A Well Calibrated Maximum Duty and Flight Time for the Flight Inspection Crew : The Key Towards Higher Safety Levels and Improved Efficiency
June 2004

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ABSTRACT

The flight inspection activity every day becomes more complex and demanding. In order to obtain a high level of quality for the flight check results, the crew is required to be more professional and to manage the flight check in the most efficient and effective way, especially in the most congested airspaces. As a result an increase of the overall crew workload cannot be avoided.

The flight inspection crew's activities are very particular and it is difficult to compare them with the so called normal flight activities (line, charter…). For instance, during an ILS check almost 95% of all the operations are performed inside the safety windows (from the initial approach to the initial climb) where the workload is heavy and where worldwide statistics show that the percentage of accidents is nearly 90% of the total. Since investigation has revealed that human error is the cause of the majority of aviation accidents, in order to maintain a satisfactory safety level in the flight inspection operation it is necessary to work on the human aspect of the problem. This suggests several considerations like training, SOPs, CRM, but another aspect has a great role in the human factor problem: human fatigue! Therefore the necessity to determine a specific and very well calibrated duty time and flight time limit, taking into account the effect on the crew's workload with regards to the following elements: aircraft type and equipment, type of navaids inspected and flight inspection environment (airspace, air traffic, weather and terrain profile).

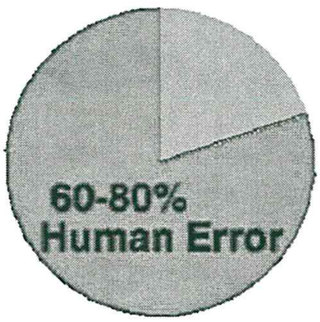
PURPOSE

The objective of this paper is to propose a new point of view from which the problems related to the flight inspection crew duty and flight time limit can be analysed. To encourage the aeronautical authorities, to consider the importance of setting specific regulations for flight inspection crew duty and flight time, in order to increase the safety level in the flight inspection operations. The solution proposed in this paper is one of the many possibilities. Our hope is to be helpful to the flight inspection community by highlighting problems and at the same time proposing a possible solution.

BACKGROUND

New insights into the causes of aircraft accidents, which follows from the introduction of flight data recorders and cockpit voice recorders into modern jet aircraft, has suggested that many accidents aren't caused by a technical malfunction of the aircraft or its systems, nor from a failure of aircraft handling skills or a lack of technical knowledge on the part of the crew. It appears instead that they are caused by the crew's inability to respond appropriately to the situation in which they find themselves. It has long been known that three out of four accidents are caused by performance errors made by a healthy and properly certified crew.

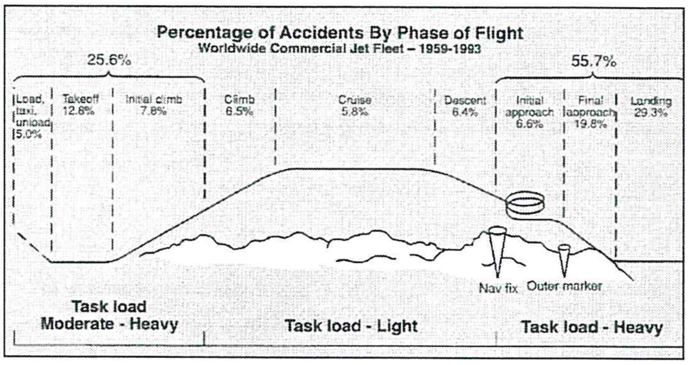
According to the Admiral Donald Engen, former Administrator of the United States Federal Aviation Administration, who has been quoted as saying (1986): "We spent over fifty years on the hardware, which is now pretty reliable. Now it's time to work with people."



Aircraft Accidents

Man is the focal point, with the aim being to increase the levels of safety in flight operations. During the past years human factors have been looked at by researchers throughout the world, producing guide lines (standard procedures, duty and flight time limits) which have been identified and adopted by nearly all the airline companies, with excellent results.

Inflight inspection is undoubtedly such a particular activity which cannot be compared with airline activities. To demonstrate this it is sufficient to think that inflight calibration achieves its objective, not by moving from one airport to another following standard procedures as done by the airlines, rather the arrival at the destination airport is when the work begins.



Source: SimuFlite CRM Manual

This work brings the flight calibration crew to operate for most of the time within the so called safety window. To fly within this safety window means flying within terminal areas, increasingly congested and difficult to manage, at a very low altitude, therefore very near to obstacles.

Worldwide statistics indicate that 80%-90% of all accidents occur within the safety window. In addition, flight profiles are often intentionally flown at the limit or outside the limit of the procedure safety volume, which takes into account the minimum clearance from the obstacles.

This doesn't make the flight inspection pilot a hero, but it does mean that he has to operate outside the well known standard procedures notably increasing his work load.

Workload

Humans have a limited mental capacity to deal with information processing. Humans are also limited physically, in terms of visual acuity, strength, dexterity and so on. Therefore, the workload reflects the degree to which the demands of the work which we have to do, fits into our mental and physical abilities.
The tasks involved in operating an aircraft usually follow a fairly ordered and standard pattern. These standard patterns guarantee that the workload remains within tolerable levels. In spite of this, during the flight some events or conditions are outside the control of the flight crew. Dealing with these events or conditions may require additional work.
It is very difficult to assess how this additional work translates into an increase in workload.

Factors Determining Workload

Workload is subjective, is experienced differently by different people, and is influenced by:

- The nature of the task, such as:
  1. physical demands (e.g. strength required, etc.);
  2. mental demands (e.g. the complexity of decisions to be made, etc.).

- The circumstances under which the task is performed, such as:
  1. standard of performance required (e.g. degree of accuracy, 75mA flight profile etc.);
  2. time available to accomplish the task (e.g. navaids near to their due date);
  3. requirement to carry out the task while doing something else (e.g. perform the check and at the same time monitor the traffic)
  4. environmental factors at that time (e.g. seasonal high or low temperatures especially with small A/C, etc.).

- The person's condition, such as:
  1. skills (both physical and mental);
  2. experience (particularly familiarity with the task in question);
  3. current health and fitness levels;
  4. emotional state (e.g. stress level, mood, etc.).

Overload

Overload occurs at very high levels of workload, when the individual's or crew's workload exceeds their ability to adequately cope with the situation. Performance deteriorates when the arousal level becomes too high and we are forced to dismiss certain tasks and focus on the key information. As a consequence, the error rate will increase.

Overload can occur suddenly or gradually. For example, a sudden overload could happen when a pilot is asked to remember one further piece of information about the flight check, whilst already trying to remember a large amount of data concerning the flight.

Duty & Flight Time

From this analysis it clearly emerges that there are many factors which intervene in determining the workload level. On some of these factors, man's intervention is limited within narrow manoeuver margins. The type of checks to be carried out and the related flight profile cannot be modified, just like the environmental conditions and the aircraft used for the flight check. But, there is one factor which can be widely influenced by man: the exposure time to high workload levels, that is the flight time.

The limits relative to flight and duty times are by now hotly debated topics, because they are directly connected to flight operations safety, and because they are often subject of difficult trade union disputes between airline companies and pilots. Fortunately, for some, and unfortunately for others, a very important role in this debate is covered by the national regulators, who are the rule makers and like an arbiter, they ensure that the rules are respected.

The very long setting up times, demonstrate that the rules are very important for the worldwide aeronautical community.

Unfortunately, these rules (limits) aren't of any use to the flight calibration world and for the special mission people in general because they deal with limits calculated and balanced on the activities of airline pilots.

An example of the unsuitability of limits calculated on airline activity is the daily flight time that is influenced by the number of landings.

For instance, the flight time limit for Japan Air Lines crew is reduced by 40% when the scheduled flight time requires four landings instead of one. The reason for this reduction is not related to the times the landing gear touches the runway, but to the times, the crew has flown the initial and the final segment of a procedure, that is how long the crew has flown within the safety window.

The rule of thumb is: the longer you operate within this area, the lower the flight time limit.

On the other side, a flight inspection crew during an ILS check operates for 90% of the time within the safety window.

It clearly emerges that these rules are not adaptable to the flight inspection activity.

The unsuitability of the rules is often taken into consideration by flight inspection service providers, where they use lower limits to those foreseen by law in the employment contracts, which regulate the service of their own pilots.

If this is true for the big companies connected to the government, it isn't always true for the small to medium sized companies, who are sometimes short sighted and only interested in maximizing their profits, sometimes asking their own pilots to work up to the legal limit.

Therefore specific regulations should be set up quickly for the special mission crew with specific reference to flight inspection activities.

These rules should set different flight time limits according to:

- The type of checks being carried out;
- Class of aircraft (that is with reference to on board comfort and technological support available to the crew);
- Period when the checking is carried out (day or night, in those countries where night checks are made);
- Airspace classification where the checks will be carried.

EQUIVALENT FLIGHT TIME

Until a specific regulation is set up and/or to inspire such a regulation we have thought up the concept of creating a correlation between the generic flight time and the flight inspection time.

The method to obtain such a correlation needs the introduction of the EQUIVALENT FLIGHT TIME.

The EQUIVALENT FLIGHT TIME, determined using specific coefficients, allows to convert the flight inspection times into a generic flight time and vice versa, with the aim to make the two timescales comparable and enabling the use of the limits dictated by the current regulation also for the flight inspection activity.

The proposed model for the EQUIVALENT FLIGHT TIME is as follows:

(1) $EFT = C * A * P * S$

(2) $FIT = GFT / EFT$

(3) $GFT = FIT * EFT$

Where:

FIT = Flight Inspection Time
GFT = Generic Flight Time
C = Type of Check
A = Type of Aircraft
P = Period
S = Air Space Class

METHODOLOGY

A decision was made to undertake a social and psychological analysis to assign numerical values to the **C**, **A**, **P** and **S** parameters.

A questionnaire was made with the aim in obtaining directly from the interested parties (Flight Inspection Pilots) their contribution regarding the flight inspection activity and the other factors which influence this.

During the preparation of the questionnaire, particular attention was given to the most influential elements in determining the workload and the possible overload level. These elements are: the different types of checks and the diverse operating circumstances in which the checks are carried out, like air space, aircraft class and time of day. The questionnaires were compiled anonymously by the pilots who were unaware of its purpose. The analysis involved 21 pilots, that is all the Italian flight inspection pilots, with an 85% response rate. This sample group provided a good representation of the Italian situation.

RESULTS

The survey's results were duly assessed and elaborated with the help of a team of psychologists.
Collected data was used to provide coefficients and quantitative data.

There follows a list of coefficients which we have discovered and are the most important in the equivalence calculation between the two flight time scales.

A corresponding numerical value was assigned to each factor.

1. **"C" Type of Check:** this is the first factor to be taken into account, according to the navaids type, will determine the crew operating conditions

I.	ILS, MLS	x1,8
II.	VOR, NDB, PAPI	x1,4
III.	RADAR, PROCEDURE etc.	x1,2

2. **"A" Type of Aircraft:** the type of aircraft used during the checks is important in determining the crew's workload. A small and propeller aircraft is surely less comfortable than a mid sized jet, especially during adverse weather conditions, or in high or low temperature conditions, and at the same time it provides the crew with lower technological support. Apart from often being more complex to manage.

I.	Propeller	X1,3
II.	Turbo Prop.	
	1. Small Size	X1
	2. Mid Size	X0,90
III.	Jet	X0,80

3. **"P" Period:** in those countries where night flight inspection is done, it is necessary to take this into account, as it is, by now internationally recognized that staff working night shifts have altered circadian rhythms with heavy repercussions on fatigue and therefore the workload. In addition to this, the crew who find themselves working in the dark, must be extra vigilant in order to identify and avoid obstacles in the flight path vicinity.

I.	Day	x1
II.	Night	x2

4. **"S" Air Space Class:** another very important factor is the air space class in which the flight check is carried out. As it is well known, the terminal air spaces are nowadays heavily congested and to operate within this space demands increased attention and vigilance by the crew, who must manage the checks with reference to other air traffic and to the ATC needs, with the aim in carrying out an efficient and effective flight check, without causing delays to the commercial air traffic.

I. **Class A** "Terminal Area" **:**

a. ILS

i. Night	X1
ii. Day	X1,5

b. All other Navaids

i. Night	X1
ii. Day	X1,2

II. **Class B,C,D:**

a. ILS

i. Night	X1
ii. Day	X1,3

b. All other Navaids

i. Night	X1
ii. Day	X1,1

III. **All Other Airspaces:** X0.75

Therefore the identified coefficients will be inserted in the following equation which gives the EFT as a result:

(1) **EFT = C * A * P * S**

Here are some examples of how the EFT can be used in order to convert the two time scales:

Example 1 :

FIT:	3h	
Type of check:	ILS	x1,8
Type of aircraft:	Jet	x0.80
Period:	Day	x1
Air Space:	Class A	X1,5

EFT = 1,8*0,80*1*1,5 = 2,16

GFT = 3 * 2,16 = 6,48 = 6h 28m

This means that a three hour flight inspection flight in such conditions is equivalent to a 6 hour and 28 minutes generic flight time.

Example 2 :

FIT:	3h	
Type of check:	ILS	x1,8
Type of aircraft:	Turbop. S.	x1
Period:	Day	x1
Air Space:	Class G	X0,75

EFT = 1,8*1*1*0,75 = 1,35

HG = 3 * 1,35 = 4,05 = 4h

Example 3 :

FIT:	4h	
Type of check:	VOR	x1,4
Type of aircraft:	Jet	x0,80
Period:	Day	x1
Air Space:	Class A	X1,2

EFT = 1,4*0,80*1*1,2 = 1,34

GFT = 4 * 1,34 = 5,37 = 5h 23m

Example 4 :

FIT:	4h	
Type of check:	VOR	x1,4
Type of aircraft:	Turbop. M.	x0,90
Period:	Day	x1
Air Space:	Class A	X1,2

EFT = 1,4*0,90*1*1,2 = 1,51
GFT = 4 * 1,51 = 6,05 = 6h

In our proposal, obviously there is a need to follow this way in a reverse mode. Therefore, with consideration to the regulation limits, set up for commercial flight activity, we can use the EFT to identify the specific flight time limit for the flight inspection activity.

CONCLUSIONS

During the last 10-20 years, thanks to new technology installed on modern aircraft, (CVR and FDR) the causes of aircraft accidents can now be found out in a very precise and accurate way. Investigations have shown that in 80-90% of the cases the accidents hadn't been caused by aircraft defects but by human error, even if the crew were in good health and properly certified.

High level workload and overload were looked into as possible reasons for the accidents. After years of making aircraft reliable, we now must look at man, as often he is the weakest link.

To effectively manage workload and overload, investigation has shown that there are many factors to be considered. Man's intervention on some of these factors is limited within narrow manoeuvre margins. But, there is one factor which can be widely influenced by man: the exposure time to high workload levels, that is the flight time.

Throughout the world well defined limits already exist, set by the national regulator, but in nearly all cases such limits have been set taking into consideration the airline activity. The flight inspection activity and the airline activity are very different, which makes it impossible to use the same limits.

For such a reason we have introduced Equivalent Flight Time (EFT), which is a mathematical method which makes the two timescales comparable. The EFT takes into consideration the most important factors in determining the workload levels. These factors have been identified through sociological and psychological research of all Italian flight inspection pilots and consequently have been assigned a numerical value. As a result we identified the conversion equation for the two timescales.

(1) **EFT = C * A * P * S**

(2) **FIT = GFT / EFT**

(3) **GFT = FIT * EFT**

Where:

FIT = Flight Inspection Time
GFT = Generic Flight Time
C = Type of Check
A = Type of Aircraft
P = Period
S = Air Space Class

With these we can use the limits set by law also for the flight inspection activity.

Our aim was to bring to the attention of the international flight inspection community this very important issue. We have attempted to propose a new point of view which takes into consideration the most important factors related to the flight inspection activity.

We hope that our work will be useful to the community, by stimulating constructive debate.

REFERENCES

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