

Workshop Discussion of the Proposed Revision from a Flight Test and Operations Viewpoint

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Introduction:

The flight test group's discussion was centered around a concern with the requirement to verify the ability of a given real pilot/airplane/flight control system to meet the specification of MIL-F-8785B and to ultimately accomplish given mission tasks. More specifically the requirements as outlined in the Revised Version of MIL-F-8785B were addressed by this group.

The following discussions, conclusions, and recommendations were the consensus of the flight test discussion group.

Paragraph 1.5 Levels of Flying Qualities

Discussion: The entire group felt that the incorporation of the atmospheric disturbance criteria into the "Level" definitions is unacceptable. Whereas, the existence of a degraded environment may well degrade the observed performance or increase the necessary compensation it is impossible to define the external disturbance with existing flight test instrumentation. To effectively test against the proposed paragraph it would require a continual metric of atmospheric state to evaluate which "level 1" applies. The level of flying qualities relates to the desired task, i.e., a low-level ground attack aircraft may well encounter inordinate turbulence (as defined in the proposed revision) with a much higher probability than 10^{-3} and still require clearly adequate flying qualities for this mission flight phase. That is the required operating environment may normally include air mass disturbances of this intensity.

If reference to degraded Flying Qualities with atmospheric disturbance is to be made it should not be done by changing the level definitions but possibly be treated as a failure state, i.e. moderate turbulence would allow satisfactory compliance with the specification by meeting level 2 requirements at the discretion of the procuring agency.

Conclusion: The concept of the proposed revision to paragraph 1.5 is unacceptable to the entire group. Any automatic degradation of F.Q. levels with atmospheric disturbance as part of the specification would be opposed by all agencies represented at this session.

Recommendation: Leave paragraph 1.5 as presently written.

Paragraph 3.1.1. Operational Missions

Discussion: Clarification necessary and correct

Recommendation: Publish as revised

Paragraph 3.2.2.1.3 Higher Order Dynamic Systems

Discussion: Although there is a definite need to insure that higher order dynamic systems are acknowledged and that adequate and safe performance is specified, the group is not convinced that the equivalent system approach should be adopted at this time.

Additional research is necessary to better define the boundaries and to produce lateral directional guidance. At the present time, flight test techniques are available to generate equivalent systems parameters although verification is still required.

Conclusion: Additional research is required but some acknowledgment of higher order systems requiring verification of safety and performance but with no legislation of technique.

Paragraph 3.2.1.1 Longitudinal Static Stability

Discussion: Considering the statement, "In no event shall there be more than one unstable mode of motion, whether it be aperiodic or oscillatory," if by modes of motion this paragraph implies the classical dynamic modes of motion (i.e. Short Period, Phugoid, Dutch Roll, Roll, Spiral Mode), then an interpretation could imply that an unstable spiral mode would require all other modes to be stable. If the paragraph is meant to refer only to the longitudinal modes (i.e. Short Period and Phugoid) then an interpretation could imply that an unstable Phugoid would require a stable Short Period. This criterion may be more restrictive than is warranted since divergent phugoids with long periods may be acceptable when coupled with "slowly" diverging Short Period modes.

Conclusion: Clarification of this statement in the paragraph is warranted.

Considering the statement, "In no event shall its time to double amplitude be less than 6 seconds," it should be clarified as to how the 6 sec criteria was obtained. If this 6 sec criteria was determined based solely on pilot evaluations from closed loop high gain tasks (i.e. landing tasks) representative of flight phase category A and C, then further investigation is warranted to insure acceptability of the 6 sec criteria during the Category B flight phase tasks (i.e. long range cruise while operating with the Level 3 failure state).

In addition, the statement, "In the presence of one or more other Level 3 flying qualities no static longitudinal instability will be permitted unless....", there is confusion as to which other flying qualities are implied. Does this refer only to other longitudinal paragraph requirements or the any other paragraph requirement throughout the MIL SPEC in which the aircraft can meet only Level 3 flying qualities?

Conclusion: Clarification of these statements in the paragraph is warranted.

Recommendation:

1. Clarification of wording of the specific paragraph statements identified is recommended.
2. Recommend that the minimum 6 sec time to double amplitude requirement be verified as applicable to Flight Phase Category B tasks (i.e., consider the consequences of a pilot on a long overwater mission whose Level 3 failure occurs with over two hours to the nearest suitable landing site. Is the longitudinal instability defined by the 6 sec to double amplitude too difficult to control for over 2 consecutive hours of flight?).

Paragraph 3.2.2.2.1 Control Forces in Maneuvering Flight

Discussion: Considering the statement, "...A departure from linearity resulting in a local gradient which differs from the average gradient for the maneuver by more than 50 percent is considered excessive."

Conclusion: The average gradient of F_s/n_z is not defined anywhere in the MIL SPEC.

Recommendation: Recommend that a definition of average gradient of F_s/n_z be defined. Consideration should be given to adapting the definition² as outlined in FDL report TR 71-134.

Paragraph 3.2.2.2.2. Control motions in maneuvering flight

Discussion: The average side stick control motion requirement of .5 pound per degree for levels 1 and 2 is in error. Reference 36* outlines a minimum side stick gradient of .5 degree per pound; however, recent flight test data from FDL funded tests refute this sidestick gradient criteria. The data base at this time is insufficient to establish a specified side stick control motion gradient.

* Hall, G. Warren and Smith, R.E., "Flight Investigation of Fighter Sidestick Force-Deflection Characteristics", AFFDL-TR-75-39, May 1975.

Recommendation:

1. Delete the .5 pound per degree for levels 1 and 2 requirement and replace this criteria with such wording that side stick control motion gradients are to be determined.
2. Further testing to specify acceptable sidestick control motion gradients is recommended.

Paragraph 3.2.2.4 Longitudinal pilot-induced oscillations

Discussion: Consider the statement, "The following requirements shall be met when the pitch control is pumped sinusoidally for all amplitudes within the structural limits of the airframe at frequencies between 1 and 10 radian/second."

There is no way to adequately or safely flight test the requirement as stated in this paragraph. The words "all amplitudes" imply maximum stick deflections must be tested and "within the structural limits" could be interpreted to mean that this test must be accomplished at all g levels attainable in the aircraft. Irregardless, max amplitude pitch control sinusoidal pumping is not recommended for safety of flight reasons.

The requirements for longitudinal PIO as stated in paragraph 3.2.2.4.3 Control System Phase Lag, utilize the criteria as described in Reference 71.* This reference is considered adequate as a longitudinal PIO Spec at this time.

Recommendation: Recommend that the following statement be deleted from paragraph 3.2.2.4, "The following requirements shall be met when the pitch control is pumped sinusoidally for all amplitudes within the structural limits of the airframe at frequencies between 1 and 10 radian/second."

Paragraph 3.3.4.1 Roll performance for Class IV airplanes

Discussion: This requirement states that "Roll performance for Class IV airplanes is specified over the following ranges of airspeeds in 1-g flight." This paragraph implies that all roll performance tests must be accomplished in 1 g flight. This precludes using a bank-to-bank test method where precisely 1 g may not be maintained throughout duration of the test. Irregardless of the test method employed, precise 1 g control can probably not be maintained throughout the roll performance tests as required by Table IX b.

* Smith, Ralph H., "A Theory for Longitudinal, Short-Period Pilot-Induced Oscillation", AFFDL-TR-77-57, June 1977.

Recommendation: Recommend that the words "in 1-g flight" be deleted from the last sentence of paragraph 3.3.4.1 (Revised).

Paragraph 3.4.11 Control Margin

Discussion: Considering the statement, "Control authority and rate margins shall be sufficient to assure safety in regions of control-surface-instability throughout the combined range of all attainable angles of attack (both positive and negative) and sideslip. This requirement applies to the prevention of loss of control and to recovery from any situation for all maneuvering. "

Where is control authority defined in the MIL SPEC?

Where are rate margins defined?

What does "sufficient to assure safety" mean?

Who decides what is safe?

Are control authority and rate margins to be sufficient to assure safety at all attainable trimmed angles of attack and sideslip or all attainable angles of attack and sideslip? (E.g. an F-16 type of aircraft pointed straight up until airspeed equals zero then begins to backslide may achieve some dramatic α 's and β 's. Are control authority and rate margins to be required for this condition?)

Recommendation: Recommend that the "words" of this paragraph as highlighted be more clearly defined.