TOTALIZER vs FMS CALCULATED FUEL

- **INTRODUCTION**

The FMS compares the fuel quantity onboard as determined by the fuel quantity indication system (FQIS) and by the subtraction of fuel used from performance initialization fuel (calculated fuel).

The measurement accuracy characteristics are different for these two ways of determining fuel quantity. The FQIS error gets smaller and smaller as fuel quantity decreases. At zero quantity the error is nil. For the calculated fuel it is the other way around. Fuel used is obtained by integrating fuel flow over time. Although the fuel flow transmitters are very accurate devices, even a very small error will eventually add up on long flights. Thus the calculated fuel error becomes greater the longer the flight is.

When comparing the "fuel on board" determined by these two methods it is not impossible to get a difference of 1000 -1500 kg on long flights. A difference of more than 1360 kg generates a "Fuel Disagree - Prog 2/2" or a "Fuel Quantity Error - Prog 2/2" message on the CDU.
The FMS message advises the pilot to decide for the FMS which fuel figure is the most accurate. If one system cannot be identified as being the more accurate, it must be considered prudent to use the lower of the two.

- **FUEL FOR THOUGHT**

How much fuel do I need ? How much fuel do I have ? Sophisticated computer programs and onboard systems are designed to answer those questions for us. However, when the systems present somewhat different answers, one can easily get a little confuse d. As a result we sometimes get rather unnecessary delays and operational/commercial penalties due to e.g. last minute 'just -in-case' fuel when an uncertainty pops -up. Hopefully this article can help sort out some of the confusion.

Fuel quantity indication system (FQIS)
Fuel quantity sensed by the FQIS in real time and displayed on the overhead panel. Total fuel (TOTALIZER) is also displayed on FMS Progress 2/2 page. The accuracy of the system increases when fuel volume decreases. The error is nil at zero quantity.

FMS calculated fuel
Fuel quantity calculated by the FMS. This figure is normally obtained by subtracting fuel used from initial total fuel on FMS PERF INIT page. The FMS then predicts fuel at coming waypoints and destination based on pre sent fuel and FMS fuel flow factor. The accuracy of the calculated fuel figure decreases with flight time due to tolerances in the fuel flow data.

Fuel used

Fuel used is the accumulated sum of fuel flow. Fuel flow transmitters, while accurate within specification, can be expected to have a small measurement error which adds up over time.

Fuel flow differences

Engine performance deteriorates over time and therefore more and more fuel is needed to generate a specific thrust. If the deterioration is equ al for both engines, then the increased fuel flow is "invisible" to the pilot. More typical is that one engine is slightly better or worse than the other. Differences of 100-150 kg/hr are considered acceptable. It is not guaranteed that a newly installe d engine will be better than the one it replaced or better than the other engine. A spare engine is not always a zero-time engine.

Fuel flow or fuel used differences between the engines do not say anything about the total fuel burn performance of the aircraft. It is possible to have a difference between two engines that are both 'good" compared to fleet average. Naturally one should be observant on rapid changes in fuel flow for any engine.

Special JET PLAN fuel factor

Many B767 operators use a speci fic program which contains *a fuel factor* for each individual aircraft registration. This fuel factor reflects the actually observed average fuel burn performance for the aircraft/engine installation over a period of time as compared to the baseline performance. The fuel factor is routinely updated several times per year, and otherwise when required e.g. in connection with engine changes.

This "fuel factor" ensures that total flight plan fue l requirements are as correct as possible for the actual performance of a particular aircraft. The fuel factor varies generally from approximately +2.0% to +6.0% depending on aircraft.

FMS fuel flow factor

The FMS fuel flow (F-F) factor is displayed on IDENT page. The F-F factor is used to adjust the basic 767 FMS performance calculations to the aircraft/engine installation's actual fuel burn performance. If the F-F factor is changed, the trip fuel as *predicted* by the FMS will increase or decrease. Th e F-F factor does not in any way affect the *actual* fuel burn of the aircraft.

FMS drag factor.

The FMS drag factor is used to adjust the basic 767 FMS performance calculations for the actual airframe drag.

FMS cost index

The cost index tells the FMS how to prioritize between the cost of fuel and time -related operating costs. Maximum range speed (maximum fuel mileage) is obtained at ECON CRZ cost index 0.

- **CONCLUSIONS**

Fuel-on-board information is provided by the FQIS and calculated fuel data. Differences up to 1000-1500 kg on 10 -12 h flights are possible as a result of the different measurement methods. The FMS uses the calculated fuel figure for its calculations and predictions unless instructed otherwise by the pilot. Which figure is the mo st correct ? Too many factors are involved to give a general answer to that question. Base your decisions on the lower figure unless you have information to support a higher figure.

Total fuel requirements for a flight are provided at the planning stag e using computed average fuel burn data. The FMS predicts fuel at enroute waypoints and destination based on gross weight and present calculated fuel. It may differ from the JETPLAN due to different performance programs, weather data, reroutings etc.

Fuel flow and fuel used differences between the engines have no meaning on total fuel requirements for a flight. Only the total fuel burn is taken into account…