FSEMC

Together "We Set the Standard."

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Subject

Working Paper Circulation
Simulator Data Validation (SDV) Working Group
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Attachments

	Subject	Source
1.	FSEMC Whitepaper on data validation	QTG Exploratory Meetings

Comments & Inquiries

The staff welcomes comments on the attached material. Comments should be directed to Scott Smith

cc

FSEMC Steering Committee

Attachment 1

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Simulator Re-Evaluations and Re-Validation Issues as Related to Regulatory Requirements

Simulator qualifications have often been somewhat of a contentious exercise in the pilot training industry. Despite fairly well laid out regulations, informed and involved personnel (stake holders), reliable high-technology equipment and techniques, proven system configurations, the process of evaluation is wrought with pitfalls that consistently defy reason and sometimes even logic. Rarely are qualification or evaluations carried out without a hitch.

In order for a simulator to be used for training and a pilot to receive “credits” in accordance with training regulation outlines, a simulator is required to be “qualified” or “certified”. The difference is not necessarily of semantics but quite targeted.

Qualifications fall essentially under three broad categories- first, there is the crucial “initial” and then the ongoing “continuing” or “recurrent” qualifications.
In between are also qualifications for upgrades, updates, moves, re-qualifications (reinstatements) and various others that may be termed as “specials”.

An examination of the different types of qualifications will show that they all fall under the giant umbrella of the “initial”. The other types of qualifications are all subsets of the “initial”. The processes for each are treated differently but the “approach”, the tools and techniques utilized have much in common. The manner of all the testing has a basis on the “initial”.

During an initial qualification, the regulations specify in detail the requirements needed to be accomplished in order to establish the assessment of a good training tool and a sound validation of the fidelity level of the simulator. From then onwards, at certain intervals, the simulator is required to undergo a subset of the initial qualification in order to prove that the original assessment made during the initial remained valid. This is more or less a simplistic view of the process!

In general, the initial, recurrents and most of the other types of qualification require the presence of the regulatory authorities as witnesses. The authorities may, in certain cases and under circumstances, allow some special qualifications to be accomplished by other designated personnel. These involve matters of confidence and credibility and sometimes personnel logistics.

Every qualification check consists of two parts- a subjective and an objective. During an initial, the subjective checks encompass fly-out’s, system checks, checks on “abnormals”, handling and operational aspects and require the expertise of qualified personnel (pilots) and engineers. The objective checks (tests) are all mainly contained in a Qualification Test Guide (QTG) and are specific to the applicable regulatory document. The tests are very detailed in nature and obtaining supporting references can be a very expensive proposition. Complete data packages have soared in pricing and retesting of questionable data may turn out impractical. The regulations also deem that all of objective tests be conducted as a pre-requisite to a qualification and presented as part of the qualification. Once the simulator undergoes the initial qualification, the cycle for continuing/recurrent qualification begins.

During recurrents, the simulator undergoes both subjective and objective checks in a much-abbreviated fashion to the initial. The idea is to sample-verify. In rare cases and especially for special qualifications, some objective portions may be dispensed with.

If the simulator has been under strict configuration control and properly maintained, subjective or objective checks should not reveal any problems during subsequent recurrents- at least in theory. The entire QTG is required to be executed and presented to the authorities on a yearly basis. This process can become tedious, repetitive and time-consuming. And, based on current methods of validation, the process may not unveil the true picture of the state of the simulator, which would be contrary to the goal for a recurrent.

Since a recurrent is an abbreviated initial and hence a subset, a case to be made that many of the problems discovered may have emanated from the initial as they can be passed down. However, tackling the “initial” issue, in spite of all sound arguments, has to be relegated to another discussion. The scope of this paper will concentrate only on the “recurrent” objective testing aspects since the possibilities of streamlining the process would be far more manageable and benefit the entire industry. Since the subjective testing does not require any such pre-tests, the effort involved is minimal.

Again, the intent of a continuing or recurrent qualification is to ascertain whether the original assessment of a simulator has been maintained. The typical recurrent involves the execution of the entire list of tests as contained in the QTG at designated intervals (normally on a yearly basis) and is accomplished by the operator. The regulatory authorities then require the witnessing and sample testing of the simulator as well as evaluating the voluminous results.

A fresh execution of the entire QTG may require a few contiguous days, even when run automatically. Since a regulatory requirement is to have the runs spread over the year, a specific quarter of the QTG is run during each quarter. Due to training times/slot constraints, runs may have to be conducted sporadically over the quarter. The process has to be repeated another three times during the year. This takes a toll on the training schedules as well as the revenue.

Hence, some means of establishing the integrity of an original assessment without imposing undue burden on the operations would be a welcome alternative to spending the time and effort (and the financial implications) for the operators. Plus there is value to helping maintain the standards. If the regulatory authorities can be convinced to the utility of such an alternative then their reassurance can be guaranteed- always with the option that, if demanded, the entire QTG would be still available for examination in its usual format.

As airplanes become more complex, more sophisticated and more computer- controlled, many of the conventional tests as specified in the regulations are delivering lesser valuable information towards validation (or revalidation) from a traditional sense. Alternative approaches will need to be considered. It is conceivable that one can come up with one or few tests which when conducted, hopefully in an integrated fashion (involving the various systems in a simulator), will deliver a result(s) that would be far more meaningful towards establishing the integrity of the entire configuration. Such a test or tests would efficiently reveal crucial factors of the simulator configuration and in a far speedier and efficient manner. The test(s) may involve a flight pattern that may incorporate various key regimes in the flight envelope and include maneuvers and

important abnormal conditions. Since, under normal circumstances, such a representative flight test may not be available as reference data for validation purposes, such a test would have to be designed judiciously and would be categorized as a "footprint" type test and subsequently evaluated in the usual fashion.

Tests may also be constructed purely from a software basis whereby the integrity of the configuration would be checked. The idea would be the use of a computational utility that would execute logic checks throughout the computational software to flag any differences from an established baseline. Such types of checks are often conducted in other computational fields and can be very quick and reliable. However, including some of the hardware in the loop, because of permissible drift or wear, may pose a challenging proposition. The basis of any such testing would be an attempt to include the entire system or as much as practical so that a good representative of the simulation- both hardware and software is checked out in an integrated fashion.

For the naysayers, it would be prudent to realize that some degree of similar "integrity" tests have already being implemented but in a micro scale and is evident per the current regulations on motion and sound systems e.g. Motion System Repeatability/Cueing Signature, Frequency Response, etc. Their utility may be debatable but the intentions are sound. The tests are intended as a check of part of these systems from an operational standpoint and establish degrees of system integrity.

Consider some of the pluses that such tests could deliver. If set up properly with diligence and designed to cover the gamut of the simulation, one or more of these test profiles may be accomplished within hours in lieu of days and run more conveniently during available time-slots and can be repeated over months. The tests would then provide, if not the same, a much deeper insight at the integrated model for analysis. A separate discussion on the implications of frequency of running and validity would be in order and is deemed outside the scope of this paper. All this would vastly reduce the time and effort currently being expended to meet regulatory requirements. A step further would be the possibility that such tests would also aid the authorities in obtaining a better preliminary assessment of the qualitative state of the simulator. If a more in depth investigation into the objectivity were warranted after such a run, the regular options again would always be available.

A typical basic QTG may contain anywhere around 100 – 200 tests. And this is not even taking into account simulators with different engine fits, augmentation modes, acceptable variants, etc. As airplanes become more complex, this set may increase dramatically in number. If the assumption is that all the tests in an average QTG can be executed correctly and without any repeated attempts in approximately 24 hours of contiguous run time (an experienced assumption), in reality, the practical time involved could be over 5 times or more and even this assumption may still be conservative. Consider certain realities and requirements that directly affect testing run time and effort:

1. Tests ***have*** to be run in a quarterly basis spread over a year.
2. Certain tests may require repeated attempts to obtain proper results.
3. Time is expended in preparation and post-testing clean up.
4. Some tests would require special testing setups including equipment setup.
5. Pilot training logistics impact on time availability.
6. Efficiency in time management of test conductors (personnel).
7. Time required to making sensible evaluation of the results. May induce re-runs.
8. Unforeseen issues which crop up and are the inevitability (Murphy's Law).

The tests in the QTG are spread judiciously over the various systems of the simulator with the obvious concentration on the flight modeling (aero, controls, engines, etc.). The sampling nature of these tests is intended to give the evaluator a clear objective overview of the fidelity of the entire system. Unfortunately each test is implemented almost in a standalone fashion. Each has its own unique “initial conditions” and tests are grouped to address specific regimes of the simulator operational envelope. There is very little crossover in addressing the transitions between the various phases of flight in a realistic and integrated way. There are minor exceptions and very few at that. Each test address validation in a discrete manner e.g. takeoff’s, dynamic engine-cuts, climbs are basically all discrete tests and each usually with different initial conditions.

It is conceivable that one or more test profiles may be able to cover the majority, if not all, of these regimes in one continuous flow- starting from one initialization. After all one is still dealing with the modeling one (“average”) airplane and obtaining real world data for such profiles may not be a practicality or even necessary. A well executed footprint profile covering each intended test regime could certainly provide the same information needed for re-validation. Without assigning any focused responsibilities, inputs from simulator manufacturers, aircraft manufacturers, operators, regulators and other interested parties should be seriously considered. Issues of weight and CG changes would need to be addressed and so would different tests that are conducted in similar flight phases. It is important to understand that these kinds of profiles are *not intended to replace existing QTG tests* but being generic in nature, to be used only during recurrents as a quick check in identifying problem areas. And such profiles may be approved either in conjunction or after a “classic” qualification.

Another interim idea floated was the use of an abbreviated list of test from the QTG. This selected list would be less cumbersome to handle on a recurrent. The idea does have its merits but really is a stopgap measure and, in the authors’ opinion, can lead to much confusion. The tests have to be selected based on airplane, vintage, hardware and software architecture and systems and the individual problems they may generate. Persistent failing tests would still be the issue. The feasibility of such an endeavor would create a parallel mini-QTG, which would be an impractical long- term solution.

The visual system is one that has no true objective tests (vis-à-vis the real world) from an operational angle. The system does have tests that are termed objective but are mostly “capability” in nature while others are evaluated subjectively (even the Visual Ground Segment Test which is set up with very “hard” numbers!). Of importance in operation (training) are training scenarios (airport scenes) and issues of color balance, focus, aliasing distortion and others and again, are subjectively assessed. Some motion tests are similar as well and these would require separate analyses.

This paper is intended to stimulate (no pun intended!) the thought processes related to repeated evaluations and ensuing inefficiencies during recurrents. The paper will hopefully generate innovative options and means of streamlining the process. As this industry expands, efficiency and cost-savings become primary drivers. Informed discussions and practical studies are needed. Each option considered would need to be examined on its merits.

Before embarking on any in depth study, the authors would like to caution any researcher against some pitfalls and trends in the thought processes that seem to

crop up persistently. It is a common belief that there are tests that take longer to set up, do not give consistent correct results, are difficult to execute or require too much effort in set-up equipment and result-interpretation. One has to be reminded that there are too many variables at stake- the operator, the simulation engineers, the airplane, the simulator manufacturer and more so the aerodynamic model, software architecture of the system and of course the test drivers. The problem may lie in any one or a combination of these variables.

If a test is inconsistent throughout the industry, the requirements for the test may need to be re-evaluated. Inconsistencies, upon careful examination, generally can be narrowed down to certain groupings or variables as mentioned. They then have to be dealt with within their respective scopes. It may point to issues in design, methodology or quality in the software or hardware. It may also point to issues with maintenance or lack in expertise.

Some of the propositions in this paper may require eventual regulatory changes. However, if a proposition is sensible then one should not waver from pursuing for change. As a reminder, all changes to the regulations over the years have been instituted from the outside (because of issues or problems). It is imperative that any changes proposed happen within the framework of the regulatory process. The regulators should be involved at all stages and proposed changes should follow a “buy-in” from them because the final benefits are equitably translatable. The current mood in the industry may be conducive to regulators in their willingness to promote such ideas towards value and efficiency.

Considerations have to be allocated to other facts as well. There are a very large number of simulators of various aircraft, vintage and manufacturers that are currently active. Certain aircraft designs may lend themselves well to an integrated check of its systems (model), others may not. Provisions have to be made to encompass the different nuances that exist. In the spirit of streamlining and efficiency, attention needs to be paid to all budding ideas ensuring that they do not result in undue burdening of existing or future operations.

It is a fact that in the past, such adventurous concepts have not been given their due. The bias towards what seem to be working rather than what can be done better should not be held as an excuse for the status quo. The effort towards proactivity is far more beneficial on the long run. In conclusion, the perceived value- as the outcome should be tempered with the effort and cost associations keeping in mind that the final goal is to benefit all parties involved. All these efforts may eventually lead to a new RQTG or RvQTG (Re-validation QTG!).

Maybe, one day there will be an “app” for such recurrents…..

The following are the authors of this whitepaper, summarizing the discussions and opinions derived from a series of QTG Exploratory Meetings held by the FSEMC.

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