Flight deck video recording of crew actions and displays during ground and flight tests is recommended to document non-verbal communications between crew, observe control manipulations, and detect display indications (including alerts)*. Video recording or streaming complements data and audio streams to complete the cockpit environmental state. Video should be recorded with on board devices that are crash/fire hardened to the maximum extent practicable. Technical characteristics, limitations of video devices, and desired visual areas of interest should be determined during the instrumentation planning phase of test program development.

Field of view(s) should be designed to assist with assessing flight crew actions, indications to the flight crew (both internal instruments/displays and external influences to the aircraft) and (if possible) critical switch/control positions. Time stamping of video data is recommended (to ease synchronization with audio or/and parametric data recordings).

Because it is more difficult to emulate flight deck video systems with "portable" recording devices, aircraft operations with inoperative flight deck video systems should be subject to more stringent restrictions than for inoperative audio systems. *A risk-based approach to determining go/no-go criteria for recording devices should be done in the planning phase of test*.

Data Security: *Policies, procedures, and necessary software/hardware for encryption and security of parametric data, audio, and video records must be considered and implemented before testing begins*. These are necessary to protect intellectual property, provide data integrity, and prevent compromise. Data "lockdown" protocols should be incorporated in the accident response plan to preserve and seal data ahead of potential internal or external investigations for incidents/accidents.

Data Privacy: Data handling and storage policies and procedures should also accommodate data privacy. *All recorded data should be treated as "proprietary and sensitive" with distribution limited to "need to know." Like other non-attributional reporting programs, recorded flight test data should be provided similar protections with severe repercussions for inappropriate or unauthorized use/release*. Data being collected and used as part of Safety Management System (SMS) Safety Assurance must also follow industry recommended practice of de-identification with similar security/privacy protocols.

As part of the test organization robust safety culture, flight test crews should be given assurances that these data shall not be used for disciplinary action (in absence of other evidence) and that these data sources are designed to be used in a non-attribution environment to help improve test execution performance and safety.

Equipment Safety Concerns: While FDR's and CVR's are constructed and mounted to meet crashworthy standards, other items that may be used, such as off the shelf cameras and other recording devices are not. Due regard to the placement and mounting of such devices should consider the potential consequences to the flight deck occupants should the aircraft experience an adverse event. Mounts should be vibration and impact resistant and should not impede egress.

Electro Magnetic Interference/Electro Magnetic Compatibility (EMI/EMC or EMIC) with other aircraft or/and system test items should also be ensured prior to flight.

Resources and Further Considerations: For further guidance, feedback or other considerations, contact with the following resources are encouraged:

The Flight Test Safety Committee, www.flighttestsafety.org, chairman@flighttestsafety.org , PO Box 986, Lancaster, CA 93584,

The Society of Experimental Test Pilots, www.setp.org , setp@setp.org, 44814 North Elm Ave., Lancaster, CA 93534 1-661-942-9574

The Society of Flight Test Engineers, www.sfte.org, sfte@sfte.org, 44814 North Elm Ave., Lancaster, CA 93534 1-661-949-2095